Mt Arthur Coal

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Open Cut Modification (EPBC 2014 / 7377)

Preliminary Documentation
Main Report and Attachments A – E

MT ARTHUR COAL MINE

OPEN CUT MODIFICATION (EPBC 2014/7377)
PRELIMINARY DOCUMENTATION

PREPARED BY
HUNTER VALLEY ENERGY COAL PTY LTD

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Executive Summary

EXECUTIVE SUMMARY

Hunter Valley Energy Coal Pty Ltd (HVEC), a wholly-owned subsidiary of BHP Billiton, owns and operates the Mt Arthur Coal Mine located approximately 5 kilometres south-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW). This document relates to aspects of the Mt Arthur Coal Open Cut Modification (Modification) (incorporating the Action) approved under the NSW *Environmental Planning and Assessment Act 1979* by the NSW Planning Assessment Commission on 26 September 2014. The Modification enables continuation of open cut mining operations for an additional operational life of four years from 2022 to 2026, an increase in the open cut disturbance areas, the use of the conveyor corridor for overburden emplacement and the duplication of the existing rail loop.

The Action is separate from, but related to, the existing Mt Arthur Coal Mine. Portions of the existing Mt Arthur Coal Mine were approved in 2012 by a separate action (Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act] [2011/5866]). It is noted that only the additional surface disturbance areas that form part of the Modification and that have not been previously subjected to Federal approval, constitute this Action.

On the 4 November 2014, HVEC lodged a referral under the EPBC Act for the Action with the Department of the Environment (DotE). Following lodgement of the referral, a delegate of the Commonwealth Minister declared the Action to be a controlled action due to potential impacts on listed threatened species and communities. The level of assessment under the EPBC Act was set at preliminary documentation and an information request was sent to HVEC on the 31 March 2015.

The purpose of this document is to provide the information requested by DotE to enable their assessment of the Action. This document provides further information on a number of Matters of National Environmental Significance (MNES) relevant to the Action, specifically listed threatened species and communities, including the:

- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community (Box-Gum Woodland CEEC);
- Regent Honeyeater (*Anthochaera phrygia);*
- Swift Parrot (*Lathamus discolor);*
- Grey-headed Flying-fox (*Pteropus poliocephalus*); and
- Spot-tailed Quoll *(Dasyurus maculatus maculatus*) (south-east mainland population).

This document also provides further information on the relevance of a leek-orchid (*Prasophyllum* sp. Wybong [C. Phelps ORG 5269]), the Pouched Greenhood (*Pterostylis gibbosa*), the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*) to the Action.

The vegetation and habitat within the Action area has been subject to historical clearing and thinning such that woodland/forest occurs in patches surrounded by cleared land and derived native grassland. The land within the Action area is used for limited periodic grazing activities. In the context of the overall Mt Arthur Coal Mine, the Action would result in the loss of 228.9 hectares (ha) of native vegetation, which is approximately 4 percent of the already active and approved mine.

There are semi-cleared patches of woodland in the Action area that comprises trees which are a hybrid between White Box (*Eucalyptus albens*) and Grey Box (*Eucalyptus moluccana*) with surrounding derived native grassland. For the previous Referral that was determined in 2012, HVEC held the view that for the Box-Gum Woodland CEEC listed under the EPBC Act, by not specifically including hybrids in the community description (as happens in some more recent determinations), does not allow for the inclusion of hybrids (i.e. hybrids are not part of the Box-Gum Woodland CEEC). Therefore, hybrids or integrates should not be considered in determining whether a particular overstorey may be part of the Box-Gum Woodland. Despite this view, if hybrids are conservatively assumed to be part of the Box-Gum Woodland CEEC, a total of approximately 58.4 ha of the community was recorded within the Action area (approximately 23.2 ha of woodland and approximately 35.2 ha of surrounding derived native grassland). Of 28 box specimens sent for identification by the National Herbarium of NSW from areas adjoining the Action (which incorporates the Action area), 27 were determined to be hybrids (*E. albens* x *E. moluccana*).

The Grey-headed Flying-fox is the only threatened fauna species listed under the EPBC Act that has been recorded within the Action area. This species was recorded foraging and there are no roost camps in or near the Action area. Two other threatened fauna species, the Large-eared Pied Bat and the Spot-tailed Quoll, have been recorded in the general locality surrounding the Action area. While these species have not been recorded within the Action area, it is possible that both could use the patches of woodland habitat in the Action area and surrounding area. The Regent Honeyeater, Swift Parrot and South-eastern Long-eared Bat have not been recorded in the general locality of the Action area and although substantial survey effort has been undertaken within the Action area, these species have not been recorded. It is noted that Hunter Eco (2012) consider the South-eastern Long-eared Bat is unlikely to occur. However, given that potential habitat occurs, for the purposes of this impact assessment, HVEC has conservatively assumed that these species are present. Notwithstanding this, and in consideration of the substantial survey efforts undertaken, it is clear that if these species are present, they would be in low densities and therefore there is no evidence of an important population. As such, in the absence of an important population, significant impacts are not possible.

Although the scale of the impacts associated with this Action is small relative to the species habitat which is likely to occur throughout the region surrounding the Action area, a number of measures are proposed to mitigate potential impacts on relevant MNES (e.g. clearance limits and rehabilitation of post-mine landforms with vegetation typical of the surrounding area).

In addition to the mitigation measures, HVEC has an existing offset package which compensates for residual impacts to the Box-Gum Woodland CEEC and Grey-headed Flying-fox as well as potentially occurring threatened species. The existing offset was reviewed by the NSW Office of Environment and Heritage and approved by the NSW Planning Assessment Commission following recommendation by the Secretary of the Department of Planning & Environment (DP&E).

There are two offset areas (totalling 540.7 ha) that are proposed to address impacts on MNES associated with this Action. These comprise:

- a 131 ha expansion of the existing Saddlers Creek Conservation area; and
- a 410 ha expansion of the existing Middle Deep Creek Offset area.

Table ES-1 provides a summary of the proposed habitat disturbance and offset for relevant MNES. The offset areas for the relevant MNES are substantially greater than the existing habitat in the disturbance area (Table ES-1).

Table ES-1
Summary of Disturbance and Offset for Relevant Matters of National Environmental Significance

	Habitat Disturbance (ha)			Habitat Offset (ha)		
	Woodland	**Grassland**	**Total**	**Woodland**	**Grassland**	**Total**
Box-Gum Woodland CEEC	23.2	35.2	**58.4**	108.2	427	**535.2**
Threatened Species: • Regent Honeyeater; • Swift Parrot; • Grey-headed Flying-fox; • Large-eared Pied Bat; and • South-eastern Long-eared Bat.	53.4	N/A*	**53.4**	113.7	427*	**540.7**
Threatened Species: • Spot-tailed Quoll.	53.4	173	**226.4**	113.7	427	**540.7**

* The derived grassland in the disturbance area is not considered habitat for these species. However, the derived grassland in the offset areas will be managed to encourage natural regeneration of woodland/forest providing a net gain in habitat for these species.

The offset areas will be managed for conservation, secured in perpetuity and a conservation bond will be lodged with DP&E to guarantee the management of the offset areas.

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Section 1 – Introduction

1 INTRODUCTION

1.1 BACKGROUND

The purpose of this document is to provide further information to the Department of the Environment (DotE) regarding aspects of the Mt Arthur Coal Open Cut Modification (the Action) to enable assessment and approval of the Action under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

The Action is separate from, but related to, the existing Mt Arthur Coal Mine. Portions of the existing Mt Arthur Coal Mine were approved in 2012 by a separate action (EPBC Act [2011/5866]). The existing Mt Arthur Coal Mine is a large, open cut operation which is approved to extract up to 32 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the open cut and up to 36 Mtpa from combined open cut and underground operation. It is noted that only the additional surface disturbance areas that form part of the Modification and that have not been previously subjected to Federal approval, are considered a component of the Action.

On the 4 November 2014, Hunter Valley Energy Coal Pty Ltd (HVEC), a wholly-owned subsidiary of BHP Billiton, lodged a referral for the Action (HVEC, 2015a) (Attachment D) with the DotE to determine whether the proposed action needed formal assessment and approval under the EPBC Act. An action requires approval under the EPBC Act if the action is likely to have a significant impact on Matters of National Environmental Significance (MNES).

On 27 January 2015, a delegate of the Commonwealth Minister declared the Action to be a controlled action for the purposes of the EPBC Act due to likely impacts on listed threatened species and communities (sections 18 and 18A) which is a controlling provision under Part 3 of the EPBC Act. The delegate of the Commonwealth Minister also determined that the Action is to be assessed by preliminary documentation and further information was requested on 31 March 2015 pursuant to section 95(A) of the EPBC Act. A copy of the request for preliminary documentation is provided in Attachment A.

The Preliminary Documentation was displayed for public comment from 14 April 2016 to 6 May 2016. During this period, no public comments were received on the document. In accordance with Section 95B(3) of the EPBC Act, HVEC notified the DotE to advise no public comments were received (Attachment E).

A modification (incorporating the Action area) to the existing Project Approval for the Mt Arthur Coal Mine (Project Approval 09_0062) under the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* was approved by the Planning Assessment Commission on 26 September 2014.

This document is structured as follows:

Section 1 Provides a summary of the proposed action and assessment requirements.

Section 2 Provides the further information that was requested in regard to the existing environment.

Section 3 Details the further information that was requested in regard to the relevant impacts.

Section 4 Provides the further information that was requested in regard to the proposed avoidance, safeguards and mitigation measures.

Section 5 Provides the further information that was requested in regard to the offset.

Section 6 Lists the references cited in this document.

Attachments to the main text are also provided as follows:

Attachment A	Request for Preliminary Documentation
Attachment B	Letter from Dr Colin Driscoll (Hunter Eco)
Attachment C	Mt Arthur Coal Open Cut Modification Ecological Assessment (Hunter Eco)
Attachment D	EPBC Referral for the Mt Arthur Coal Open Cut Modification
Attachment E	Letter Confirming No Public Comments Received on Preliminary Documentation

1.2 SUMMARY OF PROPOSED ACTION

The Mt Arthur Coal Mine is located approximately 5 kilometres (km) south-west of Muswellbrook within the Muswellbrook Shire Local Government Area in the Upper Hunter Valley of NSW (Figures 1 and 2). The Action is limited to the continuation of open cut mining operations at the Mt Arthur Coal Mine for an additional operational life of four years from 2022 to 2026, an increase in the open cut disturbance areas, the use of the conveyor corridor for overburden emplacement and the duplication of the existing rail loop (Figure 3).

The Action will also use existing infrastructure associated with the previously approved mining activities at the Mt Arthur Coal Mine including the existing coal handling and preparation plant, rail loop and spur, access roads, workshops, administration areas and water storages, retention basins and associated water management structures.

The Action is separate from, but related to, the existing Mt Arthur Coal Mine. Portions of the existing Mt Arthur Coal Mine were approved in 2012 by a separate action (EPBC Act [2011/5866]). It is noted that only the additional surface disturbance areas that form part of the Modification and that have not been previously subjected to Federal approval constitute this Action. The additional surface disturbance areas associated with the Action are shown on Figure 3. All other aspects of the operations at the Mt Arthur Coal Mine, including the mining tenements, the annual open cut ROM coal production rate, the coal processing rate, employment levels and hours of operations would remain generally consistent with that currently approved under the EPBC Act (2011/5866). Various aspects of the surface disturbance area that forms part of the Modification have already been approved as active operational areas under the EPBC Act approval (2011/5866) and for this reason these areas do not constitute part of the Action which is the subject of this document.

In the context of the overall Mt Arthur Coal Mine, the Action would result in the loss of 228.9 hectares (ha) of native vegetation, which is approximately 4 percent (%) of the already active and approved mine.

A detailed description of the Action is provided in the EPBC Act (2014/7377) referral (Attachment D).

1.3 ASSESSMENT REQUIREMENTS

Table 1 provides the assessment requirements provided by the DotE (31 March 2015) (Attachment A) and the corresponding section in document where the information is provided.

HVE-11-01 OCM EPBC PD_001A

PRELIMINARY DOCUMENTATION

FIGURE 2

Mt Arthur Coal Mine Location

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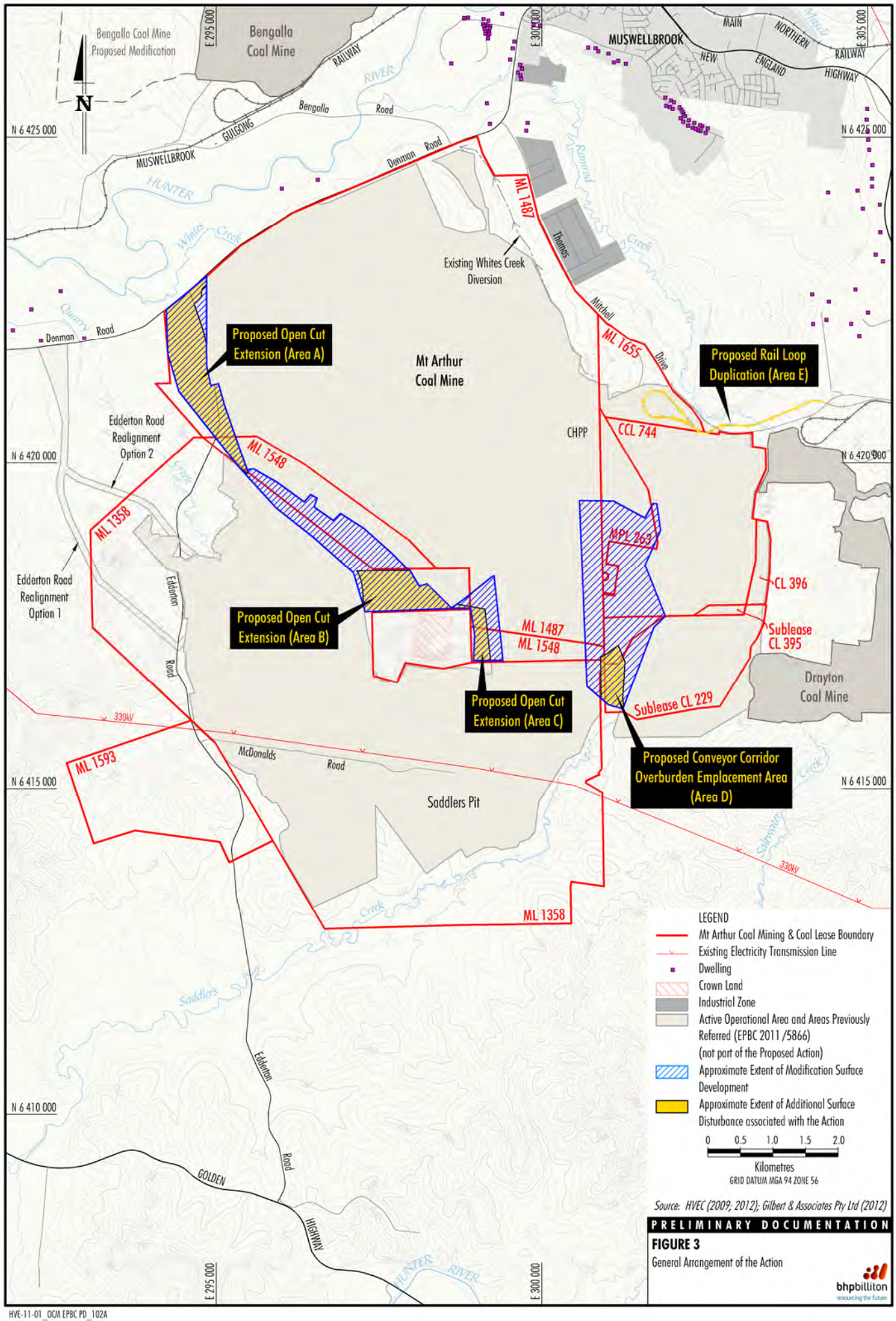
HVE-11-01_OCM EPBC PD_101A



Source: HVEC (2009; 2012); Gilbert & Associates Pty Ltd (2012)

PRELIMINARY DOCUMENTATION

FIGURE 3

General Arrangement of the Action

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HVE-11-01_OCM EPBC PD_102A

Table 1
Commonwealth Assessment Requirements

Assessment Requirements	Section
Description of the Existing Environment	
A. The Department notes that habitat is present onsite and in the surrounding area for the leek-orchid, Pouched Greenhood, Large-eared Pied Bat and South-eastern Long-eared Bat. From the information provided to date, the Department considers that surveys conducted have not been undertaken at the optimum time for detection of these species. *Please note that, unless it can be demonstrated that surveys have been undertaken in accordance with best practice survey techniques, additional targeted field surveys are required to be undertaken. In the case of the bat species, further surveys are not necessary if it is assumed that both species occur.* *Please provide the following:* *1. the survey effort, methodology and results of surveys that are timed appropriately and undertaken for a suitable period of time by a qualified person and use accepted methodology for targeting each species in their respective habitat* • *Surveys should be conducted as per the threatened orchid survey guidelines available at: http://www.environment.gov.au/resource/draft-survey-guidelines-australias-threatened-orchids and the survey guidelines for Australia's threatened bats available at: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-bats-guidelines-detecting-bats-listed-threatened.* *2. a description of the distribution and abundance of these species, including, but not limited to, the estimated size, density and location of occurrences on-site and in the region* *3. a quantification and description of the extent of suitable habitat on-site and in the region (including whether the habitat is critical to the survival of the species), and* *4. maps displaying the above information (points 1, 2 & 3) overlaid with the proposed action.*	Section 2, Attachment B
Relevant Impacts	
A. The Department requires additional information to determine the direct and indirect impacts to protected matters onsite. For each protected matter likely to be impacted by the proposed action, please provide a description of all of the direct and indirect impacts that the action will have, or is likely to have. Impacts to habitat both onsite and within adjacent land should be considered. Please include:	
1. a detailed assessment of the nature and extent of the likely relevant impacts, quantifying the total amount of suitable habitat (in hectares) expected to be impacted by the proposed action	Section 3, Table 3
2. an analysis of the scale of the impacts relative to the local and regional occurrences of the threatened species surrounding the site	Section 3
3. an account of the impact to habitat and/or habitat connectivity/corridors	Section 3.1
4. indirect impacts, including edge effects, spread of weeds, erosion and sedimentation, and their likely extent.	Section 3
B. Should the leek-orchid, Pouched Greenhood, Large-eared Pied Bat or South- eastern Long-eared Bat be found during additional surveys, or assumed present, they must be included in the description at 2A	Section 2
Proposed Avoidance, Safeguards and Mitigation Measures	
A. Please provide a consolidated list of avoidance and mitigation measures that will be undertaken to prevent or minimise potential direct and indirect impacts (refer to section on relevant impacts) to the protected matters, including:	
1. a description of the proposed avoidance and mitigation measures, including for each measure, the environmental objectives, performance criteria, monitoring, reporting (by whom, to whom, how often), corrective actions (including thresholds for actions), responsibility and timing for proposed mitigation measures	Section 4, Table 6
2. an assessment of the expected or predicted effectiveness of the mitigation measures in reducing impacts on each particular matter of NES, including supporting evidence	Section 4, Table 5
3. any statutory or policy basis for the mitigation measures	Section 4, Table 5
4. the cost of the mitigation measures, including how measures will be funded in perpetuity (and by whom)	Section 4
B. Should the leek-orchid, Pouched Greenhood, Large-eared Pied Bat or South-eastern Long-eared Bat be found during additional surveys, or assumed present, they must be included in the list at 3A.	Section 4

Table 1 (Continued)
Commonwealth Assessment Requirements

Assessment Requirements	Section
Offsets	
In the event that there are significant impacts that cannot be avoided or mitigated, a description of any offsets to compensate for any predicted or potential residual impacts on threatened species and ecological communities must be provided for each protected matter. *Where a project demonstrates compliance with an endorsed state or territory policy, the EPBC Act Offsets Policy and Guide will not need to be separately considered by the Minister or his delegate. Endorsed Policies are outlined in the draft "Environment Protection and Biodiversity Conservation Act 1999-Assessment Bilateral Agreement Conditions Policy", February 2015. The EPBC Act Offsets Policy will continue to apply where the project does not fully comply with the endorsed state or territory policy. Please provide information to demonstrate compliance with an endorsed state policy or provide the information as described at **Addendum A** to meet the EPBC Act Offsets Policy.* *The Department considers that an offset package is required to compensate for the residual impacts to White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, the Grey-headed Flying-fox, Regent Honeyeater, Swift Parrot and Spot-tailed Quoll as a result of the proposed action.* *A. Please provide an offset package for these protected matters; and* *B. Should the leek-orchid, Pouched Greenhood, Large-eared Pied Bat or South-eastern Long-eared Bat be found during additional surveys or assumed present, and impacts to these species are determined to be significant, offsets must be provided.*	Section 5

Source: Attachment A.

Mt Arthur Coal

Section 2 – Description of the Existing Environment

2 DESCRIPTION OF THE EXISTING ENVIRONMENT

This section provides the further information that was requested in regard to the existing environment. In the request for the preliminary documentation (Table 1 and Attachment A), DotE requested further information about surveys undertaken for the following four species:

- a leek-orchid (*Prasophyllum* sp. Wybong [C. Phelps ORG 5269]);
- Pouched Greenhood (*Pterostylis gibbosa*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*); and
- South-eastern Long-eared Bat (*Nyctophilus corbeni*).

This additional information is provided in the following subsections.

2.1 ORCHID TARGETED SURVEYS

Dr Colin Driscoll (Hunter Eco) undertook a targeted survey for the leek-orchid and the Pouched Greenhood in accordance with best practice survey techniques. A letter from Dr Driscoll is provided in Attachment B outlining that a targeted survey was undertaken on 19 September 2012 at the optimum time for detection of these two orchids (i.e. Spring [the leek-orchid] and August/September [Pouched Greenhood]) and is in accordance with the DotE *Draft Survey Guidelines for Australia's Threatened Orchids* (DotE, 2013a). Dr Driscoll explains that he checked that orchids were flowering elsewhere in the region before conducting the survey (including discussions with fellow ecologist Dr Stephen Bell) and conducted replicated sampling within and outside of the Action area so there is a high confidence that the leek-orchid and the Pouched Greenhood do not occur in the Action area. No further surveys or assessment of these orchid species is warranted (e.g. it is not relevant to quantify or map habitat for these species as they are demonstrated absent by the survey [which included replicated sampling]).

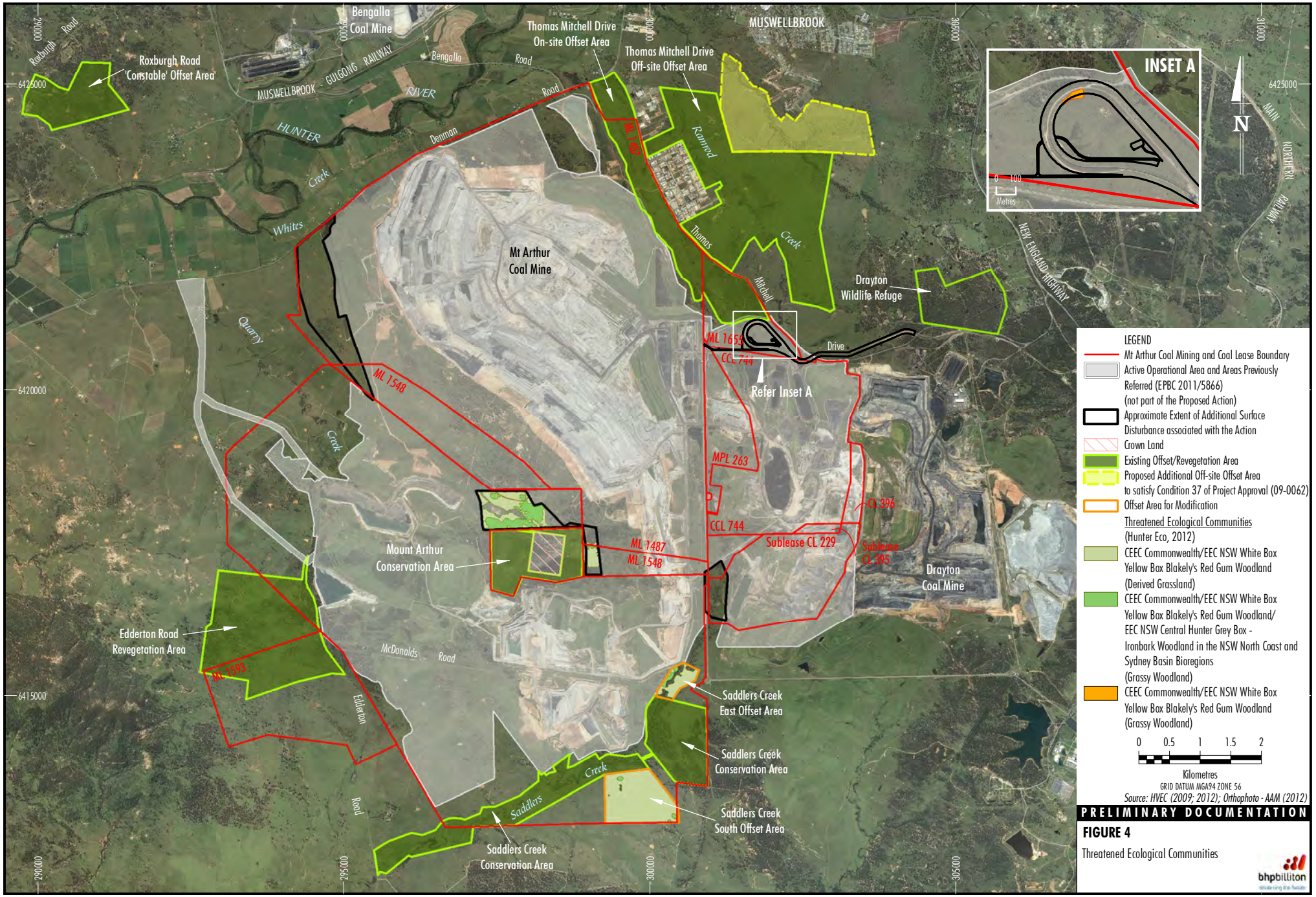
2.2 BAT TARGETED SURVEYS

Large-eared Pied Bat

Substantial bat surveys have been undertaken to enable the potential impacts on the Large-eared Pied Bat to be assessed and conclude that it is unlikely that this vulnerable bat species would be significantly impacted by the Action. No further bat surveys are proposed as part of the impact assessment.

It is assumed that the Large-eared Pied Bat could forage in the Action area given the presence of potential foraging habitat (woodland) (Figure 4) and nearby records (Figure 5). This species forages in dry sclerophyll forests and woodlands, but also occurs in sub-alpine woodland, the edges of rainforest, wet sclerophyll forest, *Callitris* spp. dominated forests and sandstone outcrop country (Queensland Department of Environment and Resource Management [DERM], 2011; Churchill, 2008).

Bat fauna of the Action area and surrounds have been comprehensively surveyed at the Mt Arthur Coal Mine over the past 16 years by qualified ecologists (Table 2). The surveys listed in Table 2 were all conducted within the optimum survey timing for the Large-eared Pied Bat [i.e. between October and March] according to the non-mandatory requirements in the *Survey Guidelines for Australia's Threatened Bats* (Department of the Environment, Water, Heritage and the Arts [DEWHA], 2010). The Large-eared Pied Bat has not been recorded in the Action area during surveys, but was recorded by Cumberland Ecology on the edge of the Action area in 2009 (Figure 5), approximately 6 km away at Muswellbrook in 2003 (Office of Environment and Heritage [OEH], 2015a) and by Umwelt to the north of the Action area at Macleans Hill in 2007 (Umwelt, 2007a).



PRELIMINARY DOCUMENTATION

FIGURE 4

Threatened Ecological Communities

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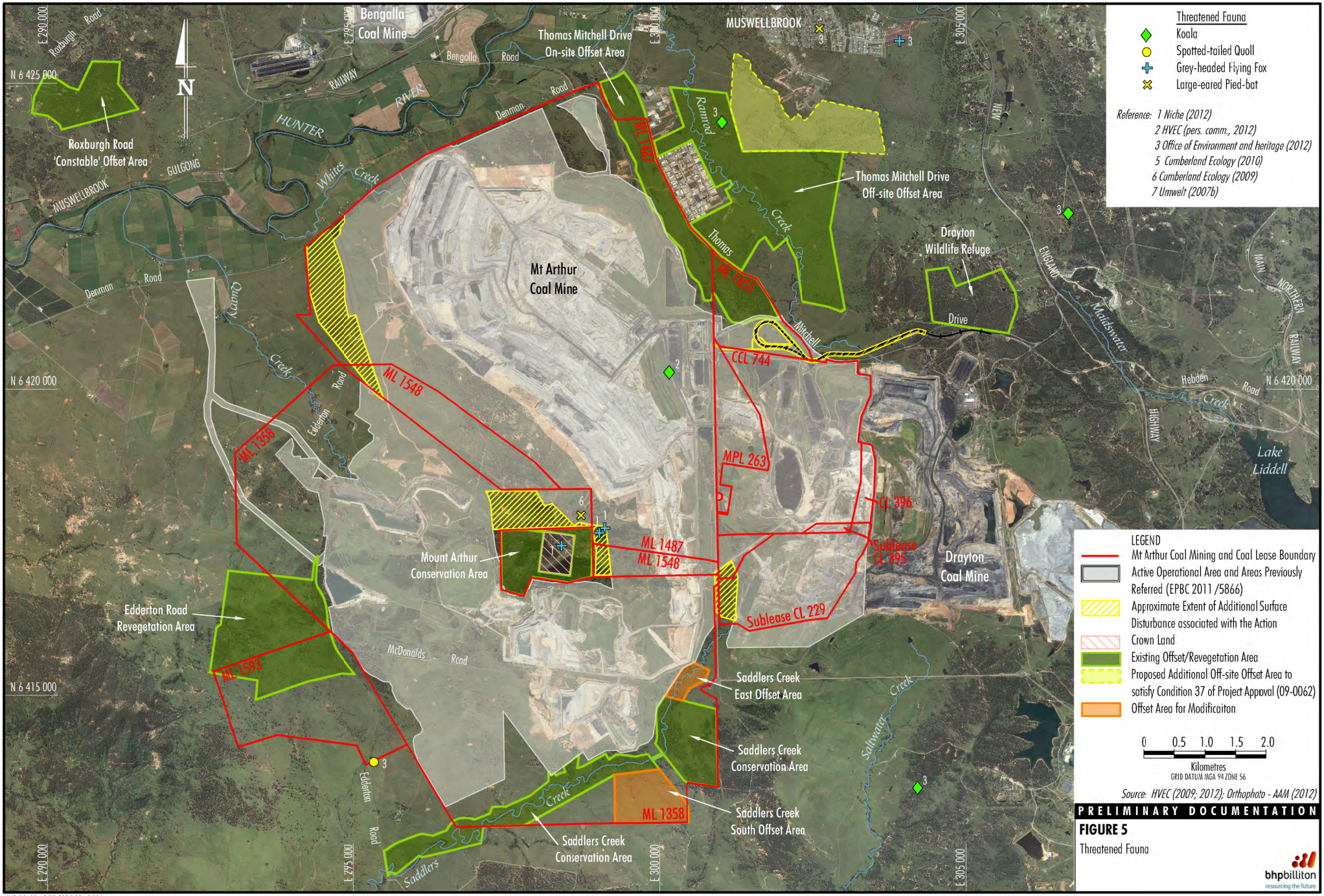
HVE-11-01_OCM EPBC PD_211C



HVE-11-01_OCM EPBC PD_103A

Table 2
Bat Studies Undertaken within the Action Area and Surrounds between the Months of October and March Since 1998

Author	Report Title	Survey Timing	Survey Methods and Effort
Dames and Moore (2000)	Mt Arthur North Coal Project Flora and Fauna Report	14-21 November 1998	• Bat detector to record bat calls (53 hours). • Harp traps (five nights).
Umwelt (2005)	2004 Ecological Monitoring Report	4-15 December 2004; 20-22 December 2004	• Anabat surveys (15 hours).
Umwelt (2006a)	Mt Arthur Coal Underground Project Preliminary Environmental Assessment	21-25 February 2005	• Anabat II echolocation recording (3 nights and 1.5 hours [walking transects]). • Harp traps (six nights).
Umwelt (2006b)	2005 Ecological Monitoring Report	December 2005	• Echolocation recording (10 hours). • Anabat stagwatching.
Umwelt (2007b)	2006 Ecological Monitoring Report	December 2006	• Anabat echolocation recording (6 nights).
Umwelt (2007c)	Ecological Assessment Proposed Mt Arthur Underground Project	7-11 March 2005; 5-7 December 2005	• Echolocation recording (10 hours). • Anabat stagwatching.
Cumberland Ecology (2009)	Mt Arthur Coal 2008 Flora and Fauna Monitoring Program Ecological Monitoring Report	19-23 January 2009	• Anabat surveys (using an Anabat SD1 unit) during nocturnal spotlighting surveys (4 hours).
Cumberland Ecology (2010)	Mt Arthur Coal 2009 Flora and Fauna Monitoring Program Ecological Monitoring Report	19-22 January 2010; 27-29 January 2010	• Anabat surveys (using an Anabat SD1 unit) during nocturnal spotlighting surveys (10 hours).
Umwelt (2012)	2012 Annual Biodiversity Monitoring Report	3-5 December 2012	• Anabat surveys (using an Anabat SD2 unit) during nocturnal spotlighting surveys (20 hours).
Umwelt (2013a)	2013 Annual Biodiversity Monitoring Report	2-4 December 2013; 12 December 2013	• Anabat surveys (using an Anabat SD2 unit) during nocturnal spotlighting surveys (1 hour).
Umwelt (2015)	2014/2015 Financial Year Ecological Development Monitoring Report	16-20 February; 2-4 March 2015	• Anabat surveys (using an Anabat SD2 unit) (9 nights).

No breeding habitat for this species occurs in the Action area. The Large-eared Pied Bat roosts in caves, crevices in cliffs and mines and abandoned, disused mud nests of Fairy Martins (DERM, 2011; Churchill, 2008; Van Dyck and Strahan, 2008). However, in the request for preliminary documentation (Table 1 and Attachment A), the DotE indicates that further surveys for the Large-eared Pied Bat are required unless it is assumed that the Large-eared Pied Bat occurs in the Action area. There are no records of this species within the Action Area, despite extensive survey effort, and no breeding habitat for this species has been mapped within the Action Area. In consideration of the substantial survey efforts undertaken, if this species is present, it would be foraging in low densities and therefore there is no evidence of an important population. This is evidenced by the 11 bat surveys undertaken within the Action Area and surrounds between October and March (Table 2) and the targeted survey undertaken for the Action by Niche (2012) from 1 May 2012 (i.e. one day outside of the non-mandatory optimum survey timing listed in the Survey Guidelines for Australia's Threatened Bats [DEWHA, 2010]). As such, in the absence of an important population, significant impacts are unlikely.

Notwithstanding this, an assessment is provided in Section 3.7 which conservatively assumes that the Large-eared Pied Bat potentially forages in the Action area.

Consistent with the *EPBC Act Significant Impact Guidelines* criteria, it is unlikely that this 'Vulnerable' bat species would be significantly impacted by the Action (after DotE, 2013b), because the Action removes potential foraging habitat which is common in the surrounding landscape and the Action is unlikely to:

- lead to a long-term decrease in the size of an important population of a species (because there is no evidence of an important population);
- reduce the area of occupancy of the species;
- adversely disrupt the breeding cycle or lead to a long-term decrease in the size of a population because no roosting habitat would be disturbed as part of the Action;
- adversely affect habitat critical to the survival of a species, due to the absence of the following in the Action area or immediate surrounds:
    - Known roosting sites.
    - Known features such as caves, crevices in cliffs and mines and abandoned, disused mud nests of Fairy Martins.
- fragment an existing important population into two or more populations (because there is no evidence of an important population);
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

Notwithstanding the above, the offset areas provide for the conservation and management of 113.7 ha of foraging and roosting habitat resources for the Large-eared Pied Bat and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5). While an EPBC Act offset is not required for this species due to there being no residual significant impact, in accordance with the DotE request for further information and in line with NSW approvals, HVEC has provided an appropriate offset for the Action which would deliver positive benefits, including long-term protection and management of habitat for the Large-eared Pied Bat.

South-eastern Long-eared Bat

Substantial bat surveys have been undertaken to enable the potential impacts on the South-eastern Long-eared Bat to be assessed and these surveys conclude that it is unlikely that this vulnerable bat species would be significantly impacted by the Action. No further bat surveys are proposed as part of the impact assessment, however, the existing pre-clearance surveys would be reviewed and revised where practicable to ensure potential impacts to bats are minimised during clearing activities.

Bat fauna within the Action area and surrounds have been comprehensively surveyed at the Mt Arthur Coal Mine over the past 16 years by qualified ecologists (Table 2). Given the wide ranging nature of the South-eastern Long-eared Bat, if this species roosts or forages in the Action area, then it is conceivable that the South-eastern Long-eared Bat would have been detected by these surrounding studies, yet it has not been previously recorded at the Mt Arthur Coal Mine.

In addition to the studies listed in Table 2, Niche Environment and Heritage (Niche) (2012) (Appendix 1 of Attachment C) undertook bat surveys in the Action areas from the 1 May 2014 (one day outside the optimum survey timing for the South-eastern Long-eared Bat [i.e. between October and April] according to the non-mandatory requirements in the *Survey Guidelines for Australia's Threatened Bats* (DEWHA, 2010). Niche (2012) (Appendix 1 of Attachment C) deployed three Wildlife Acoustics SM2 Bat detector units at six sites over ten days along identified potential flyways in the Action area (total 30 trap nights). The night-time temperature ranged from 4 to 13^{o}C. Niche (2012) (Appendix 1 of Attachment C) recorded a total of 11 bat species during the surveys and it is conceivable that the South-eastern Long-eared Bat would have been detected if present.

Based on the previous survey work, it is unlikely that the South-eastern Long-eared Bat is present in the Action area (Attachment C). However, in the request for preliminary documentation (Table 1 and Attachment A), DotE states that further surveys for the South-eastern Long-eared Bat are not necessary if it is assumed that the South-eastern Long-eared Bat occurs in the Action area. There are no records of this species within the Action Area, despite extensive survey effort. The closest record of the South-eastern Long-eared Bat is approximately 4 km south of the Action (OEH, 2015a). In consideration of the substantial survey efforts undertaken, if this species is present, it would be in low densities and therefore there is no evidence of an important population. This is evidenced by the 11 bat surveys undertaken within the Action Area and surrounds between October and March (Table 2) and the targeted survey undertaken for the Action by Niche (2012) from 1 May 2012 (i.e. one day outside of the non-mandatory optimum survey timing listed in the Survey Guidelines for Australia's Threatened Bats [DEWHA, 2010]). According to the DotE's SPRAT database, the species has been primarily recorded *in moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses* and these habitat features are absent from the Action area. As such, in the absence of an important population, significant impacts are not possible. It is noted that Hunter Eco (2012) consider the South-eastern Long-eared Bat is unlikely to occur. Notwithstanding, an assessment is provided in Section 3.8, conservatively assuming that the South-eastern Long-eared Bat potentially roosts or forages in the Action area.

The woodland/forest vegetation types in the Action area could provide potential habitat for the South-eastern Long-eared Bat (Figure 6). Approximately 53.4 ha of foraging and roosting habitat resources may be removed/modified. Consistent with the *EPBC Act Significant Impact Guidelines* criteria, this small loss of habitat is not expected to significantly affect this 'Vulnerable' species (after DotE, 2013b), because the Action removes potential foraging habitat which is common in the surrounding landscape and the Action is unlikely to:

- lead to a long-term decrease in the size of an important population of a species (because there is no evidence of an important population);
- reduce the area of occupancy of the species;
- adversely disrupt the breeding cycle or lead to a long-term decrease in the size of a population because no roosting habitat would be disturbed as part of the Action;
- adversely affect habitat critical to the survival of a species because habitat such *moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses* is absent from the Action area;
- fragment an existing important population into two or more populations (because there is no evidence of an important population);
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

Notwithstanding the above, the offset areas provide for the conservation and management of 113.7 ha of potential foraging and roosting habitat resources for the South-eastern Long-eared Bat and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5). In addition, Umwelt (2013b) recorded a confident record of an *Nyctophilus* sp. (unidentified long-eared bat) using Anabat detector survey methods (with expert analysis of recordings), which indicates that the species may be present in the offset. While an EPBC Act offset is not required for this species due to there being no residual significant impact, in accordance with the DotE request for further information and in line with NSW approvals, HVEC has provided an appropriate offset for the Action which would deliver positive benefits, including long-term protection and management of habitat for the South-eastern Long-eared Bat.

PRELIMINARY DOCUMENTATION

FIGURE 6

Vegetation Communities

bhpbilliton

HVE-11-01_OCM EPBC PD_212A

Mt Arthur Coal

bhpbilliton
resourcing the future

Section 3 – Nature and Extent of the Likely Relevant Impacts

3 NATURE AND EXTENT OF THE LIKELY RELEVANT IMPACTS

3.1 OVERVIEW

This section provides the further information that was requested in regard to the relevant direct and indirect impacts of the Action on the MNES relevant to the Action, specifically listed threatened species and communities, including the following:

- *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Box-Gum Woodland) Critically Endangered Ecological Community (CEEC);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Spot-tailed Quoll (*Dasyurus maculatus maculatus*) (south-east mainland population);
- Large-eared Pied Bat (*Chalinolobus dwyeri*); and
- South-eastern Long-eared Bat (*Nyctophilus corbeni*).

The Grey-headed Flying-fox is the only threatened fauna species listed under the EPBC Act that has been recorded within the Action area (Niche, 2012; Appendix 1 of Attachment C) (Figure 5). The Large-eared Pied Bat and the Spot-tailed Quoll have been recorded in the general locality surrounding the Action area (Figure 5). The Regent Honeyeater, Swift Parrot and South-eastern Long-eared Bat have not been recorded in the general locality surrounding the Action area.

The assessments provided in Sections 3.2 to 3.8 were conducted in with consideration of the information provided in Attachment C and the *EPBC Act Significant Impact Guidelines* criteria, including criteria regarding important populations.

The DotE's SPRAT database profile for the Large-eared Pied Bat describes that important populations of this species include those present in sandstone escarpments of the Sydney Basin. The Action is not within sandstone escarpments. Therefore, should a population exist in the locality of the Action, it would not constitute an important population.

Important populations for the Grey-headed Flying-fox and South-eastern Long-eared Bat are not identified in the relevant document listed:

- species-specific Recovery Plans (including draft recovery plans if a plan has not yet been finalised);
- Conservation Advice;
- Listing Advice; or
- other information contained within the DotE's SPRAT database.

HVEC is not aware of any other relevant published studies that define important populations for these species.

Habitat Clearance

Table 3 provides a summary of the vegetation clearance required for the Action and the corresponding habitat for relevant MNES. Vegetation mapping is shown on Figure 6.

In the context of the overall mine, the Action would result in the loss of 228.9 ha of native vegetation, which is approximately 4% of the already active and approved Mt Arthur Coal Mine.

Table 3
Vegetation Clearance and Habitat for MNES

Vegetation Community	Area (ha)	Box-Gum Woodland CEEC	Regent Honeyeater, Swift Parrot, Grey-headed Flying-fox, Large-eared Pied Bat and South-eastern Long-eared Bat	Spot-tailed Quoll
Grassland and Other				
Derived Native Grassland	136.8	-	-	✓
Derived Native Grassland, with Cooba Wattle Regrowth	1	-	-	✓
Derived Native Grassland, derived from Box-Gum Woodland	35.2	✓	-	✓
Typha Dominated Drainage Line	2.5	-	-	-
Woodland/Forest				
Central Hunter Box – Ironbark Woodland	23	✓	✓	✓
Blakely's Red Gum Woodland	0.2	✓	✓	✓
Upper Hunter Hills Box – Ironbark – Red Gum Woodland	3.4	-	✓	✓
Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant	17.9	-	✓	✓
Hunter Lowlands Red Gum Forest	1.7	-	✓	✓
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	7.1	-	✓	✓
Weeping Myall Woodland	0.1	-	✓	✓
Total (ha)	**228.9**	**58.4**	**53.4**	**226.4**

Source: Adapted from Attachment C

Habitat Connectivity

The existing connectivity of vegetation/habitat associated with the Action area is not strong as the landscape is substantially cleared (Figure 6) (Attachment C). Some of the vegetation/habitat in the Action area is located on the footslopes of Mount Arthur and contiguous with the vegetation/habitat over Mount Arthur (Figure 6). The habitat over Mount Arthur would become isolated until completion of mining because rehabilitation would be progressive (Attachment C).

Indirect Impacts

Hunter Eco (2013) (Attachment C) assessed the indirect impacts of the Action on the surrounding flora and fauna, including edge effects (noise, dust), spread of weeds, erosion and sedimentation. In summary:

- The Mt Arthur Coal Mine currently emits noise and it is unlikely that the increased noise emissions would have a significant adverse impact to local fauna populations.
- It is unlikely that any flora species or vertebrate species would be adversely impacted by dust generated as a result of the Action. A dust monitoring programme is currently implemented and would continue to be implemented at the Mt Arthur Coal Mine.
- HVEC is committed to providing biodiversity outcomes as part of mine rehabilitation. Larger woodland corridors have been established as part of rehabilitation activities associated with the Modification, minimising edge effects on biodiversity.
- The risk of impact from introduced flora and fauna to surrounding habitat is unlikely to change as a result of the Action. Measures to manage and control weeds and pests are currently implemented and would continue to be implemented for the Action.
- It is unlikely that surface runoff associated with the Action would impact flora and fauna in the surrounds, due to the mitigation measures (e.g. isolating mine drainage from undisturbed area runoff [Gilbert and Associates, 2013]).

The scale of potential indirect impacts would be localised and negligible relative to the local and regional occurrences of the threatened species present within the Action area.

The Mount Arthur Conservation Area is an approved offset area under an existing EPBC Approval (EPBC 2011/5866). The Mount Arthur Conservation Area would not be directly impacted as part of the Action. Significant indirect impacts on the Mt Arthur Conservation Area as a result of the Action are not expected because:

- fauna within the Mt Arthur Conservation Area are already subjected to noise impacts associated with the existing and approved Mt Arthur Coal Mine. Given the size of the operating mine, any noise impacts would have already occurred, with recent fauna surveys within the Mt Arthur Coal Mine recording those species that are tolerant of the current noise regime;
- it is unlikely that any flora species or vertebrate species would be adversely impacted by dust generated as a result of the Action;
- potential artificial lighting impacts from the existing and approved Mount Arthur Coal Mine are unlikely to significantly increase as a result of the Action, due to the size of the existing, approved operations, compared to the extent of the proposed activities associated with the Action;
- the landscape surrounding the conservation area is already highly fragmented. Further, HVEC is committed to providing biodiversity outcomes as part of mine rehabilitation. Larger woodland corridors have been established as part of rehabilitation activities associated with the Action, minimising edge effects on biodiversity; and
- measures to manage and control weeds and pests are currently implemented and would continue to be implemented for the Action.

3.2 WHITE BOX-YELLOW BOX-BLAKELY'S RED GUM GRASSY WOODLAND AND DERIVED NATIVE GRASSLAND

EPBC Act Status

The Box-Gum Woodland is listed as a CEEC.

Description

In NSW, the Box-Gum Woodland CEEC is characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs, and the dominance, or prior dominance, of White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) trees (Threatened Species Scientific Committee [TSSC], 2006; Department of Environment and Heritage, 2006; Department of Environment, Climate Change and Water [DECCW], 2010). Specific criteria for the Box-Gum Woodland CEEC is provided in the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands EPBC Act Policy Statement* (Department of Environment and Heritage, 2006) and *Commonwealth Listing Advice on White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Threatened Species Scientific Committee, 2006).

Occurrence within the Action Area

In some areas of the Hunter Valley, a hybrid of White Box and Grey Box (*Eucalyptus moluccana*) has been identified as the dominant tree in the vegetation community. There are semi-cleared patches of woodland in the Action area that comprises trees which are a hybrid between White Box and Grey Box with surrounding derived native grassland. Of 28 box specimens sent for identification by the National Herbarium of NSW from areas adjoining the Action (which incorporates the Action area), 27 were determined to be hybrids (*E. albens* x *E. moluccana*) (Umwelt, 2011 in Hunter Eco, 2013 [Attachment C]).

For the previous Referral that was determined in 2012 (Attachment D), HVEC held the view that the Box-Gum Woodland CEEC listed under the EPBC Act, by not specifically including hybrids in the community description (as happens in some more recent determinations), does not allow for the inclusion of hybrids (i.e. hybrids are not part of the Box-Gum Woodland CEEC). Therefore, hybrids or integrates should not be considered in determining whether a particular overstorey may be part of the Box-Gum Woodland). Despite this view, hybrids are conservatively assumed to be part of the Box-Gum Woodland CEEC for the purpose of this assessment. A letter published on the DotE's website (https://www.environment.gov.au/biodiversity/threatened/publications/advice-presence-hybrids-listed-ecological-communities) contains the opinion held by the TSSC on the presence of hybrids in ecological communities (TSSC, 2010).

Direct and Indirect Impacts of Proposed Action

Hunter Eco (2013; Attachment C) conservatively assumed that a total of 58.4 ha of Box-Gum Woodland CEEC occurs within the Action area. The Box-Gum Woodland CEEC was attributed to the following vegetation communities:

- approximately 23 ha of Central Hunter Box – Ironbark Woodland;
- approximately 0.2 ha of Blakely's Red Gum Woodland; and
- approximately 35.2 ha of Derived Native Grassland.

This is made up of 23.2 ha of the woodland variant and 35.2 ha of open grassland variant. This contrasts with 14,818 ha of the same woodland habitat mapped for the central Hunter by Peake (2006).

The Box-Gum Woodland CEEC also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal as the potential causes of indirect impacts (e.g. introduced flora and fauna) would be managed.

Avoidance and Mitigation Measures

The vegetation communities attributed to Box-Gum Woodland CEEC mostly occurs in proposed open cut extension areas (Figure 4) and therefore impacts on these vegetation communities cannot be avoided. Clearance of Box-Gum Woodland CEEC would be limited to 58.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6). Further, the following measures will be undertaken for the Action and are relevant to avoiding and mitigating impacts on the Box-Gum Woodland CEEC:

- controlling weeds; and
- controlling feral pest animals.

The above measures are not inconsistent with the *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (DECCW, 2010).

Offsets

In the request for preliminary documentation (Table 1 and Attachment A), the DotE states that an offset package is required to compensate for the residual impacts to Box-Gum Woodland CEEC. The offset package (Section 5) compensates for residual impacts on the Box-Gum Woodland CEEC. Table 4 provides a summary of the disturbance and offset for vegetation communities attributed to Box-Gum Woodland CEEC. This table shows that there is substantially more Box-Gum Woodland CEEC in the offset area compared to the disturbance area. The Box-Gum Woodland CEEC (derived grassland) in the offset areas will be managed to encourage natural regeneration to woodland providing a net gain in woodland.

Table 4
Summary of Disturbance and Offset for Box-Gum Woodland CEEC

Disturbance (ha)	Offset (ha)
58.4 ha comprising: • 35.2 ha of Derived Native Grassland, derived from Box-Gum Woodland; • 23 ha of Central Hunter Box – Ironbark Woodland; and • 0.2 ha of Blakely's Red Gum Woodland.	**535.2 ha** comprising: • 120 ha of MU10 Central Hunter Box - Ironbark Woodland (Derived grassland); • 307 ha of MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Derived grassland); • 5.2 ha of MU10 Central Hunter Box – Ironbark Woodland; and • 103 ha of MU11 Upper Hunter White Box – Ironbark Grassy Woodland.

Conclusion

The Box-Gum Woodland CEEC in the Action area is dominated by a hybrid of White Box and Grey Box, and is semi-cleared and small in relation to the area of the same woodland habitat mapped for the central Hunter by Peake (2006). An offset has been provided for the Action which provides for the conservation and enhancement of substantially more Box-Gum Woodland CEEC (Section 5).

3.3 REGENT HONEYEATER

EPBC Act Status

This Regent Honeyeater is listed as 'Endangered' under the EPBC Act.

Description

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia (OEH, 2015b). In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (OEH, 2015b).

This species has a preference for ironbark, but it also occurs in forests and woodlands of box species, Yellow Gum (*Eucalyptus leucoxylon*), Swamp Mahogany (*E. robusta*) and River Sheoak (*Casuarina cunninghamiana*) (Morcombe, 2004). It has a particular preference for blossoming Eucalypts and Mistletoe (Simpson and Day, 1999).

There are three known key breeding areas, two of them in NSW (Capertee Valley and Bundarra-Barraba regions) (OEH, 2015b). The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak (OEH, 2015b). Regent Honeyeaters usually nest in horizontal branches or forks in tall mature Eucalypts and Sheoaks and also nest in Mistletoe (OEH, 2015b).

The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of Eucalypts and Mistletoes (OEH, 2015b). It also feeds on arthropods, occasionally supplemented with fruit (Franklin *et al.,* 1988). Key Eucalypt species include Mugga Ironbark (*Eucalyptus sideroxylon*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*), White Box (*E. albens*) and Swamp Mahogany (OEH, 2015b). This species also utilises: Inland Grey Box (*E. microcarpa*), Grey Gum (*E. punctata*), Red Box (*E. polyanthemos*), Grey Box (*E. moluccana*), Narrow-leaved Ironbark (*E. crebra*), *E. caleyi,* Spotted Gum (*Corymbia maculata*), McKie's Stringybark (*E. mckieana*), Red Stringybark (*E. macrorhyncha*), Silver Top Stringybark (*E. laevopinea*), and Rough-barked Apple (*Angophora floribunda*) (OEH, 2015b). When nectar is scarce lerp and honeydew comprise a large proportion of the diet (OEH, 2015b). Insects make up about 15% of the total diet and are important components of the diet of nestlings (OEH, 2015b).

Colour-banding of the Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres (OEH, 2015b). However, the exact nature of these movements is still poorly understood (OEH, 2015b). It is likely that movements are dependent on spatial and temporal flowering and other resource patterns (OEH, 2015b).

Occurrence within the Action Area

The Action area is not near a known breeding area (as described above) and this species has not been recorded in the Action area. Potential foraging habitat for this species is present in the Action area and wider region (DotE, 2015a).

Direct and Indirect Impacts of Proposed Action

Approximately 53.4 ha of potential foraging habitat for this species is present in the Action area, including Box Ironbark woodland and Red Gum eucalypt woodland and forest. The scale of the impacts is small relative to the species habitat is likely to occur throughout the region surrounding the Action area (after DotE, 2015a). As the Action is not near a known breeding area (Capertee Valley and Bundarra-Barraba regions) and the species has not be recorded in the Action area, habitat critical to the survival of the species would be unlikely to be adversely affected by the Action.

Potential foraging habitat for the Regent Honeyeater also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal as the potential causes of indirect impacts (e.g. introduced flora and fauna) would be managed.

Avoidance and Mitigation Measures

The following measures will be undertaken for the Action and are relevant to avoiding and mitigating impacts on potential foraging habitat for the Regent Honeyeater:

- limiting clearance of Regent Honeyeater potential foraging habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6);
- revegetation of the post-mine landforms with eucalypt species that provide a potential nectar food source; and
- controlling feral pest animals.

The above measures are not inconsistent with the *Regent Honeyeater Recovery Plan 1999 – 2003* (Menkhorst *et al.,* 1999).

Offsets

In the request for preliminary documentation (Table 1 and Attachment A), DotE states that an offset package is required to compensate for the residual impacts to this species. The offset package (Section 5) compensates for residual impacts on the Regent Honeyeater. The offset areas provide for the conservation and management of 113.7 ha of foraging habitat resources for the Regent Honeyeater and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5).

Conclusion

Potential foraging habitat for the Regent Honeyeater is present in the Action area and wider region, although the species has not been recorded in the Action area or surrounds. Approximately 53.4 ha of foraging habitat resources may be removed/modified. The Action is unlikely to significantly impact the Regent Honeyeater given the absence of records within and surrounding the Action area, despite extensive targeted surveys. Notwithstanding, an offset has been provided for the Action which provides for the conservation and enhancement of substantially more habitat for the Regent Honeyeater (approximately 113.7 ha) than occurs in the Action Area (Section 5).

3.4 SWIFT PARROT

EPBC Act Status

The Swift Parrot is listed as 'Endangered' under the EPBC Act.

Description

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland (OEH, 2015b). In NSW it mostly occurs on the coast and south-west slopes (OEH, 2015b). It occurs in woodlands and forests of NSW from May to August (NSW Scientific Committee, 2011).

The Swift Parrot is dependent on flowering resources across a wide range of habitat in its wintering grounds in NSW (NSW Scientific Committee, 2011). On the mainland they occur in areas where Eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (OEH, 2015b).

Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding (OEH, 2015b). In Tasmania the breeding population has declined from in excess of 10,000 pairs to less than 1,000 pairs (NSW Scientific Committee, 2011).

The Swift Parrot favours feed trees such as winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*) (OEH, 2015b). They feed on commonly lerp infested trees including Inland Grey Box (*E. microcarpa*), Grey Box (*E. moluccana*) and Blackbutt (*E. pilularis*) (OEH, 2015b).

Occurrence within the Action Area

The Swift Parrot has not been recorded in the Action area. Potential foraging habitat for this species is present in the Action area and wider region (DotE, 2015a).

Direct and Indirect Impacts of Proposed Action

The Swift Parrot has not been recorded in the Action area. Approximately 53.4 ha of potential habitat is present for this species in the Action area, including Box Ironbark woodland and Red Gum eucalypt woodland and forest. The scale of the impacts is small relative to the species habitat is likely to occur throughout the region surrounding the Action area (after DotE, 2015a). As the Action is not near a known breeding area (Tasmania) and the species has not be recorded in the Action area, habitat critical to the survival of the species would be unlikely to be adversely affected by the Action.

Potential foraging habitat for the Swift Parrot also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal as the potential causes of indirect impacts (e.g. introduced flora and fauna) would be managed.

Avoidance and Mitigation Measures

The following measures are relevant to avoiding and mitigating impacts on potential Swift Parrot foraging habitat:

- limiting clearance of Swift Parrot potential foraging habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6);
- revegetation of the post-mine landforms with eucalypt species that provide a potential nectar food source; and
- controlling feral pest animals.

The above measures are not inconsistent with the *National Recovery Plan for the Swift Parrot Lathamus discolor* (Saunders and Tzaros, 2011).

Offsets

In the request for preliminary documentation (Table 1 and Attachment A), DotE states that an offset package is required to compensate for the residual impacts to this species. The offset package (Section 5) compensates for residual impacts on the Swift Parrot. The offset areas provide for the conservation and management of 113.7 ha of foraging habitat resources for the Swift Parrot and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5).

Conclusion

Potential foraging habitat for the Swift Parrot is present in the Action area and wider region, although the species has not been recorded in the Action area or surrounds. Approximately 53.4 ha of foraging and roosting habitat resources may be removed/modified. The Action is unlikely to significantly impact the Swift Parrot given the absence of records within and surrounding the Action area, despite extensive targeted surveys. Notwithstanding, an offset has been provided for the Action which provides for the conservation and enhancement of substantially more habitat for the Swift Parrot (approximately 113.7 ha) than occurs in the Action Area (Section 5).

3.5 GREY-HEADED FLYING-FOX

EPBC Act Status

The Grey-headed Flying-fox is listed as 'Vulnerable' under the EPBC Act.

Description

The Grey-headed Flying-fox distribution extends from Rockhampton in central Queensland, south to the vicinity of Melbourne in Victoria (OEH, 2015b; Tidemann 1998). Much of the known distribution is in NSW, with records being widespread along the East Coast and Central NSW, generally within 200 km of the coastline (OEH, 2015b).

This species requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits (Duncan *et al*., 1999; Eby, 1998). In NSW the Grey-headed Flying-fox is associated with flowering Spotted Gum (*Corymbia maculata*) and flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*E. sideroxylon*) (DECCW, 2010).

Roost sites are generally within 20 km of a regular food source and are typically located near water, such as lakes, rivers or the coast (OEH, 2015b; van der Ree *et al*., 2005). Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation (Nelson, 1965; Ratcliffe, 1931), but colonies also use highly modified vegetation in urban and suburban areas (Birt *et al*., 1998; Tidemann & Vardon, 1997; van der Ree *et al*., 2005).

The Grey-headed Flying-fox is highly mobile (Menkhorst, 1995; Tidemann, 1998). Although the extent of this species stretches approximately 2,000 km down the East Coast of Australia, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years.

Occurrence within the Action Area

There are no known or historic Grey-headed Flying-fox roosting camps within 10 km of the Action area (DotE, 2015b). This species was recorded at two locations in the Action area (Figure 5), seen foraging for nectar and pollen on blossoming Spotted Gum.

Direct and Indirect Impacts of Proposed Action

The Action would remove and modify approximately 53.4 ha of foraging habitat resources in the form of woodland and forest used by the Grey-headed Flying-fox. These resources are limited given that the habitat is highly fragmented. The scale of the impacts is small relative to the species habitat is likely to occur throughout the region surrounding the Action area (after DotE, 2015a). As there are no known or historic Grey-headed Flying-fox roosting camps within 10 km of the Action area and only limited foraging habitat occurs, habitat critical to the survival of the species would be unlikely to be adversely affected by the Action.

Potential foraging habitat for the Grey-headed Flying-fox also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal and unlikely to adversely impact this species.

Avoidance and Mitigation Measures

The following measures are relevant to avoiding and mitigating impacts on Grey-headed Flying-fox foraging habitat:

- limiting clearance of Grey-headed Flying-fox potential foraging habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6); and
- revegetation of the post-mine landforms with eucalypt species that provide a potential nectar food source.

The above measures are not inconsistent with the *Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus* (DECCW, 2009).

Offsets

In the request for preliminary documentation (Table 1 and Attachment A), DotE states that an offset package is required to compensate for the residual impacts to this species. The offset package (Section 5) compensates for residual impacts on the Grey-headed Flying-fox. The offset areas provide for the conservation and management of 113.7 ha of foraging habitat resources for the Grey-headed Flying-fox and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5). The Grey-headed Flying-fox has been recorded in the offset area.

Conclusion

The Action would remove and modify approximately 53.4 ha of foraging habitat resources in the form of woodland and forest used by the Grey-headed Flying-fox. The Action is unlikely to significantly impact the Grey-headed Flying-fox given there are no known or historic Grey-headed Flying-fox roosting camps within 10 km of the Action area (DotE, 2015b) and the foraging resources are limited. Notwithstanding, an offset has been provided for the Action which provides for the conservation and enhancement of substantially more habitat known to be used by the Grey-headed Flying-fox (approximately 113.7 ha) than occurs in the Action Area (Section 5).

3.6 SPOT-TAILED QUOLL

EPBC Act Status

The Spot-tailed Quoll is listed as 'Endangered' under the EPBC Act.

Description

The range of the Spot-tailed Quoll has contracted considerably since European settlement (OEH, 2015b). It is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland (OEH, 2015b). Only in Tasmania is it still considered common (OEH, 2015b). The species is recorded from a wide range of treed habitats including tropical, subtropical and temperate rainforests, vine thickets, wet and dry sclerophyll forest, woodland and coastal scrub (Van Dyck and Strahan, 2008). In Tasmania it also occurs in heathland (Van Dyck and Strahan, 2008).

In NSW, the Spot-tailed Quoll occurs on both sides of the Great Dividing Range (OEH, 2015b). The north-east of the state represents a stronghold for the species, as numbers in the south-east of the state have dramatically declined (OEH, 2015b). The western division of NSW has a number of scattered but unconfirmed records (OEH, 2015b).

It is an opportunistic carnivore which preys on birds, reptiles, small mammals (including gliders, possums, rats and small macropods) and invertebrates (OEH, 2015b). This species also scavenges carrion and steals domestic poultry, and as a result is often persecuted (OEH, 2015b).

This species is solitary and occupies very large home ranges (Van Dyck and Strahan, 2008). Females occupy home ranges up to about 750 ha and males up to 3,500 ha. They usually traverse their ranges along densely vegetated creeklines (OEH, 2015b).

It is mostly a nocturnal animal, although it will hunt during the day. It spends most of the time on the ground, although also an excellent climber and may raid possum and glider dens and prey on roosting birds (OEH, 2015b). The Spot-tailed Quoll may move 3 to 5 km during their daily activities and have been recorded moving up to 8 km overnight (Van Dyck and Strahan, 2008).

Occurrence within the Action Area

The Spot-tailed Quoll has not been recorded in the Action area. However, there was a tentative record during the first half of 2006 by a HVEC staff member on the main access road to the Mt Arthur Coal offices close to the intersection with Thomas Mitchell Drive (Umwelt, 2007b).

Direct and Indirect Impacts of Proposed Action

The Spot-tailed Quoll has not been recorded in the Action area. Approximately 226.4 ha potential habitat is present in the Action area, most of which is derived grassland (173 ha) (Table 3). The scale of the impacts is small relative to the species habitat is likely to occur throughout the region surrounding the Action area (after DotE, 2015a). Given this and the fact that the species has not been recorded in the Action area, habitat critical to the survival of the species would be unlikely to be adversely affected by the Action.

Potential habitat for the Spot-tailed Quoll also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal as the potential causes of indirect impacts (e.g. introduced fauna) would be managed.

Avoidance and Mitigation Measures

The following measures are relevant to avoiding and mitigating impacts on potential Spot-tailed Quoll habitat:

- limiting clearance of Spot-tailed Quoll potential habitat to 226.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6);
- pre-clearance surveys are currently undertaken and would be updated where practicable to include searches for the Spot-tailed Quoll;
- salvage and reuse of material from the site for habitat enhancement;
- revegetation of the post-mine landforms; and
- controlling feral pest animals.

There is currently no Commonwealth recovery plan for the Spot-tailed Quoll. However, any baiting programs to control the Red Fox would consider the *Draft EPBC Act Policy Statement 3.4 - Significant Impact Guidelines for the Endangered Spot-Tailed Quoll Dasyurus maculatus maculatus (South-eastern Mainland Population) and the Use of 1080* (DEWHA, 2009).

Offsets

In the request for preliminary documentation (Table 1 and Attachment A), DotE states that an offset package is required to compensate for the residual impacts to this species. The offset package (Section 5) compensates for residual impacts on the Spot-tailed Quoll. The offset areas provide for the conservation and management of 540.7 ha of habitat for the Spot-tailed Quoll (Section 5).

Conclusion

There is limited potential habitat for the Spot-tailed Quoll in the Action area (approximately 226.4 ha). While there is a single tentative record it was from 2006 (nine years ago), the species has not been definitively recorded at the Mt Arthur Coal Mine, despite more recent targeted surveys. The Action is unlikely to significantly impact this species given the limited potential habitat and lack of definitive records of the species in the locality. Notwithstanding, an offset has been provided for the Action which provides for the conservation and enhancement of substantially more habitat known to be used by the Spot-tailed Quoll (approximately 540.7 ha) than occurs in the Action Area (Section 5).

3.7 LARGE-EARED PIED BAT

EPBC Act Status

The Large-eared Pied Bat is listed as ‘Vulnerable’ under the EPBC Act.

Description

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands (OEH, 2015b). This species is endemic to Australia (Churchill, 2008). It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes (OEH, 2015b). The largest numbers of records are from sandstone escarpment country in the Sydney basin and Hunter Valley regions of central NSW (Van Dyck and Strahan, 2008).

This species roosts in caves. The females give birth to one or two young during late November and early December and are suckled until late January (Van Dyck and Strahan, 2008). The young are typically independent by late February (Churchill, 2008). It is not known whether mating occurs in the autumn or spring (Churchill, 2008). Females have been recorded raising young in maternity roosts (c. 20 to 40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years (OEH, 2015b).

The combination of relatively short, broad wings and a low weight per unit area of wing is indicative of manoeuvrable flight (Van Dyck and Strahan, 2008). This species probably forages for small, flying insects below the forest canopy (OEH, 2015b). Colony numbers are typically fewer than 10 individuals, although up to 80 have been recorded at some roosts (Van Dyck and Strahan, 2008).

Records of the Large-eared Pied Bat are widespread and scattered across eastern NSW, as mapped on the BioNet Atlas of NSW Wildlife (OEH, 2015c). A number of records occur within the region surrounding the Action area (OEH, 2015c). The closest database record of the Large-eared Pied Bat is from 2003, located approximately 8 km to the north-east of the Action (OEH, 2015a).

Occurrence within the Action Area

Bat fauna of the Action area and surrounds have been comprehensively surveyed at the Mt Arthur Coal Mine over the past 16 years by qualified ecologists (Table 2). Further, targeted surveys were undertaken for the Action by Niche (2012) from 1 May 2012 (i.e. one day outside of the non-mandatory optimum survey timing listed in the Survey Guidelines for Australia's Threatened Bats [DEWHA, 2010]). This species has not been recorded in the Action area during surveys, but has been recorded to the north of the Mt Arthur Coal Mine by Umwelt (2007a) (Figure 5).

Direct and Indirect Impacts of Proposed Action

Approximately 53.4 ha of potential foraging habitat for this species is present in the Action area, including Box Ironbark woodland and Red Gum eucalypt woodland and forest. No breeding habitat would be impacted. The scale of the impacts is small relative to the species foraging habitat is likely to occur throughout the region surrounding the Action area (after DotE, 2015a).

Potential foraging habitat for Large-eared Pied Bat also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal.

Avoidance and Mitigation Measures

The following measures are relevant to avoiding and mitigating impacts on potential Large-eared Pied Bat habitat:

- limiting clearance of Large-eared Pied Bat potential habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6); and
- revegetation of the post-mine landforms.

The above measures are not inconsistent with the *National Recovery Plan for The Large-Eared Pied Bat Chalinolobus dwyeri* (DERM, 2011).

Conclusion

Consistent with the *EPBC Act Significant Impact Guidelines* criteria, is unlikely that the Large-eared Pied Bat would be significantly impacted by the Action (after DotE, 2013b), because the Action removes potential foraging habitat (approximately 53.4 ha) which is common in the surrounding landscape and the Action. Notwithstanding the above, the offset areas provide for the conservation and management of 113.7 ha of foraging and roosting habitat resources for the Large-eared Pied Bat and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5).

3.8 SOUTH-EASTERN LONG-EARED BAT

EPBC Act Status

The South-eastern Long-eared Bat is listed as 'Vulnerable' under the EPBC Act.

Description

The distribution of the South-eastern Long-eared Bat coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being a distinct stronghold for this species (OEH, 2015b). Overall, the distribution of the South-eastern Long-eared Bat spans the western slopes and plains of NSW with the exception of the Darling Riverine Plains Bioregion, the Hay Plains in the Riverina Bioregion and the north-western semi-arid corner of NSW (Turbill and Ellis, 2006). A survey conducted on this species found that large vegetation remnants in Goonoo, Pilliga West and Pilliga East study areas are a distinct stronghold in the distribution of the species (Turbill and Ellis, 2006).

The South-eastern Long-eared Bat inhabits a variety of vegetation types, including Mallee, Bulloak (*Allocasuarina luehmannii*) and box Eucalypt dominated communities, but it is more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (OEH, 2015b).

The South-eastern Long-eared Bat inhabits dry woodlands and the River Red Gum (*Eucalyptus camaldulensis*) communities of major watercourses (Van Dyck and Strahan, 2008). The species roosts in tree hollows, exfoliating bark or crevices (OEH, 2015b). Mating takes place in autumn with one or two young born in late spring to early summer (OEH, 2015b).

The South-eastern Long-eared Bat forages for large moths and beetles over water or in arid habitats (Hall and Richards, 1979; Richards, 1983). It may utilise the understorey to hunt non-flying prey (especially caterpillars and beetles) or hunt on the ground (OEH, 2015b). A typical maternity colony consists of 10 to 20 females; males are usually solitary (Van Dyck and Strahan, 2008).

Records of the South-eastern Long-eared Bat are widespread and scattered across NSW, as mapped on the BioNet Atlas of NSW Wildlife (OEH 2015c). A number of records occur within the region surrounding the Action area (OEH, 2015c). The closest database record of the South-eastern Long-eared Bat is from the year 2000, located approximately 5 km to south of the Action (OEH, 2015a).

Occurrence within the Action Area

Bat fauna of the Action area and surrounds have been comprehensively surveyed at the Mt Arthur Coal Mine over the past 16 years by qualified ecologists (Table 2). Further, targeted surveys were undertaken for the Action by Niche (2012) from 1 May 2012 (i.e. one day outside of the non-mandatory optimum survey timing listed in the Survey Guidelines for Australia's Threatened Bats [DEWHA, 2010]). This species has not been recorded in the Action area or surrounds during surveys.

Direct and Indirect Impacts of Proposed Action

Approximately 53.4 ha of potential habitat for this species is present in the Action area, including Box Ironbark woodland and Red Gum eucalypt woodland and forest.

Potential habitat for South-eastern Long-eared Bat also occurs outside of the Action area (e.g. on the footslopes of Mount Arthur). The potential for indirect impacts from the Action on the surrounding flora and fauna has been assessed (Section 3.1 and Attachment C). It is concluded that indirect impacts would be minimal.

Avoidance and Mitigation Measures

The following measures are relevant to avoiding and mitigating impacts on potential South-eastern Long-eared Bat habitat:

- limiting clearance of South-eastern Long-eared Bat potential habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6);
- the existing pre-clearance surveys would be reviewed and revised where practicable to ensure impacts to bats are minimised during clearing activities;
- salvage and reuse of tree-hollows for habitat enhancement; and
- revegetation of the post-mine landforms.

There is currently no Commonwealth recovery plan for the South-eastern Long-eared Bat.

Conclusion

The woodland/forest vegetation types in the Action area could provide potential habitat for the South-eastern Long-eared Bat (Figure 6). Approximately 53.4 ha of foraging and roosting habitat resources may be removed/modified. Consistent with the *EPBC Act Significant Impact Guidelines* criteria, this small loss of habitat is not expected to significantly affect this 'Vulnerable' species (after DotE, 2013b), because the Action removes potential foraging habitat which is common in the surrounding landscape.

Notwithstanding the above, the offset areas provide for the conservation and management of 113.7 ha of potential foraging and roosting habitat resources for the South-eastern Long-eared Bat and 427 ha of derived grassland that would be managed to encourage natural regeneration to provide a net gain in habitat (Section 5).

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Section 4 – Proposed Impact Avoidance and Mitigation Measures

4 PROPOSED IMPACT AVOIDANCE AND MITIGATION MEASURES

This section provides the further information that was requested in regard to the proposed avoidance, safeguards and mitigation measures.

HVEC intends to manage impacts on MNES from the Action in accordance with NSW Project Approval 09_0062 MOD1 and in a manner consistent with the existing EPBC Act Approval (2011/5866). Specifically, NSW Project Approval 09_0062 MOD1 and EPBC Act Approval (2011/5866) require HVEC to implement the Mt Arthur Coal Biodiversity Management Plan. The existing Mt Arthur Coal Biodiversity Management Plan has been revised and submitted for approval in accordance with NSW Project Approval 09_0062 MOD1 (to include the Modification) and will be revised in accordance with any relevant requirements from the DotE, if the Action is approved.

In accordance with the request for the preliminary documentation (Table 1 and Attachment A), Table 5 provides a summary of impact avoidance and mitigation measures, including:

- an assessment of the expected or predicted effectiveness of the measures in reducing impacts on each particular MNES; and
- the statutory or policy basis for the measures.

Table 6 provides a description of the proposed avoidance and mitigation measures, including for each measure, the environmental objectives, performance criteria, monitoring, reporting (by whom, to whom, how often), corrective actions (including thresholds for actions), responsibility and timing for proposed measures.

4.1 EVIDENCE FOR EFFECTIVENESS OF PROPOSED MITIGATION MEASURES

The mitigation measures proposed for the Action (Tables 5 and 6) are generally considered best practice for biodiversity management within the mining industry, as outlined below as evidenced by *Leading Practice Sustainable Development Program for the Mining Industry* guidelines issued by the Commonwealth of Australia:

- **Revegetation of the post-mine landforms (Figure 7):** Revegetation of post mine landforms can provide for substantial improvement in ecological values, in accordance with the *Leading Practice Sustainable Development Program for the Mining Industry - Mine Rehabilitation* (Commonwealth of Australia, 2006). Existing rehabilitation at the Mt Arthur Coal Mine has proven successful, as demonstrated by results from Annual rehabilitation inspections presented in the Annual Environmental Management Report (AEMR) (HVEC, 2015b).
- **Protection of MNES habitat outside of the areas Action area:** The protection of vegetation in surrounding areas (i.e. no clearing outside designated areas) is considered standard biodiversity management in accordance with the *Leading Practice Sustainable Development Program for the Mining Industry - Biodiversity Management* (Commonwealth of Australia, 2007). This Biodiversity Handbook states (Commonwealth of Australia, 2007):

  > *Protection and restoration of native vegetation communities adjacent to the mine helps conserve those species likely to contribute to natural recolonisation.*

- **Pre-clearance surveys:** Pre-clearance surveys are currently undertaken at the Mt Arthur Coal Mine (HVEC, 2015b). Pre-clearance surveys are considered successful in decreasing the potential risk of direct mortality as a result of clearing activities, confirming the use of habitat or habitat features by fauna, and can allow for relocation of habitat features known to be used by fauna (e.g. hollow logs).

- **Salvaging and reusing material from the site for habitat enhancement:** Salvage and reuse of important habitat features from the clearance areas is currently undertaken at the Mt Arthur Coal Mine, consistent with the *Leading Practice Sustainable Development Program for the Mining Industry - Biodiversity Management* (Commonwealth of Australia, 2007).
- **Controlling weeds:** The Commonwealth of Australia (2007) considers the control of weeds and other pest species is an effective measure to reduce negative impacts on biodiversity. Weed management is currently undertaken at the Mt Arthur Coal Mine. Observations during the weed treatment program and follow up inspections indicate that treatment has been largely effective (HVEC, 2015b).
- **Controlling feral pests:** The Commonwealth of Australia (2007) considers the control of pest species is an effective measure to reduce negative impacts on biodiversity. Feral animal management is currently undertaken at the Mt Arthur Coal Mine and is considered to be successful (HVEC, 2015b).
- **Minimise noise and dust emissions at the source:** *Leading Practice Sustainable Development Program for the Mining Industry- A Guide to Leading Practice Sustainable Development In Mining* (Commonwealth of Australia, 2011) outlines that mine management needs to take into account dust suppression at the source, including stockpiles and conveyers areas (Commonwealth of Australia, 2011). Dust and noise suppression techniques are currently undertaken at the Mt Arthur Coal Mine and have proven successful, as demonstrated by results from Annual air quality and noise monitoring presented in the AEMR (HVEC, 2015b).
- **Reduce the potential impacts associated with surface runoff:** Erosion and sediment management is currently undertaken at the Mt Arthur Coal Mine, consistent with *Leading Practice Sustainable Development Program for the Mining Industry – Water Management* (Commonwealth of Australia, 2008). The management system includes a comprehensive set of both proactive and reactive control measures designed to minimise the impact of sediment on water sources (HVEC, 2015b). Management practices are considered successful, as demonstrated by the results presented in the AEMR (HVEC, 2015b).

HVEC is responsible for funding the costs of all mitigation measures as required. From recent operational experience, costs associated with the implementation of these mitigation measures within the Action area are estimated at between $10,000 to $50,000 per annum. This would be funded from within HVECS mining operational budget.

Table 5
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
Threatened Species				
Regent Honeyeater	E	• Limiting clearance of Regent Honeyeater potential foraging habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of potential habitat (assuming that the species may potentially use it).	*Regent Honeyeater Recovery Plan - 1999-2003* (Menkhorst *et al.*, 1999) *Threat Abatement Plan For Competition And Land Degradation By Rabbits* (DEWHA, 2008a)
		• Revegetation of the post-mine landforms with eucalypt species that provide a potential nectar food source.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species over the long-term.	
		• Controlling feral pest animals.	There is a high likelihood that this measure would effectively mitigate potential impacts as a result of feral animals.	
		• Implementation of mitigation measures to minimise noise and dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Ongoing noise and air quality monitoring, consistent with the Noise Monitoring Program and Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Reduce the potential impacts on habitat associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species associated with surface runoff from the mine site over the short to long-term.	

Table 5 (Continued)
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
Swift Parrot	E	• Limiting clearance of Swift Parrot potential foraging habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of potential habitat (assuming that the species may potentially use it).	*National Recovery Plan for the Swift Parrot Lathamus discolor* (Saunders and Tzaros, 2011) *Threat Abatement Plan for predation by feral cats* (DEWHA, 2008b)
		• Revegetation of the post-mine landforms with eucalypt species that provide a potential nectar food source.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species over the long-term.	
		• Controlling feral pests (e.g. Feral Cat [*Felis catus*]).	There is a high likelihood that this measure would effectively mitigate potential impacts as a result of feral animals.	
		• Implementation of mitigation measures to minimise noise and dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Ongoing noise and air quality monitoring, consistent with the Noise Monitoring Program and Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Reduce the potential impacts on habitat associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species associated with surface runoff from the mine site over the short to long-term.	
Grey-headed Flying-fox	V	• Limiting clearance of Grey-headed Flying-fox potential foraging habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of potential habitat (assuming that the species may potentially use it).	*Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus* (DECCW, 2009) *Action Plan for Australian Bats* (Duncan *et al*. 1999)
		• Revegetation of the post-mine landforms with eucalypt species that provide a potential nectar food source.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species over the long-term.	

Table 5 (Continued)
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
Grey-headed Flying-fox (Cont.)		• Implementation of mitigation measures to minimise noise and dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Ongoing noise and air quality monitoring, consistent with the Noise Monitoring Program and Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Reduce the potential impacts on habitat associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species associated with surface runoff from the mine site over the short to long-term.	
Spot-tailed Quoll	E	• Limiting clearance of Spot-tailed Quoll potential habitat to 226.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of potential habitat (assuming that the species may potentially use it).	*The 1996 Action Plan for Australian Marsupials and Monotremes* (Maxwell *et. al.,* 1996) *Threat Abatement Plan for predation by the European red fox* (DEWHA, 2008c) *Wild Dog Policy* (NPWS, 2005) Any baiting programs to control the Red Fox would consider the *Draft EPBC Act Policy Statement 3.4 - Significant Impact Guidelines For The Endangered Spot-Tailed Quoll Dasyurus maculatus maculatus (Southeastern Mainland Population) and the Use of 1080* (DEWHA, 2009)
		• Revegetation of the post-mine landforms.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species over the long-term.	
		• Protection of MNES habitat outside of the areas Action area.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species.	
		• Pre-clearance surveys.	There is a moderate to high likelihood that this measure would effectively mitigate potential impacts as habitat for this species would be disused should it need to be cleared.	
		• Salvaging and reusing material from the site for habitat enhancement.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species in the short-term.	

Table 5 (Continued)
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
Spot-tailed Quoll (Cont.)		• Controlling feral pest animals.	There is a high likelihood that this measure would effectively mitigate potential impacts as a result of feral animals.	
		• Implementation of mitigation measures to minimise noise and dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Ongoing noise and air quality monitoring, consistent with the Noise Monitoring Program and Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Reduce the potential impacts on habitat associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species associated with surface runoff from the mine site over the short to long-term.	

Table 5 (Continued)
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
Large-eared Pied Bat	V	• Limiting clearance of Large-eared Pied Bat potential habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of potential habitat (assuming that the species may potentially use it).	*National recovery plan for the Large-eared Pied Bat Chalinolobus dwyeri* (DERM, 2011) *Action Plan for Australian Bats* (Duncan *et al*. 1999)
		• Revegetation of the post-mine landforms.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species over the long-term.	
		• Implementation of mitigation measures to minimise noise and dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Ongoing noise and air quality monitoring, consistent with the Noise Monitoring Program and Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Reduce the potential impacts on habitat associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species associated with surface runoff from the mine site over the short to long-term.	

Table 5 (Continued)
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
South-eastern Long-eared Bat	V	• Limiting clearance of South-eastern Long-eared Bat potential habitat to 53.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of potential habitat (assuming that the species may potentially use it).	*(Draft) National Recovery Plan for the South-eastern Long-eared Bat Nyctophilus corbeni* (Schulz and Lumsden, 2010) *Action Plan for Australian Bats* (Duncan *et al*. 1999)
		• Pre-clearance surveys.	There is a moderate to high likelihood that this measure would effectively mitigate potential impacts as habitat for this species would be disused should it need to be cleared.	
		• Salvaging and reusing material from the site for habitat enhancement.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species in the short-term.	
		• Revegetation of the post-mine landforms.	There is a high likelihood that this measure would effectively minimise impacts to habitat for this species over the long-term.	
		• Implementation of mitigation measures to minimise noise and dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Ongoing noise and air quality monitoring, consistent with the Noise Monitoring Program and Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species as a result of increased noise and dust emissions over the short to long-term.	
		• Reduce the potential impacts on habitat associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts to habitat for this species associated with surface runoff from the mine site over the short to long-term.	

Table 5 (Continued)
Summary of Impact Avoidance and Mitigation Measures

Common Name	Conservation Status	Measures	Likely Success of the Mitigation Measures Achieving the Desired Outcomes	Statutory or Policy Basis for the Measures
Ecological Communities				
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	• Limiting clearance of this community to 58.4 ha (comprising the vegetation communities listed in Table 3 and shown on Figure 6).	There is a high likelihood that this measure would effectively minimise clearance of this community.	*National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (DECCW, 2010) *Threat Abatement Plan for Competition and Land Degradation by Rabbits* (DEWHA, 2008a) *Threat Abatement Plan for competition and land degradation by unmanaged goats* (DEWHA, 2008d) *Threat Abatement Plan for predation by the European red fox* (DEWHA, 2008c) *Threat Abatement Plan for predation by feral cats* (DEWHA, 2008b)
		• Controlling weeds.	There is a high likelihood that this measure would effectively mitigate potential impacts as a result of exotic plants.	
		• Controlling feral pest animals.	There is a high likelihood that this measure would effectively mitigate potential impacts as a result of feral animals.	
		• Implementation of mitigation measures to minimise dust emissions at the source.	There is a high likelihood that these measures would effectively minimise indirect impacts to this community as a result of increased dust emissions over the short to long-term.	
		• Ongoing air quality monitoring, consistent with the Air Quality Monitoring Program.	There is a high likelihood that these measures would effectively minimise indirect impacts to this community as a result of increased dust emissions over the short to long-term.	
		• Reduce the potential impacts on this community associated with surface runoff (e.g. erosion and sedimentation).	There is a high likelihood that these measures would effectively minimise indirect impacts this community associated with surface runoff from the mine site over the short to long-term.	

[1] Threatened species status listed under the EPBC Act (Current at May 2015).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

Table 6
Detail on Proposed Mitigation Measures

List of Measures	Environmental Objectives	Performance Criteria	Monitoring	Reporting (By Whom, To Whom, How Often)	Corrective Actions (Including Thresholds For Actions)	Responsibility	Timing
Revegetation of the post-mine landforms (Figure 7)	The rehabilitation strategy provides for areas for biodiversity outcomes (e.g. woodland corridors) and areas of pasture (the predominant previous site land use). However, the strategy aims for a net increase in native vegetated areas at the end of mine life. Surface development areas associated with the Mt Arthur Coal Mine are progressively rehabilitated and revegetated with species characteristic of native species endemic to the local area.	Revegetation will be conducted in accordance with the final mine landform and revegetation strategy.	Annual rehabilitation inspections (visual assessment) to evaluate how successful the rehabilitation works have been, and assess the requirement for any additional rehabilitation practices.	HVEC prepares an Annual Review report that is reported to the DP&E annually.	Contingency measures would include planting of additional tubestock/additional seeding, treatment of soils and/or supplementary watering. Thresholds for action would be determined by the status/progress of revegetation. Further detail is provided in Biodiversity Management Plan in accordance with NSW Consent Condition 40, Schedule 3 PA 09_0062 MOD1.	HVEC	Ongoing.

Table 6 (Continued)
Detail on Proposed Mitigation Measures

List of Measures	Environmental Objectives	Performance Criteria	Monitoring	Reporting (By Whom, To Whom, How Often)	Corrective Actions (Including Thresholds For Actions)	Responsibility	Timing
Protection of MNES habitat outside of the Action area	Planned disturbance areas are delineated prior to clearing activities, with restriction of clearing to the minimum area necessary to undertake the approved activities.	Clearance activities will be conducted in accordance with the clearing programme.	Inspections during clearance activities where practicable to assess the effectiveness of control measures implemented and the requirement for any additional control measures.	As above.	Contingency measures would include revegetation /rehabilitation of any extraneous clearing areas and reinforcement of pre-clearance protocols with staff members. Threshold for action would be any observation of clearing occurring outside of planned clearing areas.	HVEC	During the clearing programme.
Pre-clearance surveys	Pre-clearance surveys are conducted within all patches of forest and woodland to be cleared and threatened flora and fauna species detected are translocated into protected habitat. Pre-clearance surveys would be reviewed and revised where practicable to minimise impacts to bats during clearing activities.	Pre-clearance surveys will be conducted as part of the clearing programme.	Inspections during clearance activities where practicable to assess the effectiveness of control measures implemented and the requirement for any additional control measures.	As above.	Reinforcement of pre-clearance protocols with staff members. Threshold for actions would be observation of the pre-clearance protocol not being effectively implemented.	HVEC	During the clearing programme.

Table 6 (Continued)
Detail on Proposed Mitigation Measures

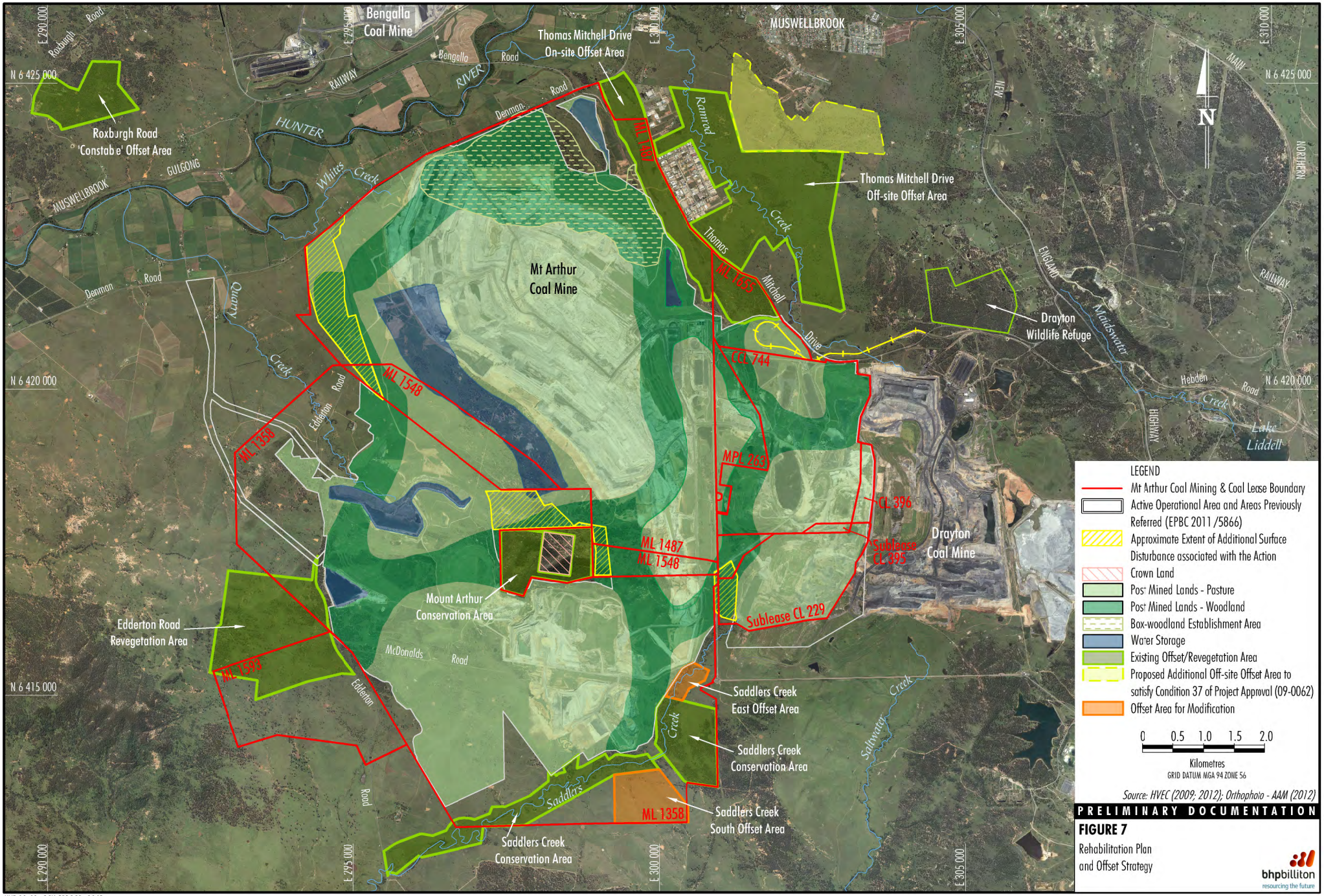
List of Measures	Environmental Objectives	Performance Criteria	Monitoring	Reporting (By Whom, To Whom, How Often)	Corrective Actions (Including Thresholds For Actions)	Responsibility	Timing
Salvaging and reusing material from the site for habitat enhancement	Large woody debris deemed suitable for habitat enhancement is identified as part of pre-clearance and post-clearance and are salvaged and re-used for habitat enhancement.	Habitat features will be salvaged as part of the clearing programme and re-used for habitat enhancement.	Inspections during clearance activities where practicable to assess the effectiveness of control measures implemented and the requirement for any additional control measures.	As above.	Reinforcement of pre-clearance protocols and post-clearance requirement to salvage potential habitat resources with staff members Threshold for action would be any observation of potential habitat resources not being re-used for habitat enhancement.	HVEC	During the clearing programme.
Controlling weeds	In 2010, Mt Arthur Coal developed a weed action plan to improve the management of noxious and environmental weeds, which identifies priority areas as well as individual species requiring management.	Weeds will be managed in accordance with relevant legislation.	Follow-up inspections to assess the effectiveness of control measures implemented and the requirement for any additional control measures.	As above.	Undertake supplementary targeted weed control activities. Threshold for action would include observation of excessive abundance of noxious and environmental weeds.	HVEC	Ongoing.

Table 6 (Continued)
Detail on Proposed Mitigation Measures

List of Measures	Environmental Objectives	Performance Criteria	Monitoring	Reporting (By Whom, To Whom, How Often)	Corrective Actions (Including Thresholds For Actions)	Responsibility	Timing
Controlling feral pests	Measures to control feral pests are implemented by an appropriately qualified person(s) and include the following where required: trapping; targeted shooting programmes and baiting. Follow-up inspections would be undertaken to assess the effectiveness of control measures implemented and the requirement for any additional control measures.	Feral pests will be managed in accordance with relevant legislation.	Follow-up inspections to assess the effectiveness of control measures implemented and the requirement for any additional control measures.	As above.	Undertake supplementary targeted feral pest control programmes. Threshold for action would include observation of excessive abundance of feral pests.	HVEC	Ongoing.
Minimise noise and dust emissions at the source	Measures to control noise emissions would be implemented and include the following where required: ensure new plant and existing plant are within the allowed parameters of the sound power specification; truck movements at night limited to dumps designated within the weekly mine plan. Measures to control dust emissions would be implemented and include the following where required: disturbance of only the minimum area necessary for mining; use of water carts or similar in unsealed coal handling areas to minimise wind-blown and traffic generated dust; automatic sprays on plant feed and clean coal stockpiles.	Noise and dust emissions will be managed in accordance with the Noise Management Plan and Air Quality and Greenhouse Gas Management Plan.	Noise and dust monitoring will be undertaken annually, as outlined in the Noise Monitoring Program and Air Quality Monitoring Program. Monitoring results will be presented in the Annual Environmental Management Report.	As above.	Implement additional control measures such as supplementary haul road watering (dust) and refinement of operational activities (noise and dust) where required. Thresholds for action would be determined by real-time monitoring trigger levels which are communicated to site personnel.	HVEC	Ongoing.

Table 6 (Continued)
Detail on Proposed Mitigation Measures

List of Measures	Environmental Objectives	Performance Criteria	Monitoring	Reporting (By Whom, To Whom, How Often)	Corrective Actions (Including Thresholds For Actions)	Responsibility	Timing
Reduce the potential impacts associated with surface runoff	Measures to control surface runoff would be implemented and include the following where required: progressive rehabilitation; sediment dams; collection drains; sediment fences; straw bale filters; kerbside turf filter strips; Humeceptors; post-rain inspections.	Surface runoff from the mine site will be managed in accordance with the Site Water Management Plan.	Surface water hydrology monitoring will be undertaken annually, as outlined in the Surface Water Monitoring Program. Monitoring results will be presented in the Annual Environmental Management Report.	As above.	Contingency measures would include revegetation /rehabilitation of any unplanned water release and reestablishment of freeboard of key water storages and sediment dams. Thresholds for action would be determined by the triggers in the Surface and Ground Water Monitoring Plan (BHP Billiton, 2015).	HVEC	Ongoing.



PRELIMINARY DOCUMENTATION

FIGURE 7

Rehabilitation Plan and Offset Strategy

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HVE-11-01_OCM EPBC PD_104B

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Section 5 – Offsets

5 OFFSETS

HVEC has an offset package which compensates for residual impacts on flora and fauna arising from the Modification. The existing offset was reviewed by the OEH and approved by the NSW Planning Assessment Commission following recommendation by the Secretary of the DP&E. OEH acknowledges that the proposed biodiversity offset package for the Mt Arthur Coal Open Cut Mine Modification 1 generally meets OEH's *Principles for the use of biodiversity offsets in NSW* (OEH, 2014), particularly in regards to the extent and nature of the vegetation they contain.

In the request for preliminary documentation (Table 1 and Attachment A), the DotE states that an offset package is required to compensate for the residual impacts to:

- Box-Gum Woodland CEEC;
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*); and
- Spot-tailed Quoll (*Dasyurus maculatus maculatus)* (south-east mainland population).

The offset package which compensates for residual impacts on flora and fauna arising from the Modification is considered to compensate for the residual impacts to the above listed MNES. Although the Large-eared Pied Bat and South-eastern Long-eared Bat would not be significantly impacted by the Action, the offset package compensates for residual impacts to these species. The offset areas are consistent with the *EPBC Act Environmental Offsets Policy* (Department of Sustainability, Environment, Water, Population and Communities [SEWPaC], 2012) and will provide a conservation outcome that will maintain or improve the viability of the relevant MNES. The suitability of the offsets has been assessed by a qualified and experienced ecologist, Dr Colin Driscoll, using the Commonwealth *Offsets assessment guide* tool. The outputs from the *Offsets assessment guide* tool indicate that offset package exceeds the minimum requirements of the *EPBC Act Environmental Offsets Policy* (SEWPaC, 2012) and that the quality of habitat included in the offset package is adequate.

Description of the Offset Package

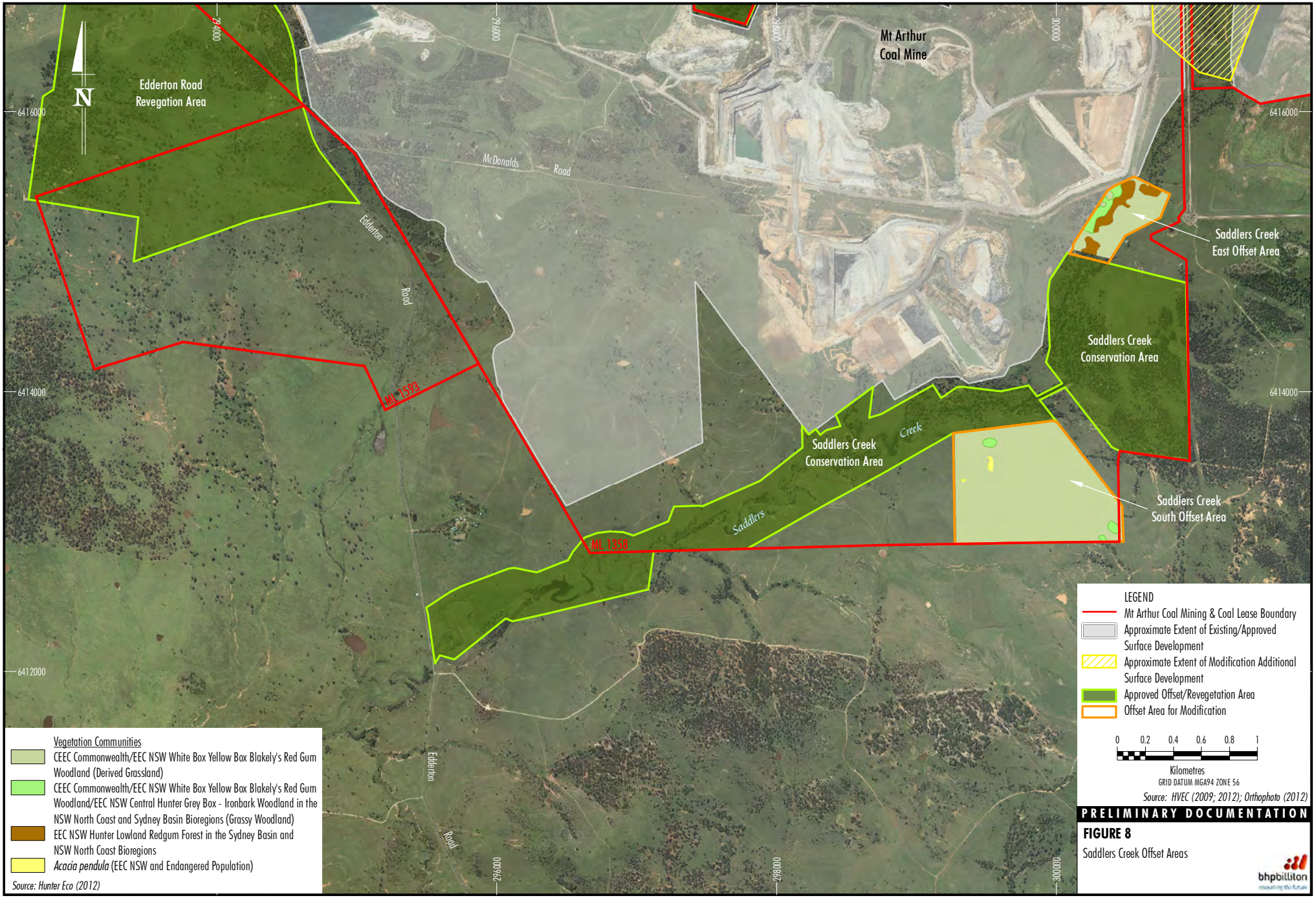
The offset package is comprised of two direct land-based offset areas (totalling 540.7 ha) **located on freehold land owned wholly by HVEC**. These two offset areas expand upon existing offset areas established by HVEC as part of a separate Action (i.e. as part of EPBC Act Approval (2011/5866). The offset areas are:

- a 131 ha expansion of the existing Saddlers Creek Conservation area located approximately 1 km south of the Action area (Figures 7 and 8); and
- a 410 ha expansion of the existing Middle Deep Creek Offset area located approximately 70 km north of the Action area (Figure 9).

The proposed offsets have not previously been used for offsetting other actions.

A conservation gain will be achieved by:

- improving existing habitat for the specific threatened species (e.g. through management of livestock grazing);
- creating new habitat for the specific threatened species (e.g. management to encourage natural regeneration of derived native grassland); and
- reducing threats to the specific threatened species (e.g. controlling weeds and pests).



PRELIMINARY DOCUMENTATION

FIGURE 8

Saddlers Creek Offset Areas

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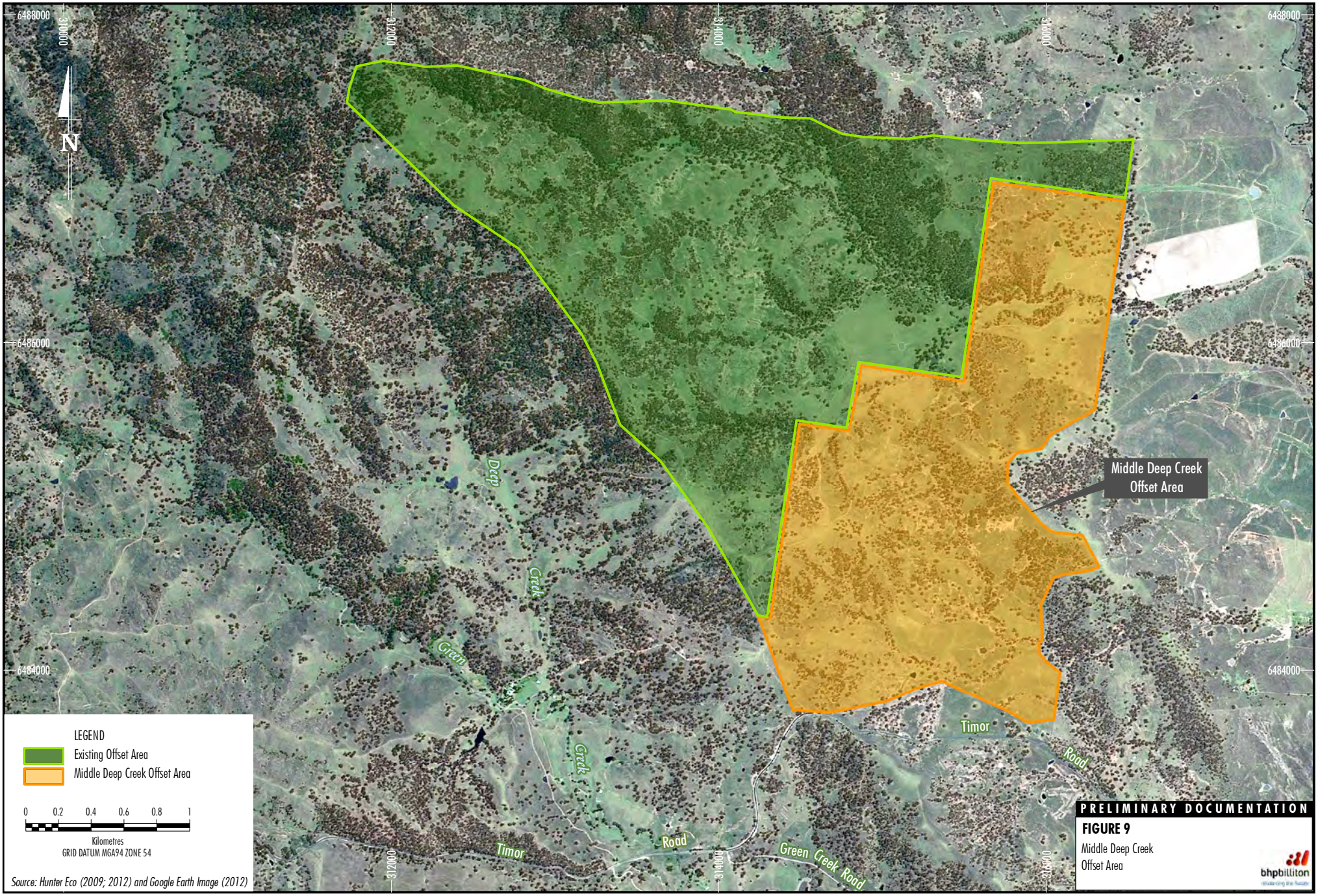

PRELIMINARY DOCUMENTATION

FIGURE 9

Middle Deep Creek
Offset Area

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Vegetation and Habitat for Matters of National Environmental Significance

Table 7 quantifies the vegetation within the offset areas and the corresponding habitat for relevant MNES. Vegetation mapping for the offset areas is shown on Figures 8 and 10.

The offset areas provide for the conservation and management of 113.7 ha of existing woodland/forest and 427 ha of derived grassland that will be managed to encourage natural regeneration to provide a net gain in habitat.

Table 7
Quantification of Vegetation Types within the Offset Areas

Vegetation Community	Area (ha)	Box-Gum Woodland CEEC	Regent Honeyeater, Swift Parrot, Grey-headed Flying-fox, Large-eared Pied Bat and South-eastern Long-eared Bat	Spot-tailed Quoll
Derived Grassland				
MU10 Central Hunter Box - Ironbark Woodland (Derived grassland) (Saddlers Creek East and South)[1]	120	✓	✓	✓
MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Derived grassland) (Middle Deep Creek)[1]	307	✓	✓	✓
Woodland/Forest				
MU10 Central Hunter Box – Ironbark Woodland (Saddlers Creek East)[1]	5.2	✓	✓	✓
MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Middle Deep Creek)[1]	103	✓	✓	✓
MU24 Hunter Lowlands Red Gum Forest (Saddlers Creek East)	5.1	-	✓	✓
MU19 Hunter Valley Weeping Myall Woodland (Saddlers Creek South)	0.4	-	✓	✓
Total	**540.7**	**535.2**	**540.7**	**540.7**

Source: Adapted from Attachment C

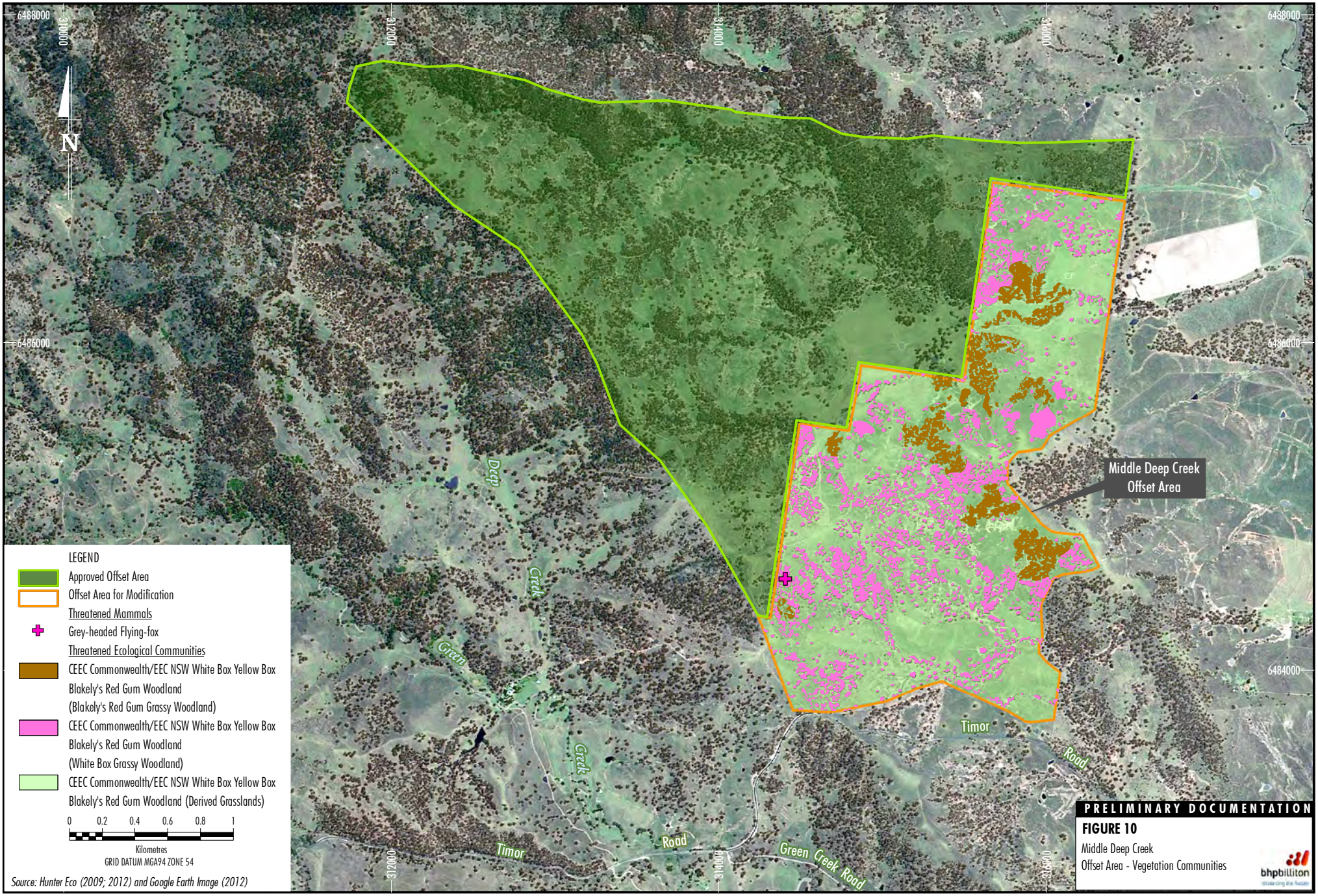
[1] White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.

Table 8 provides a summary of the proposed habitat disturbance and offset for relevant MNES. The offset areas for the relevant MNES are substantially greater than the existing habitat in the disturbance area (Table 8).

Table 8
Summary of Disturbance and Offset for Relevant Matters of National Environmental Significance

	Disturbance (ha)			Offset (ha)		
	Woodland	Grassland	Total	Woodland	Grassland	Total
Box-Gum Woodland CEEC	23.2	35.2	**58.4**	108.2	427	**535.2**
Threatened Species: • Regent Honeyeater; • Swift Parrot; • Grey-headed Flying-fox; • Large-eared Pied Bat; and • South-eastern Long-eared Bat.	53.4	N/A*	**53.4**	113.7	427*	**540.7**
Threatened Species: • Spot-tailed Quoll.	53.4	173	**226.4**	113.7	427	**540.7**

* The derived grassland in the disturbance area is not considered habitat for these species, however, the derived grassland in the offset areas will be managed to encourage natural regeneration to woodland/forest providing a net gain in habitat for these species.



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Hunter Eco (2013) undertook targeted surveys for threatened species within the offset areas Middle Deep Creek Offset area. The Grey-headed Flying-fox, the only threatened species with confirmed records in the Action area, has confirmed records in the Middle Deep Creek Offset area (Figure 10). In addition, Umwelt (2013b) recorded a confident record of an *Nyctophilus* sp. (unidentified long-eared bat) using Anabat detector survey methods (with expert analysis of recordings), which indicates that this species may be present in the offset.

The average quality of the habitat in the offset areas is higher than the average quality of the habitat in the Action area. Hunter Eco (2013) (Attachment C) notes that both offset areas contain a large number of trees with habitat hollows. The offset areas also contain approximately 930 m of Saddlers Creek and an array of creek lines in the Middle Deep Creek Offset area.

Management

The existing Mt Arthur Coal Biodiversity Management Plan has been revised and submitted for approval in accordance with NSW Project Approval 09_0062 MOD1 (to include the Modification) and will be revised in accordance with any relevant requirements from the DotE, if the Action is approved. The additional proposed offset areas will be managed, secured, monitored in accordance with NSW Project Approval 09_0062 MOD1. This includes:

- control of weeds and feral animals;
- fire management;
- control of vehicular access;
- revegetation; and
- restriction of grazing.

Revegetation

A considerable part in the additional proposed offset areas are cleared lands (approximately 427 ha) comprising derived native grassland or introduced grassland. The aim of revegetation will be to manage areas to encourage natural regeneration to reinstate woodland. Where natural regeneration is not succeeding, the following management actions will be considered to improve the ecological condition of these areas:

- planting of tubestock and/or direct seeding;
- weed management;
- fencing and signage; and
- feral fauna management.

The offset areas have a history of clearing and grazing and are currently dominated by derived native grassland. Hunter Eco (2013) (Attachment C) notes that there is considerable evidence of woodland regeneration in the proposed offset areas and this would develop further under management.

Livestock Grazing Management

If livestock grazing continued, the derived grasslands would not regenerate to forest and woodland. Consequently, livestock grazing will be largely excluded from the additional proposed offset areas through installation and maintenance of stock proof fencing. Strategic grazing may be used as a management tool for conservation purposes in accordance with *A Guide to Managing Box Gum Grassy Woodlands* (Rawlings *et al.,* 2010). Reasons for grazing may be to control weeds, to control biomass or to manipulate species composition or sward structure (Rawlings *et al.,* 2010).

Costs

HVEC is responsible for funding the costs of the offset package, and associated management measures as required.

The cost of the land required for the proposed offset is approximately $16.2M. Management costs for the offset areas for the Modification are estimated to equal approximately $100,000 per annum.

Future Tenure Arrangements - Long-term Security

HVEC will make suitable arrangements to provide appropriate long term security for the offset areas in accordance with NSW Consent Condition 39, Schedule 3 of NSW Project Approval 09_0062 MOD1.

Conservation Bond

In accordance with NSW Consent Condition 41, Schedule 3 of NSW Project Approval 09_0062 MOD1, within 6 months of the DP&E approval of the Biodiversity Management Plan, the HVEC will lodge a conservation and biodiversity bond with DP&E to ensure that the offset strategy is implemented in accordance with the performance and completion criteria of the Biodiversity Management Plan.

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Section 6 – Conclusion

6 CONCLUSION

Measures are proposed in this document to avoid and mitigate impacts on the relevant MNES. While HVEC considers that an EPBC Act offset is not required due to there being no residual significant impact on the Box-Gum Woodland CEEC, Grey-headed Flying-fox as well as potentially occurring threatened species, in accordance with the DotE request for further information and in line with NSW approvals, HVEC has provided an appropriate offset for the Action which would deliver positive benefits, including long-term protection and management of habitat.

HVEC has an offset for the Action that was reviewed by OEH and approved by the Planning Assessment Commission following recommendation by the Secretary of the DP&E. These areas are additional to offsets previously approved under the EPBC Act (EPBC 2011/5866). The offset area proposed to address impacts from the Action under the EPBC Act is approximately 540.7 ha comprising:

- a 131 ha expansion of the existing Saddlers Creek Conservation area; and
- a 410 ha expansion of the existing Middle Deep Creek Offset area.

In conclusion, the likely impacts on MNES can be sufficiently managed to avoid, mitigate and offset significant impacts on MNES.

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Mt Arthur Coal

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Attachment A – Request for Preliminary Documentation

Australian Government
Department of the Environment

EPBC Ref: 2014/7377

Ms Sarah Bailey
Manager Approvals
BHP Billiton
Thomas Mitchell Drive
Muswellbrook
NSW 2333

Dear Ms Bailey

Request Preliminary Documentation
Mt Arthur Coal open cut modification, Muswellbrook, NSW (EPBC 2014/7377)

I am writing to you in relation to your proposal to continue open cut mining operations at the Mt Arthur Coal Mine for an additional operational life of four years, an increase in the open cut disturbance areas, the use of the conveyor corridor for overburden emplacement and the duplication of the existing rail loop. On 27 January 2015, I decided that this proposal required assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), to be assessed through preliminary documentation.

While I have determined that your project will be assessed by preliminary documentation, further information is required to be able to assess the relevant impacts of the action on listed threatened species and communities. Under section 95A of the EPBC Act I am writing to ask you to provide further information contained in **Attachment A** to this document.

Please note that your project will be assessed using:

- the information contained in your original referral
- the further information to be provided as requested at Attachment A, and
- any other relevant information on the matters protected by the EPBC Act.

In any correspondence with the Department please quote the title of the action and EPBC reference, as shown on the beginning of this letter. You can send information to us:

by letter NSW & ACT Section
South-Eastern Australia Environment Assessments
Department of the Environment

GPO Box 787
CANBERRA ACT 2601

by email paula.banks@environment.gov.au

Once the Department receives satisfactory information, a direction to publish will be issued so that the preliminary documentation is made available for public comment.

If you have any questions about the referral process or this decision, please contact the project manager, Paula Banks, by email to paula.banks@environment.gov.au, or telephone 02 6274 1538 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

Paula Stagg
A/g Assistant Secretary
South-Eastern Australia Environment Assessments

31 March 2015

Attachment A

Request for Preliminary Documentation

Mt Arthur Coal open cut modification, Muswellbrook, Upper Hunter, NSW

EPBC 2014/7377

General content, format and style

The Preliminary Documentation package (PD), which includes the referral information and the additional information below, should be provided as one document with attachments, and include sufficient information to avoid the need to search for supplementary reports.

The documentation should enable interested stakeholders and the Minister to understand the environmental consequences of the proposed development. The information provided should be objective, clear, succinct, and where appropriate, supported by maps, plans, diagrams or other descriptive detail.

The level of analysis and detail in the PD should reflect the level of expected impacts on the environment. Any variables or assumptions made in the assessment must be clearly stated and discussed. The extent to which limitations, if any, of available information may influence the conclusions of the environmental assessment should be discussed.

The PD should be written so that any conclusions reached can be independently assessed. To this end, all sources must be appropriately referenced using the Harvard standard. The reference list should include the address of any "web" pages used as data sources. The PD should also include a list of persons or agencies consulted and the names of, and work done by, the persons involved in preparing the documentation.

Detailed technical information, studies or investigations necessary to support the main text, should be included. It is recommended that any supporting documentation and studies, reports or literature, from which information has been extracted and which are not normally available to the public, be made available at appropriate locations during the period for public display of the PD. The proponent should also make the documentation and supporting information available on the internet at this time.

If it is necessary to make use of material that is considered to be confidential in nature, the proponent should consult the Department of the Environment on the preferred presentation of that material, before submitting the documents to the Department.

The PD should be produced on A4 size paper capable of being photocopied, with maps and diagrams on A4 or A3 size and in colour where possible. The proponent should consider the format and style of the document appropriate for publication on the internet. The capacity of the website to store data and display the material may have some bearing on how the document is constructed.

Assessment Requirements

From the information provided to date, the Department considers that the following ecological community and species listed under the EPBC Act (protected matters) are likely to be impacted by the proposed action:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland,
- Grey-headed Flying Fox *(Pteropus poliocephalus)*,
- Regent Honeyeater (*Anthochaera phrygia*), and
- Swift Parrot *(Lathamus discolor)*
- Spot-tailed Quoll (*Dasyurus maculatus maculatus* (SE mainland population))

There is evidence that the following species listed under the EPBC Act may be present, or have habitat present on-site, or in the vicinity, and may also be impacted by the proposed action:

- a leek-orchid (*Prasophyllum sp. Wybong (C.Phelps ORG 5269)*, Critically Endangered),
- Pouched Greenhood (*Pterostylis gibbosa*, Vulnerable),
- Large-eared Pied Bat (*Chalinolobus dwyeri*, Vulnerable), and
- South-eastern Long-eared Bat (*Nyctophilus corbeni*, Vulnerable).

In order to adequately assess the likely scale and potential impacts of the proposed action on the matters listed above, additional information is required as follows.

1. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. The Department notes that habitat is present onsite and in the surrounding area for the leek-orchid, Pouched Greenhood, Large-eared Pied Bat and South-eastern Long-eared Bat. From the information provided to date, the Department considers that surveys conducted have not been undertaken at the optimum time for detection of these species.

Please note that, unless it can be demonstrated that surveys have been undertaken in accordance with best practice survey techniques, additional targeted field surveys are required to be undertaken. In the case of the bat species, further surveys are not necessary if it is assumed that both species occur.

Please provide the following:

1. the survey effort, methodology and results of surveys that are timed appropriately and undertaken for a suitable period of time by a qualified person and use accepted methodology for targeting each species in their respective habitat

- Surveys should be conducted as per the threatened orchid survey guidelines available at: http://www.environment.gov.au/resource/draft-survey-guidelines-australias-threatened-orchids and the survey guidelines for Australia's threatened bats available at: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-bats-guidelines-detecting-bats-listed-threatened.

2. a description of the distribution and abundance of these species, including, but not limited to, the estimated size, density and location of occurrences on-site and in the region

3. a quantification and description of the extent of suitable habitat on-site and in the region (including whether the habitat is critical to the survival of the species), and

4. maps displaying the above information (points 1, 2 & 3) overlaid with the proposed action.

2. RELEVANT IMPACTS

A. The Department requires additional information to determine the direct and indirect impacts to protected matters onsite. For each protected matter likely to be impacted by the proposed action, please provide a description of all of the direct and indirect impacts that the action will have, or is likely to have. Impacts to habitat both onsite and within adjacent land should be considered. Please include:

1. a detailed assessment of the nature and extent of the likely relevant impacts, quantifying the total amount of suitable habitat (in hectares) expected to be impacted by the proposed action

2. an account of the impact to habitat and/or habitat connectivity/corridors

3. an analysis of the scale of the impacts relative to the local and regional occurrences of the threatened species surrounding the site

4. indirect impacts, including edge effects, spread of weeds, erosion and sedimentation, and their likely extent.

B. Should the leek-orchid, Pouched Greenhood, Large-eared Pied Bat or South-eastern Long-eared Bat be found during additional surveys, or assumed present, they must be included in the description at 2A.

3. PROPOSED AVOIDANCE, SAFEGUARDS AND MITIGATION MEASURES

A. Please provide a consolidated list of avoidance and mitigation measures that will be undertaken to prevent or minimise potential direct and indirect impacts (refer to section on relevant impacts) to the protected matters, including:

1. a description of the proposed avoidance and mitigation measures, including for each measure, the environmental objectives, performance criteria, monitoring, reporting (by whom, to whom, how often), corrective actions (including thresholds for actions), responsibility and timing for proposed mitigation measures
2. an assessment of the expected or predicted effectiveness of the mitigation measures in reducing impacts on each particular matter of NES, including supporting evidence
3. any statutory or policy basis for the mitigation measures, and
4. the cost of the mitigation measures, including how measures will be funded in perpetuity (and by whom).

B. Should the leek-orchid, Pouched Greenhood, Large-eared Pied Bat or South-eastern Long-eared Bat be found during additional surveys, or assumed present, they must be included in the list at 3A.

4. OFFSETS

In the event that there are significant impacts that cannot be avoided or mitigated, a description of any offsets to compensate for any predicted or potential residual impacts on threatened species and ecological communities must be provided for each protected matter.

Where a project demonstrates compliance with an endorsed state or territory policy, the EPBC Act Offsets Policy and Guide will not need to be separately considered by the Minister or his delegate. Endorsed Policies are outlined in the draft "Environment Protection and Biodiversity Conservation Act 1999—Assessment Bilateral Agreement Conditions Policy", February 2015. The EPBC Act Offsets Policy will continue to apply where the project does not fully comply with the endorsed state or territory policy. Please provide information to demonstrate compliance with an endorsed state policy or provide the information as described at **Addendum A** to meet the EPBC Act Offsets Policy.

The Department considers that an offset package is required to compensate for the residual impacts to White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, the Grey-headed Flying Fox, Regent Honeyeater, Swift Parrot and Spot-tailed Quoll as a result of the proposed action.

A. Please provide an offset package for these protected matters; and

B. Should the leek-orchid, Pouched Greenhood, Large-eared Pied Bat or South-eastern Long-eared Bat be found during additional surveys or assumed present, and impacts to these species are determined to be significant, offsets must be provided.

Addendum A

MEETING THE REQUIREMENTS OF THE EPBC ACT OFFSET GUIDE

Offset measures should be consistent with the Department's the *EPBC Act environmental offsets policy* (October 2012) available at: www.environment.gov.au/epbc/publications/environmental-offsets-policy.html.

Providing answers to the following items will assist the Department to determine whether your offset measures are consistent with this policy.

A. Details in relation to a proposed offsets package, must include for direct offsets:

   i. the location and size, in hectares, of any offset site(s);

   ii. maps clearly showing for each offset site:
      - the relevant ecological features;
      - the landscape context; and
      - the cadastre boundary.

   iii. the current and future tenure arrangements (including zoning and ownership) of any proposed offset sites;

   iv. confirmed records of presence (or otherwise) of relevant protected matter(s) on the offset site(s); and

   v. detailed information regarding the presence and quality of habitat for relevant protected matter(s) on the offset site. The quality of habitat should be assessed in a manner consistent with the approach outlined in the document titled *How to use the offset assessment guide* available at: http://www.environment.gov.au/epbc/publications/environmental-offsets-policy.html;

B. Details and justification on how the offsets package will deliver a conservation outcome that will maintain or improve the viability of the protected matter(s) consistent with the *EPBC Act environmental offsets policy* (October 2012); including:

   i. management actions that will be undertaken that improve or maintain the quality of the proposed offset site(s) for the relevant protected matter(s). Management actions must be clearly described, planned and resourced as to justify any proposed improvements in quality for the protected matter(s) over time. Evidence of the likely effectiveness/success of any proposed management actions (i.e. rehabilitation / restoration / re-creation of habitat) must be provided.

   ii. the time over which management actions will deliver any proposed improvement or maintenance of habitat quality for the relevant protected matter(s). This should include the timing for delivery of the offset (e.g. timing of proposed rehabilitation/restoration of habitat in relation to the timeframe for the proposed action).

   iii. the risk of damage, degradation or destruction to any proposed offset site(s) in the absence of any formal protection and/or management over a

foreseeable time period (20 years). This information is important in determining the comparative benefit of a proposed offset. Such risk assessments may be based on:

- presence of pending development applications, mining leases or other activities on or near the proposed offset site(s) that indicate development intent;
- average risk of loss for similar sites; and
- presence and strength of formal protection mechanisms currently in place.

iv. the legal mechanism(s) that are proposed to protect offset site(s) into the future and avert any risk of damage, degradation or destruction.

C. Information regarding how the proposed offsets package is additional to what is already required, as determined by law or planning regulations, agreed to under other schemes or programs or required under an existing duty-of-care.

D. The overall cost of the proposed offsets package; including costs associated with, but not limited to:

i. acquisition and transfer of lands/property;

ii. implementation of all related management actions; and

iii. monitoring, reporting and auditing of offset performance.

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Attachment B –
Letter from Dr Colin Driscoll (Hunter Eco)

14 March 2016

Sarah Bailey
HVEC
Thomas Mitchell Drive
Muswellbrook, NSW, 2333

Dear Sarah

MT ARTHUR COAL MINE OPEN CUT MODIFICATION (2014/7377) – THREATENED ORCHID SURVEY

We refer to our previous letter dated 12 May 2015 regarding the timing of threatened orchid surveys at Mt Arthur Coal Mine. Consistent with the *Draft Survey Guidelines for Australia's Threatened Orchids - Guidelines for Detecting Orchids Listed as 'Threatened' Under The Environment Protection and Biodiversity Conservation Act 1999* (Orchid Survey Guideline) (Commonwealth of Australia, 2013), targeted surveys for the Leek-Orchid (*Prasophyllum* sp. Wybong) and the Pouched Greenhood (*Pterostylis gibbosa*) were undertaken on 19 September 2012.

A map of the GPS survey tracks on 19 September 2012 within the Modification Areas B and C is provided below. These were the only areas considered to be of potentially suitable habitat being mostly open native grassland with areas of grassy woodland. These areas were conservatively considered to be potential habitat, though neither species has been recorded near the study area, despite many ecological surveys in the vicinity of Mt Arthur Coal Mine in its decades of operation (i.e. since the 1960s).
The level of survey effort was considered to be consistent with the draft survey guidelines (Commonwealth of Australia, 2013) because:

- **The timing of the survey is consistent with the guideline requirements** for peak detectability *(i.e. Spring [the leek orchid] and August/September [Pouched Greenhood]).*
- **Replicated sampling occurred** as multiple locations were checked on 19 September 2012 as evidenced by the GPS survey tracks above (including areas outside of the Action area).
- **Timing coincided with flowering of nearby populations** (as described below).

It is noted that the survey guidelines (Commonwealth of Australia, 2013) state:

> *The most reliable way to demonstrate that the surveys were conducted at an appropriate time is to coincide the survey with the flowering time of another known nearby population of the target species. The extent of the flowering within the known population compared to other years will give an indication of how favourable the current season is and thus whether, although surveyed at flowering time, there was still a low possibility of detection due to poor seasonal conditions.*

Discussion of the flowering time of other known populations is provided below.

Leek-Orchid (*Prasophyllum* sp. Wybong)

A population of the Leek-orchid is in the vicinity of Mt Arthur at the nearby Mangoola Mine (approximately 15 km north-west of Mt Arthur). At the time of the Mt Arthur survey, I confirmed via telephone with Dr Stephen Bell (Consultant, Eastcoast Flora Survey) that the *Prasophyllum* sp. Wybong was flowering at the time. Attached is a letter from Dr Bell which documents this.

I have also previously observed this population and confirm that the potential habitat at Mangoola contains broad similarities to the potential habitat in the Action Area.

In addition, another rare orchid (*Diuris tricolor*), that co-flowers with the Leek Orchid in the region, was observed flowering on HVEC-owned land near Thomas Mitchell Drive at this time, further indicating that the surveys were conducted at an appropriate time, and in potentially suitable habitat.

GPS tracks of ground orchid survey 19 September 2012

HUNTER ECO · ABN 25 112 984 240
PO Box 1047, Toronto, NSW 2283 **Phone/Fax** +61 2 4959 8016 **Mobile** 0438 773 029 **Email** cd_enviro@bigpond.com

Pouched Greenhood (*Pterostylis gibbosa*)

Timing of the survey coincided with the National Parkes and Wildlife Service (NPWS) *Environmental Impact Assessment Guidelines Pterostylis gibbosa* (NPWS, 2002a):

> *Survey is recommended during the flowering period (September to October) as the presence of flower stalks makes the species easier to locate and flowers enable positive identification.*

The Mt Arthur Coal Mine occurs to the north and west of the current known range of this species.

It is noted that a population of this species occurs at Milbrodale in the Hunter Valley, approximately 45 km south of the Mt Arthur Coal Mine, where it occurs in grassy open forest (i.e. with some broad similarities to the potential habitat in the Action Area), although at Milbrodale it occurs in a Triassic landscape whereas it is a Permian landscape at Mount Arthur. In the attached letter, Dr Stephen Bell notes his familiarity with this population and describes that the survey timeframe is consistent with his observations of flowering time at Milbrodale.

It is noted that the Orchid Survey Guideline states that detailed characterisation of the potential habitat is relevant to the selection of appropriate survey methods and effort.

> *This characterisation is not only critical to establishing which threatened species may occur in the area, but also in the selection of appropriate survey methods and effort.*

Whilst there are some similarities between the broad habitat characteristics of Mt Arthur Coal Mine and Milbrodale, there are also some important differences in the specific geology and vegetation present that indicates that, whilst targeted survey is warranted, the Pouched Greenhood is not expected to occur at Mt Arthur.

With respect to the potential habitat at Mt Arthur, it is noted that the NSW BioNET database describes *Pterostylis gibbosa* habitat in the Hunter Valley:

> *In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark E. crebra, Forest Red Gum and Black Cypress Pine Callitris endlicheri.*

In addition, the *Illawarra Greenhood Orchid (Pterostylis gibbosa) Recovery Plan* (NPWS, 2002b) states:

> *The Milbrodale sub-population of P. gibbosa occurs at an elevation of 150 to 160 metres on soils derived from Triassic sedimentary rocks of the Narrabeen group.*

Therefore, the Milbrodale sub-population occurs on Triassic sedimentary rocks whereas the potential habitat at Mt Arthur occurs on Permian-derived geology. In addition, the woodland species present at Milbrodale are absent within the potential habitat at Mt Arthur. The absence of these key specific habitat characteristics justify the level of effort exerted in the survey.

CONCLUSION

The survey for the *Prasophyllum* sp. Wybong *and Pterostylis gibbosa* is considered to be in accordance with the Orchid Survey Guideline because:

- Replicated sampling occurred as the survey included multiple areas within and outside of the Action area.
- *Prasophyllum* sp. Wybong was flowering at the time at a site approximately 15 km from Mt Arthur Coal Mine, and in similar habitat, therefore the survey was conducted at the most appropriate time.
- The Mt Arthur Coal Mine occurs to the north and west of the current known range of *Pterostylis gibbosa.*
- *Pterostylis gibbosa* has been previously observed to be flowering at Milbrodale the time of the survey.
- *Pterostylis gibbosa* has only been located at five sites in NSW (NPWS, 2002b), with the closest being at Milbrodale in the Hunter Valley. The specific habitat characteristics in the Action area are not consistent with those at Milbrodale (i.e. the Milbrodale sub-population occurs on Triassic sedimentary rocks whereas the potential habitat at Mt Arthur occurs on Permian-derived geology). Therefore, in consideration of the specific habitat characteristics, the survey efforts and methods employed are considered to be appropriate for this species.

Should you have any queries please do not hesitate to contact me on (02) 4959 8016.

Yours faithfully,
HUNTER ECO

Dr Colin Driscoll
Environmental Biologist

HUNTER ECO · ABN 25 112 984 240
PO Box 1047, Toronto, NSW 2283 **Phone/Fax** +61 2 4959 8016 **Mobile** 0438 773 029 **Email** cd_enviro@bigpond.com

Attachment 1 – letter from Dr Stephen Bell (Consultant, Eastcoast Flora Survey)

EASTCOAST FLORA SURVEY
VEGETATION ASSESSMENT & MAPPING

PO Box 216 KOTARA FAIR NSW 2289
Ph. 02 4953 6523
ABN 38 325 015 471

14 March 2016

Dr Colin Driscoll
Hunter Eco
PO Box 1047 Toronto NSW 2283

Dear Colin

ORCHID FLOWERING & SURVEY TIMING

As requested, I provide advice with respect to flowering times of two threatened orchid species which were used to inform your survey timing for these species in September 2012 at Mount Arthur Coal.

Leek-Orchid (*Prasophyllum* sp. Wybong)

The Leek-orchid population at Mangoola Mine has been regularly surveyed by me since 2009, and flowering is known to reliably occur in mid-late September each year, with some individuals flowering into mid-October. I recall a conversation with you in mid-September 2012 where I advised that the orchids were flowering at Mangoola at that time. My records show that I recorded budding, flowering and fruiting individuals of *Prasophyllum* on 21 September 2012, and in subsequent years flowering has been recorded as early as 28 August (in 2014).

Therefore, I consider that your survey on 19 September 2012 was timed to coincide with flowering of a known nearby population.

Pouched Greenhood (*Pterostylis gibbosa*)

A population of the Pouched Greenhood occurs in Milbrodale in the Hunter Valley. I have previously monitored this population (as *P*. sp. E, prior to its inclusion in *P. gibbosa*) on two occasions, with reference to the following publications:

- Bell, S.A.J. (1994) *Survey of the Rare and Endangered Terrestrial Orchid* Pterostylis *sp. E at Milbrodale, south of Singleton*. Unpublished Report to Greening Australia & Hunter Catchment Management Trust. November 1994.
- Bell, S.A.J. (1995) *Second Survey of the Rare and Endangered Terrestrial Orchid Pterostylis sp. E at Milbrodale, south of Singleton*. Unpublished Report to Greening Australia & Hunter Catchment Management Trust. November 1995.

From my experience with this Milbrodale population, flowering is known to occur in mid-late September; my one-off survey data for 1994 is dated 29 September, but this was collected some days after flowering had commenced. The flowering of Pouched Greenhood was also discussed in our conversation in 2012. Might I add that the population at Milbrodale occurs on a low flat spur of Narrabeen sandstone/shale, elevated ~50m above the flatter Permian clays. I am not aware of any other population of this species within the Hunter Valley, apart from a collection made by John Hosking from the Wingen area in 1998, which is also an area of Narrabeen sandstone on top of Permian clays.

I note that the Recovery Plan for this species (NPWS 2002) states flowering occurs between September and October, but can begin in late August and extend until early December. Based on this information, I consider that your survey on 19 September 2012 was likely timed to coincide with flowering of a known population in the Hunter Valley.

As requested, my Curriculum Vitae is attached.

Yours faithfully,

Dr Stephen Bell
Vegetation Scientist

Attachment 1 – Stephen Bell Curriculum Vitae

Curriculum Vitae: Dr. Stephen A.J. Bell

Eastcoast Flora Survey
PO Box 216
KOTARA FAIR NSW 2289

Telephone: (02) 4953 6523
Mobile: (0407) 284 240
e-mail: sajbell@bigpond.com

Profile: http://www.stephenbell.com.au/

Conjoint Fellow School of Environmental & Life Sciences, University of Newcastle, Callaghan NSW 2308 (stephen.bell@newcastle.edu.au)

Profile: http://www.newcastle.edu.au/profile/stephen-bell

PRÉCIS

Stephen has been involved in native vegetation survey, classification and mapping in the Greater Sydney and Hunter Regions since 1990. During this time, he has undertaken comprehensive surveys for the National Parks and Wildlife Service in over 30 conservation reserves, and has been contracted to the NSW Office of Environment & Heritage as Senior Botanist and Team Leader for several large scale regional projects within the Sydney Basin bioregion. Under contract to local Councils, Stephen has co-ordinated and completed LGA-wide vegetation classification and mapping projects for Wyong, Gosford, Cessnock, Pittwater and Lake Macquarie LGAs, and has assisted in similar mapping projects for Blue Mountains LGA. Stephen has also completed several studies on Endangered Ecological Communities and threatened plant species, and published the results of some of these in the scientific literature.

On behalf of the Ecological Society of Australia, Stephen was the ecological expert on the Hunter Regional Vegetation Committee (2003), and is a past member of the Hunter Threatened Flora Recovery Team, and a founding member of the Hunter Rare Plants Committee (a sub-committee of the Hunter Region Botanic Gardens). He is also often called upon by Government for advice regarding the significance of vegetation communities and plant species within the northern Sydney Basin bioregion, and has sat on numerous expert panels in this regard. Stephen has been called upon as an Expert Witness for several cases heard in the NSW Land and Environment Court, where his knowledge on the vegetation of the Sydney Basin bioregion has been used to argue contentious land-use decisions.

Stephen has published several scientific papers on various aspects of the vegetation of the Sydney Basin, including classifications of vegetation within conservation reserves, threatened and rare plant species, and the description of new plant species. Stephen has completed nearly 4000 standard full floristic sampling plots within the Sydney Basin, which are stored and used in classification analyses for many projects. Other skills include extensive multivariate data analysis experience, and GIS mapping. Stephen's PhD thesis, completed on a part-time basis through the University of Newcastle, presented improvements in the recognition, identification and classification of restricted and significant vegetation communities, such as Threatened Ecological Communities (TECs).

In October 1996, Stephen established *Eastcoast Flora Survey*, a specialist botanical consultancy providing high quality services to government and the private sector.

ACADEMIC QUALIFICATIONS

Doctor of Philosophy (PhD), 2013	*Defining and mapping rare vegetation communities: Improving techniques to assist land-use planning and conservation* (University of Newcastle)
Bachelor of Science (Honours), 1991	*Effects of the weed Scotch Broom on bird communities in open forests on Barrington Tops* (University of Newcastle)
Bachelor of Science, 1989	*Majors in Geography and Biology* (University of Newcastle)

EMPLOYMENT HISTORY

University of Newcastle	Conjoint Fellow (Plant Sciences Group)	June 2014 - Present
Eastcoast Flora Survey	Consultant Botanist (Principal)	Oct. 1996 - Present
Ecotone Ecological Consultants Pty Ltd	Manager - Flora Studies	Jan. 1996 - Oct. 1996
Private Ecological Consultant	Sole trader	Jan. 1991 - Dec. 1995
NSW National Parks and Wildlife Service	Project Officer	Sept. 1993 - Jan. 1994
University of Newcastle, Geography Dept.	Field Tutor (Scientific)	July 1993 - Aug. 1993
NSW National Parks and Wildlife Service	Project Officer	Jan. 1993 - June 1993
University of NSW, School of Biol. Sciences	Research Assistant (Bird ecology)	Sept. 1992 - Jan. 1993
NSW National Parks and Wildlife Service	Technical Officer (Scientific)	Jan. 1992 - June 1992
RZ Mines (Newcastle)	Environmental Research Officer	Oct. 1990 - Dec. 1991
Wayne Perry & Associates P/L	Environmental Officer (Casual)	June 1990 - Oct. 1990

RESEARCH INTERESTS

- Vegetation classification and mapping, at local and regional scales
- Definition and mapping of rare and threatened vegetation communities
- Restoration of threatened grassy woodlands from derived grasslands
- Improving data sampling methods for monitoring and classification
- Re-constructing vegetation distribution using information from historical botanical explorers
- Population ecology and habitat of rare and threatened plants
- Taxonomy and significance of Hunter Region plants

MINISTERIAL APPOINTMENTS

- Committee Member, NSW Species Technical Group, Flora (*Save Our Species Program*) (2014-present)
- *Ecological Society of Australia* representative on the Hunter Regional Vegetation Committee (2001-2003)

CONFERENCE & WORKSHOP PRESENTATIONS

- Best Practice Mine Rehabilitation Conference, September 2014, Singleton, NSW; The Tom Farrell Institute for the Environment, University of Newcastle: "*Effective Biodiversity Offsets: Improving planning, valuation and monitoring practice*" (with Martin Fallding).
- Plant Identification for Flora of the Hunter Valley, 7th - 8th April 2014, Kurri Kurri, Australian Network for Plant Conservation: "*Introduction to the flora of the Hunter Valley - history, diversity and ecology*".
- HOTSPOTS Fire Project: Awabakal and Worimi Fire Forum, 27th July 2011, Williamtown, Never Never Resources: "*Vegetation of the Worimi Conservation Lands*".
- HOTSPOTS Fire Project: Wanaruah Fire Forum, 17th – 19th August 2010, Sandy Hollow, Upper Hunter Valley, Nature Conservation Council: "*Vegetation of Wanaruah Lands, Sandy Hollow*".
- Coastal Groundwater Dependent Ecosystems Workshop, 3rd – 4th September 2009, South West Rocks, NSW (Geoscience Australia): "*Surveying, classifying and mapping vegetation on the Tomago Sandbeds*".
- Vegetation Management and Biodiversity Conservation in the Hunter Region, May 2000, Singleton, NSW (Hunter Environment Lobby Inc.): "*An evaluation of vegetation survey and threatened plant species listings in the Hunter Region*"

PROFESSIONAL MEMBERSHIPS

- Ecological Society of Australia (ESA)
- Australian Network for Plant Conservation Inc. (ANPC)
- International Association for Vegetation Science (IAVS). Paper reviewer for *Journal of Vegetation Science*
- Australasian Native Orchid Society Inc. (ANOS)
- Australasian Systematic Botany Society (ASBS)

PUBLICATIONS (PEER REVIEWED)

Bell, S.A.J. & Driscoll, C. (in review) Hunter Valley Weeping Myall Woodland – is it really definable and defendable with and without Weeping Myall (*Acacia pendula*)? *Cunninghamia* in review.

Bell, S.A.J. & Walsh, N. (2015) *Leionema lamprophyllum* subsp. *fractum* (Rutaceae); a new and highly restricted taxon from the Hunter Valley of New South Wales. *Telopea* 18: 505-512.

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DeLacey, C., Bell, S., Chamberlain, S., & Bossard, K. (in review) Prediction of and realised habitat for a cryptic plant species: the Leafless Tongue Orchid *Cryptostylis hunteriana* Nicholls. *Cunninghamia*

Bell, S.A.J. & Driscoll, C. (2014) *Acacia pendula* (Weeping Myall) in the Hunter Valley of New South Wales: early explorers' journals, database records and habitat assessments raise doubts over naturally occurring populations. *Cunninghamia* 14: 179-200.

Bell, S.A.J. & Nicolle, D. (2012) *Eucalyptus expressa* (Myrtaceae): a new and distinctive species from the sandstone ranges north-west of Sydney, New South Wales. *Telopea* 14: 69-76.

Bell, S.A.J. & Stables, M. (2012) Floristic variability, distribution and an extension of range for the endangered Pittwater Spotted Gum Forest, Central Coast, New South Wales. *Cunninghamia* 12(2): 143-152.

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Bell, S.A.J. (2008) Rare or threatened vascular plant species of Wollemi National Park, central eastern New South Wales. *Cunninghamia* 10(3): 331-371.

Bell, S., Branwhite, B., & Driscoll, C. (2005) *Thelymitra 'adorata'* (Orchidaceae): population size and habitat of a highly restricted terrestrial orchid from the Central Coast of New South Wales. *The Orchadian* 15(1): 6-10.

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Bell, S.A.J. (2002) Habitat of the endangered *Hibbertia procumbens* (Labill.) DC (Dilleniaceae) from the Central Coast of New South Wales. *Victorian Naturalist* 119(2): 69-74.

Bell, S.A.J. (2001) Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* Nicholls (Orchidaceae) from the Central Coast of New South Wales. *Cunninghamia* 7(2): 195-204.

Bell, S.A.J. (2001). Notes on the distribution and conservation status of some restricted plant species from sandstone environments of the upper Hunter Valley, New South Wales. *Cunninghamia* 7(1): 77-88.

Bell, S. (2000) An evaluation of vegetation survey and threatened plant species listings in the Hunter Region. Pp. 19-34 IN *Vegetation Management and Biodiversity Conservation in the Hunter Region - Where to from here?* Ed. by M.Fallding. Proceedings of the Public Workshop. Hunter Environment Lobby. Singleton, 12 May 2000.

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Bell, S. & Holzinger, B. (2015) Wildfire reveals new populations of the endangered *Commersonia rosea* and *Monotaxis macrophylla* in northern Wollemi National Park, NSW. *Australasian Plant Conservation* 23: 2-4.

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NSW LAND & ENVIRONMENT COURT (EXPERT WITNESS)

Bell, S.A.J. (2012) *Expert Report: Bulga Milbrodale Progress Association v Minister for Planning and Infrastructure and Warkworth Mining Limited*. Land and Environment Court Proceedings No: 10224 of 2012. Unpublished Report to EDO NSW, July 2012.

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Mt Arthur Coal

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resourcing the future

Attachment C –
Mt Arthur Coal Open Cut Modification
Ecological Assessment (Hunter Eco)

Mt Arthur Coal Open Cut Modification

Ecological Assessment

By Hunter Eco

January 2013

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Executive Summary

Hunter Valley Energy Coal (HVEC) seeks to modify the existing Project Approval (PA 09_0062) for the extension of open cut coal mining at the Mt Arthur Coal Complex. The Mt Arthur Coal Mine is located in the Hunter Valley, New South Wales (NSW). The Mt Arthur Coal Open Cut Modification (herein referred to as the Modification), is a proposed continuation of open cut mining operations at the Mt Arthur Coal Mine for an additional operational life of approximately four years. The continuation of mining would include an extension to the west and south-west of approximately 400 metres.

HVEC is seeking environmental approval for the Modification under section 75W of the NSW *Environmental Planning and Assessment Act, 1979*. The purpose of this report is to provide an assessment of the potential ecological impacts associated with the Modification. The assessment has been prepared in accordance with the relevant legislation, policies and guidelines.

This report describes ecology within the proposed disturbance area and immediate surrounds. Floristic and fauna data was collected and vegetation communities were mapped across the Modification areas. Species, populations and communities listed as threatened in the schedules of the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) were the main focus of this assessment.

Assessment Methods

The assessment methodology used in this document was developed in accordance with the NSW Department of Environment and Conservation and NSW Department of Primary Industries 2005 *Draft Guidelines for Threatened Species Assessment*. This terrestrial flora and fauna assessment utilised relevant database sources, a review of past and recent surveys conducted in the Modification areas and surrounds, combined with a supplementary flora and fauna habitat field assessment.

Various flora and fauna surveys have been undertaken in the Modification area, and the area within and surrounding the Mt Arthur Coal Mine. These surveys were mainly associated with environmental assessments for various developmental stages of the Mt Arthur Coal Mine. The most recent flora and fauna surveys were undertaken in 2012 by Hunter Eco and Niche Environment and Heritage (Niche). The 2012 Niche fauna survey report is provided as an attachment to this flora and fauna assessment.

The survey methodology utilised by Hunter Eco and Niche generally conformed with the NSW Department of Environment and Conservation 2004 *Threatened Biodiversity Survey and Assessment Guidelines*. Flora surveys were conducted over seven days from 16 April 2012 to 9 May 2012, September 9 -12 and September 19 while fauna surveys were undertaken over six days on 1 May 2012 and from 7 to 11 May 2012. Threatened species that are known to occur or likely to occur were targeted during the surveys.

The survey techniques for flora included:

- targeted searches for threatened flora species;
- flora plots;
- random meanders; and
- linear transects.

The survey techniques for vertebrate fauna included:

- arboreal Elliot trapping;
- infra-red camera traps;
- hair tubes;
- ultrasonic call recording for bats;
- diurnal bird surveys;
- spotlighting;
- call playback;
- stag watching;
- koala scat searches;
- herpetological surveys; and
- frog chorus survey and aquatic habitat surveys.

Flora

The Modification area is situated within a mining and agricultural landscape. The natural vegetation in and around the Mt Arthur Coal Mine had been predominantly cleared for a variety of agricultural purposes prior to mining.

During the current survey, 239 flora species, comprising 172 native and 67 exotic species, were recorded within the Modification area. These species belong to 58 families, dominated by Poaceae (Grasses) (57 flora species), Asteraceae (Daisies) (36 flora species) and Fabaceae (Faboideae) (Legumes) (17 flora species).

One threatened flora species listed under the EPBC Act, Lobed Blue-grass (*Bothriochloa biloba*), was recorded during the current surveys in Modification Area A and surrounds. Also, one threatened population listed under the TSC Act, *Acacia pendula* (Weeping Myall) population in the Hunter catchment, was recorded in Modification Area A and surrounds.

Eleven vegetation communities were identified and mapped in the Modification area. Six of the vegetation communities identified in the Modification area represent five threatened ecological communities (TECs) listed under the TSC Act and one TEC listed under the EPBC Act. These communities included:

- *White Box Yellow Box Blakely's Red Gum Woodland* (listed under the EPBC Act as the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland*);
- *Hunter Lowland Redgum Forest* in the Sydney Basin and NSW North Coast Bioregions;
- *Central Hunter Ironbark—Spotted Gum—Grey Box Forest* in the NSW North Coast and Sydney Basin Bioregions;
- *Central Hunter Grey Box – Ironbark Woodland* in the NSW North Coast and Sydney Basin Bioregions; and
- *Hunter Valley Weeping Myall Woodland* of the Sydney Basin Bioregion.

This document assesses the potential impacts on each threatened flora species, population and TEC present, or likely to occur, in the Modification area.

Fauna

Habitat within the Modification area is mixed, consisting of derived grassland, forest and woodland. Eight broad fauna habitat types are recognised in the Modification area: Forest, disturbed Forest, Grassy Woodland, Disturbed Grassy Woodland, Grassland, Disturbed, Reeds and Rushes and Plantation. Derived grassland supports a mixture of native and exotic grass species and occurs within the Modification area due to historic clearing of woodland or forest habitats for agricultural purposes. Due to historic clearing, habitat features and complexity within the existing grassland habitat is limited.

Aquatic habitat features within the Modification area are limited to small ephemeral streams within Modification Areas B and C and a first/second order ephemeral stream within Modification Area D. The ephemeral creeks within Modification Areas B and C are situated at the top of the Saddlers Creek catchment and consist of first to second order watercourses with irregular, limited flow regimes. Although creek beds are in moderate to good condition, the limited flow regime restricts potential aquatic habitat features along the watercourses.

During the current survey, 77 fauna species, comprising three amphibians, five reptiles, 44 birds and 25 mammals were recorded within the Modification area. Of these, six were introduced species.

Historically, 22 threatened fauna species listed under the TSC Act and/or EPBC Act have been recorded in the Modification area or surrounds. Most of these species have been recorded in the wider area at the Mt Arthur Coal Mine. Two threatened bird species and three threatened mammal species have been recorded in the Modification area: Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), Varied Sittella (*Daphoenositta chrysoptera*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Freetail-bat (*Mormopterus norfolkensis*) and Southern Myotis (*Myotis macropus*).

The Grey-headed Flying-fox and Eastern Freetail-bat were recorded during the surveys conducted by Niche. The Grey-headed Flying-fox was recorded at five locations within the study area, while the Eastern Freetail-bat was recorded once during the survey.

No threatened species or TECs listed under the NSW *Fisheries Management Act, 1994* (FM Act) have been identified or are likely to occur with the Modification area, or surrounds, and are therefore not considered relevant to this flora and fauna assessment.

This document assesses the potential impacts on each threatened fauna species present, or likely to occur, in the Modification area.

Evaluation of Potential Impacts on Flora and Fauna

The significance of potential project impacts on threatened species, populations and their habitats, as well as TECs, have been identified and described in this assessment. This includes consideration of key threatening processes listed under the TSC Act, FM Act and EPBC Act. The potential ecological impacts resulting from the Modification include the:

- clearing of 228.9 hectares (ha) of native vegetation, comprised mostly of derived grasslands/reeds (175.5 ha) and Box-Gum woodland (26.6 ha), some of which is known habitat for threatened fauna species listed under the TSC Act;
- removal of approximately 90.3 ha of TECs (within the total 228.9 ha of native vegetation to be cleared);
- clearing of approximately 0.1 ha of the endangered population, *Acacia pendula* in the Hunter Catchment (within the total 228.9 ha of native vegetation to be cleared);
- removal of potential habitat for the threatened *Diuris tricolor;*

- reduction in the connectivity of habitat resources for some flora and fauna species; and
- displacement and/or loss of native vertebrate fauna associated with native vegetation clearing.

Impact assessments have been conducted on all potentially occurring threatened populations, TECs and species listed under the TSC Act. It is concluded that the Modification would not result in a significant impact on any endangered populations, TECs, threatened flora or threatened fauna species.

Impact Avoidance, Mitigation and Offset Measures

A number of management measures have already been implemented to limit ecological impacts from the approved Mt Arthur Coal Mine operations. These measures would be revised to include the actions associated with the Modification. As part of the Modification, the Mt Arthur Coal Mine Biodiversity and Rehabilitation Management Plan would be amended to include biodiversity offsets that would result in an overall gain in biodiversity.

Offset areas have been proposed along Saddlers Creek immediately south of the existing Mt Arthur Coal Mine operations area, and Middle Deep Creek in the Timor district located approximately 70 km north of Muswellbrook. These areas provide similar habitat to that which would be lost as a result of the Modification. In the case of the Middle Deep Creek Offset area, the habitat is superior as demonstrated by confirmation of seven threatened woodland bird species, two mammals and members of one endangered population.

The Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions endangered ecological community is not present in the proposed offset areas. HVEC would, however, provide an additional offset for this community in a location to be determined.

Habitat values of the proposed offset areas would increase through management actions that involve reduction or exclusion of grazing, land remediation and active rehabilitation. It is important to note that the offsets would be established, and their management plans implemented, immediately upon approval of the Modification. In addition, the Modification area would be rehabilitated upon completion of mining and a substantial net gain in biodiversity would result from the combined Modification and proposed offsets.

1 Introduction

1.1 Background

The Mt Arthur Coal Mine is located approximately 5 kilometres (km) south-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW) (**Figures 1** and **2**). The Mt Arthur Coal Mine is owned and operated by Hunter Valley Energy Coal (HVEC), a wholly owned subsidiary of BHP Billiton.

HVEC propose a modification to the existing Project Approval (09_0062) under section 75W of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) (herein referred to as the Modification).

The Modification includes a continuation of open cut mining operations at the Mt Arthur Coal Mine for an additional operational life of approximately four years. The Modification includes the following key components:

- a four year continuation of the open cut mine life from 2022 to 2026 at the currently approved maximum rate of 32 million tonnes per annum;
- an increase in open cut disturbance areas;
- use of the conveyor corridor for overburden emplacement;
- duplication of the existing rail loop;
- an increase in the maximum number of train movements per day from 24 to 38;
- the relocation of the load point for the overland conveyor which delivers coal to Macquarie Generation's Bayswater Power Station;
- the relocation and upgrade of the explosives storage, magazine and associated facilities; and
- the construction of additional offices and a control room and a small extension to the run-of-mine coal stockpile footprint.

Not all of the proposed changes would involve habitat disturbance and those that would are shown on **Figure 3** and can be summarised as follows:

- Areas A, B and C are proposed extensions to the open cut;
- Area D is a proposed overburden emplacement area; and
- Area E takes in the proposed duplication of the rail loop.

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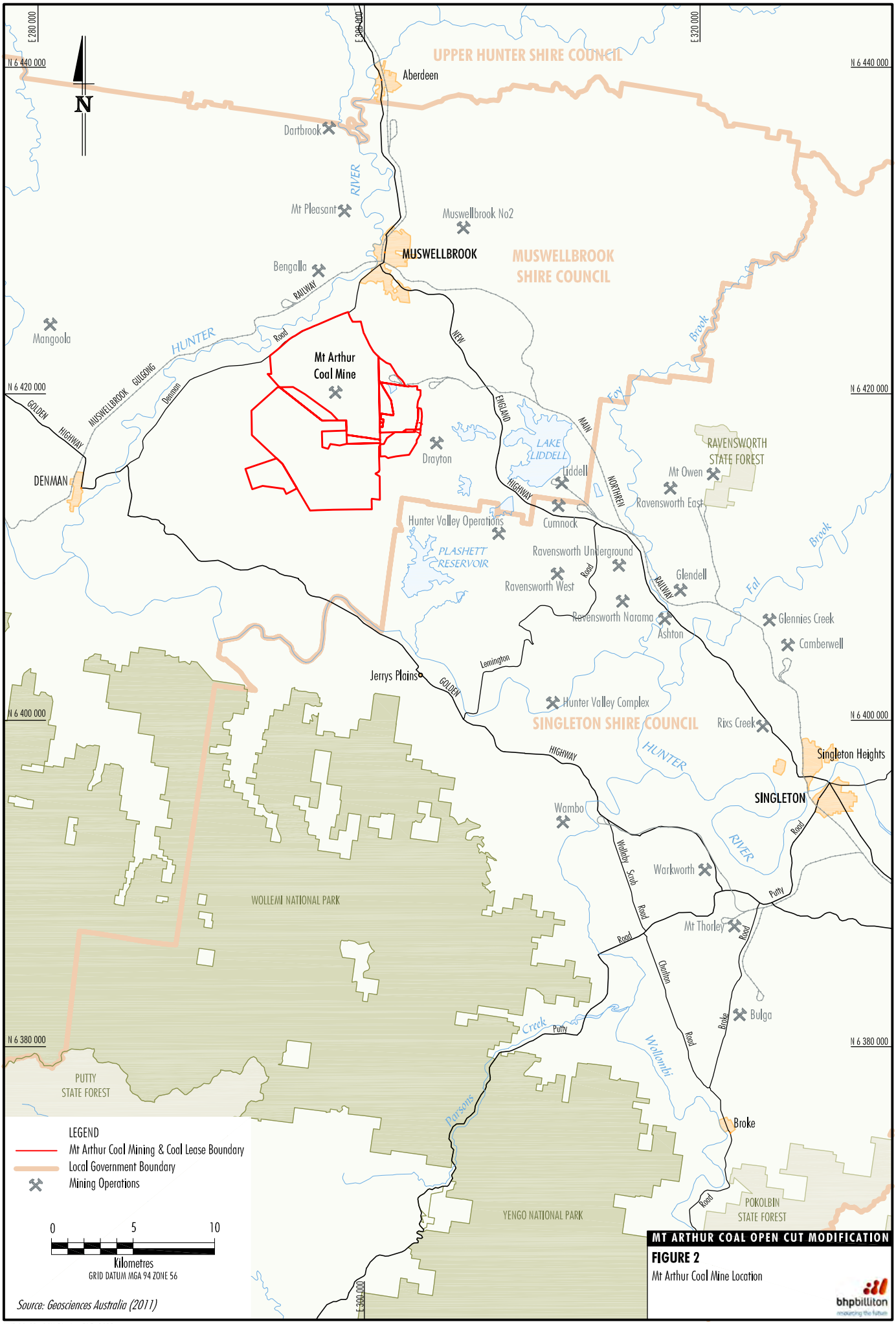

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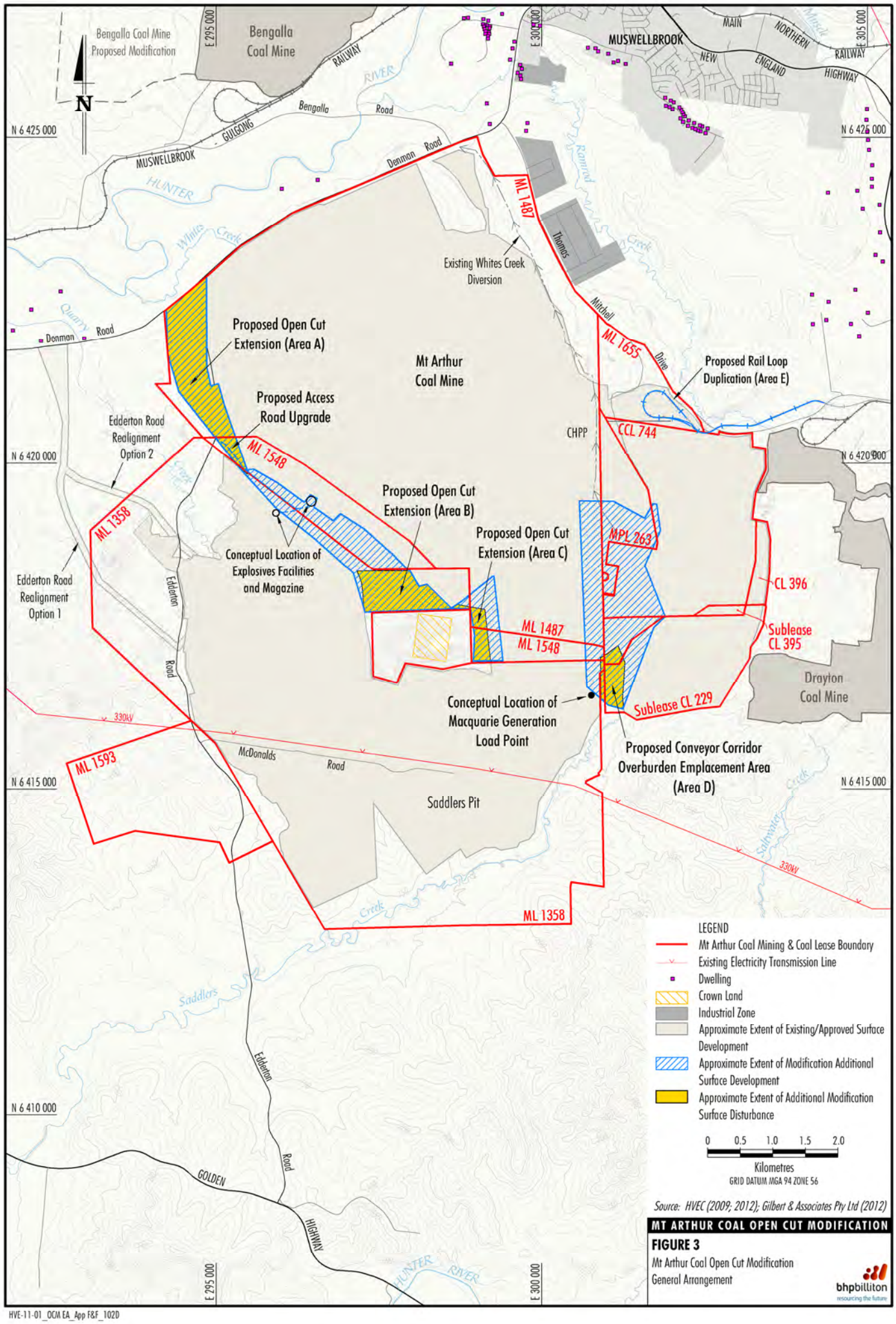

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1.2 Scope of this Report

This report describes the methods and results of an investigation into the ecological impact of mining activities in the Modification area. The primary focus of the investigation was on occurring and potentially occurring species, populations and communities listed as threatened under the NSW *Threatened Species Conservation Act, 1995* (TSC Act), NSW *Fisheries Management Act, 1999* and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

As the Modification is to be assessed under section 75W Part 3A of the EP&A Act, the investigation and impact assessment was conducted in accordance with the *Draft Guidelines for Threatened Species Assessment* (NSW Department of Environment and Conservation [DEC] and NSW Department of Primary Industries [DPI], 2005).

The aim of this investigation was to conduct a thorough assessment of the environment in and around the Modification area to maximise the opportunity for detecting threatened species, populations and communities. The assessment did not rely only on survey field results, but also took historical and regional data into account. Where survey timing was not optimal for a particular threatened species, but suitable habitat was present or previous surveys had observed the species that species was considered to be present for the purposes of the impact assessment.

2 Existing Environment

2.1 Regional Location

The Modification area is situated in a mining and agricultural landscape. **Figure 3** shows the extent of the currently approved mining area. Modification Area D is already surrounded by mined land, as is Modification Area E (**Figure 3**). The natural vegetation in and around the Mt Arthur Coal Mine had been predominantly cleared for a variety of agricultural purposes prior to mining.

The Mt Arthur Coal Mine is located in the Hunter Central Rivers Catchment Management Area, the Sydney Basin Bioregion and is at the eastern edge of the Central Western Slopes botanical division.

2.2 Climate

Temperature data for Jerry's Plains, which was the nearest station with long-term records, were obtained from the Australian Bureau of Meteorology (BoM) (2012) (**Figure 4**). Mean minimum temperatures range from approximately 4 degrees Celsius (°C) to 17°C and mean maximum temperatures from approximately 17°C to 32°C (BoM, 2012).

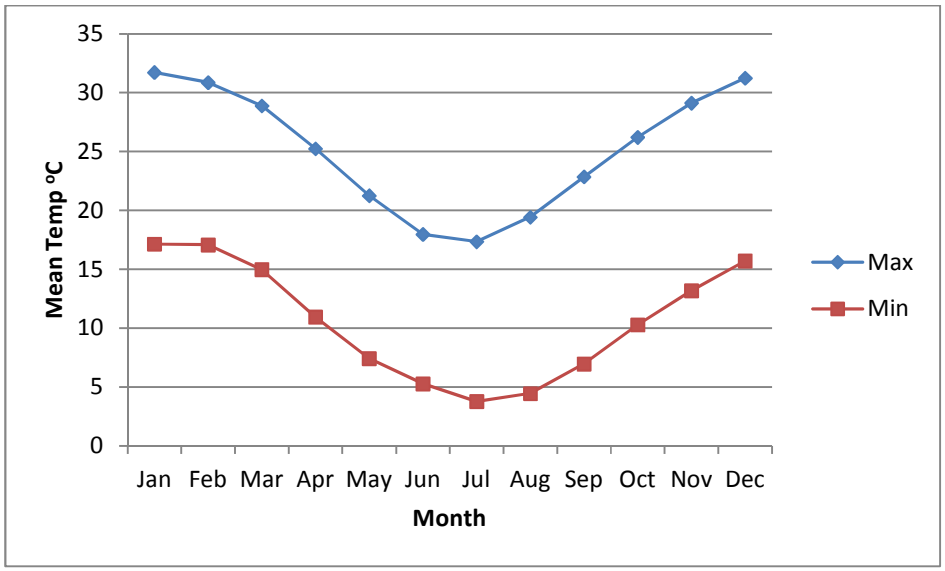


Figure 4: Mean Monthly Temperatures for Jerry's Plains 1907-2012

Rainfall data was obtained for Muswellbrook, which was the nearest station with long-term records (BoM, 2012) (**Figure 5**). The long-term mean annual rainfall is reported as 622 millimetres (mm) (BoM, 2012).

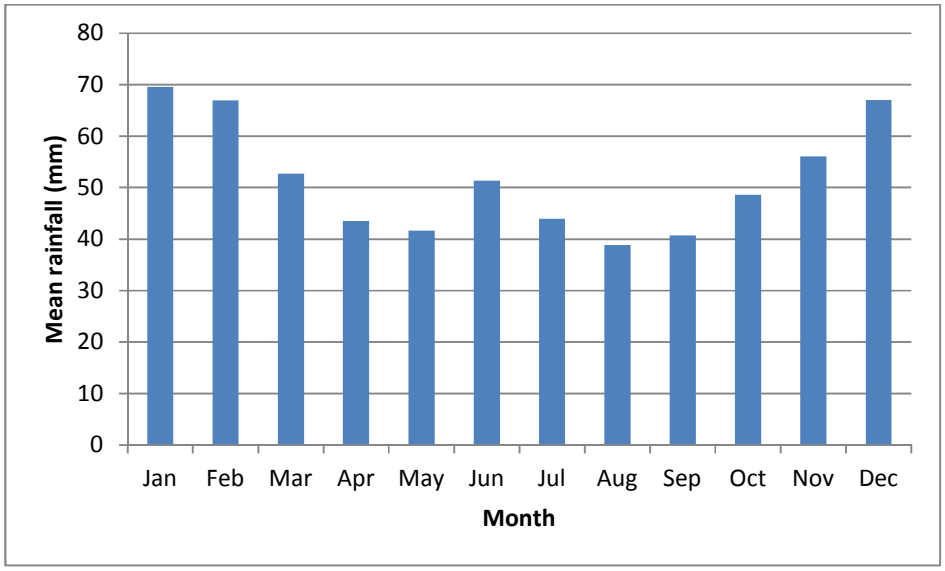


Figure 5: Mean monthly rainfall for Muswellbrook 1870-2012

2.3 Geology

The geological sequences represented in the Modification area are shown in **Table 1** (NSW Department of Mineral Resources, 1999).

Table 1: Geology of the Modification area

Geology	Age	Lithology	Modification Area
Singleton Supergroup, Whittingham Coal Measures	Permian	Coal seams, claystone tuff, siltstone, sandstone	A, B and C
Maitland Group, Mulbring Siltstone	Permian	Siltstone, claystone	D (western third)
Maitland Group, Branxton Formation	Permian	Conglomerate, sandstone, siltstone	D (eastern two thirds)
Greta Coal Measures, Rowan Formation	Permian	Coal seams, siltstone, sandstone	E

2.4 Soils

Three soil landscapes have been mapped across the Modification area (Kovak and Lawrie, 1991) as shown in **Table 2**.

Table 2: Soil types in the Modification area

Soil Landscape	Description	Modification Area
Bayswater	Covering undulating low hills. Main soil types are yellow Solodic Soils on the slopes and Alluvial Soils in drainage lines.	Area A (north) Area D (south) Area E
Liddell	Covering undulating low hills. Main soil types are Yellow Soloths and Yellow Solodic Soils on the slopes. Silaceous Sands can occur on the lower slopes.	Area A (south) Area B (north) Area C (part) Area D (north)
Ogilvie	Covering steep areas. Main soil types are shallow loams and sands.	Area B (south) Area C (centre)

2.5 Landform and Hydrology

Figure 6 shows the landforms in the Modification area, according to slope classes of McDonald *et al.,* (1998). This information is summarised in **Table 3**.

Table 3: Slope classes within the Modification area

Slope Class	Modification Area
Very gently to gently inclined	Area A
Moderately inclined with some steep areas	Area B
Steep with some moderately inclined areas	Area C
Gently to moderately inclined	Area D
Gently to moderately inclined	Area E

The hydrology around the Modification area has been substantially altered by mining. **Figure 6** also shows the creeks and flow directions through the Modification area.

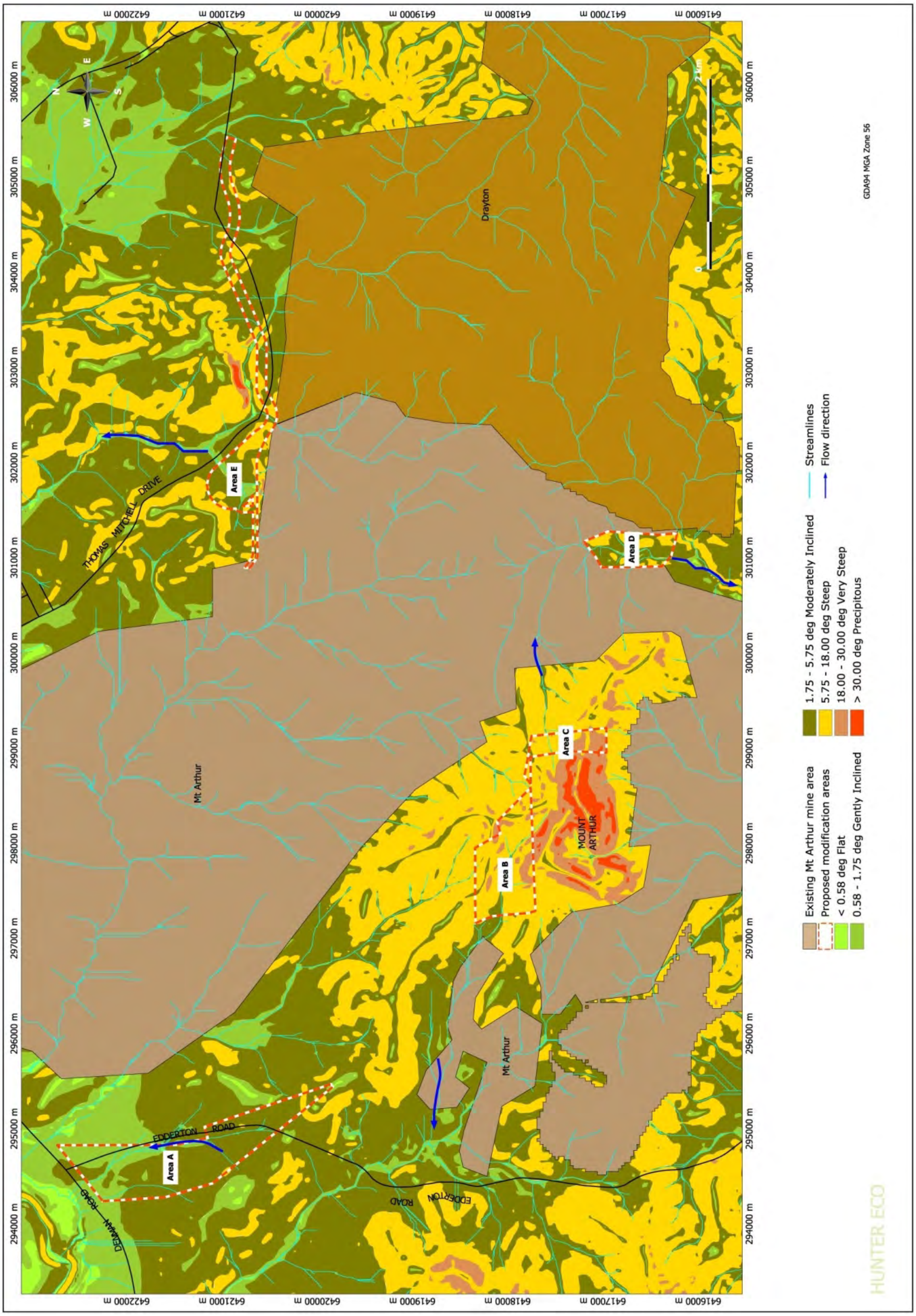


Figure 6: Landform and Hydrology in and around the Modification Area

Surface drainage generally comprises ephemeral creeks with their headwaters flowing north and south-westwards through the Modification area, and ultimately draining into the Hunter River (Gilbert and Associates, 2012). Quarry Creek, Ramrod Creek, Fairford Creek, Whites Creek and several small unnamed creeks flow northwards into the Hunter River on the northern side of the existing mining operations (Gilbert and Associates, 2012). The headwaters of Saddlers Creek flow through the south of the Study area. Saddlers Creek flows generally to the south-west (**Figure 3**) and joins the Hunter River downstream of Denman. The Hunter Valley is one of the largest coastal catchments in NSW, with a catchment area of some 22,000 square kilometres (km^2) (Gilbert and Associates, 2012).

2.6 Land Use

The land within, and surrounding, the Modification is predominately used for agricultural and industrial activities, comprising grazing and coal mining. The current dominant land uses within, and adjacent to, the Modification area include open cut coal mining, power generation and industrial activities, agriculture, and residential development. Agriculture has occurred in the area since the Muswellbrook region was first inhabited by European settlers in 1824, creating large areas of grassland interspersed with small woodland remnants (Cumberland Ecology, 2009a).

Coal mining is a common land use in the area, with Bengalla Mine located approximately 2 km to the north of the Mt Arthur Coal Complex. The two mines are separated by the Hunter River alluvial floodplain. Several other mining projects (including Drayton Mine), the Saddlers Creek Project exploration leases, Spur Hill Project exploration leases, Macquarie Generation's Bayswater Power Station Liddell Power Station and the Muswellbrook Industrial Estate, are all located in the vicinity of the Modification (Cumberland Ecology, 2009a).

2.7 Vegetation

Table 4 shows the communities mapped by the Hunter Remnant Vegetation Project (HRVP) (Peake, 2006) as being present within the Modification area. Each of the proposed development areas within the Modification area also contain a substantial amount of grassland cleared of canopy trees. These grasslands were not mapped as a vegetation type in the HRVP classification and mapping.

Table 4: HRVP Vegetation communities within the Modification area

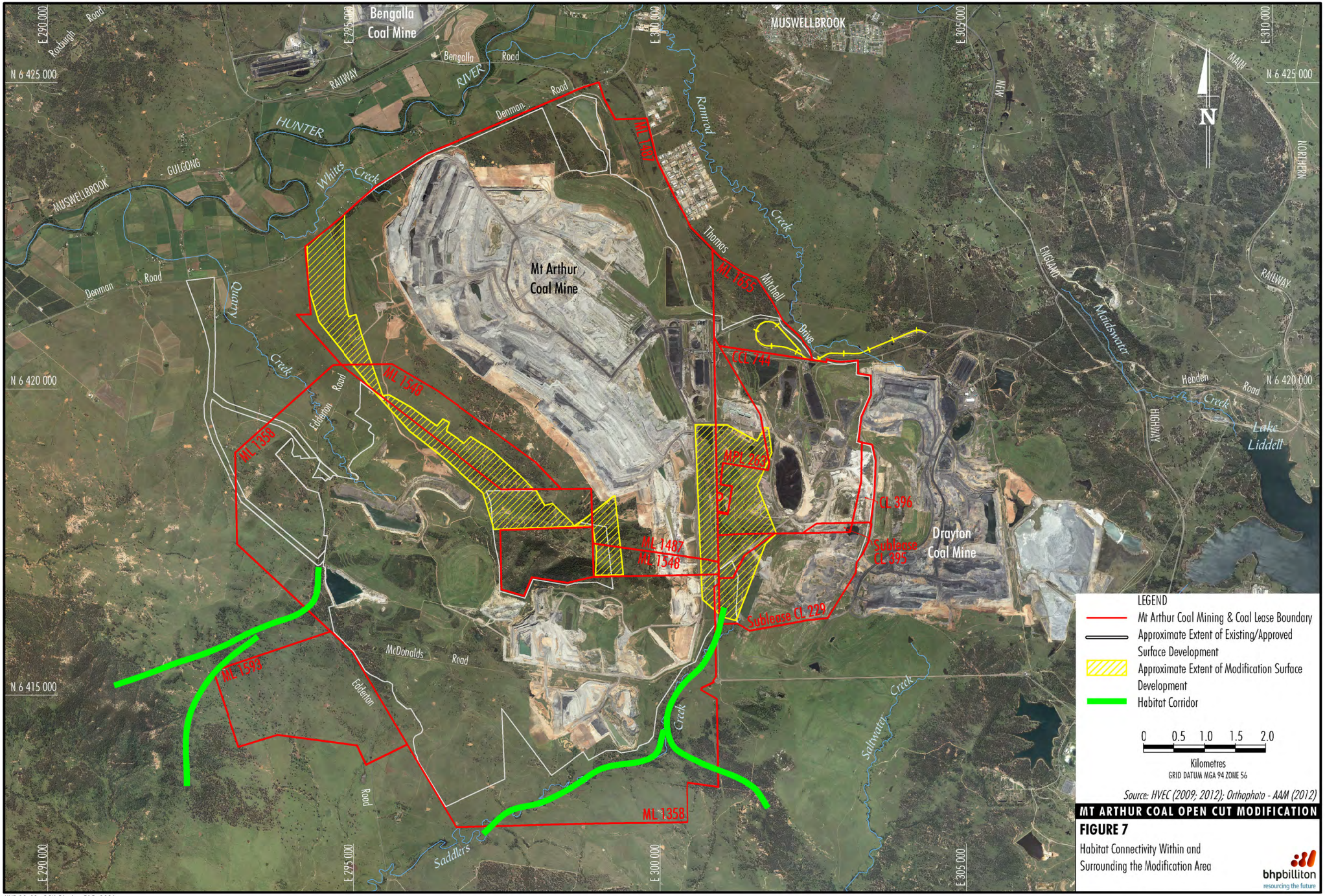
Modification Area	Vegetation Community
Area A	MU32 Central Hunter Bulloak Forest Regeneration
Areas B and C	MU27 Central Hunter Ironbark – Spotted Gum - Grey Box Forest (EEC) MU31 Mount Arthur Forest Complex (EEC)
Area D	No data
Area E	No data

EEC = Endangered Ecological Community.

2.8 Habitat Connectivity

Figure 7 shows the Modification area in relation to the existing approved mining extent including main habitat corridors. As the landscape is substantially cleared, connectivity is not strong, and the Modification area is not connected to the wider habitat areas.

The proposed Areas B and C are located on the footslopes of Mount Arthur and consist of habitat that is contiguous with that over Mount Arthur. Although **Figure 7** suggests that the habitat over Mount Arthur would be isolated until completion of mining, in reality both mining and rehabilitation would be progressive such that there would always be some overland connectivity.



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 7

Habitat Connectivity Within and Surrounding the Modification Area

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3 Overview of the Previous Surveys

This section summarises ecological information collected from the Mt Arthur Coal Mine during previous surveys and monitoring. This ecological information is presented in **Table 5.**

Previous surveys were used to obtain background data on flora and fauna species likely to occur in the Modification area.

Table 5: Previous ecological studies and reports from which background data were compiled

Report	Survey	Location	Survey Type and Time
Dames and Moore (2000)	EIS flora and fauna report	Mt Arthur North	Flora – 15-21 November 1998 Fauna – 14-21 November 1998
Umwelt Environmental Consultants (Umwelt) (2003)	Monitoring	McLeans Hill, Saddlers Creek, Mount Arthur, MD2, A171, MACT	Flora and Fauna – 1 April 2003; 7-9 May 2003
Umwelt (2005)	Monitoring	McLeans Hill, Saddlers Creek, Mount Arthur, A171, MD2, MACT	Flora – December 2004; early January 2005 Fauna – 14-15 December 2004; 20-22 December 2004
Umwelt (2006a)	Flora and Fauna	Mount Arthur, Saddlers Creek	Flora – 16-18 February 2005; 30 November 2005 Fauna – 21-25 February 2005
Umwelt (2006b)	Monitoring	McLeans Hill, Saddlers Creek, Mount Arthur, A171, MD2, MACT	Flora – November 2005 Fauna – December 2005
Umwelt (2006c)	Downcast Shaft Facility	Downcast Ventilation Shaft Facility	Flora and Fauna – 7 December 2005
Umwelt (2007a)	Monitoring	McLeans, Mount Arthur	Flora – November 2006 Fauna – December 2006
Umwelt (2007b)	Mt Arthur Underground Project	Mount Arthur Underground area	Flora – 5 to 8 April 2005; 5-7 December 2005 Fauna – 7-11 March 2005; 5-7 December 2005
Cumberland Ecology (2009a)	Mt Arthur Consolidation Project	Within Mount Arthur Consolidation boundary	Flora and Fauna – 28 August 2008; 21-23 September 2008; 30 September – 2 October 2008; 10-12 November 2008; 19-23 January 2009; 4 March 2009; 8-9 April 2009; 9-10 July 2009; and 13-14 July 2009
Cumberland Ecology (2009b)	Monitoring	A171, Mount Arthur, McLeans Hill, Saddlers Creek	Flora and Fauna – 19-23 January 2009
Cumberland Ecology (2010a)	EPBC Act referral	Areas within the active operations area	Flora and Fauna – Drawn from other studies

Table 5 (continued): Previous studies and reports from which background data were compiled

Report	Survey Type	Location	Survey Type and Time
Cumberland Ecology (2010b)	Monitoring	A171, McLeans Hill, Mt Arthur, CD1	Flora and Fauna – 19-22 January 2010; 27-29 January 2010
Cumberland Ecology (2010c)	Monitoring	A171, CD1, MACT	Flora and Fauna – 20-23 September 2010
Umwelt (2011)	Flora and fauna	Mt Arthur Consolidation Action Areas	Vegetation Communities – 29 August 2011 - 2 September 2011
Cumberland Ecology (2011)	Monitoring *Diuris tricolor* (Pine Donkey Orchid)	A171	Flora – 29 September 2011
Niche (2012) - **Appendix 1**	Current Modification	Modification areas	Fauna – 1 May 2012; 7-10 May 2012

EIS = Environmental Impact Statement.

Niche = Niche Environmental Consultants.

3.1 Flora and Fauna Species

Although the landscape has been mostly cleared, a diverse native biota (summarised in **Table 6** and detailed in **Appendix 2**) has been recorded. This is despite 32 percent (%) of the recorded flora species being introduced.

Table 6: Summary of flora and fauna species reported previously

Class	Families	Species	Introduced	Threatened
Flora	84	473	150	1
Amphibia	2	11	-	-
Reptilia	6	20	-	-
Mammalia	16	44	10	8
Aves	44	106	1	-

Several flora species previously recorded are listed by the NSW DPI (Agriculture) as noxious weeds for the Upper Hunter County Council. Previously recorded species listed as Class 3 noxious weeds include the Mother of Millions (*Bryophyllum delagoense*). Class 4 noxious weeds included Nodding Thistle (*Carduus nutans*), Bathurst Burr (*Xanthium spinosum*), Tiger Pear (*Opuntia aurantiaca*), Creeping Pear (*Opuntia humifusa*), Common Prickly Pear (*Opuntia stricta* and *Opuntia stricta* var. *stricta*), St. Johns Wort (*Hypericum perforatum*), Johnson Grass (*Sorghum halepense*), Blackberry Bramble (*Rubus fruticosus* sp. agg.), African Boxthorn (*Lycium ferocissimum*) and the Trailing Lantana (*Lantana montevidensis*). Class 5 noxious weeds included Annual Ragweed (*Ambrosia artemisiifolia*) (see **Appendix 2** for a complete list of weed species).

3.2 Vegetation Communities

The following threatened ecological communities (TECs) have been recorded within 10 km of the Modification area:

Endangered Ecological Communities (TSC Act)

- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions.
- White Box Yellow Box Blakely's Red Gum Woodland.
- Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions.
- Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions.
- Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion.
- Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion.
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions.

Vulnerable Ecological Communities (TSC Act)

- Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.

Critically Endangered Ecological Community (EPBC Act)

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

The EPBC Act critically endangered ecological community (CEEC) mapping reported in Umwelt (2011) shows the surveyed limits of the derived grassland at the boundaries of Modification Areas A, B, C and D. It would be reasonable to conclude that the protected grasslands continue into these areas.

Table 7 shows the vegetation communities mapped by the HRVP (Peake, 2006) that lie within the Mt Arthur Coal Mine. Also shown are the equivalent threatened communities, as listed under the TSC Act and EPBC Act.

For convenience the following two EECs: the *White Box Yellow Box Blakely's Red Gum Woodland* (NSW) and *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Commonwealth), will herein be referred to as Box-Gum Woodland EEC/CEEC.

The location of TECs within the Modification area is shown on **Figure 8**.

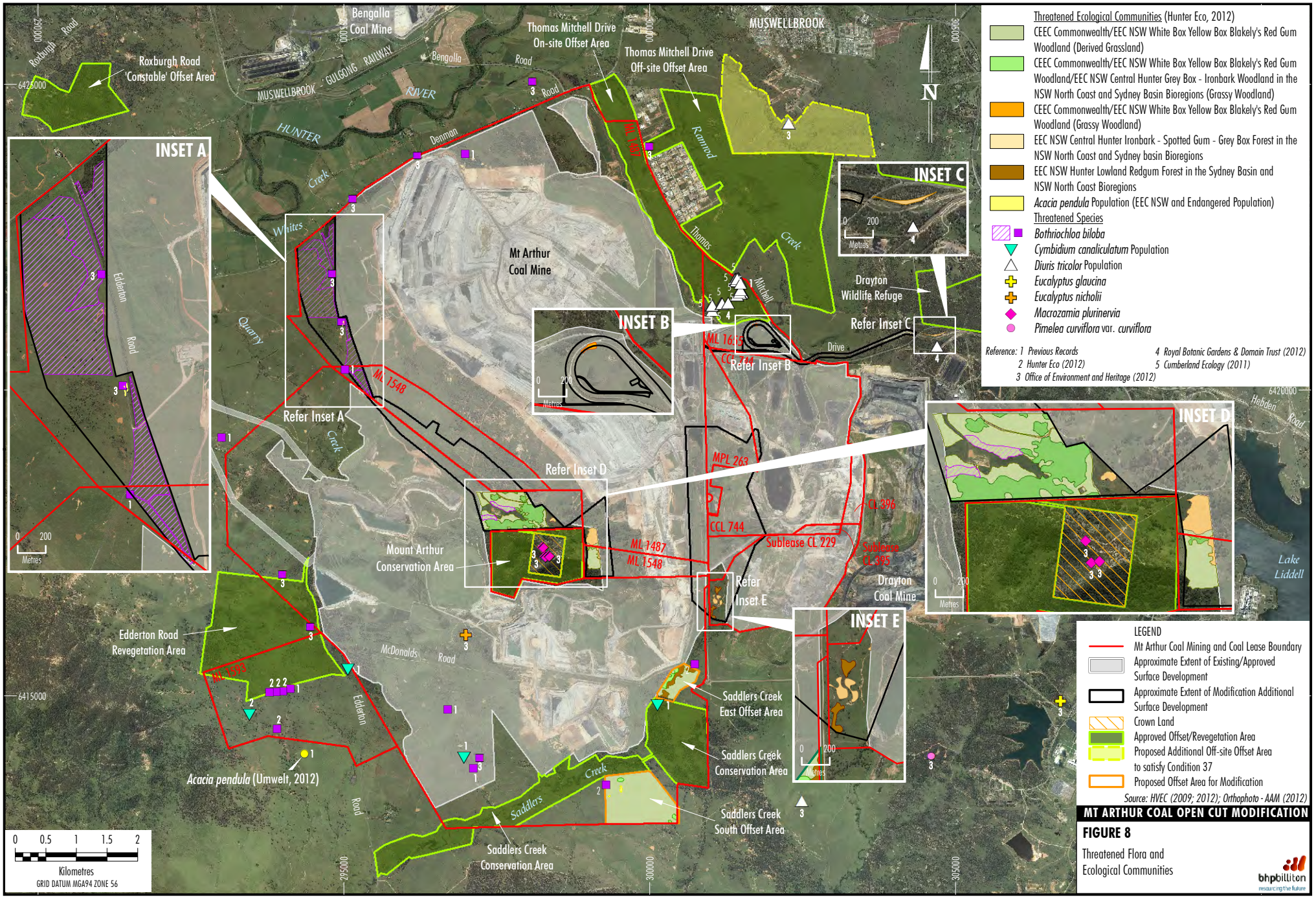

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FIGURE 8

Threatened Flora and Ecological Communities

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Table 7: Vegetation communities and their equivalent threatened community mapped within the Mt Arthur Coal Mine

HRVP Community	Equivalent threatened community	Status[1]
MU8 Western Hunter Narrabeen Footslopes Ironbark – Cypress Pine Woodland	Not threatened	-
MU9 Upper Hunter Hills Box – Ironbark – Red Gum Woodland	Not threatened	-
MU10 Central Hunter Box - Ironbark Woodland	Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E (TSC Act)
	White Box Yellow Box Blakely's Red Gum Woodland	E (TSC Act)
	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC (TSC Act)
MU11 Upper Hunter White Box - Ironbark Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	E (TSC Act)
	White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE (EPBC Act)
MU19 Hunter Valley Weeping Myall Woodland	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	E (TSC Act)
MU24 Hunter Lowlands Red Gum Forest	Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	E (TSC Act)
MU27 Central Hunter Ironbark - Spotted Gum - Grey Box Forest	Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E (TSC Act)
MU29 Upper Hunter Hills Sheltered Moist Forest	Not threatened	-
MU32 Central Hunter Bulloak Forest Regeneration	Not threatened	-
MU36 Plantation	Not threatened	-

[1] Threatened species status under the TSC Act and/or EPBC Act (current at 24 January 2013). V=vulnerable, E=endangered, CE=critically endangered.

3.3 Threatened Populations and Flora and Fauna Species

Records were extracted from the NSW Wildlife Atlas (NSW Office of Environment and Heritage [OEH], 2013), Birds Australia (2012), Australian Museum (2012), Royal Botanic Gardens Sydney and the Domain (2012) and the EPBC Act protected matters search tool (Commonwealth Department of Sustainability, Environment, Water, Population and Communities [SEWPaC], 2012a) for threatened flora species, fauna species and populations recorded within a 40 km^2 search area surrounding the Modification area. The results of these database searches are presented in **Appendix 3**.

The database results were used as a guide to determine which threatened populations or species might be present within the Modification area and surrounds. Threatened populations and species previously recorded within and near the Modification area (determined from database results and/or surveys) are listed in **Table 8**. The locations of threatened populations and species recorded within and surrounding the Modification are shown in **Figures 8** to **11**.

A total of three endangered populations, five threatened flora species and 22 threatened fauna species have previously been recorded within the Modification area or surrounds (**Table 8**). No threatened aquatic species were recorded within the Modification area. The likelihood of these species occurring within the Modification area are assessed in **Section 5**. Threatened species that have the potential to occur within the Modification area are further assessed in **Section 7**.

Part of the Muswellbrook Local Government Area (LGA) *Diuris tricolor* endangered population is monitored annually (Cumberland Ecology, 2011) in a conservation reserve located immediately north of Modification Area E.

3.4 Migratory Species

Migratory species listed in database records from the NSW Wildlife Atlas (OEH, 2013), Birds Australia (2012), Australian Museum (2012) and the EPBC Act protected matters search tool (SEWPaC, 2012a) for a 40 km^2 search area surrounding the Modification area are presented in **Appendix 3c**.

Database results indicate that 14 migratory species have been recorded within or surrounding the Modification area or have the potential to occur within or surrounding the Modification area. Three of the 14 migratory species (the White-bellied Sea-Eagle [*Haliaeetus leucogaster*], White-throated Needletail [*Hirundapus caudacutus*] and Rainbow Bee-eater [*Merops ornatus*]) have been previously recorded within or surrounding the Modification area. An assessment on whether the species is likely to occur within the Modification area or surrounds is also presented in **Appendix 3c**.

No migratory species were recorded during recent surveys conducted by Niche (**Appendix 1**). One migratory species, the White-bellied Sea-eagle (*Haliaeetus leucogaster*), was recorded near Modification Area E during recent flora surveys.

Table 8: Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
POPULATIONS				
Acacia pendula	*Acacia pendula* population in the Hunter Catchment	E	-	This population was identified in Modification Area A during the recent surveys conducted by Hunter Eco. This species has also been previously recorded surrounding the Modification area (Umwelt, 2007b, 2007c; Cumberland Ecology, 2009a).
Diuris tricolor	*Diuris tricolor*, the Pine Donkey Orchid population in the Muswellbrook LGA	E population, V plant	-	This species has not been recorded in the Modification area[2]. The population has been previously recorded within the Thomas Mitchell Drive Offset area from 2007 to the present (Cumberland Ecology, 2009a, 2011). This species has also been recorded surrounding the Modification area in the OEH (2013) and Royal Botanic Gardens Sydney and the Domain (2012) databases.
Cymbidium canaliculatum	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	This species has not been recorded in the Modification area, but has been recorded to the west of the Modification area by Umwelt (2006c) and within the Saddlers Creek Conservation area (Umwelt, 2007b).
FLORA				
Bothriochloa biloba	Bluegrass	-	V	This species has been recorded in Modification Area A during the recent surveys conducted by Hunter Eco. This species has previously been recorded to the south and west of the Modification area (Cumberland Ecology, 2010a); south of the Modification area (Umwelt, 2006c); and surrounding the Modification area (Umwelt, 2007b; Cumberland Ecology, 2009a). This species has also been recorded in the OEH (2013) database as present within Modification Area A and surrounds, and is recorded as "predicted to occur" in the EPBC Act Protected Matters Search (SEWPaC, 2012a).
Eucalyptus glaucina	Slaty Red Gum	V	V	This species has not been recorded in the Modification area, but has been recorded 10 km south-west and 5 km south-east of the Modification area in the OEH (2013) database results, and is recorded as "predicted to occur" in the EPBC Act protected matters search (SEWPaC, 2012a).

Table 8 (continued): Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
FLORA (Continued)				
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	This species has not been recorded in the Modification area, but has been recorded to the south of Modification Areas B and C in the OEH (2013) database results.
Macrozamia plurinervia	-	-	V	This species has been recorded at Mount Arthur surrounding the Modification area in the OEH (2013) database results.
Pimelea curviflora var. *curviflora*	Rice Flower	V	V	This species has not been recorded in the Modification area, but has been recorded to the far west of the Modification area in the OEH (2013) database results and is predicted to occur in the EPBC Act protected matters search (SEWPaC, 2012a).
FAUNA				
Birds				
Circus assimilis	Spotted Harrier	V	-	This species has not been recorded in the Modification area, but has been recorded to the west of the Modification (Umwelt, 2007b) as well as surrounding the Modification area in the OEH (2013) and Birds Australia (2012) database results.
Hieraaetus morphnoides	Little Eagle	V	-	This species has not been recorded in the Modification area and has been recorded by Umwelt (2007b) surrounding the Modification area. However, the exact location of the species was not reported. This species has also been recorded surrounding the Modification area in the Thomas Mitchell Drive Offset area and to the east and west of the Modification area in the OEH (2013) and Birds Australia (2012) database results.
Burhinus grallarius	Bush Stone-curlew	E	-	This species has not been recorded in the Modification area, but has been recorded to the south of Modification Area E in the Birds Australia (2012) database results.
Glossopsitta pusilla	Little Lorikeet	V	-	This species has not been recorded in the Modification area, but has been recorded to the south-west by Umwelt (2007b). This species has also been recorded to the east and west surrounding the Modification area in the OEH (2013) and Birds Australia (2012) database results.

Table 8 (continued): Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
Birds (Continued)				
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	This species has not been recorded in the Modification area, but has been recorded to the east and south surrounding the Modification area in the OEH (2013) and Birds Australia (2012) database results.
Chthonicola sagittata	Speckled Warbler	V	-	This species has not been recorded in the Modification area, but has been recorded in the Thomas Mitchell Drive Offset area and multiple times surrounding the Modification (Umwelt, 2005, 2006a, 2006b, 2007a, 2007b; Cumberland Ecology, 2009a, 2009b, 2010b, 2010c). This species has also been recorded in the Thomas Mitchell Drive Offset area and the Modification area surrounds in the OEH (2013) and Birds Australia (2012) database results.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	This species has not been recorded in the Modification area, but was recorded by Dames and Moore (2000) surrounding the Modification area. However, the exact location of the species was not reported. This species has also been recorded to the east of the Modification area in the Birds Australia (2012) database results. This species was also recorded in the OEH (2013) database results, however the record falls outside of the extent shown on **Figure 9**.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	This species has been recorded in the Modification area, within Modification Area A (Cumberland Ecology, 2009a). This species was recorded within a plantation stand within the Modification area, which would be removed as part of the Modification. This species has also been recorded surrounding the Modification area as well as within the Thomas Mitchell Drive Offset area, Saddlers Creek Conservation area and Edderton Road Revegetation area (Umwelt, 2003, 2006b, 2007b). Grey-crowned Babbler nests have been recorded in the Saddlers Creek Conservation area (Cumberland Ecology, 2009a). This species has also been recorded in the Thomas Mitchell Drive Offset area, Mount Arthur Conservation area and Saddlers Creek Conservation area and the Modification area surrounds in the OEH (2013) and Birds Australia (2012) database results.

Table 8 (continued): Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
Birds (Continued)				
Daphoenositta chrysoptera	Varied Sittella	V	-	This species has been recorded within Modification Area C (Umwelt, 2005). This species was recorded during the 2004 monitoring period near the base of Mount Arthur within the Modification area in tall open forest dominated by mature Spotted Gum (*Corymbia maculata*) (Umwelt, 2005). This species has also been recorded to the north of Modification Area B by Umwelt (2006b). This species has also been recorded in the Thomas Mitchell Drive Offset area and the Modification area surrounds in the OEH (2013) and Birds Australia (2012) database results.
Stagonopleura guttata	Diamond Firetail	V	-	This species has not been recorded in the Modification area, but has been recorded by Dames and Moore (2000) surrounding the Modification area. However, the exact location of the species was not reported. This species has also been recorded surrounding the Modification area in the OEH (2013) and Birds Australia (2012) database results.
Mammals				
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	This species has not been recorded in the Modification area, but was tentatively recorded during the first half of 2006 by a HVEC staff member on the main access road to the Mt Arthur Coal offices close to the intersection with Thomas Mitchell Drive (Umwelt, 2007b). An earlier possible sighting of the Spotted-tailed Quoll was also made on a haul road in the Bayswater mining area (Umwelt, 2007b). This species has been recorded to the south-west of the Modification area in the OEH (2013) database results and is predicted to occur in the EPBC Act protected matters search (SEWPaC, 2012a).

Table 8 (continued): Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
Mammals (Continued)				
Phascolarctos cinereus	Koala	V	V	This species has not been recorded in the Modification area, but has been recorded within the approved Mt Arthur Coal Mine to the south-west of the Thomas Mitchell Drive Offset area. The Koala recorded within the approved Mt Arthur Coal Mine was a lone male looking for a mate (HVEC, pers. comm., 2012). The Koala was taken by wildlife carers who relocated him into a rehabilitated area near where he was originally found (HVEC, pers. comm., 2012). This species was recorded within the Thomas Mitchell Drive Offset area in the OEH (2013) database results.
Petaurus norfolcensis	Squirrel Glider	V	-	This species has not been recorded in the Modification area, and has been recorded in the general locality surrounding the Modification area on several occasions between 2003 and 2010 (Umwelt, 2003, 2006a, 2006b, 2007b; Cumberland Ecology, 2010c). This species was recorded in a nest box to the immediate north of Modification Area E (Cumberland Ecology, 2010c) and has been recorded surrounding the Modification area and within the Thomas Mitchell Drive Offset area in the OEH (2013) database results.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species was recorded by Niche (**Appendix 1**) in the Modification area within the proposed C. The species was seen foraging for nectar and pollen on blossoming Spotted Gum. No breeding or roosting colonies were present. This species has also been recorded to the north of the Modification area in the OEH (2013) database results and is predicted to occur in the EPBC Act protected matters search (SEWPaC, 2012a).
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	This species has not been recorded in the Modification area, but has been recorded by Dames and Moore (2000) surrounding the Modification area. However, the exact location of the species was not reported. This species has been recorded in the Thomas Mitchell Drive Offset area and the Modification area surrounds in the OEH (2013) database results
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	The Eastern Freetail-bat was recently recorded by Niche (**Appendix 1**) within the Modification area in Modification Areas C and D. This species has also been recorded during previous surveys (Umwelt, 2006b, 2007a, 2007b) and recorded in the OEH (2013) database surrounding the Modification.

Table 8 (continued): Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
Mammals (Continued)				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	This species has not been recorded in the Modification area, but has been recorded to the north of Modification Area B by Umwelt (2007a). This species has also been recorded to the north of the Modification area at Muswellbrook in the OEH (2013) database results and is predicted to occur in the EPBC Act Protected Matters Search (SEWPaC, 2012a).
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	This species was possibly recorded by Niche (**Appendix 1**) during the current surveys within the Modification area in the proposed Northern Open Cut Extension area. This species was also recorded in the OEH (2013) database results, however the record falls outside of the extent shown on **Figure 11**.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	This species was possibly recorded by Niche (**Appendix 1**) in the proposed Northern Open Cut Extension area, proposed Southern Open Cut Extension area (eastern flank) and the proposed Overburden Emplacement Extension area. This species has also been recorded on several occasions surrounding the Modification area (Umwelt, 2003, 2005, 2006a, 2006b, 2007a, 2007b; Cumberland Ecology, 2010b, 2010c; Dames and Moore, 2000). This species has also been recorded surrounding the Modification area in the OEH (2013) database results.
Myotis macropus	Southern Myotis	V	-	The Southern Myotis has been previously recorded within the Modification area within Modification Area C by Umwelt (2003) during the 2003 monitoring undertaken annually at the Mt Arthur Coal Mine. This species has been recorded within the Thomas Mitchell Drive Offset area and Edderton Creek Revegetation area as well as surrounding the Modification area in the OEH (2013) database results as well as by Umwelt (2006a, 2006b, 2007b).

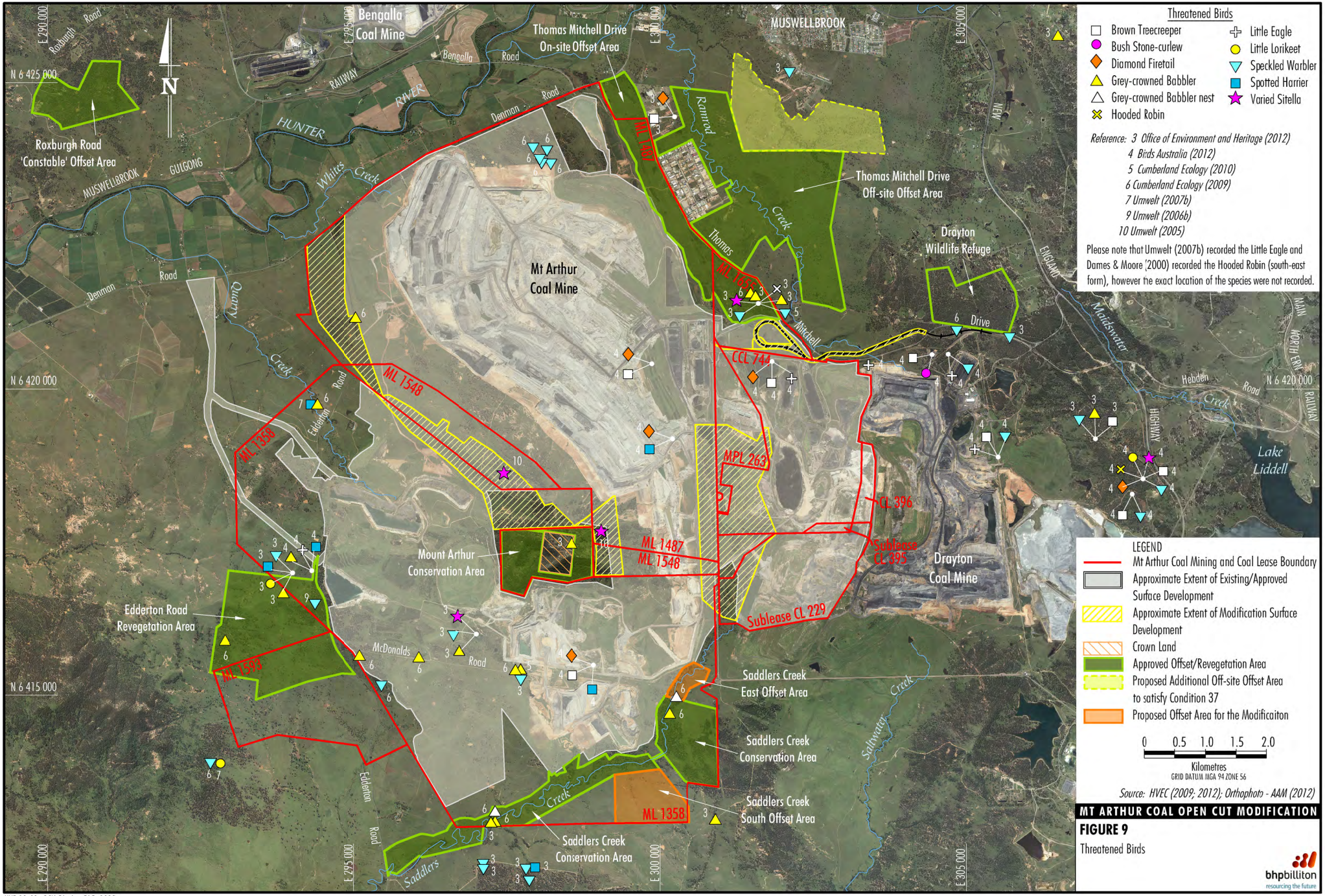
Table 8 (continued): Threatened populations and flora and fauna species previously recorded within a search area surrounding the Modification area

Scientific Name	Common Name	Conservation Status[1]		Notes
		TSC Act	EPBC Act	
Mammals (Continued)				
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	This species has not been recorded in the Modification area, but has been recorded to the west of the Modification area by Umwelt (2007a) and has been recorded to the west in the OEH (2013) database results.
Vespadelus troughtoni	Eastern Cave Bat	V	-	This species was possibly recorded by Niche (**Appendix 1**) in the proposed Northern Open Cut Extension area, proposed Southern Open Cut Extension area (eastern flank) and the proposed Overburden Emplacement Extension area. This species has been recorded within the Saddlers Creek Conservation area and Edderton Road Revegetation area and within the Modification area surrounds (Umwelt, 2006a, 2007a, 2007b). This species has also been recorded surrounding the Modification area in the OEH (2013) database results

Note: Threatened population and species locations are shown on **Figures 8** to **11**.

[1] Threatened population and threatened flora and fauna species status under the TSC Act and/or EPBC Act (current at 24 January 2013).

[2] The species can only be found during a narrow flowering period of late September to early October, meaning that its actual presence in the suitable habitat has not yet been determined.



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 9

Threatened Birds

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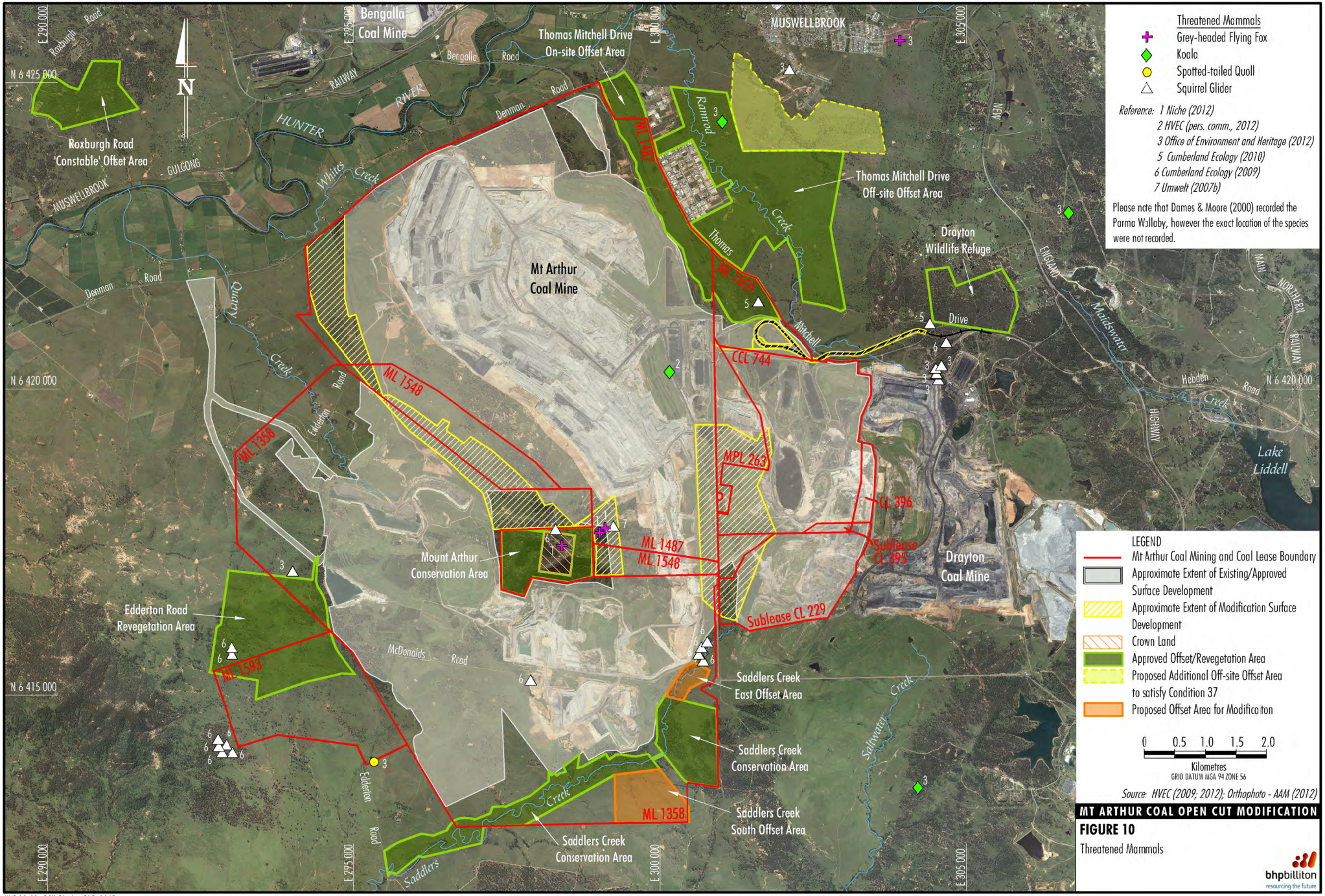

Threatened Mammals
- Grey-headed Flying Fox
- Koala
- Spotted-tailed Quoll
- Squirrel Glider

Reference: 1 Niche (2012)
2 HVEC (pers. comm., 2012)
3 Office of Environment and Heritage (2012)
5 Cumberland Ecology (2010)
6 Cumberland Ecology (2009)
7 Umwelt (2007b)

Please note that Dames & Moore (2000) recorded the Parma Wallaby, however the exact location of the species were not recorded.

LEGEND
- Mt Arthur Coal Mining and Coal Lease Boundary
- Approximate Extent of Existing/Approved Surface Development
- Approximate Extent of Modification Surface Development
- Crown Land
- Approved Offset/Revegetation Area
- Proposed Additional Off-site Offset Area to satisfy Condition 37
- Proposed Offset Area for Modification

0 0.5 1.0 1.5 2.0
Kilometres
GRID DATUM MGA 94 ZONE 56

Source: HVEC (2009; 2012); Orthophoto - AAM (2012)

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FIGURE 10

Threatened Mammals

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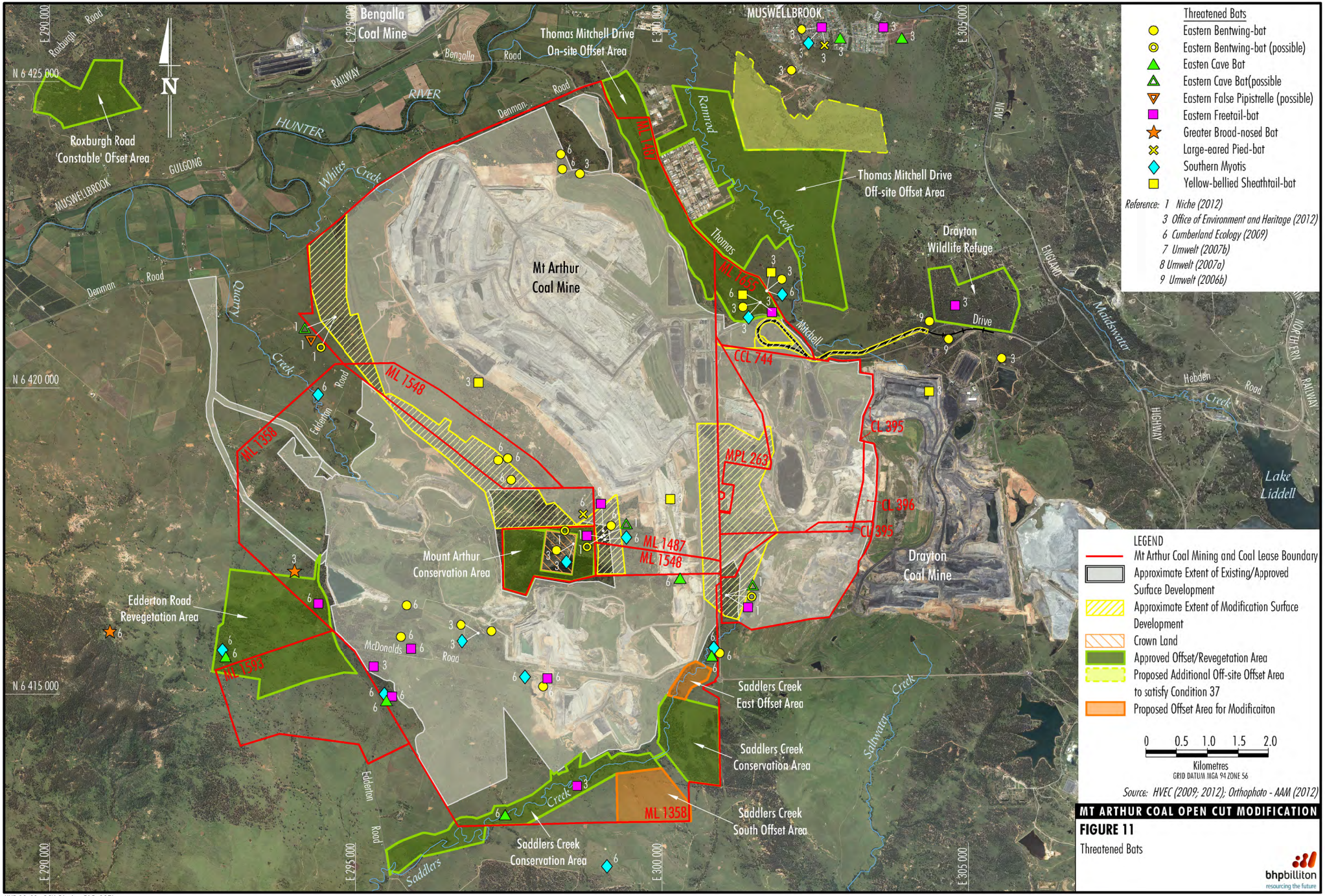

MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 11

Threatened Bats

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HVE-11-01_OCM EA_App F&F_1071

4 Supplementary Field Survey Methods

Flora species, populations and ecological communities listed as threatened in the TSC Act and the EPBC Act were the primary focus of the current survey.

Collection of floristic and vegetation data, and plotting of habitat tree locations, was conducted over seven days from 16 April 2012 to 9 May 2012. The weather was fine, clear and mild, with cold mornings. The only exception being rain on 23 April 2012. **Figure 12** shows the location of 40 floristic sample plots and the floristic meanders that were used to augment the plot data species lists.

4.1 Flora

4.1.1 *Flora Species*

Floristic content in the Modification area was determined through the use of standard 20 x 20 metre (m) sample plots, linear transects and random meanders. All species present were recorded within the bounds of each sample plot along with a score for abundance. Abundance was scored using the modified Braun-Blanquet 1-6 scale (**Table 9**).

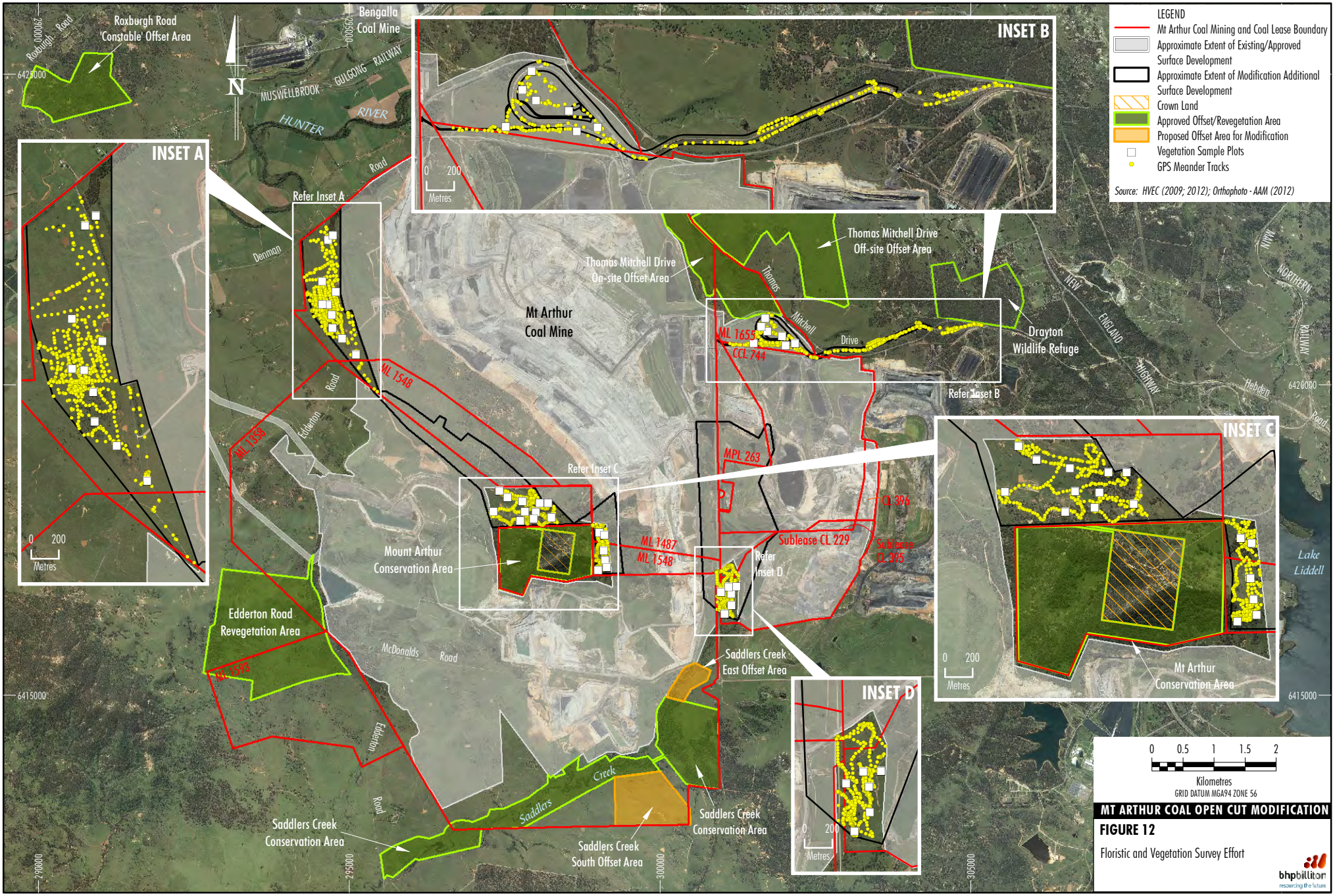
Table 9: Braun-Blanquet cover-abundance scores

Cover range	Score
<5% few individuals	1
<5% many individuals	2
5% - <25%	3
25% - <50%	4
50% - <75%	5
75% - 100%	6

Transects and meanders were used to search for species that had not been recorded in the sample plots.

4.1.2 *Vegetation Communities*

A vegetation map was prepared from ground-truthed point data, floristic plot data and ground-truthed community boundary determination. The applied methods were developed in part by the author and published in NSW Department of Environment and Climate Change (DECC) (2008a). Ground-truthed vegetation data were collected during meanders through the Modification area. Vegetation community types were determined by matching floristic content to data from the Peake (2006) classification presented in the HRVP report.



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 12

Floristic and Vegetation Survey Effort

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Floristic plot data were analysed using ordination in Primer 6 (Clark and Gorley, 2001), which groups plots of most similar diversity and biomass. Vegetation community boundaries were determined using a 2011 aerial photograph (0.5 m per pixel resolution).

The Vegetation on Mount Arthur and Footslopes

The HRVP report (Peake, 2006) classifies the vegetation across the Mount Arthur peak and footslopes as MU31 Mount Arthur Forest Complex. It is described as a mid-high to tall forest with the canopy dominated by Grey Gum (*Eucalyptus punctata*), Grey Box (*Eucalyptus moluccana*), Kurrajong (*Brachychiton populnea*) and Forest Oak (*Allocasuarina torulosa*). The understorey, described as mid-dense to dense, was reported as being dominated by Velvet Mock Olive (*Notelaea microcarpa var. microcarpa*), Western Boobialla (*Myoporum montanum*), Shiny-leaved Canthium (*Psydrax odorata*) and Sticky Daisy-bush (*Olearia elliptica*).

Peake (2006) notes that the Mount Arthur vegetation was described as a complex because there was insufficient field data to break this area into its component communities; only six data points were available for the HRVP analysis.

Because the Modification area includes part of MU31 Mount Arthur Forest Complex, further data were collected to deconstruct the 'complex'. A vegetation community map was prepared using ground-truthed data and aerial photo interpretation. This was supported by recording boundaries between selected communities using a hand-held Global Positioning System (GPS). Community classification was achieved by comparing the floristic content of the field data with the vegetation community profiles reported in Peake (2006).

Threatened Ecological Communities

In general terms, TECs were determined by comparing species recorded in the sample floristic plots against the NSW or Commonwealth Scientific Committee determinations, with the assistance of published supplementary material. The Scientific Committee determinations for Central Hunter NSW threatened communities refer to communities reported in the HRVP report (Peake, 2006) consistent with the determination. The community profiles in the HRVP report were also used to assist with this classification.

Commonwealth CEEC *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*

This community has been recorded over a wide geographic area, from central Victoria to south-eastern Queensland. Typical tree species include White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*) or Blakely's Red Gum (*Eucalyptus blakelyi*). As determined by the Commonwealth Scientific Committee, this community can exist in a variety of conditions including shrubby woodland, grassy woodland with scattered trees and open grassland devoid of trees. In some areas of the Hunter Valley a hybrid of *Eucalyptus albens* and *Eucalyptus moluccana* (*E. albens x E. moluccana*) has been identified. The Commonwealth Threatened Species Scientific Committee (TSSC) has provided supplementary advice to the effect that this hybrid box is included in the typical species list for the CEEC (http://www.environment.gov.au/epbc/publications/advice-hybrids.html). Of 28 box specimens sent for identification by the National Herbarium of NSW from areas adjoining the Modification, 27 were determined to be hybrids (*E. albens* x *E. moluccana*) (Umwelt, 2011).

HVEC have received legal opinion from two sources as to whether a community dominated by *E. albens* x *E. moluccana* hybrids would be equivalent to the listed CEEC. Both opinions concluded that the CEEC determination, by not specifically including hybrids in the community description (as happens in some more recent determinations), does not allow for the inclusion of hybrids. Thus any community dominated by such hybrids would not meet the definition of the box-gum CEEC. Also, one opinion noted that the supplementary advice provided by the TSSC regarding the unwritten assumption that the original determination included hybrids does not alter the original determination.

However, these opinions have not been tested, therefore the precautionary approach was adapted to assume that the hybrid-dominated vegetation might be the CEEC and the tests should be applied accordingly.

The Commonwealth Department of the Environment and Heritage (DEH) (2006a) *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* guidelines assist with determining the presence of this community, and these guidelines were applied to the vegetation communities mapped for the Modification. The following is a summary from the guidelines, which was used to determine whether any mapped vegetation unit represented this community (DEH, 2006a):

- Is the area 0.1 hectare (ha) or greater in size with at least one of White Box, Yellow Box or Blakely's Red Gum present, or likely to have been present, prior to clearing?
- Does the ground cover contain at least 50% perennial native species?

- Are there 12 or more native understorey species (other than grasses), and is there at least one important native species? (Important species are listed in either box-gum-species.pdf or box-gum-species.xls available at http://www.environment.gov.au/epbc/publications/box-gum.html).
- If the previous condition is not met, and the patch is equal to or greater than 2 ha in size, are there 20 or more mature trees per hectare, or natural regeneration of the main canopy species?

Sample vegetation plots 20 x 20 m in size were replicated within vegetation units determined through ground inspection and aerial photography interpretation. The plot data from within each vegetation unit were averaged, and averaged data used to determine whether the vegetation unit represented this endangered community.

NSW EEC *White Box Yellow Box Blakely's Red Gum Woodland*

This community occurs over the same range, and is essentially the same as the similarly named Commonwealth community.

For the purposes of this report, wherever the Commonwealth community was identified, the NSW community was also considered to be present.

NSW EEC Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions

The canopy species typical of this community are Grey Ironbark (*Eucalyptus crebra*), Spotted Gum (*Corymbia maculata*), and Grey Box (*Eucalyptus moluccana*). The equivalent HRVP (Peake, 2006) community, MU27 Central Hunter Ironbark – Spotted Gum – Grey Box Forest, has been recorded in the vicinity of the Modification area.

NSW EEC Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions

The canopy species typical of this community are Grey Box (*Eucalyptus moluccana*) and Grey Ironbark (*Eucalyptus crebra*). The equivalent HRVP (Peake, 2006) community, MU10 Central Hunter Box – Ironbark Woodland, has been recorded within the Modification area. The description of this community also includes hybrid White Box/Grey Box.

NSW EEC Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions

The canopy species typical of this community are Forest Red Gum (*Eucalyptus tereticornis*), Grey Box (*Eucalyptus moluccana*), Grey Ironbark (*Eucalyptus crebra*) and Grey Gum (*Eucalyptus punctata*). This EEC was gazetted prior to the HRVP (Peake, 2006) report, however, the equivalent community in that report is MU24 Hunter Lowlands Red Gum Forest.

NSW EEC Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion

The NSW Scientific Committee determination of Hunter Valley Weeping Myall Woodland as an EEC (NSW Scientific Committee, 2010a) states that "The most common tree is *Acacia pendula* (Weeping Myall), which may occur with *Eucalyptus crebra* (Narrow-leaved Ironbark), *A. salicina* (Cooba) and/or trees within the *A. homalophylla* - *A. melvillei* complex." This appears to imply that the community must always contain *Acacia pendula* that may be associated with the other species listed.

The determination was solely based on the community MU19 Hunter Valley Weeping Myall Woodland of Peake (2006). In turn, the Peake (2006) community was "...based on non-quantitative assessment, as no survey sites were conducted within it" and is described as "A mid-high to tall woodland or open forest clearly dominated by weeping myall (*Acacia pendula*)."

The foregoing indicates that the Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC is only present when *Acacia pendula* is present and may or may not have other associated species.

4.2 Fauna

4.2.1 *Fauna Species*

Niche (**Appendix 1**) undertook fauna surveys within the Modification areas on 1 May 2012, and from 7 May 2012 to 11 May 2012. Field surveys were targeted and used established survey techniques based upon:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft,* DEC 2004;
- *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna Amphibians for Development and Activities* (NSW Department of Environment, Climate Change and Water [DECCW], 2009a);
- survey guidelines for Australia's threatened bats, birds and frogs (Commonwealth Department of the Environment, Water, Heritage and the Arts, 2010a, 2010b, 2010c); and
- survey guidelines for Australia's threatened mammals and reptiles (SEWPaC, 2011a, 2011b).

Opportunistic observations and broad habitat assessments were also performed throughout the study area.

Targeted survey procedures included the use of arboreal Elliot trapping, infra-red camera traps, hair tubes, ultrasonic call recording for bats, diurnal bird surveys, spotlighting, call playback, stag watching, Koala scat searches, herpetological surveys, frog chorus survey and aquatic habitat surveys (**Appendix 1**). Targeted surveys were undertaken, and incidental searches and observations of fauna use of the study areas were made within each habitat type by examining scats, scratches and other indirect evidence (**Appendix 1**).

4.2.2 *Fauna Habitat Assessment*

Fauna habitat within the Modification area was also mapped, and is described in **Appendix 1**.

Hollow-bearing trees are an important but limited resource that provides denning places for arboreal fauna and insectivorous bats, and nesting sites for a range of birds such as owls, parrots and cockatoos and small diurnal raptors. It can take up to 80 years before a tree is sufficiently senescent to start to develop hollows, and 120-200 years to develop a range of hollow sizes suitable for fauna (reviewed in DECC, 2007a). Consequently, the loss of this habitat over a wide area can have a significant negative impact on the faunal diversity of that area and surrounds.

All trees in the Modification area were inspected for the presence of hollows. The species and location co-ordinates of hollow-bearing trees was recorded.

4.2.3 *SEPP 44 Koala Habitat*

In accordance with *State Environmental Planning Policy 44 – Koala Habitat Protection* (SEPP 44), the impact of the Modification on core and potential Koala habitat was assessed. SEPP 44 aims to encourage the conservation and proper management of areas of natural vegetation that provide habitat for Koalas, to ensure permanent free-living populations over their present range, and to reverse a long trend of population decline. Core and potential Koala habitat are defined by SEPP 44 as:

- core Koala habitat means an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population); and
- potential Koala habitat means areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

The accepted indirect method (other than direct observation of the animal) for detecting Koala activity is the Spot Assessment Technique (SAT) (Phillips and Callaghan, 2011. This method was applied in appropriate habitat within the Modification area. A one hour search was conducted within identified Koala habitat as judged by the presence of favoured feed trees (*Eucalyptus tereticornis*). Each of the 30 *E. tereticornis* trees was examined for scratches, and a one minute search for scats was performed in a 1 m radius around the base of each tree. This was then repeated for a minute whilst combing through the leaf litter. Koala call playback was also used in an attempt to elicit a response.

5 Supplementary Field Survey Results

5.1 Flora

A total of 239 flora species, comprising 172 native species and 67 exotic species, from 58 families were recorded during the current surveys within the Modification area. The most represented families were the Poaceae with 57 species, including 14 exotic species, followed by the Asteraceae with 36 species, including 15 exotic species and the Fabaceae (Faboideae) with 17 species, including seven exotic species.

Details of flora species recorded in the Modification area are provided in **Appendix 4**.

5.1.1 *Threatened Flora Species*

An evaluation of database records of threatened flora species occurring within or surrounding the Modification area, against the known habitat requirements of those species provides an assessment of likelihood of occurrence in the Modification area (**Table 10**). Habitat preference information was drawn from the following online resources:

- http://www.bionet.nsw.gov.au/
- http://plantnet.rbgsyd.nsw.gov.au/

Flora species that were determined to be potentially impacted by the Modification are assessed in **Section 7.3**.

Table 10: Threatened flora species habitat preferences and likelihood of occurrence within the Modification area

Scientific Name	Common Name	Status[1]		Habitat Preferences	Likelihood of Occurrence
		TSC Act	EPBC Act		
Bothriochloa biloba	Bluegrass	-	V	Native grasslands in the central Hunter. Has previously been recorded within the Mt Arthur Coal Mine and in the locality.	Found
Cynanchum elegans	White-flowered Wax Plant	E	E	A rainforest species.	No suitable habitat
Digitaria porrecta	Finger Panic Grass	E	E	Recorded from grasslands of the north west slopes botanical area.	Unlikely
Diuris tricolor	Pine Donkey Orchid	V	-	Known occurrences on the north-eastern side of the Mt Arthur Coal Mine. Grows in natural grassland and grassy woodland in the Muswellbrook LGA.	Possible but not found

Table 10 (continued): Threatened flora species habitat preferences and likelihood of occurrence within the Modification area

Scientific Name	Common Name	Status[1]		Habitat Preferences	Likelihood of Occurrence
		TSC Act	EPBC Act		
Eucalyptus glaucina	Slaty Red Gum	V	V	A coastal species from the north coast botanical area.	Unlikely
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	The one record in the data extraction area is a long way from the species range and is probably a misidentification.	Unlikely
Euphrasia arguta	-	CE	CE	Only recorded from grassy areas near rivers in the Bathurst to Walcha areas. Possibly extinct.	Unlikely
Macrozamia plurinervia	-	-	V	The BioNet database shows records of this plant from the top of Mount Arthur itself. PlantNet however describes it as being restricted to granite-based soils in far northern NSW. The species is very similar to *Macrozamia flexuosa* so the two could be confused.	Possible based on BioNet records. Unlikely based on PlantNet data
Pimelea curviflora var. *curviflora*	Rice Flower	V	V	The majority of records are from coastal sandstone habitat. However, there is a confirmed NSW Wildlife Atlas record from about 2.5 km south of the Modification area.	Possible, but not found
Pomaderris reperta	Denman Pomaderris	CE	CE	Grows in dry sclerophyll woodland and the only known occurrences are restricted to the Denman area, about 7 km west of the Modification area.	Unlikely
Prasophyllum sp. Wybong (C.Phelps ORG 5269)	a leek-orchid	-	CE	A grassland and grassy woodland terrestrial orchid found in Box-Gum habitat.	Possible, but not found
Pterostylis gibbosa	Illawarra Greenhood	E	E	Mainly found in the Central Coast and North Coast botanical areas with a disjunct occurrence at Milbrodale.	Unlikely
Thesium australe	Austral Toadflax	V	V	Grows in grassland and woodland and is a hemi parasite of *Themeda australis*.	Possible but very little *Themeda australis* was recorded.
Tylophora linearis	-	V	E	A dry scrub species.	Unlikely

[1] Threatened flora species status under the TSC Act and/or EPBC Act (current at 24 January 2013).

Of the threatened flora listed in **Table 10**, only *Bothriochloa biloba* was recorded within the Modification area during the May survey. Suitable habitat for *Diuris tricolor* was present in Modification Areas B and C. However, no orchids were found in these areas during a survey in mid September 2012 when *Diuris tricolor* was known to be flowering in the A171 conservation area.

5.1.2 *Vegetation Communities*

The first step in determining which vegetation communities were present in the Modification areas was to analyse the sample plot data by grouping the plots that are most similar to each other. To achieve this, the plot data (**Appendix 5**) were run through Primer 6 (Clarke and Gorley 2001). A dendrogram (**Figure 13**) shows the significantly different groupings (95% confidence) below each solid black line. To assist with interpretation each plot was given a generic classification as shown in the dendrogram key. The degree of difference between each group is then presented by multi-dimensional scaling, a process that positions the plots according to their relative similarity to each other (**Figure 14**). Overall, this analysis verified the following generic groups: grassland, box-gum shrubby, box-gum grassy, Slaty Box, Spotted Gum shrubby, Spotted Gum grassy, Red Gum Grassy and Sharp Rush.

The next step was to compare the floristic content of the plots from each of the generic groups with the community profiles of the Peake (2006) regional classification. The finally selected communities were then compared with determinations for TEC considered likely to occur in the region.

The dendrogram (**Figure 13**) showed five plots as special cases and examination of the data provided an explanation:

- Plots A2, B9 and E6 were dominated by weeds;
- Plot E2 was also dominated by weeds, particularly large areas of Sharp Rush (*Juncus acutus)*; and
- Plot E3 contained a large isolated patch of *Acacia melvillei*.

This information was used in the final vegetation community mapping to separate weedy grassland areas from native grassland areas.

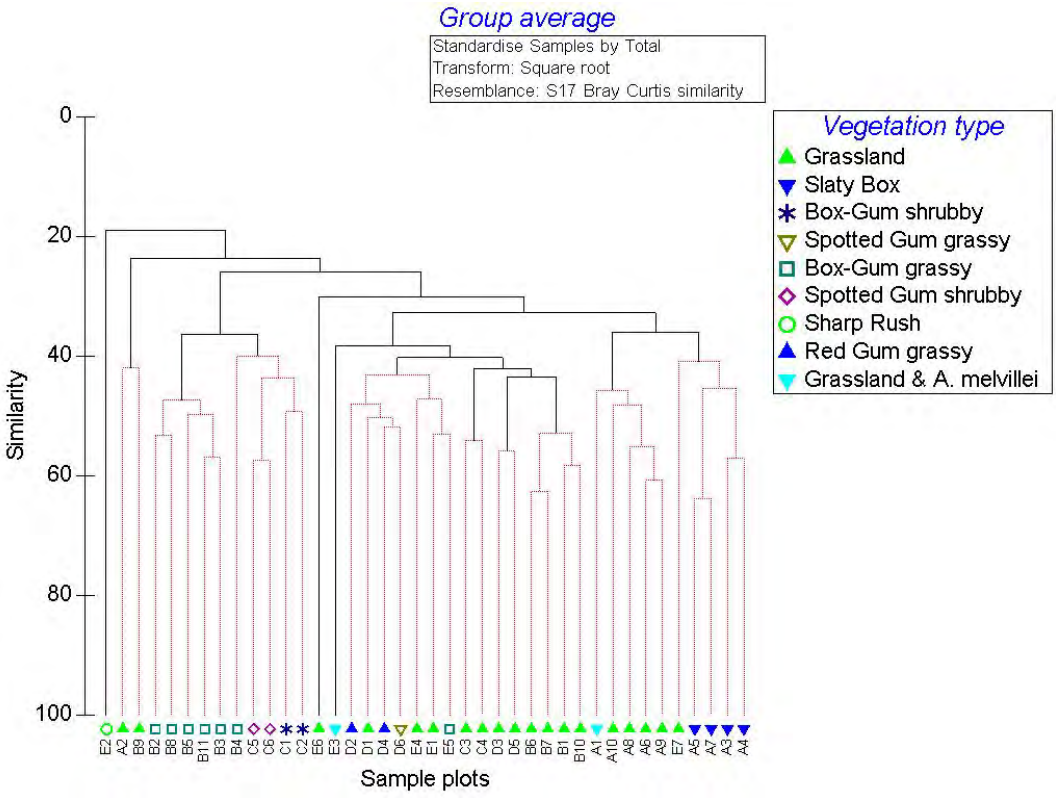


Figure 13: Dendrogram of the 40 Sample Vegetation Plots

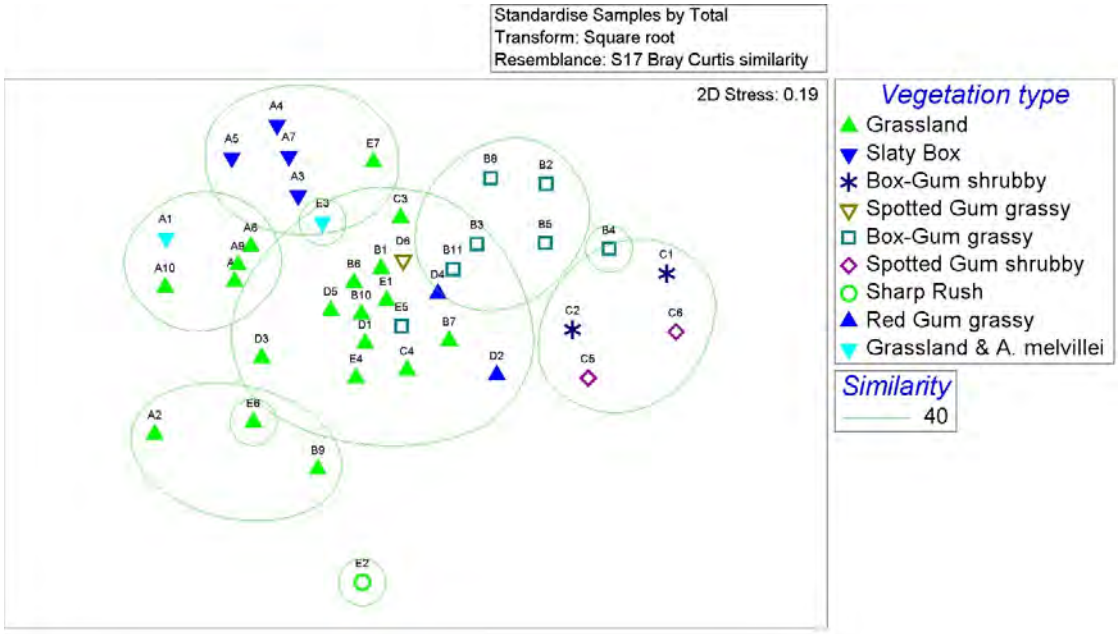


Figure 14: Non-metric Multidimensional Scaling Plot showing the Similarity Relationship between the Sample Vegetation Plots

To determine whether areas of open grassland matched the description of the Box-Gum Woodland EEC/CEEC, they were first assessed for the likelihood that they once supported the required canopy trees. Based on surrounding vegetation, it was determined that one or more of these canopy tree species were present in the open grassland of Modification Areas B, C and E. These two areas were then tested against the conditions outlined in **Section 4.1.2** with each of the criteria required to be met (results shown in **Table 11**). The open grassland in Modification Areas B and C met the condition for classification as the CEEC, whereas the open grassland in Modification Area E did not.

Table 11: Open grassland vegetation attributes

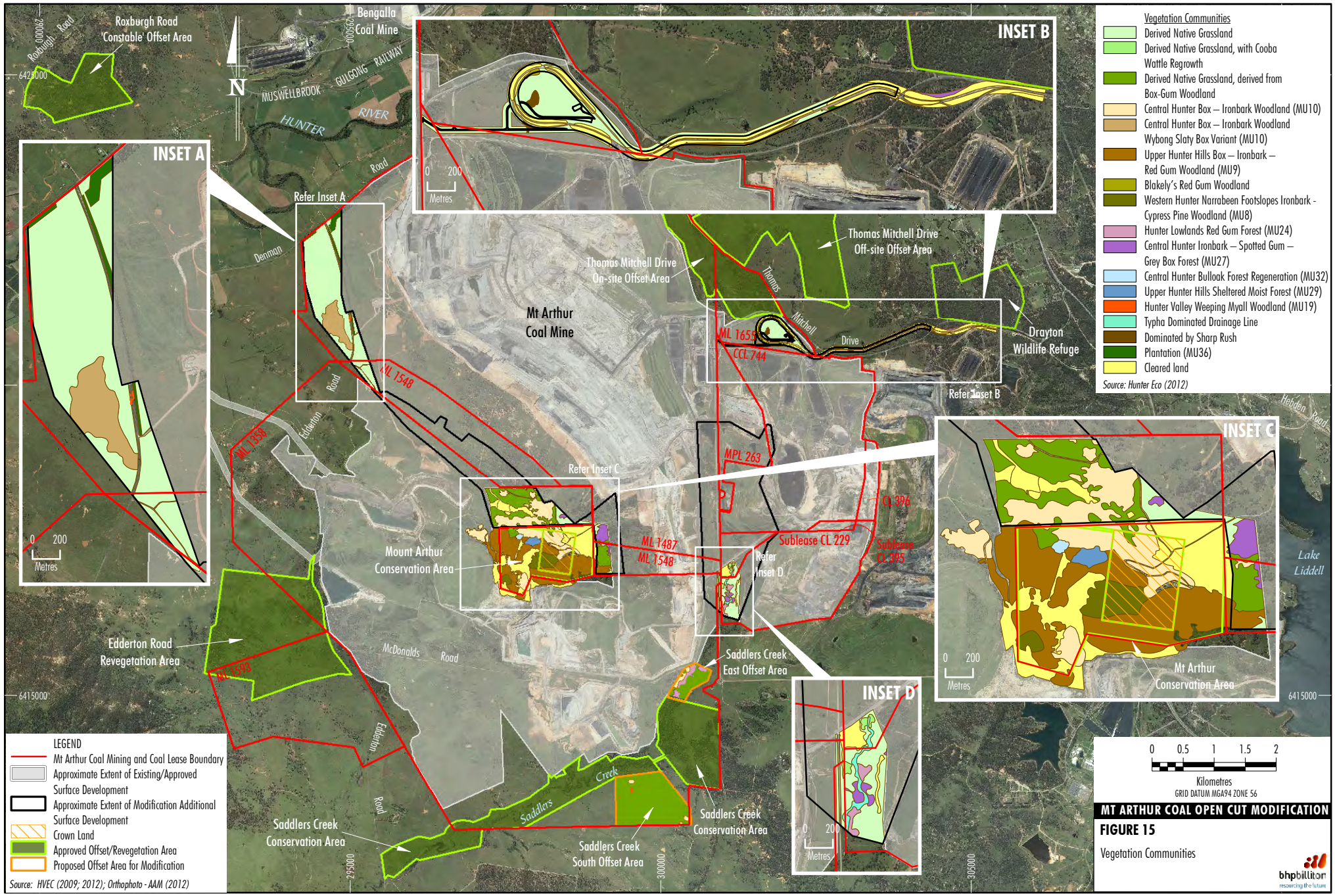
	Positive Indicator Level	Modification Area		
		Area B	Area C	Area E
Number of plots	-	5	2	4
% native cover	50	61	68	57
Native grass species	-	8	9	9
Native other species	12	15	12	9
Important Species	1	3	4	3

Mount Arthur and Footslopes Vegetation

The vegetation within Mount Arthur was mapped and is shown on **Figure 15** and described in detail below. Data from 75 ground-truth points, along with selected vegetation community boundary recording by hand-held GPS, were used to deconstruct the Mt Arthur Coal Mine vegetation. This investigation was not exhaustive, being intended only to provide an indication of the communities present. To complete this task, floristic plot data from within the different communities would need to be collected and analysed. The following HRVP (Peake, 2006) communities were considered to be present:

Central Hunter Box – Ironbark Woodland (MU10)

The dominant canopy species was *Eucalyptus albens x E. moluccana* (Hybrid White Box). This community extended into the Modification area, was representative of Box-Gum Woodland EEC/CEEC, and has been described in further detail in **Appendix 6**.



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 15

Vegetation Communities

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Upper Hunter Hills Box – Ironbark – Red Gum Woodland (MU9)
This community was located on moist sheltered ridges and slopes. It was characterised by a canopy of Blakely's Red Gum (*Eucalyptus blakelyi*), along with *Eucalyptus albens x E. moluccana* (Hybrid White Box), Rough-barked Apple (*Angophora floribunda*) and *Brachychiton populneus*. There was a dense mid to tall shrub layer consisting primarily of Native Olive (*Notelaea microcarpa*), Western Boobialla (*Myoporum montanum*) and Sticky Daisy-bush (*Olearia elliptica*). Peake (2006) reported >60 ha of this community extant within the bounds of that study. However, this would have resulted from the study being primarily aimed at remnant vegetation of the valley floor.

This community extended into the Modification area and is described in further detail in **Appendix 6**. While the presence of Blakely's Red Gum suggests that the community might be a Box-Gum Woodland TEC, the persistent and dense shrub layer rules that out.

Western Hunter Narrabeen Footslopes Ironbark – Cypress Pine Woodland (MU8)
Found in two locations on exposed western slopes, this community was dominated by Grey Ironbark (*Eucalyptus crebra*) and Black Cypress (*Callitris endlicheri*). While the geology was Permian rather than Narrabeen, the position in the landscape and the floristic content closely matched the description of Peake's (2006) Vegetation Community MU8. Peake (2006) reports 3,107 ha of this community extant within the bounds of that study. This community was not recorded within the Modification area.

Central Hunter Bulloak Forest Regeneration (MU32)
By far the dominant species was Bulloak (*Allocasuarina luehmannii*), almost as a monoculture. This community was not recorded within the Modification area.

Upper Hunter Hills Sheltered Moist Forest (MU29)
The canopy of this community was dominated by Grey Gum (*Eucalyptus punctata*), along with some Rough-barked Apple (*Angophora floribunda*) and Forest Oak (*Allocasuarina torulosa*). A dense mid to tall shrub layer was present dominated by Native Olive (*Notelaea microcarpa*) and Hairy Clerodendrum (*Clerodendrum tomentosum*). Peake (2006) reported >145 ha of this community (mapped by Peake [2006] as MU29) extant within the bounds of that study. Again, this will have resulted from the study primarily being aimed at remnant vegetation of the valley floor.

The following sections provide an overview of the vegetation communities mapped within the Modification area. **Appendix 6** provides full vegetation community profiles.

Modification Area A

The dominant vegetation within Modification Area A was open grassland with widely scattered trees (**Figure 15**). The grassland was dominated by native grasses with a large area containing the Commonwealth listed vulnerable species, *Bothriochloa biloba.* Within the *Bothriochloa biloba* distribution was a 13 ha area in which the species was the dominant grass. Elsewhere it appeared as scattered patches of about 10 or 20 square metres (~74 patches in 49 ha) or was only sporadically present (22 ha).

In the approximate centre of the area is vegetation containing mixed old growth and re-growth Bulloak (*Allocasuarina luehmannii*) along with scattered large Slaty Gum (*Eucalyptus dawsonii*). The dendrogram in **Figure 13** shows the four sample plots from this habitat grouping together, even though some plots had either no Slaty Box or no Bulloak. Based on floristic content, this community was determined to be Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant (MU10) (Peake, 2006). The floristic content and structure (particularly absent shrub layer) did not match Peake's (2006) Vegetation Community MU7 Narrabeen Footslopes Slaty Box Woodland, indicating that it was also not the NSW vulnerable ecological community *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.*

At the northern end of this area were several Fuzzy Box (*Eucalyptus conica*). and these trees are likely remnants of what was once a larger population in the locality.

A dense group of *Acacia pendula* were present on both sides of a section of Edderton Road. These plants comprise part of the NSW listed endangered population of this species in the Hunter Catchment as well as an instance of the NSW listed EEC *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion*. They were growing almost entirely in the road reserve and the ground species were dominated by weeds.

Along the eastern edge of Edderton Road and along the north-eastern edge of Denman Road there is a strip of planted vegetation comprising species that are not locally endemic (mapped as Plantation [MU36]).

Modification Area B

A mixture of open grassland and woodland characterised Modification Area B (**Figure 15**). It is reasonable to assume that the surrounding box woodland would have once been continuous across what is now cleared grassland. The majority of the open grassland was, therefore, determined to form part of the Commonwealth CEEC White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland, taking into account the diagnostic conditions met in **Table 11**. Consistent with this analysis, this grassland would also represent the NSW listed EEC White Box Yellow Box Blakely's Red Gum Woodland.

On the eastern side of this area there was a small patch of Spotted Gum (*Corymbia maculata*) classified as Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27). This would also represent the NSW listed EEC *Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions*. The grassland surrounding this Spotted Gum patch and up to the road on the ridge has been determined as being of unknown origin because there was insufficient information available to determine the original dominant canopy.

The woodland habitat (other than the Spotted Gum) was determined to fit Peake's (2006) description of Vegetation Community MU10 Central Hunter Box – Ironbark Woodland. The box species appeared to be what has been classed as a hybrid of White Box (*Eucalyptus albens*) and Grey Box (*Eucalyptus moluccana*). Umwelt (2011) reported having submitted a number of specimens from the vicinity to the Sydney herbarium for identification with almost all being identified as the hybrid. The large and sessile fruit sampled from box trees in Modification Area B during the current investigation were consistent with the hybrid. Combined with the predominantly grassy understorey, the community would form part of the Commonwealth CEEC White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

Being consistent with MU10 of Peake (2006), it would be the NSW EEC Central Hunter Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions with MU10 being described as containing the hybrid box, and MU10 being referenced in that NSW Scientific Committee EEC determination. However, this community also represents the NSW EEC White Box Yellow Box Blakely's Red Gum Woodland because that determination specifically includes intergrades of *Eucalyptus moluccana* with *Eucalyptus albens*. Thus, there is an anomaly where the same area of vegetation is representative of two different NSW listed EEC.

A large dam had been constructed in the valley floor that no longer held water. The ground surface in the vicinity of the dam, and a wide diversion contour leading into the dam, was disturbed and covered mostly with exotic grasses. Areas above and below the dam were heavily weed-infested. This area was mapped as Cleared land.

Modification Area C

The two main communities in Modification Area C were dominated by Spotted Gum (*Corymbia maculata)* and Blakely's Red Gum (*Eucalyptus blakelyi*) (**Figure 15**). The remainder of the area was open grassland.

The Spotted Gum community would represent Peake's (2006) MU27 Central Hunter Ironbark - Spotted Gum - Grey Box Forest, although the only canopy species was Spotted Gum. This represents the NSW EEC Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions the determination of which references Peake's (2006) Vegetation Community MU27.

On the southern slopes of Mount Arthur, the habitat was dominated by Blakely's Red Gum (*Eucalyptus blakelyi*) along with Grey Gum (*Eucalyptus punctata*), Rough-barked Apple (*Angophora floribunda*) and hybrid box (*E. albens x E. moluccana*). There was a dense mid to tall shrub layer consisting primarily of *Notelaea microcarpa, Myoporum montanum* and *Olearia elliptica*. Peake (2006) mapped this area as part of the MU31 Mount Arthur Forest Complex. The detailed investigation into the Mt Arthur Coal Mine community concluded that this habitat was consistent with MU9 Upper Hunter Hills Box – Ironbark – Red Gum Woodland, not a threatened community.

Most of the grassland met the requirements (**Section 4.1.2** and **Table 11**) of having been derived from Box-Gum Woodland and, therefore, was classified as part of the Box-Gum Woodland EEC/CEEC.

An area of grassland at the northern end of the area was determined as being of unknown origin because there was insufficient information available to determine the original dominant canopy.

Modification Area D

Figure 15 shows the vegetation mapped across the Modification Area D. A central feature of the area was a drainage line, being the upper reaches of Saddlers Creek, that was dominated by Broadleaf Cumbungi (*Typha orientalis*) reeds. Remnant vegetation gave some indication of the pattern before clearing. At the edges of the central creekline were patches of Forest Red Gum (*Eucalyptus tereticornis*), Spotted Gum (*Corymbia maculata*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). The Red Gum community also contained Grey Gum (*Eucalyptus punctata*), some Grey Box (*Eucalyptus moluccana*) and the box hybrid *Eucalyptus albens x E. moluccana*. The overall combination of species best matched Hunter Lowlands Red Gum Forest (MU24).

Composition of the Spotted Gum and Ironbark communities together was consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27). These two communities were representative of the similarly named NSW EEC Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions and Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions.

The surrounding grassland was deemed to be of undetermined origin although it contained mostly native species, particularly grasses. There were some localised areas where Cooba (*Acacia salicina*) was a dominant regrowth element in the grassland.

A large area at the north-western end had been either filled with spoil or used as a stockpile area as indicated by the stony ground. This area was dominated by exotic species, in particular Coolatai Grass (*Hyparrhenia hirta*) (mapped as Cleared Land).

Modification Area E

This area consisted of the rail loop and main access corridor (**Figure 3**). The primary area of interest was inside the rail loop and outside the southern side of the loop. **Figure 15** shows the vegetation mapped for the overall area. The majority of the area was open grassland. Disturbed areas along the rail line, resulting either from excavation or bunding required to create a level track, had been planted with a variety of exotic grasses such as Rhodes Grass (*Chloris gayana*), Red Natal Grass (*Melinis repens*) and Reed Canary Grass (*Phalaris arundinacea*).

Scattered box trees were observed to the south of the investigation area, but the species could not be determined as they did not carry any fertile material. An area inside the rail loop containing Blakely's Red Gum (*Eucalyptus blakelyi*) was deemed to be part of the Box-Gum Woodland EEC/CEEC. Therefore, the surrounding grassland could have been derived from Box-Gum woodland. However, as **Table 11** shows, there were, on average, insufficient native species other than grasses, for the grassland to be classified as the Commonwealth CEEC White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Meanders and sample vegetation plots through these grasslands revealed large areas that were dominated by exotics such as Coolatai Grass (*Hyparrhenia hirta*), Paspalum (*Paspalum dilatatum*) and Sharp Rush (*Juncus acutus*). It was also concluded that weed content meant that the grassland was not part of the NSW EEC *White Box Yellow Box Blakely's Red Gum Woodland.*

Table 12 provides a summary of all communities mapped across the Modification area. These vegetation communities are mapped on **Figure 15.**

Table 12: Vegetation communities and their corresponding endangered community mapped within the Modification area

Vegetation Type	Vegetation Community	HRVP Equivalent
Grassland	Derived Native Grassland	No HRVP equivalent
Grassland (Cooba Wattle Regrowth)	Derived Native Grassland, with Cooba Wattle Regrowth	No HRVP equivalent
Grassland	Derived Native Grassland, derived from Box-Gum Woodland[1, 2]	No HRVP equivalent
Reed Drainage Line	*Typha* Dominated Drainage Line	No HRVP equivalent
Sharp Rush	Dominated by Sharp Rush	No HRVP equivalent
Box-Gum (grassy)	Central Hunter Box – Ironbark Woodland[1, 2, 3]	MU10
Box-Gum (grassy)	Blakely's Red Gum Woodland[1, 2]	No HRVP equivalent
Box-Gum (shrubby)	Upper Hunter Hills Box – Ironbark – Red Gum Woodland	MU9
Slaty Box	Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant	MU10
Red Gum	Hunter Lowlands Red Gum Forest[4]	MU24
Spotted Gum	Central Hunter Ironbark – Spotted Gum – Grey Box Forest[5]	MU27
Weeping Myall	Hunter Valley Weeping Myall Woodland[6]	MU19

1 White Box Yellow Box Blakely's Red Gum Woodland EEC.

2 White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.

3 Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC.

4 Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC.

5 Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC.

6 Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC.

5.1.3 *Threatened Flora Populations*

Table 13 lists the likelihood of threatened flora populations occurring in the Modification area.

Table 13: Threatened flora populations

Population	Likelihood of Occurrence
Acacia pendula population in the Hunter Catchment	*Acacia pendula* has been recorded within the Mt Arthur Coal Mine boundary.
Cymbidium canaliculatum population in the Hunter Catchment	This tree orchid is commonly found in Grey or White Box eucalypts, but can also occur in other tree species. There were suitable host trees present in some areas within the Modification area.
Diuris tricolor population in the Muswellbrook LGA	This terrestrial orchid grows in open native grassland as well as grassy woodland. It has only been recorded in the Muswellbrook region. Suitable habitat was present in some areas within the Modification area.
Eucalyptus camaldulensis population in the Hunter Catchment	These are River Red Gums and are generally found on stream and river banks. There was no suitable habitat in the Modification area.

Acacia pendula occurs in Modification Area A and would be impacted by the Modification.

While Modification Area B contained suitable host tree species for *Cymbidium canaliculatum* (Tiger Orchid), none were found. Suitable habitat for this orchid (in established trees) would be impacted by the Modification.

Diuris tricolor has been recorded in and near the Mt Arthur Coal Mine. Suitable habitat was present in Modification Areas B and C. The species can only be found during a narrow flowering period of late September to early October. After confirming that these orchids were flowering in the A171 conservation area (19 September 2012), Modification Areas B and C were carefully searched with no orchids found. Despite no orchids being found, it is possible that some potential habitat for this orchid would be impacted by the Modification.

5.2 Fauna

A total of 77 fauna species, comprising three amphibians, five reptiles, 44 birds and 25 mammals were recorded within the Modification area by Niche (**Appendix 1**). Of these, six were introduced species. A full list of fauna species recorded within the Modification is provided in **Appendix 1**.

5.2.1 *Threatened Fauna Species*

An evaluation of database records for threatened fauna species occurring within or surrounding the Modification area, against their known habitat requirements, provides an assessment of likelihood of occurrence in the Modification area (**Table 14**). Species potentially impacted by the Modification are assessed in **Section 7.4**.

Table 14: Threatened fauna likelihood of occurrence

Scientific Name	Common Name	Status[1]		Habitat Preferences	Habitat Suitability
		TSC Act	EPBC Act		
Amphibians					
Litoria aurea	Green and Golden Bell Frog	E	V	Swamps and wetlands with deep water and reeds.	Unlikely, no suitable habitat present.
Litoria booroolongensis	Booroolong Frog	E	E	Permanent streams with some fringing vegetation cover.	Unlikely, no suitable habitat present.
Birds					
Leipoa ocellata	Malleefowl	E	V	Semi-arid to arid shrublands and low woodlands (SEWPaC, 2012b).	Unlikely, no suitable habitat present.
Oxyura australis	Blue-billed Duck	V	-	Deep water swamps and dams.	No suitable habitat present.
Stictonetta naevosa	Freckled Duck	V	-	Permanent fresh water swamps and creeks (Birdlife Australia, 2012).	No suitable habitat present.
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Wetlands.	No suitable habitat present.
Botaurus poiciloptilus	Australasian Bittern	E	E	Permanent freshwater wetlands.	No suitable habitat present.
Circus assimilis	Spotted Harrier	V	-	Woodland, grassland and shrub steppe.	Suitable habitat present. Species assessed in **Section 7.4.2**.
Hieraaetus morphnoides	Little Eagle	V	-	Woodland, forest, farmland, grasslands, crops, treeless dune fields, and recently logged areas.	Suitable habitat present. Species assessed in **Section 7.4.2**.
Burhinus grallarius	Bush Stone-curlew	E	-	Woodland and forest (Birdlife Australia, 2012).	Lack of records suggest that species is not present and would not be impacted by the Modification.
Rostratula australis	Australian Painted Snipe	E	V	Inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains.	No suitable habitat present.
Glossopsitta pusilla	Little Lorikeet	V	-	Open eucalypt forests and woodlands.	Suitable habitat present. Species assessed in **Section 7.4.4**.
Lathamus discolor	Swift Parrot	E	E	Dry sclerophyll eucalypt forests and woodlands (SEWPaC, 2012b).	Suitable habitat present. Species assessed in **Section 7.4.4**.
Neophema pulchella	Turquoise Parrot	V	-	Open woodlands and eucalypt forests with a ground cover of grasses and under storey of low shrubs.	Suitable habitat present. Species assessed in **Section 7.4.4**.

Table 14 (continued): Threatened fauna likelihood of occurrence

Scientific Name	Common Name	Status[1]		Habitat Preferences	Habitat Suitability
		TSC Act	EPBC Act		
Birds (Continued)					
Tyto novaehollandiae	Masked Owl	V	-	Diverse range of wooded habitat.	Lack of records suggest that species is not present and would not be impacted by the Modification.
Tyto tenebricosa	Sooty Owl	V	-	Moist eucalypt forests and rainforests (DEC, 2006).	Lack of records suggest that species is not present and would not be impacted by the Modification.
Ninox connivens	Barking Owl	V	-	Forests, woodlands, swamp woodlands and dense scrub.	Suitable habitat present. Species assessed in **Section 7.4.1**.
Ninox strenua	Powerful Owl	V	-	Forests and woodlands (DEC, 2006).	Lack of records suggest that species is not present and would not be impacted by the Modification.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	Eucalypt woodlands (including Box-Gum Woodland) and dry open forest.	Suitable habitat present. Species assessed in **Section 7.4.1**.
Chthonicola sagittata	Speckled Warbler	V	-	Eucalyptus dominated communities that have a grassy understorey.	Suitable habitat present. Species assessed in **Section 7.4.1**.
Anthochaera phrygia	Regent Honeyeater	CE	E	Temperate eucalypt woodlands and open forests.	Suitable habitat present. Species assessed in **Section 7.4.1**.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Drier open forests or woodlands dominated by box and ironbark eucalypts. Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees.	Suitable habitat present. Species assessed in **Section 7.4.1**.
Epthianura albifrons	White-fronted Chat	V	-	Salt marsh and other damp areas with low vegetation (Birdlife Australia, 2012).	No suitable habitat present.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	Lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee.	Suitable habitat present. Species assessed in **Section 7.4.3**.
Petroica boodang	Scarlet Robin	V	-	Forests, woodlands; and heavier vegetation when breeding.	Suitable habitat present. Species assessed in **Section 7.4.3**.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	Open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands.	Species recorded in Modification area. Species assessed in **Section 7.4.1**.

Table 14 (continued): Threatened fauna likelihood of occurrence

Scientific Name	Common Name	Status[1]		Habitat Preferences	Habitat Suitability
		TSC Act	EPBC Act		
Birds (Continued)					
Daphoenositta chrysoptera	Varied Sittella	V	-	Eucalypt forests and woodlands.	Species recorded in Modification area. Species assessed in **Section 7.4.1**.
Stagonopleura guttata	Diamond Firetail	V	-	Grassy eucalypt woodlands, open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.	Suitable habitat present. Species assessed in **Section 7.4.1**.
Mammals					
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Sclerophyll forests and woodlands, coastal heathlands and rainforests.	Suitable habitat present. Species assessed in **Section 7.4.5**.
Phascolarctos cinereus	Koala	V	V	Eucalypt forests and woodlands.	Suitable habitat present. Species assessed in **Section 7.4.6**.
Petaurus norfolcensis	Squirrel Glider	V	-	Forest and woodland with habitat hollows and nectar resources.	Suitable habitat present. Species assessed in **Section 7.4.7**.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Rocky escarpments.	No suitable habitat present.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Blossoming eucalypts or fruiting trees.	Species recorded in Modification area. Species assessed in **Section 7.4.8**.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Wet and dry forests, grasslands, shrublands, Mallee and open woodlands (Churchill, 2008).	Suitable habitat present. Species assessed in **Section 7.4.9**.
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Rainforest, Melaleuca forest, monsoon forest, tall open forest, River Red Gum and Yellow Box woodlands, riparian open forest and dry sclerophyll forest (Churchill, 2008).	Species recorded in Modification area. Species assessed in **Section 7.4.9**.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Dry sclerophyll forests and woodlands, sub-alpine woodland, edges of rainforest, wet sclerophyll forest, *Callitris* spp. dominated forests and sandstone outcrop country (Churchill, 2008).	Suitable habitat present. Species assessed in **Section 7.4.10**.

Table 14 (continued): Threatened fauna likelihood of occurrence

Scientific Name	Common Name	Status[1]		Habitat Preferences	Habitat Suitability
		TSC Act	EPBC Act		
Mammals(Continued)					
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Wet sclerophyll and coastal Mallee.	Suitable habitat present. Species assessed in **Section 7.4.9**.
Miniopterus australis	Little Bentwing-bat	V	-	Moist eucalypt forest, rainforest or dense coastal Banksia scrub.	No suitable habitat present.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands (Churchill, 2008).	Species recorded in Modification area. Species assessed in **Section 7.4.10**.
Myotis macropus	Southern Myotis	V	-	Streams and permanent waterways and usually in areas that are vegetated rather than cleared (Churchill, 2008).	Species recorded in Modification area. Species assessed in **Section 7.4.9**.
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	Rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands.	Lack of records suggest that species is not present and would not be impacted by the Modification.
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Moist gullies in mature coastal forest, rainforest, open woodland, Melaleuca swamp woodland, wet and dry sclerophyll forests, cleared paddocks with remnant trees and tree-lined creeks in open areas (Churchill, 2008).	Suitable habitat present. Species assessed in **Section 7.4.9**.
Vespadelus troughtoni	Eastern Cave Bat	V	-	Tropical mixed woodland, wet and dry sclerophyll forest (Churchill, 2008).	Suitable habitat present. Species assessed in **Section 7.4.10**.
Pseudomys novaehollandiae	New Holland Mouse	-	V	Coastal heath and dry sclerophyll forest and woodland.	Lack of records suggest that species is not present and would not be impacted by the Modification.

After: **Appendix 1**.

[1] Threatened fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).
V = Vulnerable; E = Endangered; CE = Critically Endangered

5.2.2 *Habitat Assessment*

Niche (**Appendix 1**) undertook a habitat assessment within the Modification area. A total of eight habitat types were recorded within the Modification area, *viz.:* Forest, Disturbed Forest, Grassy Woodland, Disturbed Grassy Woodland, Grassland, Disturbed, Reeds and Rushes and Plantation. A detailed description of these habitat types is provided in **Appendix 1** and **Section 6.1.2.**

Niche (**Appendix 1**) concluded that the habitat within the study area was mixed, constituting derived grassland, forest and woodland. Derived grassland supported a mixture of native and exotic grass species and occurred within the study area due to historic clearing of woodland or forest habitats for agriculture. Habitat features and complexity within the existing grassland habitat was limited and generally favoured a suite of common native fauna species rather than fauna of conservation significance. A sparse covering of scattered large trees throughout the grassland habitat added some complexity in the form of canopy features, hollows, stags and logs, although such features are somewhat isolated (**Appendix 1**).

Woodland and forest vegetation patches covered approximately half of the study area and were variable in condition, structure and habitat features as a result of different disturbance regimes, topography and environmental factors (**Appendix 1**). Habitat assessments were performed throughout six patches along or adjacent to fauna transects (**Appendix 1**).

5.2.3 *SEPP 44 Koala Habitat*

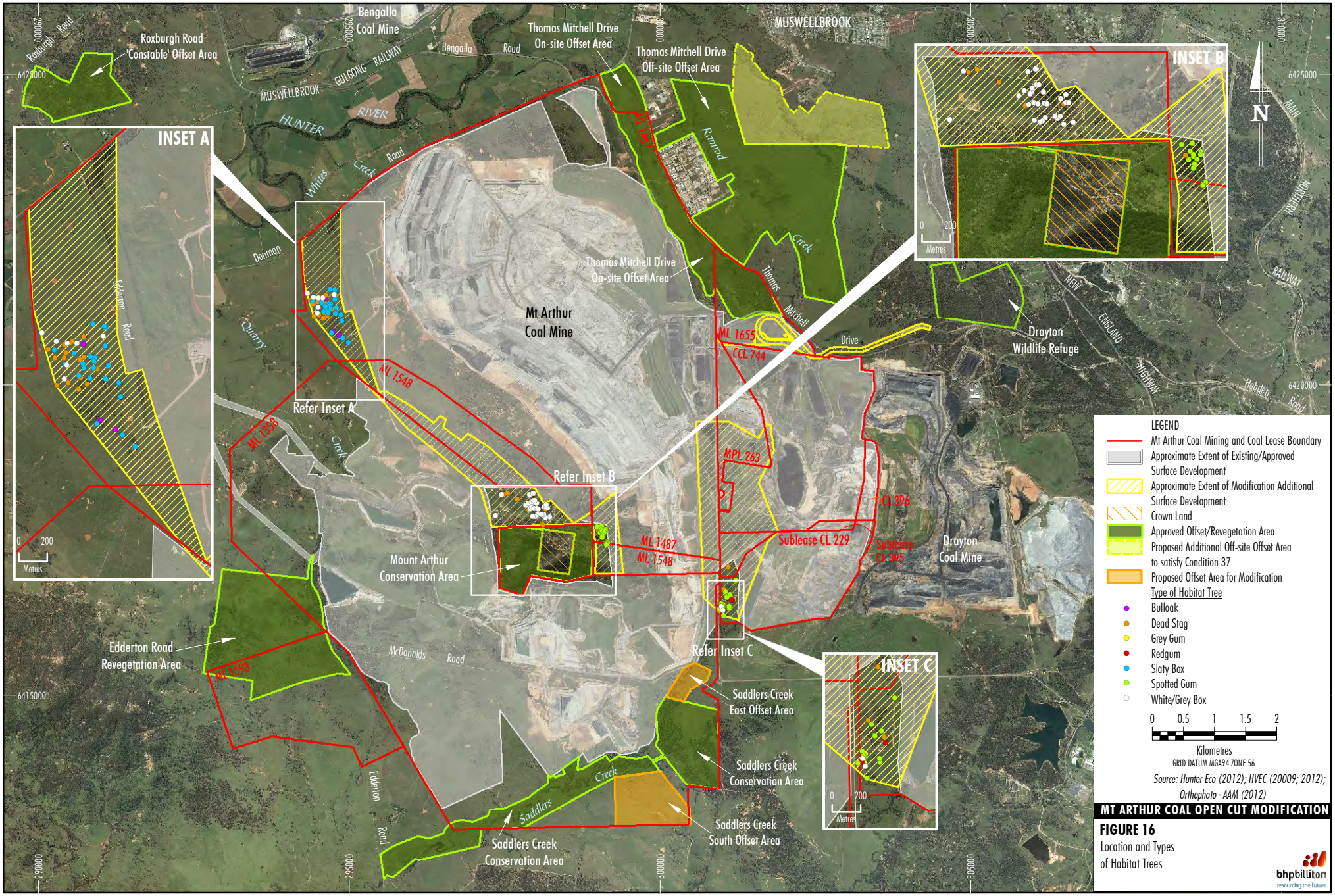
A thorough search by Niche using the Spot Assessment Technique (**Section 4.2.3**) and call playback did not result in the discovery of any Koala in the Modification area.

5.2.4 *Habitat Trees*

A total of 161 habitat trees were recorded (**Figure 16**) and the location coordinates and species details are provided in **Appendix 7**. The numbers of habitat trees in the Modification areas were as follows:

- Area A - 48;
- Area B - 58;
- Area C - 32; and
- Area D - 23.

There were no habitat trees in the proposed Modification Area E.



MT ARTHUR COAL OPEN CUT MODIFICATION

FIGURE 16
Location and Types of Habitat Trees

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6 Impact Evaluation

The Modification would result in the same types of potential impacts on biodiversity as the existing approved mine (e.g. land clearance and indirect impacts). This section describes the magnitude, extent and significance of potential impacts from the Modification in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

Section 7 provides an assessment of the potential impacts on threatened species. There are some threatened species and ecological communities which would be impacted by the Modification (e.g. *Acacia pendula*) that were not impacted by the existing approved mine.

6.1 Land Clearance

Clearing of native vegetation is listed as a key threatening process on Schedule 3 of the TSC Act. This is relevant to the Modification as land clearance would cause impacts to a range of TECs (**Section 6.1.1**) and fauna (including a number of threatened fauna species) (**Section 6.1.2**) that are known to occur in the Modification area, and potentially to other species that may occur.

Land clearance may also result in the loss of hollow-bearing trees, removal of dead wood and dead trees; bushrock removal; loss of individual animals; impacts to habitat connectivity; changes to hydrology; and removal of Koala habitat. These potential impacts are described in **Sections 6.1.3** to **6.1.8**.

6.1.1 *Loss of Native Vegetation*

The Modification would require the removal of 228.9 ha of native vegetation as outlined in **Table 15**. This comprises mostly derived grasslands (173 ha) and woodland (44.6 ha). The total land clearance area is slightly larger (259.9 ha) as it includes some introduced (such as the vegetation community dominated by Sharp Rush) or cleared map units (**Section 6.1.2**).

Table 15: Vegetation Clearance

Vegetation Type	Vegetation Community	HRVP Equivalent	Area (ha)
Grassland	Derived Native Grassland	no HRVP equivalent	136.8
Grassland (Cooba Wattle Regrowth)	Derived Native Grassland, with Cooba Wattle Regrowth	no HRVP equivalent	1
Grassland	Derived Native Grassland, derived from Box-Gum Woodland[1, 2]	no HRVP equivalent	35.2
Reed Drainage Line	*Typha* Dominated Drainage Line	no HRVP equivalent	2.5
		subtotal	175.5
Box-Gum (grassy)	Central Hunter Box – Ironbark Woodland[1, 2, 3]	MU10	23
Box-Gum (grassy)	Blakely's Red Gum Woodland[1, 2]	no HRVP equivalent	0.2
Box-Gum (shrubby)	Upper Hunter Hills Box – Ironbark – Red Gum Woodland	MU9	3.4
		subtotal	26.6
Slaty Box	Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant	MU10	17.9
Red Gum	Hunter Lowlands Red Gum Forest[4]	MU24	1.7
Spotted Gum	Central Hunter Ironbark – Spotted Gum – Grey Box Forest[5]	MU27	7.1
Weeping Myall	Weeping Myall Woodland[6]	MU19	0.1
		Total	**228.9**

1 White Box Yellow Box Blakely's Red Gum Woodland EEC.

2 White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.

3 Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC.

4 Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC.

5 Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC.

6 Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC.

The Modification area is mostly comprised of grassland. Weeping Myall Woodland and Blakely's Red Gum Woodland both comprise the smallest areas to be cleared for the Modification (approximately 0.1 ha and 0.2 ha to be cleared for each vegetation community, respectively).

Regionally Significant Vegetation

Six of the vegetation communities identified in the Modification area represent five TECs listed under the TSC Act and one TEC listed under the EPBC Act (**Table 16**).

The Modification would require the removal of approximately 90.3 ha of TECs as outlined in **Table 16**.

Table 16: Vegetation Clearance of TECs within the Modification Area

Community	Conservation Status[1]		Disturbance Area (ha)
	TSC Act	EPBC Act	
Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	E	-	0.1
White Box Yellow Box Blakely's Red Gum Woodland[2]	E	CE	58.4 comprising: • 35.2 ha of Derived Native Grassland, derived from Box-Gum Woodland; • 23 ha of Central Hunter Box-Ironbark Woodland; and • 0.2 ha of Blakely's Red Gum Woodland.
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions	E	-	23
Central Hunter Ironbark – Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E	-	7.1
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	E	-	1.7

[1] Threatened population, vegetation community, flora species or fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).
E = Endangered; CE = Critically Endangered

[2] Listed as the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC under the EPBC Act.

These communities are further assessed in **Section 7.2**.

No regionally significant vegetation corridors are located within the Modification area and none would be impacted by the Modification.

6.1.2 *Loss of Fauna Habitat*

Clearing of native vegetation is recognised as a major factor contributing to loss of biological diversity (NSW Scientific Committee, 2001a). Clearing of vegetation results in the loss of habitat for species that utilise the vegetation, and may also result in the loss of habitat resources. Habitat resources lost may be comprised of hollow-bearing trees, dead wood and dead trees, rocks and fallen timber, and food trees. The loss of these resources may negatively impact on the lifecycle and survival of fauna species that use these resources in the short and long-term.

The impacts of clearing of native and other vegetation and associated habitat loss are considered for threatened fauna species predicted or known to occur within the Modification area in **Section 7.4**. Results from past and recent fauna studies indicate that habitats within the proposed disturbance areas have limited capacity to maintain moderate fauna species diversity or viable populations of any species. Fauna breeding within the proposed disturbance areas would be limited or completely suppressed due to limited resources. Hence removal of fauna habitat within the proposed disturbance areas is unlikely to significantly impact any extant fauna species, or other species that are located across the wider landscape.

As outlined in **Section 6.1.1**, approximately 228.9 ha of native vegetation would be cleared for the Modification. The total land clearance area is slightly larger (259.9 ha) as it includes some introduced or cleared map units. The type of fauna habitat that would be removed and the location is described in **Table 17** and shown on **Figures 3** to **5** of **Appendix 1**.

Table 17: Loss of Each Habitat Type within the Modification Area

Fauna Habitat Type	Approximate Area to be cleared (ha)	Location and Description
Forest	9	This habitat type occurs as Spotted Gum - Grey Box forest within Modification Areas B and C. It comprises a moderate-sized patch of mixed age forest with Spotted Gum to 1 m in diameter and 25 m height. This habitat type has a mid-storey of regenerating Eucalyptus with a good pulse of flowering and a patchy understorey with multiple shrub species present. Mistletoe is also abundant. Hollows are common in a range of sizes with occasional large fallen logs. This habitat type is also present in small patches in Modification Area E. This habitat type is generally good condition with good habitat complexity with some apparent disturbance (extent unknown) due to previous clearing.
Disturbed Forest	3.3	This habitat type occurs as lowland forest within Modification Area D. It comprises a moderately dense cover of large older growth trees to 25 m with recent patchy regrowth of mid-storey and understorey vegetation with native and exotic grasses. Small and medium-sized hollows are frequent in older trees, with at least two large Spotted Gum and Ironbarks with large hollows (i.e. >30 centimetres [cm]). Occasional logs are present below larger trees and some weed infestations in some patches of previous disturbance are present. This habitat type is in moderate condition with some recovery of understorey and mid-storey components occurring.
Grassy Woodland	23.2	This habitat type occurs within Modification Areas A, B, C and E. It comprises a few very old trees with limited hollows. There is some regeneration of canopy species with lower strata components having limited cover and diversity. This habitat type has limited floristic diversity or feeding resources as it is predominantly native grass cover. This habitat type is in moderate condition with good recovery potential.

Table 17 (continued): Loss of Each Habitat Type within the Modification Area

Fauna Habitat Type	Approximate Area to be cleared (ha)	Location and Description
Disturbed Grassy Woodland	17.9	This habitat type occurs as disturbed grassy woodland within Modification Area A. It comprises large scattered trees to 20 m over mixed native/exotic ground cover with limited structural complexity/diversity of vegetation with understorey and mid-storey components largely absent expect for some patches of regenerating Bulloak. Hollows are present in most large mature trees ranging from small to large and logs are present beneath larger trees. This habitat type is in generally poor/moderate condition with some apparent resilience with patches of regenerating shrubs.
Grassland	173	These areas constituted a mix of native and exotic grasses with occasional herbs or forbs. Cover of other vegetative layers such as understorey or canopy was absent or very sparse. These areas were generally highly disturbed and modified due to clearing and grazing. Condition was poor – with moderate or low recovery potential.
Reeds and Rushes	2.6	This habitat type occurs as thick *Typha* along a drainage line within Modification Area D. Small patches are also present within Modification Area E. This habitat type is a potential watering point for a range of terrestrial fauna species and has limited aquatic habitat complexity/features. The drainage line component of this habitat type is generally disturbed, while the surrounding vegetation has moderate recovery potential in most areas.
Disturbed	25.1	Disturbed areas were generally roads or other infrastructure, or places where significant soil disruption including fill had occurred leading to weed domination.
Plantation	5.8	Limited fauna habitat.
Total	**259.9**	

Source: After **Appendix 1**.

6.1.3 *Loss of Hollow-bearing Trees, Removal of Dead Wood and Dead Trees*

The *loss of hollow-bearing* trees and the *removal of dead wood and dead trees* are key threatening processes listed under **Schedule 3** of the TSC Act.

There are 127 hollow-bearing trees within the Modification area. There are scattered Slaty Box trees in Modification Area A that contain hollows. These scattered trees occur within predominantly cleared farmland, but would nonetheless, provide habitat for a variety of animals.

The habitat trees in Modification Areas B and C are mainly White/Grey Box trees and are situated on the lower slopes of Mount Arthur.

The hollow-bearing trees in the Modification area provide potential habitat for a range of bird and hollow-dwelling bat species. The lack of threatened fauna species records from within and surrounding the Modification area indicate that it is it is unlikely that the removal of hollow-bearing trees within the Modification would impact threatened species. However, dead wood and dead trees may provide habitat for the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (possibly recorded), Southern Myotis (*Myotis macropus*) and Eastern Freetail-bat (*Mormopterus norfolkensis*). These species are assessed in detail in **Section 7.4.9**.

The Modification would remove dead wood and dead trees on the ground as part of clearing the habitat. The removal of these habitat components could result in impacts to a number of threatened fauna species (refer to **Section 7.4**) as well as some ground dwelling mammals and birds. The lack of threatened fauna species records from within and surrounding the Modification area indicate that it is it is unlikely that the removal of dead wood and dead trees within the Modification would impact threatened ground dwelling mammals and birds. However, the removal of dead wood and dead trees may provide habitat and may potentially impact the Eastern False Pipistrelle (possibly recorded) and Eastern Freetail-bat. These species are assessed in detail in **Section 7.4.9**.

6.1.4 *Bushrock*

Bushrock removal is a key threatening process listed under Schedule 3 of the TSC Act and is the removal of natural surface deposits of rock from rock outcrops or from areas of native vegetation. No major rock formations or continuous rock formations are present in the Modification area. While bushrock generally provides a fauna habitat resource, they are unlikely to be critical to threatened species recorded within the Modification area or those which possibly occur. Any bushrock in the proposed clearance areas would be removed, and potential impacts on fauna species within or surrounding the Modification are considered minor.

6.1.5 *Loss of Individual Animals*

Incidents of fauna mortality may result from land clearance activities as a result of direct encounters with construction works/vehicles or through the removal of habitat during clearing. HVEC currently implements a pre-clearance survey programme to minimise harm to fauna species during clearance works. The pre-clearance survey programme would continue for the Modification and is described in **Section 8.1**.

6.1.6 *Impacts on Habitat Connectivity*

Habitat fragmentation can result in a loss of habitat connectivity and an increase in edge effects which can reduce the availability and quality habitat for native flora and fauna. This may increase the numbers of introduced species, which may increase the risk of predation and competition for resources for native flora and fauna species.

The Modification would involve expansion of the existing and approved mine areas. The Modification is not likely to significantly increase the fragmentation of habitats above that already approved, due to the already highly fragmented nature of the landscape. In addition, the Modification is also unlikely to lead to an increase in edge habitat due to the already fragmented landscape.

6.1.7 *Changes to Hydrology – Ecological Value of Watercourses*

The *Alteration to the Natural Flow Regimes of Rivers and Streams and their Floodplains and Wetlands* is a key threatening process listed under Schedule 3 of the TSC Act and *Degradation of Native Riparian Vegetation along New South Wales Water Courses* is a similar Key Threatening Process under Schedule 6 of the NSW *Fisheries Management Act, 199*9.

The Modification would involve the removal of a drainage line that leads into Saddlers Creek (**Figure 3**). The drainage line that runs through to Saddlers Creek consists of a permanent shallow watercourse. Its catchment has been partly impacted by previous mining works to the east and north and is largely cleared and used for agriculture (**Appendix 1**). Habitat in this drainage line consists predominantly of thick *Typha* reed beds, with other aquatic macrophytes also present. There are no pools free of thick *Typha* growth (**Appendix 1**).

The drainage line that leads to Saddlers Creek would be removed for Modification Area D. Toe drains would be constructed around the perimeter of Modification Area D, to divert rainwater runoff from Saddlers Creek to minimise the chances of contamination from Modification Area D, that may negatively impact flora and fauna species. Diversion drains would also be established to direct uncontaminated surface water away from the mine area, and into existing creeks, rivers, or other forms of drainage. This is further described in **Section 6.2.2**.

Aquatic habitat features within the Modification area are limited to small ephemeral creeks within Modification Areas B and C and a first/second order ephemeral stream within Modification Area D. (**Appendix 1**). The ephemeral creeks within Modification Areas B and C are situated at the top of the Saddlers Creek catchment and consist of first to second order watercourses with irregular, limited flow regimes (**Appendix 1**). Although creek beds are in moderate to good condition, the limited flow regime restricts potential aquatic habitat features along the water courses (**Appendix 1**).

6.1.8 *SEPP 44 Koala Habitat*

As previously discussed (**Section 4.2.3**), based on SEPP 44, some potential habitat for Koalas would be cleared by the Modification. However, the potential habitat is not likely to be used by Koalas given the isolated nature of the habitat in the Modification area and lack of any evidence of Koala inhabitation during surveys undertaken within the Modification area (**Section 3.3**).

6.2 Indirect Impacts

Various indirect impacts on flora and fauna have been previously identified as potentially occurring from the existing Mt Arthur Coal Mine (Cumberland Ecology, 2009a). These are described below in relation to the Modification.

6.2.1 *Introduced Flora and Fauna*

The recent flora surveys conducted within the Modification area recorded a total of 67 introduced flora species. These species are listed in **Appendix 2**.

During the recent fauna surveys within the Modification area, Niche (**Appendix 1**) recorded the following six introduced mammal species: Black Rat (*Rattus rattus*), Dog (*Canis lupus familiaris*), Fox (*Vulpes vulpes*), Cat (*Felis catus*), Rabbit (*Oryctolagus cuniculus*) and European Cattle (*Bos taurus*). The risk of impact from introduced fauna to surrounding habitat or wildlife nature is not likely to change as a result of the Modification.

Measures to manage and control weeds and pests within the Mt Arthur Coal Mine are currently implemented and would continue to be implemented for the Modification. These measures are described in detail in **Section 8.1**.

6.2.2 *Runoff Water Quality*

As described in **Section 6.1.7**, the Modification would involve the placement of Modification Area D in the northern catchment of Saddlers Creek. Without controls, there is a potential for mine area runoff water to impact Saddlers Creek. Therefore, toe drains would be constructed around the perimeter of Modification Area D to collect and convey drainage from these areas to containment storages, thereby isolating mine drainage from undisturbed area runoff (Gilbert and Associates, 2012). It is unlikely that surface runoff associated with the Modification would impact flora and fauna in the surrounds, due to the mitigation measures described above. These mitigating measures are consistent with the NSW Fisheries' (1999) *Policy and Guidelines – Aquatic Habitat Management and Fish Conservation.*

6.2.3 *Groundwater Dependent Vegetation*

No groundwater dependent vegetation comprising groundwater dependent ecosystems occurs within the Modification area or immediate surrounds (after Australasian Groundwater and Environmental Consultants Pty Ltd, 2012). An area near Mt Arthur Coal Mine is mapped in the Atlas of Groundwater Dependent Ecosystems as having a moderate potential for groundwater interaction, however, the groundwater level is approximately 70 to 100 m below the ground level.

The *NSW State Groundwater Dependent Ecosystems Policy* (NSW Department of Land and Water Conservation [DLWC], 2002a) was consulted during this assessment.

6.2.4 *Noise*

The impacts of noise on fauna have shown varying levels of impact. Noise can potentially impact certain fauna species, although studies on the effect of noise on wildlife have shown potential impacts are varied. A number of studies have demonstrated that fauna are well adapted to human activities and noise (i.e. habituation), while other studies have shown that noise can mask vocalisation, and cause physiological stress and changes in movement/patterns and behaviour (Radle, 2007; Kaseloo, 2005; Institute for Environmental Monitoring and Research, 2001; Brumm and Slabbekoorn, 2005; Slabbekoorn and Peet, 2003; Hoskin and Goosem, 2010; Parris *et al*., 2009; Herrera-Montes and Aide, 2011; Chan and Blumstein, 2011).

There is a potential for increased disruption to fauna surrounding the Modification due to an increase in noise. Works undertaken in areas closer to fauna habitat (e.g. Mount Arthur) would result in greater impacts from noise on fauna species than works undertaken in areas surrounded by less or no fauna habitat. Most of the habitats within the Modification area are already subject to noise associated with the existing and approved mine. Noise emissions would increase as a result of the Modification (Wilkinson Murray, 2012).

Given the size of the operating mine, any noise impacts would have already occurred with recent fauna surveys recording those species that are tolerant of the current noise regime. It is not likely that the increased noise emissions would have a significant adverse impact to local fauna populations.

6.2.5 *Artificial Lighting*

Artificial lighting has the potential to affect the behavioural patterns of some fauna species. Some bird and bat species, for example, are attracted to insects around lights. As a consequence of this, they could become prey for larger predators (e.g. owls) which may lead to changes in population structure and community composition.

Potential artificial lighting impacts from the approved mine are unlikely to significantly increase as a result of the Modification. Works undertaken in areas closer to fauna habitat (e.g. Mount Arthur) would result in greater impacts from artificial lighting on fauna species than works undertaken in areas surrounded by less or no fauna habitat. It is considered unlikely that artificial lighting required for the Modification would significantly impact fauna.

6.2.6 *Dust*

The atmospheric dust emissions produced by the approved mine would increase slightly as a result of the Modification (PAEHolmes, 2012). This increase is primarily associated with ongoing construction activities, mining activities and overburden handling and stockpiling activities.

The approved mine currently operates with a dust monitoring programme. This programme would continue for the Modification. It is unlikely that any flora species or vertebrate species would be adversely impacted either directly or indirectly by any dust increase generated as a result of the Modification.

6.2.7 *Phytophthora cinnamomi*

Infection of native plants by Phytophthora cinnamomi is listed as a key threatening process under Schedule 3 of the TSC Act and dieback caused by the *root-rot fungus (phytophthora cinnamomi)* is listed under the EPBC Act. *Phytophthora cinnamomi* is a soil borne pathogen that is associated with plant deaths in native vegetation in NSW.

The Modification would not increase the susceptibility of plants to *Phytophthora cinnamomi*. *Phytophthora cinnamomi* spreads in water, soil or plant material, generally in moist, wet conditions (DEH, 2006b). The Modification would not increase the spread of soils or plant material at the Mt Arthur Coal Mine. In addition, HVEC currently implement control measures to stop and reduce the spread of weeds which would be continued for the Modification as discussed in **Section 8**.

6.3 Cumulative Impacts on Biodiversity

Cumulative impacts on biodiversity consist of the net effect of all activities that have occurred across a landscape since European settlement. Clearing of habitat in the Hunter Valley commenced in the early 1800s, primarily for agricultural purposes. The Mt Arthur Coal Mine was originally established in a widely cleared landscape, other than for Mount Arthur itself, and cumulative impacts by the mine on biodiversity cannot be considered in isolation from earlier impacts. This can be illustrated by habitat loss data included in the Peake (2006) HRVP. Considering the two dominant woodland communities reported for the Mt Arthur Coal Mine area, Central Hunter Box-Ironbark Woodland is estimated as 68.4% cleared, and Central Hunter Ironbark - Spotted Gum - Grey Box Forest as 60.9% cleared.

In the context of the overall mine, the Modification would result in the loss of 259.9 ha of mixed habitat, approximately 4% of the already active and approved mine operation area. However, the proposed offset comprises of approximately 427 ha of mostly cleared grassland with the net result being a cumulative gain in potential habitat as natural regeneration and active management proceeds. The offset includes conservation of a comparatively large area of *Acacia pendula*, part of the *Acacia pendula* endangered population in the Hunter Catchment and the Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion (approximately 0.4 ha).

6.4 Aquatic Threatened Species

No aquatic threatened species have been recorded within the Modification area during the current surveys conducted by Niche (**Appendix 1**) or previous surveys undertaken at the existing Mt Arthur Coal Mine (**Section 3.3**). As described in **Section 6.1.7**, aquatic habitat features within the Modification area are limited to small ephemeral streams and small farm dams and are unlikely to support threatened aquatic species.

7 Threatened Species Assessment

In the OEH's Recommended Environmental Assessment Requirements for the Modification, the OEH requested an assessment of the significance of impacts in accordance with section 5A of the EP&A Act and the *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC, 2007b). However, as the Modification is to be assessed under section 75W Part 3A of the EP&A Act, the investigation and impact assessment was conducted according to the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI 2005).

The following subsections assess the impact of the Modification on NSW State listed endangered populations (**Section 7.1**), TECs (**Section 7.2**), flora species (**Section 7.3**) and fauna species (**Section 7.4**).

7.1 Endangered Populations

7.1.1 *Acacia pendula* in the Hunter Catchment

Background on Acacia pendula in the Hunter Catchment

Acacia pendula A.Cunn. and G.Don (Fabaceae: Mimosoideae) is of the subgenus Phyllodineae having phyllodes as leaves. It is a widely distributed species ranging from Victoria, through NSW into Queensland. In NSW, the species is commonly found on the western slopes, plains and far-western plains. Outside of this range, there are sporadic occurrences of the species in the Hunter Catchment extending from Singleton to Muswellbrook and Wybong. Two disjunct locations have been confirmed at Bylong, still in the Hunter Catchment, but about 50 km from the next known location.

As the name implies, *Acacia pendula* has a weeping pendulous form when mature. However, most of the occurrences in the Hunter Catchment that are clearly not recently planted have an erect, non-pendulous form.

In the Hunter Catchment, the habitat requirements of *Acacia pendula* appear to be relatively general. It is found across Permian, Quaternary and Triassic geology and across 11 soil landscapes. At most of the sites, the acacia plants exhibit a considerable degree of clonal growth often characterised by one dominant tree surrounded by a number of suckers. This characteristic means that these plants are very persistent. Outside of the Hunter Valley the species is described as growing on major river floodplains, on heavy clay soils (Kodela and Harden, 2002) which contrasts with the range of soils and geology that characterise the Hunter occurrences.

Background on the Acacia pendula Listings under the NSW TSC Act

The NSW Scientific Committee has determined that the Hunter Catchment occurrences of the *Acacia pendula* individuals comprise an endangered population. *Acacia pendula* in the Hunter Catchment is also part of the Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC. This EEC is identified by the presence of *Acacia pendula* along with several other species that are also common to other vegetation communities within the Hunter Valley.

Despite the listings under the TSC Act, there is some uncertainty regarding the conservation status of *Acacia pendula* in the Hunter Catchment (Bell *et al.,* 2007). Bell *et al.* (2007) raised the possibility that the occurrences in the Hunter Catchment were of introduced species rather than a disjunct natural occurrence. There is considerable circumstantial evidence that supports this proposition, such as:

- *Acacia pendula* is an attractive tree with pendulous smoky-grey foliage after which the species was named. Because it is attractive, the species has been planted in domestic gardens and other landscaping throughout the Hunter Valley; several have been planted along the entrance to the Mt Arthur Coal Mine.
- Spatial analysis shows that *Acacia pendula* are located at a median distance of 24 m (range 0 – 421 m) from the centreline of the nearest road, also often being beside farm dwellings, infrastructure or near internal tracks. By contrast, records of the often associated *Acacia salicina*, are located at a median distance of 130 m from road centreline (range 2 m to 2 km). *Acacia pendula* has not been recorded in habitat well away from evidence of human activity.
- Geology and soil data point to a species having generalist habitat requirements, an attribute not normally associated with a naturally rare plant species. This would infer that the *Acacia pendula* population in the Hunter Catchment was formerly common and is now rare as a consequence of habitat clearing. However, in the early 1800's botanist Allan Cunningham travelled through the Hunter, across the ranges to the Liverpool Plains making notes on the various plant species encountered. There is no mention of *Acacia pendula* until he reached the Liverpool Plains (National Library of Australia, 2012).
- It is incongruous that a plant that exhibits such persistence, with generalist habitat requirements, would occur so sporadically across the Hunter Catchment. Spatial analysis shows that the median separation of disjunct occurrences is 3 km (range 200 m to 10 km).

In addition to the above, Bell *et al.* (2007) questioned the taxonomic certainty of the acacia plants at the various locations that have been classified as containing *Acacia pendula*. There are two different growth forms, pendulous and non-pendulous. Some of the occurrences of non-pendulous acacia with smoky-grey foliage have been identified as either *Acacia homalophylla* or *Acacia melvillei*.

Notwithstanding the above, this assessment conservatively assumes that the *Acacia pendula* in the Hunter Catchment are a single 'natural' population. It is worthwhile noting that the listing for the endangered population was based on six occurrences (**Figure 17**). Further work since the listing of the species in 2004, has revealed that there are at least 50 sites of *Acacia pendula* in the Hunter Catchment, excluding all garden and landscaping occurrences.

Description of the Occurrence in the Modification Areas

Acacia pendula is located in Modification Area A. It is situated on each side of a portion of Edderton Road, entirely within the existing road reserve, other than for a few suckers extending past the adjoining property fence (**Figure 17**). Not only are they within the road reserve, but they are growing in a dish drain and berm formed at the road edge; thus they are not growing on the original landform. Enquiries with the roads engineer at Muswellbrook Council revealed that the road was formed well over 25 years ago making these plants at least as old, and most likely much older. These patches of *Acacia pendula* are isolated in the landscape surrounded by predominantly cleared paddocks, and have been for decades. The occurrences are also within metres of the approved Mt Arthur Coal Mine (**Figure 17**).

The patch on the eastern side of the road is approximately 0.06 ha while on the western side of the road there are two patches (approximately 0.05 ha and 0.01 ha) about 15 m apart. Both patches combined cover approximately 0.1 ha. On the eastern side of the road, there is one large tree, approximately 8 – 10 m tall surrounded by more juvenile regrowth (ranging from 1 – 3 m tall). The plants on the western side of the road appear to all be young regrowth ranging from 1 – 3 m tall.

There were some flowers on the more mature trees but there were no seed pods on the plants and there was no evidence on the ground that the plants had recently borne seed. The dense nature of the regrowth was more typical of vegetative spread through suckering than through seed germination. This is consistent with observations at other sites with no reports of seed being produced (Bell *et al.,* 2007).

As described in **Section 5.1.2**, a number of *Acacia melvillei* are regrowing on the eastern side of Edderton Road, scattered over about 0.5 ha, and probably appearing as a result of cattle having been removed. This wattle is listed as a component of the NSW EEC *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion*. The *Acacia pendula* and *Acacia melvillei* patches are about 500 m apart and there is no indication in the surrounding vegetation that these two occurrences were once part of a single community. Thus, they have been left as separate entities.

Acacia pendula also occurs away from the Modification areas. **Figure 17** shows these locations with Site AP1 being in Modification Area A These sites range from 3 – 9 km distant from the Edderton Road Site AP1.

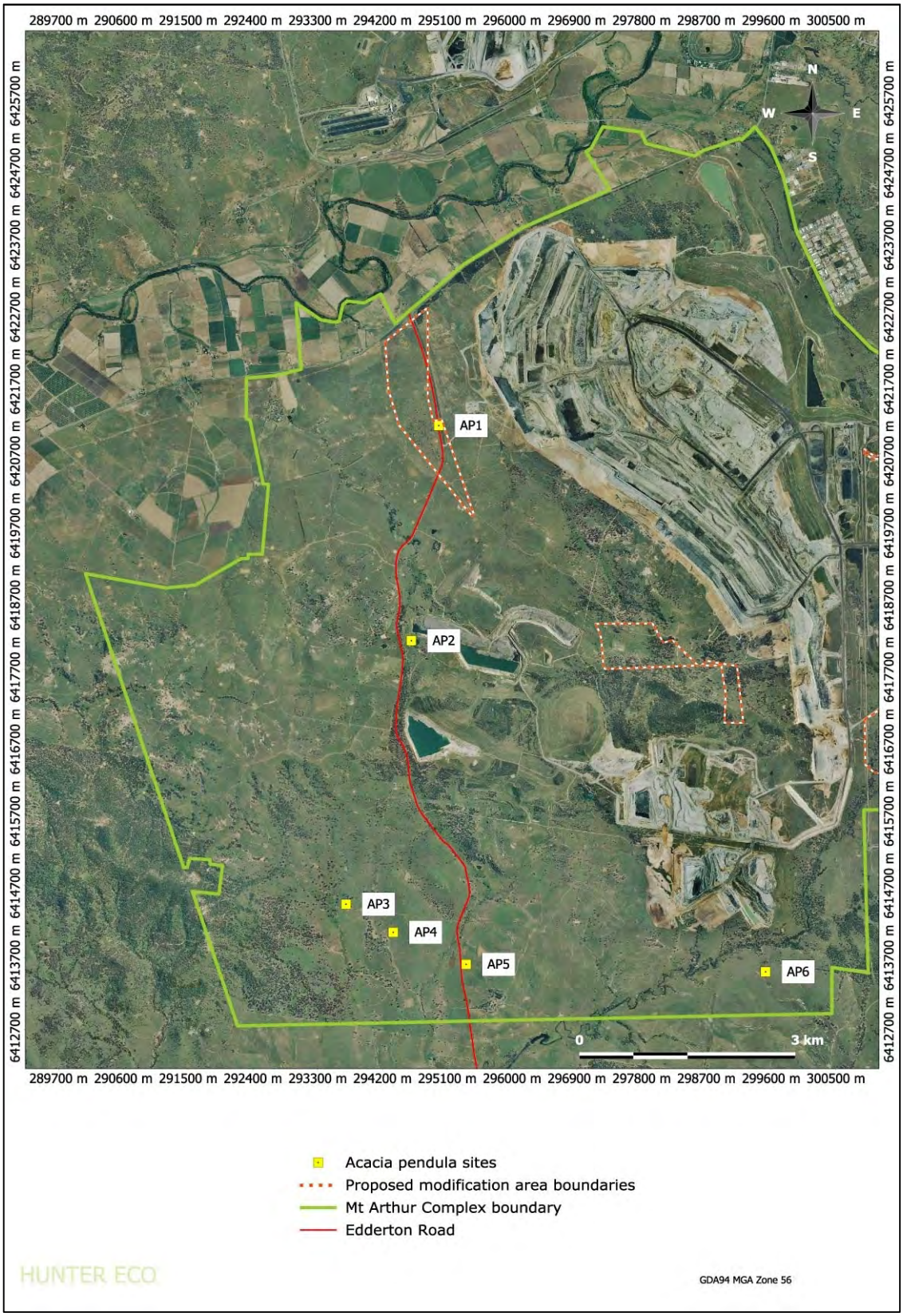


Figure 17: *Acacia pendula* sites

Details of the other sites include:

Site AP2: Located near an old farm house is a large patch of typical pendulous plants covering approximately 0.25 ha. About eight mature trees around 12 m tall were in a neat row indicating that they were planted. These trees have flowered and fruited prolifically with pods carried on the foliage and abundant shed pods on the ground. The plants appeared to have spread through both seed germination and vegetative suckering forming a large dense patch. Seeds have been collected from these plants for the purpose of introducing the species into mine rehabilitation vegetation as required by a current consent condition.

Site AP3: A small patch of regenerating suckering plants about 1 m tall covering an area of about 50 square metres. These plants appear to be responding to reduced grazing pressure.

Site AP4: A group of mature (approximately 12 m tall) trees of the non-pendulous form previously recorded by Umwelt (2007b). These trees were growing in a section of a large erosion contour berm and dish drain and occupied an area of about 0.015 ha.

Site AP5: Three small patches (non-pendulous) were located in close proximity to each other about 1.5 km east of Edderton Road.

Site AP6: A very large patch about 4 km east of Edderton Road growing in a cleared paddock. This group consisted of about 40 trees ranging from 8 – 15 m tall with a number of smaller suckers present. There was also a separate group of low suckering plants about 200 m south-east of the larger population. The area of the large patch was about 0.2 ha and the smaller patch about 0.05 ha. This site is located in an area proposed as an offset to the habitat losses that would be incurred through implementation of the Modification.

Preliminary Genetic Investigation

Recently Hunter Eco and Dr Joe Miller, Commonwealth Scientific and Industrial Research Organisation Acacia geneticist, collected samples of the Acacia *pendula-melvillei-homalophylla* group from the Hunter Valley for a preliminary investigation into the genetics of the group. Included were samples from the Edderton Road *Acacia pendula* and *Acacia melvillei* located within Modification Area A. Also included was a sample of obviously planted *Acacia pendula* from the Mangoola area. Both chloroplast (plastid) DNA and nuclear RNA were compared with known reference data for *Acacia pendula*, *Acacia melvillei*, *Acacia homalophylla* and 12 other western acacia species.

The outcome from eight different locations was:

- The planted sample matched *Acacia pendula* from outside of the Hunter Valley.
- The Edderton Road *Acacia pendula* had the plastid of *Acacia pendula* and the nucleus of *Acacia melvillei*, thus likely a hybrid of the two.
- The Edderton Road *Acacia melvillei* was in fact that species with both plastid and nucleus of *Acacia melvillei*.
- Two other samples were putative *Acacia melvillei* and three were likely hybrids.

These results serve to add caution to plans to propagate these plants until their true identity and origins have been determined through a more comprehensive genetic investigation. The results also highlight the uncertainty associated with identification on morphology alone.

Impact of the Modification on Acacia pendula in the Hunter catchment

How is it likely to affect the lifecycle of the population?

As described above, the Modification would involve removal of approximately 0.1 ha of *Acacia pendula* within the three patches along Edderton Road. It represents loss of one site out of the 50 sites that comprise the endangered population.

Other than the loss of one site, the removal of these plants would have no impact on the *Acacia pendula* population in the Hunter Valley. Genetic exchange between any of the widely separate occurrences would not occur for two reasons: the plants rarely flower, and because the flowers do not carry nectar the only likely pollinators would be native bees collecting pollen. The majority of acacia are self-incompatible meaning that seed can only be produced by pollen being transferred by way of a pollinator to a genetically different plant (Stone *et al.,* 2003). The implication from small native bee pollinators is that pollen will only be transported over short distances, commonly up to 60 m (Krauss, 2000).

As described above, the *Acacia pendula* in the Modification area is located only 30 m from the edge of the approved pit and, as mining progresses, it is likely to be impacted by changes in surface water hydrology, dust and other disturbance.

How is it likely to affect the habitat of the population and community?

The Modification would result in the complete loss of habitat at the specific location where the *Acacia pendula* population and community was recorded (approximately 0.1 ha of the *Acacia pendula* population and community). As described above, the habitat requirements of *Acacia pendula* in the Hunter Catchment appear to be relatively general. It is found across Permian, Quaternary and Triassic geology and across 11 soil landscapes. Thus, the habitat in which the subject population and community are growing is not unique.

Is the population at the limit of its known distribution?

The *Acacia pendula* at Edderton Road are not at the limit of the distribution of the endangered population.

7.1.2 *Diuris tricolor,* the Pine Donkey Orchid Population in the Muswellbrook Local Government Area

This ground orchid is known to occur in a reserve (A171) immediately north of Modification Area E. Nothing is known about its habitat requirements other than that it is generally found in grassy woodland on sandy soil. Potentially, there was suitable habitat for the species in the grassy woodland and derived grassland in Modification Areas B and C.

On 19 September 2012 the orchid was confirmed to be flowering in the A171 reserve so a search was conducted through Modification Areas B and C. No orchids were found.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Modification would not impact the lifecycle of the threatened *Diuris tricolor* as a survey of probable suitable habitat showed that the species was not present.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Modification would not affect known habitat or occurrences of the *Diuris tricolor*.

No critical habitat has been declared in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The endangered population *Pine Donkey orchid in the Muswellbrook Local Government Area* is at the eastern extent of its overall distribution. However the Modification would not affect any of this endangered population.

7.1.3 *Cymbidium canaliculatum* in the Hunter Catchment

Cymbidium canaliculatum is an arboreal orchid with broad grass-like leaves and is generally found growing in Box eucalypts, although it can also be found in other tree species. There are several records of the species within the Mt Arthur Coal Mine boundary. However, despite a thorough search, none were found in the Modification area. The *E. albens x E. moluccana* hybrid woodland in Modification Area B provided the most suitable habitat.

Two new offset areas are proposed as part of the Modification (**Figure 9**). These offsets would have similar habitat to that found within the Modification area. Thirteen occurrences of *Cymbidium canaliculatum* were recorded in the proposed Middle Deep Creek Offset (**Appendix 8**).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Modification would have no direct effect on the lifecycle of this orchid because none were found in the disturbance areas. The only indirect effect would be the loss of suitable trees in which seed could germinate. The very fine seed of *Cymbidium* are wind dispersed and the nearest *Cymbidium canaliculatum* are approximately 4 km south and south-west of Modification Area B. There is a large amount of suitable habitat within 4 km of these occurrences.

The Modification is not likely to have a negative impact on the endangered population of *Cymbidium canaliculatum.*

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The population is widespread in the Hunter Catchment and the Mt Arthur Coal Mine occurrences are not at the limits of distribution.

The proposal would result in the loss of all the potential habitat in Modification Area B but not in the loss of any individuals. In keeping with the 'improve or maintain' principle the habitat in Modification Area B would be offset at a level that would result in no net habitat loss for this endangered population.

No critical habitat has been declared in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The species is recorded as far east as the Cessnock-Kurri area in the lower Hunter and up to the foothills of the Liverpool Range in the upper Hunter. The Modification does not affect any part of this endangered population that is at the limits of its distribution.

7.1.4 *Eucalyptus camaldulensis* Population in the Hunter Catchment

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Eucalyptus camaldulensis has been recorded at several locations along the Hunter River to the north and north-west of the Modification. There are no records from within the Mt Arthur Coal Mine, an area that includes the Modification. The proposed Modification would not affect this endangered population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

There was no suitable habitat for *Eucalyptus camaldulensis* within the Modification.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Eucalyptus camaldulensis is not at the limit of its range in the area containing the Modification.

7.2 Threatened Ecological Communities

7.2.1 Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not relevant in consideration of an EEC.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Section 7.1.1 provides background information on *Acacia pendula*, the key component of Weeping Myall Woodland. The proposal would result in loss of the Edderton Road group of *Acacia pendula,* there being no other species typical of this EEC at that site. However, included in the overall offset strategy for the proposal is a much larger group of *Acacia pendula* (**Section 8.4**) resulting in a net gain in the amount of conserved Weeping Myall Woodland.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Edderton Road *Acacia pendula* plants are not at the limit of the range of Weeping Myall Woodland. The community extends as far south as the Singleton area.

7.2.2 White Box Yellow Box Blakely's Red Gum Woodland

This EEC was mapped in Modification Areas B and C and included both grassy woodland and open grassland that would have once supported one or more of the dominant indicator canopy species (**Figure 8**). A total of 35.2 ha of the open grassland variant and 23.2 ha of the woodland variant was mapped in this area (**Table 15**). This contrasts with 14,818 ha of the woodland habitat mapped for the central Hunter by Peake (2006). Derived grasslands were not included in the Peake (2006) mapping.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not relevant in consideration of an EEC.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Part of the proposal would result in the loss of this EEC in Modification Area B. However, in keeping with 'improve or maintain' principles, appropriate offsets would be provided so that the final outcome of the proposal would be no net loss.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The community is not at the limits of its distribution at this location.

7.2.3 Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions

A total of about 7.1 ha of this EEC was mapped between Modification Areas B, C and D (**Table 15**). The majority of nearly 5 ha was located in the Modification Area C (**Figure 15**). This contrasts with 18,306 ha of this community mapped for the central Hunter by Peake (2006).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not relevant in consideration of an EEC.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Part of the proposal would result in the loss of this EEC in Modification Areas B, C and D. Approximately 7.1 ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27) would be removed. The Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC is not present in the proposed offset areas. HVEC would, however, provide an additional offset for this community in a location to be determined.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The community is not at the limits of its distribution at this location.

7.2.4 Hunter Lowlands Redgum Forest in the Sydney Basin and NSW North Coast Bioregions

A total of about 1.7 ha of this EEC was mapped in Modification Area D (**Table 15**; **Figure 15**). This contrasts with 18,300 ha of this community mapped for the central Hunter by Peake (2006).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not relevant in consideration of an EEC.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Part of the proposal would result in the loss of this EEC in Modification Area D. However, in keeping with 'improve or maintain' principles, appropriate offsets would be provided so that the final outcome of the proposal would be no net loss.

No critical habitat has been declared in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The community is not at the limits of its distribution at this location.

7.2.5 Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not relevant in consideration of an EEC.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Approximately 23 ha of Central Hunter Box – Ironbark Woodland (MU10) would be removed for the Modification. There is an anomaly where the same area of vegetation is representative of two different NSW listed EECs. Being consistent with MU10 of Peake (2006), it would be the NSW EEC *Central Hunter Grey Box – Ironbark Woodland* in the NSW North Coast and Sydney Basin Bioregions with MU10 being described as containing the hybrid box, and MU10 being referenced in that NSW Scientific Committee EEC determination. However, this community will also represent the NSW EEC *White Box Yellow Box Blakely's Red Gum Woodland* because that determination specifically includes intergrades of *Eucalyptus moluccana* with *Eucalyptus albens*.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The community is not at the limits of its distribution at this location.

7.3 Flora

7.3.1 *Diuris tricolor,* the Pine Donkey Orchid

Background

Diuris tricolor is a small terrestrial orchid (NSW Scientific Committee, 2007). It has one to three erect green linear leaves to 30 cm long and a single flower stem arising from the base of the plant with one to six yellow flowers with maroon, purple and white markings (NSW Scientific Committee, 2007). The plant has no physical presence above-ground for most of the year. It shoots its leaves after the first soaking autumn-winter rains and flowers from September to November. This means that surveys for the orchid can only be successful at times when the plants are known to be flowering at least in the vicinity of the site of interest. *Diuris tricolor* is reported to occur in Box/Pine woodlands, usually in habitats with White Cypress Pine (*Callitris glaucophylla*) as one of the dominant species (Burrows, 1999; Bishop, 2000; DLWC, 2002b). However, the majority of records from the Muswellbrook LGA endangered population occur in derived native grassland with little or no canopy cover.

The *Diuris tricolor* occurs at site A171 within the Thomas Mitchell Drive Offset area (**Figure 8**) In 2007, Umwelt undertook a baseline study of the orchid population at monitoring site A171 within the Thomas Mitchell Drive Offset area and developed a Plan of Management for the *Diuris tricolor* (Umwelt, 2008a). The aim of the Plan of Management is to facilitate the appropriate conservation of the population by identifying the current and potential threats to the population and recommending actions for management, including the implementation of an appropriate monitoring programme. The species has since been monitored annually (Umwelt, 2008b, 2010; Cumberland Ecology, 2010d, 2011).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

This ground orchid is known to occur in the Thomas Mitchell Drive Offset area (site A171) immediately north of Modification Area E. Nothing is known about its habitat requirements other than that it is generally found in grassy woodland on sandy soil. Potentially, there was suitable habitat for the species in the grassy woodland and derived grassland in Modification Areas B and C.

On 19 September 2012 the orchid was confirmed to be flowering at site A171 so a thorough search was conducted through Modification Areas B and C. No orchids were found.

The Modification would not affect the lifecycle of this orchid.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

This terrestrial orchid grows in open native grassland as well as grassy woodland. While the species occurs elsewhere in NSW and Queensland, the only records east of the Great Dividing Range are from the Muswellbrook region (NSW Scientific Committee, 2007). Potential habitat was present in Modification Areas B and C.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

In NSW, populations of the species occur on the northern tablelands, central tablelands, north-western slopes and Central Western Slopes (Jones, 1993). *Diuris tricolor* is at the eastern limit of its distribution in the Muswellbrook LGA, and well separated from the main distribution. However, the Modification would not affect any local populations of this orchid.

7.4 Fauna

Table 14 in **Section 5.2.1** provides a list of threatened fauna species which have been recorded within the wider region. This list of threatened fauna species was refined to a list of threatened fauna species with records within or near the Modification area (**Table 18**).

Table 18: Threatened populations, vegetation communities, flora and fauna species that could potentially be impacted by the Modification

Scientific Name	Common Name	Conservation Status[1]	
		TSC Act	EPBC Act
Birds			
Chthonicola sagittata	Speckled Warbler	V	-
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-
Stagonopleura guttata	Diamond Firetail	V	-
Daphoenositta chrysoptera	Varied Sittella	V	-
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-
Anthochaera phrygia	Regent Honeyeater	CE	E
Tyto novaehollandiae	Masked Owl	V	-
Circus assimilis	Spotted Harrier	V	-
Hieraaetus morphnoides	Little Eagle	V	-
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-
Petroica boodang	Scarlet Robin	V	-
Glossopsitta pusilla	Little Lorikeet	V	-
Neophema pulchella	Turquoise Parrot	V	-
Lathamus discolor	Swift Parrot	E	E
Mammals			
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E
Phascolarctos cinereus	Koala	V	V
Petaurus norfolcensis	Squirrel Glider	V	-
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-
Mormopterus norfolkensis	Eastern Freetail-bat	V	-
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-
Myotis macropus	Southern Myotis	V	-
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-
Vespadelus troughtoni	Eastern Cave Bat	V	-

[1] Threatened population, vegetation community, flora species or fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).

V = Vulnerable; E = Endangered; CE = Critically Endangered

These threatened fauna species are described in detail in **Sections 7.4.1** to **7.4.10**.

The following threatened waterbird species listed in **Table 14** are unlikely to be affected by the Modification, namely the: Blue-billed Duck (*Oxyura australis*), Freckled Duck (*Stictonetta naevosa*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Australasian Bittern (*Botaurus poiciloptilus*) and Australian Painted Snipe (*Rostratula australis*) due to the absence of ideal habitat. These species may be potential visitors to areas within the Modification, however, it is considered unlikely that these species would occur within the Modification area, given the occurrence of only marginal habitat resources. On this basis, it is considered unlikely that these species would be affected by the Modification. These species are not considered further.

7.4.1 Woodland Bird Species

Introduction

There are a number of threatened woodland birds that may potentially occur within the Modification area based on their known distribution (listed in **Table 14** and discussed in **Section 5.2.1**). However, several woodland birds listed in **Table 14** and discussed in **Section 5.2.1** are not likely to occur in the Modification area or close surrounds and are therefore not listed in **Table 18**.

The following woodland species listed in **Table 14** and discussed in **Section 5.2.1** do not have records within the Modification or close surrounds (**Section 5.2.1**): Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and the Malleefowl (*Leipoa ocellata*). In addition, there is an old record from 1999 in the Birds Australia (2012) database for the Bush Stone-curlew occurring outside of the Modification area to the south of Modification Area E (**Figure 9**). It is considered that this species and habitat for this species does not occur within the Modification area.

The three above-mentioned owls are known to have home ranges of up to 1,000 ha, so at best the Modification area would form a small part of a home range for any of these owls. These owls prey upon small to large arboreal mammals such as gliders, Common Ring-tailed Possums (*Pseudocheirus peregrinus*) and Brush-tailed Possums (*Trichosurus vulpecula*). Historical fauna records, supported by the recent Niche study, show that there is not likely to be sufficient prey species in or around the Modification area to support these birds. Furthermore, the likelihood of these species occurring within the Modification area has considerably decreased as a result of on-going approvals for clearing of potential habitats in adjoining areas. Since these threatened woodland bird species are unlikely to occur within the Modification area, they are unlikely to be affected by the Modification. These species are not considered further.

Threatened Woodland Bird Species Likely to be Affected

Eight threatened woodland birds may be potentially impacted by the Modification, namely the: Speckled Warbler (*Chthonicola sagittata*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*), Diamond Firetail (*Stagonopleura guttata*), Varied Sittella (*Daphoenositta chrysoptera*), Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*), Regent Honeyeater (*Anthochaera phrygia*) and Masked Owl (*Ninox novaehollandiae*). All species, except the Black-chinned Honeyeater (eastern subspecies), have been recorded immediately surrounding the Modification area, while the Varied Sittella and Grey-crowned Babbler (eastern subspecies) have been recorded within the Modification area.

None of these woodland bird species were recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**). An assessment on the potential impacts to these species as a result of the Modification is provided below.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The various forms of woodland that occur within the Modification area provide habitat resources for a limited number of threatened woodland species, including the eight threatened woodland bird species listed above. The potential impacts associated with the Modification on the lifecycle of these birds are listed below.

Speckled Warbler (Chthonicola sagittata)

The Speckled Warbler has been recorded in the OEH (2013) and Birds Australia (2012) databases surrounding the Modification area (**Figure 9**). This species has not been previously recorded within the Modification area (**Figure 9**).

The Speckled Warbler nests on the ground in grass tussocks, dense litter and fallen branches (NSW Scientific Committee, 2001b). This species is sedentary and lives in pairs or trios (NSW Scientific Committee, 2001b). The home range of this species varies from 6 to 12 ha (NSW Scientific Committee, 2001b).

The Modification would remove and modify habitat resources potentially used by this species. However, the lack of records from within and surrounding the Modification area indicate that it is unlikely that the Modification would affect the lifecycle of the Speckled Warbler.

Brown Treecreeper (eastern subspecies) (Climacteris picumnus victoriae)

The Brown Treecreeper (eastern subspecies) has been recorded in the OEH (2013) and Birds Australia (2012) databases surrounding the Modification area (**Figure 9**). This species has not been previously recorded within the Modification area (**Figure 9**).

The Brown Treecreeper (eastern subspecies) lays two to three eggs generally in tree hollows and has the highest breeding success in areas with lower shrub densities, moderate levels of ground cover, greater amounts of foraging substrate and greater invertebrate biomass (Garnett *et al.,* 2011).

This species is gregarious and is often seen in family groups of four to five, but a territory may only be defended by one or two birds (Morcombe, 2004).

Fragmentation of habitat disrupts dispersal and recruitment, especially of immature females (Garnett *et al.,* 2011). Connectivity with scattered trees is more important than fragment size for reducing local extinctions and this species is not found in patches less than 700 m from the nearest patch >10 ha unless there are scattered trees <100 m apart (Garnett *et al.,* 2011).

The Modification would remove and modify habitat resources potentially used by this species. However, the lack of records from within and surrounding the Modification area indicate that it is unlikely that the Modification would affect the lifecycle of the Brown Treecreeper (eastern subspecies).

Diamond Firetail (Stagonopleura guttata)

The Diamond Firetail has been recorded surrounding the Modification area by Dames and Moore (2000). Cumberland Ecology (2009a) report that Dames and Moore (2000) recorded this species in dense shrub layers fringing White's Creek in central portions of what is now the Northern Open Cut. In addition, this species has been recorded in the OEH (2013) and Birds Australia (2012) databases surrounding the Modification area (**Figure 9**).

The Diamond Firetail generally nests in loosely scattered colonies, after which in autumn and through winter, large flocks may form (Morcombe, 2004). The nests are bottle-shaped and are built in trees and bushes (NSW Scientific Committee, 2001c).

This species usually occurs in small flocks of 20 to 30 birds (Morcombe, 2004).

The Modification would remove and modify habitat resources potentially used by this species. However, the lack of records from within and surrounding the Modification area indicate that it is unlikely that the Modification would affect the lifecycle of the Diamond Firetail.

Varied Sittella (Daphoenositta chrysoptera)

The Varied Sittella has been recorded surrounding the Modification area and has been recorded once within the Modification area within Modification Area C (Umwelt, 2005) (**Figure 9**). This species was recorded during the 2004 monitoring period near the base of Mount Arthur within the Modification area in tall open forest dominated by mature Spotted Gum (*Corymbia maculata*) (Umwelt, 2005). This species was recorded within Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27) within the Modification area (**Figure 15**), which would be removed as part of the Modification.

The Varied Sittella lives in smaller breeding flocks through spring and summer (Morcombe, 2004). This species builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often reuses the same fork or tree in successive years (NSW Scientific Committee, 2010b).

The Modification would remove and modify habitat resources potentially used by this species.

Grey-crowned Babbler (eastern subspecies) (Pomatostomus temporalis temporalis)

The Grey-crowned Babbler (eastern subspecies) has been recorded from areas surrounding the Modification area on several occasions between 2003 and 2009 (**Figure 9**). This species has also been recorded once within the Modification area within Modification Area A (Cumberland Ecology, 2009a) (**Figure 9**). This species was recorded within a plantation stand within the Modification area, which would be removed as part of the Modification.

The Grey-crowned Babbler (eastern subspecies), a sedentary species, is highly gregarious and is typically found in family flocks of about 15 (Morcombe, 2004). This species builds conspicuous dome-shaped nests and breed co-operatively in sedentary family groups of 2 to 13 (NSW Scientific Committee, 2001d).

The Modification would remove and modify habitat resources potentially used by this species.

Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*)

The Black-chinned Honeyeater has not been recorded within the Modification area or immediate surrounds. However, potential roosting and foraging resources for this species are present within the Modification area.

The Black-chinned Honeyeater (eastern subspecies) is sedentary, migratory and locally nomadic (Morcombe, 2004). This species build suspended, cup-shaped nests in which two eggs are usually laid (Garnett *et al*., 2011; NSW Scientific Committee, 2001e).

The Modification would remove and modify habitat resources potentially used by this species. However, the lack of records from within and surrounding the Modification area indicate that it is unlikely that the Modification would affect the lifecycle of the Black-chinned Honeyeater (eastern subspecies).

Regent Honeyeater (Anthochaera phrygia)

The Regent Honeyeater has not been recorded within the Modification area or immediate surrounds. However, potential foraging habitat, due to the high nectar resources associated with Eucalyptus-dominated communities found within the Modification area, and shelter resources for this species are present. There is a national recovery plan for this species (Menkhorst *et al.*, 1999).

The Regent Honeyeater builds a cup-shaped nest of fibres located in forks in live eucalypt (including *Angophora*) or she-oak canopy (NSW Scientific Committee, 2010c). A clutch of two or three eggs is laid from late winter to early summer, with multiple attempts per season (NSW Scientific Committee, 2010c).

Breeding sub-populations mainly occur around Capertee Valley in central-eastern NSW and the Bundarra-Barraba region in northern inland NSW (NSW Scientific Committee, 2010c).

The Modification would remove and modify foraging and shelter habitat resources potentially used by this species. However, the lack of records from within and surrounding the Modification area indicate that it is unlikely that the Modification would affect the lifecycle of the Regent Honeyeater.

Masked Owl (Ninox novaehollandiae)

The Masked Owl has not been recorded within the Modification area or immediate surrounds. However, potential roosting and foraging habitat is found within the Modification area. There is a state recovery plan for the Masked Owl (DEC, 2006).

The Masked Owl roosts and nests in heavy woodland areas (Morcombe, 2004). This species roosts during the day in tree hollows, caves and dense foliage including exotic trees (DEC, 2006).

This species has a clutch of one to four eggs in the wild and a single clutch is laid per year or sometimes there is no breeding within a year (DEC, 2006).

The Masked Owl lives as monogamous, sedentary life-long pairs in large permanent home ranges (DEC, 2006).

The Modification would remove and modify habitat resources potentially used by this species. However, the lack of records from within and surrounding the Modification area indicate that it is unlikely that the Modification would affect the lifecycle of the Masked Owl.

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Control of weeds to minimise their potential to degrade the species potential habitat on Company-owned land.
- Pest control to minimise the potential for pests to impact these species or their habitats.
- Nest box monitoring and maintenance to ensure that nest boxes located outside of the Modification area are maintained and suitable for bird species.
- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any threatened bird species. Clearing activities would avoid (where possible), the breading season of threatened birds known to occur within the area.
- Creation of habitat corridors to link isolated remnant vegetation stands.
- Control of dust emissions to minimise the potential for dust to impact these species.
- Implement noise control measures to minimise the potential for noise to impact these species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 9**). These offsets would have similar habitat to that found within the Modification area. The habitat within the proposed offsets would also provide potential habitat for the threatened woodland bird species listed above. The following woodland birds have been confirmed as occurring in the proposed Middle Deep Creek Offset: Brown Treecreeper, Diamond Firetail, Grey-crowned Babbler, Speckled Warbler, Hooded Robin, Little Lorikeet and Varied Sitella (**Appendix 8**).

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Modification would remove and modify approximately 53.4 ha of potential/actual habitat resources potentially used by the above eight woodland species. In the case of the Brown Treecreeper (eastern subspecies), Diamond Firetail, Black-chinned Honeyeater (eastern subspecies), Regent Honeyeater and Masked Owl, these resources are limited and have not been previously widely used. The habitat within the Modification area is also highly fragmented due to the previous works undertaken at the Mt Arthur Coal Mine. Mitigation measures, such as the creation of habitat corridors, would provide links to other areas of potential habitat for these species outside of the Modification area. In addition, none of these species were recorded utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the above woodland birds.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

None of the eight woodland bird species are at the limits of their ranges in the study area. In NSW, the Speckled Warbler, Brown Treecreeper (eastern subspecies), Diamond Firetail and Grey-crowned Babbler (eastern subspecies) are found west of the Great Dividing Range (NSW Scientific Committee, 2001b, 2001c, 2001d, 2001f; Blakers *et al.,* 1984; Schodde and Mason, 1999). Speckled Warbler, Brown Treecreeper (eastern subspecies), Diamond Firetail and Black-chinned Honeyeater (eastern subspecies) populations also occur in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys (Blakers *et al.,* 1984; Schodde and Mason, 1999; NSW Scientific Committee, 2001b, 2001c, 2001e, 2001f).

The Grey-crowned Babbler (eastern subspecies) is less common at higher altitudes of the tablelands (NSW Scientific Committee, 2001d) and isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (Blakers *et al.,* 1984; Schodde and Mason, 1999).

The Varied Sittella has a nearly continuous distribution in NSW from the coast to the far west (Higgins and Peter, 2002; Barrett *et al.,* 2003).

Within NSW, breeding sub-populations of the Regent Honeyeater are fragmented and occur mainly around the Capertee Valley in central-eastern NSW and the Bundarra-Barraba region in northern inland NSW (NSW Scientific Committee, 2010c). Minor and sporadic breeding occurs in other areas such as Warrumbungle National Park, Pilliga forests, Mudgee-Wollar region, and the Hunter and Clarence Valleys (NSW Scientific Committee, 2010c).

7.4.2 Birds of Prey

Introduction

Two birds of prey, the Spotted Harrier (*Circus assimilis*) and Little Eagle (*Hieraaetus morphnoides*), have been previously recorded in the general locality surrounding the Modification. None of these birds of prey were recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**). An assessment on the potential impacts to these species as a result of the Modification is provided below.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Spotted Harrier was recorded by Umwelt (2007b) to the immediate west of proposed Modification Area A and was recorded to the west and south of the Modification in the OEH (2013) and Birds Australia (2012) databases (**Figure 9**).

The Spotted Harrier is nomadic, part migratory or dispersive, its movements linked to abundance of prey species (Morcombe, 2004). This species builds a stick nest in a tree and lays eggs in spring or autumn, with young remaining in the nest for several months (NSW Scientific Committee, 2010d).

The Little Eagle was recorded by Umwelt (2007b), however, the exact location of the species record is unknown. In addition, this species was recorded in the OEH (2013) and Birds Australia (2012) databases immediately north and south of Modification Area E and to the west of the Modification (**Figure 9**).

The Little Eagle is sedentary in adulthood and dispersive when young (Morcombe, 2004). For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring (NSW Scientific Committee, 2010e).

The results of past and current Mt Arthur Coal Mine fauna surveys show that prey species for these raptors would most likely be introduced rodents and rabbits, along with native birds. The Modification area is located at the edge of thousands of hectares of woodland/grassland mosaic across which these species could forage.

It is unlikely that the Modification would affect the lifecycle of the Spotted Harrier or Little Eagle, as indicated by the lack of records within and immediately surrounding the Modification area. The Modification would remove and modify minor habitat resources potentially used by these species.

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any threatened bird species. The critical time for birds of prey is when they are nesting. If any active nests of threatened birds of prey are found during pre-clearance surveys clearing should be delayed until the young have left the nest. To avoid long delays, it would be preferable that woodland and forest clearing be conducted outside of the known breeding season of these birds.
- Creation of habitat corridors to link isolated remnant vegetation stands.
- Control of dust emissions to minimise the potential for dust to impact these species.
- Implement noise control measures to minimise the potential for noise to impact these species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 9**). These offsets would have similar habitat to that found within the Modification area. The habitat within the proposed offsets would also provide potential habitat for the threatened birds of prey listed above.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Modification would remove and modify approximately 226.4 ha of potential/actual habitat resources potentially used by the above two bird of prey species. These resources are limited for the Spotted Harrier and Little Eagle and have not been previously widely used. The habitat within the Modification area is also highly fragmented due to the previous works undertaken at the Mt Arthur Coal Mine. Mitigation measures, such as the creation of habitat corridors, would provide links to other areas of potential habitat for these species outside of the Modification area. In addition, none of these species were recorded as utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the above bird of prey species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The two bird of prey species are not at the limits of their ranges in the study area. Spotted Harrier and Little Eagle individuals disperse widely in NSW and comprise a single population (NSW Scientific Committee, 2010d, 2010e). The Little Eagle occurs in most parts of NSW except the densely forested areas of the Dividing Range escarpment (NSW Scientific Committee, 2010e).

7.4.3 Robins

Introduction

Two robin species, the Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*) and Scarlet Robin (*Petroica boodang*), have been previously recorded in the general locality surrounding the Modification. None of these robins were recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**). An assessment on the potential impacts to these species as a result of the Modification is provided below.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Hooded Robin (south-eastern form) was recorded by Dames and Moore (2000), however, the exact location of the species record is unknown. In addition, this species was recorded in the Birds Australia (2012) database approximately 6 km from Modification Area D (**Figure 9**).

The Hooded Robin (south-eastern form) is sedentary in adulthood and dispersive when young (Morcombe, 2004). Hooded Robins live in small family groups of pairs or trios with an average home range of 18 ha (NSW Scientific Committee, 2001g). This species is highly mobile and builds a cup nest and usually lays two eggs (NSW Scientific Committee, 2001g; Garnett *et al*., 2011). The Hooded Robin has a nesting territory of approximately 6-50 ha which it defends in breeding pairs or groups (Garnett *et al*., 2011).

The Scarlet Robin has not been recorded within the Modification area or immediate surrounds. However, potential foraging resources for this species are present within the Modification area.

The Scarlet Robin is locally migratory or dispersive (Morcombe, 2004). This species appears to mostly breed in rainforest with nests usually placed near the top of the sub-canopy at a mean height of 5.5 m (Garnett *et al*., 2011). The open cup nest is often placed in the fork of a tree, constructed from fibres and cobwebs (NSW Scientific Committee, 2010f).

It is unlikely that the Modification would affect the lifecycle of the Hooded Robin (south-eastern form) or Scarlet Robin, due to the lack of records within and surrounding the Modification area. The Modification would remove and modify minor habitat resources potentially used by these species.

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any threatened bird species.
- Creation of habitat corridors to link isolated remnant vegetation stands.
- Control of dust emissions to minimise the potential for dust to impact these species.
- Implement noise control measures to minimise the potential for noise to impact these species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 9**). These offsets would have similar habitat to that found within the Modification area. The habitat within the proposed offsets would also provide potential habitat for the threatened robin species listed above. The Hooded Robin was confirmed to occur within the proposed Middle Deep Creek Offset area (**Appendix 8**).

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Modification would remove and modify approximately 53.4 ha of potential/actual habitat resources potentially used by the above two robin species. These resources are limited for the Hooded Robin (south-eastern form) and Scarlet Robin and have not been previously widely used. The habitat within the Modification area is also highly fragmented due to the previous works undertaken at the Mt Arthur Coal Mine. Mitigation measures, such as the creation of habitat corridors, would provide links to other areas of potential habitat for these species outside of the Modification area. In addition, none of these species were recorded as utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the above robin species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The two robin species are not at the limits of their ranges in the study area. The Hooded Robin (south-eastern form) occurs throughout NSW except for the north-west of the state (Schodde and Mason, 1999). In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes (Higgins and Peter, 2002).

7.4.4 *Parrots*

Introduction

Three parrot species, the Little Lorikeet (*Glossopsitta pusilla*), Turquoise Parrot (*Neophema pulchella*) and Swift Parrot (*Lathamus discolor*), have been previously recorded or tentatively recorded in the general locality surrounding the Modification, or the Modification area is considered to represent potential habitat for the species. None of these parrot species were recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**). An assessment on the potential impacts to these species as a result of the Modification is provided below.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Little Lorikeet (Glossopsitta pusilla)

The Little Lorikeet was recorded by Umwelt (2007b) to the south-west of the Modification (**Figure 9**). In addition, this species has been recorded to the east and west of the Modification in the Birds Australia (2012) and OEH (2013) databases (**Figure 9**).

The Little Lorikeet is a nomadic species and is gregarious, usually foraging in small flocks, often with other species of lorikeet (NSW Scientific Committee, 2009a). This species nests in small hollows, approximately 3 cm in diameter that are located at heights of between 2 and 15 m, mostly in Blakely's Red Gum (*Eucalyptus blakelyi*), Manna Gum (*E. viminalis*) and Tumbledown Gum (*E. dealbata*) (NSW Scientific Committee, 2009a).

Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot was tentatively recorded during surveys for the Bayswater No. 3, but exact locations were not recorded (Cumberland Ecology, 2009a).

The Turquoise Parrot is semi-nomadic and seldom forms large flocks and is commonly encountered in pairs of six to eight birds (Morcombe, 2004; NSW National Parks and Wildlife Service [NPWS], 1999a). The Turquoise Parrot usually nests less than 2 m above the ground in hollows of small trees, dead eucalyptus or in holes or stumps, fence posts or even logs lying on the ground (NPWS, 1999a).

Swift Parrot (Lathamus discolor)

The Swift Parrot has not been recorded within the Modification area or immediate surrounds. However, potential foraging habitat, due to the high nectar resources associated with Eucalyptus-dominated communities found within the Modification area and shelter resources for this species are present. There is a national recovery plan for the Swift Parrot (Birds Australia, 2011).

The Swift Parrot breeds in Tasmania and migrates to overwinter on the mainland in flowering woodlands and forests (Garnett *et al*., 2011). This species distribution fluctuates with food availability as they feed on psyllid lerps, seeds and fruit (Garnett *et al*., 2011).

It is unlikely that the Modification would affect the lifecycle of the Little Lorikeet, Turquoise Parrot or Swift Parrot, as indicated by the lack of records within and surrounding the Modification area. The Modification would remove and modify minor habitat resources potentially used by these species.

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Nest box monitoring and maintenance to ensure that nest boxes located outside of the Modification area are maintained and suitable for bird species.
- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any threatened bird species.
- Creation of habitat corridors to link isolated remnant vegetation stands.
- Control of dust emissions to minimise the potential for dust to impact these species.
- Implement noise control measures to minimise the potential for noise to impact these species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 9**). These offsets would have similar habitat to that found within the Modification area. The habitat within the proposed offsets would also provide potential habitat for the threatened parrot species listed above. The Little Lorikeet has been confirmed to occur in the proposed Middle Deep Creek Offset (**Appendix 8**).

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Modification would remove and modify approximately 53.4 ha of potential/actual habitat resources potentially used by the above three parrot species. These resources are limited for the Little Lorikeet, Turquoise Parrot and Swift Parrot and have not been previously widely used. The habitat within the Modification area is also highly fragmented due to the previous works undertaken at the Mt Arthur Coal Mine. Mitigation measures, such as the creation of habitat corridors, would provide links to other areas of potential habitat for these species outside of the Modification area. In addition, none of these species were recorded utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the above parrot species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The three parrot species are not at the limits of their ranges in the study area. In NSW, the Little Lorikeet is distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri (Barrett *et al.,* 2003). The Turquoise Parrot occurs mainly on the western side of the tablelands, inland slopes and adjoining plains in the eastern half of NSW, and in some dry coastal valleys (especially in the Sydney Basin) (NSW Scientific Committee, 2009b). The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds (NSW Scientific Committee, 2000). This species is found in Tasmania the remaining months where it breeds (NSW Scientific Committee, 2000).

7.4.5 Spotted-tailed Quoll

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) was tentatively recorded during the first half of 2006 by a HVEC staff member on the main access road to the Mt Arthur Coal offices close to the intersection with Thomas Mitchell Drive (Umwelt, 2007a). An earlier possible sighting of the Spotted-tailed Quoll was also made on a haul road in the Bayswater mining area (Umwelt, 2007a). This species was not recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**). There is draft national recovery plan for the Spotted-tail Quoll (Long and Nelson, 2004).

Spotted-tail Quolls are solitary and occupy a very large home range that for females can range from 180 - 1,000 ha and for males can range from 2,000 - 5, 000 ha (Van Dyck and Strahan, 2008). This means that the Modification area would, at best, be a small part of a home range for this species.

Suitable den sites for this species includes hollow logs, tree hollows, rocky outcrops and caves (SEWPaC, 2012b).

It is unlikely that the Modification would affect the lifecycle of the Spotted-tail Quoll, due to the low abundance of potential den sites within the Modification area caused by the long history of disturbance at the Mt Arthur Coal Mine site. In addition, there have been no confirmed records of this species in close proximity to the Modification with the closest record from the OEH (2013) database approximately 4.5 km south-west of the Modification (**Figure 10**).

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Control of weeds to minimise their potential to degrade the species potential habitat on Company-owned land.
- Pest control to minimise the potential for pests to impact this species or its habitats.
- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any Spotted-tailed Quolls. Should any Spotted-tailed Quolls be recorded, they would be captured and translocated to potential habitat outside of the Modification area into one of the conservation, offset or revegetation areas.
- Creation of habitat corridors to link isolated remnant vegetation stands.

- Control of dust emissions to minimise the potential for dust to impact this species.
- Implement noise control measures to minimise the potential for noise to impact this species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 10**). These offsets would have similar habitat to that found within the Modification area. The habitat within the proposed offsets would also provide potential habitat for the Spotted-tailed Quoll.

These on-going measures would continue to benefit wildlife following the implementation of the Modification as discussed further in **Section 8**.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Spotted-tail Quoll is recorded in a wide range of treed habitats including tropical, subtropical and temperate rainforests, vine thickets, wet and dry sclerophyll forest, woodland and coastal scrub (Van Dyck and Strahan, 2008).

The Modification would remove and modify approximately 226.4 ha potential/actual foraging habitat resources in the form of woodland, forest and grassland used by the Spotted-tailed Quoll. However, these resources are limited given that it is highly fragmented and has not been previously widely used. As described previously, there is a low abundance of potential den sites within the Modification area. In addition, this species was not recorded as utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the Spotted-tailed Quoll.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Spotted-tailed Quoll is not at the limit of its range in the study area. Spotted-tailed Quoll records are generally confined to within 200 km of the coast and range from the Queensland border to Kosciuszko National Park (SEWPaC, 2012b).

7.4.6 Koala

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Koala (*Phascolarctos cinereus*) has been recorded once in the OEH (2013) database in the Thomas Mitchell Drive Off-site Offset area, approximately 3.2 km north of Modification Area E and within the approved Mt Arthur Coal Mine to the south-west of the Thomas Mitchell Drive Offset area (HVEC, pers. comm., 2012) (**Figure 10**). The Koala recorded within the approved Mt Arthur Coal Mine was a lone male most likely looking for a mate (HVEC, pers. comm., 2012). The Koala was taken by wildlife carers who relocated him into a rehabilitated area near where he was originally found (HVEC, pers. comm., 2012). This species was not recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**). There is state recovery plan for the Koala (DECC, 2008b).

Koalas spend most of their time with a home range which varies according to the local abundance of preferred food trees (Van Dyck and Strahan, 2008). In high quality habitat, this home range may be as small as 1-2 ha while in less favourable habitat, such as semiarid country, home range may be as large as 100 ha, with males occupying a larger home range than females (Van Dyck and Strahan, 2008).

The Modification would remove and modify minor habitat resources potentially used by this species.

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Control of weeds to minimise their potential to degrade the species potential habitat on Company-owned land.
- Pest control to minimise the potential for pests to impact this species or its habitats.
- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any Koalas. Should any Koalas be recorded, they would be captured and translocated to potential habitat outside of the Modification area into one of the conservation, offset or revegetation areas.
- Creation of habitat corridors to link isolated remnant vegetation stands.

- Control of dust emissions to minimise the potential for dust to impact this species.
- Implement noise control measures to minimise the potential for noise to impact this species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 10**). These offsets would have similar habitat to that found within the Modification area. The habitat within the proposed offsets would also provide potential habitat for the Koala.

These on-going measures would continue to benefit wildlife following the implementation of the Modification as discussed further in **Section 8**.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Koalas occur in a fragmented range in eastern Australia, in foothills and coastal plains, as well as in coastal forests further north along watercourses where River Red Gums (*Eucalyptus camaldulensis*) occurs (Van Dyck and Strahan, 2008). This species inhabits a range of eucalypt forest and woodland communities (Van Dyck and Strahan, 2008).

The Modification would remove and modify approximately 53.4 ha of potential/actual habitat resources in the form of woodland and forest used by the Koala. However, these resources are limited given that the habitat is highly fragmented and has not been previously widely used. In addition, this species was not recorded as utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the Koala.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Koala is not at the limit of its range in the study area. The Koala mainly occurs on the Central and North Coasts, although significant populations also exist on the Western Slopes and Plains, such as in the Pilliga region and Gunnedah and Walgett LGAs (SEWPaC, 2012b). Koalas are known from a number of sites on the Central and Southern Tablelands and there are also records from the Northern Tablelands (SEWPaC, 2012b).

7.4.7 Squirrel Glider

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Squirrel Glider (*Petaurus norfolcensis*) has been recorded in the general locality surrounding the Modification area on several occasions between 2003 and 2010 (**Figure 10**). This species was recorded in a nest box to the immediate north of Modification Area E (Cumberland Ecology, 2010c) (**Figure 10**). This species has also been recorded in close proximity to Modification Areas B and C (**Figure 10**). This species was not recorded during the current survey within the Modification area conducted by Niche (**Appendix 1**).

Home ranges of the Squirrel Glider have been estimated between 0.65-8.55 ha (NPWS, 1999b). Movements tend to be greater for males than females and the range of a family group is likely to vary according to habitat quality and availability of resources (NPWS, 1999b).

The Modification area is situated in a highly modified landscape and may not contain habitat components critical to the lifecycle of this species.

It is unlikely that the Modification would affect the lifecycle of the Squirrel Glider, due to the low abundance of habitat resources within the Modification area caused by the long history of disturbance at the Mount Arthur site. The Modification would remove and modify minor habitat resources potentially used by this species.

A number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification:

- Control of weeds to minimise their potential to degrade the species potential habitat on Company-owned land.
- Pest control to minimise the potential for pests to impact this species or its habitats.
- Nest box monitoring and maintenance to ensure that nest boxes located outside of the Modification area are maintained and suitable for Squirrel Gliders.
- Vegetation clearance procedures, such as pre-clearance surveys of forests and woodland areas to be removed, would be undertaken to identify the presence of any Squirrel Gliders. Should any Squirrel Gliders be recorded, they would be captured and translocated to potential habitat outside of the Modification area into one of the conservation, offset or revegetation areas.
- Creation of habitat corridors to link isolated remnant vegetation stands.

- Control of dust emissions to minimise the potential for dust to impact this species.
- Implement noise control measures to minimise the potential for noise to impact this species.

In addition, two new offset areas are proposed as part of the Modification (**Figure 10**). These offsets would have similar habitat to that found within the Modification area. The Squirrel Glider has been confirmed to occur in the Middle Deep Creek Offset (**Appendix 8**).

These on-going measures would continue to benefit wildlife following the implementation of the Modification as discussed further in **Section 8**.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Squirrel Glider is primarily found in woodland and open forest, with an overstorey including *Eucalyptus* spp., *Angophora* spp. or *Corymbia* spp. and a shrubby understorey of *Acacia* spp. or *Banksia* spp. (Van Dyck and Strahan, 2008). Those flora species appear to be important components of the Squirrel Glider habitat, and provide a winter source of nectar and hollow-bearing trees for shelter (Van Dyck and Strahan, 2008).

The Modification would remove and modify approximately 53.4 ha of potential/actual habitat resources in the form of woodland and forest used by the Squirrel Glider. However, these resources are limited given that the habitat is highly fragmented and has not been previously widely used. In addition, this species was not recorded utilising habitat within the Modification area during the recent survey conducted by Niche (**Appendix 1**).

It is unlikely that the Modification would significantly affect, if at all, the Squirrel Glider.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Squirrel Glider is not at the limit of its range in the study area. In NSW, this species occurs on the North Coast and on the inland slopes, probably as two populations as it is sparse or absent on the higher elevations of the tablelands (NSW Scientific Committee, 2008).

7.4.8 Grey-headed Flying-fox

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded within the Modification area during the current surveys conducted by Niche (**Appendix 1**). This species was recorded within the Modification Area C in the Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27) vegetation community, which would be removed as part of the Modification (**Figure 10**). The species was seen foraging for nectar and pollen on blossoming Spotted Gum. No breeding or roosting colonies were present. There is a draft national recovery plan for the Grey-headed Flying-fox (DECCW, 2009b).

The breeding range of the Grey-headed Flying-fox is currently from Maryborough to Melbourne (Van Dyck and Strahan, 2008). Up to 75% of foraging forays are within 20 km of the camp, but may be up to 50 km for a productive food source (Van Dyck and Strahan, 2008).

While the Grey-headed Flying-fox may be attracted to foraging within the Modification area, a number of existing measures were developed to avoid and mitigate potential impacts on this species as it occurs in the surrounds. These measures would continue to be implemented for the Modification. Pre-clearance surveys of forests and woodland areas to be removed would be undertaken to identify the presence of any Grey-headed Flying-foxes. Should any Grey-headed Flying-foxes be recorded, they would be captured and translocated to potential habitat outside of the Modification area into one of the conservation, offset or revegetation areas. These areas have been developed to ensure that potential habitat for these species is available surrounding the Modification. In addition, several habitat corridors have been created to link isolated remnant vegetation stands.

Two new offset areas are proposed as part of the Modification. These offsets would have similar habitat to that found within the Modification area (**Figure 10**). The Grey-headed Flying-fox has been confirmed to occur in the Middle Deep Creek Offset (**Appendix 8**).

These on-going measures would continue to benefit wildlife following the implementation of the Modification as discussed further in **Section 8**.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Grey-headed Flying-fox roosts by day, gives birth and mates at 'camps' in dense riparian vegetation (Van Dyck and Strahan, 2008). Grey-headed Flying-foxes form camps in almost any dense vegetation greater than 3 m in height and usually roost near water in stands of vegetation such as mangrove, rainforest, Melaleuca, Casuarina or introduced trees (Churchill, 2008).

The Modification would remove and modify approximately 53.4 ha of potential/actual foraging and roosting habitat resources in the form of woodland and forest used by the Grey-headed Flying-fox. These resources are limited given that the habitat is highly fragmented.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Grey-headed Flying-fox is not at the limit of its range in the study area (SEWPaC, 2012b).

7.4.9 Tree-dwelling Bats

Introduction

This section assesses the potential impacts of the Modification on tree-dwelling bat species. There are a number of threatened tree-dwelling bat species that may potentially occur within the Modification area based on their known distribution (listed in **Table 14** and discussed in **Section 5.2.1**). However, one species (the Corben's Long-eared Bat [*Nyctophilus corbeni*]) listed in **Table 14** and discussed in **Section 5.2.1** is not likely to occur in the Modification area or close surrounds and is therefore not listed in **Table 18**.

The Corben's Long-eared Bat is unlikely to be affected by the Modification. It is considered unlikely that this species would occur within the Modification area, as indicated by the lack of records for this species in the Modification area and close surrounds. On this basis, it is considered unlikely that this species would be affected by the Modification. This species is not considered further.

Threatened Tree-dwelling Bat Species Likely to be Affected

Five threatened tree-dwelling bat species may be potentially impacted by the Modification, namely the: Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Southern Myotis (*Myotis adversus*).

The Eastern Freetail-bat was recorded within the Modification area while the Eastern False Pipistrelle was possibly recorded within the Modification area during the recent surveys conducted by Niche (**Appendix 1**). An assessment on the potential impacts to these species as a result of the Modification is provided below.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Yellow-bellied Sheathtail-bat has been recorded in the general locality of the Modification by Dames and Moore (2000). This species was detected using echolocation recording during the Northern Open Cut study, where it was recorded foraging over Spotted Gum open forest remnants associated with the north-eastern slopes of Mount Arthur (Cumberland Ecology, 2009a). The exact location of this record is unknown, however, it may be close to or within the Modification Area C. This species was also detected by Dames and Moore (2000) foraging over remnant woodland and open forest in the northern and eastern sections of the Northern Open Cut Project area (Cumberland Ecology, 2009a), however, exact locations are unknown.

Spotted Gum forest and woodland would be removed as part of the Modification. This species has also been recorded in the OEH (2013) database surrounding the Modification (**Figure 11**). This species was not recorded during the current surveys conducted by Niche (**Appendix 1**) within the Modification area.

The Eastern Freetail-bat was recently recorded by Niche (**Appendix 1**) within the Modification area in Modification Areas C and D (**Figure 11**). This species has also been recorded during previous surveys surrounding the Modification (**Figure 11**). This species was recorded within the Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27) vegetation community (**Figure 15**), which would be removed as part of the Modification.

The Eastern False Pipistrelle was possibly recorded during the current surveys (**Appendix 1**) within the Modification area in Modification Area A (**Figure 11**). This species was recorded in the Central Hunter Box - Ironbark Woodland Wybong Slaty Box Variant vegetation community (**Figure 15**), which would be removed as part of the Modification.

The Greater Broad-nosed Bat has been previously recorded in the general locality surrounding the Modification area by Umwelt (2007b) and has also been recorded in the OEH (2013) database (**Figure 11**). This species was not recorded during the current surveys conducted by Niche (**Appendix 1**) within the Modification area.

The Southern Myotis has been previously recorded within the Modification area within the Modification Area C (**Figure 11**). This species has also been recorded on numerous occasions surrounding the Modification and was recorded in the OEH (2013) database (**Figure 11**). This species was recorded within the Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27) vegetation community, which would be removed as part of the Modification (**Figure 15**). This species was not recorded during the current surveys conducted by Niche (**Appendix 1**) within the Modification area.

While tree-dwelling bats may be attracted to foraging and roosting habitats within the Modification area, a number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification. Pre-clearance surveys of forests and woodland areas to be removed would be undertaken to identify the presence of any threatened bat species. Should any threatened bats be recorded, they would be captured and translocated to potential habitat outside of the Modification area into one of the conservation, offset or revegetation areas. These areas have been developed to ensure that potential habitat for these species is available surrounding the Modification. In addition, several habitat corridors have been created to link isolated remnant vegetation stands.

Two new offset areas are proposed as part of the Modification. These offsets would have similar habitat to that found within the Modification area (**Figure 11**). The habitat within the proposed offsets would also provide potential habitat for the tree-dwelling bat species listed above.

These on-going measures would continue to benefit wildlife following the implementation of the Modification as discussed further in **Section 8**.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The habitat requirements for the threatened tree-dwelling bat species are as follows:

- The Yellow-bellied Sheathtail-bat can be found in most habitats, including wet and dry forests, grasslands, shrublands, Mallee and open woodlands (Churchill, 2008). This species roosts in large tree hollows and has been found in the abandoned nests of Sugar Gliders and are usually found in mixed-sex groups of two to six and occasionally up to 30 (Churchill, 2008; Van Dyck and Strahan, 2008).

- The Eastern Freetail-bat inhabits rainforest, Melaleuca forest, monsoon forest, tall open forest, River Red Gum and Yellow Box woodlands, riparian open forest and dry sclerophyll forest (Churchill, 2008). The Eastern Freetail-bat roosts mainly in tree hollows but will also roost under bark, in buildings and cracks in posts (Churchill, 2008). All known natural roosts have occurred within the hollows of large mature *Eucalyptus* spp. (Van Dyck and Strahan, 2008). Several hundred have been previously recorded in a roost (Churchill, 2008).
- The Eastern False Pipistrelle is found in wet sclerophyll and coastal Mallee and prefer habitats with tall trees, greater than 20 m in height and a dense understorey (Churchill, 2008). This species generally roosts in hollows of Eucalyptus trees in colonies of three to 80 (Churchill, 2008) and sometimes in buildings (Van Dyck and Strahan, 2008).
- The Greater Broad-nosed Bat inhabits a variety of habitats including moist gullies in mature coastal forest, rainforest, open woodland, Melaleuca swamp woodland, wet and dry sclerophyll forests, cleared paddocks with remnant trees and tree-lined creeks in open areas (Churchill, 2008). The Greater Broad-nosed Bat roosts in tree hollows, cracks and fissures in trunks and dead branches, under exfoliating bark, as well as the roofs of old buildings (Churchill, 2008; Van Dyck and Strahan, 2008).
- The Southern Myotis have a strong association with streams and permanent waterways, most frequently at low elevations and in flat or undulating country and usually in areas that are vegetated rather than cleared (Churchill, 2008). This species roosts near water in caves, tree hollows, among vegetation, in clumps of *Panadanus* spp., under bridges, in mines, road culverts and stormwater drains (Churchill, 2008; Van Dyck and Strahan, 2008). They are often found roosting alone or in pairs in disused Fairy Martin nests (Churchill, 2008).

The Modification is likely to remove and modify approximately 226.4 ha of potential/actual foraging and roosting habitat resources for the Yellow-bellied Sheathtail-bat. Approximately 53.4 ha of potential/actual foraging and roosting habitat resources may be removed/modified for the Modification for the Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Southern Myotis. This small loss of habitat is not expected to significantly affect these species, since large patches of suitable habitat exist in the surrounding area and in the greater locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

None of the threatened tree-dwelling bat species listed above are at the limits of their known distributions.

7.4.10 Cave-dwelling Bats

Introduction

This section assesses the potential impacts of the Modification on cave-dwelling bat species. There are a number of threatened cave-dwelling bat species that may potentially occur within the Modification area based on their known distribution (listed in **Table 14** and discussed in **Section 5.2.1**). However, one species (the Little Bentwing-bat [*Miniopterus australis*]) listed in **Table 14** and discussed in **Section 5.2.1** is not likely to occur in the Modification area or close surrounds and is therefore not listed in **Table 18**.

The Little Bentwing-bat is unlikely to be affected by the Modification. It is considered unlikely that this species would occur within the Modification area, as indicated by the lack of records for this species in the Modification area and close surrounds. On this basis, it is considered unlikely that this species would be affected by the Modification. This species is not considered further.

Threatened Cave-dwelling Bat Species Likely to be Affected

Three threatened cave-dwelling bat species may be potentially impacted by the Modification, namely the Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Eastern Cave Bat (*Vespadelus troughtoni*).

The Eastern Bentwing-bat and Eastern Cave Bat were possibly recorded within the Modification area during the recent surveys conducted by Niche (**Appendix 1**). An assessment on the potential impacts to these species as a result of the Modification is provided below.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Large-eared Pied Bat was recorded to the north of Modification Area B outside of the Modification area (**Figure 11**). It has also been recorded in the OEH (2013) database at Muswellbrook (**Figure 11**). This species was not recorded during the current surveys conducted by Niche (**Appendix 1**) within the Modification area. There is a national recovery plan for the Large-eared Pied Bat (Queensland Department of Environment and Resource Management, 2011).

The Eastern Bentwing-bat and Eastern Cave Bat were possibly found during the recent fauna surveys within the Modification area (**Appendix 1**) in all Modification Areas other than Area E (**Figure 11**). These species were recorded within the Central Hunter Ironbark – Spotted Gum – Grey Box Forest (MU27) and Derived Native Grassland vegetation communities which would be removed as part of the Modification (**Figure 15**). These species have also been recorded during previous surveys and were recorded in the OEH (2013) database surrounding the Modification area (**Figure 11**).

While cave-dwelling bats may be attracted to foraging habitats within the Modification area, a number of existing measures were developed to avoid and mitigate potential impacts on these species as they occur in the surrounds. These measures would continue to be implemented for the Modification. Pre-clearance surveys of forests and woodland areas to be removed would be undertaken to identify the presence of any threatened bat species. Should any threatened bats be recorded, they would be captured and translocated to potential habitat outside of the Modification area into one of the conservation, offset or revegetation areas. These areas have been developed to ensure that potential habitat for these species is available surrounding the Modification. In addition, several habitat corridors have been created to link isolated remnant vegetation stands.

Two new offset areas are proposed as part of the Modification. These offsets would have similar habitat to that found within the Modification area (**Figure 11**). The habitat within the proposed offsets would also provide potential habitat for the cave-dwelling bat species listed above.

These on-going measures would continue to benefit wildlife following the implementation of the Modification as discussed further in **Section 8**.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The habitat requirements for the threatened cave-dwelling bat species are as follows:

- The Large-eared Pied Bat inhabits dry sclerophyll forests and woodlands, but also occur in sub-alpine woodland, the edges of rainforest, wet sclerophyll forest, *Callitris* spp. dominated forests and sandstone outcrop country (Churchill, 2008). This species roosts in caves, crevices in cliffs and mines and abandoned, disused mud nests of Fairy Martins in colonies of three to 40 (Churchill, 2008; Van Dyck and Strahan, 2008).
- The Eastern Bentwing-bat is found in rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands (Churchill, 2008). The Eastern Bentwing-bat roosts in caves as well as man-made constructions such as abandoned mines and road culverts (Churchill, 2008).

- The Eastern Cave Bat inhabits tropical mixed woodland, wet and dry sclerophyll forest along the coast and the Great Dividing Range, extending to the drier forests of the western slopes and inland areas (Churchill, 2008). This species roosts in small groups in well-lit areas in sandstone overhanging cliffs, boulder piles, mines, road culverts and occasionally in buildings (Churchill, 2008; Van Dyck and Strahan, 2008).

The Modification is likely to remove and modify approximately 226.4 ha of potential/actual foraging and roosting habitat resources for the Eastern Bentwing-bat. Approximately 53.4 ha of potential/actual foraging and roosting habitat resources may be removed/modified for the Modification for the Large-eared Pied Bat and Eastern Cave Bat. This small loss of habitat is not expected to significantly affect these species, since large patches of suitable habitat exist in the surrounding area and in the greater locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

None of the threatened tree-dwelling bat species listed above are at the limits of their known distributions.

8 Impact Avoidance, Mitigation and Offset Measures

8.1 Existing Impact Avoidance and Mitigation Measures at the Mt Arthur Coal Mine

A *Biodiversity and Rehabilitation Management Plan* (BHP Billiton, 2012) has been developed to facilitate the management of biodiversity at the existing approved Mt Arthur Coal Mine. **Table 19** outlines the existing impact avoidance and mitigation measures that are currently implemented (after BHP Billiton, 2012).

Table 19: Existing impact avoidance and mitigation measures at the Mt Arthur Coal Mine

Measure	Description
Rehabilitation	
Revegetation of the post-mine landforms	The rehabilitation strategy provides for areas for biodiversity outcomes (e.g. woodland corridors) and areas of pasture (the predominant previous site land use). However, the strategy aims for a net increase in native vegetated areas at the end of mine life. Surface development areas associated with the Mt Arthur Coal Mine are progressively rehabilitated and revegetated with species characteristic of native species endemic to the local area. Annual ecological monitoring has taken place at the Mt Arthur Coal Mine from 2003 (Umwelt, 2003, 2005, 2006b, 2007a; Cumberland Ecology, 2009b, 2010b, 2010c; Wildthing Environmental Consultants, 2008). Permanent monitoring plots within remnant and rehabilitation areas have been established throughout the Mt Arthur Coal Mine site and are monitored annually. The *Biodiversity and Rehabilitation Management Plan* (BHP Billiton, 2012) describes the use of artificial roosting/nesting boxes, nesting structures (mammal and avian), fallen timber and creation of drainage depressions for frogs.
Rehabilitation of creeks and drainage lines on the site	The drainage pattern of the final landform would be designed to integrate with the surrounding catchments and revegetated to achieve long-term stability and erosion control.
Management of salinity	Salinity levels in topsoil and subsoil are monitored to prevent salinity impacting on vegetation establishment and landform stability.
Conservation and reuse of topsoil	Topsoil is currently conserved so that it can be respread onto the surface during rehabilitation. Respread topsoil may contain native seed and beneficial micro-organisms which have been shown to be advantageous to the more rapid development of a sustainable and productive ecosystem.
Vegetation Clearance	
Protection of vegetation and soil outside of the disturbance areas	Conservation and offset areas have been created to protect vegetation and soil outside of the disturbance area.
Pre-clearance surveys	Pre-clearance surveys are conducted within all patches of forest and woodland to be cleared and threatened flora and fauna species detected are translocated into protected habitat. Planned disturbance areas are delineated prior to clearing activities, with restriction of clearing to the minimum area necessary to undertake the approved activities.

Table 19 (continued): Existing impact avoidance and mitigation measures at the Mt Arthur Coal Mine

Measure	Description
Vegetation Clearance (Continued)	
Collecting and propagating seed	Seed present during land clearance activities would be collected for use in plant propagation programmes to provide tube stock for revegetation activities. The Mt Arthur Coal Mine has an existing Consent Condition requiring re-establishment of *Acacia pendula*. This has involved collection of seed from *Acacia pendula* to be used in a propagation programme.
Salvaging and reusing material from the site for habitat enhancement	Large woody debris deemed suitable for habitat enhancement is identified as part of pre-clearance and post-clearance and are salvaged and reused for habitat enhancement.
General Management	
Nest Box Programme	A nest box monitoring programme is currently undertaken at the Mt Arthur Coal Mine. A total of 48 nest boxes have been established at two remnant sites (one site is within the Thomas Mitchell Drive Offset area). These boxes are visually examined annually for the presence of scats, nesting material, chewing or scratching marks, discarded bones, etc.). Box types include: Squirrel Glider boxes, microbat boxes and bird boxes.
Controlling weeds	In 2010, HVEC developed a weed action plan to improve the management of noxious and environmental weeds, which identifies priority areas as well as individual species requiring management.
Controlling feral pests	Measures to control exotic animals are implemented by an appropriately qualified person(s) and include: the destruction of pests habitat, trapping, targeted shooting programmes and baiting. Follow-up inspections would be undertaken to assess the effectiveness of control measures implemented and the requirement for any additional control measures.
Managing grazing and agriculture on-site	Several measures are currently undertaken to manage grazing including managing stock, grazing and fertiliser use.
Controlling access	Access is controlled by restricting vehicle access, preventing access to open pits or other hazardous locations, and constructing a safety berm and/or security fence at the void crest (highwalls and endwalls) to provide an engineered barrier between the pit and the surrounding area.
Bushfire management	Several measures are currently undertaken to manage bushfire including monitoring fuel loads, fire bans, restriction of potential ignition sources, emergency preparedness training for mine-site personnel and the establishment of firebreaks.

8.2 Proposed Impact Avoidance and Mitigation Measures for the Modification

Table 20 outlines the proposed impact avoidance and mitigation measures that would be implemented for the Modification.

Table 20: Proposed additional impact avoidance and mitigation measures for the Modification

Proposed Impact Avoidance and Mitigation Measure	Description of Measure
Pine Donkey Orchid (*Diuris tricolor)* translocation	If any *Diuris tricolor* are identified in the Modification area during the pre-clearance surveys an evaluation of whether or not the plants should be translocated would be made by an appropriately qualified person. For example, if only one plant was found then it may not be worth translocating due to the presence of known populations in the Thomas Mitchell Drive Offset area.
Weeping Myall (*Acacia pendula*) Propagation	The Mt Arthur Coal Mine has an existing Consent Condition requiring re-establishment of *Acacia pendula*. To date this has involved collection of seed from *Acacia pendula* to be used in a propagation programme. However, it is believed that the seed is being collected from local planted *Acacia pendula* not the *Acacia pendula* which is 'native' to the Hunter Catchment. Re-establishment of *Acacia pendula* would focus on trials of growing the plants from cuttings because the *Acacia pendula* which is 'native' to the Hunter Catchment isn't known to produce seed (**Section 7.1.1**).
Weeping Myall (*Acacia pendula*) Translocation	If the trial to re-establish *Acacia pendula* using cuttings is not successful, the possibility of translocating *Acacia pendula* plants would be investigated. An evaluation of whether or not the plants should be translocated would be made by an appropriately qualified person.
Threatened Species Database	Threatened species sightings at the Mt Arthur Coal Mine would be reported to the environmental officer and maintained on a database.

Koala Monitoring

As described in **Section 7.4.6**, a Koala has been sighted in the Thomas Mitchell Drive Off-site Offset area (OEH, 2013) and within the approved Mt Arthur Coal Mine to the south-west of the Thomas Mitchell Drive Offset area (HVEC, pers. comm., 2012) (**Figure 10**).

The Koala would continue to be monitored through annual ecological monitoring surveys and pre-clearance surveys.

Revegetation of the Post-mine Landforms

Refinements to the revegetation of the post-mine landforms would include:

- limiting the location of the 'rehabilitation areas' to approved disturbance areas;
- increasing the width of the 'rehabilitation areas' corridors to a minimum of 500 m;
- post-mining land use compatible with surrounding land uses to provide environmental and community benefits; and
- consideration of the landform and location of final voids.

8.3 Existing Biodiversity Offset Strategy

The NSW and Commonwealth Project Approvals for the approved Mt Arthur Coal Mine describe the existing biodiversity offset strategy for the mine (**Table 21**). The offset strategy for the approved Mt Arthur Coal Mine comprises 3,939 ha of existing vegetation and cleared land (**Figure 18; Table 21**).

Table 21: Overview of the Existing Biodiversity Offset Strategy

Area	Offset Type	Existing Minimum Size (ha)
Development Consent Condition 36		
Mt Arthur Conservation Area	Existing vegetation	105
Saddlers Creek Conservation Area	Existing vegetation	295
Thomas Mitchell Drive Off-site Offset Area	Existing vegetation and vegetation to be established	495
Thomas Mitchell Drive On-site Offset Area	Vegetation to be established	222
Roxburgh Road 'Constable' Offset Area	Existing vegetation and vegetation to be established	110
Additional Off-site Offset Area (Expansion of the Thomas Mitchell Drive Off-site Offset Area – **Figure 19**)	Existing vegetation and vegetation to be established	165
Rehabilitation Areas	Vegetation to be established	1,915* (including 500 ha of Box-Gum Woodland)
Additional Areas under Commonwealth Approval (EBPC 2011/5866)		
Middle Deep Creek Offset Area	Existing vegetation and vegetation to be established	632** (including 493 ha of Box-Gum Woodland)
	Total	3,939

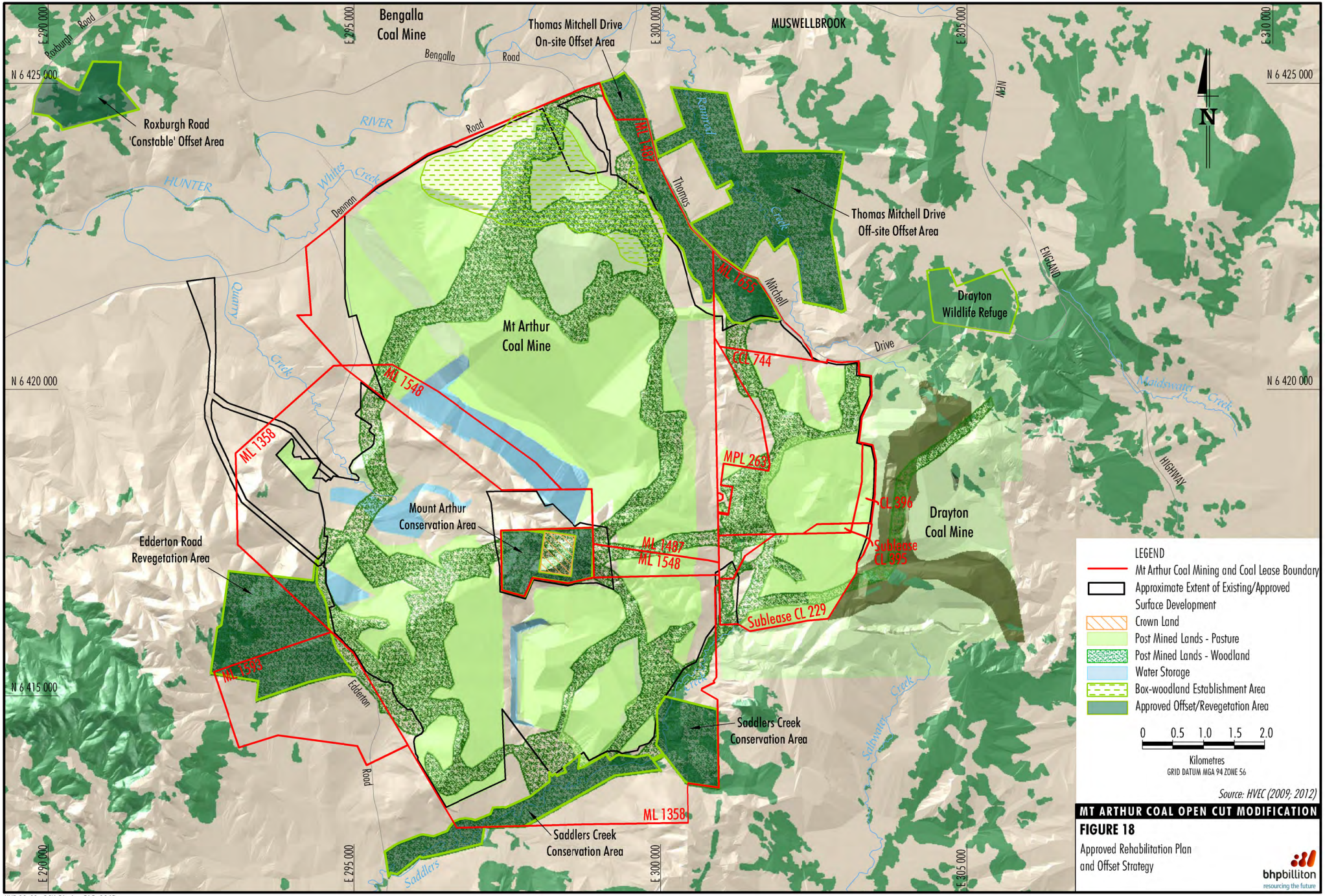
Source: NSW and Commonwealth Project Approvals for the approved Mt Arthur Coal Mine.

* Includes the Edderton Road Revegetation Area (154 ha).

** Umwelt (2011).

In accordance with Consent Condition 37, HVEC is to identify an additional offset area which expands the Thomas Mitchell Drive Off-site Offset area (**Table 21**). HVEC's proposed location for the additional offset area is shown on **Figure 19** and is comprised of 165 ha consisting of primarily of derived grassland with paddock trees and a creek line dominated by Swamp Oak (*Casuarina glauca*). This location is to be confirmed by detailed surveys and following consultation with the relevant regulatory authority.

The existing NSW and Commonwealth Environmental Approvals specify 'rehabilitation areas' in the existing biodiversity offset strategy (**Table 21**). This includes 1,915 ha of vegetation (including 500 ha of Box-Gum Woodland) to be established in corridors as shown on **Figure 19**. The existing NSW approval states that the rehabilitation strategy must provide for at least 30% of the disturbance area for open cut operations at the Mt Arthur Coal Mine to be rehabilitated to woody vegetation.



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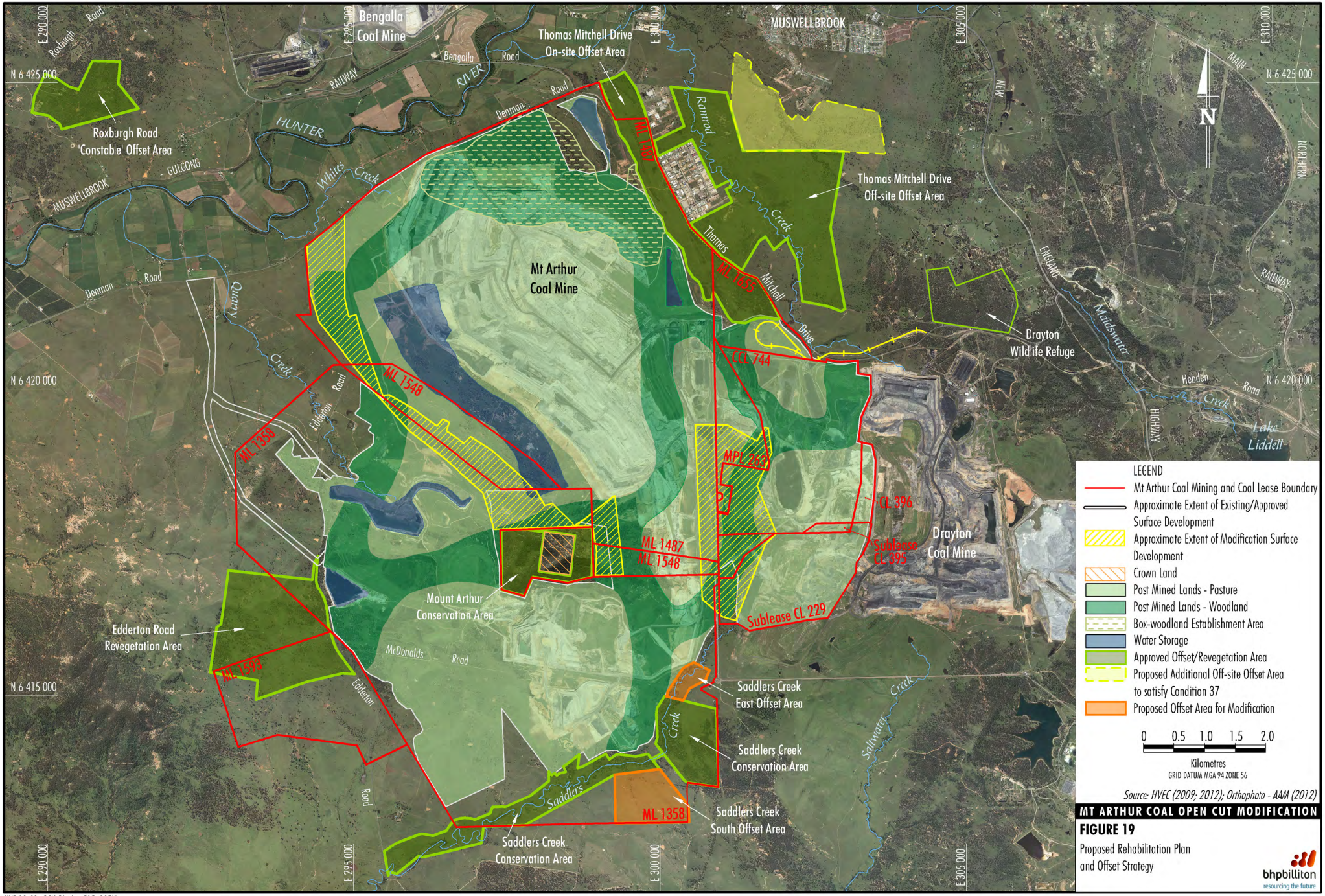

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FIGURE 19

Proposed Rehabilitation Plan and Offset Strategy

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Key components of the existing offset areas are:

- Management of livestock grazing in accordance with *A Guide to Managing Box Gum Grassy Woodlands* (Rawlings *et al.,* 2010) and re-establishment of vegetation within the offset areas.
- Management and monitoring of the offset areas against performance and completion criteria (including monitoring of the *Diuris tricolor* in the Thomas Mitchell Drive Offset area).
- Nest Box Programme in the Thomas Mitchell Drive Offset area.
- Long-term security of the offset areas.
- Provision of a conservation bond to the NSW Government.
- Reporting to NSW and Commonwealth Governments.

8.4 Proposed Biodiversity Offset Strategy

Measures that are proposed to avoid and mitigate impacts from the Modification on flora and fauna are described in **Section 8.2**. This section describes an offset proposal aimed at addressing the residual impacts from the Modification.

The Director-General's Requirements for the Modification state that a comprehensive offset strategy is required as part of the Modification to ensure the proposal maintains or improves the terrestrial and aquatic biodiversity values in the region in the medium to long-term.

The revised biodiversity offset strategy is shown in **Table 22**. The Modification would require the following changes to the existing biodiversity offset strategy:

- **Refinement of the location of the 'rehabilitation areas'**. The existing NSW and Commonwealth Environmental Approvals specify 'rehabilitation areas' in the existing biodiversity offset strategy (**Table 21**). This includes 1,761 ha[1] of vegetation (including 500 ha of Box-Gum Woodland) to be established in corridors as shown on **Figure 19**. Refinements would include:
  - limiting the location of the 'rehabilitation areas' to approved disturbance areas;
  - increasing the width of the 'rehabilitation areas' corridors to a minimum of 500 m (except for a portion where the width is 380 m);
  - integration of the 'rehabilitation areas' with the landform and location of final voids; and
  - maintaining woodland corridors across greater than 30% of the disturbance area for open cut operations at the Mt Arthur Coal Mine.

[1] This number excludes the Edderton Road Revegetation Area.

- **Additional offset area to account for additional clearance.** This would include:
  - expanding the existing Saddlers Creek Conservation area by 131 ha (**Figure 19**); and
  - expanding the existing Middle Deep Creek Offset area by 410 ha (**Figure 20**).

Table 22: Revised Biodiversity Offset Strategy

Area	Offset Type	Existing Minimum Size (ha)	Proposed Minimum Size (ha)
Development Consent Condition 36			
Mt Arthur Conservation Area	Existing vegetation	105	105 (no change)
Saddlers Creek Conservation Area	Existing vegetation and vegetation to be established	295	426
Thomas Mitchell Drive Off-site Offset Area	Existing vegetation and vegetation to be established	495	495 (no change)
Thomas Mitchell Drive On-site Offset Area	Vegetation to be established	222	222 (no change)
Roxburgh Road 'Constable' Offset Area	Existing vegetation and vegetation to be established	110	110 (no change)
Additional Off-site Offset Area	Existing vegetation and vegetation to be established	165	250.1*
Edderton Road Revegetation Area	Existing vegetation and vegetation to be established	154	154 (no change)
Rehabilitation Areas	Vegetation to be established	1,761**** (including 500 ha of Box-Gum Woodland)	2,642** (including 500 ha of Box-Gum Woodland)
Middle Deep Creek Offset Area	Existing vegetation and vegetation to be established	632*** (including 493 ha of Box-Gum Woodland)	1,042 (including 596 ha of Box-Gum Woodland)
	Total	3,939	5,446.1

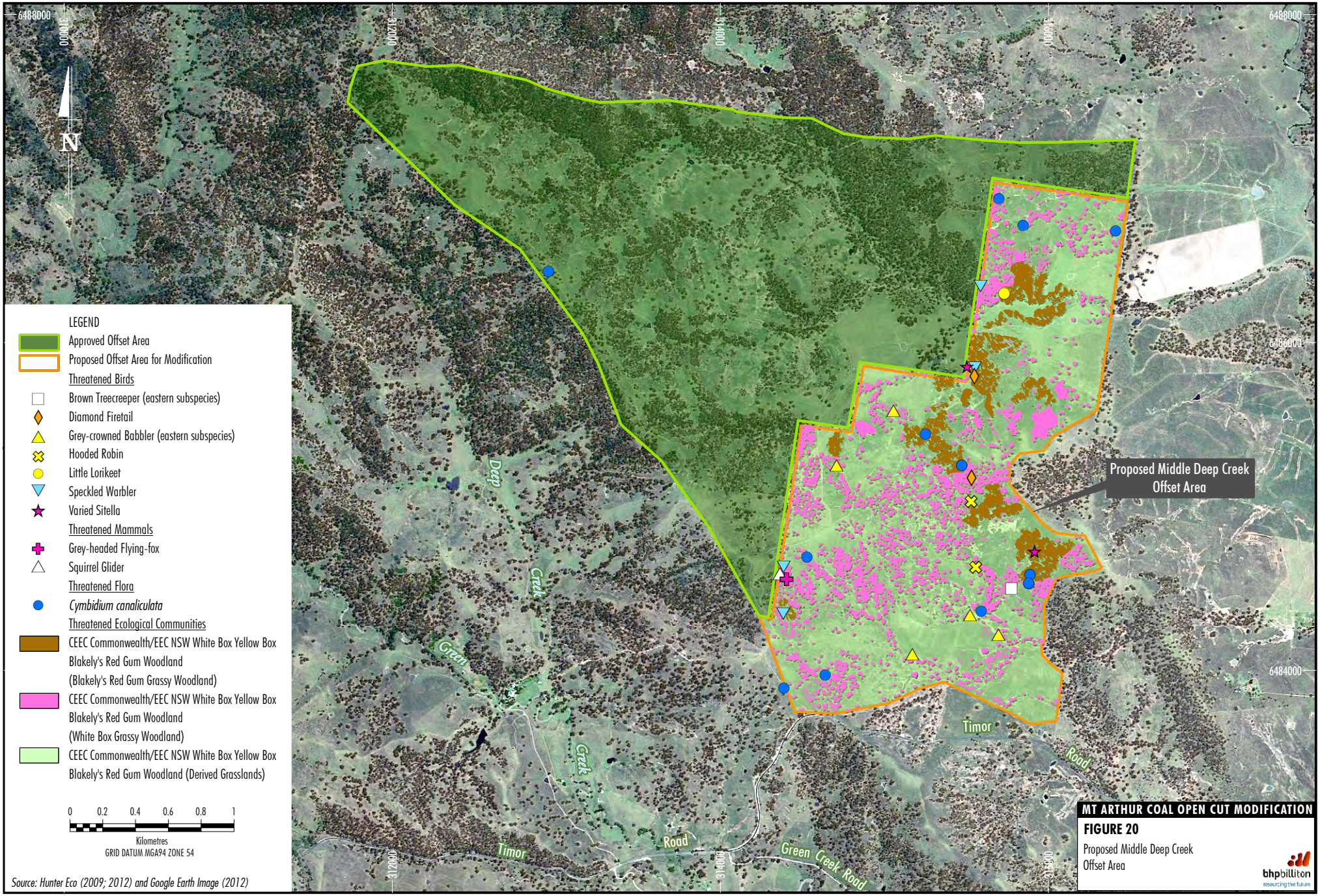
Highlighted rows have been updated.

* HVEC would provide an additional 21.3 ha offset for Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC and an additional 63.8 ha offset for Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC in a location to be determined.

** This value is 34% of the total mine disturbance footprint.

*** Umwelt (2011).

**** This number excludes the Edderton Road Revegetation Area.



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Vegetation Communities

The additional offset areas are described in detail in **Appendix 8** and below. The proposed offset areas contain the following vegetation communities based on Peake (2006), or their equivalent:

- MU10 Central Hunter Box – Ironbark Woodland;
- MU24 Hunter Lowlands Red Gum Forest;
- MU11 Upper Hunter White Box – Ironbark Grassy Woodland; and
- MU19 Hunter Valley Weeping Myall Woodland.

Table 23 compares the vegetation types/map units within the Modification area with those in the proposed offset area.

Table 23: Quantification of vegetation types within the disturbance area and offset area

Disturbance				**Offset by:**	
Vegetation Type	**Vegetation Community**	**HRVP Equivalent**	**Area (ha)**	**Vegetation Community**	**Area (ha)**
Grassland	Derived Native Grassland	no HRVP equivalent	136.8	MU10 Central Hunter Box - Ironbark Woodland (Derived grassland) (Saddlers Creek East and South) [1, 2]	120
Grassland (Cooba Wattle Regrowth)	Derived Native Grassland, with Cooba Wattle Regrowth	no HRVP equivalent	1		
Grassland	Derived Native Grassland, derived from Box-Gum Woodland[1, 2]	no HRVP equivalent	35.2	MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Derived grassland) (Middle Deep Creek) [1, 2]	307
Reed Drainage Line	*Typha* Dominated Drainage Line*	no HRVP equivalent	2.5		
		subtotal	175.5		427
Box-Gum (grassy)	Central Hunter Box – Ironbark Woodland[1, 2, 3]	MU10	23	MU10 Central Hunter Box – Ironbark Woodland (Saddlers Creek East) [1, 2, 3]	5.2
Box-Gum (grassy)	Blakely's Red Gum Woodland[1, 2]	no HRVP equivalent	0.2	HVEC would also provide an additional 63.8 ha offset for this community in a location to be determined	63.8
Box-Gum (shrubby)	Upper Hunter Hills Box – Ironbark – Red Gum Woodland	MU9	3.4		
Slaty Box	Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant	MU10	17.9	MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Middle Deep Creek) [1, 2]	103
		subtotal	44.5		170.2

Table 23 (continued): Quantification of vegetation types within the disturbance area and offset area

Disturbance				Offset by:	
Red Gum	Hunter Lowlands Red Gum Forest[4]	MU24	1.7	MU24 Hunter Lowlands Red Gum Forest (Saddlers Creek East) [4]	5.1
Spotted Gum	Central Hunter Ironbark – Spotted Gum – Grey Box Forest[5]	MU27	7.1	HVEC would provide an additional 21.3 ha offset for this community in a location to be determined.	21.3
Weeping Myall	Weeping Myall Woodland[6]	MU19	0.1	MU19 Hunter Valley Weeping Myall Woodland (Saddlers Creek South) [6]	0.4
		Total	**228.9**		**624**

1 White Box Yellow Box Blakely's Red Gum Woodland EEC.

2 White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.

3 Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC.

4 Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC.

5 Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC.

6 Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC.

* This is also partly offset by the inclusion of the Saddlers Creek and Middle Deep Creek watercourse in the offset strategy.

The vegetation communities in the proposed offset areas are generally a good match for those which are proposed to be cleared. In most cases, the area multipliers are very good, with a greater quantity of the vegetation communities represented in the proposed offset areas when compared to the disturbance areas (**Table 23**).

Of particular note, all of the vegetation communities in the proposed offset areas are listed as one or more TECs (**Table 23**) suggesting the conservation values of the proposed offset areas are overall greater.

There is one TEC which is not represented in the Saddlers Creek and Middle Deep Creek Offset areas, namely the Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions EEC (7.1 ha) (**Table 23**). This TEC occurs in multiple patches in the Modification area (Areas B, C and D – **Figure 15**). HVEC would provide an additional 21.3 ha offset for this community in a location to be determined.

In addition, only 5.2 ha of the Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC is represented in the proposed offset areas (**Table 23**). This EEC occurs in multiple patches in the Modification area (Areas B and C – **Figure 15**). HVEC would provide an additional 63.8 ha offset for this community in a location to be determined.

The proposed offset areas are suitably located to increase existing offset areas established by HVEC. The Middle Deep Creek Offset area is located approximately 70 km north of the Modification area (**Figure 20**), and therefore there are some differences in the vegetation. The Box-Gum (grassy) Woodland in the Modification area largely meets the definition of MU10 while the Box-Gum (grassy) Woodland in the offset area meets the definition of MU11 (after Peake, 2006) (**Table 23**). However, both represent the Box-Gum Woodland EEC/CEEC. A small stand of Blakely's Red Gum Woodland (0.2 ha) was recorded in the Modification area and Blakely's Red Gum is present in the Middle Deep Creek Offset area but has been included in mapping of MU11 (**Appendix 8**).

The proposed offset areas contain 1.6 km of Saddlers Creek as well as an array of creek lines at Middle Deep Creek. These creek lines are a beneficial inclusion as they provide a habitat resource for a range of plants and animals, some of which may be aquatic. Noting also that the *Typha* Dominated Drainage Line is partly offset by the inclusion of these watercourses into the offset strategy (**Table 23**).

The proposed offset areas contain substantially more Box-Gum Woodland EEC/CEEC than would be cleared for the Modification (**Table 24**). This is largely because approximately 137.8 ha of non-threatened derived grasslands would be offset with derived grasslands of the Box-Gum Woodland EEC/CEEC (**Table 24**).

Table 24: Quantification of threatened ecological communities within the disturbance area and offset area

Community	Conservation Status[1]		Disturbance Area (ha)	Offset by:
	TSC Act	EPBC Act		
Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	E	-	0.1	0.4
White Box Yellow Box Blakely's Red Gum Woodland[2]	E	CE	58.4 ha comprising: • 35.2 ha of Derived Native Grassland, derived from Box-Gum Woodland; • 23 ha of Central Hunter Box – Ironbark Woodland; and • 0.2 ha of Blakely's Red Gum Woodland.	537 ha comprising: • 120 ha of MU10 Central Hunter Box - Ironbark Woodland (Derived grassland); • 307 ha of MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Derived grassland); • 5.2 ha of MU10 Central Hunter Box – Ironbark Woodland; and • 103 ha of MU11 Upper Hunter White Box – Ironbark Grassy Woodland.

Table 24 (continued): Quantification of threatened ecological communities within the disturbance area and offset area

	Disturbance			Offset by:
Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC	E	-	23	69
Central Hunter Ironbark – Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions	E	-	7.1	21.3
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	E	-	1.7	5.1

[1] Threatened population, vegetation community, flora species or fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).

E = Endangered; CE = Critically Endangered.

[2] Listed as the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC under the EPBC Act.

Threatened Species

Table 25 lists the threatened populations and species with the potential to occur in the proposed offset area.

Table 25: Threatened populations and species with the potential to occur in the proposed offset area

Scientific Name	Common Name	Conservation Status[1]		Affected by the Modification	Recorded (R) or Potential (P) Habitat in the Proposed Offset area
		TSC Act	EPBC Act		
Flora					
Acacia pendula in the Hunter Catchment	Weeping Myall population in the Hunter Catchment	E	-	Yes	R
Cymbidium canaliculatum	*Cymbidium canaliculatum* population in the Hunter Catchment	E	-	No	R
Fauna					
Birds					
Chthonicola sagittata	Speckled Warbler	V	-	No	R
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	No	R
Stagonopleura guttata	Diamond Firetail	V	-	No	R

Table 25 (continued): Threatened populations and species with the potential to occur in the proposed offset area

Scientific Name	Common Name	Conservation Status[1]		Affected by the Modification	Recorded (R) or Potential (P) Habitat in the Proposed Offset area
		TSC Act	EPBC Act		
Birds (Continued)					
Daphoenositta chrysoptera	Varied Sittella	V	-	Yes	R
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	Yes	R
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	No	P
Anthochaera phrygia	Regent Honeyeater	CE	E	No	P
Tyto novaehollandiae	Masked Owl	V	-	No	P
Circus assimilis	Spotted Harrier	V	-	No	P
Hieraaetus morphnoides	Little Eagle	V	-	No	P
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	No	R
Petroica boodang	Scarlet Robin	V	-	No	P
Glossopsitta pusilla	Little Lorikeet	V	-	No	R
Neophema pulchella	Turquoise Parrot	V	-	No	P
Lathamus discolor	Swift Parrot	E	E	No	P
Mammals					
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	No	P
Petaurus norfolcensis	Squirrel Glider	E	-	No	R
Phascolarctos cinereus	Koala	V	V	No	P
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Yes	R
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	No	P
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Yes	P
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Possibly	P
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	No	P
Myotis macropus	Southern Myotis	V	-	Yes	P
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	No	P
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Possibly	P
Vespadelus troughtoni	Eastern Cave Bat	V	-	Possibly	P

[1] Threatened population, flora species or fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).

V = Vulnerable; E = Endangered; CE = Critically Endangered.

Key Benefits of the proposed offset areas

Key benefits of the proposed additional Saddlers Creek Conservation area (**Figures 19 and 21**) are:

- Presence of the endangered population, *Acacia pendula* (a tree) in the Hunter Catchment and the EEC Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion.
- Presence of the Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC.
- Presence of the Box-Gum Woodland EEC/CEEC.
- Presence of the Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions.
- Scattered patches of *Bothriochloa biloba* across the open grassland.
- Inclusion of approximately 930 m of Saddlers Creek.
- Potential to benefit local fauna populations (and threatened fauna) impacted by the Modification.
- A large number of trees with habitat hollows.

Key benefits of the proposed additional Middle Deep Creek Offset area are:

- Presence of the Box-Gum Woodland EEC/CEEC.
- Thirteen Tiger Orchid (*Cymbidium canaliculatum*) plants were recorded being part of the NSW listed endangered population *Cymbidium canaliculatum Population in the Hunter Catchment*.
- A number of threatened woodland birds were recorded: Diamond Firetail, Speckled Warbler, Hooded Robin (south-east form), Grey-crowned Babbler (eastern subspecies), Varied Sittella, Little Lorikeet and Brown Treecreeper (eastern subspecies). The Squirrel Glider and Grey-headed Flying-fox were also recorded.
- Potential habitat for the threatened Swift Parrot, Regent Honeyeater, Little Eagle, Scarlet Robin, Flame Robin, Brush-tailed Phascogale, Spotted-tailed Quoll, Yellow-bellied Glider, perhaps the Common Planigale and Eastern Bentwing-bat.
- Inclusion of an array of creek lines at Middle Deep Creek.
- A large number of trees with habitat hollows.

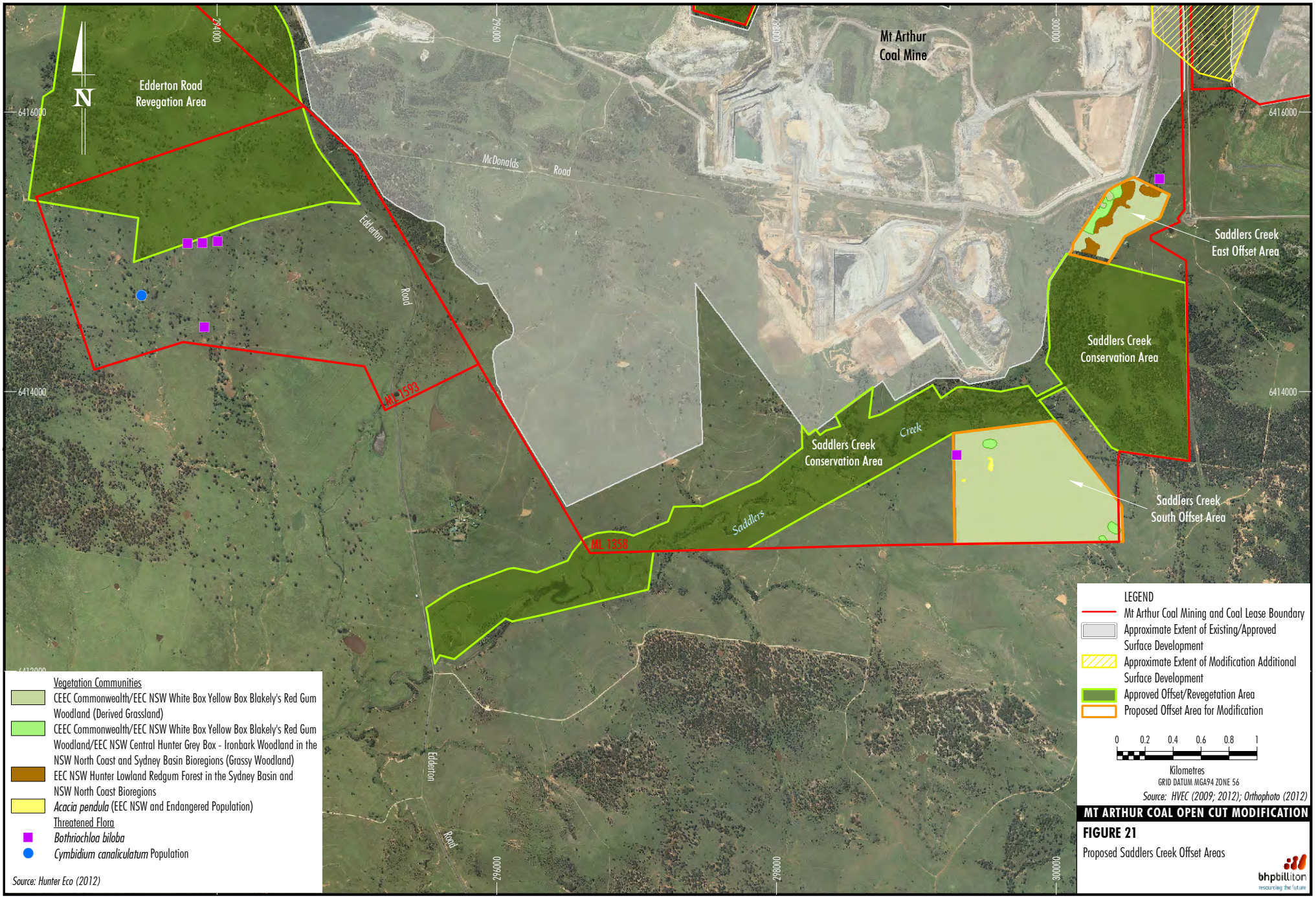

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FIGURE 21

Proposed Saddlers Creek Offset Areas

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Management

The additional proposed offset areas would be managed, secured, monitored in the same way as the existing offset areas in accordance with the Project Approval for the existing Mt Arthur Coal Mine. This includes, control of weeds and feral animals, restriction of grazing, fire management and control of vehicular access. Ecological monitoring will continue and management plans would be updated to reflect the additional Modification areas.

Enduring security of the offset areas would be provided within 12 months following approval of the Modification (e.g. a Voluntary Planning Agreement [VPA] under the EP&A Act).

The *Biodiversity and Rehabilitation Management Plan* (BHP Billiton, 2012) would be revised to include the additional proposed offset areas. Within 6 months of the approval of the revised plan, HVEC would provide a conservation bond to the NSW Government to ensure that the revised offset strategy is implemented.

Measures specific to the additional proposed offset areas are described below.

Revegetation

A considerable part in the additional proposed offset areas are cleared lands (approximately 427 ha) comprising derived native grassland or introduced grassland. The aim of revegetation would be to reinstate woodland using a range of canopy, mid and understorey flora species.

If livestock grazing continued, the derived grasslands would not regenerate to forest and woodland. Consequently, livestock grazing would be largely excluded from the additional proposed offset areas through installation and maintenance of stock proof fencing. Strategic grazing may be used as a management tool for conservation purposes in accordance with *A Guide to Managing Box Gum Grassy Woodlands* (Rawlings *et al.,* 2010). Reasons for grazing may be to control weeds, to control biomass or to manipulate species composition or sward structure (Rawlings *et al.,* 2010).

Additional Habitat Features in the Saddlers Creek Conservation Area

The existing next box programme (**Section 8.1**) would be expanded to include the Saddlers Creek Conservation area. Nest boxes would be installed within the proposed offset areas to supplement arboreal habitat. Data relating to the utilisation and condition of the nest boxes would be collected on an on-going basis.

Large woody debris from felled trees and existing logs in the approved Mt Arthur Coal Mine footprint deemed suitable for habitat enhancement would be relocated to the Saddlers Creek Conservation area.

8.4.1 Reconciliation of the Proposed Offset Strategy against OEH Offset Principles

As described earlier, the Director-General's Requirements for the Modification state that a comprehensive offset strategy is required as part of the Modification to ensure the proposal maintains or improves the terrestrial and aquatic biodiversity values in the region in the medium to long-term.

A substantial net gain in biodiversity would result from the combined Modification and proposed offsets considering the habitat values of the proposed offset areas would increase through active management. The offsets would be established, and their management plans implemented, within 12 months following approval of the Modification enabling habitat to increase in the order of ten years before open cut mining extends into the Modification areas. This timing would also enable rehabilitation and revegetation of the post mine landforms to be advanced.

A reconciliation of the proposed offset proposal against the OEH Offset Principles (OEH, 2012) is shown in **Table 26**.

Table 26: Reconciliation of the proposed offset strategy against OEH offset principles

OEH Offset Principles (OEH, 2012)	How the Proposed Offset Addresses the OEH Offset Principles
Impacts must be avoided first by using prevention and mitigation measures.	Measures to avoid and mitigate impacts are described in this section. The proposed offset strategy addresses residual impacts.
All regulatory requirements must be met.	HVEC is required to meet all statutory requirements. The proposed offset strategy does not duplicate other licence/approval requirements.
Offsets must never reward ongoing poor performance.	The proposed offset strategy is proposed to address residual impacts associated with the Modification only.
Offsets will complement other government programmes.	The offset would be added to the reserve network in NSW.
Offsets must be underpinned by sound ecological principles.	The proposed offsets were selected for their similarity to the habitat that would be lost as a result of the Modification proceeding.
Offsets should aim to result in a net improvement in biodiversity over time.	The proposed offsets have a history of clearing and grazing and are currently dominated by derived native grassland. There is considerable evidence of woodland regeneration in the proposed offset areas and this would develop further under careful management. Significant areas of scouring and erosion in the proposed offset areas would be the subject of active remediation. Significant weeds would be controlled or eradicated. The proposed Saddlers Creek Offset areas have considerable scope for regeneration and rehabilitation of grassland to woodland. This area also contains a substantial patch of the non-pendulous form of *Acacia pendula* that can be allowed to regenerate from prior and future grazing by being fenced. The proposed Middle Deep Creek Offset area is superior in ecological value to any of the habitat to be cleared in the Modification. This is demonstrated by the confirmed presence of seven threatened woodland bird species, Squirrel Glider, Grey-headed Flying-fox and 13 Tiger Orchids. Its value would only increase as natural regeneration proceeds along with active rehabilitation of selected areas.

Table 26 (continued): Reconciliation of the proposed offset strategy against OEH offset principles

OEH Offset Principles (OEH, 2012)	How the Proposed Offset Addresses the OEH Offset Principles
Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.	The land tenure underlying the proposed offset area would be secured in perpetuity for wildlife conservation (e.g. a VPA under the EP&A Act).
Offsets should be agreed prior to the impact occurring.	The offset strategy is proposed as part of the Modification. The implementation of the biodiversity offset is likely to be a condition of Project Approval.
Offsets must be quantifiable. The impacts and benefits must be reliably estimated.	Refer to **Tables 22 and 23**.
Offsets must be targeted.	The proposed offsets were selected for their similarity to the habitat that which would be lost as a result of the Modification proceeding.
Offsets must be located appropriately.	The proposed offset areas expand upon existing offset areas established for the Modification.
Offsets must be supplementary.	The proposed offsets have not previously been used for offsetting other actions.
Offsets and their actions must be enforceable through Development Consent conditions, licence conditions, conservation agreements or a contract.	Measures to monitor and independently audit the biodiversity offset are provided. The implementation of the biodiversity offset is likely to be a condition of Project Approval.

9 Conclusion

The Modification would occur in a landscape that has been substantially altered, in the first instance by many years of clearing and grazing, and more recently by mining. The ecological impact of this has been demonstrated over many years of surveys, including current surveys, showing much reduced biodiversity in comparison with what would be expected in an undisturbed landscape. On the scale of the overall currently approved HVEC operations the Modification is small.

Offset areas have been proposed for along Saddlers Creek immediately south of the existing Mt Arthur operations area, Middle Deep Creek in the Timor district located approximately 70 km north of Muswellbrook and the Edderton Road Revegetation Area located adjacent and to the west of the Modification. These areas provide similar habitat to that which would be lost as a result of the Modification. In the case of the Middle Deep Creek Offset area, the habitat is superior, as demonstrated by confirmation of seven threatened woodland bird species, two mammals and members of one endangered population. Habitat values of the proposed offset areas would increase through management actions that involve reduction or exclusion of grazing, land remediation and active rehabilitation. It is important to note that the offsets would be established, and their management plans implemented, immediately upon approval of the Modification. In addition, the Modification area would be rehabilitated upon completion of mining and a substantial net gain in biodiversity would result from the combined Modification and proposed offsets.

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APPENDIX 1

MT ARTHUR COAL FAUNA SURVEY REPORT (NICHE, 2012)

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MOUNT ARTHUR COAL

FAUNA SURVEY REPORT

October 2012

DOCUMENT CONTROL

Business Unit	Niche Environment and Heritage, Central Coast/Hunter Office		
Project No.	1227		
Document Description	Fauna survey for proposed Mount Arthur Coal 2012 Modification.		
	Name	**Signed**	**Date**
Supervising Manager(s)	Rhidian Harrington		23 October 20012

Person managing this document	**Person(s) writing this document**
Rhidian Harrington	Simon Tweed

Internal Review	**Name**
	Rhidian Harrington

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Prepared for:	**Organisation**
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Front Cover Photograph: Thick-tailed Gecko - *Underwoodisaurus milii* adjacent to the study area.

EXECUTIVE SUMMARY

Niche Environment and Heritage Pty Ltd was commissioned to conduct a fauna survey for areas potentially subject to future expansion of open cut coal mining activities at the Mount Arthur Coal Mine owned by BHP Billiton - Mount Arthur Coal.

The purpose of this study is to provide baseline data and mapping of the fauna values within the proposed mining areas and surrounds.

A fauna survey using a range of methods to target threatened species was carried out over five days in early May 2012. The survey, together with a review of relevant databases for threatened species, informed the list of threatened fauna with the potential to occur within the study area.

A total of **77** vertebrate species were recorded during the field surveys, comprising 44 birds, **25** mammals (including six introduced species), five reptiles and three frogs.

Two threatened species were recorded during the fauna survey: the Grey-headed Flying-fox (*Pteropus poliocephalus*) and Eastern Freetail-bat (*Mormopterus norfolkensis*). The Grey-headed Flying-fox was recorded at five locations within the study area, while the Eastern Freetail-bat was recorded once during the survey. A further three bat species, the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern Cave Bat (*Vespadelus troughtoni*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), may have been recorded but call recordings from these species were not of sufficient quality to be certain.

Remnant woodland vegetation within the study area is in moderate to good condition. Fauna habitat throughout the study area has varied conservation importance for threatened fauna species, with the largest patches of remnant vegetation around Mount Arthur providing the greatest conservation value relative to other parts of the study area.

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1 INTRODUCTION

1.1 Background

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Resource Strategies on behalf of Mt Arthur Coal to conduct fauna surveys for areas associated with expansion of open cut coal mining activities at the Mount Arthur Coal site. The study areas are adjacent to existing mining activities or approved mining areas at the Mount Arthur site, which is located approximately 10 kilometres (km) south of Muswellbrook in the Hunter Valley, New South Wales (NSW) (Figure 1).

This fauna survey was conducted concurrently with vegetation mapping surveys across the proposed sites (Hunter Eco, 2012). This report does not contain any discussion or evaluation of potential impacts on threatened fauna for any future development scenario.

1.2 Objectives

The purpose of this study is to provide baseline data and mapping of the fauna values within the study area.

The key objectives of this report are to:

- Describe the fauna and fauna habitats within the study area; and
- Describe and map threatened fauna species or populations listed on the NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) that are known or likely to occur within the study area.

2 METHODS

2.1 Review of Materials

Aerial photography was examined prior to survey to identify habitat types for fauna and determine stratification units for survey design. Two dominant habitat classes were found to occur within the study area comprising Grassy Woodland and Riparian Woodland. There was also a large amount of open grassland.

Database searches, consisting of 10 km searches around the study area (bounding coordinates used: 150.87, -32.205; 151.02, -32.35; 150.84; -32.49; 150.70; -32.35) were conducted in May 2012 to produce a list of potentially occurring threatened and migratory species. The following databases were used:

- NSW National Parks and Wildlife Service Atlas of NSW Wildlife (NSW Office of Environment and Heritage, 2012); and
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) Protected Matters Search Tool (SEWPaC, 2012).

2.2 Field Survey

A preliminary site inspection and deployment of bat echolocation recording devices was conducted on 1st of May 2012, with the remainder of field surveys undertaken the following week from 7th of May to 11th of May 2012. The survey design targeted threatened species previously found within 10 km of the study area and with a reasonable chance of occurring on the basis of available habitat types.

Three study areas were surveyed, namely: Study Area A, Study Area B and Study Area C (which comprised three separate areas). The location of the study areas are shown on Figures 1 and 2.

Field surveys incorporated targeted survey using established survey techniques (Table 1) and were based upon: the *Draft Threatened Biodiversity Survey and Assessment Guidelines* (NSW Department of Environment and Conservation [DEC], 2004); *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna Amphibians for Development and Activities* (NSW Department of Environment, Climate Change and Water, 2009); Commonwealth Department of the Environment, Water, Heritage and the Art (2010a, 2010b, 20010c) survey guidelines for Australia's threatened bats, birds and frogs; and SEWPAC's (2011a, 2011b) survey guidelines for Australia's threatened mammals and reptiles. Opportunistic observations and broad habitat assessments were also performed throughout the study area. Targeted survey procedures and effort are presented in Table 1 and Table 2, respectively.

Targeted survey methods were positioned to include the main habitat types within the study area and maximise spatial coverage. There was a slight bias towards more mature aged forest within the study area so that traps were close to important micro-habitat features such as hollow-bearing trees and hollow logs. Only bird surveys and incidental recordings incorporated grassland habitat.

In addition to targeted survey, incidental searches and observations of fauna use of the study areas were made within each habitat type by examining scats, scratches and other indirect evidence.

Table 1: Targeted fauna survey methods at HVO Proposed Southern Project

Method	Details
Arboreal Elliot trapping	Target fauna - gliders. Elliot B traps were placed along each of four trapping transects. Elliot traps were mounted to trees on a wooden shelf approximately 2 metres (m) above the ground. Traps were baited with a mixture of honey, oats and peanut butter, with creamed honey smeared at the back of the trap. A honey mixture was regularly sprayed on the tree around the trap. Traps were checked each morning and any captured animals were identified and released at the site of capture.
Infra-red camera traps	Target species - Spotted-tailed Quoll and other terrestrial species. Four motion sensing camera traps were placed at ground level at each of four trapping sites. A PVC tube baited with sardines and a mixture of honey, oats and peanut butter was placed in front of the camera traps. Upon recovery, the pictures were individually analysed and animals were identified to the lowest possible taxonomic level.
Hair tubes	PVC hair tubes were attached to trees with packing tape or secured under logs or other debris on the ground. Double sided tape was only adhered to the upper and lateral inner surface of the tubes so as to limit the incidence of 'by catch'. Tubes were baited with sardines (half of the ground tubes) or a mixture of honey, oats and peanut butter (remaining half of ground tubes and all tree tubes). Hair samples were sent to Barbara Triggs for analysis.
Ultrasonic call recording for bats	Three Wildlife Acoustics SM2 Bat detector units were deployed at six sites over ten days along identified potential flyways.
Diurnal bird surveys	2 hectare (ha) bird surveys were conducted across the study area for at least 20 minutes at a time. Birds were identified with the use of 10 X 42 binoculars or from their calls. Where possible surveys were conducted as close as possible to dawn or dusk when bird activity is greatest.
Spotlighting	Spotlighting surveys targeting owls and arboreal mammals were performed predominantly on foot or via a vehicle along roads and tracks.
Call playback	Target species - Powerful Owl, Barking Owl, Masked Owl, Squirrel Glider and Koala. Call-playback sites were established across the study area to enable maximum coverage. After an initial listening period of five minutes calls of the target species were broadcast through a 10 watt megaphone for two - five minutes followed by a five minute listening period and a two minute period of spotlighting.
Stag watching	Stag watches were performed prior to dusk at identified potential owl or mammal nesting/roosting trees or stags.
Koala scat searches	A one hour search was conducted within identified Koala habitat as judged by the presence of favoured feed trees (*Eucalyptus tereticornis*). Each of the 30 trees were examined for scratches and a one minute search 1 m around the base of the tree was performed looking for scats. This was then repeated for a minute whilst combing through the leaf litter.
Herpetological surveys	Herpetological surveys included spotlighting around aquatic features during nocturnal survey and diurnal targeted searches under rocks, timber, logs and tree bark in identified potential habitat throughout the study area.
Frog chorus survey and aquatic habitat surveys	Frogs were listened for at farm dams and permanent and ephemeral drainage lines throughout the study area. Active searching for frogs using spotlights was also conducted around watercourses.

Table 2: Targeted fauna survey effort within the Mount Arthur modification study area

Survey Method	1 May 2012	7 May 2012	8 May 2012	9 May 2012	10 May 2012	11 May 2012	Total (Method/Site)	Total Effort (Method)
	Effort Measured in hours							
Spotlighting								
Study Area A				0.5	1		1.5	
Study Area A*				0.5			0.5	
Study Area B		0.75			1		1.75	
Study Area C (North/Central)		0.5					0.5	
Study Area C (East)		0.75			1.5		2.25	
Study Area C (Central)			1	0.75		1	2.75	**9.25**
Call-playback and Stag watching								
Study Area A				1.25			1.25	
Study Area B		0.75					0.75	
Study Area C (North)		0.5					0.5	
Study Area C (East)		0.75			1		1.75	
Study Area C (Central)			1.25	1			2.25	**6.5**
Bird Survey								
Study Area A				0.75	0.5		1.25	
Study Area B			0.5	0.75			1.25	
Study Area C (East)			0.75	0.75	0.75	0.5	2.75	
Study Area C (North)			0.5		0.5		1	**6.25**
Koala SAT search (Study Area C)					1		1	**1**

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Table2: Targeted fauna survey effort within the Mount Arthur modification study area (Continued)

Survey Method	1 May 2012	7 May 2012	8 May 2012	9 May 2012	10 May 2012	11 May 2012	Total (Method/Site)	Total Effort (Method)
	Effort measured in days/nights							
Infra Red Cameras								
Study Area A			4	4	4			
Study Area B		4	4	4	4			
Study Area C (East)		4	4	4	4			
Study Area C (North)		4	4	4	4			**60**
Tree-mounted Elliot Traps (B size)								
Study Area A			5	5	5			
Study Area B		5	5	5	5			
Study Area C (East)		5	5	5	5			
Study Area C (North)		5	5	5	5			**75**
Hair Tubes								
Study Area A			12	12	12			
Study Area B		12	12	12	12			
Study Area C (East)		12	12	12	12			
Study Area C (North)		12	12	12	12			**180**
SM2 Bat Echolocation Recorder								
Study Area A	6	1						
Study Area B			1	1	1			
Study Area C (East)	6	1	1	1	1			
Study Area C (Central)	6	1	1	1	1			**30**

KEY: * = Also included frog census.

2.3 Survey Conditions

The weather was predominantly warm with light breezes during the day followed by cool nights. Bureau of Meteorology records from Jerrys Plains, NSW are presented in Table 3.

Habitat assessments were conducted along each transect and other locations (Section 3.1; Figure 3 - Figure 5). Habitat characteristics and parameters that were assessed included:

- Aspect/slope of the site;
- Dominant vegetation, floristic composition and structure;
- Composition of ground layer (bare earth, litter etc.);
- Presence and relative abundance of key habitat features (e.g. tree hollows, large logs, exfoliating rock, flowering resources, aquatic features);
- Condition and disturbance factors; and
- Vegetation age structure.

Table 3: Weather conditions at Jerry's Plains (20 km south of study area) during field survey

Date	Min temp (°C)	Max temp (°C)	Rainfall (mm)	9am Temp (°C)	9am wind dir.	9am wind speed (km/h)	3pm Temp (°C)	3pm cloud amount (oktas)	3pm wind dir.	3pm wind speed (km/h)
1/05/2012	4.5	24.5	0	13	E	2	23.5	3	E	2
2/05/2012	6	27	0	13.5	NE	4	26.5	4	WNW	6
3/05/2012	13	24	1.6	16	-	Calm	24	3	N	7
4/05/2012	8	23.5	0	12.5	NW	7	23	3	N	2
5/05/2012	5	24	0	12.5	-	Calm	21.5	2	S	2
6/05/2012	4.5	22	0	12	NW	11	21	1	NW	11
7/05/2012	5.5	22.5	0	10	-	Calm	21.5	7	NW	2
8/05/2012	4	24.5	0	11.5	NNW	7	23.5	0	NNW	2
9/05/2012	5.5	28	0	13.5	NW	9	27	0	NNW	4
10/05/2012	7.5	29.5	0	15	NW	7	28.5	0	NW	4
11/05/2012	7	29	0	15	NW	7	28.5	4	WNW	4

Source: Australian Bureau of Meteorology 2012

2.4 Limitations

The timing of this study (Autumn 2012) may have limited the potential for some frog species to be detected. However, good quality habitat for threatened frog species recorded from the locality (in particular Green and Golden Bell Frog – *Litoria aurea*) was absent from the study area. There was limited suitable habitat for threatened frog species yet the survey was outside of the calling periods for threatened frogs within the locality. Day searches were not considered as effective as night searches given the seasonality and target species.

Survey effort prescribed in the DEC's (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* was not employed for reptiles as threatened reptiles have not been recorded within the locality and potential habitat for threatened reptiles within the study area was limited.

3 RESULTS

3.1 Habitat Assessment and Description

Habitat within the study area is mixed, constituting derived grassland, forest and woodland. Derived grassland supported a mixture of native and exotic grass species and occurs within the study area due to historic clearing of woodland or forest habitats for agriculture. Habitat features and complexity within the existing grassland habitat is limited and generally favours a suite of common native fauna species rather than fauna of conservation significance. A sparse covering of scattered large trees throughout the grassland habitat adds some complexity in the form of canopy features, hollows, stags and logs, although such features are somewhat isolated. Habitat assessment results are provided in Appendix 1.

Woodland and forest vegetation patches cover approximately half of the study area and are variable in condition, structure and habitat features as a result of different disturbance regimes, topography and environmental factors. Habitat assessments were performed throughout six patches along or adjacent to fauna transects (Figures 3 to 5). A description of each of the vegetation patches investigated is shown in Table 4.

Table 4: Habitat assessment of example areas within remnant vegetation patches of the Mount Arthur proposed modification areas.

Habitat Description	Habitat Features/Location	Condition/Recovery Potential
1 – Drainage line with thick *Typha*	Thick *Typha* within the portion of the drainage line adjacent to transect within Area A. Potential watering point for a range of fauna. Limited aquatic habitat complexity/features.	Disturbed drainage line near top of catchment. Surrounding vegetation has moderate recovery potential in most areas. The currently altered hydrological regime of the watercourse will remain.
2 - Disturbed forest	Lowland forest around trapping transect of Area A. Moderately dense cover of large older growth trees to 25 m with recent patchy regrowth of mid-storey and understorey vegetation, but mostly native and exotic grasses. Frequent small to medium hollows in older trees. At least two large Spotted Gum and Ironbarks with large hollows (i.e. >30 cm). Occasional logs below larger trees. Some weed infestations present.	Moderate - some recovery of understorey and mid-storey components occurring. Weed invasions threaten in some patches of previous disturbance. Site is partially isolated by surrounding mining activities and agricultural land, depending on fauna mobility.
3 - Disturbed grassy woodland	Disturbed grassy woodland within Area B. Large scattered trees to 20 m over mixed native/exotic ground cover. Limited structural complexity/diversity of vegetation with understorey and mid-storey components largely absent expect for some patches of regenerating Bulloke. Hollows present in most large mature trees ranging from small to large. Some logs beneath larger trees.	Poor/moderate - some apparent resilience with patches of regenerating shrubs. Large expanse of paddocks surrounding.

Table4: Habitat assessment of example areas within remnant vegetation patches of the Mount Arthur proposed modification areas (Continued).

Habitat Description	Habitat Features	Condition/Recovery Potential
4 – Forest	Spotted Gum - Grey Box forest around eastern trapping transect of Area C . Moderate-sized patch of mixed age forest with Spotted Gum to 1 m in diameter and 25 m height. Mid-storey of regenerating Eucalyptus. Good pulse of flowering. Patchy understorey with multiple shrub species present. Hollows common throughout at a range of sizes. Occasional large logs. Occasional mistletoe.	Good. Some apparent disturbance through previous clearing, but extent unknown. Recovering woodland with good habitat complexity.
5 – Grassy woodland	Example A - Mixed-age dense grassy woodland patch around northern trapping transect of Area C. Trees to 20 m high and 60 cm diameter. Few very old trees and hollows uncommon. Some regeneration of canopy species but lower strata components have limited cover and diversity. Example B - Mixed-aged open grassy woodland – Area C west of track with northern bat recorder. Hollows and logs uncommon. Limited floristic diversity or feeding resources. Predominantly native grass cover.	Moderate - with good recovery potential.
6 – Grassland	These areas constituted a mix of native and exotic grasses with occasional herbs or forbs. Cover of other vegetative layers such as understorey or canopy was absent or very sparse. These areas were generally highly disturbed and modified due to clearing and grazing.	Poor – with moderate or low recovery potential.
7 – Disturbed	Disturbed areas were generally roads or other infrastructure, or places where significant soil disruption including fill had occurred leading to weed domination.	Poor with very low recovery potential.

Within the remnant vegetation patches of the study area, the predominant habitat type is woodland, with taller forest remnants within Study Area A lacking canopy cover and consequently functioning as woodland or open woodland. The patch of Central Hunter Ironbark-Spotted Gum-Grey Box Forest along the eastern border of Study Area C was the major forest remnant investigated within the study area, which has retained its forest structure.

Larger and better consolidated woodland/forest habitats within the study area offer a variety of micro-habitat features for resident fauna. A high to moderate level of resilience of the different habitat types is apparent in most of the larger denser woodland patches, as evidenced by a moderate diversity of native ground cover and shrubs and a low cover of weeds.

Some regeneration of woodland/forest areas is evident within the study area over recent decades, most notably around Study Area C, with younger trees abundant in some areas coinciding with older remnant trees. The majority of tree hollows and large woody debris is associated with the scattered old remnant trees. Whilst grazing has continued on the site, stocking rates appear to be light and cattle tend not to access the larger patches of regenerating vegetation, leading to better habitat quality in those larger patches.

3.2 Aquatic Habitat Features

Aquatic habitat features within the study area were limited to small ephemeral streams and small farm dams within Study Area C. The ephemeral streams within Study Area C consist of 1st to 2nd order watercourses with an irregular, limited flow regime, being situated at the top of the catchment areas for Saddlers and Quarry Creeks. The low flow regime limits potential aquatic habitat features along the watercourses, although condition is moderate to good.

The drainage line that runs through Study Area A is part of Saddlers Creek and consists of a permanent shallow watercourse. Its catchment has partly been impacted by previous mining works to the east and north, but is largely cleared and used for agriculture. Habitat in this drainage line consists predominantly of thick *Typha* reed beds, with other aquatic macrophytes also present in places. There are no pools free of thick *Typha* growth. The farm dams throughout the study area offer limited habitat values, being largely devoid of aquatic vegetation or other habitat features, but provide a watering point for a range of terrestrial species.

3.3 Fauna

A total of 77 vertebrate species were recorded during the field surveys, comprising 44 birds, 25 mammals (including six introduced species), five reptiles and three frogs (Appendix 2). Most of these species are common and widespread throughout the locality and wider region, including within more disturbed habitats. There was a low diversity of woodland bird species and small native terrestrial mammals were not recorded. Marsupial diversity was very low and the species present were species that are generally common and widespread. Few reptiles were recorded, though targeted survey was limited to opportunistic searches through rocky habitat or around congregations of logs. Both of these habitats were rare within the study area and there were very limited areas of outcropping and exfoliating rock.

The faunal assemblage is likely indicative of the highly modified landscape and presence of introduced predators. The area around Study Area C comprises roughly 500 ha of land with small to medium sized patches of remnant vegetation (the largest approximately 60 ha) largely surrounded by open cut mining and agriculture. There are numerous pathways to the Mount Arthur area providing easy access for introduced predators. Expansive potential source areas for native species, such as Wollemi National Park occur approximately 10-15 km to the southwest of Mount Arthur, but connectivity to this areas is poor, particularly for terrestrial mammals vulnerable to predation.

3.4 Threatened Species

Two threatened species were recorded during the survey: Grey-headed Flying-fox (*Pteropus poliocephalus*) and Eastern Freetail-bat (*Mormopterus norfolkensis*). The Grey-headed Flying-fox was recorded at five locations within the study area, while the Eastern Freetail-bat was recorded once during the survey. A further three bat species may have been recorded but call recordings from these species were not of sufficient quality to be certain or else the calls overlap significantly with other species so that a definitive identification is not possible. These species were Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern Cave Bat (*Vespadelus troughtoni*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*).

Threatened animal species recorded or considered to have a moderate chance of occurring are all mobile species and moderately common within the region in their preferred habitats. These species are listed in Appendix 3. The threatened fauna species recorded within the study area and the co-ordinates where these species were recorded are listed in Table 5.

Table 5: Threatened fauna recorded within the study area

Species	Co-ordinates (GDA 94; MGA Zone 56)		Threatened Species Status[1]	
	Easting	Northing	EPBC Act	TSC Act
Grey-headed Flying-fox - *Pteropus poliocephalus*	299107 299018 298396	6417731 6417654 6417445	Vulnerable	Vulnerable
Eastern Freetail-bat - *Mormopterus norfolkensis*	299019 301052	6417568 6416618	-	Vulnerable
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)*	299019 298413 294659 301052	6417568 6417671 6421162 6416618	-	Vulnerable
Eastern Cave Bat (*Vespadelus troughtoni*)*	299061 294659 301052	6417594 6421162 6416618	-	Vulnerable
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)*	294659	6421162	-	Vulnerable

[1] Threatened species status under the TSC Act and/or EPBC Act (current as of 4 July 2012).

* Possible record.

4 CONCLUSION

A total of **77** vertebrate species were recorded during the field surveys, comprising 44 birds, **25** mammals (including six introduced species), five reptiles and three frogs.

Two threatened species were recorded during the fauna survey: the Grey-headed Flying-fox (*Pteropus poliocephalus*) and Eastern Freetail-bat (*Mormopterus norfolkensis*). The Grey-headed Flying-fox was recorded at five locations within the study area, while the Eastern Freetail-bat was recorded once during the survey. A further three bat species, the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern Cave Bat (*Vespadelus troughtoni*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), may have been recorded but call recordings from these species were not of sufficient quality to be certain.

Remnant woodland vegetation within the study area is in moderate to good condition. Fauna habitat throughout the study area has varied conservation importance for threatened fauna species, with the largest patches of remnant vegetation around Mount Arthur providing the greatest conservation value.

5 REFERENCES

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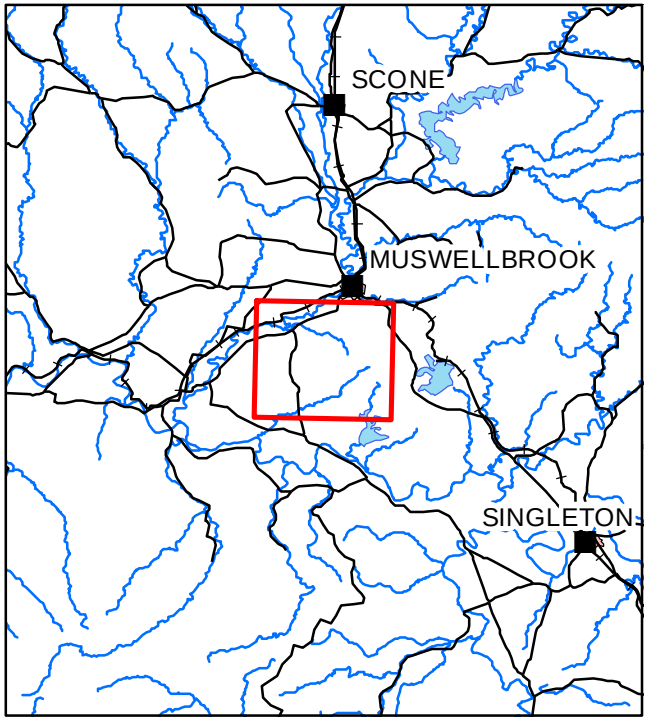
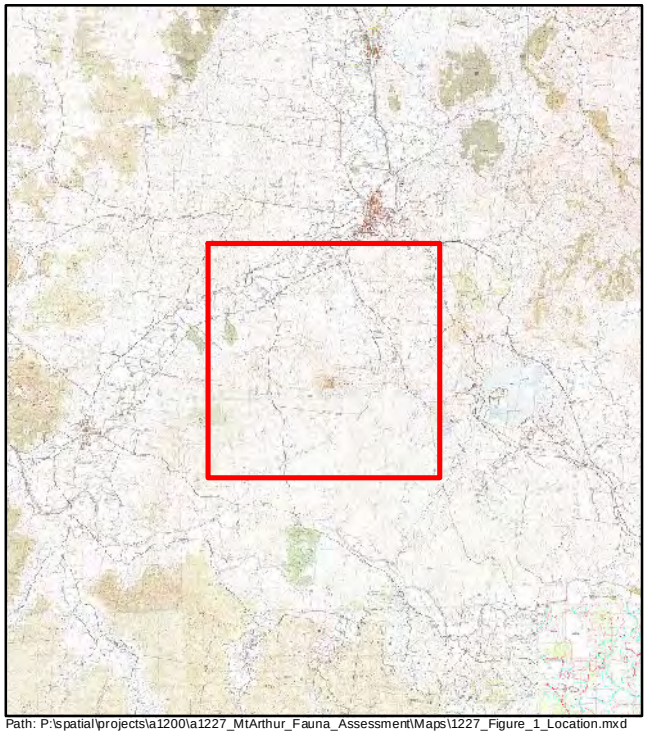
FIGURES





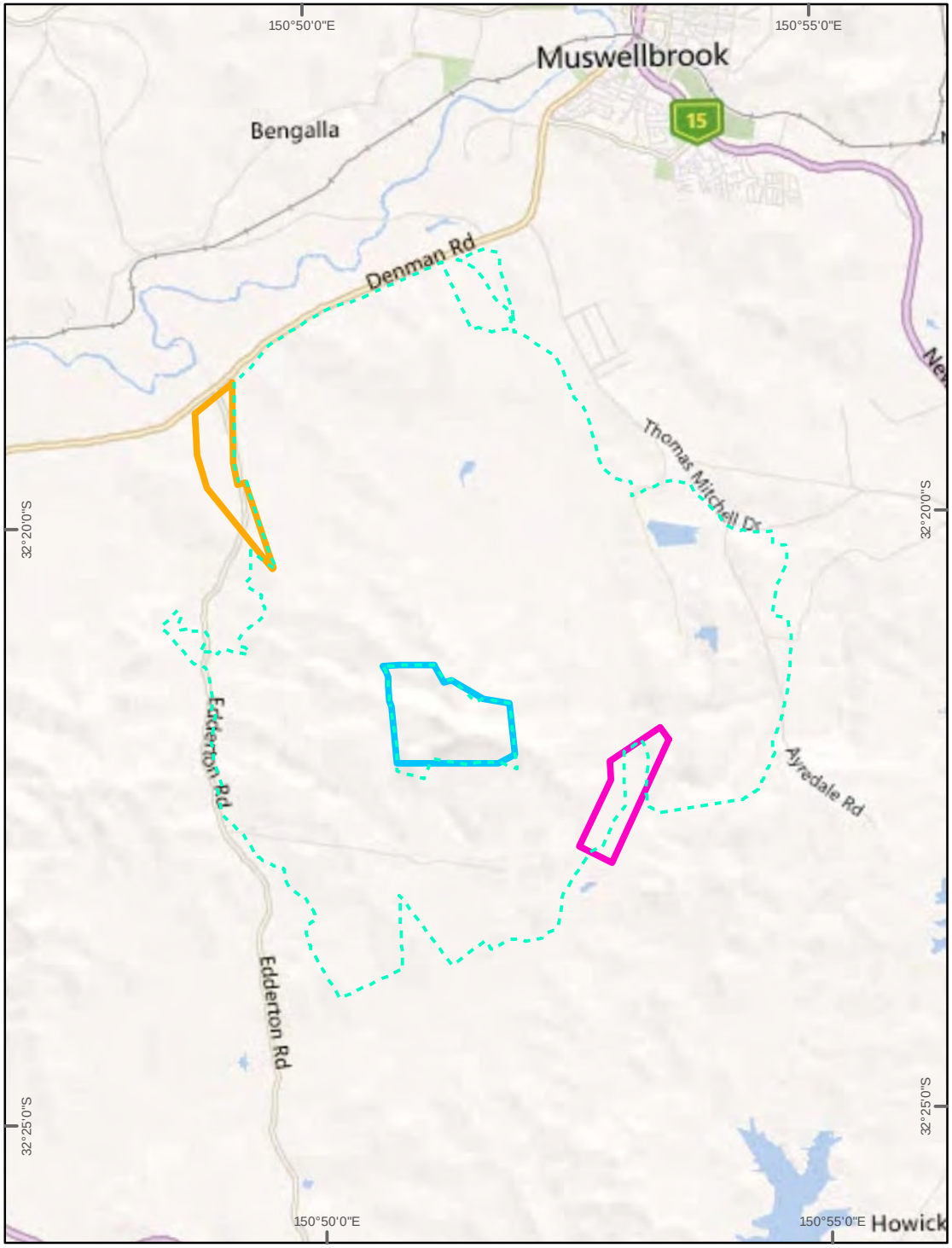


Figure 1: Location Map

Mount Arthur Open Cut Modification

Drawn by: RJ

Project Mgr: RH

Date: 6/07/2012

Approved Disturbance Area

Study Areas

- Area A
- Area B
- Area C

N
W E
S

km
0 1 2 3 4

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Horizontal Datum:
GDA 1994 MGA Zone 56

Imagery: (c) 2010 Microsoft and its data suppliers

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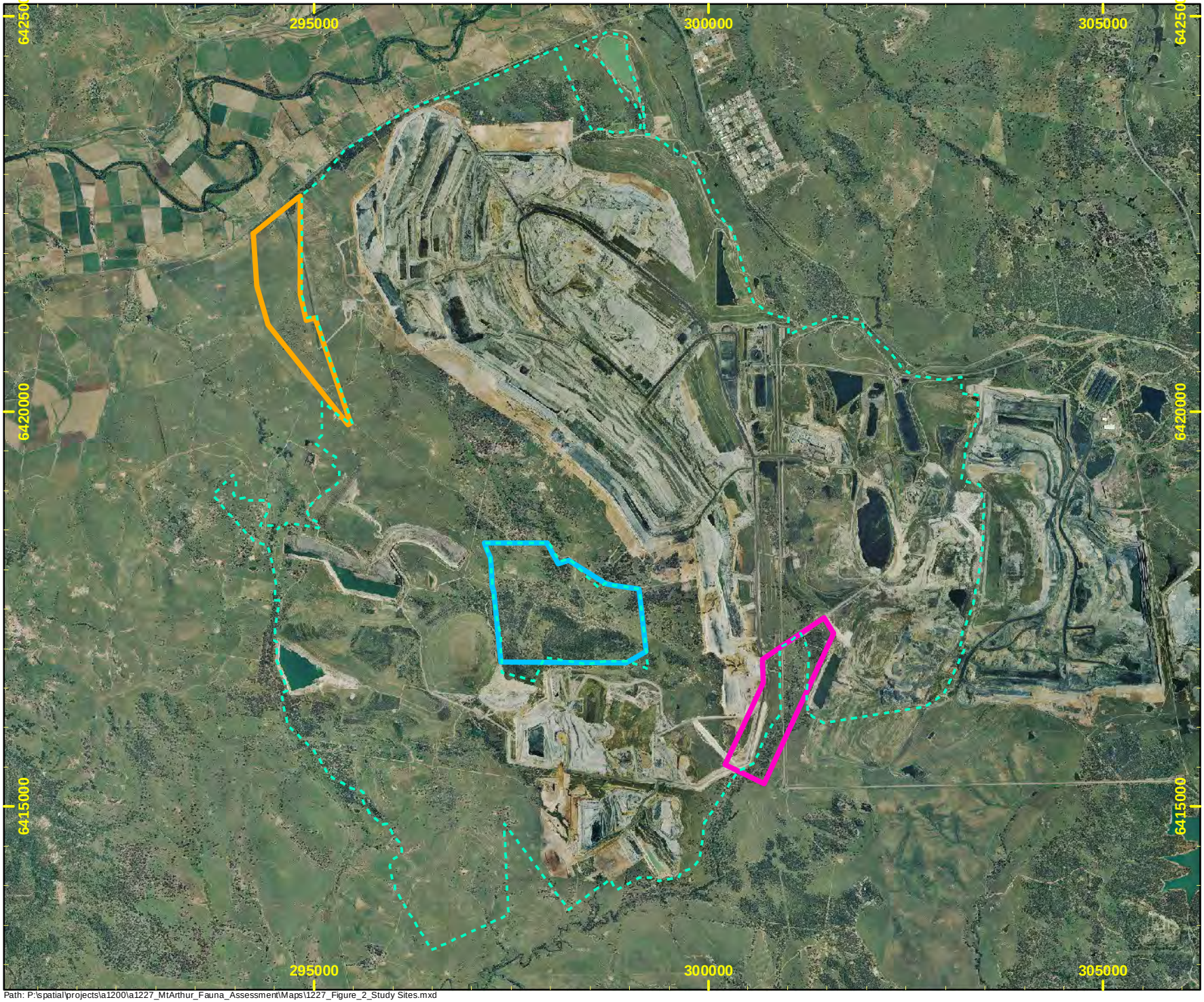

Figure 2: Site Map

Mount Arthur Open Cut Modification

Drawn by: RJ

Project Mgr: RH

Date: 6/07/2012

Approved Disturbance Area

Study Areas

- Area A
- Area B
- Area C

N
W E
S

km

0 0.5 1 1.5 2 2.5

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Horizontal Datum:
GDA 1994 MGA Zone 56

Imagery: (c) BHP

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Figure 3: Fauna Habitat Type, Survey Methods and Threatened Species
Mount Arthur Open Cut Modification - Study Area A

Drawn by: RJ

Project Mgr: RH

Date: 23/10/2012

Imagery: (c) BHP

Horizontal Datum: GDA 1994 MGA Zone 56

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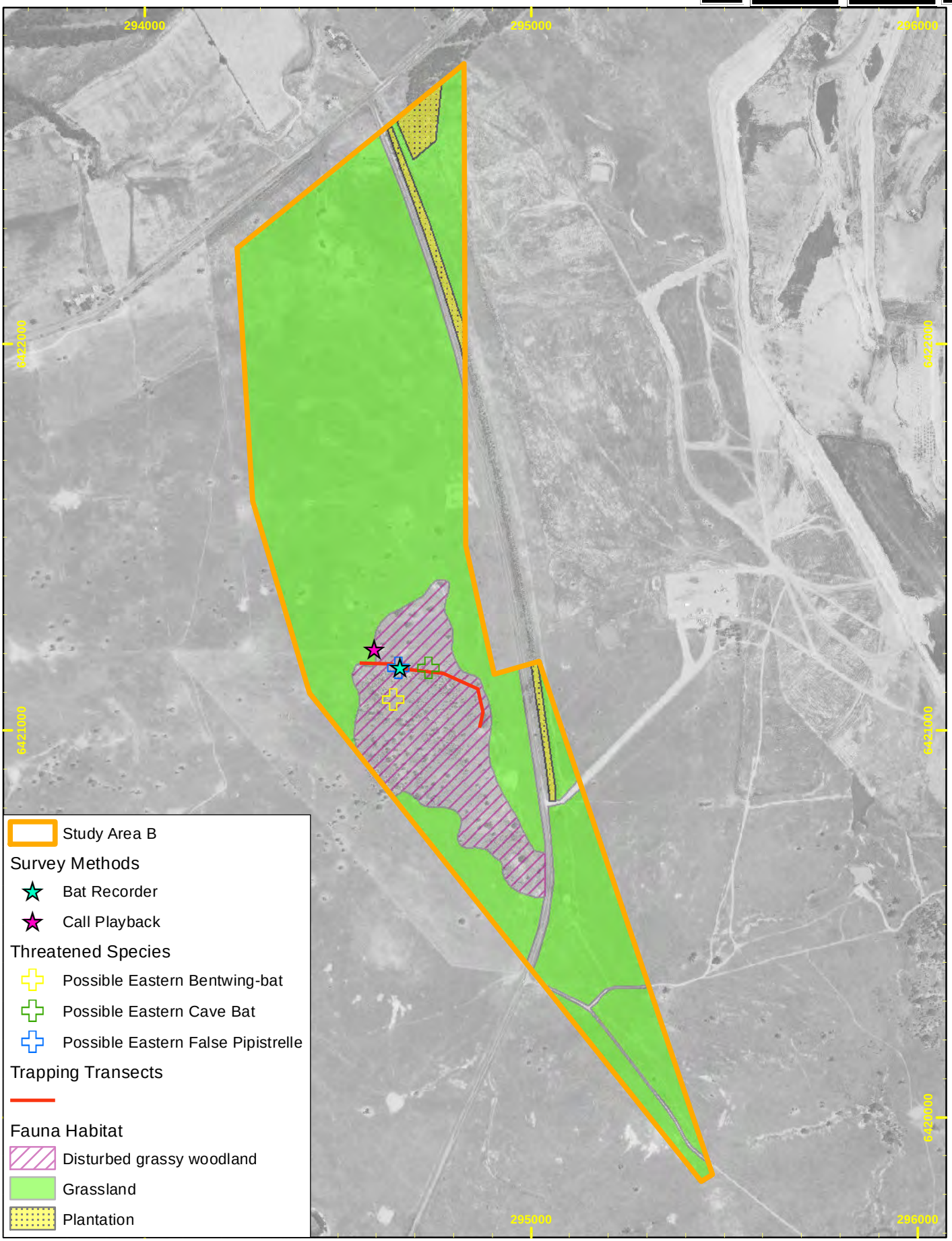

Figure 4: Fauna Habitat Type, Survey Methods and Threatened Species
Mount Arthur Open Cut Modification - Study Area B

Drawn by: RJ

Project Mgr: RH

Date: 6/07/2012

Imagery: (c) BHP

Horizontal Datum: GDA 1994 MGA Zone 56

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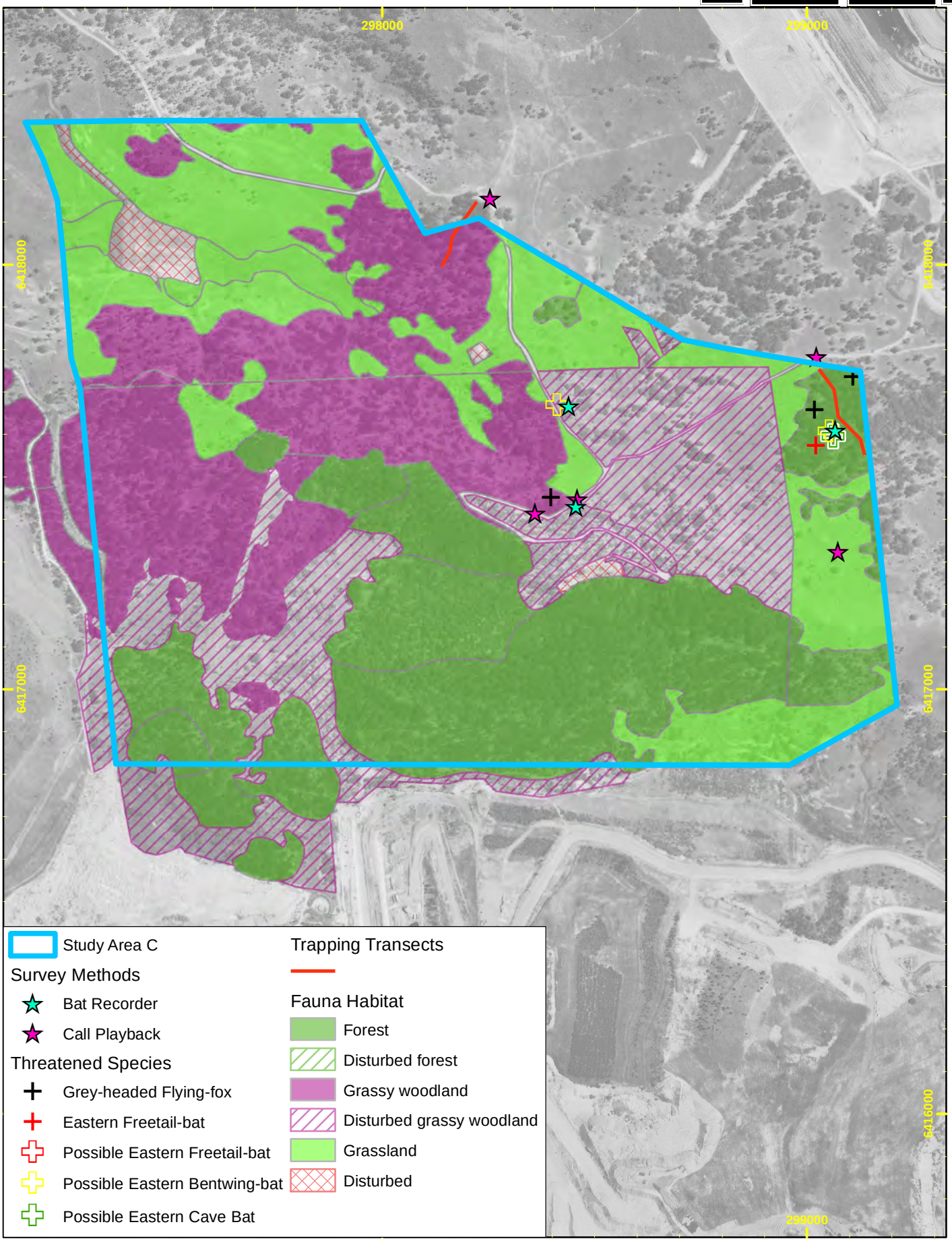

Figure 5: Fauna Habitat Type, Survey Methods and Threatened Species
Mount Arthur Open Cut Modification - Study Area C

Drawn by: RJ

Project Mgr: RH

Date: 23/10/2012

Imagery: (c) BHP

Horizontal Datum: GDA 1994 MGA Zone 56

N W E S

Metres

0 100 200 300 400

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Path: P:\spatial\projects\a1200\a1227_MtArthur_Fauna_Assessment\Maps\1227_Figure_5_Methods_Area_C.mxd

APPENDICES

Appendix 1: Habitat Assessment - Results

Habitat Assessment Sheet: Area A

Habitat Type: Disturbed Spotted Gum, Ironbark, Grey Box Forest

Central Coordinates: 150.885; -32.369

Locality/Geomorphology/Slope: Open depression with gently sloping sides and drainage line. Main drainage to south with east and west facing gentle slopes.

Broad Vegetation Description:

Canopy – moderately dense along transect but patchy throughout, height 20 – 25 metres (m), tree diameter at breast height (d.b.h.) to 1.2 m but more commonly 20 - 40 centimetres (cm). Some very large Narrow-leaved Ironbark (*Eucalyptus crebra*) and Spotted Gum (*Corymbia maculata*) outside of transect.

Midstorey – patchy - height 10 - 18 m. Sparse throughout but locally more dense amongst stands of regenerating trees. Predominantly regenerating *Acacia* spp., *Casuarina* spp. and *Eucalyptus* spp. canopy species.

Understorey - patchy to 2 m mixed native woody shrubs and occasional exotics.

Groundcover: cover 75 - 90%, Predominantly native grasses with occasional disturbance tolerant shrubs and forbs. Areas of exotic grasses (e.g. Coolatai Grass [*Hyparrhenia hirta*]) where previous soil disturbance has occurred mostly around edges. Areas of erosion scald.

Habitat Features:

Occasional tree hollows with larger trees supporting large hollows >30 cm, though these are rare. Occasional logs and woody debris associated with older trees.

Creek provides permanent aquatic habitat thoughout with low diversity of aquatic habitat components – almost exclusively shallow water habitat with dense Typha growth. Occasionally additional macrophytes, but limited.

Disturbance: Modified vegetation due to degradation of all strata levels though moderate to good recovery potential with good recruitment. Requires management of Coolatai Grass. Past disturbance from cattle with some evidence of continued light disturbance from cattle and rabbits.

Habitat Assessment Sheet: Area B

Habitat Type: Disturbed Grassy Woodland. Paddocks with patchy regeneration and large remnant woodland trees.

Central Coordinates: 150.819; -32.328

Locality/Geomorphology/Slope: Open plain with gentle northerly aspect.

Broad Vegetation Description:

Canopy – sparse and patchy cover, height to 20 m tree d.b.h. to 1.2 m. Slaty Box dominated.

Midstorey – overall low cover with patchy stands of dense regeneration of Bulloke and Eucalyptus species. Height 5 - 10 m.

Understorey - sparse with occasional regenerating *Eucalyptus* spp. and woody shrubs.

Groundcover: moderately dense to dense cover of mixed native and exotic grasses.

Habitat Features:

Occasional hollows and large logs associated with large remnant trees; farm dams within area, but with poor habitat.

Disturbance: Predominantly cleared throughout with continued grazing at moderate levels.

Habitat Assessment Sheet: Area C (Transect 1)

Habitat Type: Spotted Gum-Grey Box Forest

Central Coordinates: 150.865; -32.360

Locality/Geomorphology/Slope: Moderately steep south facing hillslope.

Broad Vegetation Description:

Canopy – height to 25 m tree d.b.h. to 1 m. Spotted Gum (dominant) and Grey Box (*Eucalyptus microcarpa*).

Midstorey – height 10-18 m., moderately dense. Predominantly Spotted Gum.

Understorey – 25 - 50% cover of Blackthorn (*Bursaria spinosa*), Coffee Bush (*Breynia oblongifolia*), *Acacia* spp., species from the Santalaceae family, *Cassinia* spp. and *Notelaea* spp.

Groundcover: 50% cover of mixed native grasses, shrubs and herbs, moderately deep leaf litter patches.

Habitat Features:

Frequent medium and small hollows (<30 cm diameter) and also some nest boxes; surface rock rare becoming more common in gully; large logs common; ephemeral drainage line at bottom of gully with some small pools, but lack of permanent aquatic habitat and no instream macrophytes. Occasional mistletoe, stags and bare branches. Prolific flowering of some individual Spotted Gums.

Disturbance: Apparent previous selective clearing (particularly Ironbark species), but otherwise good condition with intact vegetation at all strata levels and moderate species richness. Limited current cattle disturbance.

Habitat Assessment Sheet: Area C (Transect 2)

Habitat Type: Grassy Woodland – derived community mixed age.

Central Coordinates: 150.855; -32.356

Locality/Geomorphology/Slope: Steep south-west facing slope from ridgetop extending into gully.

Broad Vegetation Description:

Canopy – height to 20 m; max tree d.b.h. 60 cm; Spotted Gum, Grey Box and Forest Red Gum (*Eucalyptus tereticornis*).

Midstorey – height 5 - 15 m Spotted Gum, Grey Box and Forest Red Gum.

Understorey – sparse and patchy Blackthorn and some regenerating canopy species.

Groundcover – Patchy, dominated by native grasses with some herbs shrubs and bare earth patches.

Habitat Features:

Hollows occasional, mistletoe common; logs occasional; stags uncommon; surface rock uncommon though becoming common on opposite side of gully; ephemeral creek at bottom of gully, though permanent pools absent; small farm dams near site.

Disturbance: Previous clearing.

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Appendix 2: Fauna Recorded from the Study Area

Common Name	Scientific Name	Conservation Status[1]		Observation Type	Study Area A	Study Area B	Study Area C (North)	Study Area C (East)	Study Area C (Central)	Outside Sites
		TSC Act	EPBC Act							
Amphibians										
Common Eastern Froglet	*Crinia signifera*				x					
Smooth Toadlet	*Uperoleia laevigata*			H	x					
Verreaux's Frog	*Litoria verreauxii*			H	x	x			x	
Reptiles										
Thick-tailed Gecko	*Underwoodisaurus milii*			O					x	
Southern Rainbow-skink	*Carlia tetradactyla*					x				
Dark-flecked Garden Sunskink	*Lampropholis delicata*					x				
Lace Monitor	*Varanus varius*			CT				x		
Red-bellied Black Snake	*Pseudechis porphyriacus*				x	x				
Birds										
Brown Quail	*Coturnix ypsilophora*									x
Nankeen Kestrel	*Falco cenchroides*				x	x	x			
Australian Hobby	*Falco longipennis*			O						x
Brown Falcon	*Falco berigora*					x				
Black-shouldered Kite	*Elanus axillaris*			O		x				
Wedge-tailed Eagle	*Aquila audax*				x	x				
Masked Lapwing	*Vanellus miles*			O, H	x					
Crested Pigeon	*Ocyphaps lophotes*			O		x				
Galah	*Eolophus roseicapillus*			H, O, S	x	x		x		
Sulphur-crested Cockatoo	*Cacatua galerita*			S, O, H	x	x		x		
Crimson Rosella	*Platycercus elegans*			H, O		x		x		

Common Name	Scientific Name	Conservation Status[1]		Observation Type	Study Area A	Study Area B	Study Area C (North)	Study Area C (East)	Study Area C (Central)	Outside Sites
		TSC Act	EPBC Act							
Eastern Rosella	*Platycercus eximius*				x	x		x		
Australian King-Parrot	*Alisterus scapularis*			O				x		
Shining Bronze-Cuckoo	*Chalcites lucidus*			H					x	
Barn Owl	*Tyto alba*			O, S, H	x					
Tawny Frogmouth	*Podargus strigoides*			H					x	
Laughing Kookaburra	*Dacelo novaeguineae*			O		x				
White-throated Treecreeper	*Cormobates leucophaea*			H					x	
Superb Fairy-wren	*Malurus cyaneus*			H, O	x	x	x	x		
Spotted Pardalote	*Pardalotus punctatus*			H, O			x	x	x	
Striated Pardalote	*Pardalotus striatus*			H, O	x		x	x	x	
Buff-rumped Thornbill	*Acanthiza reguloides*			O					x	
Yellow-faced Honeyeater	*Lichenostomus chrysops*			H, O			x	x		
Noisy Miner	*Manorina melanocephala*			H, O	x	x		x		
Noisy Friarbird	*Philemon corniculatus*			O/H	x			x		
Rose Robin	*Petroica rosea*			O/H				x		
Golden Whistler	*Pachycephala pectoralis*			O/H				x		
Grey Fantail	*Rhipidura albiscapa*			H, O	x		x	x		
Grey Butcherbird	*Cracticus torquatus*			H, O				x		
Magpie-lark	*Grallina cyanoleuca*			O						x
Pied Butcherbird	*Cracticus nigrogularis*			O/H	x	x		x	x	
Australian Magpie	*Cracticus tibicen*			H, O, CT				x		
Pied Currawong	*Strepera graculina*			H, O			x	x		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			O	x					
Olive-backed Oriole	*Oriolus sagittatus*			O		x				
Australian Raven	*Corvus coronoides*			H, O, CT	x	x		x		

Common Name	Scientific Name	Conservation Status[1]		Observation Type	Study Area A	Study Area B	Study Area C (North)	Study Area C (East)	Study Area C (Central)	Outside Sites
		TSC Act	EPBC Act							
White-winged Chough	*Corcorax melanorhamphos*			O, H				x		
Common Starling*	*Sturnus vulgaris*			O		x				
Welcome Swallow	*Hirundo neoxena*			O	x					
Silvereye	*Zosterops lateralis*			H, O			x	x		
Mistletoebird	*Dicaeum hirundinaceum*									
Australian Pipit	*Anthus novaeseelandiae*			O						x
Red-browed Finch	*Neochmia temporalis*			H, O			x	x	x	
Zebra Finch	*Taeniopygia guttata*			H, O	x					x
Mammals										
Short-beaked Echidna	*Tachyglossus aculeatus*			CT, IO				x		
Common Wombat	*Vombatus ursinus*			I, O	x			x	x	
Common Brushtail Possum	*Trichosurus vulpecula*			S, C, HT, ET	x			x	x	
Eastern Grey Kangaroo	*Macropus giganteus*			O	x	x	x	x	x	
Common Wallaroo	*Macropus robustus*			O					x	x
Red-necked Wallaby	*Macropus rufogriseus*			O, HT, CT			x	x	x	
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	S, H	x			x	x	
Eastern Freetail-bat	*Mormopterus norfolkensis*	V			?			x		
	Mormopterus 'Species 4' (big penis)					x	x			
White-striped Freetail-bat	*Tadarida australis*						x	?		
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V			?	?	?	?		
Gould's Wattled Bat	*Chalinolobus gouldii*				?	x	x	?		
Chocolate Wattled Bat	*Chalinolobus morio*			EC	x	?	x	x		
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V				?				
Eastern Broad-nosed Bat	*Scotorepens orion*					?				
Large Forest Bat	*Vespadelus darlingtoni*					?	?	?		

Common Name	Scientific Name	Conservation Status[1]		Observation Type	Study Area A	Study Area B	Study Area C (North)	Study Area C (East)	Study Area C (Central)	Outside Sites
		TSC Act	EPBC Act							
Southern Forest Bat	*Vespadelus regulus*						?	x		
Eastern Cave Bat	*Vespadelus troughtoni*	V			?	?		?		
Little Forest Bat	*Vespadelus vulturnus*				x	?	?			
Black Rat*	*Rattus rattus*			CT				x		
Dog*	*Canis lupus familiaris*									x
Fox*	*Vulpes vulpes*			CT	x					x
Cat*	*Felis catus*			O					x	x
Rabbit*	*Oryctolagus cuniculus*			O, IO, CT	x	x	x	x	x	
European cattle*	*Bos taurus*			O, CT						

KEY: * = introduced species; CT = Camera Trap; O = Observed; H = Heard; S = Spotlight; IO = Indirect Observation (i.e. burrows, scats etc.); ET = Elliot Trap; Ec = Echolocation recording; HT = Hair Tube.

[1] Threatened and/or migratory species status under the TSC Act and/or EPBC Act (current as of 4 July 2012).
V = Vulnerable; E = Endangered; CE = Critically Endangered; M = Migratory.

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Appendix 3: Threatened Fauna Species Potentially Occurring within the Study Area or Surrounds

Note: Highlighted species were located or recorded as possibly occurring during the current survey. Fauna that are exclusively dependant on marine environments, including near shore environments, were removed from the table. Non-referenced habitat information has been sourced from: *Threatened Species Profiles for threatened species, endangered populations and endangered ecological communities listed under the NSW Threatened Species Conservation Act 1999* (NSW Office of Environment and Heritage, 2012).

Species	Conservation Status[1]		Habitat
	EPBC Act	TSC Act	
Amphibians			
Green and Golden Bell Frog *Litoria aurea*	V	E	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available.
Booroolong Frog *Litoria booroolongensis*	E	E	The Booroolong Frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. It has disappeared from much of the Northern Tablelands, however several populations have recently been recorded in the Namoi catchment. Lives along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses.
Birds			
Black-necked Stork *Ephippiorhynchus asiaticus*		E	In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast (for example, near Moree, north-east of Hay and in Victoria). Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation.
Australasian Bittern *Botaurus poiciloptilus*	E	E	The Australasian Bitterns is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleoacharis* spp.).
Cattle Egret *Ardea ibis*	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Commonwealth Department of the Environment, Water, Heritage and the Arts [DEWHA] 2012).
Great Egret *Ardea alba*	M		Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent water bodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, salt marshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers.

Species	Conservation Status[1]		Habitat
	EPBC Act	TSC Act	
White-bellied Sea-eagle *Haliaeetus leucogaster*	M		A migratory species that is resident to Australia. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and salt marshes (DEWHA 2012).
Spotted Harrier *Circus assimilis*		V	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.
Little Eagle *Hieraaetus morphnoides*		V	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees (DEWHA 2012).
Australian Painted Snipe *Rostratula australis*	V, M	E	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (DEWHA 2012).
Latham's Snipe *Gallinago hardwickii*	M		Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey, 2007).
Little Lorikeet *Glossopsitta pusilla*		V	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.
Turquoise Parrot *Neophema pulchella*		V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and under storey of low shrubs. Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins, 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist.
Swift Parrot *Lathamus discolor*	E	E	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (DEWHA 2012). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey, 1997).
Masked Owl *Tyto novaehollandiae*		V	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins, 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins, 1999). Nest hollows are usually located within dense forests or woodlands. Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet.
Barking Owl *Ninox connivens*	-	V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey, 2007).

Species	Conservation Status[1]		Habitat
	EPBC Act	TSC Act	
White-throated Needletail *Hirundapus caudacutus*	M		An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzey, 2007).
Rainbow Bee-eater *Merops ornatus*	M		Usually occurs in open or lightly timbered areas, often near water (DEWHA 2012).
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	-	V	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses.
Speckled Warbler *Pyrrholaemus saggitatus*		V	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.
Black-chinned Honeyeater (eastern subspecies) *Melithreptus gularis gularis*	-	V	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (Eucalyptus sideroxylon), White Box (E. albens), Inland Grey Box (E. microcarpa), Yellow Box (E. melliodora) and Forest Red Gum (E. tereticornis). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees.
Regent Honeyeater *Anthochaera phrygia*	E, M	CE	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (Pizzey, 2007).
Hooded Robin (south-eastern form) *Melanodryas cucullata cucullata*		V	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.
Scarlet Robin *Petroica boodang*		V	The Scarlet Robin's range includes all state capitals. Occurs in forests, woodlands; and heavier vegetation when breeding. During autumn and winter occurs in more open and Cleared areas. It has dispersive or locally migratory seasonal movements. Is conspicuous in open and suburban habitats.
Grey-crowned Babbler (eastern subspecies) *Pomatostomus temporalis temporalis*		V	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains.

Species	Conservation Status[1]		Habitat
	EPBC Act	TSC Act	
Diamond Firetail *Stagonopleura guttata*		V	Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.
Varied Sittella *Daphoenositta chrysoptera*		V	Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia. Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows.
Black-faced Monarch *Monarcha melanopsis*	M		A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey, 2007).
Satin Flycatcher *Myiagra cyanoleuca*	M		Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey, 2007).
Mammals			
Spotted-tailed (Eastern) Quoll *Dasyurus maculatus maculatus*	E	V	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests. Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage.
Koala *Phascolarctos cinereus*	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.
Squirrel Glider *Petaurus norfolcensis*		V	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA.
Brush-tailed Rock-wallaby *Petrogale penicillata*	V	E	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices.
Grey-headed Flying-fox *Pteropus poliocephalus*	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km.

Species	Conservation Status[1]		Habitat
	EPBC Act	TSC Act	
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*		V	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Breeding has been recorded from December to mid-March, when a single young is born. Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.
Eastern Freetail-bat *Mormopterus norfolkensis*		V	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye 1995; Churchill 1998).
Little Bent-wing Bat *Miniopterus australis*		V	Coastal north-eastern NSW and eastern Queensland (Churchill, 2008). Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites (Law, 1996). Little Bent-wing Bat has a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects.
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*		V	Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts.
Soith-eastern Long-eared Bat *Nyctophilus corbeni*	V	V	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation types, including mallee, bulloke Allocasuarina leuhmanni and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark.
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill, 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill, 1998).
Eastern False Pipistrelle *Falsistrellus tasmaniensis*		V	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill, 1998). Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst, 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites.
Large-footed Myotis (Southern Myotis) *Myotis macropus (adversus)*		V	Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Churchill 1998).

Species	Conservation Status[1]		Habitat
	EPBC Act	TSC Act	
Greater Broad-nosed Bat *Scoteanax rueppellii*		V	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill, 1998). In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches (Churchill, 1998).
Eastern Cave Bat *Vespadelus troughtoni*		V	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. Cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.
New Holland Mouse *Pseudomys novaehollandiae*	V	-	Coastal heath and dry sclerophyll forest and woodland.f

[1] Threatened and/or migratory species status under the TSC Act and/or EPBC Act (current as of 4 July 2012).
V = Vulnerable; E = Endangered; CE = Critically Endangered; M = Migratory.

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APPENDIX 2

FLORA AND FAUNA PREVIOUSLY RECORDED WITHIN THE MT ARTHUR COAL MINE

FLORA

Family Name	Scientific Name	Common Name	Status[1]
Acanthaceae	*Brunoniella australis*	Blue Trumpet	
	Pseuderanthemum variabile	Pastel Flower	
	Rostellularia adscendens var. *adscendens*		
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair	
	Cheilanthes austrotenuifolia	Rock Fern	
	Cheilanthes distans	Bristly Cloak Fern	
	Cheilanthes sieberi subsp. *sieberi*	Mulga Fern	
Aizoaceae	**Galenia pubescens*	Galenia	
	Tetragonia tetragonioides	New Zealand Spinach	
Alismataceae	*Damasonium minus*	Starfruit	
Alliaceae	**Nothoscordum borbonicum*	Onion Weed	
Amaranthaceae	**Alternanthera pungens*	Khaki Weed	
	**Amaranthus quitensis*	South American Amaranth	
	**Gomphrena celosioides*	Gomphrena Weed	
	Ptilotus semilanatus		
Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily	
	Arthropodium minus		
	Dichopogon fimbriatus	Nodding Chocolate Lily	
	Dichopogon strictus	Chocolate Lily	
	Laxmannia compacta		
	Thysanotus patersonii	Twining Fringe-Lily	
	Thysanotus tuberosus	Common Fringe-lily	
Apiaceae	**Cyclospermum leptophyllum*	Slender Celery	
	**Foeniculum vulgare*	Fennel	
	Centella asiatica	Indian Pennywort	
	Daucus glochidiatus	Native Carrot	
	Hydrocotyle laxiflora	Stinking Pennywort	
Apocynaceae	*Parsonsia eucalyptophylla*	Gargaloo	
Asclepiadaceae	**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	
	**Gomphocarpus physocarpus*	Balloon Cotton Bush	
Asphodelaceae	**Asphodelus fistulosus*	Onion Weed	
Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern	
Asteraceae	**Ambrosia artemisiifolia*	Annual ragweed	
	**Ambrosia tenuifolia*	Lacy Ragweed	
	**Arctotheca calendula*	Capeweed	
	**Aster subulatus*	Wild Aster	
	**Bidens pilosa*	Cobbler's Pegs	

Family Name	Scientific Name	Common Name	Status[1]
	**Carduus nutans*	Nodding Thistle	
	**Carthamus lanatus*	Saffron Thistle	
	**Chondrilla juncea*	Skeleton Weed	
	**Cirsium vulgare*	Spear Thistle	
	**Conyza bonariensis*	Flaxleaf Fleabane	
	**Conyza sumatrensis*		
	**Coreopsis lanceolata*	Coreopsis	
	**Crepis capillaris*	Smooth Hawksbeard	
	**Dimorphotheca ecklonis*	Cape Daisy	
	Euchiton involucratus	Star Cudweed	
	**Galinsoga parviflora*	Potato Weed	
	**Gamochaeta coarctata*		
	**Gamochaeta purpurea*	Purple Cudweed	
	**Hedypnois rhagadioloides*	Cretan Weed	
	**Lactuca saligna*	Willow-leaved Lettuce	
	**Lactuca serriola*	Prickly Lettuce	
	**Onopordum acanthium* subsp. *acanthium*	Scotch Thistle	
	**Senecio madagascariensis*	Fireweed	
	**Silybum marianum*	Variegated Thistle	
	**Soliva sessilis*	Bindyi	
	**Sonchus oleraceus*	Common Sowthistle	
	**Tagetes minuta*	Stinking Roger	
	**Taraxacum officinale*	Dandelion	
	**Tragopogon porrifolius*	Salsify	
	**Xanthium spinosum*	Bathurst Burr	
	**Bidens subalternans*	Greater Beggar's Ticks	
	Brachyscome linearifolia		
	Brachyscome multifida	Cut-leaved Daisy	
	Calocephalus citreus	Lemon Beauty-heads	
	Calotis cuneifolia	Purple Burr-Daisy	
	Calotis lappulacea	Yellow Burr-daisy	
	Cassinia arcuata	Sifton Bush	
	Cassinia quinquefaria		
	Chrysocephalum apiculatum	Common Everlasting, Yellow Buttons	
	Chrysocephalum semipapposum	Clustered Everlasting	
	Cotula australis	Common Cotula	
	**Cotula coronopifolia*	Water Buttons	
	Craspedia variabilis		
	Cymbonotus lawsonianus	Bear's Ear	

Family Name	Scientific Name	Common Name	Status[1]
	Euchiton gymnocephalus		
	Euchiton sphaericus		
	**Facelis retusa*	Annual Trampweed	
	Glossocardia bidens	Cobbler's Tack	
	Gnaphalium sphaericum		
	**Hypochaeris radicata*	Catsear	
	Lagenophora stipitata	Blue Bottle-daisy	
	Minuria leptophylla		
	Olearia elliptica	Sticky Daisy Bush	
	Ozothamnus diosmifolius	White Dogwood	
	Podolepis jaceoides	Showy Copper-wire Daisy	
	Pseudognaphalium luteoalbum	Jersey Cudweed	
	Senecio hispidulus	Hill Fireweed	
	Senecio quadridentatus	Cotton Fireweed	
	Sigesbeckia orientalis		
	Solenogyne bellioides		
	Vernonia cinerea var. *cinerea*		
	Vittadinia cuneata	Fuzzweed	
	Vittadinia cuneata f. *cuneata*		
	Vittadinia muelleri		
	Vittadinia pterochaeta	Rough Fuzzweed	
	Vittadinia sulcata		
	Vittadinia triloba		
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine	
Boraginaceae	*Cynoglossum australe*		
	Cynoglossum suaveolens		
Brassicaceae	**Capsella bursa-pastoris*	Shepherd's Purse	
	**Hirschfeldia incana*	Buchan Weed	
	**Lepidium africanum*		
	**Lepidium bonariense*		
	**Rapistrum rugosum*	Turnip Weed	
	Lepidium pseudohyssopifolium	Peppercress	
	**Raphanus raphanistrum*	Wild Radish	
Cactaceae	**Harrisia martinii*	Moonlight Cactus	
	**Opuntia aurantiaca*	Tiger Pear	
	**Opuntia humifusa*	Creeping Pear	
	**Opuntia stricta*	Common Prickly Pear	
	**Opuntia stricta* var. *stricta*	Common Prickly Pear	
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell	
	Wahlenbergia gracilis	Australian Bluebell	

Family Name	Scientific Name	Common Name	Status[1]
	Wahlenbergia luteola		
	Wahlenbergia stricta	Tall Bluebell	
Caryophyllaceae	**Agrostemma githago*	Corn Cockle	
	**Cerastium glomeratum*	Mouse-ear Chickweed	
	**Petrorhagia nanteuilii*		
	**Petrorhagia velutina*		
	**Polycarpon tetraphyllum*	Four-leaved Allseed	
	**Silene gallica*	French Catchfly	
	**Silene nocturna*		
	**Spergularia rubra*	Sandspurry	
	Cerastium fontanum	Mouse-ear Chickweed	
	**Paronychia brasiliana*	Chilean Whitlow Wort	
	Stellaria flaccida		
Casuarinaceae	*Allocasuarina luehmannii*	Bulloak	
	Allocasuarina torulosa	Forest Oak	
	Allocasuarina verticillata	Drooping Sheoak	
	Casuarina cunninghamiana	River Oak	
	Casuarina glauca	Swamp Oak	
Celastraceae	*Maytenus silvestris*	Narrow-leaved Orangebark	
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	
	Einadia hastata	Berry Saltbush	
	Einadia nutans subsp. *linifolia*		
	Einadia polygonoides		
	Einadia trigonos	Fishweed	
	Enchylaena tomentosa	Ruby Saltbush	
	Maireana microphylla	Small-leaf Bluebush	
	Salsola kali var. *kali*		
	Sclerolaena birchii	Galvinized Burr	
Chloanthaceae	*Spartothamnella juncea*	Bead Bush	
Clusiaceae	**Hypericum perforatum*	St. Johns Wort	
	Hypericum gramineum	Small St John's Wort	
Commelinaceae	*Commelina cyanea*	Native Wandering Jew	
	Commelina ensifolia	Scurvy Grass	
	Murdannia graminea	Grass Lily	
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed	
	Dichondra repens	Kidney Weed	
	Evolvulus alsinoides var. *decumbens*		
Crassulaceae	**Bryophyllum delagoense*	Mother of millions	
	Crassula decumbens var. *decumbens*		

Family Name	Scientific Name	Common Name	Status[1]
	Crassula sieberiana	Australian Stonecrop	
Cupressaceae	*Callitris endlicheri*	Black Cypress Pine	
Cyperaceae	**Cyperus eragrostis*	Umbrella Sedge	
	**Cyperus rotundus*	Nutgrass	
	**Cyperus tenellus*		
	Bolboschoenus caldwellii		
	Carex inversa		
	Cyperus fulvus	Sticky Sedge	
	Cyperus gracilis	Slender Flat-sedge	
	Eleocharis acuta		
	Eleocharis dulcis		
	Fimbristylis dichotoma	Common Fringe-sedge	
Dilleniaceae	*Hibbertia obtusifolia*	Hoary guinea flower	
Euphorbiaceae	*Beyeria viscosa*	Pinkwood	
	Breynia oblongifolia	Coffee Bush	
	Chamaesyce drummondii	Caustic Weed	
	Phyllanthus similis		
	Phyllanthus virgatus		
	Poranthera microphylla		
Fabaceae (Caesalpinioideae)	*Senna aciphylla*	Sprawling Cassia	
	Senna clavigera		
Fabaceae (Faboideae)	**Medicago polymorpha*	Burr Medic	
	**Medicago sativa*	Lucerne	
	**Medicago truncatula*	Barrel Medic	
	**Melilotus indicus*	Hexham Scent	
	**Trifolium arvense*	Haresfoot Clover	
	**Trifolium campestre*	Hop Clover	
	**Trifolium dubium*	Yellow Suckling Clover	
	**Trifolium repens*	White Clover	
	**Trifolium subterraneum*	Subterraneum Clover	
	**Vicia sativa*		
	Bossiaea heterophylla	Variable Bossiaea	
	Bossiaea prostrata		
	Bossiaea rhombifolia subsp. *rhombifolia*		
	Daviesia acicularis		
	Daviesia genistifolia	Broom Bitter Pea	
	Desmodium brachypodum	Large Tick-trefoil	
	Desmodium gunnii	Slender Tick-trefoil	
	Desmodium varians	Slender Tick-trefoil	

Family Name	Scientific Name	Common Name	Status[1]
	Glycine clandestina		
	Glycine microphylla	Small-leaf Glycine	
	Glycine tabacina		
	Hardenbergia violacea	False Sarsaparilla	
	Hovea linearis		
	Indigofera australis	Australian Indigo	
	Jacksonia scoparia	Dogwood	
	Swainsona galegifolia	Smooth Darling Pea	
	Templetonia stenophylla	Leafy Templetonia	
	Zornia dyctiocarpa var. *dyctiocarpa*	Zornia	
Fabaceae (Mimosoideae)	**Acacia podalyriifolia*	Queensland Silver Wattle	
	**Acacia saligna*	Golden Wreath Wattle	
	**Mimosa pudica*	Common Sensitive Plant	
	Acacia amblygona	Fan Wattle	
	Acacia binervia	Coast Myall	
	Acacia decora	Western Silver Wattle	
	Acacia excelsa	Ironwood	
	Acacia falcata		
	Acacia genistifolia	Early Wattle	
	Acacia gunnii	Ploughshare Wattle	
	Acacia implexa	Hickory Wattle	
	Acacia melanoxylon	Blackwood	
	Acacia melvillei - homalophylla		
	Acacia paradoxa	Kangaroo Thorn	
	Acacia parramattensis	Parramatta Wattle	
	Acacia parvipinnula	Silver-stemmed Wattle	
	Acacia pendula	Boree	EP (TSC Act)
	Acacia salicina	Cooba	
Gentianaceae	**Centaurium erythraea*	Common Centaury	
	**Centaurium tenuiflorum*		
	Schenkia spicata	Spike Centaury	
Geraniaceae	**Erodium botrys*	Long Storksbill	
	**Erodium cicutarium*	Common Storksbill	
	Erodium crinitum	Blue Storksbill	
	Geranium dissectum		
	Geranium solanderi var. *solanderi*		
	Pelargonium inodorum		
Goodeniaceae	*Goodenia ovata*	Hop Goodenia	
	Goodenia paniculata	Branched Goodenia	

Family Name	Scientific Name	Common Name	Status[1]
	Goodenia pinnatifida		
	Scaevola aemula	Fairy Fanflower	
	Scaevola albida var. *albida*		
	Scaevola humilis		
Hydrocharitaceae	*Ottelia ovalifolia*	Swamp Lily	
Hypoxidaceae	*Hypoxis hygrometrica*	Golden Weather-grass	
Iridaceae	**Romulea rosea*	Onion Grass	
Juncaceae	**Juncus acutus*	Sharp Rush	
	Juncus usitatus		
	Luzula flaccida		
Lamiaceae	**Marrubium vulgare*	White Horehound	
	**Stachys arvensis*	Stagger Weed	
	Ajuga australis	Austral Bugle	
	Mentha satureioides	Native Pennyroyal	
	Plectranthus parviflorus	Cockspur Flower	
	Scutellaria humilis	Dwarf Skullcap	
Lauraceae	**Cinnamomum camphora*	Camphor Laurel	
Linaceae	**Linum trigynum*	French Flax	
	**Linum usitatissimum*	Flax	
	Linum marginale	Native Flax	
Lobeliaceae	*Pratia purpurascens*	Whiteroot	
Lomandraceae	*Lomandra confertifolia*	Mat-rush	
	Lomandra filiformis	Wattle Mat-rush	
	Lomandra filiformis subsp. *filiformis*	Many-flowered Mat-rush	
	Lomandra glauca	Pale Mat-rush	
	Lomandra longifolia	Spiny-headed Mat-rush	
	Lomandra multiflora subsp. *multiflora*		
Loranthaceae	*Amyema cambagei*		
	Amyema miquelii		
	Amyema pendulum subsp. *pendulum*		
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	
	Geitonoplesium cymosum	Scrambling Lily	
Malvaceae	**Lagunaria patersonia*	Norfolk Island Hibiscus	
	**Modiola caroliniana*	Red-flowered Mallow	
	**Sida rhombifolia*	Paddy's Lucerne	
	Abutilon oxycarpum	Lantern Bush	
	Hibiscus sturtii	Hill Hibiscus	
	Hibiscus sturtii var. *sturtii*	Hill Hibiscus	
	Sida cordifolia		

Family Name	Scientific Name	Common Name	Status[1]
	Sida corrugata	Corrugated Sida	
	Sida cunninghamii	Ridged Sida	
	Sida filiformis	Fine Sida	
Moraceae	*Ficus rubiginosa*	Port Jackson Fig	
Myoporaceae	*Eremophila debilis*	Amulla	
	Eremophila deserti	Turkeybush	
	Myoporum acuminatum	Boobialla	
	Myoporum montanum	Western Boobialla	
	Myoporum parvifolium	Creeping Boobialla	
Myrtaceae	*Angophora floribunda*	Rough-barked Apple	
	Corymbia maculata	Spotted Gum	
	Eucalyptus albens	White Box	
	Eucalyptus albens x E. moluccana	White/Grey Box hybrid	
	Eucalyptus blakelyi	Blakely's Red Gum	
	Eucalyptus camaldulensis	River Red Gum	EP (TSC Act)
	Eucalyptus canaliculata	Grey Gum	
	Eucalyptus conica	Fuzzy Box	
	Eucalyptus crebra	Narrow-leaved Ironbark	
	Eucalyptus dawsonii	Slaty Gum	
	Eucalyptus melliodora	Yellow Box	
	Eucalyptus moluccana	Grey Box	
	Eucalyptus punctata	Grey Gum	
	Eucalyptus tereticornis	Forest Red Gum	
	Melaleuca armillaris	Bracelet Honey-myrtle	
	Melaleuca decora		
	Melaleuca styphelioides	Prickly-leaved Tea Tree	
Nyctaginaceae	*Boerhavia dominii*	Tarvine	
Oleaceae	**Olea europaea* subsp. *cuspidata*	African olive	
	Jasminum suavissimum		
	Notelaea longifolia	Large Mock-olive	
	Notelaea microcarpa	Native Olive	
	Notelaea microcarpa var. *microcarpa*	Velvet Mock Olive	
Orchidaceae	*Cymbidium canaliculatum*	Tiger Orchid	EP (TSC Act)
	Cymbidium suave	Snake Orchid	
	Dendrobium speciosum	Rock Lily	
	Diuris punctata	Purple Donkey Orchid	
	Diuris tricolor	Painted Donkey Orchid	EP (TSC Act)
	Microtis unifolia	Common Onion Orchid	
	Pterostylis mutica	Midget Greenhood	

Family Name	Scientific Name	Common Name	Status[1]
Oxalidaceae	**Oxalis corniculata*		
	**Oxalis pes-caprae*		
	Oxalis exilis		
	Oxalis perennans		
Phormiaceae	*Dianella caerulea*	Blue Flax-lily	
	Dianella longifolia	Blue Flax-Lily	
	Dianella revoluta var. *revoluta*	Blue Flax-Lily	
Pittosporaceae	*Billardiera scandens*	Hairy Appleberry	
	Bursaria spinosa	Blackthorn	
	Bursaria spinosa subsp. *spinosa*	Blackthorn	
Plantaginaceae	**Plantago lanceolata*	Lamb's Tongues	
	**Plantago myosuros*		
	Plantago debilis		
Poaceae	**Avena barbata*	Bearded Oats	
	**Axonopus fissifolius*	Narrow-leafed Carpet Grass	
	**Briza minor*	Shivery Grass	
	**Bromus catharticus*	Praire Grass	
	**Bromus hordeaceus*	Soft Brome	
	**Bromus molliformis*	Soft Brome	
	**Chloris gayana*	Rhodes Grass	
	Cynodon dactylon	Common Couch	
	**Echinochloa esculenta*	Japanese Millet	
	**Ehrharta erecta*	Panic Veldtgrass	
	**Eragrostis curvula*	African Lovegrass	
	**Hordeum glaucum*	Northern Barley Grass	
	**Hordeum leporinum*	Barley Grass	
	**Hyparrhenia hirta*	Coolatai Grass	
	**Lolium perenne*	Perennial Ryegrass	
	**Lolium rigidum*	Wimmera Ryegrass	
	**Melinis repens*	Red Natal Grass	
	**Panicum maximum* var. *maximum*	Guinea Grass	
	**Paspalum dilatatum*	Paspalum	
	**Pennisetum clandestinum*	Kikuyu Grass	
	**Setaria italic*	Foxtail Millet	
	**Setaria parviflora*		
	**Sorghum halepense*	Johnson Grass	
	Sorghum leiocladum	Wild Sorghum	
	**Stenotaphrum secundatum*	Buffalo Grass	
	**Urochloa mutica*	Para Grass	

Family Name	Scientific Name	Common Name	Status[1]
	**Urochloa panicoides*	Urochloa Grass	
	**Vulpia bromoides*	Squirrel Tail Fesque	
	Aristida jerichoensis	Jericho Wiregrass	
	Aristida personata	Purple wire-grass	
	Aristida ramosa	Purple Wiregrass	
	Aristida vagans	Threeawn Speargrass	
	Austrodanthonia bipartita	Wallaby Grass	
	Austrodanthonia fulva	Wallaby Grass	
	Austrodanthonia racemosa		
	Austrodanthonia racemosa var. *obtusata*		
	Austrodanthonia racemosa var. *racemosa*		
	Austrodanthonia richardsonii	Straw Wallaby-grass	
	Austrodanthonia tenuior		
	Austrostipa aristiglumis	Plains Grass	
	Austrostipa scabra	Speargrass	
	Austrostipa scabra subsp. *scabra*	Speargrass	
	Austrostipa verticillata	Slender Bamboo Grass	
	Bothriochloa biloba		V (EPBC Act)
	Bothriochloa decipiens	Red Grass	
	Bothriochloa decipiens var. *decipiens*		
	Bothriochloa macra	Red Grass	
	Chloris truncata	Windmill Grass	
	Chloris ventricosa	Tall Chloris	
	Cymbopogon refractus	Barbed Wire Grass	
	Dactyloctenium radulans	Button Grass	
	Dichanthium sericeum	Queensland Bluegrass	
	Dichelachne crinita	Longhair Plumegrass	
	Dichelachne micrantha	Shorthair Plumegrass	
	Digitaria brownii	Cotton Panic Grass	
	Echinopogon ovatus	Forest Hedgehog Grass	
	**Eleusine tristachya*	Goose Grass	
	Elymus scaber var. *scaber*	Common Wheatgrass	
	Enneapogon gracilis	Slender Nineawn	
	Enneapogon nigricans	Niggerheads	
	Enteropogon acicularis		
	Entolasia stricta	Wiry Panic	
	Eragrostis brownii	Brown's Lovegrass	
	Eragrostis leptostachya	Paddock Lovegrass	
	Eriochloa pseudoacrotricha	Early Spring Grass	

Family Name	Scientific Name	Common Name	Status[1]
	Eulalia aurea	Silky Browntop	
	Isachne globosa	Swamp Millet	
	Lachnagrostis filiformis		
	Microlaena stipoides	Weeping Grass	
	Microlaena stipoides var. *stipoides*		
	Panicum effusum	Hairy Panic	
	Panicum queenslandicum	Yadbila Grass	
	Panicum simile	Two-colour Panic	
	Paspalidium criniforme		
	Paspalidium distans		
	Paspalidium gracile	Slender Panic	
	Paspalum distichum	Water Couch	
	Phragmites australis	Common Reed	
	**Poa annua*	Winter Grass	
	Poa labillardierei	Tussock Grass	
	Poa sieberiana		
	Sporobolus creber	Slender Rat's Tail Grass	
	Sporobolus elongatus	Slender Rat's Tail Grass	
	Themeda australis	Kangaroo Grass	
Polygonaceae	**Polygonum arenastrum*	Wireweed	
	**Polygonum aviculare*	Wireweed	
	Persicaria decipiens	Slender Knotweed	
	Rumex brownii	Swamp Dock	
Portulacaceae	*Calandrinia eremaea*		
	Portulaca oleracea	Pigweed	
Potamogetonaceae	*Potamogeton crispus*	Curly Pondweed	
Primulaceae	**Anagallis arvensis*	Scarlet/Blue Pimpernel	
Ranunculaceae	*Clematis aristata*	Old Man's Beard	
	Clematis glycinoides var. *glycinoides*	Headache Vine	
	Ranunculus inundatus	River Buttercup	
Rhamnaceae	*Cryptandra amara*	Bitter cryptandra	
	Cryptandra amara var. *longiflora*		
Rosaceae	*Acaena novae-zelandiae*	Bidgee-widgee, Biddy Biddy	
	**Rubus fruticosus* sp. agg.		
	Rubus parvifolius	Native Raspberry	
Rubiaceae	**Richardia stellaris*		
	Asperula conferta	Common Woodruff	
	Galium propinquum	Maori Bedstraw	
	Opercularia aspera	Coarse Stinkweed	

Family Name	Scientific Name	Common Name	Status[1]
	Opercularia diphylla		
	Pomax umbellata		
	Psydrax odorata	Shiny-leaved Canthium	
	Psydrax odorata f. *buxifolia*		
Rutaceae	*Geijera parviflora*	Wilga	
Salicaceae	**Salix babylonica*	Weeping Willow	
Santalaceae	*Exocarpos cupressiformis*	Native Cherry	
Sapindaceae	*Dodonaea viscosa*	Sticky Hop-bush	
Scrophulariaceae	**Linaria pelisseriana*	Pelisser's Toadflax	
	**Verbascum thapsus*	Great Mullein	
	**Verbascum virgatum*	Twiggy Mullein	
	Veronica calycina	Hairy Speedwell	
	Veronica plebeia	Trailing Speedwell	
Solanaceae	**Lycium ferocissimum*	African Boxthorn	
	**Nicotiana glauca*	Tree Tobacco	
	**Solanum nigrum*	Black-berry Nightshade	
	**Solanum pseudocapsicum*	Madeira Winter	
	Solanum americanum	Glossy Nightshade	
	Solanum amblymerum	Narrawa Burr	
	Solanum brownii	Violet Nightshade	
	Solanum opacum	Green-berry Nightshade	
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia	
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*	Kurrajong	
Thymelaeaceae	*Pimelea curviflora*		
	Pimelea curviflora var. *divergens*		
	Pimelea curviflora var. *sericea*		
	Pimelea glauca	Smooth Rice-flower	
	Pimelea linifolia	Slender Rice-flower	
	Pimelea linifolia subsp. *linifolia*	Queen of the Bush	
Typhaceae	*Typha orientalis*	Broad-leaved Cumbungi	
Urticaceae	**Urtica dioica*	Giant Nettle	
Verbenaceae	**Glandularia aristigera*	Mayne's Pest	
	**Lantana montevidensis*	Trailing Lantana	
	**Verbena bonariensis*	Purpletop	
	**Verbena litoralis*		
	**Verbena officinalis*	Common Verbena	
	**Verbena rigida*	Veined Verbena	
	**Verbena rigida* var. *rigida*	Veined Verbena	
	**Verbena x brasiliensis*	Gin Case	
	Clerodendrum tomentosum	Hairy Clerodendrum	

Family Name	Scientific Name	Common Name	Status[1]
	Verbena gaudichaudii		
Violaceae	*Melicytus dentatus*	Tree Violet	
Viscaceae	*Notothixos cornifolius*	Kurrajong Mistletoe	
Vitaceae	*Cayratia clematidea*	Native Grape	
Xanthorrhoeaceae	*Xanthorrhoea glauca*		

[1] Threatened flora species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).
V = Vulnerable; EP = Endangered Population.
* Introduced species.

BIRDS

Order	Family	Scientific Name	Common Name	Status[1]
ACCIPITRIFORMES	**Accipitridae**	*Accipiter fasciatus*	Brown Goshawk	
		Aquila audax	Wedge-tailed Eagle	
		Circus assimilis	Spotted Harrier	V (TSC Act)
		Elanus axillaris	Black-shouldered Kite	
ANSERIFORMES	**Anatidae**	*Anas gracilis*	Grey Teal	
		Anas rhynchotis	Australasian Shoveler	
		Anas superciliosa	Pacific Black Duck	
		Chenonetta jubata	Australian Wood Duck	
		Cygnus atratus	Black Swan	
APODIFORMES	**Apodidae**	*Hirundapus caudacutus*	White-throated Needletail	
CAPRIMULGIFORMES	**Aegothelidae**	*Aegotheles cristatus*	Australian Owlet-nightjar	
	Podargidae	*Podargus strigoides*	Tawny Frogmouth	
CHARADRIIFORMES	**Charadriidae**	*Elseyornis melanops*	Black-fronted Dotterel	
		Vanellus miles	Masked Lapwing	
CICONIIFORMES	**Ardeidae**	*Egretta novaehollandiae*	White-faced Heron	
	Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	
COLUMBIFORMES	**Columbidae**	*Ocyphaps lophotes*	Crested Pigeon	
CORACIIFORMES	**Halcyonidae**	*Dacelo novaeguineae*	Laughing Kookaburra	
		Todiramphus sanctus	Sacred Kingfisher	
	Meropidae	*Merops ornatus*	Rainbow Bee-eater	
CUCULIFORMES	**Cuculidae**	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	
		Eudynamys orientalis	Eastern Koel	
		Scythrops novaehollandiae	Channel-billed Cuckoo	
FALCONIFORMES	**Falconidae**	*Falco berigora*	Brown Falcon	
		Falco cenchroides	Nankeen Kestrel	
		Falco longipennis	Australian Hobby	
		Falco peregrinus	Perigrine Falcon	
GALLIFORMES	**Megapodiidae**	*Coturnix pectoralis*	Stubble Quail	
		Coturnix ypsilophora	Brown Quail	
GRUIFORMES	**Rallidae**	*Fulica atra*	Eurasian Coot	
		Gallinula tenebrosa	Dusky Morehen	
		Porphyrio porphyrio	Purple Swamphen	
PASSERIFORMES	**Acanthizidae**	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	
		Acanthiza nana	Yellow Thornbill	
		Acanthiza pusilla	Brown Thornbill	
		Acanthiza reguloides	Buff-rumped Thornbill	

Order	Family	Scientific Name	Common Name	Status[1]
		Chthonicola sagittata	Speckled Warbler	V (TSC Act)
		Gerygone albogularis	White-throated Gerygone	
		Gerygone fusca	Western Gerygone	
		Gerygone mouki	Brown Gerygone	
		Sericornis frontalis	White-browed Scrubwren	
		Smicrornis brevirostris	Weebill	
	Alaudidae	*Alauda arvensis*	Eurasian Skylark	
		Mirafra javanica	Horsefield's Bushlark	
	Artamidae	*Artamus cyanopterus*	Dusky Woodswallow	
		Artamus superciliosus	White-browed Woodswallow	
		Cracticus nigrogularis	Pied Butcherbird	
		Cracticus tibicen	Australian Magpie	
		Cracticus torquatus	Grey Butcherbird	
		Strepera graculina	Pied Currawong	
	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	
		Lalage sueurii	White-winged Triller	
	Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	
	Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper	
	Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	
	Corvidae	*Corvus coronoides*	Australian Raven	
		Corvus orru	Torresian Crow	
	Estrildidae	*Neochmia temporalis*	Red-browed Finch	
		Stagonopleura guttata	Diamond Firetail	V (TSC Act)
		Taeniopygia bichenovii	Double-barred Finch	
		Taeniopygia guttata	Zebra Finch	
	Hirundinidae	*Hirundo neoxena*	Welcome Swallow	
		Petrochelidon ariel	Fairy Martin	
	Maluridae	*Malurus cyaneus*	Superb Fairy-wren	
	Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	
		Anthochaera carunculata	Red Wattlebird	
		Lichenostomus chrysops	Yellow-faced Honeyeater	
		Lichenostomus penicillatus	White-plumed Honeyeater	
		Lichenostomus virescens	Singing Honeyeater	
		Manorina melanocephala	Noisy Miner	

Order	Family	Scientific Name	Common Name	Status[1]
		Melithreptus brevirostris	Brown-headed Honeyeater	
		Melithreptus lunatus	White-naped Honeyeater	
		Philemon citreogularis	Little Friarbird	
		Philemon corniculatus	Noisy Friarbird	
	Monarchidae	*Grallina cyanoleuca*	Magpie-lark	
	Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit	
	Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	
	Neosittidae	*Daphoenositta chrysoptera*	Varied Sitella	V (TSC Act)
	Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	
	Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	
		Pachycephala pectoralis	Golden Whistler	
		Pachycephala rufiventris	Rufous Whistler	
	Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	
		Pardalotus striatus	Striated Pardalote	
	Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	
		Melanodryas cucullata	Hooded Robin	V (TSC Act)
		Petroica goodenovii	Red-capped Robin	
	Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler	V (TSC Act)
	Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	
		Rhipidura leucophrys	Willie Wagtail	
	Sturnidae	**Sturnus tristis*	Common Myna	
		Sturnus vulgaris	Common Starling	
	Timaliidae	*Zosterops lateralis*	Silvereye	
PODICIPEDIFORMES	**Podicipedidae**	*Tachybaptus novaehollandiae*	Australasian Grebe	
PSITTACIFORMES	**Cacatuidae**	*Cacatua galerita*	Sulphur-crested Cockatoo	
		Cacatua sanguinea	Little Corella	
		Eolophus roseicapillus	Galah	
	Psittacidae	*Alisterus scapularis*	Australian King Parrot	
		Glossopsitta concinna	Musk Lorikeet	
		Glossopsitta pusilla	Little Lorikeet	V (TSC Act)
		Platycercus adscitus	Pale-headed Rosella	
		Platycercus elegans	Crimson Rosella	
		Platycercus eximius	Eastern Rosella	
		Psephotus haematonotus	Red-rumped Parrot	
STRIGIFORMES	**Strigidae**	*Ninox novaeseelandiae*	Southern Boobook	
	Tytonidae	*Tyto javanica*	Eastern Barn Owl	

[1] Threatened flora species status listed under the TSC Act (current at 24 January 2013).
V = Vulnerable

AMPHIBIANS

Family	Scientific Name	Common Name
Hylidae	*Litoria caerulea*	Green Tree Frog
	Litoria fallax	Eastern Sedge-frog
	Litoria freycineti	Wallum Rocket Frog
	Litoria latopalmata	Broad-palmed Frog
	Litoria peronii	Peron's Tree Frog
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet
	Limnodynastes ornatus	Ornate Burrowing Frog
	Limnodynastes peronii	Perons Tree Frog
	Limnodynastes tasmaniensis	Spotted Grass Frog
	Uperoleia laevigata	Smooth Toadlet
	Uperoleia tyleri	Tyler's Toadlet

Note: No species are listed as threatened.

REPTILES

Family	Scientific Name	Common Name
Agamidae	*Amphibolurus muricatus*	Jacky Lizard
	Pogona barbata	Bearded Dragon
Chelidae	*Chelodina longicollis*	Long-necked Tortoise
Elapidae	*Furina diadema*	Red-naped Snake
	Parasuta dwyeri	Dwyers Snake
	Pseudechis guttatus	Blue-bellied Black Snake
	Pseudechis porphyriacus	Red-bellied Black Snake
	Pseudonaja textilis	Eastern Brown Snake
	Rhinoplocephalus nigrescens	Eastern Small-eyed Snake
Gekkonidae	*Diplodactylus vittatus*	Eastern Stone Gecko
	Oedura robusta	Robust Velvet Gecko
	Underwoodisaurus milii	Thick-tailed Gecko
Scincidae	*Carlia tetradactyla*	Southern Rainbow Skink
	Ctenotus robustus	Robust Ctenotus
	Ctenotus taeniolatus	Copper-tailed Skink
	Egernia modesta	Eastern Rock-skink
	Egernia striolata	Tree Skink
	Lampropholis delicata	Dark-flecked Garden Sunskink
	Tiliqua scincoides	Eastern Blue-tongued Lizard
Varanidae	*Varanus varius*	Lace Monitor

Note: No species are listed as threatened.

MAMMALS

Order	Family	Scientific Name	Common Name	Status[1]
ARTIODACTYLA	**Bovidae**	**Bos Taurus*	Cattle	
CARNIVORA	**Canidae**	**Canis lupus dingo*	Dingo	
		**Canis lupus familiaris*	Domestic Dog	
		**Vulpes vulpes*	Red Fox	
	Felidae	**Felis catus*	Cat	
CHIROPTERA	**Emballonuridae**	*Saccolaimus flaviventris*	Yellow-bellied Sheath-tailed Bat	V (TSC Act)
	Molossidae	*Mormopterus norfolkensis*	East Coast Freetail Bat	V (TSC Act)
		Mormopterus planiceps	Southern Freetail-bat	
		Mormopterus sp.	A Freetail Bat	
		Nyctinomus australis	White-striped Freetail Bat	
	Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V (TSC Act) V (EPBC Act)
		Chalinolobus gouldii	Gould's Wattled Bat	
		Chalinolobus morio	Chocolate Wattled Bat	
		Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V (TSC Act)
		Myotis macropus	Large-footed Myotis	V (TSC Act)
		Nyctophilus geoffroyi	Lesser Long-eared Bat	
		Nyctophilus sp.	a long-eared bat	
		Scoteanax rueppellii	Greater Broad-nosed Bat	V (TSC Act)
		Scotorepens balstoni	Inland Broad-nosed Bat	
		Scotorepens orion	Eastern Broad-nosed Bat	
		Vespadelus pumilus	Eastern Forest Bat	
		Vespadelus regulus	Southern Forest Bat	
		Vespadelus troughtoni	Eastern Cave Bat	V (TSC Act)
		Vespadelus vulturnus	Little Forest Bat	
DASYUROMORPHIA	**Dasyuridae**	*Antechinus stuartii*	Brown Antechinus	
DIPROTODONTIA	**Macropodidae**	*Macropus giganteus*	Eastern Grey Kangaroo	
		Macropus parma	Parma Wallaby	V (TSC Act)
		Macropus robustus	Common Wallaroo	
		Macropus rufogriseus	Red-necked Wallaby	
		Wallabia bicolour	Swamp Wallaby	
	Petauridae	*Petaurus breviceps*	Sugar Glider	
		Petaurus norfolcensis	Squirrel Glider	V (TSC Act)

Order	Family	Scientific Name	Common Name	Status[1]
	Phalangeridae	*Trichosurus vulpecular*	Common Brushtail Possum	
	Pseudocheiridae	*Pseudocheirus peregrines*	Ring-tailed Possum	
	Vombatidae	*Vombatus ursinus*	Common Wombat	
LAGOMORPHA	**Leporidae**	**Lepus* sp.	Brown Hare	
		**Oryctolagus cuniculus*	European Rabbit	
MONOTREMATA	**Tachyglossidae**	*Tachyglossus aculeatus*	Short-beaked Echidna	
PERAMELEMORPHIA	**Peramelidae**	*Isoodon macrourus*	Northern Brown Bandicoot	
		Perameles nasuta	Long-nosed Bandicoot	E (TSC Act)
RODENTIA	**Muridae**	**Mus musculus*	House Mouse	
		Rattus fuscipes	Bush Rat	
		**Rattus norvegicus*	Black Rat	
		**Rattus rattus*	Black Rat	

[1] Threatened flora species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).
V = Vulnerable; E = Endangered.
* Introduced species.

APPENDIX 3

THREATENED SPECIES DATABASE RECORDS

Appendix 3a Threatened flora species database records

Scientific Name	Common Name	Status[1]		Database		
		TSC Act	EPBC Act	OEH (2013)[2]	SEWPaC (2012)[3]	Royal Botanic Gardens Sydney and the Domain (2012)[4]
ASCLEPIADACEAE						
Cynanchum elegans	White-flowered Wax Plant	E	E	-	•	-
Tylophora linearis	-	V	E	-	•	-
MYRTACEAE						
Eucalyptus glaucina	Slaty Red Gum	V	V	•	•	-
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	•	-	-
ORCHIDACEAE						
Diuris tricolor	Pine Donkey Orchid	V	-	•	-	•
Prasophyllum sp. Wybong (C.Phelps ORG 5269)	a leek-orchid	-	CE	-	•	-
Pterostylis gibbosa	Illawarra Greenhood	E	E	-	•	-
POACEAE						
Bothriochloa biloba	Bluegrass	-	V	•	•	-
Digitaria porrecta	Finger Panic Grass	E	E	-	•	-
RHAMNACEAE						
Pomaderris reperta	Denman Pomaderris	CE	CE	•	•	-
SANTALACEAE						
Thesium australe	Austral Toadflax	V	V	-	•	-
SCROPHULARIACEAE						
Euphrasia arguta	-	CE	CE	-	•	-
THYMELAEACEAE						
Pimelea curviflora var. *curviflora*	Rice Flower	V	V	•	•	-
ZAMIACEAE						
Macrozamia plurinervia	-	-	V	•	-	-

[1] Threatened flora species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).
V = Vulnerable; E = Endangered; CE = Critically Endangered

[2] Office of Environment and Heritage (2013) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 22 January 2013.

[3] Department of Sustainability, Environment, Water, Population and Communities (2012) *EPBC Act Protected Matters Search for the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 13 April 2012.

[4] Royal Botanic Gardens Sydney and the Domain (2012) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 30 May 2012.

Appendix 3b Threatened fauna species database records

Scientific Name	Common Name	Status[1]		Database		
		TSC Act	EPBC Act	OEH (2013)[2]	SEWPaC (2012)[3]	Birds Australia (2012)[4]
Amphibians						
HYLIDAE						
Litoria aurea	Green and Golden Bell Frog	E	V	•	•	-
Litoria booroolongensis	Booroolong Frog	E	E	-	•	-
Birds						
MEGAPODIIDAE						
Leipoa ocellata	Malleefowl	E	V	-	•	-
ANATIDAE						
Oxyura australis	Blue-billed Duck	V	-	•	-	-
Stictonetta naevosa	Freckled Duck	V	-	•	-	-
CICONIIDAE						
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	•	-	-
ARDEIDAE						
Botaurus poiciloptilus	Australasian Bittern	E	E	-	•	-
ACCIPITRIDAE						
Circus assimilis	Spotted Harrier	V	-	•	-	•
Hieraaetus morphnoides	Little Eagle	V	-	•	-	•
BURHINIDAE						
Burhinus grallarius	Bush Stone-curlew	E	-	-	-	•
ROSTRATULIDAE						
Rostratula australis	Australian Painted Snipe	E	V	-	•	-
PSITTACIDAE						
Glossopsitta pusilla	Little Lorikeet	V	-	•	-	•
Lathamus discolor	Swift Parrot	E	E		•	-
Neophema pulchella	Turquoise Parrot	V	-	•	-	-
TYTONIDAE						
Tyto novaehollandiae	Masked Owl	V	-	•	-	-
Tyto tenebricosa	Sooty Owl	V	-	•	-	-
STRIGIDAE						
Ninox connivens	Barking Owl	V	-	•	-	-
Ninox strenua	Powerful Owl	V	-	•	-	-
CLIMACTERIDAE						
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	•	-	•
ACANTHIZIDAE						
Chthonicola sagittata	Speckled Warbler	V	-	•	-	•

Appendix 3b Threatened fauna species database records (continued)

Scientific Name	Common Name	Status[1]		Database		
		TSC Act	EPBC Act	OEH (2013)[2]	SEWPaC (2012)[3]	Birds Australia (2012)[4]
Birds (Continued)						
MELIPHAGIDAE						
Anthochaera phrygia	Regent Honeyeater	CE	E	•	•	-
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	•	-	-
Epthianura albifrons	White-fronted Chat	V	-	-	-	•
PETROICIDAE						
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	•	-	•
Petroica boodang	Scarlet Robin	V	-	•	-	-
POMATOSTOMIDAE						
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	•	-	•
NEOSITTIDAE						
Daphoenositta chrysoptera	Varied Sittella	V	-	•	-	•
ESTRILDIDAE						
Stagonopleura guttata	Diamond Firetail	V	-	•	-	•
Marsupials						
DASYURIDAE						
Dasyurus maculatus	Spotted-tailed Quoll	V	E	•	•	-
PHASCOLARCTIDAE						
Phascolarctos cinereus	Koala	V	V	•	-	-
PETAURIDAE						
Petaurus norfolcensis	Squirrel Glider	E		•	-	-
MACROPODIDAE						
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	•	•	-
PTEROPODIDAE						
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	•	•	-
EMBALLONURIDAE						
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	•	-	-
MOLOSSIDAE						
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	•	-	-
VESPERTILIONIDAE						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	•	•	-

Appendix 3b Threatened fauna species database records (continued)

Scientific Name	Common Name	Status[1]		Database		
		TSC Act	EPBC Act	OEH (2013)[2]	SEWPaC (2012)[3]	Birds Australia (2012)[4]
Mammals(Continued)						
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	•	-	-
Miniopterus australis	Little Bentwing-bat	V	-	•	-	-
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	•	-	-
Myotis macropus	Southern Myotis	V	-	•	-	-
Nyctophilus corbeni (South-eastern form)	Corben's Long-eared Bat	V	V	•	•	-
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	•	-	-
Vespadelus troughtoni	Eastern Cave Bat	V	-	•	-	-
MURIDAE						
Pseudomys novaehollandiae	New Holland Mouse	-	V	-	•	-

Note: Please note that there were no threatened fauna species recorded in Australian Museum (2012) Australian Museum (2012) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 27 April 2012.

1 Threatened fauna species status listed under the TSC Act and/or EPBC Act (current at 24 January 2013).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

2 Office of Environment and Heritage (2013) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 22 January 2013.

3 Department of Sustainability, Environment, Water, Population and Communities (2012) *EPBC Act Protected Matters Search for the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 13 April 2012.

4 Birds Australia (2012) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 9 May 2012.

Appendix 3c Migratory species recorded from the databases within and surrounding the Modification

Scientific Name	Common Name	Database				Type of Presence
		OEH (2013)[1]	SEWPaC (2012)[2]	Birds Australia (2012)[3]	Australian Museum (2012)[4]	
Anthochaera phrygia	Regent Honeyeater	•	•	•	•	Species habitat may occur within area.
Apus pacificus	Fork-tailed Swift		•			Species or species habitat may occur within area.
Ardea ibis	Cattle Egret	•	•			Species or species habitat may occur within area.
Ardea modesta	Eastern Great Egret	•	•	•		Species or species habitat may occur within area.
Gallinago hardwickii	Latham's Snipe		•	•		Species or species habitat may occur within area.
*Haliaeetus leucogaster**	White-bellied Sea-Eagle		•	•		Species or species habitat likely to occur within area.
*Hirundapus caudacutus**	White-throated Needletail	•	•	•		Species or species habitat likely to occur within area.
Sterna caspia	Caspian Tern	•				Species or species habitat unlikely to occur within area.
Leipoa ocellata	Malleefowl		•			Species or species habitat unlikely to occur within area.
*Merops ornatus**	Rainbow Bee-eater	•	•	•		Species or species habitat may occur within area.
Monarcha melanopsis	Black-faced Monarch		•			Breeding may occur within area.
Myiagra cyanoleuca	Satin Flycatcher	•		•		Breeding likely to occur within area.
Rhipidura rufifrons	Rufous Fantail	•		•		Species or species habitat may occur within area.
Rostratula australis	Australian Painted Snipe		•			Species or species habitat unlikely to occur within area.

[1] Office of Environment and Heritage (2013) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 22 January 2013.

[2] Department of Sustainability, Environment, Water, Population and Communities (2012) *EPBC Act Protected Matters Search for the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 13 April 2012.

[3] Birds Australia (2012) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 9 May 2012.

[4] Australian Museum (2012) Australian Museum (2012) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 27 April 2012.

* Species recorded in or near the Modification area.

APPENDIX 4

FLORISTIC LIST BY MODIFICATION EXTENSION AREA

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
Acanthaceae						
Rostellularia adscendens		✓	✓			
Adiantaceae						
Adiantum aethiopicum	Common Maidenhair			✓		
Cheilanthes distans	Bristly Cloak Fern		✓			
Cheilanthes sieberi		✓	✓	✓	✓	✓
Aizoaceae						
**Galenia pubescens*	Galenia	✓	✓		✓	✓
Anacardiaceae						
**Schinus areira*	Pepper Tree				✓	
Anthericaceae						
Caesia parviflora	Pale Grass-lily		✓	✓		
Apiaceae						
Centella asiatica	Indian Pennywort		✓	✓		
Hydrocotyle laxiflora	Stinking Pennywort		✓			
Asclepiadaceae						
**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	✓	✓	✓	✓	✓
Asparagaceae						
**Asparagus aethiopicus*	Asparagus Fern				✓	
Asphodelaceae						
**Asphodelus fistulosus*			✓	✓		
Asteraceae						
**Aster subulatus*	Wild Aster					✓
**Bidens pilosa*	Cobbler's Pegs	✓	✓	✓	✓	✓
Brachyscome ciliaris var. *subintegrifolia*		✓		✓		
Brachyscome multifida var. *dilatata*	Cut-leaf Daisy		✓	✓		
Calotis cuneifolia	Purple Burr-Daisy					✓
Calotis hispidula	Bogan Flea		✓			
Calotis lappulacea	Yellow Burr-daisy		✓	✓	✓	✓
**Carthamus lanatus*	Saffron Thistle		✓		✓	
Cassinia quinquefaria				✓	✓	
Chrysocephalum apiculatum	Common Everlasting	✓	✓	✓	✓	✓

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
**Cichorium intybus*	Chicory	✓				
**Cirsium vulgare*	Spear Thistle	✓	✓	✓	✓	✓
**Conyza bonariensis*	Flaxleaf Fleabane					✓
**Conyza canadensis*				✓		
**Conyza sumatrensis*	Tall Fleabane	✓	✓	✓	✓	
Cymbonotus lawsonianus	Bear's Ear		✓	✓		
Euchiton involucratus	Star Cudweed			✓	✓	
Euchiton sphaericus			✓		✓	
Glossocardia bidens	Cobbler's Tack		✓		✓	
**Hypochaeris radicata*	Catsear		✓		✓	
**Lactuca saligna*	Willow-leaved Lettuce	✓	✓		✓	
**Lactuca* sp.						✓
Lagenifera gracilis	Slender Lagenophora		✓			
Minuria leptophylla		✓	✓			
Olearia elliptica	Sticky Daisy Bush			✓		
Senecio diaschides				✓		
Senecio hispidulus	Hill Fireweed				✓	
**Senecio madagascariensis*	Fireweed	✓	✓	✓	✓	✓
Senecio quadridentatus	Cotton Fireweed		✓	✓	✓	✓
Sigesbeckia orientalis			✓	✓		
**Sonchus oleraceus*	Common Sowthistle	✓	✓		✓	
**Taraxacum officinale*	Dandelion		✓	✓	✓	✓
Vittadinia cervicularis f. *cervicularis*			✓	✓		
Vittadinia cuneata var. *cuneata*		✓	✓		✓	✓
Vittadinia dissecta var. *hirta*						✓
**Xanthium occidentale*	Noogoora Burr				✓	
Brassicaceae						
**Brassica rapa* subsp. *sylvestris*	Turnip		✓	✓		
**Hirschfeldia incana*	Buchan Weed					✓
**Lepidium africanum*		✓	✓			✓
Lepidium pseudohyssopifolium	Peppercress		✓			✓
**Sinapis arvensis*	Charlock					✓

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
Cactaceae						
**Opuntia stricta* var. *stricta*	Common Prickly Pear	✓	✓	✓	✓	✓
Campanulaceae						
Wahlenbergia communis	Tufted Bluebell	✓	✓	✓	✓	✓
Casuarinaceae						
Allocasuarina littoralis	Black She-oak		✓	✓		
Allocasuarina luehmannii	Bulloak	✓			✓	✓
Celastraceae						
Maytenus silvestris	Narrow-leaved Orangebark			✓		
Chenopodiaceae						
Atriplex semibaccata	Creeping Saltbush	✓	✓			
**Chenopodium album*	Fat Hen			✓		
Chenopodium glaucum		✓				
Einadia nutans	Climbing Saltbush		✓	✓	✓	✓
Enchylaena tomentosa	Ruby Saltbush	✓			✓	✓
Maireana microphylla	Small-leaf Bluebush	✓	✓	✓	✓	
Sclerolaena birchii	Galvinized Burr					✓
Sclerolaena muricata	Black Rolypoly	✓	✓	✓	✓	✓
Chloanthaceae						
Spartothamnella juncea	Bead Bush		✓	✓	✓	
Clusiaceae						
Hypericum gramineum	Small St John's Wort				✓	
**Hypericum perforatum*	St. Johns Wort				✓	✓
Convolvulaceae						
Convolvulus erubescens	Blushing Bindweed	✓	✓	✓		
Dichondra repens	Kidney Weed	✓	✓	✓	✓	✓
Dichondra species A		✓				
Polymeria calycina			✓		✓	
Cyperaceae						
Carex inversa			✓		✓	✓
Cyperus fulvus	Sticky Sedge				✓	
Cyperus gracilis			✓			
Fimbristylis dichotoma	Common Fringe-sedge		✓	✓	✓	
Scleria mackaviensis			✓			

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
Euphorbiaceae						
Breynia oblongifolia	Coffee Bush			✓	✓	
Chamaesyce drummondii	Caustic Weed		✓			
Phyllanthus gunnii			✓			
Phyllanthus virgatus			✓			
Fabaceae (Caesalpinioideae)						
Senna odorata				✓		
Fabaceae (Faboideae)						
Daviesia genistifolia	Broom Bitter Pea			✓		
Desmodium brachypodum	Large Tick-trefoil				✓	
Desmodium gunnii	Slender Tick Trefoil		✓	✓		
Desmodium rhytidophyllum			✓	✓		
Desmodium varians	Slender Tick-trefoil		✓	✓		
Glycine clandestina		✓			✓	
Glycine microphylla	Small-leaf Glycine			✓	✓	
Glycine tabacina		✓	✓	✓	✓	✓
Hardenbergia violacea	False Sarsaparilla		✓	✓	✓	
**Medicago minima*	Woolly Burr Medic					✓
**Medicago orbicularis*	Button Medic		✓			
**Medicago sativa*	Lucerne	✓				
**Melilotus indicus*						✓
Swainsona galegifolia	Smooth Darling Pea			✓		
**Trifolium incarnatum*	Crimson Clover	✓				
**Trifolium* sp.						✓
**Trifolium subterraneum*	Subterraneum Clover				✓	
Fabaceae (Mimosoideae)						
Acacia cultriformis	Knife-leaved Wattle		✓			
Acacia decora	Western Golden Wattle	✓	✓			✓
Acacia falcata					✓	
Acacia implexa	Hickory Wattle		✓			
Acacia maidenii	Maiden's Wattle		✓	✓		
Acacia salicina	Cooba		✓	✓	✓	✓
Gentianaceae						
**Centaurium erythraea*	Common Centaury		✓			✓

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
**Centaurium tenuiflorum*			✓	✓		
Geranium solanderi	Native Geranium	✓	✓	✓		
Scaevola albida	Pale Fan-flower		✓			
Juncaceae						
**Juncus acutus*	Sharp Rush				✓	✓
Lamiaceae						
Ajuga australis	Austral Bugle		✓			
**Mentha pulegium*	Pennyroyal		✓			
Mentha satureioides	Native Pennyroyal		✓	✓	✓	✓
Scutellaria humilis	Dwarf Skullcap		✓	✓		
Teucrium species A		✓				
Linaceae						
Linum marginale	Native Flax		✓	✓	✓	✓
**Linum trigynum*	French Flax	✓	✓	✓	✓	✓
Lobeliaceae						
Isotoma fluviatilis subsp. *fluviatilis*	Swamp Isotome		✓	✓		
Lomandraceae						
Lomandra confertifolia	Mat-rush	✓	✓	✓	✓	✓
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush		✓			
Lomandra longifolia	Spiny-headed Mat-rush	✓	✓		✓	
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	✓	✓	✓	✓	✓
Luzuriagaceae						
Geitonoplesium cymosum	Scrambling Lily		✓	✓		
Malvaceae						
Abutilon oxycarpum	Lantern Bush		✓			✓
**Modiola caroliniana*	Red-flowered Mallow	✓	✓			
Sida corrugata	Corrugated Sida	✓	✓	✓		✓
Sida cunninghamii	Ridged Sida	✓				
**Sida rhombifolia*	Paddy's Lucerne			✓		
**Sida spinosa*						✓
Moraceae						
Ficus rubiginosa	Port Jackson Fig, Rusty Fig				✓	
Myoporaceae						
Eremophila debilis	Amulla		✓	✓	✓	
Myoporum montanum	Western Boobialla		✓	✓	✓	

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
Myrtaceae						
Angophora floribunda	Rough-barked Apple		✓	✓		
Corymbia maculata	Spotted Gum		✓	✓	✓	
Eucalyptus blakelyi	Blakely's Red Gum			✓		✓
Eucalyptus dawsonii	Slaty Gum	✓				
Eucalyptus moluccana x albens	Grey Box		✓	✓	✓	✓
Eucalyptus punctata	Grey Gum			✓		
Eucalyptus tereticornis	Forest Red Gum				✓	
Oleaceae						
Notelaea microcarpa	Native Olive		✓	✓	✓	
Oxalidaceae						
Oxalis chnoodes			✓			✓
Oxalis perennans			✓	✓		
Oxalis sp.					✓	✓
Phormiaceae						
Dianella caerulea	Blue Flax-lily		✓			
Dianella longifolia	Blue Flax-lily		✓			
Dianella revoluta	Blue Flax-lily		✓	✓	✓	✓
Dianella tasmanica	Tasman Flax-lily			✓		
Pittosporaceae						
Bursaria spinosa	Blackthorn	✓	✓	✓	✓	✓
Plantaginaceae						
Plantago gaudichaudii	Narrow Plantain		✓	✓		
**Plantago lanceolata*	Lamb's Tongues			✓		
Poaceae						
**Aira cupaniana*	Silver Hairgrass				✓	
Aristida acuta			✓			
Aristida calycina			✓		✓	
Aristida personata	Purple Wire-grass	✓	✓		✓	
Aristida ramosa	Purple Wiregrass		✓			
Austrodanthonia fulva	Wallaby Grass		✓			✓
Austrodanthonia setacea	Smallflower Wallaby-grass		✓	✓	✓	
Austrostipa aristiglumis	Plains Grass	✓				
Austrostipa scabra	Speargrass		✓			
Austrostipa scabra subsp. *falcata*		✓	✓	✓	✓	✓
Austrostipa scabra subsp. *scabra*	Speargrass		✓	✓	✓	✓
Austrostipa verticillata	Slender Bamboo Grass	✓	✓		✓	✓

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
Bothriochloa biloba		✓	✓			
Bothriochloa decipiens	Red Grass	✓	✓	✓	✓	✓
Bothriochloa macra	Red Grass	✓	✓			✓
**Bromus catharticus*	Praire Grass		✓	✓	✓	✓
**Bromus molliformis*	Soft Broome		✓	✓		
**Chloris gayana*	Rhodes Grass	✓	✓	✓		
Chloris truncata	Windmill Grass		✓	✓	✓	✓
Chloris ventricosa	Tall Chloris	✓	✓	✓	✓	✓
Cymbopogon refractus	Barbed Wire Grass	✓	✓	✓	✓	✓
**Cynodon dactylon*	Common Couch	✓	✓		✓	✓
Dichanthium sericeum subsp. *sericeum*	Queensland Bluegrass	✓	✓	✓	✓	✓
Dichelachne crinita	Longhair Plumegrass	✓	✓	✓	✓	✓
Dichelachne rara			✓			
Digitaria brownii	Cotton Panic Grass	✓	✓	✓	✓	✓
Digitaria diffusa	Open Summer Grass	✓				
Digitaria divaricatissima	Umbrella Grass	✓	✓			
Digitaria ramularis			✓			✓
Elymus scaber var. scaber	Common Wheatgrass	✓		✓		
Enneapogon gracilis	Slender Nineawn		✓			
Enneapogon nigricans	Niggerheads		✓			
Enteropogon acicularis		✓				
Eragrostis alveiformis		✓			✓	✓
Eragrostis brownii	Brown's Lovegrass	✓				
Eragrostis lacunaria	Purple Lovegrass	✓		✓	✓	
Eragrostis leptostachya	Paddock Lovegrass	✓	✓	✓	✓	✓
Eriochloa pseudoacrotricha	Early Spring Grass	✓			✓	✓
Eulalia aurea	Silky Browntop	✓	✓	✓	✓	✓
**Hyparrhenia hirta*	Coolatai Grass		✓	✓	✓	✓
**Lolium multiflorum*	Italian Ryegrass		✓			✓
**Lolium perenne*	Perennial Ryegrass			✓		
**Melinis repens*	Red Natal Grass				✓	✓
Microlaena stipoides	Weeping Grass		✓	✓	✓	✓
Panicum effusum	Hairy Panic	✓	✓			✓
**Panicum maximum* var. *maximum*	Guinea Grass					✓
Panicum queenslandicum	Yadbila Grass	✓	✓	✓	✓	✓
Panicum simile	Two-colour Panic		✓			
Paspalidium distans		✓	✓		✓	

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
**Paspalum dilatatum*	Paspalum	✓	✓	✓	✓	✓
Paspalum distichum	Water Couch				✓	✓
**Pennisetum clandestinum*	Kikuyu Grass				✓	
**Phalaris arundinacea* var. *arundinacea*	Reed Canary Grass					✓
**Setaria parviflora*	Slender Pigeon Grass					✓
Sporobolus caroli	Fairy Grass	✓				
Sporobolus creber	Slender Rat's Tail Grass	✓	✓	✓	✓	✓
Themeda australis	Kangaroo Grass		✓	✓		✓
Polygalaceae						
Polygala japonica	Dwarf Milkwort		✓			
Polygonaceae						
Persicaria decipiens	Slender Knotweed				✓	
Persicaria subsessilis	Hairy Knotweed				✓	
**Polygonum arenastrum*	Wireweed	✓				
Rumex brownii	Swamp Dock		✓	✓		
Primulaceae						
**Anagallis arvensis*	Scarlet/Blue Pimpernel	✓	✓	✓	✓	✓
Ranunculaceae						
Clematis glycinoides	Headache Vine		✓	✓	✓	
Rhamnaceae						
Cryptandra amara	Bitter cryptandra				✓	
Rosaceae						
Acaena ovina			✓	✓		
Rubus parvifolius	Native Raspberry			✓		
Rubiaceae						
Asperula conferta	Common Woodruff		✓	✓	✓	✓
**Galium aparine*	Goosegrass					✓
Galium propinquum	Maori Bedstraw		✓	✓		
Psydrax odorata	Shiny-leaved Canthium		✓			
Santalaceae						
Exocarpos strictus	Dwarf Cherry			✓		
Sapindaceae						
Dodonaea viscosa subsp. *angustifolia*	Narrow-leaved Hopbush			✓		
Scrophulariaceae						
**Verbascum virgatum*	Twiggy Mullein		✓		✓	
Veronica plebeia	Trailing Speedwell		✓	✓	✓	✓

Family and Scientific Name	Common Name	Modification Area				
		A	B	C	D	E
Solanaceae						
**Lycium ferocissimum*	African Boxthorn			✓		✓
Solanum elegans	Spiny Kangaroo Apple		✓			
**Solanum nigrum*	Black-berry Nightshade		✓			
**Solanum physalifolium* var. *nitidibaccatum*				✓	✓	
Solanum prinophyllum	Forest Nightshade		✓			
Solanum sp.			✓			
Stackhousiaceae						
Stackhousia muricata	Western Stackhousia		✓			
Sterculiaceae						
Brachychiton populneus	Kurrajong		✓	✓	✓	
Thymelaeaceae						
Pimelea curviflora var. gracilis			✓	✓		
Typhaceae						
Typha orientalis	Broad-leaved Cumbungi				✓	
Verbenaceae						
**Verbena bonariensis*	Purpletop		✓	✓		✓
**Verbena rigida*		✓				✓
Xanthorrhoeaceae						
Xanthorrhoea glauca				✓		

* Introduced species.

APPENDIX 5

VEGETATION SAMPLE PLOT DATA

Family Name	Scientific Name	Plot and Cover-Abundance Scores									
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Acanthaceae	*Rostellularia adscendens* var. *adscendens*		3								
Adiantaceae	*Cheilanthes sieberi*			2	2		1	1		1	
Aizoaceae	**Galenia pubescens*	1		1	3	3		2		1	
Asclepiadaceae	**Gomphocarpus fruticosus*	1					1		4		
Asteraceae	**Bidens pilosa*		3								
Asteraceae	**Carthamus lanatus*		2				1			1	
Asteraceae	**Cirsium vulgare*		2	1							
Asteraceae	**Conyza sumatrensis*		1			1	1	1			
Asteraceae	**Senecio madagascariensis*	1	1	1		1	1	1	1	1	
Asteraceae	*Brachyscome ciliaris* var. *subintegrifolia*							1			
Asteraceae	*Chrysocephalum apiculatum*					1		2			
Asteraceae	**Lactuca saligna*		1	1							
Asteraceae	*Vittadinia cuneata* f. *cuneata*			1							
Brassicaceae	**Lepidium africanum*				1	2		1			
Cactaceae	**Opuntia stricta* var. *stricta*						1				
Campanulaceae	*Wahlenbergia communis*			1						1	1
Casuarinaceae	*Allocasuarina luehmannii*			4	5	3		1			
Chenopodiaceae	*Atriplex semibaccata*				1	1					
Chenopodiaceae	*Chenopodium glaucum*				1						
Chenopodiaceae	*Enchylaena tomentosa*				1	2					
Chenopodiaceae	*Maireana microphylla*				1	2	1	1			
Chenopodiaceae	*Sclerolaena muricata*					1					
Convolvulaceae	*Convolvulus erubescens*		1								
Convolvulaceae	*Dichondra repens*										1
Convolvulaceae	*Dichondra* species A	1									
Cyperaceae	*Fimbristylis dichotoma*			1	1		1				
Fabaceae (Faboideae)	**Medicago sativa*	1									
Fabaceae (Faboideae)	**Trifolium incarnatum*		1								
Fabaceae (Faboideae)	*Glycine clandestina*			1							
Fabaceae (Faboideae)	*Glycine tabacina*			1			3			1	1
Fabaceae (Mimosoideae)	*Acacia decora*									1	
Geraniaceae	*Geranium solanderi*				1						
Lamiaceae	*Teucrium* species A		1								
Linaceae	**Linum trigynum*	1									

Family Name	Scientific Name	Plot and Cover-Abundance Scores									
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Lomandraceae	*Lomandra confertifolia*			1	1			1	1		
Lomandraceae	*Lomandra longifolia*									2	
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*			1							
Malvaceae	**Sida rhombifolia*				1	1	1	1	1	1	1
Malvaceae	*Sida corrugata*				1			1			1
Myrtaceae	*Eucalyptus dawsonii*					1		3	1		
Plantaginaceae	**Plantago lanceolata*	1	2	2	1	2	2		1	2	2
Poaceae	**Bromus catharticus*		1								
Poaceae	**Bromus molliformis*		1								
Poaceae	**Lolium perenne*		1						1		
Poaceae	**Paspalum dilatatum*								1	1	
Poaceae	*Aristida personata*							1			
Poaceae	*Aristida ramosa*	3	3	4	4	1	2	3	5	2	2
Poaceae	*Austrodanthonia fulva*	2					1	2	1	1	
Poaceae	*Austrostipa aristiglumis*		1								
Poaceae	*Austrostipa scabra* subsp. *falcata*				1	1	1	1		1	
Poaceae	*Austrostipa verticillata*		2		1	1					
Poaceae	*Bothriochloa biloba*	2	3				3		2	3	6
Poaceae	*Bothriochloa decipiens*		1	2	1	1		1			
Poaceae	*Bothriochloa macra*	1				2					
Poaceae	*Chloris truncata*					2	1	1			
Poaceae	*Chloris ventricosa*			1	2	2	2	1	2		
Poaceae	*Cymbopogon refractus*	1		1	1					1	
Poaceae	*Dichanthium sericeum* subsp. *sericeum*	3				1	2	1	3	3	1
Poaceae	*Dichelachne crinita*	1									
Poaceae	*Digitaria brownii*		1	1	1	1	1		1	1	1
Poaceae	*Digitaria diffusa*									1	
Poaceae	*Digitaria divaricatissima*		1								
Poaceae	*Elymus scaber* var. *scaber*									1	
Poaceae	*Enteropogon acicularis*							1		1	
Poaceae	*Eragrostis alveiformis*			2		2		2			
Poaceae	*Eragrostis benthamii*					2					
Poaceae	*Eragrostis brownii*			1							
Poaceae	*Eragrostis lacunaria*										1
Poaceae	*Eragrostis leptostachya*			1	1						
Poaceae	*Eriochloa pseudoacrotricha*					2	1	1		1	
Poaceae	*Eulalia aurea*			1	1				2	1	
Poaceae	*Panicum effusum*	1		1		1	1				

Family Name	*Scientific Name*	Plot and Cover-Abundance Scores									
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Poaceae	*Panicum queenslandicum*	2	2	1		2	1	2	1	2	2
Poaceae	*Paspalidium distans*		1	1	1		1				
Poaceae	*Sporobolus caroli*	1									
Poaceae	*Sporobolus creber*	3		1	2	3	3	3	2	3	1
Polygonaceae	**Polygonum arenastrum*				1						
Polygonaceae	*Rumex brownii*									1	
Primulaceae	**Anagallis arvensis*		1								
Verbenaceae	**Verbena rigida*	1									

* Introduced species.

Family Name	Scientific Name	Plot and Cover-Abundance Scores										
		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Acanthaceae	*Rostellularia adscendens*								1			
Acanthaceae	*Rostellularia adscendens* var. *adscendens*				1							
Adiantaceae	*Cheilanthes distans*		1			1						
Adiantaceae	*Cheilanthes sieberi*	1		1	2	2	1	1	1		1	2
Aizoaceae	**Galenia pubescens*						1			2		
Anthericaceae	*Caesia parviflora*					1						
Apiaceae	*Centella asiatica*					1						
Apiaceae	*Hydrocotyle laxiflora*						1	1				
Asclepiadaceae	**Gomphocarpus fruticosus*	2	1	1	1		2	2	1	1	2	2
Asphodelaceae	**Asphodelus fistulosus*		1						2	1		
Asteraceae	**Bidens pilosa*			1						1		
Asteraceae	**Carthamus lanatus*									1		
Asteraceae	**Cirsium vulgare*	2	1					2	1	4	3	1
Asteraceae	**Conyza sumatrensis*					1			1	5	2	2
Asteraceae	**Hypochaeris radicata*										1	
Asteraceae	**Senecio madagascariensis*	3	1	1	2	2	3	3	2		2	2
Asteraceae	**Sonchus oleraceus*				1							
Asteraceae	**Taraxacum officinale*						4	3				
Asteraceae	*Brachyscome multifida* var. *dilatata*				1							
Asteraceae	*Calotis hispidula*										1	
Asteraceae	*Calotis lappulacea*		2	2	2	3			3			2
Asteraceae	*Chrysocephalum apiculatum*	2			1		2	3	2		1	2
Asteraceae	*Cymbonotus lawsonianus*	1				1						
Asteraceae	*Euchiton sphaericus*	1		1	1						1	1
Asteraceae	*Glossocardia bidens*		1	1					1			1
Asteraceae	**Lactuca saligna*						1			1		1
Asteraceae	*Lagenifera gracilis*				1							
Asteraceae	*Minuria leptophylla*										1	
Asteraceae	*Senecio quadridentatus*					1			1	2	1	1
Asteraceae	*Sigesbeckia orientalis*		1			1			1			1
Asteraceae	*Vittadinia cervicularis* var. *cervicularis*										2	
Asteraceae	*Vittadinia cuneata* f. *cuneata*	2	2		1	2	2	2	2		2	
Brassicaceae	**Brassica rapa* subsp. *sylvestris*									1		
Brassicaceae	**Lepidium africanum*		1									
Brassicaceae	*Lepidium pseudohyssopifolium*		1									

Family Name	Scientific Name	Plot and Cover-Abundance Scores										
		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Cactaceae	**Opuntia stricta var. stricta*						1				1	1
Campanulaceae	*Wahlenbergia communis*		1			1	1	1	1	1	1	
Casuarinaceae	*Allocasuarina littoralis*				1							
Chenopodiaceae	*Atriplex semibaccata*		1	1								
Chenopodiaceae	*Einadia nutans*		1									
Chenopodiaceae	*Maireana microphylla*	1	1						1			
Chloanthaceae	*Spartothamnella juncea*		2	1	2	3			1			1
Convolvulaceae	*Convolvulus erubescens*								1			1
Convolvulaceae	*Dichondra repens*	2	2	2	2	2	2	1	2	2		1
Convolvulaceae	*Polymeria calycina*		1	1	1	1						
Cyperaceae	*Carex inversa*									3		
Cyperaceae	*Cyperus gracilis*		1			1			1			1
Cyperaceae	*Fimbristylis dichotoma*	1										
Cyperaceae	*Scleria mackaviensis*		1									
Euphorbiaceae	*Chamaesyce drummondii*			1							1	
Euphorbiaceae	*Phyllanthus gunnii*		1									
Euphorbiaceae	*Phyllanthus virgatus*											1
Fabaceae (Faboideae)	*Desmodium gunnii*		1	1	2	1						
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*										1	
Fabaceae (Faboideae)	*Desmodium varians*					1						
Fabaceae (Faboideae)	*Glycine tabacina*	1	2	1			1		2		1	
Fabaceae (Faboideae)	*Hardenbergia violacea*								1			
Fabaceae (Mimosoideae)	*Acacia cultriformis*		3									1
Fabaceae (Mimosoideae)	*Acacia decora*			2								3
Fabaceae (Mimosoideae)	*Acacia implexa*				2							
Fabaceae (Mimosoideae)	*Acacia salicina*								2			
Gentianaceae	**Centaurium erythraea*						1	1			1	1
Gentianaceae	**Centaurium tenuiflorum*										1	
Geraniaceae	*Geranium solanderi*				2			1		1		
Goodeniaceae	*Scaevola albida*											1
Lamiaceae	*Ajuga australis*		1			1			2			
Lamiaceae	*Mentha satureioides*	2		1			1	2			3	2
Lamiaceae	*Scutellaria humilis*					1						
Linaceae	**Linum trigynum*	1										
Linaceae	*Linum marginale*			1			1				1	1
Lobeliaceae	*Isotoma fluviatilis* subsp. *fluviatilis*				1							
Lomandraceae	*Lomandra confertifolia*	2	3	2	1	3	1	1	3		2	2

Family Name	Scientific Name	Plot and Cover-Abundance Scores										
		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*				1							
Lomandraceae	*Lomandra longifolia*								3			
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	2	3	1	2	1		1				2
Luzuriagaceae	*Geitonoplesium cymosum*		2		1							
Malvaceae	**Modiola caroliniana*									2		
Malvaceae	**Sida rhombifolia*	1	1	1		1	3	2	1	4	2	2
Malvaceae	*Abutilon oxycarpum*		1									
Malvaceae	*Sida corrugata*		2	2		1	1	1	2			1
Myoporaceae	*Eremophila debilis*		2	1		1		1				1
Myoporaceae	*Myoporum montanum*					1			3			1
Myrtaceae	*Corymbia maculata*				2							
Myrtaceae	*Eucalyptus moluccana*		2	4	2	2			4			4
Oleaceae	*Notelaea microcarpa*		2	2	1	3						1
Oxalidaceae	*Oxalis chnoodes*	1	1						1			
Oxalidaceae	*Oxalis perennans*					1						
Phormiaceae	*Dianella caerulea*								1			
Phormiaceae	*Dianella longifolia*		1					1				1
Phormiaceae	*Dianella revoluta*				1							
Phormiaceae	*Dianella tasmanica*		1	1	1							
Pittosporaceae	*Bursaria spinosa*		1		1	1		1	1			
Plantaginaceae	**Plantago lanceolata*	2		1		2	3				2	1
Plantaginaceae	*Plantago gaudichaudii*	1	2			1	1		2			1
Poaceae	**Bromus catharticus*									1		
Poaceae	**Hyparrhenia hirta*										1	
Poaceae	**Paspalum dilatatum*	1		1			2	3			1	1
Poaceae	*Aristida acuta*								1	1		
Poaceae	*Aristida personata*		3	4					3			
Poaceae	*Aristida ramosa*	3		5		1		3		2	4	3
Poaceae	*Austrodanthonia fulva*	1		2	2	2			2		1	1
Poaceae	*Austrodanthonia setacea*				3							
Poaceae	*Austrostipa scabra*		2									
Poaceae	*Austrostipa scabra* subsp. *falcata*							1	2			1
Poaceae	*Austrostipa scabra* subsp. *scabra*			1		1			2			
Poaceae	*Austrostipa verticillata*									5		1
Poaceae	*Bothriochloa biloba*										3	
Poaceae	*Bothriochloa decipiens*	1	2			1	1	2		1		1
Poaceae	*Bothriochloa macra*						1		1			

Family Name	Scientific Name	Plot and Cover-Abundance Scores										
		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Poaceae	*Chloris truncata*			1								
Poaceae	*Chloris ventricosa*	4	2	2	1	3	2	2	3	1	4	3
Poaceae	*Cymbopogon refractus*	2	2	2		2	1		1		1	1
Poaceae	*Dichanthium sericeum* subsp. *sericeum*	2		2			1				2	1
Poaceae	*Dichelachne crinita*	1										
Poaceae	*Dichelachne rara*					1						
Poaceae	*Digitaria brownii*		2				1	1	3	1		2
Poaceae	*Digitaria divaricatissima*										1	
Poaceae	*Digitaria ramularis*								1			
Poaceae	*Elymus scaber* var. *scaber*		1									
Poaceae	*Enneapogon gracilis*		1									
Poaceae	*Enneapogon nigricans*								1			
Poaceae	*Eragrostis leptostachya*			1	1							
Poaceae	*Microlaena stipoides*								1	1		1
Poaceae	*Panicum effusum*		1			2	1		2			
Poaceae	*Panicum queenslandicum*	3	1	2	2		1		2	3	1	3
Poaceae	*Panicum simile*								1			
Poaceae	*Paspalidium distans*		1	1					1	1		
Poaceae	*Sporobolus creber*	1					1				1	2
Poaceae	*Themeda australis*	2			1				3			3
Polygalaceae	*Polygala japonica*				1							
Polygonaceae	*Rumex brownii*	1					1			1		
Primulaceae	**Anagallis arvensis*		1	1	1			1	1	1	1	
Ranunculaceae	*Clematis glycinoides*			1	1	1						1
Rosaceae	*Acaena ovina*	2		1	1		3	3			1	1
Rubiaceae	*Asperula conferta*	2	1		1	1	1	1			2	2
Rubiaceae	*Galium propinquum*		1			1						
Rubiaceae	*Psydrax odorata*		2	2	1	1						3
Scrophulariaceae	**Verbascum virgatum*										1	
Scrophulariaceae	*Veronica plebeia*				1	1		1		1		
Solanaceae	**Solanum nigrum*								1	2		1
Solanaceae	*Solanum elegans*					1						
Solanaceae	*Solanum* sp.								1			
Stackhousiaceae	*Stackhousia muricata*							1				
Sterculiaceae	*Brachychiton populneus*			1		2			1			3
Thymelaeaceae	*Pimelea curviflora*	1										2
Verbenaceae	**Verbena bonariensis*									2	1	

* Introduced species.

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		C1	C2	C3	C4	C5	C6
Acanthaceae	*Rostellularia adscendens* var. *adscendens*		1				
Adiantaceae	*Cheilanthes sieberi*	2			1	1	2
Anthericaceae	*Caesia parviflora*					1	
Apiaceae	*Centella asiatica*	2				1	
Asclepiadaceae	**Gomphocarpus fruticosus*		1	1	3	1	
Asphodelaceae	**Asphodelus fistulosus*			1			
Asteraceae	**Bidens pilosa*		1		1	1	
Asteraceae	**Cirsium vulgare*		1	1	3	1	
Asteraceae	**Conyza sumatrensis*		1			1	1
Asteraceae	**Conyza canadensis*	1					
Asteraceae	*Euchiton involucratus*	1					
Asteraceae	**Senecio madagascariensis*	2	1	3	2		1
Asteraceae	**Taraxacum officinale*		2			1	
Asteraceae	*Brachyscome multifida* var. *dilatata*	1					
Asteraceae	*Calotis lappulacea*		1	2	1	1	
Asteraceae	*Cassinia quinquefaria*	1	1				
Asteraceae	*Chrysocephalum apiculatum*		1		1		
Asteraceae	*Cymbonotus lawsonianus*		1	1	1		
Asteraceae	*Olearia elliptica*	3	2				
Asteraceae	*Senecio diaschides*		1				
Asteraceae	*Senecio quadridentatus*	1	1				
Asteraceae	*Sigesbeckia orientalis*		1	1	1	1	1
Asteraceae	*Vittadinia cervicularis* var. *cervicularis*			1			
Brassicaceae	**Brassica rapa* subsp. *sylvestris*			1			
Cactaceae	**Opuntia stricta* var. *stricta*			1	1	1	1
Campanulaceae	*Wahlenbergia communis*				1		
Celastraceae	*Maytenus silvestris*						3
Chenopodiaceae	*Einadia nutans*	1	1				
Chenopodiaceae	*Maireana microphylla*			1			
Chloanthaceae	*Spartothamnella juncea*	1	1			2	2
Convolvulaceae	*Convolvulus erubescens*						1
Convolvulaceae	*Dichondra repens*	2	2	2	1	2	2
Euphorbiaceae	*Breynia oblongifolia*					3	

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		C1	C2	C3	C4	C5	C6
Fabaceae (Caesalpinioideae)	*Senna odorata*					3	
Fabaceae (Faboideae)	**Medicago orbicularis*		1	1			
Fabaceae (Faboideae)	*Daviesia genistifolia*					3	1
Fabaceae (Faboideae)	*Desmodium gunnii*		1		1	2	2
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*						1
Fabaceae (Faboideae)	*Desmodium varians*		1			1	
Fabaceae (Faboideae)	*Glycine microphylla*	1					1
Fabaceae (Faboideae)	*Glycine tabacina*			1	2		
Fabaceae (Faboideae)	*Hardenbergia violacea*		1				
Fabaceae (Faboideae)	*Swainsona galegifolia*		1				
Fabaceae (Mimosoideae)	*Acacia maidenii*		1				3
Gentianaceae	**Centaurium tenuiflorum*		1				
Geraniaceae	*Geranium solanderi*		1				
Lamiaceae	*Mentha satureioides*			1	3	1	
Linaceae	**Linum trigynum*			1			
Linaceae	*Linum marginale*		1		1		
Lobeliaceae	*Isotoma fluviatilis* subsp. *fluviatilis*	1					
Lomandraceae	*Lomandra confertifolia*	2	3				1
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	1	1				1
Luzuriagaceae	*Geitonoplesium cymosum*	1	1			1	2
Malvaceae	**Sida rhombifolia*			2	1	1	
Malvaceae	*Sida corrugata*		1	2			
Myoporaceae	*Eremophila debilis*						1
Myoporaceae	*Myoporum montanum*		2	1	1	1	1
Myrtaceae	*Angophora floribunda*	2					
Myrtaceae	*Corymbia maculata*					4	5
Myrtaceae	*Eucalyptus blakelyi*	3	5				
Myrtaceae	*Eucalyptus moluccana*	2					
Oleaceae	*Notelaea microcarpa*	4	3			4	3
Oxalidaceae	*Oxalis perennans*	1				1	
Phormiaceae	*Dianella longifolia*	1	2		1	1	1

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		C1	C2	C3	C4	C5	C6
Phormiaceae	*Dianella tasmanica*	1	1			1	1
Pittosporaceae	*Bursaria spinosa*	1	1				1
Plantaginaceae	**Plantago lanceolata*		1			1	
Plantaginaceae	*Plantago gaudichaudii*					1	
Poaceae	**Hyparrhenia hirta*				1		
Poaceae	**Paspalum dilatatum*		1			1	
Poaceae	*Aristida personata*		1	3			
Poaceae	*Aristida ramosa*	2	3			3	
Poaceae	*Austrodanthonia fulva*			1			
Poaceae	*Austrodanthonia setacea*	4	1			1	3
Poaceae	*Austrostipa scabra* subsp. *falcata*			1			
Poaceae	*Austrostipa scabra* subsp. *scabra*	1				1	
Poaceae	*Bothriochloa decipiens*		1				
Poaceae	*Chloris truncata*			1			
Poaceae	*Chloris ventricosa*			3	3		
Poaceae	*Cymbopogon refractus*	1	1	1	1	2	2
Poaceae	*Dichanthium sericeum* subsp. *sericeum*			3	2		
Poaceae	*Dichelachne crinita*	1	1	1			
Poaceae	*Digitaria brownii*			1	1		
Poaceae	*Eragrostis lacunaria*				1		
Poaceae	*Eragrostis leptostachya*	1					
Poaceae	*Microlaena stipoides*					2	2
Poaceae	*Panicum queenslandicum*			2	1		
Poaceae	*Sporobolus creber*			1			
Poaceae	*Themeda australis*	2					
Primulaceae	**Anagallis arvensis*	1	1	1		1	1
Ranunculaceae	*Clematis glycinoides*	1	1			2	2
Rosaceae	**Acaena ovina*	1				1	
Rosaceae	*Rubus parvifolius*	1					
Rubiaceae	*Asperula conferta*	2	1	1			
Rubiaceae	*Galium propinquum*	1				1	1
Sapindaceae	*Dodonaea viscosa* subsp. *angustifolia*	2					
Scrophulariaceae	*Veronica plebeia*					1	2
Solanaceae	*Solanum physalifolium* var. *nitidibaccatum*	1					1
Sterculiaceae	*Brachychiton populneus*					1	1

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		C1	C2	C3	C4	C5	C6
Verbenaceae	**Verbena bonariensis*				1		

* Introduced species.

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		D1	D2	D3	D4	D5	D6
Adiantaceae	*Cheilanthes sieberi*	2	2	2	2	2	2
Aizoaceae	**Galenia pubescens*			3		3	
Asclepiadaceae	**Gomphocarpus fruticosus*	2	1	1		1	
Asteraceae	**Bidens pilosa*	1	3				1
Asteraceae	**Carthamus lanatus*					1	
Asteraceae	**Cirsium vulgare*	1	1	1		1	
Asteraceae	**Conyza sumatrensis*	1					
Asteraceae	*Euchiton involucratus*		1				
Asteraceae	**Hypochaeris radicata*						1
Asteraceae	**Senecio madagascariensis*	2	2	3	3	2	2
Asteraceae	**Taraxacum officinale*	1	1		2		
Asteraceae	**Xanthium occidentale*		2				
Asteraceae	*Calotis lappulacea*		1		1		2
Asteraceae	*Chrysocephalum apiculatum*	1	1	1	1	2	2
Asteraceae	*Glossocardia bidens*					1	
Asteraceae	**Lactuca saligna*		1				
Asteraceae	*Senecio hispidulus*		1				
Asteraceae	*Senecio quadridentatus*	1	1				
Asteraceae	*Vittadinia cuneata* f. *cuneata*		1		1		
Cactaceae	**Opuntia stricta* var. *stricta*			1		1	1
Campanulaceae	*Wahlenbergia communis*	1	1		1	1	1
Casuarinaceae	*Allocasuarina luehmannii*				1		1
Chenopodiaceae	*Einadia nutans*					1	2
Chenopodiaceae	*Enchylaena tomentosa*		1				1
Chloanthaceae	*Spartothamnella juncea*		1				
Clusiaceae	**Hypericum perforatum*	1					
Clusiaceae	*Hypericum gramineum*	1					
Convolvulaceae	*Dichondra repens*	1	2		2	2	2
Convolvulaceae	*Polymeria calycina*		1				
Cyperaceae	*Carex inversa*	1			1		
Cyperaceae	*Cyperus fulvus*		1				
Fabaceae (Faboideae)	**Trifolium subterraneum*		1				
Fabaceae (Faboideae)	*Desmodium brachypodum*				1		
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*	1					
Fabaceae (Faboideae)	*Glycine clandestina*	1					
Fabaceae (Faboideae)	*Glycine microphylla*		1				
Fabaceae (Faboideae)	*Glycine tabacina*					1	
Fabaceae (Faboideae)	*Hardenbergia violacea*		3				

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		D1	D2	D3	D4	D5	D6
Fabaceae (Mimosoideae)	*Acacia salicina*	2	1		2		1
Lamiaceae	*Mentha satureioides*	3			1	2	
Linaceae	**Linum trigynum*					1	
Linaceae	*Linum marginale*				1		
Lomandraceae	*Lomandra confertifolia*				2		
Lomandraceae	*Lomandra longifolia*		1		2		
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*						1
Malvaceae	**Sida rhombifolia*	2		3	2	2	1
Myoporaceae	*Eremophila debilis*	1			1		
Myrtaceae	*Angophora floribunda*				1		
Myrtaceae	*Corymbia maculata*		2		2		4
Myrtaceae	*Eucalyptus moluccana*						1
Myrtaceae	*Eucalyptus tereticornis*		5		4		
Oxalidaceae	*Oxalis* sp.			1		1	1
Phormiaceae	*Dianella longifolia*	1					
Phormiaceae	*Dianella tasmanica*		3				1
Plantaginaceae	**Plantago lanceolata*	3	2	2		5	2
Poaceae	**Aira cupaniana*					1	
Poaceae	**Chloris gayana*	2	2				
Poaceae	*Cynodon dactylon*		3		1		
Poaceae	**Hyparrhenia hirta*					2	
Poaceae	**Lolium multiflorum*		1				
Poaceae	**Paspalum dilatatum*	2	2	1	2	2	1
Poaceae	*Aristida calycina*					1	
Poaceae	*Aristida personata*		3				1
Poaceae	*Aristida ramosa*	1	1	3	5		1
Poaceae	*Austrodanthonia fulva*		1		1		1
Poaceae	*Austrodanthonia setacea*		1				
Poaceae	*Austrostipa scabra* subsp. *falcata*						1
Poaceae	*Austrostipa scabra* subsp. *scabra*						2
Poaceae	*Austrostipa verticillata*	1		3			
Poaceae	*Bothriochloa decipiens*		1		1	1	2
Poaceae	*Chloris ventricosa*	3	3		2	3	3
Poaceae	*Cymbopogon refractus*	1	1		1	1	2
Poaceae	*Dichanthium sericeum* subsp. *sericeum*	1	2				1
Poaceae	*Dichelachne crinita*		1				
Poaceae	*Digitaria brownii*	2		2		3	2
Poaceae	*Elymus scaber var. scaber*						1

Family Name	Scientific Name	Plot and Cover-Abundance Scores					
		D1	D2	D3	D4	D5	D6
Poaceae	*Eragrostis alveiformis*						1
Poaceae	*Eragrostis lacunaria*				1		
Poaceae	*Eragrostis leptostachya*				1		
Poaceae	*Eriochloa pseudoacrotricha*				1	1	
Poaceae	*Eulalia aurea*	1					
Poaceae	*Microlaena stipoides*	1	2	4	1	1	3
Poaceae	*Panicum queenslandicum*	2	1	2	2	2	2
Poaceae	*Paspalidium distans*	1			1		
Poaceae	*Sporobolus creber*	2			1	1	1
Primulaceae	**Anagallis arvensis*	1	1				
Ranunculaceae	*Clematis glycinoides*		3		1		
Rubiaceae	*Asperula conferta*	3			1	1	1
Scrophulariaceae	*Veronica plebeia*	1	1		1		1
Solanaceae	**Lycium ferocissimum*		1		1		1
Solanaceae	*Solanum physalifolium* var. *nitidibaccatum*				1		
Sterculiaceae	*Brachychiton populneus*		2				

* Introduced species.

Family Name	Scientific Name	Plot and Cover-Abundance Scores						
		E1	E2	E3	E4	E5	E6	E7
Adiantaceae	*Cheilanthes sieberi*	1		1	2	1		2
Aizoaceae	**Galenia pubescens*			3		1	1	
Asclepiadaceae	**Gomphocarpus fruticosus*						1	
Asteraceae	**Aster subulatus*		1					
Asteraceae	**Bidens pilosa*	1				1		1
Asteraceae	**Carthamus lanatus*					2		
Asteraceae	**Cirsium vulgare*	1	3		1	2		
Asteraceae	**Conyza bonariensis*	1						
Asteraceae	**Lactuca sp.*		1					
Asteraceae	**Senecio madagascariensis*	3	3	1	3	2	1	2
Asteraceae	**Taraxacum officinale*	1	1			1		
Asteraceae	*Calotis cuneifolia*					1		
Asteraceae	*Calotis lappulacea*				1	2		
Asteraceae	*Chrysocephalum apiculatum*			1	2	2		3
Asteraceae	*Senecio quadridentatus*	1				1	1	1
Asteraceae	*Vittadinia cuneata* f. *cuneata*					1		
Asteraceae	*Vittadinia dissecta* var. *hirta*	2						
Brassicaceae	**Hirschfeldia incana*			1				
Brassicaceae	**Lepidium africanum*							1
Brassicaceae	**Sinapis arvensis*						1	
Brassicaceae	*Lepidium pseudohyssopifolium*			1				1
Cactaceae	**Opuntia stricta* var. *stricta*					1		
Campanulaceae	*Wahlenbergia communis*	1		1				
Casuarinaceae	*Allocasuarina luehmannii*							1
Chenopodiaceae	*Einadia nutans*					1		
Chenopodiaceae	*Enchylaena tomentosa*			1				1
Chenopodiaceae	*Sclerolaena birchii*		1					
Clusiaceae	**Hypericum perforatum*	2			3			
Convolvulaceae	*Dichondra repens*	1				2	1	
Cyperaceae	*Carex inversa*			1				
Cyperaceae	*Fimbristylis dichotoma*	1						
Fabaceae (Faboideae)	**Medicago minima*						1	
Fabaceae (Faboideae)	**Melilotus indicus*						1	
Fabaceae (Faboideae)	**Trifolium* sp.						2	
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*			1				
Fabaceae (Faboideae)	*Glycine tabacina*	1						
Fabaceae (Mimosoideae)	*Acacia decora*							1

Family Name	Scientific Name	Plot and Cover-Abundance Scores						
		E1	E2	E3	E4	E5	E6	E7
Fabaceae (Mimosoideae)	*Acacia salicina*					4		
Gentianaceae	**Centaurium erythraea*					1	1	
Juncaceae	**Juncus acutus*		3					
Lamiaceae	*Mentha satureioides*			2				
Linaceae	**Linum trigynum*			1				
Linaceae	*Linum marginale*	2		1		1		1
Lomandraceae	*Lomandra confertifolia*	2		2	2	2		3
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	2				1		1
Malvaceae	**Modiola caroliniana*						1	
Malvaceae	**Sida rhombifolia*			2	1	3	1	2
Malvaceae	*Abutilon oxycarpum*			1				
Malvaceae	*Sida corrugata*			1				
Malvaceae	**Sida spinosa*			1				
Myrtaceae	*Eucalyptus blakelyi*					4		
Myrtaceae	*Eucalyptus moluccana*							1
Oxalidaceae	*Oxalis chnoodes*					1		
Oxalidaceae	*Oxalis* sp.	1						
Plantaginaceae	**Plantago lanceolata*	1	1	3	3	3	3	
Poaceae	**Aira cupaniana*							1
Poaceae	**Chloris gayana*		1	1			2	
Poaceae	*Cynodon dactylon*	1	6	1		1		
Poaceae	**Hyparrhenia hirta*	3				3	1	
Poaceae	**Melinis repens*					1	1	
Poaceae	**Panicum maximum* var. *maximum*						1	
Poaceae	**Paspalum dilatatum*	3	1	1	3	3	1	1
Poaceae	**Phalaris arundinacea* var. *arundinacea*					1		
Poaceae	**Setaria parviflora*	2						
Poaceae	*Aristida personata*	3		3				
Poaceae	*Aristida ramosa*	2	1			2		2
Poaceae	*Austrodanthonia fulva*	2			1	2		1
Poaceae	*Austrostipa scabra* subsp. *falcata*	1		3		2		
Poaceae	*Austrostipa scabra* subsp. *scabra*						1	
Poaceae	*Austrostipa verticillata*					3		
Poaceae	*Bothriochloa decipiens*			1			1	
Poaceae	*Bothriochloa macra*	2						2
Poaceae	*Chloris ventricosa*	3	1			2		2
Poaceae	*Cymbopogon refractus*	2		1	2	2	1	1
Poaceae	*Dichanthium sericeum* subsp. *sericeum*	2		3	3	2	4	
Poaceae	*Dichelachne crinita*	1			1	1		

Family Name	Scientific Name	Plot and Cover-Abundance Scores						
		E1	E2	E3	E4	E5	E6	E7
Poaceae	*Digitaria brownii*	1					1	
Poaceae	*Digitaria ramularis*			1				
Poaceae	*Eragrostis alveiformis*			2				1
Poaceae	*Eragrostis leptostachya*					1		
Poaceae	*Eriochloa pseudoacrotricha*			1				
Poaceae	*Microlaena stipoides*	2				1		
Poaceae	*Panicum effusum*							1
Poaceae	*Panicum queenslandicum*	3		2	2	2		2
Poaceae	*Sporobolus creber*	2		2			2	1
Poaceae	*Themeda australis*	2			3			1
Polygonaceae	*Rumex brownii*	1						
Primulaceae	**Anagallis arvensis*			1		1	1	
Rubiaceae	*Asperula conferta*	1	1		1			
Scrophulariaceae	*Veronica plebeia*	1		1	1			
Solanaceae	**Lycium ferocissimum*			1		1		
Solanaceae	*Solanum prinophyllum*	1						1
Verbenaceae	**Verbena bonariensis*	1		1	1		1	
Verbenaceae	**Verbena rigida*	1			2	2		

* Introduced species.

APPENDIX 6

VEGETATION COMMUNITY PROFILES

The following are summary descriptions of the vegetation communities that were recorded within the Modification area.

VEGETATION COMMUNITY	Derived Native Grassland ([A]Box-Gum and [B]Unknown)
HRVP MAP UNIT	N/A
CONSERVATION STATUS	[A]White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC listed under the EPBC Act [A]White Box Yellow Box Blakely's Red Gum Woodland EEC listed under the TSC Act [B]None
RECORDED IN	All Modification areas
Plots: 30	**Mean diversity:** 27.2 species

DESCRIPTION	
Canopy	None
Shrubs	None
Ground	*Aristida ramosa, Aristida personata, Chloris ventricosa, Sporobolus creber, Dichanthium sericeum, Bothriochloa decipiens, Bothriochloa biloba, Panicum queenslandicum, Hyparrhenia hirta, Digitaria brownii*
Climbers and creepers	*Glycine tabacina*
Weeds – low to high abundance	**Senecio madagascariensis, *Hyparrhenia hirta*
Significant Species	*Bothriochloa biloba*

VEGETATION COMMUNITY	Central Hunter Box – Ironbark Woodland
HRVP MAP UNIT	MU10
CONSERVATION STATUS	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC listed under the EPBC Act White Box Yellow Box Blakely's Red Gum Woodland EEC listed under the TSC Act
RECORDED IN	Modification Areas B and C
Plots: 6	**Mean diversity:** 49 species

DESCRIPTION	
Canopy	*Eucalyptus albens x E. moluccana*
Shrubs	*Acacia cultriformis, Psydrax odorata, Spartothamnella juncea, Notelaea microcarpa, Acacia decora, Bursaria spinosa*
Ground	*Aristida ramosa, Aristida personata, Lomandra confertifolia, Austrostipa scabra* subsp. *falcata, Bothriochloa decipiens, Eremophila debilis, Pimelea curviflora* var. *gracilis*
Climbers and creepers	*Geitonoplesium cymosum, Polymeria calycina, Desmodium gunnii*
Weeds – low abundance	**Senecio madagascariensis*
Significant Species	None recorded

VEGETATION COMMUNITY	Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant
HRVP MAP UNIT	MU10
CONSERVATION STATUS	Not threatened
RECORDED IN	Modification Area A
Plots: 4	**Mean diversity:** 27 species

DESCRIPTION	
Canopy	*Eucalyptus dawsonii, Allocasuarina luehmannii*
Shrubs	*Maireana microphylla*
Ground	*Aristida ramosa, Chloris ventricosa, Sporobolus creber, Bothriochloa biloba, Eriochloa pseudoacrotricha, Glycine tabacina*
Climbers and creepers	*Glycine clandestina, Glycine tabacina*
Weeds – moderate abundance	**Galenia pubescens, *Plantago lanceolata*
Significant Species	*Bothriochloa biloba*

VEGETATION COMMUNITY	Upper Hunter Hills Box – Ironbark – Red Gum Woodland
HRVP MAP UNIT	MU9
CONSERVATION STATUS	Not threatened
RECORDED IN	Modification Area C
Plots: 2	**Mean diversity:** 44 species

DESCRIPTION	
Canopy	*Eucalyptus blakelyi, Eucalyptus albens x E. moluccana, Angophora floribunda, Brachychiton populneus*
Shrubs	*Notelaea microcarpa, Olearia elliptica, Dodonaea viscosa, Myoporum montanum, Spartothamnella juncea, Psydrax odorata,*
Ground	*Austrodanthonia setacea, Asperula conferta, Aristida ramosa, Centella asiatica*
Climbers and creepers	*Rubus parvifolius, Geitonoplesium cymosum, Clematis glycinoides, Hardenbergia violacea, Desmodium varians, Desmodium gunnii*
Weeds – low abundance	**Senecio madagascariensis, *Plantago lanceolata*
Significant Species	None recorded

VEGETATION COMMUNITY	Hunter Lowlands Red Gum Forest
HRVP MAP UNIT	MU24
CONSERVATION STATUS	Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC
RECORDED IN	Modification Area D
Plots: 2	**Mean diversity:** 45 species

DESCRIPTION	
Canopy	*Eucalyptus tereticornis, Eucalyptus punctata, Corymbia maculata, Brachychiton populneus*
Shrubs	*Spartothamnella juncea, Acacia salicina*
Ground	*Dianella tasmanica, Aristida personata, Chloris ventricosa*
Climbers and creepers	*Clematis glycinoides, Hardenbergia violacea, Veronica plebeia, Glycine microphylla, Polymeria calycina*
Weeds – moderate abundance	**Cynodon dactylon, *Bidens pilosa, *Chloris gayana, *Paspalum dilatatum*
Significant Species	None recorded

VEGETATION COMMUNITY	Central Hunter Ironbark – Spotted Gum – Grey Box Forest – Grassy Variant
HRVP MAP UNIT	MU27
CONSERVATION STATUS	Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSWNorth Coast and Sydney Basin Bioregions EEC
RECORDED IN	Proposed Modification Area D
Plots: 1	**Mean diversity:** 39 species

DESCRIPTION	
Canopy	*Corymbia maculata, Eucalyptus albens x E. moluccana*
Shrubs	*Acacia salicina, Allocasuarina luehmannii*
Ground	*Chloris ventricosa, Microlaena stipoides, Digitaria brownii, Austrostipa scabra* subsp. *scabra*
Climbers and creepers	*Veronica plebeia*
Weeds – low abundance	**Plantago lanceolata, *Senecio madagascariensis, *Lycium ferocissimum*
Significant Species	None recorded

VEGETATION COMMUNITY	Central Hunter Ironbark – Spotted Gum – Grey Box Forest – Shrubby Variant
HRVP MAP UNIT	MU27
CONSERVATION STATUS	Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the NSW North Coast and Sydney basin Bioregions EEC
RECORDED IN	Modification Areas B and C
Plots: 2	**Mean diversity:** 30 species

DESCRIPTION	
Canopy	*Corymbia maculata, Brachychiton populneus*
Shrubs	*Notelaea microcarpa, Daviesia genistifolia, Senna baronfieldii, Breynia oblongifolia, Spartothamnella juncea, Acacia maidenii, Maytenus sylvestris, Bursaria spinosa*
Ground	*Aristida ramosa, Microlaena stipoides, Dichondra repens, Austrodanthonia setacea*
Climbers and creepers	*Clematis glycinoides, Geitonoplesium cymosum, Desmodium gunnii,*
Weeds – low abundance	**Anagallis arvensis*
Significant Species	None recorded

VEGETATION COMMUNITY	Hunter Valley Weeping Myall Woodland
HRVP MAP UNIT	MU19
CONSERVATION STATUS	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC
RECORDED IN	Proposed Modification Area A
Plots: 2	**Mean diversity:** 28 species

DESCRIPTION	
Canopy	None
Shrubs	*Acacia pendula*
Ground	*Sporobolus creber*, *Dichanthium sericeum* subsp. *sericeum*, *Bothriochloa biloba*
Climbers and creepers	*Desmodium rhytidophyllum*
Weeds – low abundance	**Senecio madagascariensis*
Significant Species	*Acacia pendula*, *Bothriochloa biloba*

VEGETATION COMMUNITY	*Typha* Dominated Drainage Line
HRVP MAP UNIT	N/A
CONSERVATION STATUS	None
RECORDED IN	Modification Area D
Plots: None	**Mean diversity:** N/A
[No image]	
DESCRIPTION	
Canopy	None
Shrubs	None
Ground	*Typha orientalis*
Climbers and creepers	None
Weeds – low to high abundance	**Cynodon dactylon *Xanthium occidentale*
Significant Species	None

VEGETATION COMMUNITY	N/A
HRVP MAP UNIT	N/A
CONSERVATION STATUS	None
RECORDED IN	Modification Area A
Plots: N/A	**Mean diversity:** N/A

DESCRIPTION	
Canopy	None
Shrubs	None
Ground	Grassy, typical of surrounding derived grassland
Climbers and creepers	
Weeds – low to high abundance	**Chloris gayana*, **Bidens pilosa*
Significant Species	None

VEGETATION COMMUNITY	N/A
HRVP MAP UNIT	N/A
CONSERVATION STATUS	None
RECORDED IN	Modification Area E
Plots: 1	**Mean diversity:** 14 species

DESCRIPTION	
Canopy	None
Shrubs	None
Ground	**Juncus acutus, *Cynodon dactylon, *Senecio madagascariensis, *Cirsium vulgare*
Climbers and creepers	None
Weeds –high abundance	**Juncus acutus, *Cynodon dactylon, *Senecio madagascariensis, *Cirsium vulgare*
Significant Species	None

APPENDIX 7

SPECIES AND LOCATION OF HABITAT TREES

Coordinates are GDA94 MGA Zone 56

Modification Area	Species	Easting	Northing
Area A	Bulloak	294621	6421398
	Bulloak	294739	6420860
	Bulloak	294844	6420796
	Dead Stag	294718	6421218
	Dead Stag	294621	6421445
	Dead Stag	294626	6421305
	Dead Stag	294598	6421285
	Dead Stag	294542	6421415
	Dead Stag	294523	6421399
	Dead Stag	294488	6421393
	Dead Stag	294372	6421358
	Dead Stag	294419	6421302
	Dead Stag	294485	6421299
	Dead Stag	294496	6421339
	Dead Stag	294602	6421161
	Dead Stag	294511	6421123
	Dead Stag	294432	6421105
	Dead Stag	294646	6421112
	Dead Stag	294585	6421074
	Slaty Box	294796	6421244
	Slaty Box	294774	6421383
	Slaty Box	294773	6421514
	Slaty Box	294767	6421523
	Slaty Box	294687	6421540
	Slaty Box	294670	6421311
	Slaty Box	294704	6421300
	Slaty Box	294692	6421275
	Slaty Box	294692	6421229
	Slaty Box	294626	6421227
	Slaty Box	294617	6421258
	Slaty Box	294415	6421355
	Slaty Box	294555	6421331
	Slaty Box	294490	6421253
	Slaty Box	294589	6421175
	Slaty Box	294715	6420834
	Slaty Box	294895	6420757
	Slaty Box	294985	6420675

Area	Species	Easting	Northing
Area A (Continued)	Slaty Box	294882	6421027
	Slaty Box	294869	6421125
	Slaty Box	294775	6421151
	Slaty Box	294664	6421156
	White/Grey Box	294759	6421451
	White/Grey Box	294574	6421402
	White/Grey Box	294506	6421402
	White/Grey Box	294428	6421415
	White/Grey Box	294327	6421475
	White/Grey Box	294503	6421249
	White/Grey Box	294486	6421152
Area B	Dead Stag	297886	6417992
	Dead Stag	298157	6418004
	Dead Stag	298116	6417743
	Dead Stag	297703	6418159
	Dead Stag	297488	6418230
	Dead Stag	297549	6418249
	White/Grey Box	298225	6417874
	White/Grey Box	298158	6417860
	White/Grey Box	298115	6417902
	White/Grey Box	298132	6417917
	White/Grey Box	298096	6417916
	White/Grey Box	298028	6417910
	White/Grey Box	298006	6417883
	White/Grey Box	297990	6417877
	White/Grey Box	297952	6417887
	White/Grey Box	297910	6418001
	White/Grey Box	297945	6418016
	White/Grey Box	297976	6418008
	White/Grey Box	298019	6418014
	White/Grey Box	298040	6418004
	White/Grey Box	298136	6418041
	White/Grey Box	298171	6418015
	White/Grey Box	298192	6418016
	White/Grey Box	298171	6418073
	White/Grey Box	298014	6418091
	White/Grey Box	297933	6418091
	White/Grey Box	297921	6418076
	White/Grey Box	297842	6418064
	White/Grey Box	297880	6418098

Area	Species	Easting	Northing
Area B (Continued)	White/Grey Box	297934	6418116
	White/Grey Box	297964	6418139
	White/Grey Box	297981	6418139
	White/Grey Box	297905	6418235
	White/Grey Box	297965	6418250
	White/Grey Box	297958	6418251
	White/Grey Box	297451	6418236
	White/Grey Box	297355	6417894
	White/Grey Box	297945	6418016
	White/Grey Box	297976	6418008
	White/Grey Box	298019	6418014
	White/Grey Box	298040	6418004
	White/Grey Box	298136	6418041
	White/Grey Box	298171	6418015
	White/Grey Box	298192	6418016
	White/Grey Box	298171	6418073
	White/Grey Box	298014	6418091
	White/Grey Box	297933	6418091
	White/Grey Box	297921	6418076
	White/Grey Box	297842	6418064
	White/Grey Box	297880	6418098
	White/Grey Box	297934	6418116
	White/Grey Box	297964	6418139
	White/Grey Box	297981	6418139
	White/Grey Box	297905	6418235
	White/Grey Box	297965	6418250
	White/Grey Box	297958	6418251
	White/Grey Box	297451	6418236
	White/Grey Box	297355	6417894
Area C	Dead Stag	299015	6417645
	Dead Stag	299075	6417585
	Spotted Gum	298987	6417718
	Spotted Gum	299063	6417726
	Spotted Gum	299048	6417673
	Spotted Gum	299037	6417613
	Spotted Gum	299072	6417637
	Spotted Gum	299070	6417650
	Spotted Gum	299124	6417667
	Spotted Gum	299121	6417650
	Spotted Gum	299097	6417618

Area	Species	Easting	Northing
Area C (Continued)	Spotted Gum	299078	6417578
	Spotted Gum	299070	6417549
	Spotted Gum	299157	6417454
	Spotted Gum	299140	6417439
	Spotted Gum	299136	6417430
	Dead Stag	299015	6417645
	Dead Stag	299075	6417585
	Spotted Gum	298987	6417718
	Spotted Gum	299063	6417726
	Spotted Gum	299048	6417673
	Spotted Gum	299037	6417613
	Spotted Gum	299072	6417637
	Spotted Gum	299070	6417650
	Spotted Gum	299124	6417667
	Spotted Gum	299121	6417650
	Spotted Gum	299097	6417618
	Spotted Gum	299078	6417578
	Spotted Gum	299070	6417549
	Spotted Gum	299157	6417454
	Spotted Gum	299140	6417439
	Spotted Gum	299136	6417430
Area D	Dead Stag	301031	6416697
	Dead Stag	301143	6416581
	Dead Stag	301100	6417072
	Grey Gum	301013	6416459
	Grey Gum	300994	6416432
	Grey Gum	301009	6416394
	Redgum	300995	6416438
	Redgum	300988	6416398
	Redgum	301154	6416538
	Spotted Gum	301055	6416668
	Spotted Gum	301076	6416589
	Spotted Gum	301080	6416582
	Spotted Gum	300990	6416479
	Spotted Gum	300958	6416393
	Spotted Gum	301007	6416445
	Spotted Gum	300996	6416442

Area	Species	Easting	Northing
Area D (Continued)	Spotted Gum	301024	6416288
	Spotted Gum	301115	6416396
	Spotted Gum	301113	6416427
	Spotted Gum	301126	6416620
	Spotted Gum	301218	6416853
	White/Grey Box	300991	6416428
	White/Grey Box	301012	6416368

APPENDIX 8

SADDLERS CREEK AND MIDDLE DEEP CREEK FLORA AND FAUNA SURVEY REPORT

Saddlers Creek and Middle Deep Creek

Flora and Fauna Survey Report

By Hunter Eco

January 2013

CONTENTS

TABLES

FIGURES

1 Introduction

This is a report of the ecological attributes of three areas to determine whether all or part of these areas might be appropriate for offsetting habitat that would be lost through proceeding with the proposed Mt Arthur Coal Modification:

- Saddlers Creek East (35 hectares [ha]) located along Saddlers Creek;
- Saddlers Creek South (103 ha) located further down Saddlers Creek; and
- Middle Deep Creek (410 ha) located in the Timor district in the upper Hunter.

A map showing these locations is provided in **Figure 1**.

2 Field Survey Methods

Field data were collected from the three areas in June 2012 and September 2012 (**Table 1**).

Table 1 Field data collection times

Survey Area	Field Data Collection Dates
Saddlers Creek East	19/6/2012, 18/9/2012
Saddlers Creek South	19/6/2012
Middle Deep Creek	22/6/2012, 9-12/9/2012

2.1 Vegetation Communities and Flora

A vegetation map was prepared from ground-truthed point data, floristic plot data and ground-truthed community boundary determination. The applied methods were developed by, Bell and Driscoll NSW Department of Environment, and Climate Change (DECC) (2008). Ground-truthed vegetation data were collected during meanders through the study area. Vegetation community types were determined by matching floristic content of the ground-truthed data to the species provided in the Peake Hunter Remnant Vegetation Project (HRVP) (2006) classification.

Vegetation community classification would generally be supported by data collected from standard 20 metre square (0.04 ha) floristic plots in which all species were identified and their abundance given a score based on the modified Braun-Blanquet 1-6 scale. However, field work was conducted at times when a large number of plants were either not present or could not be identified. This was particularly the case for grasses with most species having no fertile material, but also applied to small flowering annual and perennial herbs.

Figure 1 The location of sites

Rather than collect plot data, floristic lists were compiled for different vegetation types through the use of long meanders during which all species that could be were identified.

Data analysis was then conducted using hierarchical agglomerative clustering (Primer 6: Clarke and Gorley 2001) with presence only data input. Data from the floristic plots that were collected during the survey of the proposed Modification area were converted to presence only and comparison was made with data from the areas surveyed during this survey period.

2.2 Fauna

All birds seen and heard were recorded as well as all mammals and reptiles. Spotlighting was conducted on three nights at Middle Deep Creek with particular attention being given to areas with flowering eucalypts. Two camera traps were placed at Middle Deep Creek, one at a small pond and the other on an animal pathway, to record any passing wildlife. The cameras were left recording for three days and nights.

More detailed fauna investigation was not conducted at Saddlers Creek East because it was continuous with the habitat that had recently been subject of a fauna survey by Niche (2012). At Saddlers Creek South, the habitat was too sparse for a fauna survey to be useful.

2.3 Hollow Trees

The location (geographic coordinates using a hand-held global positioning system [GPS]) and species of all trees with habitat hollows was recorded in Saddlers Creek East. There were no such trees in Saddlers Creek South. At Middle Deep Creek, there were too many trees with habitat hollows to record in a reasonable time.

3 Field Survey Results

Table 2 provides a summary of the species recorded in Saddlers Creek East and Middle Deep Creek during the survey. Detailed transects were not conducted across Saddlers Creek South because it consisted primarily of open grassland with a few scattered trees. The significant findings in that area were the Lobed Blue Grass (*Bothriochloa biloba*) (listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]) in the open grassland and a large stand of Weeping Myall (*Acacia pendula*) which is a component of the Endangered Population *Acacia pendula (a tree) in the Hunter Catchment* and the *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion* endangered ecological community (EEC), both of which are listed as threatened under the NSW *Threatened Species Conservation Act, 1994* (TSC Act). Flora and fauna species recorded within these areas are provided in **Appendices 1 and 2**.

Table 2 Summary of flora and fauna species recorded

	Total Species	Exotic	Threatened Species listed under the TSC Act
Saddlers Creek East			
Flora			
Creekline habitat	54	20	0
Grassy woodland habitat	51	13	0
Combined habitats	82	24	0
Fauna			
Birds	15	0	0
Mammals	4	1	0
Reptiles	1	0	0
Middle Deep Creek			
Flora			
Drainage line habitat	41	7	0
White Box habitat	41	5	0
Blakely's Red Gum habitat	32	4	0
Combined habitats	102	12	1
Fauna			
Birds	64	0	7
Mammals	12	6	2
Reptiles	1	0	0

3.1 Saddlers Creek East

The vegetation associated with the creek itself consisted of Hunter Lowland Redgum Forest (MU24) dominated by Forest Red Gum (*Eucalyptus tereticornis*) and Rough-barked Apple (*Angophora floribunda*) along with some localised Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*Eucalyptus blakelyi*) and Swamp Oak (*Casuarina glauca*). Small tree-covered areas adjoining the riparian habitat were dominated by hybrid White Box with the occasional Spotted Gum (*Corymbia maculata*), Yellow Box (*Eucalyptus melliodora*) and Narrow-leaved Ironbark (*Eucalyptus crebra*). *Eucalyptus tereticornis* occasionally extended in to these areas. At one location against the creekline there were a small number of Grey Box (*Eucalyptus moluccana*). Overall, these areas were considered to be representative of *Central Hunter Box – Ironbark Woodland* (MU10). The open grassland would probably have been derived from this (MU10). There was only one location near the riparian habitat that contained a few *Bothriochloa biloba* otherwise, the dominant grasses were *Aristida* spp. and *Austrostipa* spp.

Floristic details from the survey can be found in **Appendix 1** and site photographs can be seen in **Appendix 3**.

3.2 Saddlers Creek South

Saddlers Creek South had very little patch vegetation most of which contained hybrid White Box/Grey Box. The most significant patch consisted of what appeared to be *Acacia pendula* (non pendulous) (MU19), about 10 m tall and previously unrecorded (**Appendix 3**). There was also a patch of low regrowth with a similar *Acacia* spp. about 200 m away from the large group of trees. These two groups combined could be representative of the endangered population *Acacia pendula (a tree) in the Hunter catchment*, and the *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion* EEC listed under the TSC Act.

There were scattered patches of Lobed Blue Grass (*Bothriochloa biloba*) (listed as Vulnerable under the EPBC Act) across the open grassland of this area. Other grass species were Queensland Blue Grass (*Dichanthium sericeum*), *Aristida* spp., Western Rat-tail Grass (*Sporobolus creber*) and Yadbila Grass (*Panicum queenslandicum*).

3.3 Middle Deep Creek

Four vegetation communities were recorded within Middle Deep Creek:

- White Box grassy woodland (MU11);
- Blakely's Red Gum grassy woodland (MU11);
- Narrow incised drainage line habitat; and
- Derived native grassland (MU11).

In summary, the overall dominant tree species of White Box (*Eucalyptus albens*) and Blakely's Red Gum (*Eucalyptus blakelyi*) in grassy woodland were consistent with the following threatened ecological communities (TEC):

- *White Box Yellow Box Blakely's Red Gum Woodland* occurring within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes Bioregions listed as an EEC under the TSC Act.
- *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* listed as a critically endangered ecological community (CEEC) under the EPBC Act.

The narrow incised drainage line habitat was tightly restricted being only 5 – 10 m wide, was not present in all drainage lines and was mostly restricted to the upper drainage line. Occasionally, associated with this habitat were the canopy trees Rough-barked Apple (*Angophora floribunda*) and Thin-leaved Stringy-bark (*Eucalyptus eugenioides*). Three quarters of the land consisted of open grassland that contained varying amounts of *Aristida* species, Red Grass (*Bothriochloa decipiens*) (no Queensland Blue Grass [*Bothriochloa biloba*] was encountered) *Dichanthium sericeum*, Western Rat-tailed Grass (*Sporobolus creber*) and Plump Windmill Grass (*Chloris ventricosa*).

The surrounding woodland TEC habitat means that a large amount of the grassland would be consistent with the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* TEC. **Figure 2** shows the vegetation mapped.

Thirteen Tiger Orchids (*Cymbidium canaliculatum*) were recorded, being part of the NSW listed *Endangered population of the orchid* Cymbidium canaliculatum *R. Br. in the Hunter Catchment* listed under the TSC Act. A search of data from the Atlas of NSW Wildlife from within a 10 km radius of Middle Deep Creek revealed that the Tiger Orchid was the only threatened flora species recorded.

Floristic details from the survey can be found in **Appendix 2** and photos of Middle Deep Creek can be found in Appendix 4..

The Atlas of NSW Wildlife, from within a 10 km radius of Middle Deep Creek (**Table 3**) reported 10 bird, three marsupial, one bat and one amphibian threatened species. Seven of the reported bird species and one of the marsupial species were recorded during the surveys. In addition the Grey-headed Flying-fox (*Pteropsis poliocephalus*) was recorded.

The threatened Squirrel Glider (*Petaurus norfocensis*) was found feeding in White Box blossom during spotlighting. The habitat appeared to be suitable for the threatened Brush-tailed Phascogale (*Phascogale penicillata*), Spotted-tailed Quoll (*Dasyurus maculatus*), Yellow-bellied Glider (*Petaurus australis*), and perhaps the Common Planigale (*Planigale maculata*).

Of the species listed in **Table 3** there was no suitable habitat for the Brush-tailed Rock Wallaby (*Petrogale penicillata*) and the Booroolong Frog (*Litoria booroolongensis*). The Little Eagle (*Hieraaetus morphnoides*) and Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis)* could be found there along with other threatened insectivorous bats so far not recorded.

The White Box were flowering and had attracted flocks of Noisy Friarbird (*Philemon corniculatus*) and Musk Lorikeet (*Glossopsitta concinna*). This resource (as well as Blakely's Red Gum when in flower) could also attract the threatened Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*). The woodland habitat was also suited to the Scarlet Robin (*Petroica boodang*) and Flame Robin (*Petroica phoenicea*).

Figure 2 shows the location of the recorded threatened species.

Table 3 Fauna records from within a 10 km radius of Middle Deep Creek

Family	Scientific Name	Common Name	NSW Status
BIRDS			
Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V
Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V
Acanthizidae	*Chthonicola sagittata*	Speckled Warbler	V
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V
Petroicidae	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	V
Petroicidae	*Petroica boodang*	Scarlet Robin	V
Petroicidae	*Petroica phoenicea*	Flame Robin	V
Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V
MARSUPIALS			
Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V
Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	E
MICROCHIROPTERAN BATS			
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V
AMPHIBIANS			
Hylidae	*Litoria booroolongensis*	Booroolong Frog	E

Source: Atlas of NSW Wildlife June 2012

Bold indicates species recorded at Middle Deep Creek

V = vulnerable and E = endangered

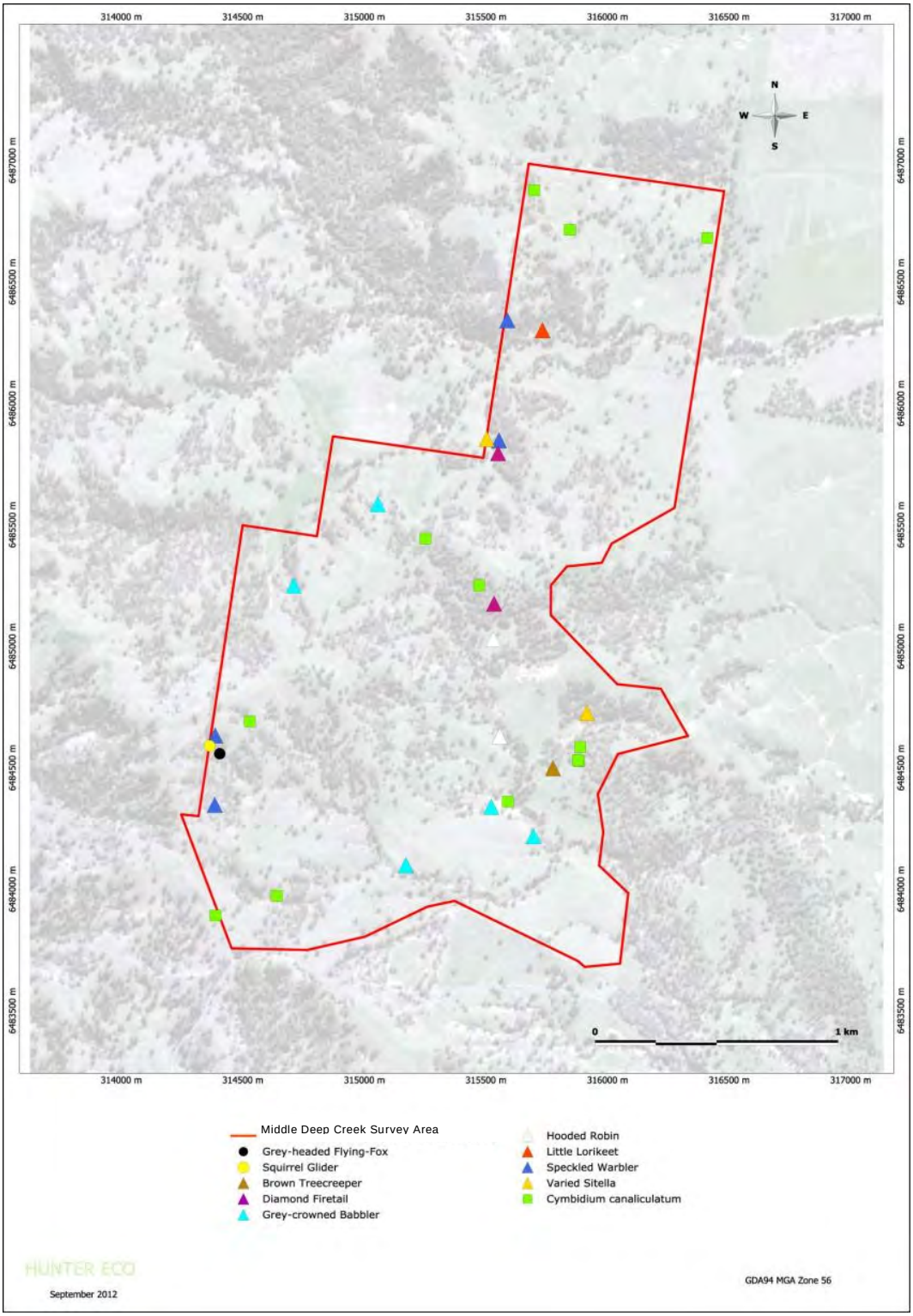

Figure 2 The location of threatened species recorded across the Middle Deep Creek survey area

3.4 Data Analysis

As described in Section 1, hierarchical agglomerative clustering was applied to presence only floristic data from:

- Saddlers Creek East;
- Middle Deep Creek;
- Proposed Modification Area D; and
- Combined data from box-gum habitat in proposed Modification Area B.

The Kulczynski similarity measure for presence absence data was used (Clarke and Gorley 2001). The aim was to determine whether the habitat in the current survey areas was similar to the habitat that is to be lost in the proposed Modification areas.

An examination of the resulting dendrogram (**Figure 3**) shows the following:

- At the coarsest level of the analysis (similarity 25), the Middle Deep Creek habitat was similar to habitat in proposed Modification areas B and D and these were different to Saddlers Creek East habitat;
- At a finer level (similarity 45) the two Middle Deep Creek woodland habitats were similar but different from the drainage line habitat. The two Modification Area D habitats were similar but different from the box-gum habitat in Modification Area B. The two habitats in Saddlers Creek East were similar but different to all others.

The data suggest that a reason for Saddlers Creek East showing as different to the other sampled vegetation is probably because Swamp Oak (*Casuarina glauca*), Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*Eucalyptus blakelyi*) and Narrow-leaved Iron-bark (*Eucalyptus crebra*) are present in that area and not in proposed Modification Area D. *Eucalyptus crebra* is present in Area D but was not recorded in sample plots from that area.

From this analysis it is reasonable to conclude that the habitat in the survey areas is similar to that in the proposed Modification Areas B and D.

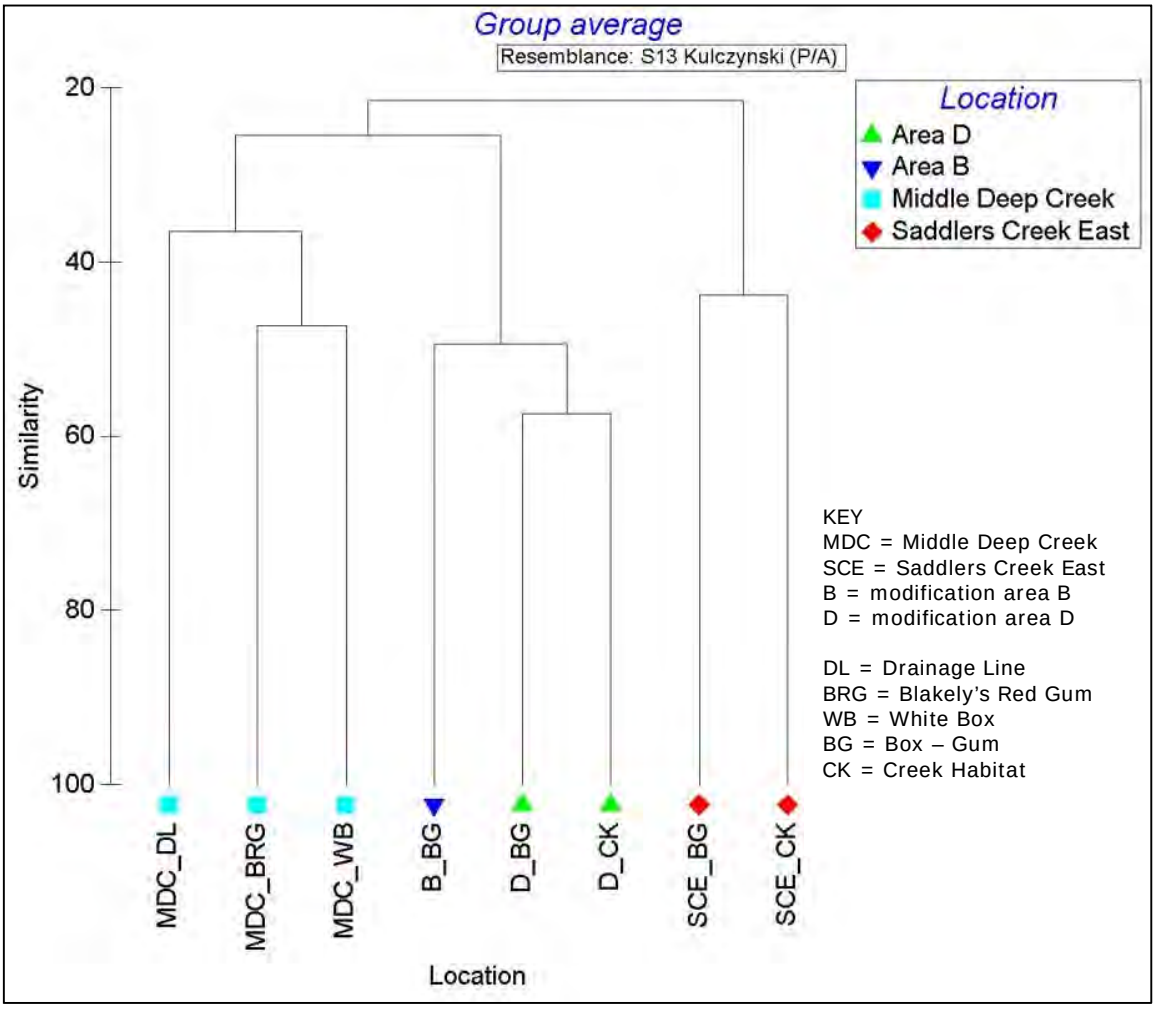

Figure 3 Dendrogram showing the similarity between sampled habitats

3.5 Vegetation Communities

Based on a floristic comparison with the community profiles provided in Peake (2006) Table 4 shows the communities mapped in the survey areas. **Figures 4** and **5** provide vegetation maps of Saddlers Creek and Middle Deep Creek.

Table 4 Vegetation communities

Community	Area (ha)
Saddlers Creek East and South	
MU10 Central Hunter Box - Ironbark Woodland[1, 2, 3]	7
MU10 Central Hunter Box - Ironbark Woodland (Derived grassland)[2, 3]	120
MU19 Hunter Valley Weeping Myall Woodland[4]	0.40
MU24 Hunter Lowlands Redgum Forest[5]	11
Middle Deep Creek	
MU11 Upper Hunter White Box – Ironbark Grassy Woodland (White Box dominant)[2, 3]	74
MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Blakely's Red Gum dominant)[2, 3]	29
MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Derived grassland)[2, 3]	307

[1] NSW EEC Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions

[2] NSW EEC White Box Yellow Box Blakely's Red Gum Woodland

[3] Commonwealth CEEC White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

[4] NSW EEC Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion

[5] NSW EEC Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions

MU10 Central Hunter Box - Ironbark Woodland

A small amount of this community was present in Saddlers Creek East. It was dominated by White Box (*Eucalyptus albens*) along with some Narrow-leaved Ironbark (*Eucalyptus crebra*). **Appendix 3** provides floristic details.

MU11 Upper Hunter White Box – Ironbark Grassy Woodland

Recorded only in Middle Deep Creek, there was no ironbark present but in most other respects the content matched the formal profile. As **Figure 5** shows, the community was readily subdivided into areas clearly dominated by a canopy of White Box (*Eucalyptus albens*) and areas dominated by Blakely's Red Gum (*Eucalyptus blakelyi*). **Appendix 2** provides floristic details.

MU19 Hunter Valley Weeping Myall Woodland

Recorded in Saddlers Creek South and consisted of about 40 large trees of the non-pendulous form of the Hunter *Acacia pendula* group. There was a considerable amount of suckering regrowth that included a smaller patch about 200 m from the main patch.

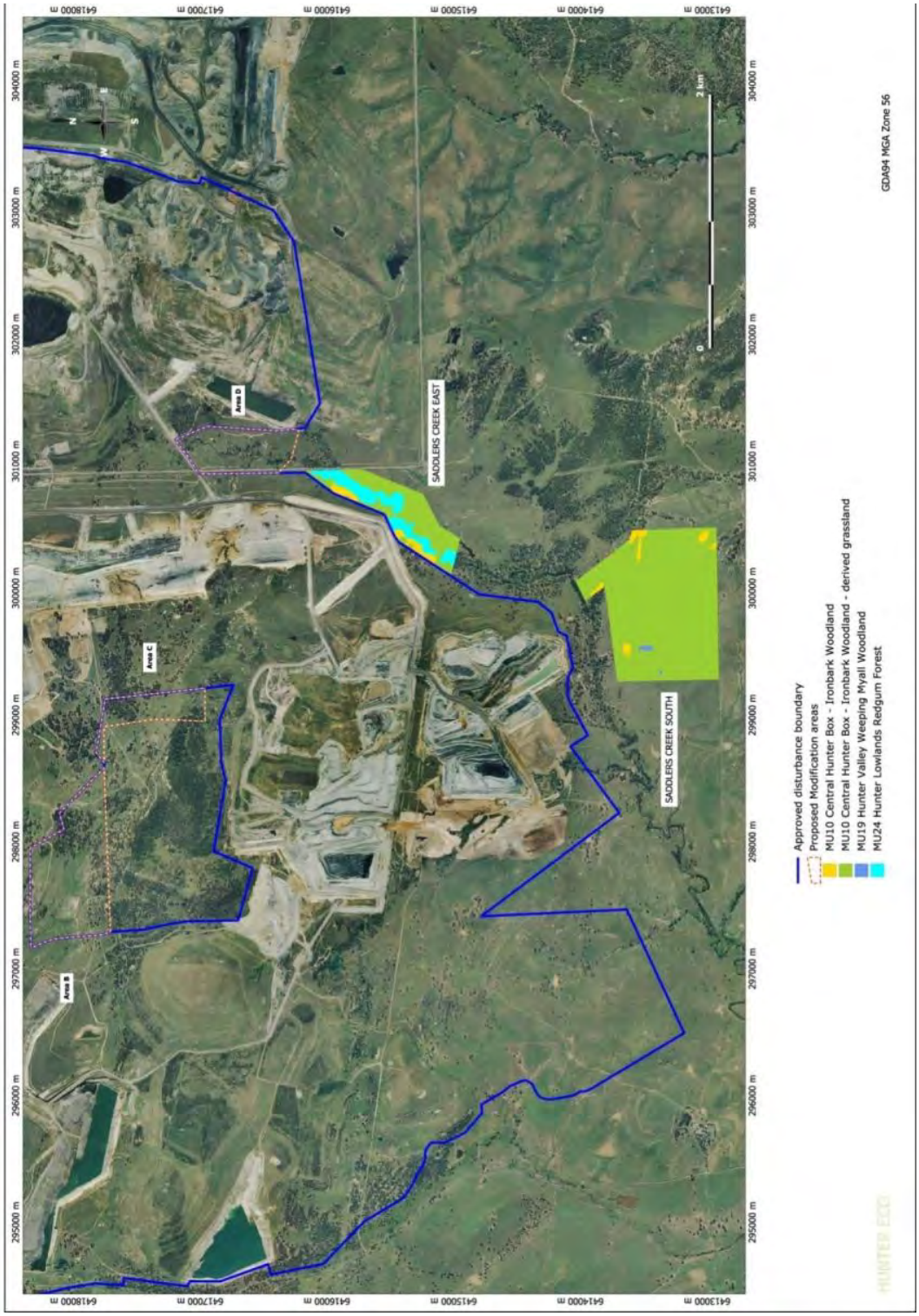

Figure 4 The vegetation mapped across Saddlers Creek survey areas

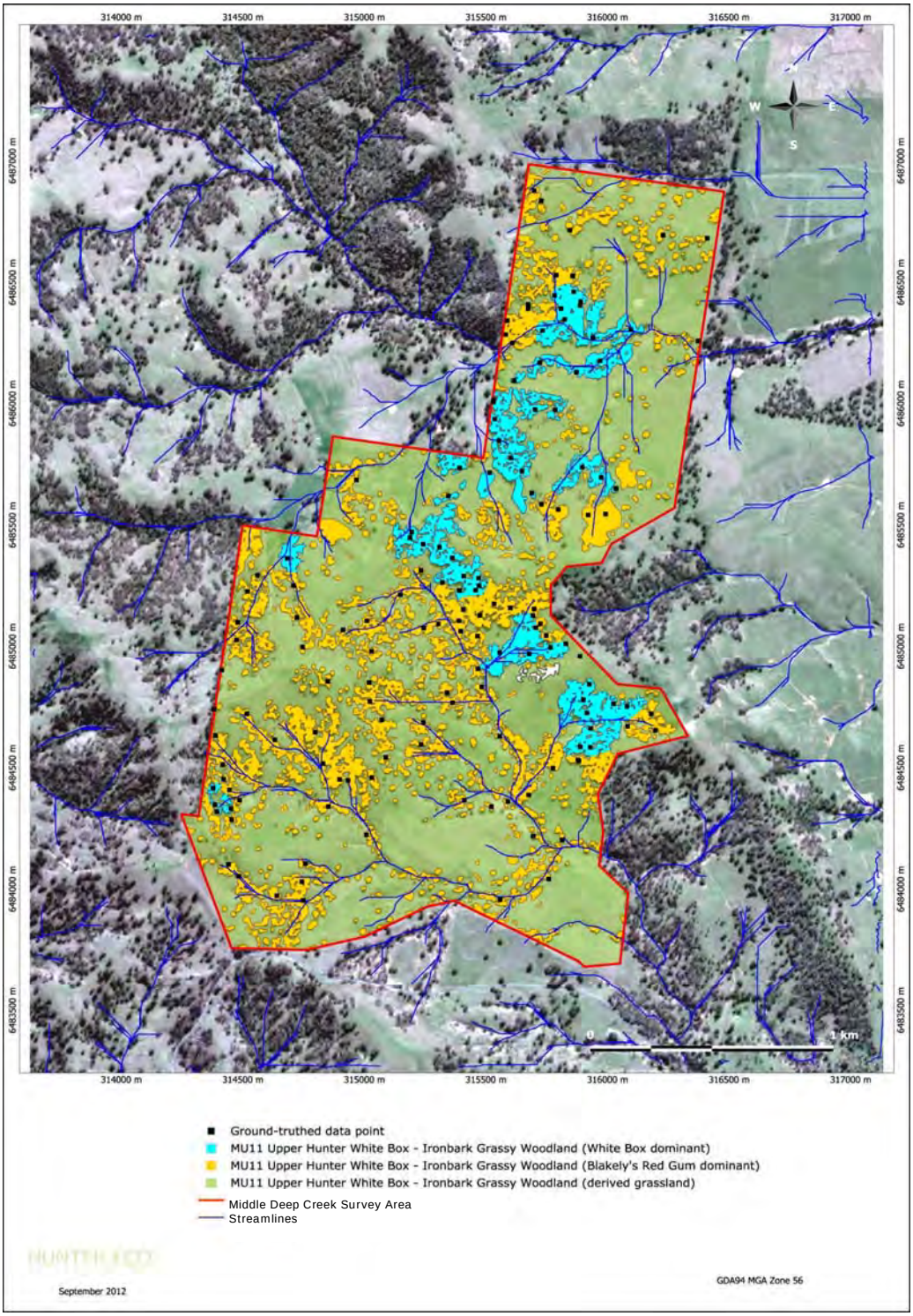

Figure 5 The vegetation mapped across the Middle Deep Creek survey area

MU24 Hunter Lowlands Red Gum Forest

This community in Saddlers Creek East was a continuation of the same community within proposed Modification Area D. The main canopy species were Forest Red Gum (*Eucalyptus tereticornis*) and Rough-barked Apple (*Angophora floribunda*); there were also a number of Yellow Box (*Eucalyptus melliodora*). **Appendix 1** provides further floristic detail.

3.6 Habitat Condition

Apart from the obvious fact of long-term clearing and grazing, there were areas that will benefit from targeted rehabilitation:

Saddlers Creek East has a heavily eroded area of about 3 ha (**Figure 6** and **Appendix 3)**. There are also a number of weeds needing to be controlled, in particular Mother of Millions (*Bryophyllum* sp.) and African Boxthorn (*Lycium ferocissimum*), both of which are declared noxious weeds in the Upper Hunter County Council control area.

Middle Deep Creek also has heavily eroded areas totalling over 5 ha (**Figure 7** and **Appendix 4**). While there are a number of weed species present, Sweet briar (*Rosa rubiginosa*) is a declared noxious weed needing to be kept under control. This plant is common but not rampant and a targeted spraying program should substantially reduce its numbers.

Figure 6 Location of heavily eroded areas in Saddlers Creek East

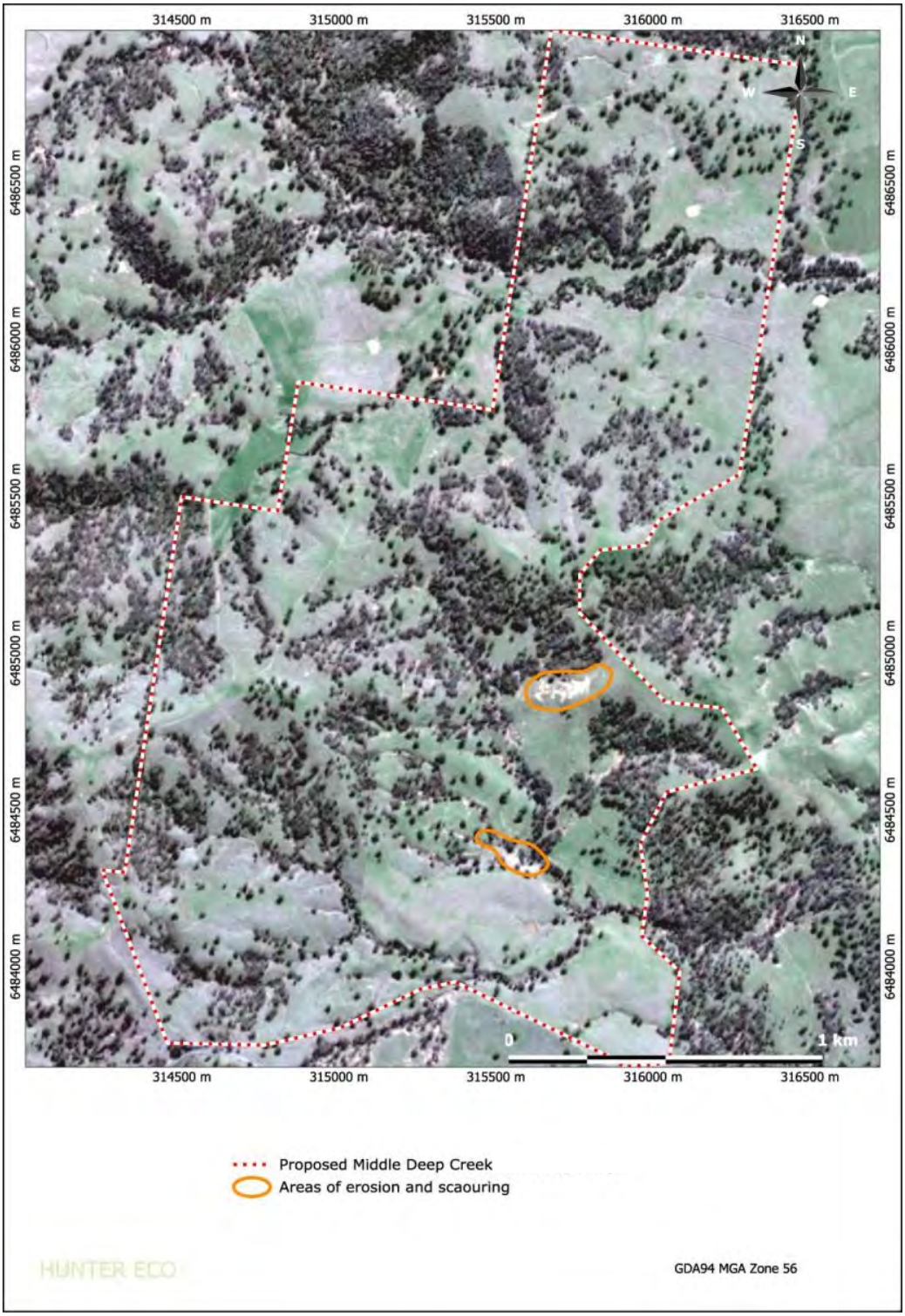

Figure 7 Location of heavily eroded areas in Middle Deep Creek

4 Conclusion

In combination, the habitat in the survey areas has been shown to be similar in most respects to that which would be lost if the proposed Mt Arthur Coal Modification were to proceed. The respective habitats are similar both in terms of vegetation communities described in the regional classification of Peake (2006) and their equivalent NSW State and Commonwealth threatened ecological communities. Middle Deep Creek contains several threatened bird and mammal species and significant representation of the Hunter Valley Tiger Orchid endangered population.

Over 75% of the survey areas consisted of derived native grassland, cleared of canopy, and subjected to long-term grazing. Implementation of an appropriate management plan would result in a significant increase in habitat quality and faunal diversity as woodland regenerated.

5 References

Department of Environment and Climate Change (2008) *Vegetation of the Cessnock-Kurri Region, Survey, Classification & Mapping, Cessnock LGA, New South Wales*, Department of Environment and Climate Change (NSW), Sydney.

Niche Environment and Heritage (2012) *Mount Arthur Coal Fauna Survey Report.*

Peake, T.C. (2006). The Vegetation of the Central Hunter Valley, New South Wales. A report on the findings of the Hunter Remnant Vegetation Project. Hunter–Central Rivers Catchment Management Authority, Paterson.

Appendix 1 Saddlers Creek East Flora and Fauna Details

Saddlers Creek East Creekline Meander Flora Species

Aizoaceae		**Moraceae**
**Galenia pubescens*		*Ficus rubiginosa*
Asclepiadaceae		**Myoporaceae**
**Gomphocarpus fruticosus*		*Myoporum montanum*
**Gomphocarpus physocarpus*		**Myrtaceae**
Asteraceae		*Angophora floribunda*
**Cirsium vulgare*		*Corymbia maculata*
**Senecio madagascariensis*		*Eucalyptus albens*
**Taraxacum officinale*		*Eucalyptus melliodora*
**Xanthium occidentale*		*Eucalyptus moluccana*
Cassinia quinquefaria		*Eucalyptus tereticornis*
Cactaceae		**Oleaceae**
**Opuntia stricta*		*Notelaea microcarpa*
Campanulaceae		**Plantaginaceae**
Wahlenbergia communis		**Plantago lanceolata*
Wahlenbergia luteola		**Poaceae**
Casuarinaceae		**Cynodon dactylon*
Casuarina glauca		**Lolium perenne*
Chenopodiaceae		**Pennisetum clandestinum*
Maireana microphylla		*Austrostipa verticillata*
Chloanthaceae		*Bothriochloa decipiens*
Spartothamnella juncea		*Chloris ventricosa*
Crassulaceae		*Cymbopogon refractus*
**Bryophyllum delagoense*		*Phragmites australis*
Fabaceae (Mimosoideae)		**Primulaceae**
Acacia salicina		**Anagallis arvensis*
Gentianaceae		**Ranunculaceae**
**Centaurium erythraea*		*Clematis glycinoides*
Geraniaceae		**Rosaceae**
Geranium solanderi		*Rubus moluccanus*
Juncaceae		**Rubiaceae**
**Juncus acutus*		*Asperula conferta*
Linaceae		*Psydrax odorata*
**Linum trigynum*		**Santalaceae**
Linum marginale		*Exocarpos cupressiformis*
Lomandraceae		**Solanaceae**
Lomandra longifolia		**Lycium ferocissimum*
Lomandra multiflora		**Sterculiaceae**

Luzuriagaceae		*Brachychiton populneus*
Geitonoplesium cymosum		**Typhaceae**
Malvaceae		*Typha orientalis*
**Sida rhombifolia*		**Verbenaceae**
Sida corrugata		**Verbena bonariensis*

Saddlers Creek East Grassy Woodland Flora Species

Adiantaceae		**Myrtaceae**
Cheilanthes sieberi		*Corymbia maculata*
Aizoaceae		*Eucalyptus blakelyi*
**Galenia pubescens*		*Eucalyptus crebra*
Anthericaceae		*Eucalyptus punctata*
Caesia parviflora		*Eucalyptus tereticornis*
Asteraceae		**Oleaceae**
**Cirsium vulgare*		*Notelaea microcarpa*
**Senecio madagascariensis*		**Phormiaceae**
**Xanthium occidentale*		*Dianella tasmanica*
Cassinia quinquefaria		**Pittosporaceae**
Chrysocephalum apiculatum		*Bursaria spinosa*
Cymbonotus lawsonianus		**Plantaginaceae**
Bignoniaceae		**Plantago lanceolata*
Pandorea pandorana		*Plantago gaudichaudii*
Chenopodiaceae		**Poaceae**
Maireana microphylla		**Briza minor*
Chloanthaceae		**Chloris gayana*
Spartothamnella juncea		**Hyparrhenia hirta*
Convolvulaceae		**Pennisetum clandestinum*
Dichondra repens		*Austrodanthonia fulva*
Euphorbiaceae		*Austrostipa setacea*
Breynia oblongifolia		*Austrostipa verticillata*
Fabaceae (Faboideae)		*Elymus scaber*
Hardenbergia violacea		*Panicum queenslandicum*
Swainsona galegifolia		*Sporobolus creber*
Fabaceae (Mimosoideae)		*Themeda australis*
Acacia falcata		**Primulaceae**
Linaceae		**Anagallis arvensis*
Linum marginale		**Ranunculaceae**
Lomandraceae		*Clematis glycinoides*
Lomandra confertifolia		**Solanaceae**
Lomandra longifolia		**Cestrum aurantiacum*
Lomandra multiflora		**Lycium ferocissimum*

Malvaceae		**Sterculiaceae**
**Sida rhombifolia*		*Brachychiton populneus*
Sida corrugata		**Thymelaeaceae**
Myoporaceae		*Pimelea linifolia*
Myoporum montanum		

Saddlers Creek East Combined Floristic List

Adiantaceae		**Myoporaceae**
Cheilanthes sieberi		*Myoporum montanum*
Aizoaceae		**Myrtaceae**
**Galenia pubescens*		*Angophora floribunda*
Anthericaceae		*Corymbia maculata*
Caesia parviflora		*Eucalyptus albens*
Asclepiadaceae		*Eucalyptus blakelyi*
**Gomphocarpus fruticosus*		*Eucalyptus crebra*
**Gomphocarpus physocarpus*		*Eucalyptus melliodora*
Asteraceae		*Eucalyptus moluccana*
**Cirsium vulgare*		*Eucalyptus punctata*
**Senecio madagascariensis*		*Eucalyptus tereticornis*
**Taraxacum officinale*		**Oleaceae**
**Xanthium occidentale*		*Notelaea microcarpa*
Cassinia quinquefaria		**Phormiaceae**
Chrysocephalum apiculatum		*Dianella tasmanica*
Cymbonotus lawsonianus		**Pittosporaceae**
Bignoniaceae		*Bursaria spinosa*
Pandorea pandorana		**Plantaginaceae**
Cactaceae		**Plantago lanceolata*
**Opuntia stricta*		*Plantago gaudichaudii*
Campanulaceae		**Poaceae**
Wahlenbergia communis		**Briza minor*
Wahlenbergia luteola		**Chloris gayana*
Casuarinaceae		**Cynodon dactylon*
Casuarina glauca		**Hyparrhenia hirta*
Chenopodiaceae		**Lolium perenne*
Maireana microphylla		**Pennisetum clandestinum*
Chloanthaceae		*Austrodanthonia fulva*
Spartothamnella juncea		*Austrostipa setacea*
Convolvulaceae		*Austrostipa verticillata*
Dichondra repens		*Bothriochloa decipiens*
Crassulaceae		*Chloris ventricosa*
**Bryophyllum delagoense*		*Cymbopogon refractus*

Euphorbiaceae		*Elymus scaber*
Breynia oblongifolia		*Panicum queenslandicum*
Fabaceae (Faboideae)		*Phragmites australis*
Hardenbergia violacea		*Sporobolus creber*
Swainsona galegifolia		*Themeda australis*
Fabaceae (Mimosoideae)		**Primulaceae**
Acacia falcata		**Anagallis arvensis*
Acacia salicina		**Ranunculaceae**
Gentianaceae		*Clematis glycinoides*
**Centaurium erythraea*		**Rosaceae**
Geraniaceae		*Rubus moluccanus*
Geranium solanderi		**Rubiaceae**
Juncaceae		*Asperula conferta*
**Juncus acutus*		*Psydrax odorata*
Linaceae		**Santalaceae**
**Linum trigynum*		*Exocarpos cupressiformis*
Linum marginale		**Solanaceae**
Lomandraceae		**Cestrum aurantiacum*
Lomandra confertifolia		**Lycium ferocissimum*
Lomandra longifolia		**Sterculiaceae**
Lomandra multiflora		*Brachychiton populneus*
Luzuriagaceae		**Thymelaeaceae**
Geitonoplesium cymosum		*Pimelea linifolia*
Malvaceae		**Typhaceae**
**Sida rhombifolia*		*Typha orientalis*
Sida corrugata		**Verbenaceae**
Moraceae		**Verbena bonariensis*
Ficus rubiginosa		

Saddlers Creek East Fauna Species

Birds		Mammals and Reptiles
Accipitridae		**Leporidae**
Black-shouldered Kite		**Rabbit**
Elanus axillaris		**Oryctolagus cuniculus*
Artamidae		**Macropodidae**
Australian Magpie		**Eastern Grey Kangaroo**
Gymnorhina tibicen		*Macropus giganteus*
Grey Butcherbird		**Phalangeridae**
Cracticus torquatus		**Common Brushtail Possum**
Cacatuidae		*Trichosurus vulpecula*
Galah		**Tachyglossidae**
Cacatua roseicapilla		**Echidna**
Sulphur-crested Cockatoo		*Tachyglossus aculeatus*
Cacatua galerita		**Varanidae**
Corvidae		**Lace Monitor**
Australian Raven		*Varanus varius*
Corvus coronoides		
Falconidae		
Nankeen Kestrel		
Falco cenchroides		
Halcyonidae		
Laughing Kookaburra		
Dacelo novaeguineae		
Hirundinidae		
Welcome Swallow		
Hirundo neoxena		
Maluridae		
Superb Fairy-wren		
Malurus cyaneus		
Meliphagidae		
Noisy Miner		
Manorina melanocephala		
Pardalotidae		
Striated Pardalote		
Pardalotus striatus		
Phasianidae		
Brown Quail		
Coturnix ypsilophora		
Psittacidae		
Australian King-Parrot		
Alisterus scapularis		
Eastern Rosella		
Platycercus eximius		

Saddlers Creek East Habitat Hollow Trees Species and Location Coordinates

Species	Easting	Northing
Dead Stag	300914	6415975
	300913	6416083
	300286	6415029
	300277	6415027
Eucalyptus albens	300884	6415909
	300913	6415955
	300850	6415947
	300845	6415940
	300839	6415914
	300808	6415869
	300746	6415785
	300755	6415665
	300766	6415714
	300768	6415697
	300762	6415601
	300724	6415526
	300725	6415517
	300716	6415517
	300708	6415403
	300632	6415415
	300404	6415291
	300392	6415281
	300382	6415281
	300403	6415251
	300410	6415231
	300384	6415242
	300382	6415229
	300387	6415214
	300382	6415212
	300374	6415203
	300311	6415197
	300308	6415193
	300302	6415194
	300300	6415192
	300301	6415176
	300263	6415066
	300198	6415185
	300233	6415175
	300253	6415163

Species	Easting	Northing
Eucalyptus albens	300296	6415268
	300316	6415262
	300320	6415255
	300336	6415242
	300458	6415393
	300459	6415411
	300473	6415418
	300487	6415460
	300471	6415469
Eucalyptus blakelyi	300215	6415087
	300412	6415375
Eucalyptus crebra	300664	6415623
Eucalyptus melliodora	300778	6415806
	300739	6415732
	300746	6415719
Eucalyptus punctata	300901	6416077
Eucalyptus tereticornis	300910	6416093
	300811	6416038
	300778	6415922
	300759	6415847
	300780	6415823
	300731	6415785
	300697	6415785
	300712	6415752
	300707	6415718
	300680	6415700
	300669	6415672
	300672	6415653
	300678	6415631
	300693	6415639
	300721	6415661
	300743	6415653
	300781	6415669
	300755	6415634
	300694	6415486
	300736	6415485
	300740	6415418
	300745	6415379
	300742	6415387

Eucalyptus albens	300260	6415162		*Eucalyptus tereticornis*	300434	6415322
	300251	6415179			300313	6415208
	300220	6415194			300284	6415148
	300218	6415207			300267	6415064
	300232	6415244			300319	6415250
	300285	6415237			300370	6415299
	300301	6415261			300475	6415414

Appendix 2 Middle Deep Creek Flora and Fauna Details

Middle Deep Creek Drainage Line Meander Floristic List

Adiantaceae		**Fabaceae (Mimosoideae)**
Adiantum aethiopicum		*Acacia paradoxa*
Cheilanthes sieberi		**Geraniaceae**
Pellaea falcata var. falcata		*Geranium solanderi*
Apiaceae		**Lomandraceae**
Daucus glochidiatus		*Lomandra confertifolia*
Asteraceae		*Lomandra filiformis subsp. coriacea*
**Bidens pilosa*		**Luzuriagaceae**
**Cirsium vulgare*		*Eustrephus latifolius*
**Conyza sp.*		*Geitonoplesium cymosum*
**Euchiton involucratus*		**Myrtaceae**
**Taraxacum officinale*		*Eucalyptus albens*
Cassinia quinquefaria		*Eucalyptus blakelyi*
Sigesbeckia australiensis		**Oleaceae**
Sigesbeckia orientalis subsp. orientalis		*Notelaea microcarpa*
Bignoniaceae		**Orchidaceae**
Pandorea pandorana		*Pterostylis pedunculata*
Cactaceae		**Oxalidaceae**
**Opuntia stricta*		*Oxalis chnoodes*
Campanulaceae		**Pittosporaceae**
Wahlenbergia communis		*Bursaria spinosa*
Convolvulaceae		**Poaceae**
Dichondra repens		*Poa sp.*
Cyperaceae		**Primulaceae**
Cyperus sphaeroideus		**Anagallis arvensis*
Fabaceae (Faboideae)		**Ranunculaceae**
Desmodium brachypodum		*Clematis glycinoides var. glycinoides*
Desmodium gunnii		**Rosaceae**
Desmodium varians		*Rubus parvifolius*
Glycine clandestina		
Glycine microphylla		
Glycine tabacina		
Hardenbergia violacea		
Trifolium sp.		

* Denotes introduced species

Middle Deep Creek White Box Meander Floristic List

Apiaceae		**Lomandraceae**
Centella asiatica		*Lomandra confertifolia*
Asphodelaceae		*Lomandra filiformis subsp. filiformis*
Bulbine bulbosa		*Lomandra multiflora*
Asteraceae		**Myrtaceae**
**Cirsium vulgare*		*Eucalyptus albens*
**Conyza sp.*		**Oleaceae**
Brachyscome microcarpa		*Notelaea microcarpa*
Cassinia quinquefaria		**Oxalidaceae**
Helichrysum scorpioides		*Oxalis chnoodes*
Leptorhynchos squamatus subsp. A		**Pittosporaceae**
Olearia elliptica		*Bursaria spinosa*
Colchicaceae		**Poaceae**
Burchardia umbellata		**Hordeum leporinum*
Wurmbea biglandulosa		*Aristida ramosa*
Convolvulaceae		*Chloris ventricosa*
Convolvulus erubescens		*Cymbopogon refractus*
Dichondra repens		*Dichelachne crinita*
Epacridaceae		*Panicum queenslandicum*
Melichrus urceolatus		**Primulaceae**
Fabaceae (Faboideae)		**Anagallis arvensis*
Glycine microphylla		**Ranunculaceae**
Glycine tabacina		*Ranunculus lappaceus*
Templetonia stenophylla		**Rhamnaceae**
Fabaceae (Mimosoideae)		*Cryptandra spinescens*
Acacia decora		**Rubiaceae**
Acacia paradoxa		*Asperula conferta*
Geraniaceae		**Thymelaeaceae**
Geranium solanderi		*Pimelea curviflora*
Lamiaceae		*Pimelea linifolia*
**Salvia verbenaca*		
Mentha satureioides		

* Denotes introduced species

Middle Deep Creek Blakely's Red Gum Meander Floristic List

Adiantaceae		**Lomandraceae**
Cheilanthes sieberi		*Lomandra confertifolia*
Asteraceae		*Lomandra filiformis subsp. coriacea*
**Bidens pilosa*		*Lomandra multiflora*
**Cirsium vulgare*		**Myrtaceae**
**Conyza sp.*		*Eucalyptus blakelyi*
Cassinia quinquefaria		**Oleaceae**
Chrysocephalum apiculatum		*Notelaea microcarpa*
Glossocardia bidens		**Oxalidaceae**
Clusiaceae		*Oxalis sp.*
Hypericum gramineum		**Phormiaceae**
Convolvulaceae		*Dianella longifolia*
Dichondra repens		**Poaceae**
Epacridaceae		*Aristida ramosa*
Melichrus urceolatus		*Austrostipa verticillata*
Euphorbiaceae		*Bothriochloa decipiens*
Poranthera microphylla		*Chloris ventricosa*
Fabaceae (Faboideae)		*Cymbopogon refractus*
Glycine tabacina		*Dichanthium sericeum*
Fabaceae (Mimosoideae)		*Eragrostis sp.*
Acacia paradoxa		*Panicum effusum*
Geraniaceae		*Panicum queenslandicum*
Geranium solanderi		**Primulaceae**
Lamiaceae		**Anagallis arvensis*
Mentha satureioides		

* Denotes introduced species

Middle Deep Creek Combined Floristic List

Adiantaceae		**Geraniaceae**
Adiantum aethiopicum		*Geranium solanderi*
Cheilanthes sieberi		**Lamiaceae**
Pellaea falcata var. falcata		**Salvia verbenaca*
Apiaceae		*Ajuga australis*
Centella asiatica		*Mentha satureioides*
Daucus glochidiatus		**Lomandraceae**
Asphodelaceae		*Lomandra confertifolia*
Bulbine bulbosa		*Lomandra filiformis subsp. coriacea*
Asteraceae		*Lomandra filiformis subsp. filiformis*
**Bidens pilosa*		*Lomandra multiflora*
**Cirsium vulgare*		**Luzuriagaceae**
**Conyza sp.*		*Eustrephus latifolius*
**Euchiton involucratus*		*Geitonoplesium cymosum*
**Senecio madagascariensis*		**Myrtaceae**
**Taraxacum officinale*		*Angophora floribunda*
Brachyscome microcarpa		*Eucalyptus albens*
Cassinia quinquefaria		*Eucalyptus blakelyi*
Chrysocephalum apiculatum		*Eucalyptus eugenioides*
Cymbonotus lawsonianus		**Oleaceae**
Glossocardia bidens		*Notelaea microcarpa*
Helichrysum scorpioides		**Orchidaceae**
Leptorhynchos squamatus subsp. A		*Cymbidium canaliculatum*
Olearia elliptica		*Pterostylis pedunculata*
Sigesbeckia australiensis		**Oxalidaceae**
Sigesbeckia orientalis subsp. orientalis		*Oxalis chnoodes*
Triptilodicus pygmaeus		*Oxalis sp.*
Bignoniaceae		**Phormiaceae**
Pandorea pandorana		*Dianella longifolia*
Cactaceae		**Pittosporaceae**
**Opuntia stricta*		*Bursaria spinosa*
Campanulaceae		**Poaceae**
Wahlenbergia communis		**Hordeum leporinum*
Wahlenbergia luteola		**Lolium perenne*
Chenopodiaceae		*Aristida ramosa*
Maireana microphylla		*Austrostipa verticillata*
Clusiaceae		*Bothriochloa decipiens*
Hypericum gramineum		*Chloris ventricosa*
Colchicaceae		*Cymbopogon refractus*

Burchardia umbellata		*Dichanthium sericeum*
Wurmbea biglandulosa		*Dichelachne crinita*
Convolvulaceae		*Eragrostis sp.*
Convolvulus erubescens		*Imperata cylindrica*
Dichondra repens		*Panicum effusum*
Cupressaceae		*Panicum queenslandicum*
Callitris endlicheri		*Poa sp.*
Callitris glaucophylla		*Sporobolus creber*
Cyperaceae		**Primulaceae**
Cyperus sphaeroideus		**Anagallis arvensis*
Epacridaceae		**Ranunculaceae**
Melichrus urceolatus		*Clematis glycinoides var. glycinoides*
Euphorbiaceae		*Ranunculus lappaceus*
Poranthera microphylla		**Rhamnaceae**
Fabaceae (Faboideae)		*Cryptandra amara var. longiflora*
Daviesia genistifolia		*Cryptandra spinescens*
Desmodium brachypodum		**Rosaceae**
Desmodium gunnii		*Rubus parvifolius*
Desmodium varians		**Rubiaceae**
Glycine clandestina		**Sherardia arvensis*
Glycine microphylla		*Asperula conferta*
Glycine tabacina		**Sapindaceae**
Hardenbergia violacea		*Dodonaea viscosa subsp. angustifolia*
Pultenaea microphylla		**Thymelaeaceae**
Swainsona galegifolia		*Pimelea curviflora*
Swainsona parviflora		*Pimelea linifolia*
Templetonia stenophylla		**Violaceae**
Trifolium sp.		*Viola betonicifolia*
Fabaceae (Mimosoideae)		
Acacia decora		
Acacia melanoxylon		
Acacia paradoxa		

* Denotes introduced species

Middle Deep Creek Bird Species

Accipitridae		**Meliphagidae cont.**
Wedge-tailed Eagle		**Scarlet Honeyeater**
Aquila audax		*Myzomela sanguinolenta*
Aegothelidae		**White-naped Honeyeater**
Australian Owlet-nightjar		*Melithreptus lunatus*
Aegotheles cristatus		**White-plumed Honeyeater**
Anatidae		*Lichenostomus penicillatus*
Australian Wood Duck		**Yellow-faced Honeyeater**
Chenonetta jubata		*Lichenostomus chrysops*
Grey Teal		**Meropidae**
Anas gracilis		**Rainbow Bee-eater**
Artamidae		*Merops ornatus*
Australian Magpie		**Neosittidae**
Gymnorhina tibicen		**Varied Sittella V-TSCAct**
Dusky Woodswallow		*Daphoenositta chrysoptera*
Artamus cyanopterus		**Oriolidae**
Grey Butcherbird		**Olive-backed Oriole**
Cracticus torquatus		*Oriolus sagittatus*
Pied Butcherbird		**Pachycephalidae**
Cracticus nigrogularis		**Grey Shrike-thrush**
Pied Currawong		*Colluricincla harmonica*
Strepera graculina		**Rufous Whistler**
White-browed Woodswallow		*Pachycephala rufiventris*
Artamus superciliosus		**Pardalotidae**
Cacatuidae		**Brown Gerygone**
Galah		*Gerygone mouki*
Cacatua roseicapilla		**Speckled Warbler V-TSCAct**
Sulphur-crested Cockatoo		*Chthonicola sagittata*
Cacatua galerita		**Spotted Pardalote**
Campephagidae		*Pardalotus punctatus*
Black-faced Cuckoo-shrike		**Striated Pardalote**
Coracina novaehollandiae		*Pardalotus striatus*
Climacteridae		**Striated Thornbill**
Brown Treecreeper (eastern subspecies) V-TSCAct		*Acanthiza lineata*
Climacteris picumnus victoriae		**Weebill**
White-throated Treecreeper		*Smicrornis brevirostris*
Cormobates leucophaeus		**White-throated Gerygone**
Columbidae		*Gerygone olivacea*
Brush Bronzewing		**Yellow-rumped Thornbill**

Phaps elegans	*Acanthiza chrysorrhoa*
Crested Pigeon	**Passeridae**
Ocyphaps lophotes	**Diamond Firetail V-TSCAct**
Corcoracidae	*Stagonopleura guttata*
White-winged Chough	**Double-barred Finch**
Corcorax melanorhamphos	*Taeniopygia bichenovii*
Corvidae	**Petroicidae**
Australian Raven	**Eastern Yellow Robin**
Corvus coronoides	*Eopsaltria australis*
Dicaeidae	**Hooded Robin V-TSCAct**
Mistletoebird	*Melanodryas cucullata*
Dicaeum hirundinaceum	**Jacky Winter**
Dicruridae	*Microeca fascinans*
Grey Fantail	**Podargidae**
Rhipidura fuliginosa	**Tawny Frogmouth**
Magpie-lark	*Podargus strigoides*
Grallina cyanoleuca	**Podicipedidae**
Restless Flycatcher	**Australasian Grebe**
Myiagra inquieta	*Tachybaptus novaehollandiae*
Satin Flycatcher	**Pomatostomidae**
Myiagra cyanoleuca	**Grey-crowned Babbler (eastern subspecies) V-TSCAct**
Willie Wagtail	*Pomatostomus temporalis temporalis*
Rhipidura leucophrys	**Psittacidae**
Halcyonidae	**Australian King-Parrot**
Laughing Kookaburra	*Alisterus scapularis*
Dacelo novaeguineae	**Crimson Rosella**
Maluridae	*Platycercus elegans*
Superb Fairy-wren	**Eastern Rosella**
Malurus cyaneus	*Platycercus eximius*
Meliphagidae	**Little Lorikeet V-TSCAct**
Brown-headed Honeyeater	*Glossopsitta pusilla*
Melithreptus brevirostris	**Musk Lorikeet**
Fuscous Honeyeater	*Glossopsitta concinna*
Lichenostomus fuscus	**Strigidae**
Noisy Friarbird	**Southern Boobook**
Philemon corniculatus	*Ninox novaeseelandiae*
Noisy Miner	**Tytonidae**
Manorina melanocephala	**Barn Owl**
Red Wattlebird	*Tyto alba*
Anthochaera carnunculata	

Middle Deep Creek Mammal and Reptile Species

MAMMALS
Canidae
Dog
**Canis lupus familiaris*
Fox
**Vulpes vulpes*
Cervidae
Sambar Deer
**Cervus unicolor*
Leporidae
European Brown Hare
**Lepus sp.*
Rabbit
**Oryctolagus cuniculus*
Macropodidae
Common Wallaroo
Macropus robustus
Eastern Grey Kangaroo
Macropus giganteus
Red-necked Wallaby
Macropus rufogriseus
Petauridae
Squirrel Glider *V-TSC Act*
Petaurus norfolcensis
Phalangeridae
Common Brushtail Possum
Trichosurus vulpecula
Pteropodidae
Grey-headed Flying-fox *V-TSC Act*
Pteropus poliocephalus
Suidae
Pig
**Sus scrofa*
REPTILES
Agamidae
Bearded Dragon
Pogona barbata

* Denotes introduced species

Appendix 3 Saddlers Creek Site Photographs

Saddlers Creek East creekline habitat

Saddlers Creek East erosion

Saddlers Creek South Weeping Myall Woodland stand and surrounding grassland

Appendix 4 Middle Deep Creek site photographs

White Box Grassy Woodland

Blakely's Red Gum Grassy Woodland

Incised drainage line habitat

Tiger Orchid (*Cymbidium canaliculatum*)

Eroded hillside

Mt Arthur Coal

bhpbilliton
resourcing the future

Attachment D –
EPBC Referral for the
Mt Arthur Coal Open Cut Modification

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

Referral of proposed action

What is a referral?

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides for the protection of the environment, especially matters of national environmental significance (NES). Under the EPBC Act, a person must not take an action that has, will have, or is likely to have a significant impact on any of the matters of NES without approval from the Australian Government Environment Minister or the Minister's delegate. (Further references to 'the Minister' in this form include references to the Minister's delegate.) To obtain approval from the Environment Minister, a proposed action should be referred. The purpose of a referral is to obtain a decision on whether your proposed action will need formal assessment and approval under the EPBC Act.

Your referral will be the principal basis for the Minister's decision as to whether approval is necessary and, if so, the type of assessment that will be undertaken. These decisions are made within 20 business days, provided sufficient information is provided in the referral.

Who can make a referral?

Referrals may be made by or on behalf of a person proposing to take an action, the Commonwealth or a Commonwealth agency, a state or territory government, or agency, provided that the relevant government or agency has administrative responsibilities relating to the action.

When do I need to make a referral?

A referral must be made for actions that are likely to have a significant impact on the following matters protected by Part 3 of the EPBC Act:

- World Heritage properties (sections 12 and 15A)
- National Heritage places (sections 15B and 15C)
- Wetlands of international importance (sections 16 and 17B)
- Listed threatened species and communities (sections 18 and 18A)
- Listed migratory species (sections 20 and 20A)
- Protection of the environment from nuclear actions (sections 21 and 22A)
- Commonwealth marine environment (sections 23 and 24A)
- Great Barrier Reef Marine Park (sections 24B and 24C)
- A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E)
- The environment, if the action involves Commonwealth land (sections 26 and 27A), including:
    - actions that are likely to have a significant impact on the environment of Commonwealth land (even if taken outside Commonwealth land);
    - actions taken on Commonwealth land that may have a significant impact on the environment generally;
- The environment, if the action is taken by the Commonwealth (section 28)
- Commonwealth Heritage places outside the Australian jurisdiction (sections 27B and 27C)

You may still make a referral if you believe your action is not going to have a significant impact, or if you are unsure. This will provide a greater level of certainty that Commonwealth assessment requirements have been met.

To help you decide whether or not your proposed action requires approval (and therefore, if you should make a referral), the following guidance is available from the Department's website:

- the Policy Statement titled Significant Impact Guidelines 1.1 – Matters of National Environmental Significance. Additional sectoral guidelines are also available.

- the Policy Statement titled Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies.
- the Policy Statement titled Significant Impact Guidelines: Coal seam gas and large coal mining developments—Impacts on water resources.
- the interactive map tool (enter a location to obtain a report on what matters of NES may occur in that location).

Can I refer part of a larger action?

In certain circumstances, **the Minister may not accept a referral for an action that is a component of a larger action and may request the person proposing to take the action to refer the larger action for consideration under the EPBC Act (Section 74A, EPBC Act).** If you wish to make a referral for a staged or component referral, read 'Fact Sheet 6 Staged Developments/Split Referrals' and contact the Referrals Gateway (1800 803 772).

Do I need a permit?

Some activities may also require a permit under other sections of the EPBC Act or another law of the Commonwealth. Information is available on the Department's web site.

Is your action in the Great Barrier Reef Marine Park?

If your action is in the Great Barrier Reef Marine Park it may require permission under the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act). If a permission is required, referral of the action under the EPBC Act is deemed to be an application under the GBRMP Act (see section 37AB, GBRMP Act). This referral will be forwarded to the Great Barrier Reef Marine Park Authority (the Authority) for the Authority to commence its permit processes as required under the Great Barrier Reef Marine Park Regulations 1983. If a permission is not required under the GBRMP Act, no approval under the EPBC Act is required (see section 43, EPBC Act). The Authority can provide advice on relevant permission requirements applying to activities in the Marine Park.

The Authority is responsible for assessing applications for permissions under the GBRMP Act, GBRMP Regulations and Zoning Plan. Where assessment and approval is also required under the EPBC Act, a single integrated assessment for the purposes of both Acts will apply in most cases. Further information on environmental approval requirements applying to actions in the Great Barrier Reef Marine Park is available from http://www.gbrmpa.gov.au/ or by contacting GBRMPA's Environmental Assessment and Management Section on (07) 4750 0700.

The Authority may require a permit application assessment fee to be paid in relation to the assessment of applications for permissions required under the GBRMP Act, even if the permission is made as a referral under the EPBC Act. Further information on this is available from the Authority:

Great Barrier Reef Marine Park Authority

2-68 Flinders Street PO Box 1379
Townsville QLD 4810
AUSTRALIA

Phone: + 61 7 4750 0700
Fax: + 61 7 4772 6093

www.gbrmpa.gov.au

What information do I need to provide?

Completing all parts of this form will ensure that you submit the required information and will also assist the Department to process your referral efficiently. If a section of the referral document is not applicable to your proposal enter N/A.

You can complete your referral by entering your information into this Word file.

Instructions

Instructions are provided in blue text throughout the form.

Attachments/supporting information

The referral form should contain sufficient information to provide an adequate basis for a decision on the likely impacts of the proposed action. You should also provide supporting documentation, such as environmental reports or surveys, as attachments.

Coloured maps, figures or photographs to help explain the project and its location should also be submitted with your referral. Aerial photographs, in particular, can provide a useful perspective and context. Figures should be good quality as they may be scanned and viewed electronically as black and white documents. Maps should be of a scale that clearly shows the location of the proposed action and any environmental aspects of interest.

Please ensure any attachments are below three megabytes (3mb) as they will be published on the Department's website for public comment. To minimise file size, enclose maps and figures as separate files if necessary. If unsure, contact the Referrals Gateway (email address below) for advice. Attachments larger than three megabytes (3mb) may delay processing of your referral.

Note: the Minister may decide not to publish information that the Minister is satisfied is commercial-in-confidence.

How do I pay for my referral?

From 1 October 2014 the Australian Government commenced cost recovery arrangements for environmental assessments and some strategic assessments under the EPBC Act. If an action is referred on or after 1 October 2014, then cost recovery will apply to both the referral and any assessment activities undertaken. Further information regarding cost recovery can be found on the Department's website.

Payment of the referral fee can be made using one of the following methods:

- **EFT Payments can be made to:**

  BSB: 092-009
  Bank Account No. 115859
  Amount: $7352
  Account Name: Department of the Environment.
  Bank: Reserve Bank of Australia
  Bank Address: 20-22 London Circuit Canberra ACT 2601
  Description: The reference number provided (see note below)

- **Cheque** - Payable to "Department of the Environment". Include the reference number provided (see note below), and if posted, address:

  The Referrals Gateway
  Environment Assessment Branch
  Department of the Environment
  GPO Box 787
  Canberra ACT 2601

- **Credit Card**

  Please contact the Collector of Public Money (CPM) directly (call (02) 6274 2930 or 6274 20260 and provide the reference number (see note below).

Note: in order to receive a reference number, submit your referral and the Referrals Gateway will email you the reference number.

How do I submit a referral?

Referrals may be submitted by mail or email.

Mail to:

Referrals Gateway
Environment Assessment Branch
Department of Environment
GPO Box 787
CANBERRA ACT 2601

- If submitting via mail, electronic copies of documentation (on CD/DVD or by email) are required.

Email to: epbc.referrals@environment.gov.au

- Clearly mark the email as a 'Referral under the EPBC Act'.
- Attach the referral as a Microsoft Word file and, if possible, a PDF file.
- **Follow up with a mailed hardcopy including copies of any attachments or supporting reports.**

What happens next?

Following receipt of a valid referral (containing all required information) you will be advised of the next steps in the process, and the referral and attachments will be published on the Department's web site for public comment.

The Department will write to you within 20 business days to advise you of the outcome of your referral and whether or not formal assessment and approval under the EPBC Act is required. There are a number of possible decisions regarding your referral:

The proposed action is NOT LIKELY to have a significant impact and does NOT NEED approval

No further consideration is required under the environmental assessment provisions of the EPBC Act and the action can proceed (subject to any other Commonwealth, state or local government requirements).

The proposed action is NOT LIKELY to have a significant impact IF undertaken in a particular manner

The action can proceed if undertaken in a particular manner (subject to any other Commonwealth, state or local government requirements). The particular manner in which you must carry out the action will be identified as part of the final decision. You must report your compliance with the particular manner to the Department.

The proposed action is LIKELY to have a significant impact and does NEED approval

If the action is likely to have a significant impact a decision will be made that it is a *controlled action*. The particular matters upon which the action may have a significant impact (such as World Heritage values or threatened species) are known as the *controlling provisions*.

The controlled action is subject to a public assessment process before a final decision can be made about whether to approve it. The assessment approach will usually be decided at the same time as the controlled action decision. (Further information about the levels of assessment and basis for deciding the approach are available on the Department's web site.)

The proposed action would have UNACCEPTABLE impacts and CANNOT proceed

The Minister may decide, on the basis of the information in the referral, that a referred action would have clearly unacceptable impacts on a protected matter and cannot proceed.

Compliance audits

If a decision is made to approve a project, the Department may audit it at any time to ensure that it is completed in accordance with the approval decision or the information provided in the referral. If the project changes, such that the likelihood of significant impacts could vary, you should write to the Department to advise of the changes. If your project is in the Great Barrier Reef Marine Park and a decision is made to approve it, the Authority may also audit it. (See "*Is your action in the Great Barrier Reef Marine Park,"* p.2, for more details).

For more information

- call the Department of the Environment Community Information Unit on 1800 803 772 or
- visit the web site http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999

All the information you need to make a referral, including documents referenced in this form, can be accessed from the above web site.

Referral of proposed action

Project title: MT ARTHUR COAL OPEN CUT MODIFICATION

1 Summary of proposed action

1.1 **Short description**

The Mt Arthur Coal Mine is located approximately 5 kilometres (km) south-west of Muswellbrook within the Muswellbrook Shire Local Government Area (LGA) in the Upper Hunter Valley of New South Wales (NSW) (Figures 1 and 2).

This EPBC Referral relates to aspects of the Mt Arthur Coal Open Cut Modification (Modification) (incorporating the Action). The Action is limited to the continuation of open cut mining operations at the Mt Arthur Coal Mine for an additional operational life of four years from 2022 to 2026, an increase in the open cut disturbance areas, the use of the conveyor corridor for overburden emplacement and the duplication of the existing rail loop.

The Action will also use existing infrastructure associated with the previously approved mining activities at the Mt Arthur Coal Mine including the existing coal handling and preparation plant (CHPP), rail loop and spur, access roads, workshops, administration areas and water storages, retention basins and associated water management structures.

The Action is separate from, but related to, the existing Mt Arthur Coal Mine. Portions of the existing Mt Arthur Coal Mine were approved in 2012 by a separate Action (Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act] [2011/5866]). It is noted that only the additional surface disturbance areas that form part of the Modification and that have not been previously subjected to Federal approval are referred as a component of the Action. The relevant components of the additional surface disturbance areas associated with the Action are shown on Figure 3.

The Mt Arthur Coal Mine is owned and operated by Hunter Valley Energy Coal (HVEC), a wholly-owned subsidiary of BHP Billiton.

1.2 **Latitude and longitude**

Table 1
Location of the Action

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
Open Pit Extensions and Overburden Emplacement						
1	-32	19	3	150	48	17
2	-32	18	27	150	49	16
3	-32	20	40	150	50	51
4	-32	21	55	150	53	39
5	-32	22	44	150	53	14
6	-32	21	22	150	49	57
Rail Loop Duplication						
1	-32	19	38	150	53	20
2	-32	19	40	150	55	28
3	-32	20	13	150	55	28
4	-32	20	11	150	53	19

The additional surface disturbance areas associated with the Action and location points are shown on Figure 3.

1.3 **Locality and property description**

The Mt Arthur Coal Mine is located approximately 5 km south-west of Muswellbrook within the Muswellbrook Shire LGA in the Upper Hunter Valley of NSW (Figures 1 and 2).

The current mining leases (MLs) held by HVEC include ML 1487, ML 1548, ML 1358, ML 1593 and ML 1655 (Figure 3). In addition, HVEC also holds Coal Lease (CL) 396, Consolidated CL 774, Mining Purpose Lease 263 and Subleases CL 229 and CL 395. The additional surface disturbance areas associated with the Action are located wholly within HVEC's existing mining tenements and application area (i.e. ML 1487, ML 1358, ML 1548, Sublease CL 229, ML 1655 and Mining Lease Application [MLA 476]).

The majority of land associated with the Action is owned by HVEC, with some parcels of land owned by other mine operators and power generation companies. Other than the existing Edderton Road (the realignment of Edderton Road was approved under EPBC 2011/5866), there is no Crown Land located within the additional surface disturbance areas associated with the Action.

1.4 **Size of the development footprint or work area (hectares)**

The total area of additional surface disturbance associated with the Action is approximately 262 hectares (ha), including the proposed extents of the open cut extension areas, the conveyor corridor overburden emplacement area and the rail loop duplication (refer to Areas A to E in Figure 3).

1.5 **Street address of the site**

Mt Arthur Coal
Thomas Mitchell Drive
MUSWELLBROOK NSW 2333.

1.6 **Lot description**

The Action is located wholly within HVEC's existing mining tenements and application area (i.e. ML 1487, ML 1358, ML 1548, Sublease CL 229, ML 1655 and MLA 476).

Relevant parcels of land within the area of the additional surface disturbance areas associated with the Action are displayed on Figure 4.

1.7 **Local Government Area and Council contact (if known)**

The Mt Arthur Coal Mine is located wholly within the Muswellbrook Shire LGA (Figure 2). The Action is not subject to a local government planning approval, however, does require planning approval from the NSW Minister for Planning (or delegate). Refer to Section 2.4 of this referral for further details about the state planning approval for the Mt Arthur Coal Mine.

The relevant contact at the Muswellbrook Shire Council (MSC) is Mr Steve McDonald (General Manager). His contact details are as follows:

Administration Centre, Maitland Street, Muswellbrook
PO Box 122, Muswellbrook, NSW 2333
Phone: 02 6549 3700
Fax: 02 6549 3701
Email: council@muswellbrook.nsw.gov.au

1.8 **Time frame**

The proposed Modification (incorporating the Action) is subject to the granting of a Modification application to the existing Project Approval for the Mt Arthur Coal Mine (Project Approval 09_0062) under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) by the NSW Minister for Planning. Should the proposed Modification be granted, open cut mining operations will continue at Mt Arthur Coal Mine from Years 2022 to 2026.

1.9	**Alternatives to proposed action**		No
		✓	Yes, you must also complete section 2.2
1.10	**Alternative time frames etc**	✓	No
			Yes, you must also complete Section 2.3. For each alternative, location, time frame, or activity identified, you must also complete details in Sections 1.2-1.9, 2.4-2.7 and 3.3 (where relevant).
1.11	**State assessment**		No
		✓	Yes, you must also complete Section 2.5
1.12	**Component of larger action**	✓	No
			Yes, you must also complete Section 2.7

1.13 **Related actions/proposals**		No
	✓	Yes, provide details: The Action is separate from, but related to, the existing Mt Arthur Coal Mine. Portions of the existing Mt Arthur Coal Mine were approved in 2012 by a separate Action (EPBC 2011/5866). It is noted that only the additional surface disturbance areas that form part of the Modification and that have not been previously subjected to Federal approval have been referred as a component of the Action.
1.14 **Australian Government funding**	✓	No
		Yes, provide details:
1.15 **Great Barrier Reef Marine Park**	✓	No
		Yes, you must also complete Section 3.1 (h), 3.2 (e)

2 Detailed description of proposed action

2.1 Description of proposed action

The Mt Arthur Coal Mine is located approximately 5 km south-west of Muswellbrook within the Muswellbrook Shire LGA in the Upper Hunter Valley of NSW (Figures 1 and 2). The additional surface disturbance areas associated with the Action are located wholly within HVEC's existing mining tenements and application area (i.e. ML 1487, ML 1358, ML 1548, Sublease CL 229, ML 1655 and MLA 476).

The Action would include the following components:

- a four year continuation of the open cut mine life from 2022 to 2026 at the currently approved maximum rate of 32 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal;
- an increase in open cut disturbance areas;
- use of the conveyor corridor for overburden emplacement; and
- duplication of the existing rail loop.

It is noted that all other aspects of the operations at the Mt Arthur Coal Mine, including the mining tenements, the annual open cut ROM coal production rate, the coal processing rate, employment levels and hours of operations would remain generally consistent with that currently approved under the EPBC Act (2011/5866). Various aspects of the surface disturbance area that forms part of the Modification have already been approved as active operational areas under the EPBC Act approval (2011/5866) and for this reason these areas do not constitute part of the Action which is the subject of this EPBC Referral.

The additional surface disturbance areas associated with the Action are shown in Figure 3, including the extents of the additional surface infrastructure including the proposed rail loop duplication.

Open Cut Mining Operations

The Wittingham coal measures would continue to be mined in the open cut extension areas (Figure 3). Seams which subcrop within the open cut extension areas are the Bowfield and Arrowfield Seams towards the northern extent of the open cut extension area and the Woodlands Hill and Glen Munro seams towards the southern extent.

The open cut extension areas are situated on the western limb of the north-northwest oriented Muswellbrook Anticline, with coal seams generally dipping to the west-southwest toward the Calool Syncline – Denman Anticline systems.

Conventional truck and shovel open cut mining would continue to be used at the Mt Arthur Coal Mine for a further four years until 2026. This would involve the extraction of approximately 128 million tonnes of ROM coal. Open cut mining operations would continue to be undertaken at the currently approved rate of up to 32 Mtpa.

Overburden Management

Approximately 512 million bank cubic metres of additional overburden would be excavated as a result of the Action. The majority of this overburden would be used to in-fill the Northern Open Cut, with some overburden to be placed within the conveyor corridor.

The existing overland conveyor to the Bayswater Power Station is contained within a 'corridor' surrounded by existing mine landforms and infrastructure.

Surface Infrastructure

In addition to the abovementioned changes to the open cut and overburden management, some changes to existing infrastructure is also proposed as part of the Action.

Of relevance to the Action, HVEC proposes a high capacity optional duplication of the existing rail loop which would allow for additional trains to be loaded and dispatched during peak times. The need for the duplication would be determined by ship loading requirements at the Port of Newcastle, and constraints on the Main Northern Railway.

When constructed, the rail loop duplication would consist of approximately 5 km of new track, immediately adjacent to the existing rail loop. Note that the duplicated rail loop would be located within the existing rail spur corridor.

However, other changes to the existing infrastructure proposed as a component of the Modification which do not form part of the Action, include the following:

- Relocation of load point for existing overland conveyor to Bayswater Power Station.
- Relocation of explosives magazines and facilities.
- Construction of additional office facilities and control room, adjacent to the CHPP.
- Expansion of the mine infrastructure area and ROM stockpile.
- Construction of an additional administration building.

All of these infrastructure changes occur within the active operational areas under the EPBC Act approval (2011/5866) and therefore do not impact on any matters of national environmental significance.

Water Supply and Management

The existing surface water runoff controls aimed at preventing up-catchment runoff water from entering open cut mining operational areas at the Mt Arthur Coal Mine would mostly be retained and where necessary upgraded for the Action.

Some additional up-catchment runoff water control structures would be constructed for the Action to manage surface water movement to/from the additional surface disturbance areas associated with the Action.

Other Activities

There would be no change to the CHPP rejects management at the Mt Arthur Coal Mine as a result of the Action, with all coarse rejects produced by the CHPP continuing to be co-disposed of within the overburden emplacement areas or utilised in the construction of tailings dams, stockpiles or other infrastructure. Fine rejects (tailings) would continue to be stored within the tailings storage facility on-site.

Similarly, the Action would not change annual ROM or product coal production rates and hence average rail movements would remain the same (although peak rail movements would increase).

Biodiversity Offsets

The Action would require the refinement of the location of the 'rehabilitation areas'. The existing NSW and Commonwealth Environmental Approvals specify the need for 'rehabilitation areas' in the existing biodiversity offset strategy. This includes 1,915 ha of vegetation (including 500 ha of Box-Gum Woodland) to be established in corridors as shown on Figure 5. This is greater than 30 percent (%) of the disturbance area for open cut operations at the Mt Arthur Coal Mine.

Additional biodiversity offset areas have been proposed as part of the Modification to account for additional clearance associated with the Action and are shown on Figures 5 and 6.

This would include:

- expanding the existing Saddlers Creek Conservation area by 131 ha; and
- expanding the existing Middle Deep Creek Offset area by 410 ha.

In addition to the above, HVEC has committed to an additional 85 ha offset area at a location to be determined.

The additional proposed biodiversity offset areas would be managed, secured, monitored in the same way as the existing biodiversity offset areas in accordance with the Project Approval (09_0062) for the Mt Arthur Coal Mine. This includes the control of weeds and feral animals, management of grazing, fire management and control of vehicular access. Hunter Eco (2013) concluded that the Middle Deep Creek Offset area is *superior in ecological value to any of the habitat to be cleared in the Modification* and that a substantial net gain in biodiversity would result from the combination of the Modification and the proposed offsets.

2.2 Alternatives to taking the proposed action

Given that the Action objectives include the continuation of open cut mining at the Mt Arthur Coal Mine, limited alternatives are available. Notwithstanding, alternatives to the proposed mine plan, infrastructure changes and final voids for the Action have been considered by HVEC in the development of the project description and design for the Action as described in Section 2.1.

- **Proposed Mine Plan –** the additional open cut areas associated with the Action are a logical westerly progression of the Northern Open Cut, involving a westerly extension/cutback of the approved open cut highwall. Potential alternative plans for coal resource recovery would involve development of separate or satellite open cut pits which would have the potential for greater surface disturbance than that proposed in the Modification and have not been considered further.
- **Mt Arthur Rail Loop Duplication –** current analysis and modelling indicates that the loop duplication may be needed because of ship loading requirements at the Port of Newcastle, and constraints on the Main Northern Railway line. Construction of the loop duplication adjacent to the existing loop has many advantages, including reduction of additional disturbance areas and use of common/existing rail infrastructure between the two loops. Due to the logical advantages of the loop duplication over other potential options, other options were not considered further.
- **Final Voids –** as a component of the Action, the Saddlers Pit void would be backfilled and the overall catchment areas reporting to final voids would be reduced. In the case of Saddlers Pit, backfilling of the void is considered to be preferable to the alternative scenario (i.e. leaving the pit as a final void as is currently approved). The final landforms, including final voids, would continue to be reviewed by HVEC.

2.3 Alternative locations, time frames or activities that form part of the referred action

Alternatives that have been considered for the Action are discussed in Section 2.2.

2.4 Context, planning framework and state/local government requirements

Current mining operations at the Mt Arthur Coal Mine are undertaken in accordance with Project Approval 09_0062 granted by the NSW Minister for Planning on 24 September 2010.

The Action forms part of an Environmental Assessment which accompanied a request to modify the Project Approval 09_0062 which has been made under section 75W of the EP&A Act. In February 2012, HVEC submitted a Preliminary Environmental Assessment for the Modification (of which the Action forms part of) to the then NSW Department of Planning and Infrastructure (DP&I) (now the Department of Planning and Environment [DP&E]) and submitted a request for Director-General's Requirements (DGRs). In April 2012, a delegate of the Director-General provided DGRs for the Modification. A Project Application and Environmental Assessment was lodged by HVEC, and the then DP&I exhibited the documents and sought public submissions in April/May 2013.

Many of the agencies, special interest groups and members of the public consulted for the Modification (described in Section 2.6) provided their comments and feedback on the Project Application and Environmental Assessment. HVEC then provided responses to the submissions, and the Secretary's Assessment Report recommending approval of the Action was issued in May 2014. The Action has been referred to the Planning Assessment Commission (PAC) for determination. The PAC visited the site on 14 July 2014 and held a public meeting in Muswellbrook on 15 July 2014. The Modification was approved by the PAC on 26 September 2014.

NSW Environmental Planning and Assessment Act, 1979

The EP&A Act and the NSW *Environmental Planning and Assessment Regulation, 2000* set the framework for planning and environmental assessment in NSW. Modification of the Project Approval (09_0062) for the Mt Arthur Coal Mine (of which the Action forms part of) was approved under section 75W of Part 3A of the EP&A Act. Part 3A was repealed in 2011 but it continues to apply to projects that were originally approved under this part of the Act.

Other Leases, Licence and Approvals

Relevant leases, licences or approvals required under other NSW legislation would also be obtained and/or varied for the Action as required, including but not necessarily limited to:

- variations to the existing Environment Protection Licence (EPL) 11457 under the NSW *Protection of the Environment Operations Act, 1997*;
- additional water licences under the NSW *Water Management Act, 2000* and NSW *Water Act, 1912*; and
- the updating of existing environmental management plans and mining operation plans where relevant.

2.5 Environmental impact assessments under Commonwealth, state or territory legislation

The Environmental Assessment for the Modification was prepared by HVEC to support the request to modify the Project Approval 09_0062 under section 75W of the EP&A Act.

The Environmental Assessment provides a comprehensive assessment of all potential impact from the Modification (including the Action) by addressing the DGRs. The Environment Assessment included the preparation of the following specialist studies:

- Agricultural Impact Statement.
- Groundwater Impact Assessment.
- Surface Water Assessment.
- Ecological Assessment.
- Aboriginal and Non-Indigenous Cultural Heritage Assessment.
- Air Quality and Greenhouse Gas Assessment.
- Noise and Blasting Assessment.
- Landscape and Visual Impact Assessment.
- Geochemistry Assessment of Overburden and Interburden.
- Socio-Economic Assessment.

- Road Transport Assessment.
- Environmental Risk Assessment.

The Ecological Assessment was prepared by Hunter Eco (2013) and provided a comprehensive assessment of potential impacts of the Modification (including the Action) on threatened species and communities as listed in the EPBC Act and the NSW *Threatened Species Conservation Act, 1995*.

The Groundwater Impact Assessment was prepared by Australasian Groundwater & Environmental Consultants Pty Ltd (AGE) (2013) and describes the hydrogeological regime of the Modification (including the Action) and identifies potential risks and constraints. The Surface Water Assessment was prepared by Gilbert & Associates Pty Ltd (2013). Both of these assessments provided a comprehensive assessment of the potential impacts of the Modification (including the Action) on water resources.

The Environmental Assessment was lodged with the then DP&I for assessment and approval. Mr David Kitto (Director, Mining) is the relevant contact officer at the DP&E and the contact details are provided below:

23-33 Bridge Street, Sydney NSW 2000
GPO Box 39, Sydney NSW 2001
Phone: 02 9228 6111
Fax: 02 9228 6455
Email: information@planning.nsw.gov.au
Application Number: 09_0062 MOD 1

A description of the public consultation undertaken as a component of the Environmental Assessment is provided in Section 2.6.

2.6 Public consultation (including with Indigenous stakeholders)

Comprehensive consultation with Local, State and Federal Government agencies, infrastructure owners, service providers and other resource companies has been undertaken for the Environmental Assessment of the Modification (which includes the Action). Regular consultation was conducted with community members and other interested parties regarding the Modification.

Consultation with Government Agencies

Department of Sustainability, Environment, Water, Population and Communities

In November 2012, HVEC provided the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now the Department of the Environment [DotE]) with a letter, information sheet regarding the Modification (incorporating the Action) and a summary of ecological study results.

Department of Planning and Infrastructure

HVEC discussed the Action with the DP&I (now the DP&E) in November 2011. DGRs for the Modification were subsequently issued on 30 April 2012. HVEC has continued to consult with the DP&I, including meetings held in May and June 2012.

A briefing regarding the Modification was held with the DP&I Singleton branch in November 2012.

DP&I representatives in Sydney were also provided with an update on the Modification in November 2012, which included an overview of potential environmental impacts and community consultation undertaken by HVEC.

Office of Environment and Heritage (including the Environment Protection Authority and the Heritage Branch)

The NSW Office of Environment and Heritage (OEH) were provided information regarding the Modification in October 2012. A meeting was also held with the NSW Environment Protection Authority (EPA) and OEH in November 2012, where the Modification description, noise and air quality assessment results, the Aboriginal heritage assessment and flora and fauna study results were discussed. Key aspects raised with the EPA and OEH were:

- the limited changes (and some minor improvements) in air and noise effects associated with the Modification;
- the consultation undertaken with Aboriginal Stakeholders;
- the survey methodology and timing with respect to threatened flora species;
- the Action in relation to the existing EPL 11457; and
- the assessment of the proposed biodiversity offset.

Department of Primary Industries

In November 2012, HVEC distributed a letter and information sheet regarding the Modification to the following divisions of the NSW Department of Primary Industries (DPI). An offer to meet was also made by HVEC to the:

- Department of Agriculture, Fisheries and Forestry; and
- Catchments and Lands (Crown Lands Division).

NSW Office of Water

HVEC provided the NSW Office of Water (NOW) with an information sheet regarding the Modification in February 2012. In June 2012, HVEC provided the NOW representatives with a presentation regarding the Modification and a field inspection was also undertaken. Air quality, noise, cumulative impacts, land use, water and ecology issues were discussed. In October 2012, the NOW was provided with an updated information sheet regarding the Modification.

A specific Modification (incorporating the Action) briefing was held with the NOW in November 2012, where the Modification description, surface and groundwater study results were discussed. Key aspects discussed with NOW were:

- the Aquifer Interference Policy;
- the groundwater assessment results; and
- the site water and salt balance results.

Division of Resources and Energy (within the Department of Trade and Investment, Regional Infrastructure and Services)

In February 2012, HVEC provided the NSW Division of Resources and Energy (DRE) with an information sheet regarding the Modification. HVEC held a meeting with DRE representatives in May 2012 to provide a Modification briefing and information sheet. A field inspection was also undertaken. Potential air quality, noise, cumulative impacts, land use, water and ecology impacts were discussed.

In October 2012, an updated information sheet was provided and HVEC presented an update briefing on the Modification to representatives of the DRE. Revision of the rehabilitation strategy, water management and final landform stability were discussed.

NSW Dams Safety Committee

In November 2012, HVEC provided the NSW Dams Safety Committee with a letter and information sheet and offered to meet with the NSW Dams Safety Committee regarding the Modification.

Hunter-Central Rivers Catchment Management Authority

The Hunter-Central Rivers Catchment Management Authority (CMA) was provided with a letter and information sheet regarding the Modification in November 2012. HVEC met with the CMA in January 2013, where an update regarding the Modification was provided. Opportunities for a collaborative approach in relation to conservation initiatives at Saddlers Creek were discussed.

NSW Health

In November 2012, HVEC provided NSW Health with a letter and information sheet regarding the Modification. HVEC met with NSW Health in January 2013, where an introduction to the Modification and an overview of potential noise and air quality effects was provided. Assessment of potential blasting emissions were discussed.

Transport for NSW (including Centre for Transport Planning, Roads and Maritime Services)

In November 2012, an information sheet regarding the Modification and summary of results, with focus on the traffic assessment, was provided to Transport for NSW. Later that month, HVEC met with Transport for NSW to discuss the Modification, in particular, the outcomes of the road transport and rail assessments.

Muswellbrook Shire Council

In January 2012, HVEC met with the MSC to discuss the Modification. The MSC were provided with a briefing and information sheet. In May 2012, HVEC held a meeting with the MSC to provide an update on the Modification and to discuss final landform concerns raised by MSC. In July 2012 MSC representatives met with HVEC to discuss Modification offsets and potential impacts on the draft Muswellbrook Land Use Plan.

In October 2012, HVEC provided an update on the Modification to representatives of MSC. Key aspects discussed by the MSC included:

- road traffic and the increase in rail movements;
- final void management;
- air quality monitoring and cumulative impacts; and
- local biodiversity offset areas.

In addition to the above, HVEC and MSC are currently negotiating an extension of the existing Voluntary Planning Agreement to cater for the Modification.

Consultation with Infrastructure Owners, Service Providers and Other Resource Companies

Australian Rail Track Corporation, RailCorp and Newcastle Port Corporation

In November 2012, HVEC provided the Australian Rail Track Corporation, RailCorp and the Newcastle Port Corporation with a letter and information sheet regarding the Modification.

Anglo Coal (Drayton Management) Pty Limited

HVEC held a meeting with Anglo Coal Drayton representatives in March 2012. An update on the Modification was provided and a discussion held in relation to potential noise impacts in the vicinity of Antienne. In December 2012, HVEC met with Anglo Coal Drayton to provide an update on the Modification and discuss the potential cumulative noise and air quality impacts.

Xstrata – Mangoola Coal

In March 2012, HVEC provided Mangoola Coal with an information sheet regarding the Modification. In November 2012, HVEC and Mangoola Coal representatives met to discuss the Modification and potential cumulative impacts with the Mangoola Coal Mine. In addition, HVEC met with Mangoola Coal representatives in January 2013 to discuss cumulative air quantity impacts.

Bengalla Mining Company Pty Limited

HVEC provided Bengalla Mining Company Pty Limited with an information sheet regarding the Modification in February and November 2012.

Macquarie Generation

In March 2012, HVEC met with Macquarie Generation representatives to provide a Modification briefing and discuss the relocation of the Macquarie Generation conveyor load point. Macquarie Generation was provided with an updated information sheet regarding the Modification in November 2012.

Hunter Valley Coal Chain Coordinator Limited

In November 2012, HVEC provided Hunter Valley Coal Chain Coordinator Limited with a letter and information sheet regarding the Modification.

Consultation with the Local Community and Affected Landholders

Information sheets regarding the Modification were distributed to the local community in February and October 2012. The information sheets were also made available on the BHP Billiton website. HVEC employees and representatives have also undertaken face-to-face meetings with numerous potentially affected landholders regarding the Modification.

In February 2011 and October 2012, HVEC provided the Mt Arthur Coal Community Consultative Committee (CCC) with a detailed brief regarding the Modification. Key aspects of the briefing included additional rail movements, traffic assessment, potential noise impact and final landform. HVEC has continued to provide updates to the CCC during the assessment of the Modification.

Consultation with Other Interested Parties/Organisations

Hunter Thoroughbred Breeders Association

HVEC provided the Hunter Thoroughbred Breeders Association with a letter and information sheet regarding the Modification in November 2012. A meeting was held with a representative of the Hunter Thoroughbred Breeders Association in December 2012 to discuss the Modification's progress and specialist study results.

Coolmore Stud

HVEC provided Coolmore Stud with a letter and information sheet regarding the Modification in November 2012. In January 2013, HVEC met with a representative of Coolmore stud. The meeting included a briefing on the Modification specialist study results and cumulative impacts.

Woodlands Stud

In February 2012, HVEC met with a representative of Woodlands Stud to present a Modification briefing, fact sheet and information of potential improvements for visual and dust impacts. In November 2012, HVEC provided a letter and updated information sheet of the Modification and specialist study results. A meeting was held between HVEC and Woodlands Stud representatives in December 2012 to discuss the Modification's progress and specialist study results.

Consultation with Indigenous Stakeholders

Consultation with Indigenous stakeholders has been conducted in accordance with the requirements of the OEH policy *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (NSW Department of Environment, Climate Change and Water [DECCW], 2010).

Indigenous stakeholders were identified through correspondence with local authorities, government agencies and community organisations in accordance with Section 4.1.2 of the OEH policy *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010). These organisations include the Wanaruah Local Aboriginal Land Council, Office of the Registrar of the *Aboriginal Land Rights Act 1983*, Native Title Services Corporation, OEH, the National Native Title Tribunal, Hunter Central Rivers CMA and MSC.

Written notification of the Modification was provided to Indigenous stakeholders identified through correspondence with the organisations listed above. These stakeholders were invited to register an interest in the process of consultation for the Modification. A notice was also placed in the Hunter Valley News on Wednesday 1 February 2012 seeking registrations of interest from any additional interested Indigenous stakeholders.

The following Indigenous stakeholders registered their interest in being involved in the consultation process associated with the Modification (incorporating the Action) (in alphabetical order):

- Aboriginal Native Title Consultants;
- Aliera French Trading;
- Bawurra;
- Breeza Plains Cultural Heritage Consultancy;
- Bunda Consultants;
- Cacatua Culture Consultants;
- Carrawonga Consultants;
- Cheryl Moodie Consultants;
- Culturally Aware;
- Deslee Talbott Consultants;
- DFTV Enterprises;
- Gidawaa Walang Cultural Heritage Consultancy;
- Gomery Cultural Consultants;
- Hunter Traditional Owners Environmental and Management Services;
- Hunter Valley Aboriginal Corporation;
- Indigenous Outcomes;
- Jarban & Mugrebea;
- Kawul Cultural Services;
- Kayaway Eco Cultural & Heritage Services;
- Lower Hunter Wonnarua Council Inc.;
- Mingga Consultants;
- Mooki Plains Management;
- Muswellbrook Cultural Consultants;
- Myland Cultural and Heritage Group;
- Ngarramang-Kuri Aboriginal Culture and Heritage;
- Roger Noel Matthews;
- Scott Smith;
- T&G Culture Consultants;
- Tocomwall;
- Ungooroo Aboriginal Corporation;
- Upper Hunter Heritage Consultants;
- Upper Hunter Wonnarua Council Inc.;
- Valley Culture;
- Wattaka Wonnarua Cultural Consultants;
- Wanaruah Local Aboriginal Land Council;
- Warrigagil Cultural Services;
- Widescope Indigenous Group Pty Ltd;
- Wonn 1 Contracting;
- Wonnarua Nation Aboriginal Corporation;
- Wonnarua Culture Heritage; and
- Yinaar Cultural Services.

All Indigenous stakeholders were provided with a Proposed Methodology (i.e. draft assessment methodology) for the Aboriginal and Non-Indigenous Cultural Heritage Assessment for their review and comment. Representatives from the Indigenous stakeholder groups have also participated in the field surveys undertaken for the area associated with the Action for a seven day period from 10 to 24 April 2012.

A Draft Aboriginal and Non-Indigenous Cultural Heritage Assessment was issued to the indigenous stakeholders on 9 August 2012 for their review and comment, including survey results, archaeological and cultural significance assessment (based on feedback received during consultation and fieldwork), potential impacts and any proposed management and mitigation measures. All Indigenous stakeholders were invited to attend a meeting and site inspection on 30 August 2012. All comments received from the Indigenous stakeholders on the Draft Aboriginal and Non-Indigenous Cultural Heritage Assessment were considered and/or addressed in the final Aboriginal and Non-Indigenous Cultural Heritage Assessment.

2.7 A staged development or component of a larger project

The Action is a stand-alone variation to the operations at the Mt Arthur Coal Mine. Whilst the Action is inherently linked to existing related industry in the Upper Hunter region and the existing Mt Arthur Coal Mine, it is not directly related to any additional proposed actions within the region requiring approval under the EPBC Act. It is noted however, that portions of the existing Mt Arthur Coal Mine were approved in 2012 by a separate Action (EPBC 2011/5866). Only the additional surface disturbance areas that form part of the Modification and that have not been previously subjected to Federal approval have been referred as a component of the Action.

3 Description of environment & likely impacts

3.1 Matters of national environmental significance

3.1 (a) World Heritage Properties

Description

No World Heritage Properties are situated in the Action area. The closest World Heritage Property is the Greater Blue Mountains Area. The Wollemi National Park, which is part of the Greater Blue Mountains Area, is located approximately 15 km south-west of the Action area.

Nature and extent of likely impact

The Greater Blue Mountains Area is situated approximately 15 km south-west of the Action area and, therefore, a considerable distance from the area of any potential direct or indirect impacts of the Action. Secondary effects on the Greater Blue Mountains Area, including the Action's contribution to global greenhouse gas emissions, would be relatively small.

In addition, the Action would not have a significant impact on the World Heritage values of the Greater Blue Mountains Area given the Action would not cause one or more of the World Heritage values to be lost, one or more of the World Heritage values to be degraded or damaged, or one or more of the World Heritage values to be notably altered, modified, obscured or diminished. Accordingly, the Action would not have, and is not likely to have, a significant impact on the World Heritage values of the Greater Blue Mountains Area.

3.1 (b) National Heritage Places

Description

No National Heritage Places are situated in the Action area. The Greater Blue Mountains Area (recognised as a World Heritage Property) is also a National Heritage Place. The Greater Blue Mountains Area is approximately 15 km south-west of the Action area (as described in Section 3.1(a) above).

Nature and extent of likely impact

As described above, the Greater Blue Mountains Area is a considerable distance from the area of any potential direct or indirect impacts of the Action.

In addition, the Action would not have a significant impact on the National Heritage values of the Greater Blue Mountains Area given the Action would not cause one or more of the National Heritage values to be lost, one or more of the National Heritage values to be degraded or damaged, or one or more of the National Heritage values to be notably altered, modified, obscured or diminished. Accordingly, the Action would not have, and is not likely to have, a significant impact on the National Heritage values of the Greater Blue Mountains Area.

3.1 (c) Wetlands of International Importance (declared Ramsar wetlands)

Description

No Ramsar wetlands are situated in the Action area or immediate surrounds. The closest Ramsar wetland to the Action area is the Hunter Estuary Wetlands, which is located approximately 106 km south-east of the Action.

Nature and extent of likely impact

The Hunter Estuary Wetlands are situated approximately 106 km south-east (i.e. downstream) of the Action, and it is unlikely that the Hunter Estuary Wetlands would be affected by any potential direct or indirect effect of the Action.

The Action would not have a significant impact on the ecological character of the Hunter Estuary Wetlands Ramsar site as it would:

- not result in areas of the wetland being destroyed or substantially modified;
- not result in a substantial and measurable change in the hydrological regime of the wetland;
- not result in the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected;
- not result in a substantial and measurable change in the water quality of the wetland; and
- not result in an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.

3.1 (d) Listed threatened species and ecological communities

Description

The flora and fauna of the Action area and surrounds have been comprehensively surveyed over the past 16 years. Surveys have targeted threatened species and ecological communities listed under the EPBC Act.

The various flora and fauna surveys that have been conducted within the Action area and surrounds are listed in Table 2. The intensive survey works provide a high level of understanding of the flora and fauna species that are present within the Action area and surrounds, resulting in a high degree of certainty in regards to assessing the environmental impacts of the Action.

Table 2
Studies Undertaken Within the Action Area and Surrounds

Report	Survey	Survey Type and Time
Dames and Moore (2000)	EIS Flora and Fauna Report	Flora – 15-21 November 1998 Fauna – 14-21 November 1998
Umwelt Environmental Consultants (Umwelt) (2003)	Monitoring	Flora – April and May 2003 Fauna – 1 April 2003; 7-9 May 2003
Umwelt (2005)	Monitoring	Flora – December 2004; early January 2005 Fauna – 14-15 December 2004; 20-22 December 2004
Umwelt (2006a)	Flora and Fauna	Flora – 16-18 February 2005; 30 November 2005 Fauna – 21-25 February 2005
Umwelt (2006b)	Monitoring	Flora – November 2005 Fauna – December 2005
Umwelt (2006c)	Ecological Assessment	Flora and Fauna – 7 December 2005
Umwelt (2007a)	Monitoring	Flora – November 2006 Fauna – December 2006
Umwelt (2007b)	Mt Arthur Underground Project	Flora – 5-8 April 2005; 5-7 December 2005 Fauna – 7-11 March 2005; 5-7 December 2005
Cumberland Ecology (2009a)	Mt Arthur Consolidation Project	Flora and Fauna – 28 August 2008; 21-23 September 2008; 30 September – 2 October 2008; 10-12 November 2008; 19-23 January 2009; 4 March 2009; 8-9 April 2009; 9-10 July 2009; and 13-14 July 2009
Cumberland Ecology (2009b)	Monitoring	Flora and Fauna – 19-23 January 2009
Cumberland Ecology (2010a)	EPBC Act referral	Flora and Fauna – Drawn from other studies
Cumberland Ecology (2010b)	Monitoring	Flora and Fauna – 19-22 January 2010; 27-29 January 2010
Cumberland Ecology (2010c)	Monitoring	Flora and Fauna – 20-23 September 2010

Table 2 (Continued)
Studies Undertaken Within the Action Area and Surrounds

Report	Survey	Survey Type and Time
Umwelt (2011)	Flora and Fauna	Vegetation Communities – 29 August - 2 September 2011
Cumberland Ecology (2011)	Monitoring *Diuris tricolor* (Pine Donkey Orchid)	Flora – 29 September 2011
Niche (2012)	Open Cut Modification Fauna Report	Fauna – 1 May 2012; 7-11 May 2012
Hunter Eco (2013)	Open Cut Modification Environmental Assessment	Flora – 16 April 2012 - 9 May 2012; 9 -12 September 2012; 19-September 2012
Umwelt (2012)	Monitoring	Flora and Fauna – 3-5 December 2012
Umwelt (2013)	Monitoring	Flora and Fauna – 2-4 December 2013; 12 December 2013

No flora species currently listed as threatened under the EPBC Act have been identified during previous surveys of the Action area and surrounds. The Grey-headed Flying-fox (*Pteropus poliocephalus*), listed as Vulnerable under the EPBC Act, is the only threatened fauna species that has been recorded in the Action area. One Threatened Ecological Community has also been potentially identified within the Action area, namely White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as Critically Endangered under the EPBC Act. Threatened flora and fauna species, and ecological communities predicted to occur in the wider region are described in the subsections below.

An Ecological Assessment for the Action was undertaken by Hunter Eco (2013) and is presented in Attachment B.

In particular, the following sections within Hunter Eco (2013) are relevant to the Action:

- Section 5 – Supplementary Field Survey Results.
- Section 6 – Impact Evaluation.
- Section 7 – Threatened Species Assessment (including assessment of Threatened Ecological Communities and the Grey-headed Flying-fox).
- Section 8 – Impact Avoidance, Mitigation and Offset Measures.

Threatened Flora Species

Flora surveys were undertaken in 2012 within the Action area and immediate surrounds to specifically target threatened species that could potentially occur (Hunter Eco, 2013). The flora surveys undertaken included a variety of techniques and methods, including targeted searches for threatened flora species; flora plots; random meanders; and linear transects.

A list of threatened flora species listed under the EPBC Act that have the potential to occur in the Action area was generated from database searches (i.e. EPBC Protected Matters Search Tool [DotE, 2014a] and BioNet website [OEH, 2014a]) of a 40 square kilometres (km^2) search area centred on the Action (Table 3).

None of the flora species listed as threatened under the EPBC Act have been recorded in the Action area or immediate surrounds, despite targeted surveys. Hunter Eco (2013) considered it unlikely that any of the threatened flora species listed under the EPBC Act would be affected by the Action, due to the lack of recorded sightings in the Action area and/or lack of potential habitats (Table 3).

Table 3
Potential Threatened Flora Species

Species Name	Common name	EPBC Status[1]	Database		Distribution/Habitat Requirements in Relation to the Action	Recorded in Action Area	Likelihood of Occurrence within Action Area and Immediate Surrounds
			EPBC Protected Matters Search (2014)[2]	BioNet (2014)[3]			
Streblus pendulinus	Siah's Backbone	E	•	-	This species occurs in warmer rainforests, predominantly along watercourses (DotE, 2014b). There are no known records within 10 km of the Action area.	No	Unlikely, no potential habitat occurs within the Action area or surrounds.
Eucalyptus glaucina	Slaty Red Gum	V	•	•	This species has not been recorded in the Action area, but has been recorded approximately 10 km south-west and approximately 5 km south-east (OEH, 2014a) of the Action area.	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	-	•	This species occurs in dry, grassy woodlands. It has not been recorded in the Action area, but was recorded in 2004 approximately 2 km to the south of the Action area (record accuracy: 100,000 km) (OEH, 2014a). The Action area is not within known/ predicted distributions (OEH, 2014b).	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), or years of monitoring (Table 2). Considering the low accuracy of the closest record, and the current distributions mapped by OEH (2014b), it is unlikely this species will be affected by the Action.
Prasophyllum sp. Wybong (C. Phelps ORG 5269)	a leek-orchid	CE	•	-	A grassland and grassy woodland terrestrial orchid found in Box-Gum habitat.	No	The Action area contains potential habitat, but this species has not been found during targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Pterostylis gibbosa	Illawarra Greenhood	E	•	-	All known populations of this species grow in open forest or woodland, on flat or gently sloping land with poor drainage (OEH 2014b). Predominantly found in the Central Coast and North Coast botanical areas with a disjunct occurrence at Milbrodale.	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Thesium australe	Austral Toadflax	V	•	-	Grows in grassland and woodland and is a hemi parasite of *Themeda australis.*	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Euphrasia arguta	-	CE	•	-	Only recorded from grassy areas near rivers in the Bathurst to Walcha areas. Known/predicted distributions do not overlap with Action area (OEH, 2014b).	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).

[1] Threatened flora species status listed under the EPBC Act (Current at August 2014).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

[2] DotE (2014a).

[3] OEH (2014a).

Threatened Fauna Species

Fauna surveys and habitat assessments were undertaken in autumn of 2012 within the Action area and immediate surrounds by Niche (2012). The fauna surveys undertaken included a variety of techniques and methods, including:

- arboreal Elliott trapping (Elliott trap B);
- ground fauna surveys (infra-red camera traps, hair tubes);
- bat surveys (ultrasonic call recording);
- diurnal bird surveys;
- call playback for owls and arboreal marsupials;
- spotlight surveys;
- call playback;
- stag watching;
- koala surveys;
- herpetological surveys; and
- frog chorus survey and aquatic habitat surveys.

In addition to these comprehensive surveys of the Action area, an abundance of fauna surveys have been conducted over the wider locality (Table 2). Many of these surveys have used techniques consistent with Hunter Eco (2013) and Niche (2012). In addition the following methods have been used:

- mist nets (for live capture of Microchipterian bats) (Dames & Moore, 2000; Cumberland Ecology, 2009a);
- harp traps (Dames & Moore, 2000; Umwelt, 2006a; Cumberland Ecology, 2009a);
- opportunistic searches of potential bat roosts (Dames & Moore, 2000);
- terrestrial Elliott B trapping (Dames & Moore, 2000; Umwelt, 2006a);
- terrestrial Type A Elliott traps (Dames & Moore, 2000; Umwelt, 2006a; Cumberland, 2009a);
- pitfall traps (Dames & Moore, 2000; Cumberland Ecology, 2009a);
- cage traps (Dames & Moore, 2000; Umwelt, 2006a; Cumberland Ecology, 2009a);
- arboreal PVC traps (Dames & Moore, 2000; Cumberland Ecology, 2009a);
- timed area searches for reptiles and amphibians (Dames & Moore, 2000);
- indirect fauna recording (Dames & Moore, 2000; Umwelt, 2006a);
- hair funnel transects (targeting ground fauna) (Umwelt, 2003; Umwelt, 2005; Umwelt, 2006b; Umwelt, 2006a); and
- nest box monitoring (Umwelt, 2003; Umwelt, 2005; Umwelt, 2006b; Umwelt, 2012; Umwelt, 2013; Cumberland Ecology, 2009a; Cumberland Ecology, 2009b; Cumberland Ecology, 2010c).

A list of threatened fauna species listed under the EPBC Act that have the potential to occur in the Action area was generated from database searches (i.e. EPBC Protected Matters Search Tool [DotE, 2014a] and BioNet website [OEH, 2014a]) using a 40 km^2 search area centred on the Action (Table 4).

No listed fish, amphibian or reptile species have been recorded within the Action area or surrounds according to the EPBC Act protected matters search (DotE, 2014a), database records (OEH, 2014a) or fauna surveys (Table 2) despite comprehensive surveys and targeted searches being conducted across the Action area.

Table 4
Potential Threatened Fauna Species

Scientific Name	Common Name	Database			Distribution/Habitat Requirements in Relation to the Action	Recorded in Action Area[5]	Habitat suitability and Likelihood of Occurrence within Action Area and Immediate Surrounds
		EPBC Status[1]	EPBC Protected Matters Search (2014)[2]	BioNet (2014)[3]			
Fish							
Bidyanus bidyanus	Silver Perch	CE	●	-	This species is found in fast-flowing waters, but is also found in rivers, lakes and reservoirs (Atlas of Living Australia, 2014).	No	Unlikely, no potential habitat present in the Action area and surrounds.
Amphibians							
Litoria aurea	Green and Golden Bell Frog	V	●	-	Species inhabits swamps and wetlands with deep water and reeds.	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area as no potential habitat is present. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Litoria booroolongensis	Booroolong Frog	E	●	-	This species is known to occur in permanent streams with some fringing vegetation cover.	No	Hunter Eco (2013) considers this species unlikely to occur in the Action area as no potential habitat is present. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Birds							
Botaurus poiciloptilus	Australasian Bittern	E	●	-	Species inhabits permanent freshwater wetlands.	No	Hunter Eco (2013) considers that there is no potential habitat for this species in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2). Further, no potential habitat occurs.
Rostratula australis	Australian Painted Snipe	E	●	-	Is known from inundated or waterlogged grassland or saltmarsh, dams, ricecrops, sewage farms andbore drains.	No	Hunter Eco (2013) considers that there is no potential habitat for this species in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Lathamus discolor	Swift Parrot	E	●	-	Over winter this species inhabits dry sclerophyll eucalypt forests, including Box-Ironbark and woodlands (OEH, 2014b).	No	This species has not been recorded in the Action area. Approximately 53.1 ha of potential habitat is present for this species in the Action area, including Box-Ironbark woodland and Red Gum eucalypt woodland and forest.
Anthochaera Phrygia	Regent Honeyeater	E	●	●	This species inhabits temperate eucalypt woodlands and open forests, particularly Box-Ironbark (OEH, 2014b).	No	This species has not been recorded in the Action area. Approximately 53.1 ha of potential habitat for this species is present in the Action area, including Box-Ironbark woodland and Red Gum eucalypt woodland and forest.

Table 4 (Continued)
Potential Threatened Fauna Species

Scientific Name	Common Name	Database			Distribution/Habitat Requirements in Relation to the Action	Recorded in Action Area[5]	Habitat suitability and Likelihood of Occurrence within Action Area and Immediate Surrounds
		EPBC Status[1]	EPBC Protected Matters Search (2014)[2]	BioNet (2014)[3]			
Mammals							
Dasyurus maculatus maculatus	Spotted-tail Quoll (southeastern mainland population)	E	●	●	Sclerophyll forests and woodlands, coastal heathlands and rainforests. This species was recorded in 2004 approximately 2.5 km to the south-west of the Action area (record accuracy: within 10 km) in the OEH (2014a) database results.	No[4]	This species has not been recorded in the Action area. Approximately 226.4 ha potential foraging habitat is present in the Action area, in the form of woodland, forest and grassland.
Phascolarctos cinereus	Koala	V	●	●	Species is limited to eucalypt forests and woodlands. Was recorded in 2004 approximately 7 km away near Muswellbrook (record accuracy: within 10 km) (OEH, 2014a), in 1954 approximately 6 km south-west of the Action area (record accurate to 100 metres [m]) (OEH, 2014a) and approximately 3 km away from the Action area (HVEC pers. comm., 2012).	No	This species has not been recorded in the Action area. Approximately 53.1 ha of potential habitat for this species is present in the Action area, in the form of eucalypt forests and woodlands.
Petrogale penicillata	Brush-tailed Rock-wallaby	V	●	-	Known from areas with rocky escarpments.	No	Hunter Eco (2013) considers that there is no potential habitat for this species in the Action area. No records of this species occur within the Action area, despite targeted surveys conducted by Hunter Eco (2013), and years of monitoring (Table 2).
Pteropus poliocephalus	Grey-headed Flying-fox	V	●	●	Species found in blossoming eucalypts or fruiting trees. Has been recorded in Action area by Niche (2012). The species was seen foraging for nectar and pollen on blossoming Spotted Gum. No breeding or roosting colonies were present.This species was also recorded in 2004 approximately 9 km to the north of the Action area in the OEH (2014a) database results (record accurate to 250 m).	Yes[5]	Known, species recorded in Action area.
Nyctophilus corbeni	South-eastern Long-eared Bat	V	●	●	Species inhabits rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands.	No	Hunter Eco (2013) considers the lack of records of this species in the Action area and surrounds suggest that species is not present and would not be impacted by the Action.
Chalinolobus dwyeri	Large-eared Pied Bat	V	●	●	Inhabits dry sclerophyll forests and woodlands, edges of rainforest, wet sclerophyll forest, and sandstone outcrop country (Churchill, 2008). This species has not been recorded in the Action area, but was recorded in 2009 by Cumberland Ecology on the edge of the Action area, in 2003 approximately 6 km away at Muswellbrook (record 1km accuracy) (OEH, 2014a) and in 2007 by Umwelt to the north of the Action area at Macleans Hill (Umwelt, 2007a).	No[6]	This species has not been recorded in the Action area. Approximately 53.1 ha of potential habitat for this species is present in the Action area, in the form of forests and woodlands. This species has been recorded in close proximity to the Action area.

Table 4 (Continued)
Potential Threatened Fauna Species

Scientific Name	Common Name	Database			Distribution/Habitat Requirements in Relation to the Action	Recorded in Action Area[5]	Habitat suitability and Likelihood of Occurrence within Action Area and Immediate Surrounds
		EPBC Status[1]	EPBC Protected Matters Search (2014)[2]	BioNet (2014)[3]			
Mammals (Continued)							
Pseudomys novaehollandiae	New Holland Mouse	V	•	-	Found in coastal heath and dry sclerophyll forest and woodland.	No	Hunter Eco (2013) considers the lack of records of this species in the Action area and surrounds suggest that species is not present and would not be impacted by the Action.

1 Threatened fauna species status listed under the EPBC Act (Current at August 2014).
V = Vulnerable; E = Endangered; CE = Critically Endangered.

2 DotE (2014a).

3 OEH (2014a).

4 This species has not been recorded in the Action area, but was tentatively recorded during the first half of 2006 by a HVEC staff member on the main access road to the Mt Arthur Coal offices close to the intersection with Thomas Mitchell Drive (Umwelt, 2007b). An earlier possible sighting of the Spotted-tailed Quoll was also made on a haul road in the Bayswater mining area (Umwelt, 2007b).

5 Recorded multiple times within the Action area and its immediate surrounds, and also approximately 5 km away at Muswellbrook by Niche (2012).

6 Recorded on the edge of the Action area (Cumberland Ecology, 2009b), at Macleans Hill, approximately 3 km away (Umwelt, 2007), and also approximately 5 km away at Muswellbrook (OEH, 2014).

The Grey-headed Flying-fox was the only threatened fauna species listed under the EPBC Act that was recorded within the Action area (Hunter Eco, 2013). The occurrence of this species is discussed below.

Grey-headed Flying-fox

The Grey-headed Flying-fox distribution extends from Rockhampton in central Queensland, south to the vicinity of Melbourne in Victoria (OEH, 2014b; Tidemann 1998). Much of the known distribution is in NSW, with records being widespread along the East Coast and Central NSW, generally within 200 km of the coastline (OEH, 2014b).

This species requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits (Duncan et al., 1999; Eby, 1998). In NSW the Grey-headed Flying-fox is associated with flowering Spotted Gum (*Corymbia maculate*) and flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*E. sideroxylon*) (DECCW, 2010).

Roost sites are generally within 20 km of a regular food source and are typically located near water, such as lakes, rivers or the coast (OEH, 2014b; van der Ree *et al*., 2005). Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation (Nelson, 1965; Ratcliffe, 1931), but colonies also use highly modified vegetation in urban and suburban areas (Birt *et al*., 1998; Tidemann & Vardon, 1997; van der Ree *et al*., 2005).

The Grey-headed Flying-fox is highly mobile (Menkhorst, 1995; Tidemann, 1998). Although the extent of this species stretches approximately 2,000 km down the East Coast of Australia, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years.

This species was recorded at two locations in the Action area, in Area C (Figure 3), seen foraging for nectar and pollen on blossoming Spotted Gum. No breeding or roosting colonies were present. This species was also recorded approximately 9 km to the north of the Action area at Muswellbrook, in the OEH (2014a) database results (record accurate to 250 m).

There are no known or historic roosting camps within 10 km of the Action area (DotE, 2014c). The Action would remove and modify approximately 53.4 ha of potential/actual foraging and roosting habitat resources in the form of woodland and forest used by the Grey-headed Flying-fox. These resources are limited given that the habitat is highly fragmented.

Threatened Ecological Communities

The EPBC Protected Matters Search Tool (for a 40 km^2 area surrounding the Action area) indicated one potentially occurring Threatened Ecological Community, namely the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, which is a listed Critically Endangered Ecological Community under the EPBC Act, (herein referred to as Box-Gum Woodland CEEC).

The Box-Gum Woodland CEEC can exist in a variety of conditions including shrubby woodland, grassy woodland with scattered trees and open grassland devoid of trees. Hunter Eco (2013) describes that in some areas of the Hunter Valley a hybrid of *Eucalyptus albens* and *Eucalyptus moluccana* has been identified as the dominant tree in the ecological community. Hunter Eco (2013) recognises that the *E. albens* x *E. moluccana* hybrid occurs within the Action area. Of 28 box specimens sent for identification by the National Herbarium of NSW from areas adjoining the Modification (which incorporates the Action area), 27 were determined to be hybrids (*E. albens* x *E. moluccana*) (Umwelt, 2011 in Hunter Eco, 2013).

There is a view that the Box-Gum Woodland CEEC determination, by not specifically including hybrids in the community description (as happens in some more recent determinations), does not allow for the inclusion of hybrids (i.e. hybrids are not part of the Box-Gum Woodland CEEC). Despite this view, Hunter Eco (2013) conservatively assumed that the hybrids were part of the Box-Gum Woodland CEEC and a total of 58.4 ha of the community was recorded within the Action area. The Box-Gum Woodland CEEC was attributed to the following vegetation communities:

- approximately 23.0 ha of Central Hunter Box – Ironbark Woodland (MU10);
- approximately 0.2 ha of Blakely's Red Gum Woodland; and
- approximately 35.2 ha of Derived Native Grassland, derived from Box-Gum Woodland.

This is made up of 35.2 ha of open grassland variant and 23.2 ha of the woodland variant.

Nature and extent of likely impact

This section assesses the potential impacts on threatened species or threatened ecological communities under the EPBC Act, and identifies the nature and extent of any likely impacts.

The vegetation disturbance for major surface infrastructure for the Action includes the disturbance of the following vegetation types in the approximate areas listed below (Figure 7):

- Derived Grassland: approximately 136.8 ha;
- Derived Grassland, derived from Box-Gum Woodland: approximately 35.2 ha;
- Derived Grassland with Cooba Wattle Regrowth: approximately 1 ha;
- Central Hunter Box – Ironbark Woodland (MU10): approximately 23 ha;
- Central Hunter Box – Ironbark Woodland Wybong Slaty Box Variant (MU10): approximately 17.9 ha;
- Central Hunter Box – Spotted Gum – Grey Box Forest (MU27): approximately 7.1 ha;
- Upper Hunter Hills Box – Ironbark – Red Gum Woodland (MU9): approximately 3.4 ha;
- Hunter Lowlands Red Gum Forest (MU24): approximately 1.7 ha;
- *Typha* Dominated Drainage Line: approximately 2.5 ha;
- Blakely's Red Gum Woodland: approximately 0.2 ha; and
- Weeping Myall Woodland: approximately 0.1 ha[1].

[1] The patch of Weeping Myall woodland mapped by Hunter Eco (2013) within the major surface infrastructure area for the Action is 0.1 ha in size, and therefore does not meet the size threshold of 0.5 ha listed in the *Policy Statement 3.17 – Weeping Myall Woodlands* (Department of the Environment, Water, Heritage and the Arts, 2009).

Non-native and non-vegetation areas are excluded from the list above, including cleared areas, plantings and existing infrastructure.

Threatened Flora Species

This section evaluates whether the likely impact on threatened flora species is significant in accordance with the *Matters of National Significance: Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act, 1999* (Significant Impact Guidelines) (DotE, 2013). All flora species listed in Table 3 were considered to be unlikely to occur within the Action area, and targeted searches did not identify any of these species. The Action is therefore not likely to impact any individual flora species.

Threatened Fauna Species

The Grey-headed Flying-fox was the only threatened fauna species listed under the EPBC Act that was recorded within the Action area (Hunter Eco, 2013). Table 5 evaluates the nature and extent of likely impacts on each individual threatened fauna species discussed in the above sections.

Table 5
Potential Impacts on Fauna Species and their Habitats

Scientific Name	Common Name	Nature and Extent of Likely Impacts
Fish		
Bidyanus bidyanus	Silver Perch	The Action is not likely to significantly impact this species given the absence of records within and surrounding the Action area, the lack of potential habitat present and the nature and extent of clearing.
Amphibians		
Litoria aurea	Green and Golden Bell Frog	The Action is not likely to significantly impact these species given the absence of records within and surrounding the Action area, the lack of potential habitat present and the nature and extent of clearing.
Litoria booroolongensis	Booroolong Frog	
Birds		
Botaurus poiciloptilus	Australasian Bittern	The Action is not likely to significantly impact these species given the absence of records within and surrounding the Action area, the lack of potential habitat present, and the nature and extent of clearing.
Rostratula australis	Australian Painted Snipe	
Lathamus discolour	Swift Parrot	Despite potential habitat being present within the Action area, the Action is not likely to significantly impact these species given the absence of records within and surrounding the Action area, despite extensive targeted surveys.
Anthochaera Phrygia	Regent Honeyeater	
Mammals		
Dasyurus maculates	Spotted-tailed Quoll	Despite potential habitat being present within the Action area, the Action is not likely to significantly impact this species given the absence of records within the Action area, despite extensive targeted surveys.
Phascolarctos cinereus	Koala	Despite potential habitat being present within the Action area, the Action is not likely to significantly impact this species given the absence of records within the Action area, despite targeted surveys, and the nature and extent of clearing.
Petrogale penicillata	Brush-tailed Rock-wallaby	The Action is not likely to significantly impact this species given the absence of records within and surrounding the Action area, the lack of potential habitat present and the nature and extent of clearing.
Pteropus poliocephalus	Grey-headed Flying-fox	The Action is not likely to significantly impact this species given: • The Grey-headed Flying-fox has been recorded in the Action area and has also been recorded in surrounds (Figure 9). • This species' foraging resources are not limited to the Action area and there is no typical potential roosting habitat in the disturbance area for the Action (i.e. caves and sandstone cliffs). • The Action is highly unlikely to adversely affect individuals or populations or interfere in their lifecycle given the comparably small disturbance area of the Action and mobility of this species.
Nyctophilus corbeni (South Eastern Form)	South-eastern Long-eared Bat	The Action is not likely to significantly impact this species given the absence of records within and surrounding the Action area, despite targeted searches.
Chalinolobus dwyeri	Large-eared Pied Bat	Despite potential habitat being present within the Action area, the Action is not likely to significantly impact this species given the absence of records within and surrounding the Action area, despite targeted surveys.
Pseudomys novaehollandiae	New Holland Mouse	The Action is not likely to significantly impact this species given the absence of records within and surrounding the Action area, despite targeted searches.

The Action is not likely to have a significant impact on any threatened fauna species listed under the EPBC Act as it is unlikely that the Action would:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered, endangered or vulnerable species becoming established in the species' habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

The Grey-headed Flying-fox has been recorded at the Middle Deep Creek Offset area, which will be expanded by 410 ha as part of the Action.

Threatened Ecological Communities

There is a view that the Box-Gum Woodland CEEC determination, by not specifically including hybrids in the community description (as happens in some more recent determinations), does not allow for the inclusion of hybrids. However, Hunter Eco (2013) conservatively assumed that the hybrids were part of the Box-Gum Woodland CEEC (Figure 8).

The Action is not likely to have a significant impact on threatened ecological communities listed under the EPBC Act as it is unlikely that the Action would:

- reduce the extent of an ecological community;
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- adversely affect habitat critical to the survival of an ecological community;
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;
- cause a substantial change in species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established;
- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which can kill or inhibit the growth of species in the ecological community; or
- interfere with the recovery of an ecological community.

Additional biodiversity offset areas have been proposed as part of the Modification to account for additional clearance associated with the Action and are shown on Figures 5 and 6.

This would include:

- expanding the existing Saddlers Creek Conservation area by 131 ha; and
- expanding the existing Middle Deep Creek Offset area by 410 ha.

The additional proposed biodiversity offset areas would include the following vegetation communities to offset the areas of Box-Gum Woodland CEEC to be disturbed as part of the Action:

- 120 ha of MU10 Central Hunter Box – Ironbark Woodland (Derived grassland) (Saddlers Creek East and South);
- 307 ha of MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Derived grassland) (Middle Deep Creek);
- 5.2 ha of MU10 Central Hunter Box – Ironbark Woodland (Saddlers Creek East); and
- 103 ha of MU11 Upper Hunter White Box – Ironbark Grassy Woodland (Middle Deep Creek).

In addition to the above, HVEC has committed to an additional 85 ha offset area at a location to be determined. The additional proposed biodiversity offset areas would be managed, secured, monitored in the same way as the existing biodiversity offset areas in accordance with the Project Approval (09_0062) for the Mt Arthur Coal Mine. This includes the control of weeds and feral animals, management of grazing, fire management and control of vehicular access. Hunter Eco (2013) concluded that the Middle Deep Creek Offset area is *superior in ecological value to any of the habitat to be cleared in the Modification* and that a substantial net gain in biodiversity would result from the combination of the Modification and the proposed offsets.

3.1 (e) Listed migratory species

Description

Migratory species are those animals that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations (DotE, 2014b).

Table 6 provides a list of migratory fauna species listed under the EPBC Act that have the potential to occur in the Action area. This list was generated from database searches (including the EPBC Protected Matters Search Tool and the BioNet website) of a 40 km^2 search radius centred over the Action.

For many species in Table 6, the Action area lacks the extent or presence of habitat needed to support them other than to allow for occasional appearances as nomads, vagrants or individuals with 'passing through' status. At any one time, appearances of these species within the Action area would represent a very small sample of their wider populations.

Two migratory species have been recorded during fauna surveys conducted in the Action area and surrounds, namely the Rainbow Bee-eater (*Merops ornatus*) (Umwelt, 2006) and the White-throated Needletail (*Hirundapus caudacutus*) (Umwelt, 2006; Umwelt, 2007; Cumberland Ecology, 2009a, 2009b, 2010a, 2010b; Umwelt, 2012) (Table 6).

Table 6
Migratory Species

Scientific Name	Common Name	Database			Distribution/Habitat Requirements in Relation to the Action	Recorded in Action Area	Likelihood of Occurrence within Action Area and Immediate Surrounds[4]
		EPBC Protected Matters Search (2014)[1]	BioNet (2014)[2]	Birds Australia (2012)[3]			
Apus pacificus	Fork-tailed Swift	●	-	-	This species is almost exclusively aerial and mostly occurs over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. Often occurs over cliffs and beaches and also over islands and sometimes well out to sea (DotE, 2014b).	No	Species or species habitat may occur within area.
Ardea alba	Great Egret	●	-	●	This species prefers shallow water, particularly when flowing, but may be seen in any watered area, including damp grasslands (DotE, 2014b).	No	Species or species habitat may occur within area.
Ardea ibis	Cattle Egret	●	●	-	This species is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor (DotE, 2014b).	No	Species or species habitat may occur within area.
Gallinago hardwickii	Latham's Snipe	●	-	●	This species is a non-breeding migrant to the south-east of Australia. Seen in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration (DotE, 2014b).	No	Species or species habitat may occur within area.
Haliaeetus leucogaster	White-bellied Sea-Eagle	●	-	●	Species inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna (DotE, 2014b).	No	Species or species habitat likely to occur within area.
Hirundapus caudacutus	White-throated Needletail	●	●	●	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (DotE, 2014b).	No[5]	Species or species habitat likely to occur within area.
Hydroprogne caspia	Caspian Tern	-	●	-	Species is mostly found in sheltered coastal embayments and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes, waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks (DotE, 2014b).	No	Species or species habitat unlikely to occur within area.
Merops ornatus	Rainbow Bee-eater	●	●	●	Found throughout mainland Australia most often in open forests, woodlands and shrublands, and cleared areas, usually near water. It can be found on farmland with remnant vegetation and in orchards and vineyards. It may use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels (DotE, 2014b).	No[6]	Species or species habitat may occur within area.
Monarcha melanopsis	Black-faced Monarch	●	-	-	Found along the coast of eastern Australia, becoming less common further south. Inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating (DotE, 2014b).	No	Breeding may occur within area.
Myiagra cyanoleuca	Satin Flycatcher	●	-	●	This species is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests (DotE, 2014b).	No	Breeding likely to occur within area.

Table 6 (Continued)
Migratory Species

Scientific Name	Common Name	Database			Distribution/Habitat Requirements in Relation to the Action	Recorded in Action Area	Likelihood of Occurrence within Action Area and Immediate Surrounds[4]
		EPBC Protected Matters Search (2014)[1]	BioNet (2014)[2]	Birds Australia (2012)[3]			
Rhipidura rufifrons	Rufous Fantail	•	-	•	Found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Inhabits tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests (DotE, 2014b).	No	Species or species habitat may occur within area.
Rostratula australis	Australian Painted Snipe	•	-	-	Is known from inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (HVEC, 2013a).	No	Species or species habitat unlikely to occur within area.

1 DotE (2014a) *EPBC Act Protected Matters Search for the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 7 July 2014.

2 OEH (2014a) *BioNet Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 7 July 2014.

3 Birds Australia (2012) *Database Records within the following Search Area: -32.2663, 150.9616; -32.4402, 150.9616; -32.4402, 150.7535; -32.2663, 150.7535.* Data received: 9 May 2012.

4 Hunter Eco (2013).

5 Recorded in the surrounds during opportunistic sightings by Umwelt (2006), at McLeans Hill by Umwelt (2007) and Cumberland Ecology (2010a), at Mt Arthur North East by Cumberland Ecology (2009a) and Umwelt (2012), at South Pit Extension and Mount Arthur Underground by Cumberland Ecology (2009b), and at "A171" by Cumberland Ecology (2010b).

6 Has been recorded near the Action area at Mt Arthur North East by Umwelt (2006).

Nature and extent of likely impact

The Action is not likely to have a significant impact on migratory species listed under the EPBC Act as it is unlikely that the Action would:

- substantially modify, destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

This is because:

- None of these species are considered to be at the limit of their known migratory ranges.
- Each of these species is highly mobile and their foraging and territorial ranges far exceed the Action area.
- Each of these species is highly mobile and the Action area is not considered to contain important foraging or breeding habitat for these species.
- The Action area does not constitute an area of important habitat for any of these species.

The proposed Action is unlikely to disrupt the lifecycle of any of these species.

3.1 (f) Commonwealth marine area

Description

There are no Commonwealth Marine Areas located in the vicinity of the Action. The Commonwealth Marine Area generally stretches from 3 to 200 nautical miles from the Australian coast (DotE, 2014d). As the Action is not located within a Commonwealth Marine Area, the Action is unlikely to impact marine species within a Commonwealth Marine Area.

Nature and extent of likely impact

The Action does not occur within a Commonwealth Marine Area, and accordingly, is unlikely to have a significant impact on any Commonwealth Marine Area.

3.1 (g) Commonwealth land

Description

A search of the EPBC Act database using the Protected Matters Search Tool indicates that six areas of Commonwealth Land exists within a 10 km radius centred on the Action. These areas of Commonwealth Land include the following (DotE, 2014a):

- Australian Postal Commission.
- Australian Telecommunications Commission.
- Commonwealth Bank of Australia.
- Commonwealth Trading Bank of Australia.
- Defence Housing Authority.
- Muswellbrook Gres Depot.

The Action will not take place on Commonwealth Land.

Nature and extent of likely impact

The Action will not occur on Commonwealth Land, and accordingly, is unlikely to have a significant impact on any Commonwealth Land.

3.1 (h) The Great Barrier Reef Marine Park

Description

The Action is not within the Great Barrier Reef Marine Park, or the catchment area of the Great Barrier Reef Marine Park.

Nature and extent of likely impact

The Action will not impact the Great Barrier Reef Marine Park, and accordingly, will not have a significant impact on the Great Barrier Reef Marine Park.

3.1 (i) A water resource, in relation to coal seam gas development and large coal mining development

Description

A description of the existing environment in relation to the hydrological characteristics, quality and value of the water resources is provided below.

The NOW has developed two groundwater source categories to define the value of groundwater resources as part of the *NSW Aquifer Interference Policy* (NSW Government, 2012):

- highly productive groundwater (total dissolved solids [TDS] of less than 1,500 milligrams per litre [mg/L] and contains water supply works that can yield water at a rate greater than 5 litres per second [L/sec]); and
- less productive groundwater (groundwater that does not meet the highly productive definition).

The terms “highly productive” and “less productive” are referred to throughout this section.

A Groundwater Impact Assessment for the Action was undertaken by AGE (2013) and is presented in Attachment C.

Hydrology of the Water Resources

The Wittingham Coal Measures would continue to be mined in the open cut extension areas proposed for the Action. Seams which subcrop within the open cut extension area are the Bowfield and Arrowfield Seams towards the northern extent of the open cut extension area, and the Woodlands Hill and Glen Munro seams towards the southern extent (HVEC, 2013b). The target coal seams for the Action are located within the Jerrys Plains and Vane Subgroups, forming part of the Wittingham Coal measures.

Groundwater Resources

The key hydrostratigraphic units (or water sources) within the Action area and surrounds include the following (Attachment C):

- alluvium along the Hunter River and Saddlers Creek;
- weathered bedrock (regolith); and
- the coal seams of the Permian Wittingham Coal Measures.

The Hunter River alluvium is associated with the Hunter River, is up to 13 m thick and contains basal gravel varying between about 2.5 and 4 m in thickness. The alluvial deposits of the Hunter River to the immediate north of the Mt Arthur Coal Mine are a significant source of groundwater (AGE, 2013), and the Hunter River alluvial aquifer is classified as a highly productive aquifer by the NOW under the *NSW Aquifer Interference Policy* (NSW Government, 2012).

The regolith (or shallow bedrock) groundwater system comprises surficial soils and weathered bedrock. The depth of the profile is variable and depends on factors including the depth of weathering and the extent and frequency of fracturing. The regolith acts as a potential temporary water store during sustained wet periods and provides a potential source for recharge to the underlying coal measures, however, it is inferred that this recharge is limited (AGE, 2013).

The Permian strata occurs across the whole of the Mt Arthur Coal Mine area and may be categorised into the following hydrogeological units (Attachment C):

- hydrogeologically “tight” (e.g. very low permeability) and hence very low yielding to essentially dry sandstone and lesser siltstone that comprise the majority of the Permian interburden/overburden; and
- low to moderately permeable coal seams which are the prime water bearing strata within the Permian sequence.

The Permian deposits occur across the entire Action area as a regular layered sedimentary sequence. In accordance with the *NSW Aquifer Interference Policy* (NSW Government, 2012), this aquifer is considered to be less productive due to its low yield and low water quality.

Historic and ongoing mining within the Mt Arthur Coal Mine area (including surrounding mining operations) has resulted in depressurisation of the Permian coal measures. This depressurisation has resulted in localised changes to the groundwater gradient beneath the Hunter River alluvium with discharge from the coal seams to the alluvium reversed to leakage from the alluvium to the coal seams in the vicinity of open cut mining (AGE, 2013).

Recharge to the alluvium is likely to occur from direct infiltration of rainfall and runoff from elevated bedrock sub-crop areas. Apart from infiltration of rainfall and runoff from elevated areas, the alluvium along the Hunter River is potentially recharged during very dry periods from flow in the Hunter River. Release of water from Glenbawn Dam upstream of the Action area maintains flow in the river (AGE, 2013). Interflow may occur from thin, limited alluvial deposits associated with minor ephemeral streams, and this flow may lead to short lived perched groundwater bodies that drain rapidly to downstream alluvium, creeks and gullies (AGE, 2013).

Groundwater recharge to the Permian rock system is considered likely to occur by rainfall infiltration via the regolith. Groundwater flow occurs toward the lower lying areas where discharge occurs into the alluvial valleys and creeks/rivers (AGE, 2013).

Surface Water Resources

The Mt Arthur Coal Mine (including the Action) is located to the south of the Hunter River, within the Hunter River catchment, which has an area of approximately 22,000 km^2 (Hunter-Central Rivers CMA, 2013).

The Hunter River is a perennial river, with flows regulated by three main water storages, Glenbawn Dam, Glennies Creek Dam and Lostock Dam. Near the Mt Arthur Coal Mine, the Hunter River is regulated by Glenbawn Dam which is located approximately 30 km upstream (Gilbert & Associates, 2013).

Local hydrology comprises a number of drainage lines and creeks flowing north and south-west towards the Hunter River. Quarry Creek, Ramrod Creek, Fairford Creek, Whites Creek and a number of small unnamed creeks drain the western and northern parts of the Mt Arthur Coal Mine area and flow northwards into the Hunter River. Southwards flowing drainage lines in the Mt Arthur Coal Mine area report to Saddlers Creek which flows generally to the south-west and joins the Hunter River downstream of Denman.

Surface drainage within the Mt Arthur Coal Mine mining tenements generally comprises ephemeral and first order creeks (Gilberts & Associates, 2013). There are no perennial rivers or streams within the boundaries of the Action area.

The Action would result in changes to flows in local creeks due to the progression of open cut mining and associated subsequent capture and re-use of drainage from operational catchment areas (HVEC, 2013b).

The catchment areas of Quarry Creek, Fairford Creek and Ramrod Creek for the maximum extent of the Action would be slightly less than those for the maximum extent of the currently approved operations. The decrease in catchment area and corresponding decrease in average flow rates are unlikely to have a material effect on riparian flows or licensed extraction from Ramrod Creek (Gilbert & Associates, 2013). Given these minor changes, impacts associated with the excision of catchment from these creeks are not discussed further.

The catchment areas for Whites Creek, the unnamed creeks and Saddlers Creek for the maximum extent of the Action would be greater than those for the maximum extent of the currently approved operations. The increase in catchment area for Whites Creek and the unnamed creeks are expected to result from progressive rehabilitation of overburden emplacements, while the increase in catchment area for Saddlers Creek is a result of redesign of overburden emplacements (Gilbert & Associates, 2013).

Groundwater and Surface Water Interactions

The alluvial deposits of the Hunter River to the immediate north of the Mt Arthur Coal Mine are a significant source of groundwater (AGE, 2013). Monitoring data suggests that the Hunter River alluvial groundwater levels have remained relatively constant with no direct correlation to rainfall trends, indicating some buffering of the alluvial groundwater levels by the potentially interconnected Hunter River (AGE, 2013). Recharge to the Hunter River alluvium is likely to occur from direct infiltration of rainfall and runoff from elevated bedrock sub crop areas, in addition, recharge from flow in the Hunter River potentially occurs during very dry periods (AGE, 2013). Release of water from Glenbawn Dam upstream of the Action area maintains flow in the river.

Interflow may occur from thin, limited alluvial deposits associated with minor ephemeral streams, and this flow may lead to short lived perched groundwater bodies that drain rapidly to downstream alluvium, creeks and gullies.

Relevant Water Sharing Plans

The NSW State Government has implemented a number of water sharing plans (WSPs) (i.e. state water resource plans) for rivers and groundwater systems under the *Water Management Act, 2000*, that are applicable to the Action.

The regulatory instruments and applicable water sources and water management zones relevant to the Action are described in Table 7. For the groundwater resources, the relevant aquifer and level of productivity is also presented. Further details regarding licensing entitlements for the Action are provided below.

Table 7
Relevant State Water Resource Plans and Water Sources

Regulatory Instrument	Water Source	Relevant Aquifer	Productivity[1]
Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009	Hunter Regulated River Alluvial Water Source (u/s Glennies Creek Management Zone).	Hunter River Alluvial Aquifer	Highly Productive
Water Act, 1912	-	Porous Rock	Less Productive
Water Sharing Plan for the Hunter Regulated River Water Source 2003	Hunter Regulated River Water Source (Zone 1)[2].	-	-

[1] As designated by the NOW.

[2] Management zone refers to all of the Hunter Regulated River Water Source upstream of the junction of the Hunter River and Glennies Creek.

The Permian porous rock aquifer within the Action area is regulated under the *Water Act, 1912*, as no applicable WSP has commenced to date for this water source. This aquifer is considered less productive by the NOW.

Water Quality of the Water Resources

Groundwater Resources

Groundwater monitoring for the Mt Arthur Coal Mine is undertaken in accordance with the *Ground Water Monitoring Program* (BHP Billiton, 2012a) which details the groundwater monitoring program, groundwater impact assessment criteria and groundwater monitoring methodology.

Surrounding groundwater resources are monitored by an independent consultant as required at 46 statutory monitoring sites. Analysis of all water samples is undertaken by a NATA accredited laboratory. Monitoring of water levels and water quality parameters is undertaken on a bi-monthly basis at monitoring bores, which generally consist of a small diameter observation well lined with plastic pipe. Chemical speciation is undertaken on all bores twice yearly, and permeability testing is undertaken during installation of new monitoring bores to determine local groundwater flow conditions.

Groundwater salinity data collected during monitoring indicates that the average salinity in the Hunter River alluvium is quite variable with an average of approximately 4,044 microSiemens per centimetre (µ/cm) however in a range from 636 µ/cm to 7,320 µ/cm (based on samples collected over a period from January 2008 to April 2014).

Comparatively, the groundwater salinity data collected within the Permian porous rock indicated an average salinity of 4,633 µ/cm (based on samples collected over a period from January 2008 to April 2014). AGE (2013) concluded that the groundwater in the Permian system is of poor quality and is considered typical of coal seam quality. The general low yield and poor quality of the groundwater in the coal seams indicates that the environmental value of the water can be classified as “primary industry” with the main potential use being for stock watering (AGE, 2013).

Groundwater monitoring data suggests, based on bore electrical conductivity monitoring results, a lowering of salinity in alluvial monitoring bores directly to the north of the Northern Open Cut. It is likely this change is due to a reduction in groundwater flux of more saline groundwater from the Permian porous rock to the Hunter River alluvium, resulting from pit dewatering. The Modification modelling predicts a continued dewatering in the mine pit area, suggesting an ongoing "sink" in the local Permian coal measures, which host a less productive groundwater resource. Due to this ongoing sink in the Permian coal measures, there is not expected to be significant migration or deterioration in groundwater quality resulting from the Modification (AGE, 2013).

Surface Water Resources

Surface water quality monitoring for the Mt Arthur Coal Mine is undertaken in accordance with the *Surface Water Monitoring Program* (BHP Billiton, 2014) which details the surface water monitoring program, surface water impact assessment criteria and surface water monitoring methodology (HVEC, 2013b).

HVEC has conducted an extensive water quality monitoring program at the Mt Arthur Coal Mine (including the Action area) and have compiled a database of water quality observations with site data from 1995. Baseline water quality monitoring has been undertaken at numerous sites, including local creeks and mine site water storage dams. Monitoring locations include sites on Quarry Creek, Fairford Creek, Whites Creek, Whites Creek Diversion, sediment dams, the Environmental Dam, the Bayswater Main Dam, Ramrod Creek and Saddlers Creek (Gilberts & Associates, 2013).

An analysis of surface water quality monitoring data collected from the Action area and surrounds during regular surface water quality monitoring at the Mt Arthur Coal Mine is summarised in Table 8. A comparison to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000 Guidelines) (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand [ANZECC & ARMCANZ], 2000) default trigger values for ecosystems, irrigation and stock water is also provided.

Table 8
Surface Water Quality Monitoring Data

Analyte	Units	ANZECC Default Trigger Values			Water Quality Monitoring Results (averages)							
		Ecosystem Value^	Irrigation Value	Stock Water Value	SW1	SW2	SW3	SW4	SW12	SW13	SW15	SW18
pH	pH	6.5 - 8.0	6 - 9*	6 - 9*	7.31	7.49	7.91	8.22	7.94	7.48	8.49	8.35
Salinity	µs/cm	125 – 2,200	2,000#	2,500-10,000	7,733	6,968	5,688	8,744	5,110	376	3,996	3,583
Turbidity	NTU	6 - 50	-	-	34.1	29.8	3.8	3.9	5.6	33.2	19.6	4.7
Nitrate as N	mg/L	-	-	1,772	0.2	0.1	0.1	0.0	0.0	0.2	0.1	0.2
TDS	mg/L	-	-	<2,000 to <4,000	6,271	5,719	3,626	5,205	3,596	214	2,785	2,543
Sulphate	mg/L	-	-	1,000 to 2,000	2,551	2,478	623	352	1,188	9	1,038	1,134
Filtered Iron	mg/L	-	-	-	0.44	0.18	0.07	0.06	0.05	2.25	0.05	0.05

^ South East Australia, slightly disturbed ecosystems, lowland river.

* To limit corrosion and fouling of pumping, irrigation and stock watering systems (surface waters).

\# Lucerne irrigation on loam soil.

In Table 8 above, Sites SW1, SW2 and SW3 are located along Saddlers Creek, SW4 is located along Quarry Creek, SW12 is located along Ramrod Creek, SW13 is located along Fairford Creek, SW15 is located along the Whites Creek Diversion and SW18 is located above Whites Creek.

The data presented in Table 8 indicates that the water quality within the Action area and surrounds is generally acceptable for irrigation and stock water purposes, but would not generally provide ecosystem value due to elevated salinity levels.

Value of the Water Resources

As detailed in Section 5.2.1 of the *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments—impacts on water resources* (Significant Impact Guidelines – Water Resources) (DotE, 2013), the value of a water resource is determined by its utility for third party uses, including environmental and other public benefit outcomes (e.g. use by other industries, recreation and tourism uses or the maintenance of ecosystem function).

Groundwater Resources

A search of the NOW database of registered bores and wells indicates that there are approximately 50 registered bores in the Action area and surrounds (using a 5 km radius from the Mt Arthur Coal Mine) (AGE, 2013). The registered bores include one bore licensed for domestic, two for stock and irrigation supply, 13 for stock and domestic only, 22 for stock supplies only, six for domestic, irrigation and stock, two for monitoring and four unknown. It is noted that there are no registered bores in the alluvium of Saddlers Creek (AGE, 2013).

Fifteen of the bores are thought to be associated with groundwater extraction from the Hunter River alluvial aquifer based on their location and depth. The remaining 35 bores are located in sandstone, conglomerate, siltstone or coal of the Permian strata. It is noted that there are no registered bores located in the alluvium of Saddlers Creek (AGE, 2013).

The NOW database gives an indication of groundwater usage in the vicinity of the Mt Arthur Coal Mine and the Action area. The data suggests that groundwater from the Permian groundwater systems is used primarily for stock use, whereas those bores in the alluvial flats are used for a combination of irrigation, stock and domestic supply. This is likely due to its lower yield and poorer water quality (AGE, 2013).

In the region, the majority of groundwater extraction for agriculture is from the Hunter River alluvial aquifer, with approximately 29,055 mega litres per annum (ML/annum) of groundwater entitlement (Department of Water and Energy, 2009).

Potentially groundwater dependent ecosystems (GDEs) in the Action area and surrounds were identified through a review of the relevant WSPs, the regional mapping of GDEs in the Bureau of Meteorology *Atlas of Groundwater Dependent Ecosystems* (2014) and consideration of the depth to groundwater in the Action area.

There are currently no high priority GDEs identified within the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* in the vicinity of Mt Arthur Coal Mine. Further to this, no groundwater dependent vegetation comprising GDEs occur within the Action area or immediate surrounds (Hunter Eco, 2013).

It is noted that an area near Mt Arthur Coal Mine is mapped in the *Atlas of Groundwater Dependent Ecosystems* (Bureau of Meteorology, 2014) as having a moderate potential for groundwater interaction, however, the groundwater level is approximately 70 to 100 m below the ground level. This indicates that there is low potential for GDEs in this location. The *NSW State Groundwater Dependent Ecosystems Policy* (NSW Department of Land and Water Conservation, 2002) was consulted during this Assessment (Hunter Eco, 2013).

The Hunter River alluvial aquifer is considered to be a more valuable resource than the Permian porous rock aquifer, due to its high level of use for agriculture and its classification as a highly productive aquifer by the NOW.

Surface Water Resources

The major surface water resource in proximity to the Action area is the Hunter River. Glennies Creek is also regulated, and is controlled by the Glennies Creek Dam which provides water to the lower reaches of the Hunter River (NSW Department of Infrastructure, Planning and Natural Resources [DIPNR], 2004).

Extraction and use of water from the Hunter River is subject to regulation under the *Water Sharing Plan for the Hunter Regulated River Water Source 2003* which was enacted under the NSW *Water Management Act, 2000* in 2004. The key objective of the WSP is to provide water to support ecological processes and environmental flows in the river, manage water access licences, water allocation, trading of licences and allocations, extraction of water, operation of dams and the overall management of flows.

Glenbawn Dam is used to regulate flows downstream including reaches near the Action area and the Mt Arthur Coal Mine. Water is extracted from the Hunter River for basic landholder stock and domestic rights, while extraction licences for mining, industry, water utility provision, high security entitlements and general security entitlements have also been issued. Significant volumes of water are also taken and stored for power station use in Lake Liddell. Downstream of the Mt Arthur Coal Mine, the Hunter River is the major regional source of farm water supply for irrigation, stock watering and domestic use (Gilbert & Associates, 2013).

Table 9 outlines the access licence requirements for water extraction at the commencement of the *Water Sharing Plan for the Hunter Regulated River Water Source 2003* (DIPNR, 2004).

Table 9
Hunter River Water Access Licence Requirements

Water Access Licence Category	Total Share Component
Basic Landholder Rights (Domestic and Stock)	*5,515 ML/year (estimate)*
Major Utility	36,000 ML/year
Local Water Utility	10,832 ML/year
Domestic and Stock	1,738 ML/year
High Security	22,159 unit shares
General Security	128,163 unit shares[1]
Supplementary Water	49,000 unit shares

Note: These share components are estimates of the requirements at the commencement of the *Water Sharing Plan for the Hunter Regulated River Water Source 2003.*

[1] The Hunter Regulated River Water Source Management Zone 1 (i.e. the relevant zone of the Action) has a total share component of 75,035 share units for regulated river (general security) access licences.

According to the Water Access Licence Statistics register administered by NOW, during the 2013/2014 water year there were 249 domestic and stock access licences, five local water utility access licences, one major utility access licences, 803 regulated river (general security) access licences, 159 regulated river (high security) access licences and 244 supplementary water access licences for the Hunter River (NOW, 2014).

Nature and extent of likely impact

Section 5.2 of the Significant Impact Guidelines – Water Resources states the following:

> *An action is likely to have a significant impact on a water resource if there is a real or not remote chance or possibility that it will directly or indirectly result in a change to:*
>
> - *the hydrology of a water resource,*
> - *the water quality of a water resource,*
>
> *that is of sufficient scale or intensity as to reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes, or to create a material risk of such reduction in utility occurring.*

The potential impacts of the Action in regards to the hydrology and water quality of water resources are considered below. A summary of the key potential impacts of the Action on water resources is provided in Attachment D. In summary, the Action is not likely to significantly impact on water resources.

A Groundwater Impact Assessment has been prepared by AGE (2013) to assess the potential impacts of the Action and any cumulative impacts on the groundwater systems within and in proximity to the Action, and is provided as an attachment to this Referral (Attachment C). The groundwater modelling undertaken as part of the Groundwater Impact Assessment was undertaken in accordance with the *Australian Groundwater Modelling Guidelines* sponsored by the National Water Commission (Barnett *et al*. 2012).

Hydrology of the Water Resources

Section 5.3 of the Significant Impact Guidelines – Water Resources provides the following guidance on changes to hydrological characteristics:

> *A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action:*
>
> *a) changes in the water quantity, including the timing of variations in water quantity*
>
> *b) changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. large scale subsidence)*
>
> *c) changes in the area or extent of a water resource*
>
> *where these changes are of sufficient scale or intensity as to significantly reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes.*

The potential impacts of the Action in regards to each of the hydrological characteristics of water resources are considered below.

Potential Impacts on Integrity of Hydrogeological Connections

Potential impacts associated with the Action would be related to the ongoing dewatering of the Project open cut to allow mining to continue.

Historic and ongoing mining within the Mt Arthur Coal Mine area (including surrounding mining operations) has resulted in depressurisation of the Permian coal measures. This depressurisation has resulted in localised changes to the groundwater gradient beneath the alluvium with discharge from the coal seams to the alluvium reversed to leakage from the alluvium to the coal seams in the vicinity of open cut mining. This has resulted in a gradual improvement in the quality of water at the base of the Hunter River alluvium.

Water quality at the base of the Hunter River alluvium is anticipated to continue to improve in the area of predicted water level change as groundwater discharge from the Permian groundwater systems to the alluvium continues to decline.

In terms of hard rock aquifers, the numerical model predicts the Action would result in an ongoing localised groundwater sink in the Permian coal measures. Due to this ongoing sink there is not expected to be significant migration or deterioration in groundwater quality resulting from the Action.

Potential Impacts on Existing Groundwater Users

Maximum drawdown impacts of the Action, in addition to cumulative impacts of surrounding mines on existing groundwater users in the region, were simulated as a component of the groundwater modelling.

The progression of open cut mining resulting from the Action would contribute to the development of a localised groundwater sink within the immediate area of mining activities (HVEC, 2013b). The incremental increase in watertable drawdown associated with the Action is located entirely within HVEC-owned land (Figure 10) (with the exception of the existing Edderton Road and a small portion of crown land associated with Mount Arthur) and extends partially into the Hunter River alluvium (but does not extend under the Hunter River) (HVEC, 2013b).

AGE (2013) predicted that three bores located within the Hunter River alluvium would incur an incremental drawdown of more than 2 m as a result of the Action. These bores are located within HVEC-owned land. Therefore, no privately owned bores located within the extent of the alluvium associated with the Hunter River would experience a decline greater than 2 m as a result of the Action (AGE, 2013).

Further, AGE (2013) also predicted that one bore outside the extent of the Hunter River alluvium would incur an incremental drawdown of more than 2 m as a result of the Action. This bore is located within HVEC-owned land. Therefore, no privately owned bores located outside the extent of the alluvium associated with the Hunter River would experience a decline greater than 2 m as a result of the Action.

Notwithstanding, the *Surface and Groundwater Response Plan* (BHP Billiton, 2012b) would be reviewed and, if necessary, revised to incorporate the Action. Notwithstanding the negligible effects due to the Action predicted at surrounding private bores (AGE, 2013), consistent with the Project Approval (09_0062) for the Mt Arthur Coal Mine, in the event of interruption to water supply resulting from the Action, an alternative water supply will be provided, until such interruption ceases.

The process for identifying and compensating the interruption to water supply resulting from Mt Arthur Coal operations would be in accordance with the "protocol for adverse affects to nearby users" outlined in the *Surface and Groundwater Response Plan* (BHP Billiton, 2012b).

It is therefore considered that the Action would not significantly reduce the current or future utility of the groundwater resources for third party users and other public benefits.

Water Take Associated with the Action and Licensing

The progression of open cut mining resulting from the Action would contribute to the development of a localised groundwater sink within the immediate area of mining activities, including the extension of the zone of depressurisation/drawdown to the west, an increase in groundwater inflows to the open pits, minor changes in leakage rates from the alluvial systems and the minor loss of groundwater yield at existing bore locations.

The maximum predicted annual groundwater volumes required to be licensed for the approved operations and for the Action are summarised in Table 10 (HVEC, 2013b).

Table 10
Groundwater Take Associated with the Action

Relevant Legislation	Groundwater Source	Predicted Maximum Annual Licensing Requirements (ML/annum)		
		Approved	Incremental Increase due to the Action	Total Including the Action
Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009	Hunter River Alluvium	252	12	264
Water Act, 1912	Permian Porous Rock	1,270	No increase	1,270

The only predicted source of additional water take associated with the Action is from the Hunter River alluvial aquifer, with a maximum rate of 264 ML/annum. As detailed in Table 10, there would be no increase in the water take from the Permian porous rock associated with the Action.

The water take from the Hunter River alluvial aquifer associated with the Action represents approximately 0.01% of the current alluvial aquifer access licence allocation under the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*.

Therefore, it is anticipated that there would be no significant impacts on the hydrological characteristics of the water resources in relation to the Action, as there would be no change in water quantity or the extent of the water resources which would significantly reduce the current or future use of the water resource.

Licensing and Water Entitlements

Under the *Water Management Act, 2000*, all water taken by aquifer interference activities is required to be accounted for within the extraction limits set by any relevant WSPs. Therefore, licensing under the *Water Management Act, 2000* is required to account for any loss of water resulting from the Action to the Hunter River and the Hunter River alluvial aquifer. Licensing to account for water taken from the coal seams under the *Water Act, 1912* is also required for any mine inflows from the Permian porous rock aquifer.

HVEC currently hold licence entitlements of 364 ML/annum for the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* and 1,900 ML/annum for water extracted from porous rock. Comparison of HVECs licence entitlements against the predicted maximum annual licensing requirements for the Action shows that adequate licences are available to account for the potential take of water associated with the approved operations and the Action. If required, HVEC would transfer water entitlements between water management zones in order to adequately licence groundwater extraction (HVEC, 2013b).

Potential Impacts on Culturally Significant Sites

There are no culturally significant sites listed in the relevant WSPs. Therefore, there are no potential impacts on culturally significant sites anticipated as a result of the Action.

Potential Impacts on Groundwater Dependent Ecosystems

As described above, no GDEs have been identified within the Action area. Further to this, no groundwater dependent vegetation comprising GDEs occur within the Action area or immediate surrounds (Hunter Eco, 2013).

Water Quality of the Water Resources

Section 5.4 of the Significant Impact Guidelines – Water Resources provides the following guidance on changes to water quality:

> *A significant impact on a water resource may occur where, as a result of the action:*
>
> *a) there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised ....*
>
> *b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or*
>
> *c) high quality water is released into an ecosystem which is adapted to a lower quality of water.*

The regional water quality objectives relevant to the Action area include the following:

- ANZECC 2000 Guidelines ([ANZECC & ARMCANZ, 2000); and
- The National Water Quality Management Strategy (DotE, 2014e).

Impacts Associated with Mining Operations

The Action is not predicted to result in a significant migration or deterioration in groundwater quality within the Hunter River alluvial aquifer (AGE, 2013). Therefore, the Action is not expected to lower the beneficial use class of groundwater within the vicinity of the mining tenements or the Action area. The environmental value of the Hunter River alluvial aquifer proximal to the Mt Arthur Coal Mine has been classified as “primary industry” with the main use being for irrigation and stock dewatering (AGE, 2013).

A decrease in salinity has been observed in alluvial monitoring bores to the north of the Northern Open Cut and it is likely that this is due to a decrease in flux of more saline groundwater from the Permian porous rock to the Hunter River alluvium as a result of pit dewatering (AGE, 2013). Therefore, as the Action is predicted to continue to result in flux from the Hunter River alluvium to the Permian porous rock, the Action is not expected to result in an increase in long-term average salinity in the Hunter River.

Notwithstanding the minor impacts to alluvium associated with the Action, HVEC would install a lower permeability barrier for any open cut operations within 150 m of Hunter River alluvials as described below:

> *Mt Arthur Coal will continue to monitor hydro-geomorphological conditions and scrutinise for evidence of any groundwater ingress or endwall instability indicators as it progresses the previously approved mining towards the Hunter River Alluvials. Mining (other than that already approved in the MAN [Mt Arthur North] EIS) will not extend beyond a nominal 150 m buffer zone from the Hunter River Alluvials until agreement is reached with DWE regarding the installation of a lower permeability barrier along the point of connections of mining and the alluvium or other appropriate safeguards.*

The Action would result in local depressurisation of the Permian porous rock during mining operations associated with the Action (AGE, 2013). Following completion of mining the final void pit lake would behave as a sink in the local groundwater environment (AGE, 2013). In consideration of this, there is not expected to be a migration of groundwater away from the Action area in the Permian porous rock either during mining or following completion of mining activities. On this basis, the Action would not lower the beneficial use category of the groundwater within the Permian system.

Attachment E provides the current Project Approval (09_0062) with conditions that were recently updated to reflect approval of the Modification. In relation to the protection of water resources, these conditions require:

- Schedule 3, Condition 28:

  > *The Proponent shall not undertake any open cut mining operations within 150 metres of the Hunter River alluvials and Saddlers Creek alluvials that has not been granted approval under previous consents/approvals for Mt Arthur mine complex without the prior written approval of the Secretary. In seeking this approval the Proponent shall demonstrate, to the satisfaction of the Secretary in consultation with NOW, that adequate safeguards have been incorporated into the Surface and Ground Water Response Plan (see condition 34 below) to minimise, prevent or offset groundwater leakage from the alluvial aquifers.*

- Schedule 3, Condition 29 – a Site Water Management Plan, including:
  - Schedule 3, Condition 30 – Site Water Balance.
  - Schedule 3, Condition 31 – Erosion and Sediment Control Plan.
  - Schedule 3, Condition 32 – Surface Water Monitoring Program.
  - Schedule 3, Condition 33 – Groundwater Monitoring Program.
  - Schedule 3, Condition 34 – Surface and Ground Water Response Plan.

Licensed Water Discharges

The HRSTS is a water quality management scheme and is provided for by the NSW *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation, 2002*. The HRSTS has operated along the Hunter River since 2002, and aims to minimise the impact of saline water discharges from industry on the Hunter River water users and the environment. The main authorities involved in the management of the HRSTS are the EPA and the NOW.

Under the HRSTS, discharges of saline water into the Hunter River catchment are permitted only during periods when the Hunter River is considered to be in high flow or flood flow, and only by persons who hold licences that authorise such discharges (discharge licences).

Under the HRSTS, the discharge of salt is managed so that salinity levels in the Hunter River do not exceed 600 µs/cm at Denman or 900 µs/cm at Glennies Creek and Singleton during periods of high flow. Discharges into the Hunter River are managed through a system of discharge “credits” which determine the discharge of each mine or power station participating in the HRSTS (NSW Government, 2013).

The water management systems at the Mt Arthur Coal Mine would continue to be developed in accordance with best management principles including minimising contamination of site water, maximising re-use of mine water on-site and managing water so that any releases from site are controlled in accordance with the HRSTS. Any controlled releases from the Mt Arthur Coal Mine would be made in accordance with the Mt Arthur Coal Mine Environmental Protection Licence and the requirements of the HRSTS (Gilberts & Associates, 2013). It is therefore considered that there would be no significant impacts on the Hunter River water source, as a result of the Action and the relevant local water quality objectives would not be materially compromised.

Conclusion

The Action would result in minor changes to the existing hydrological regime in the vicinity of the Mt Arthur Coal mine. Whilst there would be a small increase in water take from the Hunter alluvial aquifer (12 ML/annum), this is within HVEC's licensed entitlements (364 ML/annum) and would not result in a significant drawdown at privately owned bores. Impacts on the less productive Permian porous rock aquifer are similarly minor. Attachment D provides a summary of impact on water resources.

This assessment is supported by the NOW's comments on the Modification, which state (NOW, 2013):

> *The proposed Modification as modelled will result in negligible increased impact to that already approved.*

In addition, the DP&E relevantly concluded (DP&E, 2014):

> *Given these considerations, the Department is satisfied the modification would not significantly increase surface water impacts relative to the existing operations.*
>
> *...*
>
> *Overall, the Department is satisfied that the proposed modification would not result in any significant additional groundwater impacts compared to the existing operations.*

The Action would not result in the lowering of beneficial use categories in any of the relevant aquifers or any surface water releases, and would not result in a significant change to the water quality of the receiving environment. Therefore it is considered that the Action would not materially compromise relevant local or regional water quality objectives.

The Action would not result in any significant changes in the ability to achieve relevant local or regional water quality objectives (i.e. water quality targets of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality [ANZECC & ARMCANZ, 2000] or the National Water Quality Management Strategy [DotE, 2014e]). There would be no significant worsening of the local quality water and or high quality water releases into systems adapted to lower quality water, as a result of the Action.

It is therefore considered that there would be no significant impact on the water quality of the Hunter River, Hunter River alluvial aquifer or the Permian porous rock aquifer.

3.2 Nuclear actions, actions taken by the Commonwealth (or Commonwealth agency), actions taken in a Commonwealth marine area, actions taken on Commonwealth land, or actions taken in the Great Barrier Reef Marine Park

3.2 (a)	**Is the proposed action a nuclear action?**	✓	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment		

3.2 (b)	**Is the proposed action to be taken by the Commonwealth or a Commonwealth agency?**	✓	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment		

3.2 (c)	**Is the proposed action to be taken in a Commonwealth marine area?**	✓	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(f))		

3.2 (d)	**Is the proposed action to be taken on Commonwealth land?**	✓	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(g))		

3.2 (e)	**Is the proposed action to be taken in the Great Barrier Reef Marine Park?**	✓	No
			Yes (provide details below)
	If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(h))		

3.3 Other important features of the environment

3.3 (a) Flora and fauna

Threatened flora and fauna species that are known to occur or could possibly occur within the Action area and surrounds are described in Section 3.1(d). The general kinds of fauna and flora that occur in the Action area and surrounds are summarised below, as well as a description of the regional and local setting of the Action.

Regional and Local Setting

The Action is located in the Sydney Basin Bioregion (Hunter Eco, 2013) as defined originally by Thackway and Cresswell (1995) in the *Interim Biogeographic Regionalisation for Australia: a Framework for Establishing the National System of Reserves*, and is located at the eastern edge of the Central-West Slopes botanical division (Centre for Australian National Biodiversity Research, 2012). The Action is located in the Hunter-Central Rivers CMA boundary (HVEC, 2013b).

Flora

Vegetation types within the Action area and surrounds are shown on Figure 7.

During surveys undertaken by Hunter Eco (2013), 239 flora species, comprising 172 native and 67 exotic species were recorded in the Action area. The land within each of the Action areas differs due to previous clearing and agricultural practices prior to mining in the surrounding areas. The vegetation disturbance associated with the Action additional surface disturbance areas includes the vegetation types described in Section 3.3(c) below.

Fauna

As detailed in Section 3.1(d) fauna surveys in the Action area have been undertaken by Niche (2012) using a variety of survey techniques. Fauna species are represented by fish, amphibians, arboreal mammals, bats and macropods (Hunter Eco, 2013).

3.3 (b) Hydrology, including water flows

The Action is located within the Hunter River catchment, and to the south of the Hunter River (Figure 2). The Hunter River catchment has an area of approximately 22,000 km^2, and is the largest coastal catchment in NSW (Hunter-Central Rivers CMA, 2013).

The Hunter River flows all year round and discharges into the Port of Newcastle approximately 170 km downstream. The Hunter River flows at Muswellbrook are regulated by discharges from the Glenbawn Dam (Gilbert & Associates, 2013).

Surface drainage at the Mt Arthur Coal Mine generally comprises ephemeral creeks with headwaters within the Action area flowing north and south-westwards, ultimately draining into the Hunter River. Quarry Creek, Ramrod Creek, Fairford Creek, Whites Creek and several small unnamed creeks flow northwards into the Hunter River on the northern side of the existing mining operations at the Mt Arthur Coal Mine. Saddlers Creek has its headwaters in the south of the Action area. Saddlers Creek flows generally to the south-west and joins the Hunter River downstream of Denman (Gilbert & Associates, 2013).

Water resources in proximity to the Action are considered in detail in Section 3.1(i).

3.3 (c) Soil and Vegetation characteristics

The stratigraphic sequence across the Mt Arthur Coal Mine comprises two distinct units, namely a Permian coal seam sequence with an overburden and interburden consisting of lithic sandstone, interbedded with siltstone, tuffaceous claystone and mudstone. The Permian sediments are unconformably overlain by thin Quaternary alluvial deposits. The Quaternary alluvial deposits consist of sand and gravel along the creek valleys within the Mt Arthur Coal Mine, and in the alluvial floodplain of the Hunter River to the north (AGE, 2013).

Soil landscapes in the Action area have been mapped by the former NSW Department of Land and Water Conservation as described in the *Soil Landscapes of the Singleton 1:250,000 Sheet* (Kovac and Lawrie, 1991).

Three soil landscapes occur within the Action area, including the following (GSS Environmental, 2012):

- Bayswater Soil Landscape (30% of study area).
- Liddell Soil Landscape (55% of study area).
- Ogilive Soil Landscape (15% of study area).

The Bayswater Soil Landscape unit occurs on the Singleton Coal Measures and comprises undulating low hills to the south west of Muswellbrook, which range in elevation from 140 to 220 m, with 3 to 10% slopes. Local relief is 40 to 60 m. Much of the area has been cleared of woodland for grazing on unimproved pastures, with some remnants of Forest Red Gum (*Eucalyptus tereticornis*) and Forest Oak (*Allocasuarina torulosa*). The soils are dominated by yellow loams on slopes with alluvial soils in drainage lines, with some duplex soils on slopes, and depositional material with sandy clay loam, loam and clay loam textures forming infrequently in drainage lines. Limitations to soils in this unit include moderate sheet and gully erosion, structural degradation and crusting and hardsetting surfaces (GSS Environmental, 2012).

The Liddell Soil Landscape unit occurs on the Singleton Coal Measures and comprises undulating low hills with a few undulating hills, ranging in elevation from 140 to 220 m, with 4 to 7% slopes. Local relief is 60 to 120 m. Much of the area has been cleared of woodland for grazing on unimproved pastures, with some remnant open woodland of ironbark, box and gum species. The soils are dominated by yellow loams on slopes with, with some duplex sandy textures soils on lower slopes, and sands and skeletal soils forming infrequently throughout. Limitations to soils in this unit include moderate to high erosion hazard, occasionally high soil salinity, and structural degradation (GSS Environmental, 2012).

The Ogilvie Soil Landscape unit occurs in association with the Narrabeen Group sandstone, shales and conglomerates, comprised of steep hills and escarpments with cliffs, which range which from 180 to 260 m, with 15 to 60% slopes. Local relief is 100 to 220 m. The landscape is characterised by remnant woodland consisting of ironbark, box and gum species. The soils are dominated by shallow, skeletal soils on crests and upper slopes, loams forming on lower slopes with sands on flats and drainage lines. Limitations to soils in this unit include moderate sheet and gully erosion, structural degradation and mass movement and rock outcrop (GSS Environmental, 2012).

The vegetation disturbance associated with the Action additional surface disturbance areas includes the following vegetation types in the approximate areas listed below (Figure 7):

- Derived Grassland: approximately 136.8 ha.
- Derived Grassland, derived from Box-Gum Woodland: approximately 35.2 ha.
- Derived Grassland with Cooba Regeneration: approximately 1 ha.
- Central Hunter Box – Ironbark Woodland (MU10): approximately 23 ha.
- Central Hunter Box – Ironbark Woodland Wybong Slaty Variant (MU10): approximately 17.9 ha.
- Central Hunter Box – Spotted Gum – Grey Box Forest (MU27): approximately 7.1 ha.
- Upper Hunter Hills Box – Ironbark – Red Gum Woodland (MU9): approximately 3.4 ha.
- Hunter Lowlands Red Gum Forest (MU24): approximately 1.7 ha.
- *Typha* Dominated Drainage Line: approximately 2.5 ha.
- Blakely's Red Gum Woodland: approximately 0.2 ha
- Weeping Myall Woodland: approximately 0.1 ha[2].

Note that non-native and non-vegetative areas have been excluded from the list above, including cleared areas, plantings and existing infrastructure.

3.3 (d) Outstanding natural features

The Mt Arthur Coal Mine (including the Action) is located to the south of the Hunter River, wholly within the Hunter River catchment area. There are no perennial rivers or streams within the Action area.

The dominant natural features surrounding the Action area include Mount Arthur and Mount Ogilvie, which are located within the Mt Arthur Coal Mine operation area and to the west of the Action area, respectively.

3.3 (e) Remnant native vegetation

Refer to Sections 3.1(d), 3.3(a) and 3.3(c) above and Figure 7.

3.3 (f) Gradient (or depth range if action is to be taken in a marine area)

The topography surrounding the Mt Arthur Coal Mine and the Action area is gently undulating to hilly, dominated by Mount Arthur (approximately 482 m Australian Height Datum [AHD]), located within the mine operational area, and Mount Ogilvie (approximately 468 m AHD), located to the west of the Mt Arthur Coal Mine (HVEC, 2013a).

The north of the Mt Arthur Coal Mine gently slopes up from the alluvial flats of the Hunter River at an elevation of approximately 120 m AHD, rising to approximately 230 m AHD at Macleans Hill and becoming progressively steeper in the vicinity of Mount Arthur and Mount Ogilvie. From Mount Ogilvie, the southern portion of the Mt Arthur Coal Mine slopes down to form part of the Saddlers Creek floodplain (HVEC, 2013a).

[2] The patch of Weeping Myall woodland mapped by Hunter Eco (2013) within the major surface infrastructure area for the Action is 0.1 ha in size, and therefore does not meet the size threshold of 0.5 ha listed in the *Policy Statement 3.17 – Weeping Myall Woodlands* (Department of the Environment, Water, Heritage and the Arts, 2009).

3.3 (g) Current state of the environment

The Mt Arthur Coal Mine is situated within the Upper Hunter region which has a long history of rural land use for a variety of agricultural and industrial activities, predominantly livestock grazing and coal mining. Other land uses include equine industries and viticulture. The current dominant land uses within and adjacent to the existing ML boundaries include open cut coal mining, power generation and industrial activities, agriculture, rural residential and residential areas. Land within the Action area is currently used for limited periodic grazing activities and mining operations (HVEC, 2013b).

As described in Section 1.3, the majority of land within the Action area is owned by HVEC, with some parcels of land owned by other mine operators and power generation companies.

As described in Section 3.1(d), Hunter Eco (2013) and Niche Environment and Heritage (2012) (undertook detailed baseline flora and fauna surveys within the Action area and surrounds.

A total of 67 introduced flora species were recorded within the Action area and surrounds during flora surveys undertaken in April and May 2012 (Hunter Eco, 2013). Several flora species previously recorded within the Mt Arthur Coal Mine are listed by the DPI (Agriculture) as noxious weeds for the Upper Hunter County Council. One species previously recorded listed as a Class 3 noxious weed includes Mother of Millions (*Bryophyllum delagoense*) (Hunter Eco, 2013). Class 4 noxious weeds include: Nodding Thistle (*Carduus nutans*), Bathurst Burr (*Xanthium spinosum*), Tiger Pear (*Opuntia aurantiaca*), Creeping Pear (*Opuntia humifusa*), Common Prickly Pear (*Opuntia stricta* and *Opuntia stricta* var. *stricta*), St. Johns Wort (*Hypericum perforatum*), Johnson Grass (*Sorghum halepense*), Blackberry Bramble (*Rubus fruticosus* sp. agg.), African Boxthorn (*Lycium ferocissimum*) and Trailing Lantana (*Lantana montevidensis*) (Hunter Eco, 2013). Class 5 noxious weeds include the Annual Ragweed (*Ambrosia artemisiifolia*) (Hunter Eco, 2013).

During the fauna surveys undertaken within the Action area and surrounds in May 2012, Niche Environment and Heritage recorded the following six introduced mammal species: Black Rat (*Rattus rattus*), Dog (*Canis lupus familiaris*), Fox (*Vulpes vulpes*), Cat (*Felis catus*), Rabbit (*Oryctolagus cuniculus*) and European Cattle (*Bos taurus*) (Niche, 2012).

3.3 (h) Commonwealth Heritage Places or other places recognised as having heritage values

As described in Section 3.1(b), no National Heritage Places are situated within the Action area. The closest National Heritage Place is the Greater Blue Mountains Area. Wollemi National Park, which is part of the Greater Blue Mountains Area, is located approximately 15 km south-west of the Action area.

The closest Commonwealth Heritage Place is the Muswellbrook Post Office, which is located approximately 6 km north-east of the Action area. The Muswellbrook Post Office is a considerable distance from the area of any potential direct or indirect impacts of the Action.

3.3 (i) Indigenous heritage values

A number of Aboriginal heritage surveys and assessments have previously been undertaken in the Modification area and surrounds (HVEC, 2013b). Building on this previous body of work, an Aboriginal and Non-Indigenous Cultural Heritage Assessment has been prepared for the Mt Arthur Coal Mine, including the Action areas by RPS Australia East Pty Ltd (2013). The Aboriginal and Non-Indigenous Cultural Heritage Assessment used the findings of the previous archaeological investigations, search results from the Aboriginal Heritage Information Management System (AHIMS) database and the results of the Aboriginal cultural heritage survey (including the Action area) conducted by archaeologists and representatives of the Aboriginal community in April 2012.

A search of the AHIMS database identified 27 previously recorded Aboriginal heritage sites within or nearby the Action area. These included 25 artefact sites, one potential archaeological deposit (PAD) and one grinding groove site (RPS, 2013).The subsequent Aboriginal archaeological and cultural heritage survey undertaken for the Action identified 28 new sites within the Action area including 15 artefact scatters, 12 isolated find sites and one PAD (RPS, 2013).

The 28 newly recorded sites were considered to be of low significance on both local and regional scales, except for newly recorded sites AS 11, 12, 20, 21, 22, 23, 24 and 25 which were considered to be moderately significant on a local scale, and the newly recorded PAD with artefact scatter which was considered to be highly significant on a local scale and moderately significant on a regional scale (RPS, 2013).

Mitigation, management and monitoring measures were determined for the Modification in consultation with the registered Aboriginal stakeholders. As described in the Aboriginal and Non-Indigenous Cultural Heritage Assessment, the existing *Aboriginal Heritage Management Plan* for the Mt Arthur Coal Mine would be updated in consultation with the Aboriginal community and the OEH to specify management and mitigation measures relevant to the Action area (RPS, 2013). A discussion regarding the consultation undertaken with the Aboriginal community is provided in Section 2.6.

There are no indigenous land use agreements, joint management arrangements or Aboriginal Land Claims existing over the Action area.

3.3 (j) Other important or unique values of the environment

As detailed in Section 3.1(a), the Wollemi National Park is located approximately 15 km south-west of the Action area. The Action would have no interaction or significant impacts on the Wollemi National Park.

No national parks, conservation reserves or wetlands of national importance occur within the Action area or surrounds. Refer to Sections 3.1(a), 3.1(b) and 3.1(c).

3.3 (k) Tenure of the action area (eg freehold, leasehold)

As described in Section 1.3, the Action disturbance area is located wholly within the existing mining tenements and application area held by HVEC (i.e. ML 1487, ML 1548, ML 1358, ML 1655 and MLA 476), on freehold land owned by HVEC or Drayton (Anglo Coal [Drayton Management] Pty Limited).

Relevant parcels of land within the area of the Action are presented on Figure 4.

3.3 (l) Existing land/marine uses of area

The Mt Arthur Coal Mine is situated within the Upper Hunter region which has a long history of rural land use for a variety of agricultural and industrial activities, predominantly livestock grazing and coal mining. Other land uses include equine industries and viticulture. The current dominant land uses within and adjacent to the existing ML boundaries include open cut coal mining, power generation and industrial activities, agriculture, rural residential and residential areas (HVEC, 2013b).

Land within the Action area is currently used for limited periodic grazing activities and mining operations (HVEC, 2013b).

Existing development in the locality of the Action area include:

- the Golden Highway (State Route 84), Denman Road and Edderton Road;
- the Main Northern Railway;
- surrounding mining operations (i.e. Bengalla Coal Mine and Drayton Coal Mine); and
- electrical infrastructure (330 kilovolt voltage powerlines).

The operational mines in the vicinity of the Action area include:

- Drayton Coal Mine, located immediately east of the Mt Arthur Coal Mine.
- Bengalla Coal Mine, located approximately 2 km north of the Mt Arthur Coal Mine.
- Mt Pleasant Coal Mine, located approximately 8 km north of the Mt Arthur Coal Mine.
- Mangoola Coal Project, located approximately 10 km north-west of the Mt Arthur Coal Mine.

3.3 (m) Any proposed land/marine uses of area

Rehabilitation planning at Mt Arthur Coal Mine will attempt to maximise opportunities for a diverse post-mining landscape and range of land uses. It is proposed that final land uses will include pastoral, commercial forestry, recreation and/or wildlife habitat opportunities (HVEC, 2013b).

The conceptual location of proposed native woodland and forest communities on rehabilitated lands is consistent with the DPI's Synoptic Plan (Andrews, 1999).

Land immediately south and adjacent to the Mt Arthur Coal Mine boundary is subject to a current mining application for the proposed Drayton South Coal Project. Further south, Spur Hill Management Pty Ltd is seeking consent to develop an underground mining operation (the Spur Hill Underground Coking Coal Project), with a mine life of up to 25 years.

4 Measures to avoid or reduce impacts

Mt Arthur Coal Environmental Management Strategy

HVEC has developed an Environmental Management Strategy (EMS) (BHP Billiton, 2013) and has implemented a comprehensive EMS that provides a framework to facilitate compliance with legal and other requirements (including statutory approvals, BHP Billiton requirements and stakeholder expectations).

The objectives of the EMS are to meet the requirements of the Project Approval 09_0062 (Attachment E), EPBC Act Approval (2011/5866), and to manage and minimise the impact of the Mt Arthur Coal Mine on the surrounding environment and community, as well as providing the community with an overview of the EMS in place at Mt Arthur Coal Mine (BHP Billiton, 2013).

A number of management plans, monitoring program and strategies are sub-components of the EMS, including:

- Air Quality Management Plan;
- Air Quality Monitoring Program;
- Noise Management Plan;
- Noise Monitoring Program;
- Blast Management Plan;
- Blast Monitoring Program;
- Surface Water Monitoring Program;
- Site Water Management Plan;
- Site Water Balance;
- Erosion and Sediment Control Plan;
- Surface and Groundwater Response Plan;
- Groundwater Monitoring Program;
- European Heritage Management;
- Aboriginal Heritage Management Plan;
- Biodiversity Management Plan;
- Biodiversity Monitoring Program;
- Rehabilitation Management Plan;
- Rehabilitation Strategy;
- Biodiversity Offset Strategy;
- Blast Management Plan; and
- Blast Monitoring Program.

The performance of the EMS and its associated plans, program and documents are reported annually in the Annual Environmental Management Report (AEMR), in accordance with the Project Approval 09_0062, and in the Annual Return in accordance with EPL 11457.

Mt Arthur Coal Environmental Monitoring Program

A key component of the EMS is the Environmental Monitoring Program (EMP). The EMP allows HVEC to effectively manage and measure its environmental performance through a comprehensive monitoring system.

The Mt Arthur Coal Mine environmental monitoring system includes the following:

- five meteorological stations (including stations on real-time noise monitors);
- three High Volume Air Samplers, particulate matter less than 10 micrometres in diameter (PM_{10}), seven real-time continuous dust monitors, 13 depositional dust gauges;
- four permanent continuous noise monitors, one mobile continuous noise monitor, eight quarterly attended noise monitoring locations;
- six blast monitors;
- 46 groundwater monitoring locations; and
- 23 surface water sampling points.

EMP monitoring results are published in the AEMR and are distributed to government agencies, employees, the CCC, and the local library via the BHP Billiton website (www.bhpbilliton.com/).

5 Conclusion on the likelihood of significant impacts

5.1 Do you THINK your proposed action is a controlled action?

✓	No, complete section 5.2
	Yes, complete section 5.3

5.2 Proposed action IS NOT a controlled action.

On the basis of the reasons provided in Section 3, the Action is not considered to be a controlled action as it is not likely to have a significant impact on:

- the World Heritage values of a declared World Heritage property;
- the National Heritage values of a National Heritage Place;
- the ecological character of a declared Ramsar wetland;
- a listed threatened species, threatened ecological community, or their habitat;
- a listed migratory species;
- the hydrology or water quality of water resources (in consideration of the value of the resources);
- the environment in a Commonwealth marine area;
- the environment on Commonwealth land; or
- the Great Barrier Reef Marine Park.

5.3 Proposed action IS a controlled action

	Matters likely to be impacted
	World Heritage values (sections 12 and 15A)
	National Heritage places (sections 15B and 15C)
	Wetlands of international importance (sections 16 and 17B)
	Listed threatened species and communities (sections 18 and 18A)
	Listed migratory species (sections 20 and 20A)
	Protection of the environment from nuclear actions (sections 21 and 22A)
	Commonwealth marine environment (sections 23 and 24A)
	Great Barrier Reef Marine Park (sections 24B and 24C)
	A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E)
	Protection of the environment from actions involving Commonwealth land (sections 26 and 27A)
	Protection of the environment from Commonwealth actions (section 28)
	Commonwealth Heritage places overseas (sections 27B and 27C)

6 Environmental record of the responsible party

		Yes	No
6.1	**Does the party taking the action have a satisfactory record of responsible environmental management?**	✓	

Provide details

BHP Billiton has and continues to maintain a strong commitment to health, safety, environmental responsibility and sustainable development which is incorporated in their Charter. BHP Billiton, has established and is committed to continuing open and constructive dialogue with the local community and stakeholders regarding strong environmental management as part of their operations.

BHP Billiton provide the communities in which they operate, government, employees and other stakeholders with an annual Sustainability Report to provide an understanding of their performance against three pillars of sustainability, namely economic, environmental and social criteria.

The annual Sustainability Report provides information on BHP Billiton's environmental performance, the components of which are detailed below:

- compliance with statutory environmental requirements;
- energy consumption;
- fresh and recycled water consumption;
- water management issues and subsequent water savings action plans;
- greenhouse gases, and dust emissions;
- general, hazardous and coal wash waste management;
- minimising the impacts of transport;
- subsidence management;
- rehabilitation of disused mining infrastructure;
- land management; and
- biodiversity management.

The annual Sustainability Reports from 2005 to 2013 can be accessed via the following link: http://www.bhpbilliton.com/home/aboutus/sustainability/reports/Pages/default.aspx

BHP Billiton has a strong record in mine safety, environmental care and business operation. BHP Billiton conducts its mining operations in accordance with a range of regulatory consents, leases and licences.

6.2	**Has either (a) the party proposing to take the action, or (b) if a permit has been applied for in relation to the action, the person making the application - ever been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources?** **If yes, provide details of environmental policy and planning framework** BHP Billiton's approach to environmental management is incorporated in BHP Billiton's Charter, which states that they have 'an overriding commitment to health, safety, environmental responsibility and sustainable development'. The International Council on Mining and Metals Sustainable Development Framework and the Sustainable Development Policy (http://www.bhpbilliton.com/home/aboutus/regulatory/Documents/creisAppR1BhpPol004SustainableDevelopmentPolicy.pdf), states that BHP Billiton will: • Strive to achieve leading industry practice. • Meet or, where less stringent than our standards, exceed applicable legal and other requirements. • Set and achieve targets that promote efficient use of resources and include reducing and preventing pollution. • Enhance biodiversity protection by assessing and considering ecological values and land use in our activities. BHP Billiton's commitment to reducing greenhouse gas emissions is expressed in their Climate Change Policy, and their Policy commitments are reflected in Company-wide environmental targets. BHP Billiton enhances biodiversity protection by assessing and considering ecological values and land-use aspects in investment, operational and closure activities.		✓
6.3	**If the party taking the action is a corporation, will the action be taken in accordance with the corporation's environmental policy and planning framework?** BHP Billiton develops Management Plans addressing impacts including biodiversity, water, waste, land and air, for all sites operated by BHP Billiton. These Management Plans include: • a baseline assessment of the environmental values potentially impacted; • an environmental impact assessment; • controls to mitigate environmental impacts; and • monitoring and review programs to assess the environmental impacts and effectiveness of the controls. BHP Billiton will not mine or explore within the boundaries of World Heritage listed properties and will ensure that activities adjacent to these are compatible with the outstanding universal values for which the properties have been listed.	✓	

	BHP Billiton will not mine or explore within the boundaries of International Union for the Conservation of Nature (IUCN) Protected Areas Categories I-IV, unless an action plan designed to deliver measurable benefits to biodiversity has been developed that is commensurate with the level of biodiversity impacts. BHP Billiton will not proceed with activities where the direct impacts would result in extinction of species listed by the IUCN as being threatened with extinction. BHP Billiton rehabilitates disturbed areas consistent with the pre-disturbance land use or alternate land uses are developed in consultation with stakeholders. BHP Billiton will not dispose of tailings or waste rock into a river or marine environment.		
6.4	**Has the party taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?** **Provide name of proposal and EPBC reference number (if known)** Dendrobium Coal Mining Project (2001/214). Extension of Underground Mining Operations at The Bulli Seam Operations (2010/5350). Mt Arthur Coal Extension Project (2011/5866). Caroona Coal Project (2014/7173).	✓	

7 Information sources and attachments

(For the information provided above)

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7.2 Reliability and date of information

The information presented in Section 3 was sourced from publicly available data and current surveys/assessments undertaken for the Action. Information in this referral was compiled using assessments prepared for the Mt Arthur Coal Mine Open Cut Modification Environmental Assessment, and included:

- HVEC project team (*project information*);
- Atlas of NSW Wildlife (OEH, 2014) and the EPBC Act Protected Matters Search Tool (DotE, 2014a) (*database searches within and surrounding the Action area*);
- assessments prepared for the Action as a component of the Mt Arthur Coal Mine Open Cut Modification Environmental Assessment including the following:
  - AGE (2013) (*Mt Arthur Coal Open Cut Modification Groundwater Impact Assessment*);
  - Gilbert & Associates (2013) (*Mt Arthur Coal Open Cut Modification Surface Water Assessment*); and
  - Hunter Eco (2013) (Mt Arthur Coal Open Cut Modification Ecological Assessment).

Minimal uncertainty regarding the information used in Section 3 is expected given:

- the comprehensive nature of the studies;
- the consultation process conducted with key stakeholders to date; and
- the mitigation measures proposed for the Action.

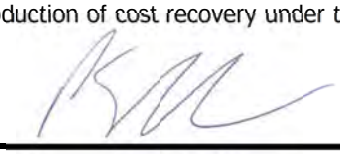
7.3 Attachments

		✓ attached	Title of attachment(s)
You must attach	figures, maps or aerial photographs showing the project locality (section 1)	✓	Figure 1 – Regional Location Figure 2 – Mt Arthur Coal Mine Location Figure 3 – General Arrangement of the Action Figure 4 – Relevant Land Ownership
	GIS file delineating the boundary of the referral area (section 1)		
	figures, maps or aerial photographs showing the location of the project in respect to any matters of national environmental significance or important features of the environments (section 3)	✓	Figure 1 – Regional Location Figure 2 – Mt Arthur Coal Mine Location Figure 3 – General Arrangement of the Action Figure 4 – Relevant Land Ownership Figure 5 – Proposed Rehabilitation Plan and Offset Strategy Figure 6 – Proposed Middle Deep Creek Offset Area Figure 7 – Vegetation Communities Figure 8 – Threatened Flora and Ecological Communities Figure 9 – Threatened Fauna Figure 10 – Predicted Extent of Additional Watertable Drawdown Attributable to the Action
If relevant, attach	copies of any state or local government approvals and consent conditions (section 2.5)	✓	Attachment E – Project Approval 09_0062.
	copies of any completed assessments to meet state or local government approvals and outcomes of public consultations, if available (section 2.6)	✓	Attachment B – Mt Arthur Coal Open Cut Modification Ecological Assessment. Attachment C – Mt Arthur Coal Open Cut Modification Groundwater Impact Assessment.
	copies of any flora and fauna investigations and surveys (section 3)	✓	Attachment B – Mt Arthur Coal Open Cut Modification Ecological Assessment.
	technical reports relevant to the assessment of impacts on protected matters that support the arguments and conclusions in the referral (section 3 and 4)	✓	Attachment B – Mt Arthur Coal Open Cut Modification Ecological Assessment. Attachment C – Mt Arthur Coal Open Cut Modification Groundwater Impact Assessment.
	report(s) on any public consultations undertaken, including with Indigenous stakeholders (section 3)	-	Not applicable.

8 Contacts, signatures and declarations

Project title: MT ARTHUR COAL OPEN CUT MODIFICATION

8.1 Person proposing to take action

Name	Peter Sharpe
Title	Asset President – NSW Energy Coal
Organisation	Hunter Valley Energy Coal Pty Ltd
ACN / ABN (if applicable)	062894464 / 39 062 894 464
Postal address	Mt Arthur Coal, Thomas Mitchell Drive, Muswellbrook, NSW 2333
Telephone	02 6544 5800
Email	Peter.J.Sharpe@bhpbilliton.com
Declaration	I declare that to the best of my knowledge the information I have given on, or attached to this form is complete, current and correct. I understand that giving false or misleading information is a serious offence. I agree to be the proponent for this action. I acknowledge that I may be liable for fees related to my proposed action following the introduction of cost recovery under the EPBC Act.
Signature	 Date 28 October, 2014

8.2 Person preparing the referral information (if different from 8.1)

Name	
Title	
Organisation	Organisation name should match entity identified in ABN/ACN search
ACN / ABN (if applicable)	
Postal address	
Telephone	
Email	
Declaration	I declare that to the best of my knowledge the information I have given on, or attached to this form is complete, current and correct. I understand that giving false or misleading information is a serious offence.
Signature	Date

REFERRAL CHECKLIST

HAVE YOU:

- ☑ Completed all required sections of the referral form?
- ☑ Included accurate coordinates (to allow the location of the proposed action to be mapped)?
- ☑ Provided a map showing the location and approximate boundaries of the project area?
- ☑ Provided a map/plan showing the location of the action in relation to any matters of NES?
- ☑ Provided a digital file (preferably ArcGIS shapefile, refer to guidelines at Attachment A) delineating the boundaries of the referral area?
- ☑ Provided complete contact details and signed the form?
- ☑ Provided copies of any documents referenced in the referral form?
- ☑ Ensured that all attachments are less than three megabytes (3mb)?
- ☑ Sent the referral to the Department (electronic and hard copy preferred)?

FIGURES

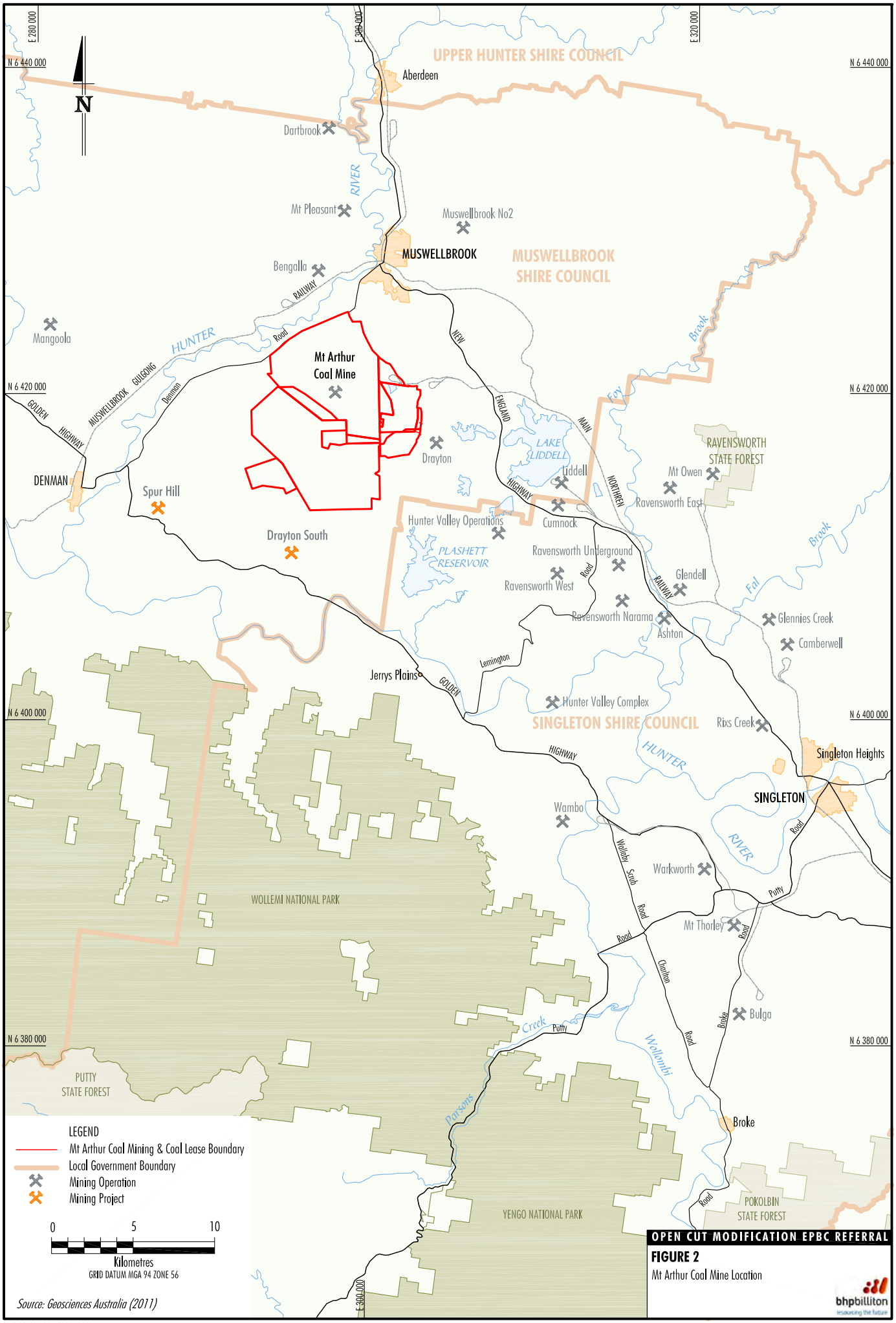
OPEN CUT MODIFICATION EPBC REFERRAL

FIGURE 1

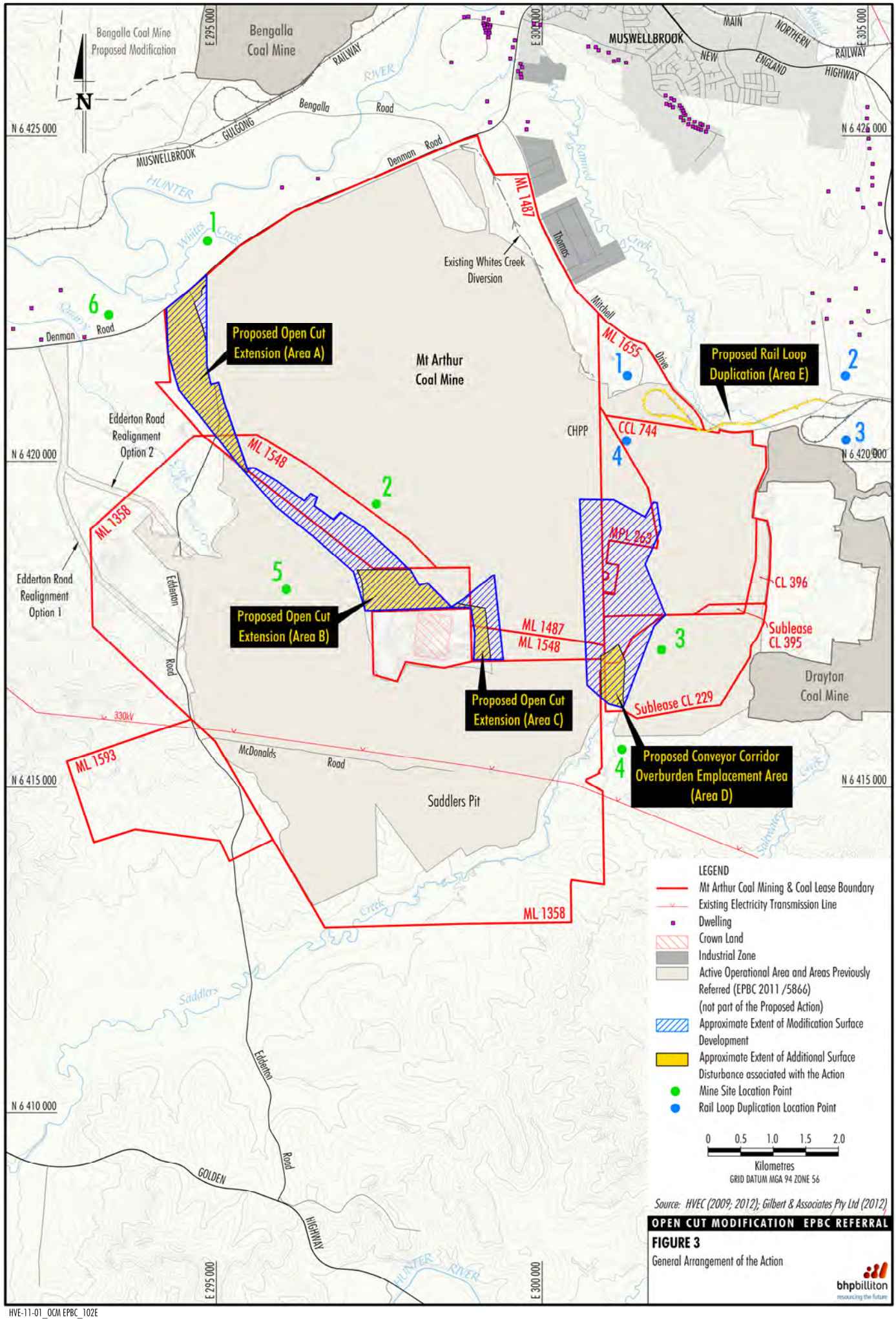
Regional Location

bhpbilliton
resourcing the future

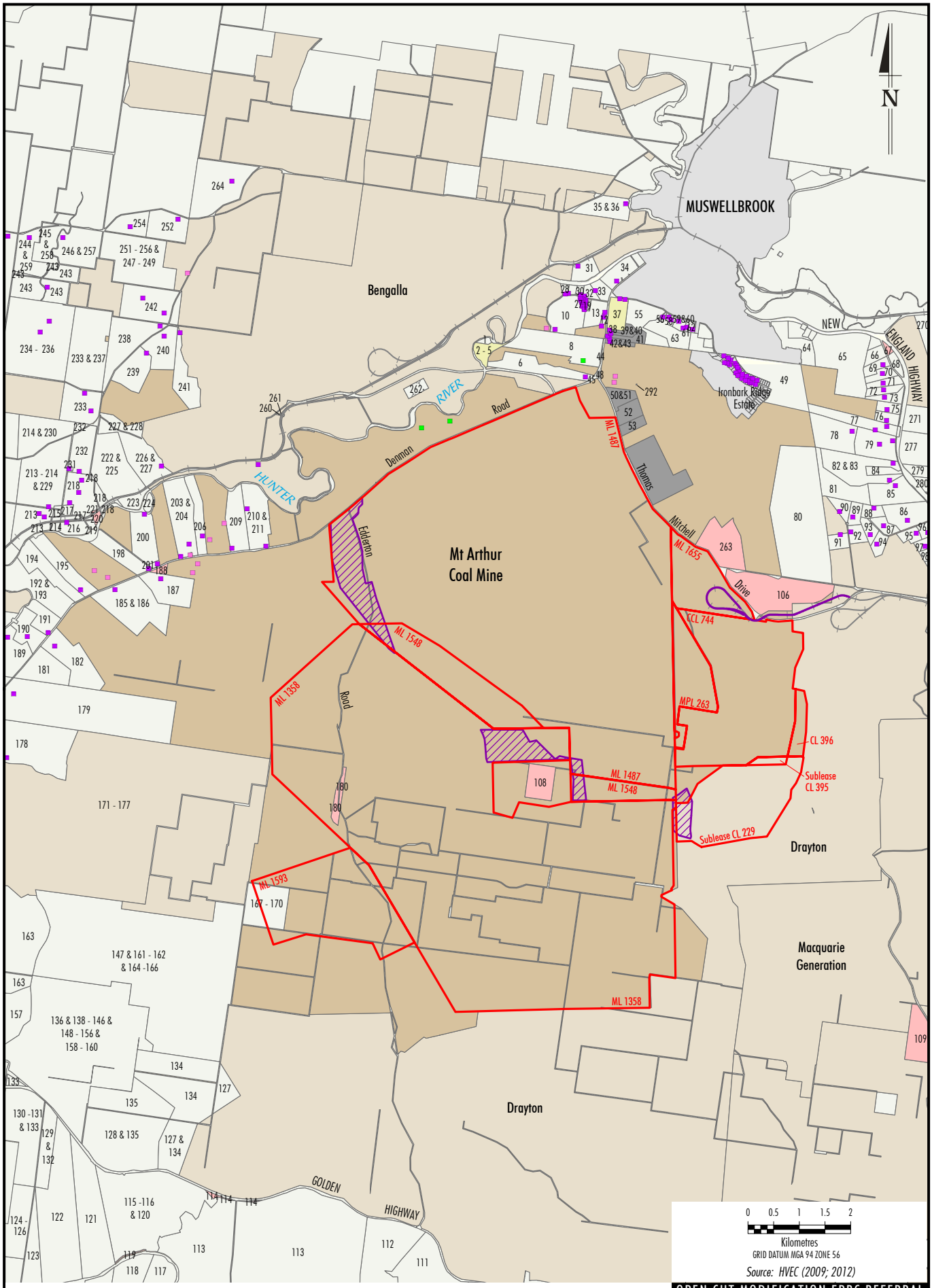
HVE-11-01 OCM EPBC_001A



HVE-11-01_OCM EPBC_101B



HVE-11-01_OCM EPBC_102E



OPEN CUT MODIFICATION EPBC REFERRAL

FIGURE 4

Relevant Land Ownership

bhpbilliton
resourcing the future

HVE-11-01_OCM EPBC_201C

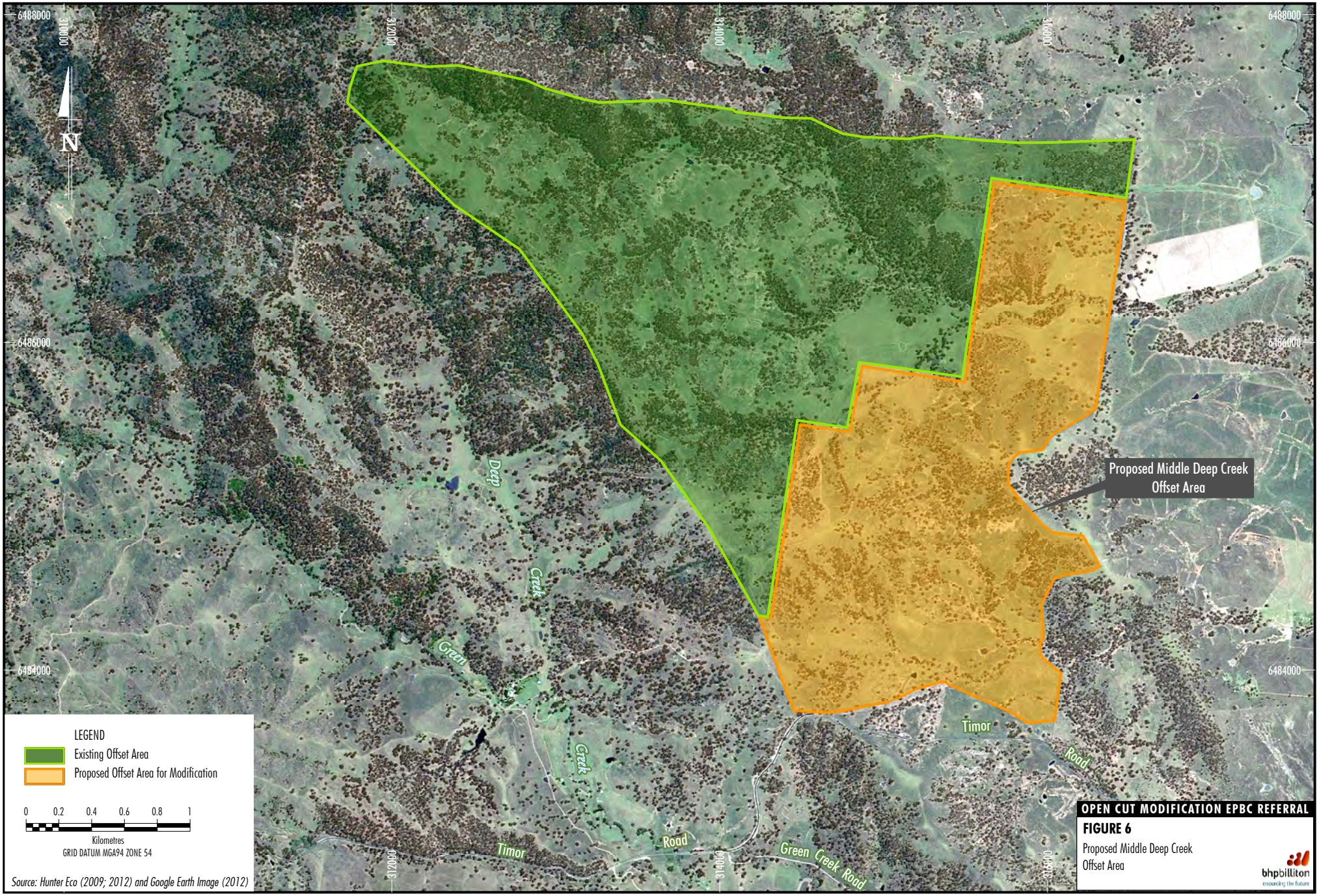
OPEN CUT MODIFICATION EPBC REFERRAL

FIGURE 5

Proposed Rehabilitation Plan and Offset Strategy

bhpbilliton
resourcing the future

HVE-11-01_OCM EPBC_104C



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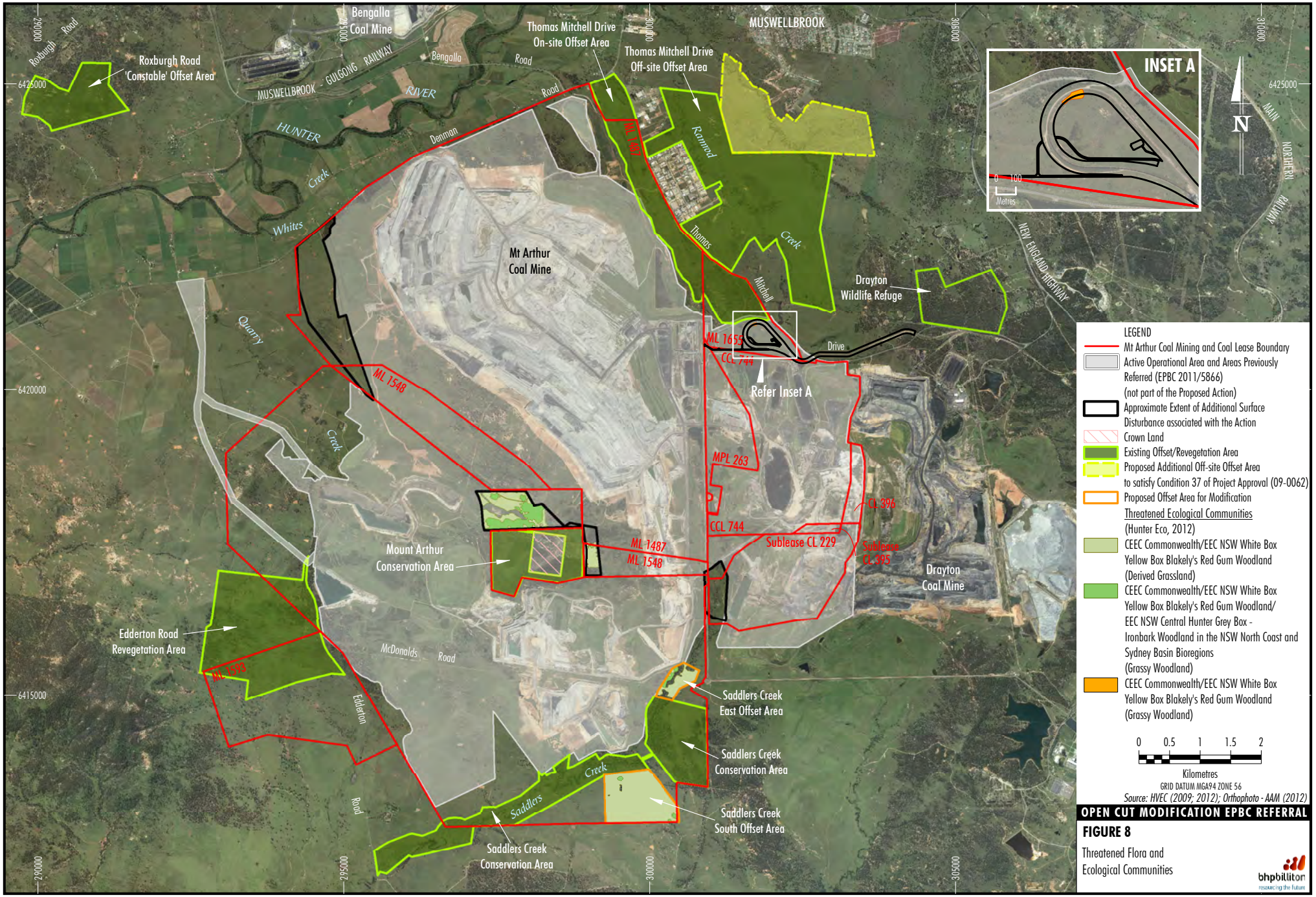


OPEN CUT MODIFICATION EPBC REFERRAL

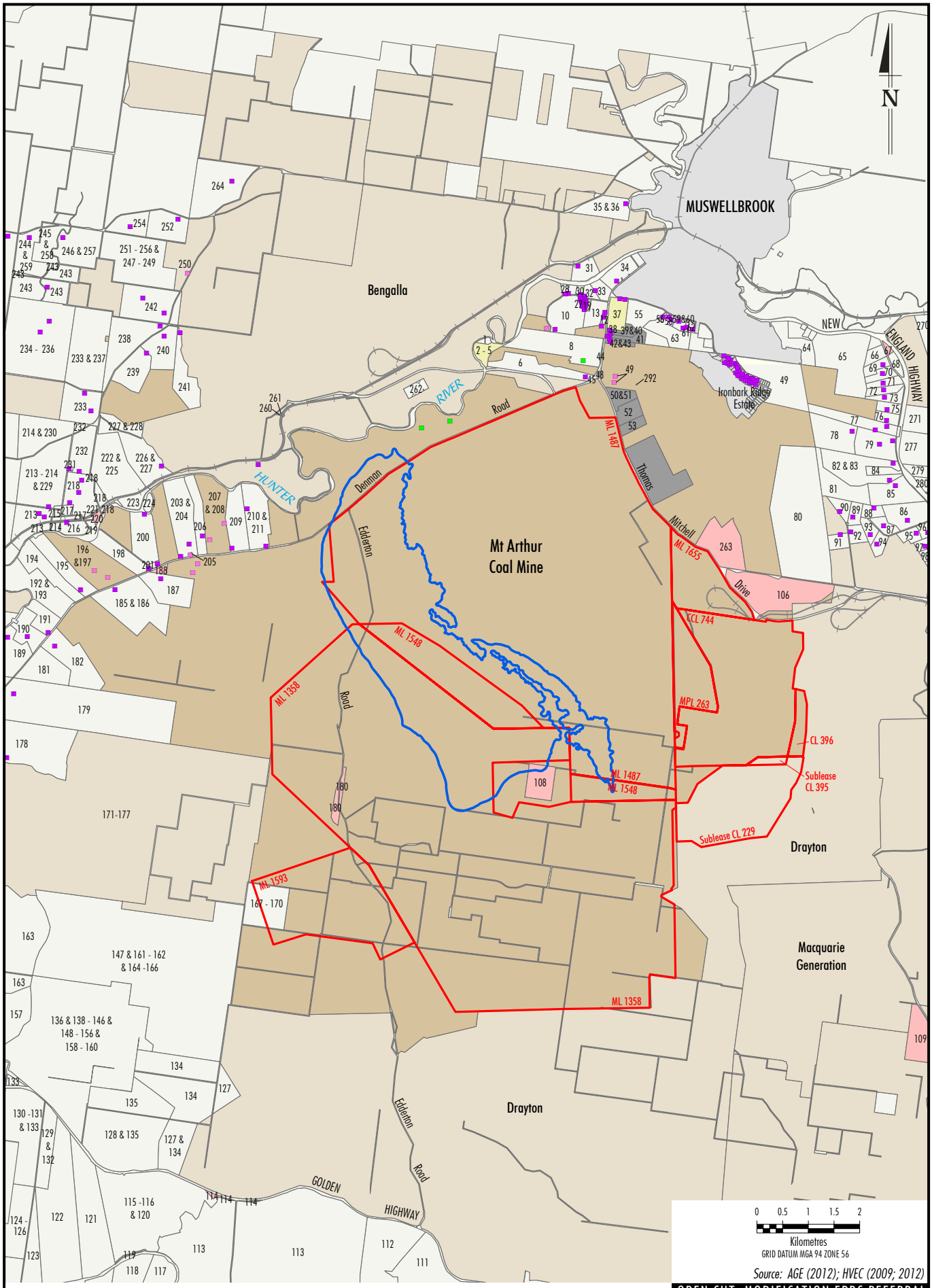
FIGURE 8

Threatened Flora and Ecological Communities

bhpbilliton resourcing the future

HVE-11-01_OCM EPBC_211C

HVE-11-01_OCM EPBC_105B



HVE-11-01_OCM EPBC_204B

Attachment A

Geographic Information System (GIS) data supply guidelines

If the area is less than 5 hectares, provide the location as a point layer. If the area greater than 5 hectares, please provide as a polygon layer. If the proposed action is linear (eg. a road or pipeline) please provide a polyline layer.

GIS data needs to be provided to the Department in the following manner:

- Point, Line or Polygon data types: ESRI file geodatabase feature class (preferred) or as an ESRI shapefile (.shp) zipped and attached with appropriate title
- Raster data types: Raw satellite imagery should be supplied in the vendor specific format.
- Projection as GDA94 coordinate system.

Processed products should be provided as follows:

- For data, uncompressed or lossless compressed formats is required - GeoTIFF or Imagine IMG is the first preference, then JPEG2000 lossless and other simple binary+header formats (ERS, ENVI or BIL).
- For natural/false/pseudo colour RGB imagery:
    - If the imagery is already mosaiced and is ready for display then lossy compression is suitable (JPEG2000 lossy/ECW/MrSID). Prefer 10% compression, up to 20% is acceptable.
    - If the imagery requires any sort of processing prior to display (i.e. mosaicing/colour balancing/etc) then an uncompressed or lossless compressed format is required.

Metadata or 'information about data' will be produced for all spatial data and will be compliant with ANZLIC Metadata Profile. (http://www.anzlic.org.au/policies_guidelines#guidelines).

The Department's preferred method is using ANZMet Lite, however the Department's Service Provider may use any compliant system to generate metadata.

All data will be provide under a Creative Commons license (http://creativecommons.org/licenses/by/3.0/au/)

ATTACHMENT B

MT ARTHUR COAL OPEN CUT MODIFICATION ECOLOGICAL ASSESSMENT

(HUNTER ECO, 2013)

[NOT INCLUDED IN THIS VERSION - PLEASE REFER TO ATTACHMENT C OF THE PRELIMINARY DOCUMENTATION]

ATTACHMENT C

MT ARTHUR COAL OPEN CUT MODIFICATION GROUNDWATER IMPACT ASSESSMENT

(AUSTRALASIAN GROUNDWATER & ENVIRONMENTAL CONSULTANTS, 2013)

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REPORT ON

MT ARTHUR COAL OPEN CUT MODIFICATION GROUNDWATER IMPACT ASSESSMENT

1.0 INTRODUCTION

Hunter Valley Energy Coal Pty Ltd (HVEC), a wholly owned subsidiary of BHP Billiton Ltd, is proposing to extend the currently approved open cut mine footprint at the Mt Arthur Coal Mine. As such, it is seeking approval for a modification to its approved Mt Arthur Consolidation Project from the Minister of Planning and Infrastructure, under section 75W of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979*.

HVEC has two current approvals for the Mt Arthur Coal Mine, these being:

- PA09_0062 granted on 24 September 2010 for the Mt Arthur Coal Consolidation Project. This approval is for open cut mining and infrastructure and allows a mining rate of up to 32 million tonnes per annum (Mtpa); and
- PA06_0091 granted on the 2 December 2008 for underground mining at the rate of 8 Mtpa.

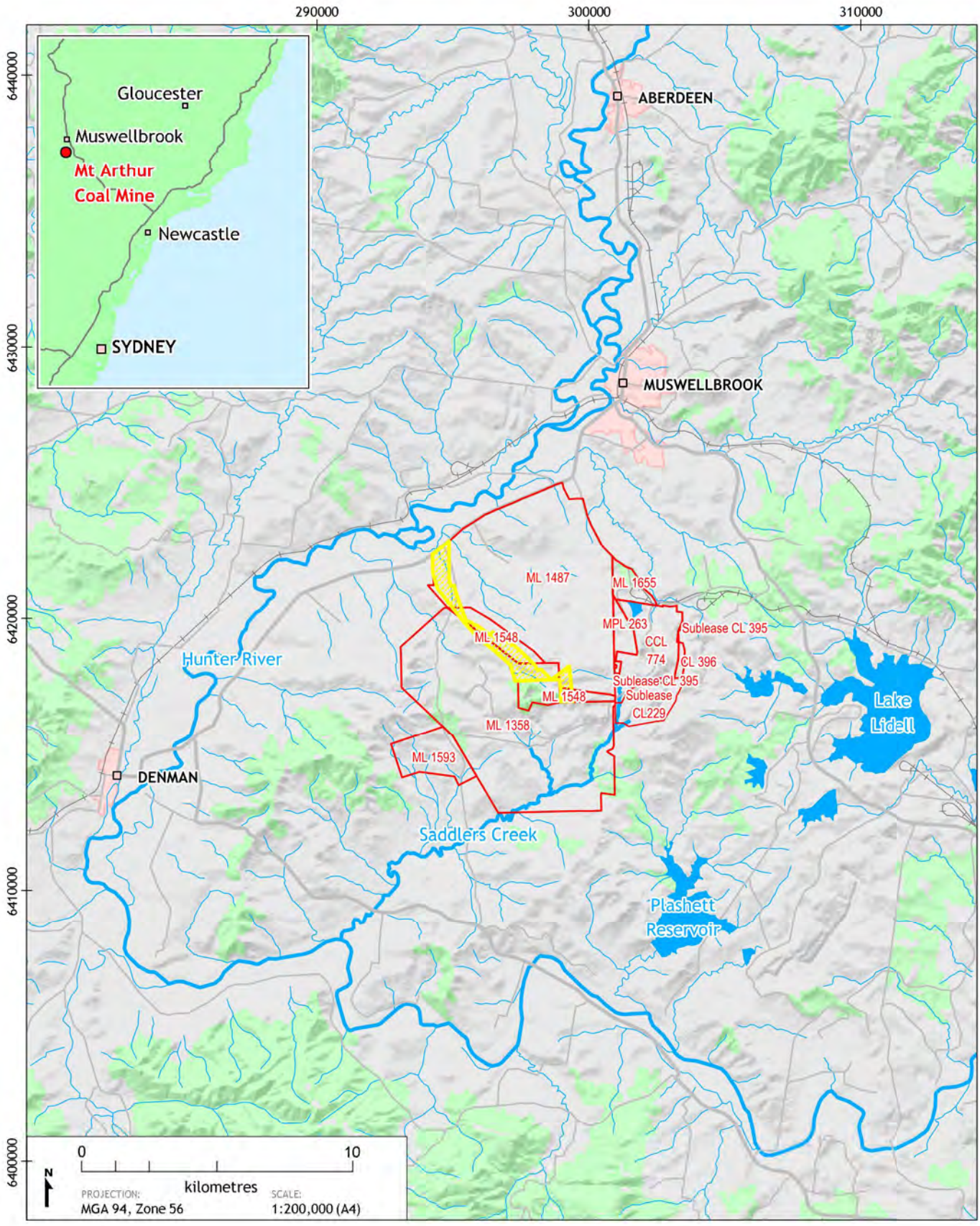
The Mt Arthur Coal Open Cut Modification (the Modification) includes the continuation of open cut mining operations at the Mt Arthur Coal Mine for an additional operational life of approximately four years (i.e. from Year 2022 to Year 2026).

The Modification involves an expansion of the open cut disturbance area to the south-west, as shown on Figures 1 and 2. The Modification Area lies between the approved open cut mine and the approved underground mine (Figure 2).

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) were commissioned by HVEC to undertake a groundwater impact assessment of the proposed Modification. This report, which describes the groundwater impact assessment, forms part of the Environmental Assessment (EA) being prepared by Resource Strategies Pty Ltd, in support of the application for approval of the Modification.

The report describes the hydrogeological regime of the Site area and identifies potential risks and constraints. The assessment is based on a refined three-dimensional transient, groundwater flow model of the Mt Arthur Coal Mine that was originally developed in 2009 for the Mt Arthur Coal Consolidation Project EA and has been updated to include the Modification.

In the context of this report, the term Site refers to the Mt Arthur Coal Mine Site and the term MAU is used to describe the Mt Arthur Underground Mine. The Model Area/Boundary refers to the extent of the numerical model footprint.



LEGEND:

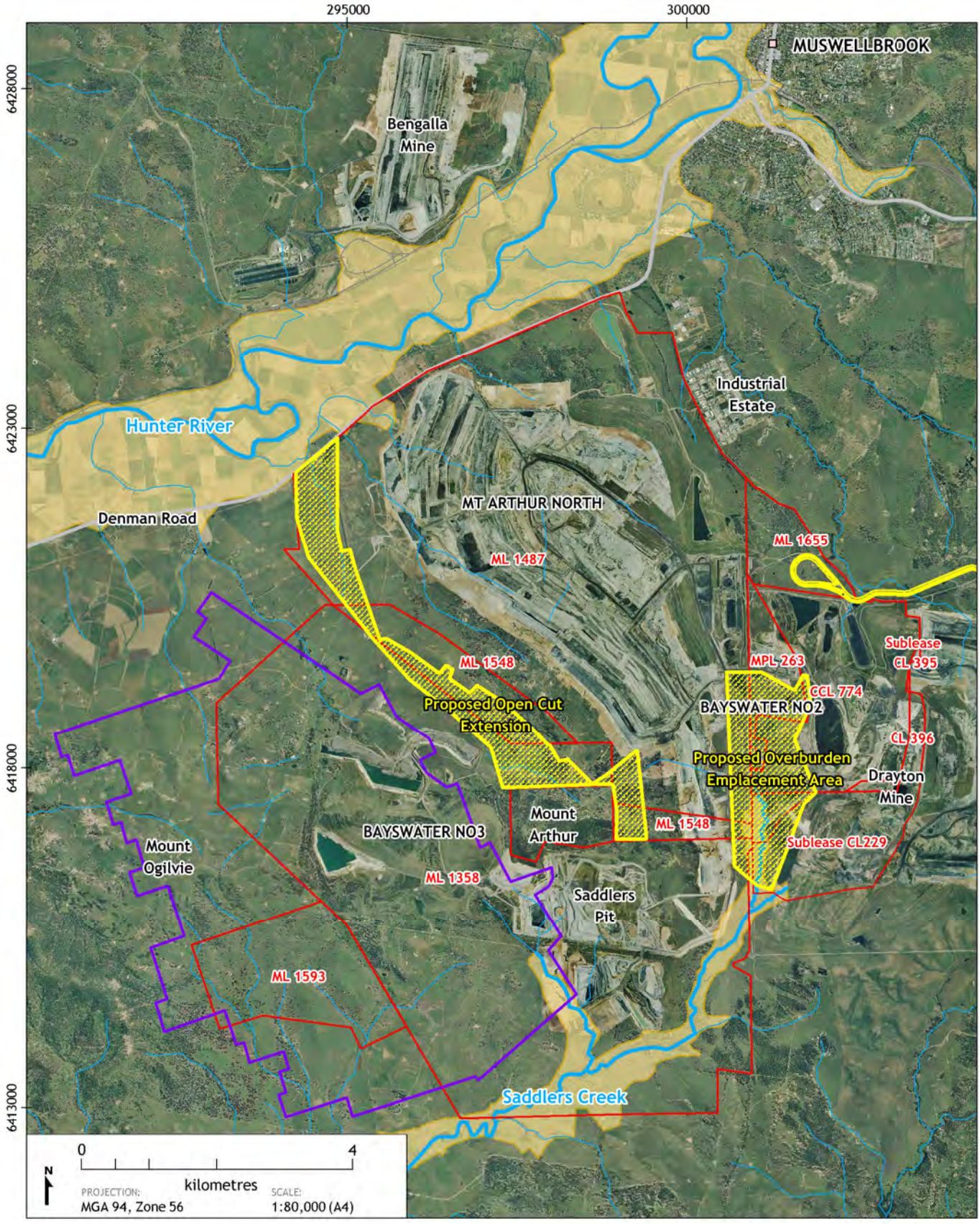
- Mt Arthur Coal Mining & Coal Lease Boundary
- Mine Modification Area
- Native Vegetation
- Road/Track
- Rail
- Town
- Reservoir/Lake
- River
- Creek

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

General Location Plan

DATE: 23/1/2013

FIGURE No: 1



LEGEND:

- Mt Arthur Coal Mining & Coal Lease Boundary
- Modification Area
- Proposed Rail Loop
- Mt Arthur Underground
- Alluvium
- River
- Creek
- Town
- Road
- Rail

Air Photo courtesy of Mt Arthur Coal Mine - photo date 15/11/2011

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Mt Arthur Mine Modification Study Area

DATE: 23/1/2013

FIGURE No: 2

2.0 PROJECT OVERVIEW

HVEC is seeking a modification to the Mt Arthur Coal Consolidation Project to facilitate the extension of open cut mining activities for a further four years. Open cut extraction of an additional 128 million tonnes is proposed. The Modification generally comprises:

- a four year continuation of the open cut mine life from 2022 to 2026 at the currently approved maximum rate of 32 Mtpa;
- an increase in open cut disturbance areas;
- use of the conveyor corridor for overburden emplacement;
- duplication of the existing rail loop;
- an increase in the maximum number of train movements per day from 24 to 38;
- the relocation of the load point for the overland conveyor which delivers coal to Macquarie Generation's Bayswater Power Station;
- the relocation and upgrade of the explosives storage, magazine and associated facilities; and
- the construction of additional offices and a control room and a small extension to the run-of-mine coal stockpile footprint.

3.0 SCOPE OF WORK

3.1 Legislation

The Director-General's Requirements (DGRs) for the Modification provided by the NSW Department of Planning and Infrastructure (DP&I) on 30 April 2012 included the following in regard to the soil and water assessments:

- *detailed assessment of potential impacts on the quality and quantity of existing surface and groundwater resources, including:*
    - *detailed modelling of potential groundwater impacts, including and potential impacts on the alluvial aquifers of the Hunter River;*
    - *impacts on affected licensed water users and basic landholder rights; and*
    - *impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including environmental flows and potential flooding impacts;*
- *a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume, salinity and frequency of any water discharges), water supply infrastructure and water storage structures;*
- *an assessment of proposed water discharge quantities and quality/ies against receiving water quality and flow objectives;*
- *assessment of impacts of salinity from mining operations, including disposal and management of coal rejects and modified hydrogeology, a salinity budget and the evaluation of salt migration to surface and groundwater sources;*
- *identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;*
- *demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);*
- *a description of the measures proposed to ensure the modified project can operate in accordance with the requirements of any relevant WSP or water source embargo;*
- *a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts; and*
- *compliance with the Hunter River Salinity Trading Scheme (HRSTS).*

The Site area investigated as part of the groundwater study had an approximate radius of 15 kilometres (km) surrounding the Modification Area and existing mine, and encompassed the alluvium surrounding the mine.

The NSW Office of Water (NOW) also provided relevant agency comments, as follows:

- *Adequate, secure and appropriately authorised water supply is available for all activities for the life of the mine.*
- *Compliance with the rules in the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources and relevant legislation, water management policies and guidelines.*

- *Assessment of risks to the Hunter Regulated Alluvium which may be posed by the mining extension, including extended and cumulative depressurisation of the alluvial groundwater source, and impacts to groundwater quality which may result from extension of the mining operation.*
- *Development of adequate baseline monitoring (minimum of fortnightly data sampling for at least 2 years prior to mine operations, and appropriate scaled real time monitoring) of all surface water and groundwater sources and dependent ecosystems within and adjacent to the mining operation area for calibration of models and development of trigger criteria.*
- *Predictive assessments of potential impacts to surface water and groundwater sources, basic landholder's rights to water, adjacent licensed water users and dependent ecosystems and ongoing monitoring to enable comparison with predictions.*
- *Mitigation strategies to address impacts on surface water and groundwater sources and dependent ecosystems for the operational and post mining phases of the proposal and final landform*.

In their agency comments the following information was requested to demonstrate the above:

- *Details of all groundwater sources and existing groundwater users within the area (including the environment) and details of any potential impacts on these users;*
- *Identification of potential Groundwater Dependent Ecosystems (GDEs);*
- *Baseline monitoring (minimum of fortnightly data sampling for at least 2 years prior to mine operations) for groundwater quantity and quality for all aquifers and GDEs;*
- *Description of aquifer hydraulic properties, chemical characteristics and connectivity (including to surface water sources);*
- *Assessment of GDEs for condition and water quantity and quality requirements for both terrestrial and aquatic systems (macroinvertebrate, macrophyte and stygofauna) and is to include diversity and abundance assessments;*
- *Details of the results of any models or predictive tools used to predict groundwater drawdown, inflows into the site and impacts on affected water sources and adjacent water users;*
- *Assessment of the potential effects of mining operations on the quality of groundwater both in the short and long term including any pollutants potentially infiltrating into the groundwater sources and proposed waste water disposal methods and approval from the relevant authority;*
- *Demonstration of how the groundwater extraction will be managed within defined limits, so that groundwater levels and quality which are critical for GDEs will not be disrupted and there is sufficient flow to sustain ecological processes and maintain biodiversity;*
- *Protective measures that will minimise any impacts on groundwater sources, connected surface water sources, users and GDEs, including detailed description of measures to isolate the mining operation from Waukivory Creek and its connected alluvium and engineering works necessary to prevent drainage into the mining operation from surface water sources and/or alluvial groundwater sources; and*
- *Determination of critical thresholds for negligible impacts to groundwater sources and GDEs.*

Of the information specified by NOW to be included in the Modification EA, dot point 9 above refers to Waukivory Creek which is understood to be related to the Rocky Hill Coal Project near Gloucester. As Waukivory Creek is not related to the Mt Arthur Coal Mine, this dot point has been taken to refer to the Hunter River.

3.2 Methodology

The objective of the groundwater study was to assess the impact of the Modification on the hydrogeological regime and to meet the applicable DGRs. A scope of work was developed to achieve the objectives that included:

- identification of groundwater resources in the vicinity of the Site which could be impacted by the Modification – namely the Hunter River and Saddlers Creek alluvium; and
- assessment of the potential for any groundwater impacts resulting from the Modification, including modelling the cumulative groundwater impacts of the Modification with existing and proposed mining (including groundwater impacts on each identified privately owned bore).

The hydrogeological conceptual model, calibration and predictive model strategy used in this study has been developed to meet the study objectives and is consistent with that adopted by AGE (2009) for the Mt Arthur Coal Consolidation Project EA, including:

- the inclusion of the Hunter River and Saddlers Creek alluvial sediments and associated river boundary conditions within the model;
- simulation of flux to and from these alluvial bodies during mining predictive model runs;
- the simulation of water table drawdown for assessment of effects on groundwater abstraction and/or groundwater dependent ecosystems (GDEs); and
- prediction of pit inflows resulting from the Modification.

This assessment has been prepared in consideration of the Australian Modelling Guidelines (Barnett *et al*., 2012). A comparison of the model and report against these guidelines is presented in Section 17.

4.0 LEGISLATION, POLICY AND GUIDELINES

The following section outlines NSW State Government legislation, policy and guidelines with respect to groundwater that must be addressed in the assessment and operation of mining proposals.

4.1 Water Act 1912

The *Water Act 1912* (Water Act) governs the issue of water licences from water sources including rivers, lakes and groundwater aquifers in NSW. It also manages the trade of water licences and allocations.

The Water Act is progressively being replaced by the *Water Management Act 2000* (WM Act), but some provisions of the Water Act are still in force where Water Sharing Plans (WSPs) are not in place. This is the case in the bedrock outcrop area where the Modification is located.

Two WSPs have commenced for the Hunter River and groundwater sources that surround the Modification. Water access licences and approvals to take and use water are granted according to the WM Act.

4.2 Water Management Act 2000

The objectives of the WM Act include the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources. It provides relevantly for three types of approvals:

- Management works approvals:
  - water supply work approval;
  - drainable work approval; and
  - flood work approval (section 90 of the WM Act).
- Water use approvals which authorise the use of water at a specified location for a particular purpose, for up to 10 years (section 89 of the WM Act).
- Activity approvals comprising:
  - controlled activity approval; and
  - aquifer interference activity approval.

The WM Act requires that the activities avoid or minimise their impact on the water resource and land degradation, and where possible the land must be rehabilitated (see the Water Management Principles set out in section 5 of the WM Act).

4.3 Water Sharing Plans

4.3.1 Hunter Regulated River Water Sharing Plan

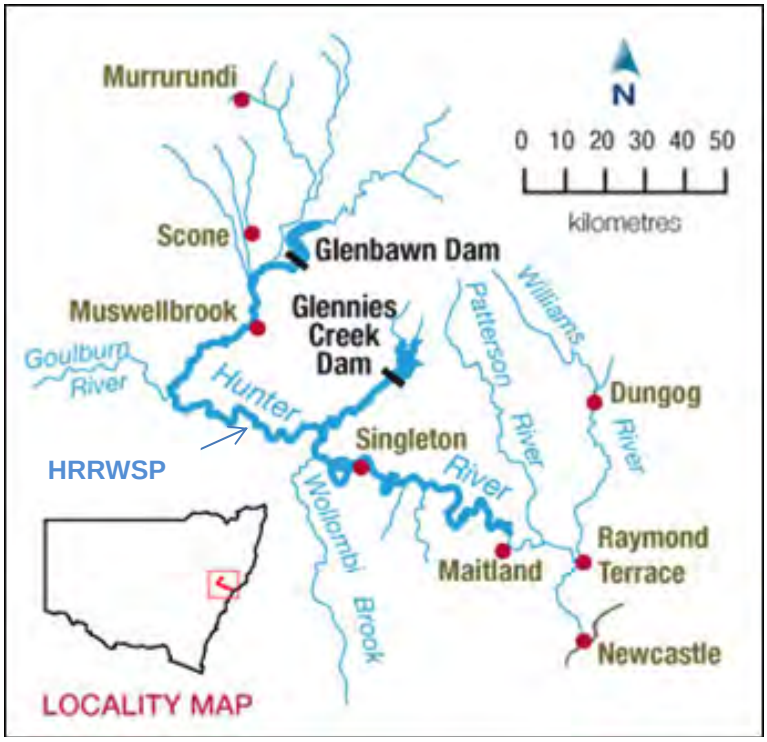
The Hunter Regulated River Water Sharing Plan 2003 (HRRWSP) commenced on 1st July 2004 and applies for a period of 10 years to 30 June 2014. It is a legal document made under the WM Act.

The HRRWSP contains rules for how water is shared between the environment and water users and different categories of licences.

The Hunter River is located in the central eastern area of NSW and drains an area of some 22,000 square kilometres (km^2). The Hunter River originates in the Mount Royal Range north-east of Scone and travels approximately 450 km to the sea at Newcastle. The river is regulated from Glenbawn Dam to Maitland, a distance of about 250 km. Glennies Creek is regulated by Glennies Creek Dam, which also provides water to the lower reaches of the Hunter River. The area to which the WSP applies is shown on Figure 3.

The HRRWSP applies to rivers (and associated alluvial sediments) regulated by Glenbawn and Glennies Creek Dams. The water source is divided into three management zones. These are:

- the Hunter River from Glenbawn Dam to its junction with Glennies Creek;
- the Hunter River downstream of its junction with Glennies Creek; and
- Glennies Creek downstream of Glennies Creek Dam.



Source: NOW (2011).

Figure 3: Locality Map for the Hunter Regulated River Water Sharing Plan

The Project is located within the first Hunter River management zone listed above; this being the Hunter River from Glenbawn Dam to its junction with Glennies Creek.

The vision for the HRRWSP is to achieve a healthy diverse and productive water source and sustainable management for the community, environment, towns, agriculture and industry. The HRRWSP also recognises the significance of water to the Aboriginal community.

The WM Act requires that the sharing of water must protect the water source and its dependent ecosystems and that WSPs establish specific environmental water rules. The environmental water rules are designed to:

- reserve all water volume above a specified limit for the environment;
- ensure that flows in the river do not drop below a prescribed minimum flow rate;
- provide water in Glenbawn and Glennies Creek Dams that can be used for water quality and other environmental management purposes; and
- preserve a portion of natural flows during periods when supplementary water access licences are permitted to extract water.

The HRRWSP provides for domestic and stock rights and native title rights – both forms of basic landholder rights which allow some extraction of water from the river without an access licence. All water extraction, other than basic landholder rights extractions, must be authorised by an access licence.

4.3.2 Hunter Unregulated and Alluvial Water Sources Water Sharing Plan

The Hunter Unregulated and Alluvial Water Sources Water Sharing Plan (HURAWSP) commenced on 1 August 2009 and applies for a period of 10 years to 31 July 2019. It is also a legal document made under the WM Act. Figure 4 displays the area to which the HURAWSP applies.

Source: NOW (2011).

Figure 4: Water Sharing Plan Area for the Hunter Unregulated and Alluvial Water Sources

WSPs for unregulated rivers and groundwater systems (such as the HURAWSP) have been completed using a "macro" or broader scale river catchment or aquifer system approach. Unregulated rivers are those which rely only on natural flow and are not regulated by releases from upstream dams.

The closest unregulated stream to the Modification is Sandy Creek, located about 7 km west of the current Site area.

The HURAWSP set rules for sharing water between the environment and water users and clearly defines shares in available water for licence holders, enabling better water trading opportunities. WSPs support the long-term health of rivers and aquifers by making water available specifically for the environment.

With respect to groundwater, macro WSPs for unregulated rivers may include rules that recognise that some alluvial aquifers are highly connected to their parent streams and in these circumstances, the goal of water sharing rules is to manage the surface water and highly connected groundwater as one resource.

A long-term average annual extraction limit referred to as the Extraction Management Unit applies across an entire catchment area. The limit is a longer term management tool against which total extraction will be monitored and managed over the 10-year life of the plan. The rules in the plan that determine when licence holders can and cannot pump on a daily basis are more specific. Basic landholder rights (i.e. extraction of a "reasonable use" volume of surface or groundwater for stock or domestic supply) do not require a water access licence, however, water access licences are required for mining activities where these activities intercept an unregulated river or connected aquifer water.

The HURAWSP includes alluvial sediments not covered by the HRRWSP.

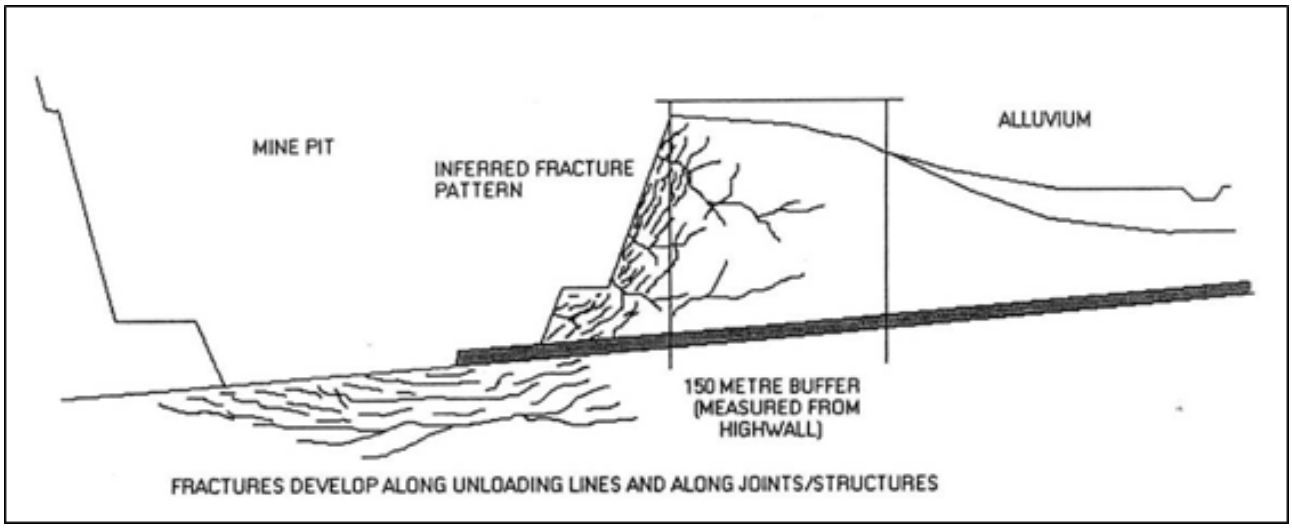
4.4 Buffer Zone Guidelines

Guidelines were prepared for the Hunter Region in April 2005, by the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR, 2005) (now the DP&I) to assist the coal mining industry in managing risks when mining close to streams using either longwall or open cut mining methods. The guidelines relate to the classification of the stream that may be impacted by mining.

The guidelines provide a range of assessment and management criteria for each stream classification. This range is developed on the basis of:

- A checklist for minor stream systems (Schedule 1) with monitoring and remediation procedures to minimise the extent of damage which occurs to them.
- A notification system for significant stream systems (Schedule 2) to the department, so that an agreed monitoring and management regime can be developed for the stream system involved.
- A precautionary stance for primary rivers (Schedule 3), subject to environmental assessment which can demonstrate that the impact on those rivers and associated alluvial groundwaters can be minimised.

Based on the management guidelines, the Hunter River system is classified as a Schedule 3 stream/river. The guideline document indicates that the NOW is adopting a precautionary approach to mining in the vicinity of Schedule 3 streams and associated alluvial groundwater, involving a buffer between the mining area and the stream. The guideline requires a buffer of 150 metres (m) between an open cut mining area and the stream and its related alluvium, as shown on Figure 5.



Source: DIPNR (2005).

Figure 5: Buffer Zone Requirement for Open Cut Mining Operations Next to Rivers/Alluvium

In accordance with the Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments:

> *Mining (other than that already approved in the MAN EIS) will not extend beyond a nominal 150 m buffer zone from the Hunter River Alluvials until agreement is reached with NOW regarding the installation of a lower permeability barrier along the point of connections of mining and the alluvium or other appropriate safeguards.*

5.0 PREVIOUS STUDIES

5.1 Summary of Recent Studies

A number of previous studies have been undertaken within the Mt Arthur Coal Mine and surrounds dating back to 1979. The two most recent studies, both of which are highly relevant to the modification application, were undertaken in support of the MAU Project and the Mt Arthur Coal Consolidation Project approvals. The reports were prepared by Mackie Environmental Research Pty Ltd (MER) (2007) and AGE (2009) for the Underground and Consolidation Projects respectively.

MER (2007) conducted a groundwater impact assessment of multi-seam, longwall extraction, to obtain approval for the proposed MAU Project. A regional finite element groundwater model comprising 13 layers was developed incorporating each target seam and including the Hunter River and Saddlers Creek alluvium. Total groundwater seepage to the underground operations is predicted to steadily increase over the period of mining from 0.5 megalitres per day (ML/day) during entry and development of the Woodlands Hill Seam, to a maximum 6 ML/day at completion of mining in the deeper Piercefield Seam. Vertical leakage from the Hunter River alluvium due to depressurisation of the coal seam was predicted to remain unchanged whereas vertical leakage from the Saddlers Creek alluvium may be affected with a reduction in upward leakage from the coal seams of 0.08 ML/day. Recovery of groundwater levels post mining was predicted to take 50 years.

AGE (2009) conducted a study for the groundwater impact assessment as part of the Mt Arthur Coal Consolidation Project EA. A regional finite element groundwater model comprising eight model layers was developed which included the Hunter River and Saddlers Creek alluvium. Simulated groundwater inflow to the Northern Open Cut is predicted to rise from 0.85 ML/day to 2.45 ML/day between 2009 and 2016 and stabilise in the latter part of mining at about 2.4 ML/day. Simulated groundwater inflow to Saddlers Pit is predicted to stabilise after 2011 at a relatively constant rate of 0.15ML/day and leakage of groundwater from the Hunter River alluvial aquifer is predicted to be about 0.74 ML/day at the end of mining in 2022, with the alluvial aquifer affected over a length of approximately 6 km.

Both of these documents provide a summary of the historical studies undertaken at the Site in prior years and both rely to some extent on the data obtained from the earlier investigations. Section 9 provides a summary of the groundwater regime of the Site based on these reports, and a summary of the findings and conclusions of each report. Where newly available data (e.g. groundwater levels) are available, data sets have been updated.

5.2 Summary of Relevant Historical Studies

The earliest study cited was undertaken by Australian Groundwater Consultants Pty Ltd (AGC) in 1979 for the Electricity Commission of NSW. The investigation included:

- “packer” permeability tests at 10.54 m intervals to 216 m depth on a deep borehole;
- three falling head tests to obtain comparative permeability data; and
- two airlift/recovery type hydraulic tests.

The overall objective was to obtain data on the hydraulic characteristics of the stratigraphic profile in order to provide an assessment of groundwater inflow to a 2 km shallow strip mining operation at the Northern Open Cut. The seams of interest were the Vaux, Bayswater, Edinglassie and Ramrod Creek.

In August 1980 AGC revised and extended the prediction of groundwater inflow to take into consideration changes to the proposed mining areas, including a shallow pit north of Whites Creek and a deep pit north of Mt Arthur. An assessment was also undertaken of dewatering using deep boreholes and the potential impact of dewatering on the Hunter River alluvium. The Hunter River alluvium was also broadly considered as a water supply source.

AGC also undertook a groundwater investigation for the Mt Arthur South Coal Project in 1981 and the data obtained from this report is summarised by Sinclair Knight and Partners (SKP) in 1981. The AGC (1981) report assessed inflow to the pits and the potential to obtain a groundwater supply for coal processing.

Laurie Montgomerie and Petit Pty Ltd undertook a groundwater investigation for the Mt Arthur North Coal Project in 1982. The report summarises the results of a long-term pumping test and describes numerical modelling of the coal seam aquifer in Whites Creek and Ramrod Creek Pits using assumed borefield dewatering networks.

A groundwater study for the Mt Arthur North Coal Project and surrounding areas was undertaken by MER in March 2000 as part of an Environmental Impact Statement (EIS) prepared by Coal Operations Australia Limited (2000). The study included review of existing information, field investigations, groundwater monitoring, sampling and analysis. Additional monitoring piezometers were constructed as part of the studies and a composite piezometric surface was developed for the region. Historical and more recent hydraulic properties and hydrochemistry of groundwaters were summarised and a mathematical groundwater model of the aquifer systems was developed to assess the impact of open cut mining on the groundwater regime.

AGE (2003) completed a preliminary assessment of potential risks and constraints associated with groundwater for a proposed multi-seam underground mining operations within the Site. Inflow assessments were based on hydraulic properties reported from previous investigations and the proposed mine plan. It was assessed that inflow could range from 1.5 ML/day (17 litres per second [L/s]) from the shallow Glen Munro Seam to 0.14 ML/day (1.7 L/s) for the deep Edinglassie Seam, with cumulative inflow to the Edinglassie Seam from all overlying seams, assuming a top-down mining sequence of the seams, and goaf interconnections of the mined seams, of 3.6 ML/day (42 L/s). The maximum radius of influence of seam depressurisation was predicted to be 3.25 km from the perimeter of the mined area.

In March 2006 AGE completed an internal groundwater impact assessment for Mt Arthur Coal on the Northern Open Cut's impact on the groundwater regime (AGE, 2006a), particularly the Hunter River and Saddlers Creek alluvium, and to assess future inflows to the pits. A three-dimensional, transient, finite element model was developed with predictive modelling indicating a peak inflow rate of 2.9 ML/day at year 7, declining and stabilising at 1.5 ML/day at year 10. The model indicated an area of impact of about 3.2 km^2 of Hunter River alluvium after 21 years with flow rates from the alluvium to the pits of 0.47 ML/day (5.4 L/s), comparable to the annual rainfall recharge rate on that area of alluvium. Similarly the model indicated a reduced recharge to Saddlers Creek of 0.04 ML/day to 0.07 ML/day.

In July 2006, AGE undertook a groundwater impact assessment of the proposed South Pit Extension using a regional finite element model (AGE, 2006b). The study which was undertaken to obtain project approval found that the impact of the South Pit Extension will be overprinted during most of the mine life by dewatering of the adjacent Northern Open Cut Pit. Simulated groundwater inflow to the pit was of the order of 0.3 ML/day after 21 years of mining and the radius of depressurisation from the pit crest was predicted to be 1 km to 1.5 km.

All of the studies discussed in Section 5 have been considered in undertaking the current assessment.

6.0 METHODOLOGY

The methodology adopted for assessing the groundwater impact of the Modification is outlined below:

- Data review:
  - Updated mine plans were supplied by HVEC for the Years 2016, 2018 and 2022. The updated pit shells for Years 2016, 2018 and 2022 reflect the current mine development schedule to a finer detail than those available during the AGE (2009) study. In addition to these updated mine plans, HVEC provided a new mine plan covering the Modification (Year 2026).
  - Updated groundwater monitoring data and climate data available since the AGE (2009) groundwater impact assessment was reviewed. The updated groundwater monitoring bore level data and climate data was used for model verification purposes.

- Conceptual groundwater model development:
  - The conceptual hydrogeological model developed during the Mt Arthur Coal Consolidation Project (AGE, 2009) was reviewed. It was assessed that no further work was required to revise or re-conceptualise the groundwater regime and that the AGE (2009) conceptual hydrogeological model is still current and relevant to this study (Section 9).

- Verification of the AGE (2009) model:
  - The AGE (2009) model was verified against the latest available transient groundwater level data. The verification was carried out to determine if the model required recalibration prior to any numerical model refinement and predictions for the Modification. The verification determined that the 2009 model parameterisation was adequate for prediction of the Modification and that recalibration was not necessary (Section 12.7).

- Numerical modelling:
  - The three-dimensional numerical model developed and calibrated during the AGE (2009) study was used as a basis for the Modification assessment. This approach was adopted as the verification identified that the model calibration completed in 2009 was valid for the pre-mining steady state and that the model was fit for purpose for the Modification.
  - Model mesh refinement was carried out within the Modification Area and the newly available mine plan data (i.e. mine plans for years 2016, 2018, 2022 and 2026) was incorporated into the predictive scenarios.
  - Assessment and reporting criteria for the predictive scenarios were maintained as close as possible to those of the 2009 study for comparison purposes, these being:
    - changes in groundwater fluxes to the Hunter River and Saddlers Creek alluvial groundwater systems;
    - monitoring of drawdowns with relation to alluvial groundwater systems and surrounding groundwater users; and
    - prediction of pit inflows and inflows to the underground.

7.0 REGIONAL SETTING

7.1 Location

The Mt Arthur Coal Mine is located in the Upper Hunter Valley of NSW approximately 5 km south-west of Muswellbrook (Figure 1). The Mining Leases, Coal Lease, Consolidated Coal Lease, Mining Purposes Lease and sub-leases are located south of the Hunter River (Figures 1 and 2). The Site is bounded by Denman Road to the north-west and Thomas Mitchell Drive to the north-east.

7.2 Surrounding Mining Operations

The existing Bengalla Mine is located to the north of the Mt Arthur Coal Mine (Figures 6 and 7). The existing Drayton Mine is located to the south-east of the Mt Arthur Coal Mine (Figure 7). These mines occupy undulating hillslopes, similar in agricultural land use to the Site. Further to the south-west lies the Mount Ogilvie exploration area. Coal mining activities associated with the Bengalla Mine are located approximately 3 km to the north of the Site (Figure 7). The approved Mt Pleasant Mine is located on the northern side of the Bengalla Mine, approximately 4 km north of the Northern Open Cut northern Site boundary. Currently approval is being sought for the Drayton South mine located to the south of Saddlers Creek and for an extension to the Bengalla Mine.

7.3 Topography and Drainage

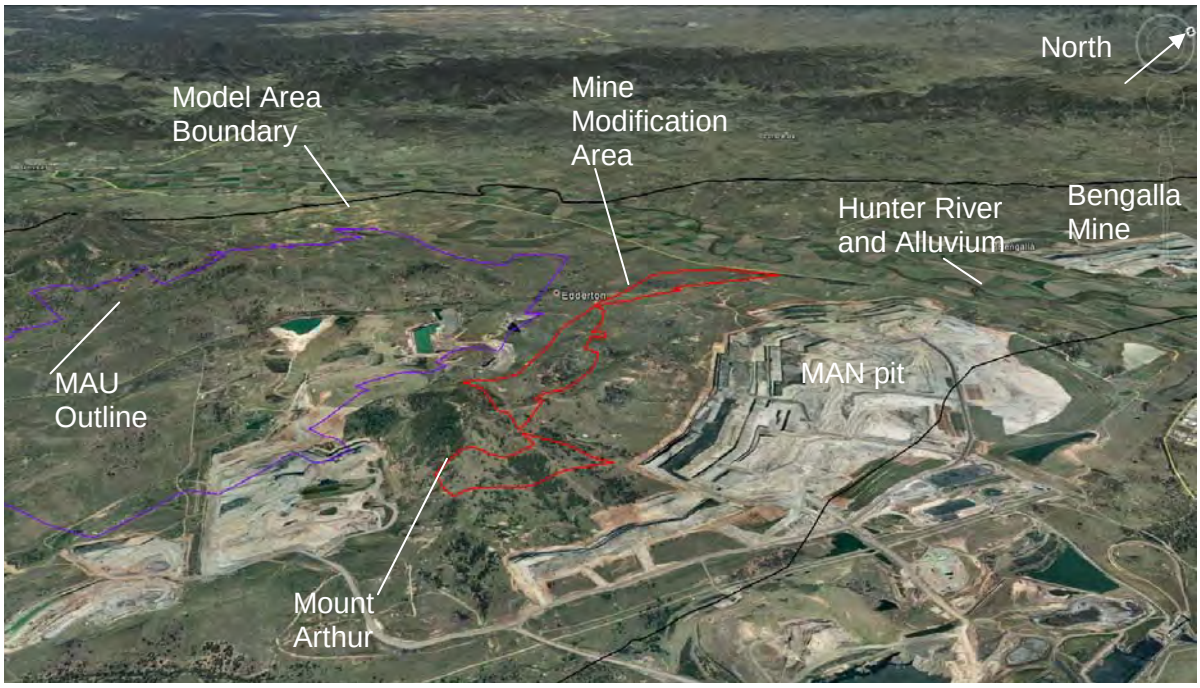
The topography of the Site is gently undulating, steepening in the south-eastern corner near the base of Mount Arthur. Surface elevations vary from approximately 140 m Australian Height Datum (AHD) along Denman Rd to the north of the Modification Area and up to 482 m AHD at Mount Arthur.

Surface drainage generally comprises ephemeral creeks with headwaters within the Modification Area flowing north and south-westwards, ultimately draining into the Hunter River. Quarry Creek, Ramrod Creek, Fairford Creek, Whites Creek and several small unnamed creeks flow northwards into the Hunter River on the northern side of the existing mining operations. Saddlers Creek has its headwaters in the south of the Modification Area. Saddlers Creek flows generally to the south-west (Figure 1) and joins the Hunter River downstream of Denman. The extension of the Northern Open Cut associated with the Modification is above the recorded 1955 flood level, which is estimated to be equivalent to a 100 year average recurrence interval event (Gilbert & Associates, 2012).

The Hunter River flows all year round and discharges into the Port of Newcastle approximately 170 km downstream of the Site. The Hunter River flows at Muswellbrook are regulated by discharges from the Glenbawn Dam.

7.4 Land Use

Land use other than coal mining in the local area includes residential and rural residential dwellings and industrial operations, while alluvial lands near the Hunter River are utilised for crop production including vineyards and orchards, thoroughbred breeding and cattle grazing. Much of the surrounding lands have been cleared of original vegetation cover and are predominantly grassland. Areas of original and remnant vegetation are scattered throughout the Modification Area especially on Mount Arthur, within the upper portion of Saddlers Creek Catchment and in the western portions of the Modification Area.



Source: Google Earth.

Figure 6: Three-Dimensional View of Mt Arthur Coal Mine

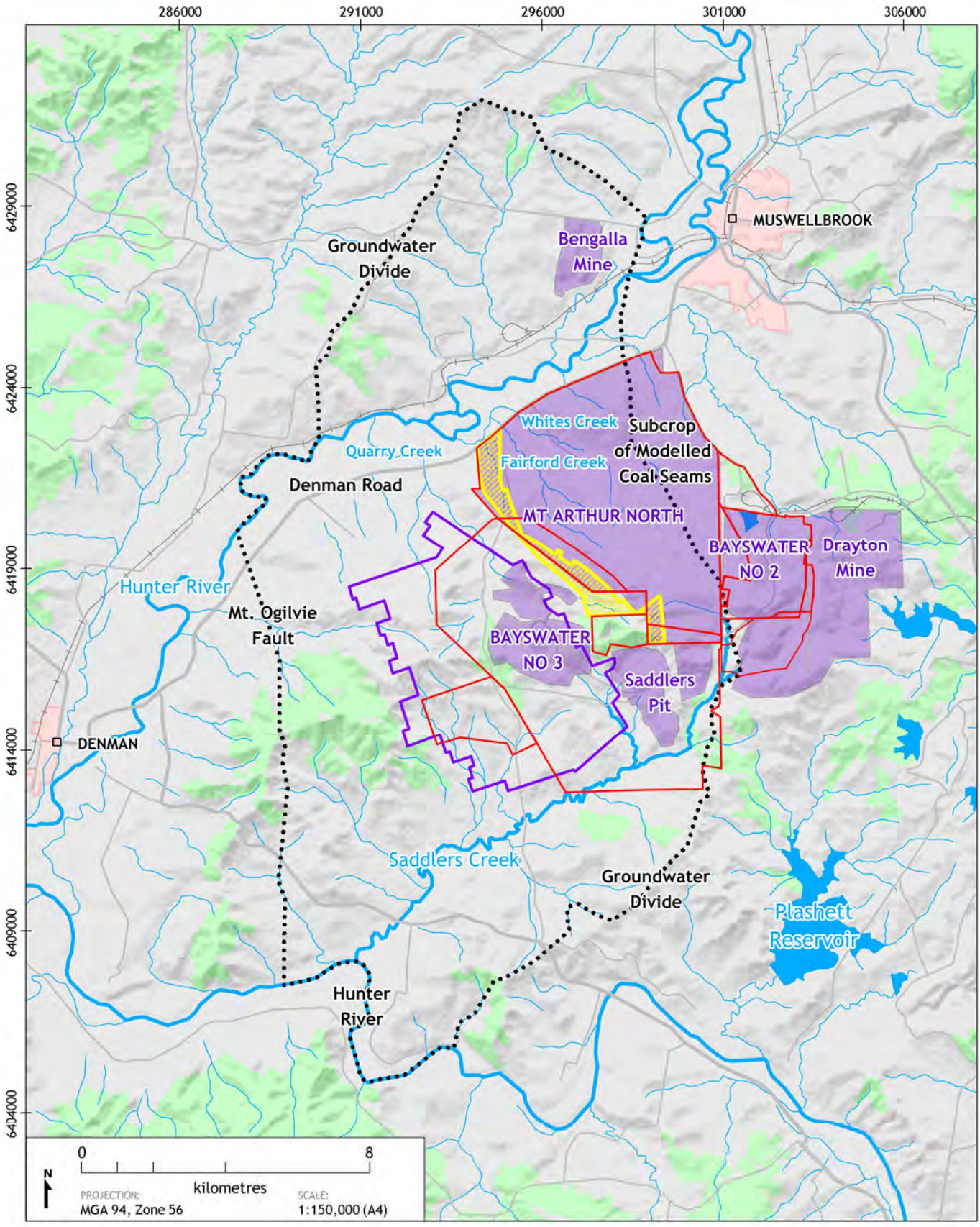
7.5 Climate

The climate in the Mt Arthur Coal Mine is typical of temperate areas and is characterised by hot summers featuring thunderstorms and mild dry winters. Statistical data of mean monthly temperatures are available from Jerrys Plains Station. The mean maximum temperature during winter varies in the range of 17.4 to 19.4 degrees Celsius (°C) and in summer, the mean maximum daily temperature reaches 31.7°C (January). The average annual rainfall is 645 millimetres (mm), with January being the wettest month (76.8 mm). Evaporation of 1,642 millimetres per year (mm/year) exceeds mean rainfall throughout the year, the highest moisture deficit occurring during summer. Average monthly rainfall for Jerry Plains Post Office meteorological station shows summer dominated rainfall (Table 1).

Table 1: AVERAGE MONTHLY PRECIPITATION JERRYS PLAINS POST OFFICE (061086) (1884 to 2012)

Month	Rainfall (mm)
January	77
February	73
March	59
April	44
May	41
June	48
July	44
August	37
September	42
October	52
November	61
December	68

Source: Bureau of Meteorology (BoM) (2012).



LEGEND:

- Mt Arthur Coal Mining & Coal Lease Boundary
- Mine Modification Area
- Existing Mine Area
- Model Boundary
- Mt Arthur Underground
- Road/Track
- Rail
- Town
- Reservoir/Lake
- River
- Creek
- Native Vegetation

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Existing Mine Leases and Conceptual Model Area

DATE: 23/1/2013

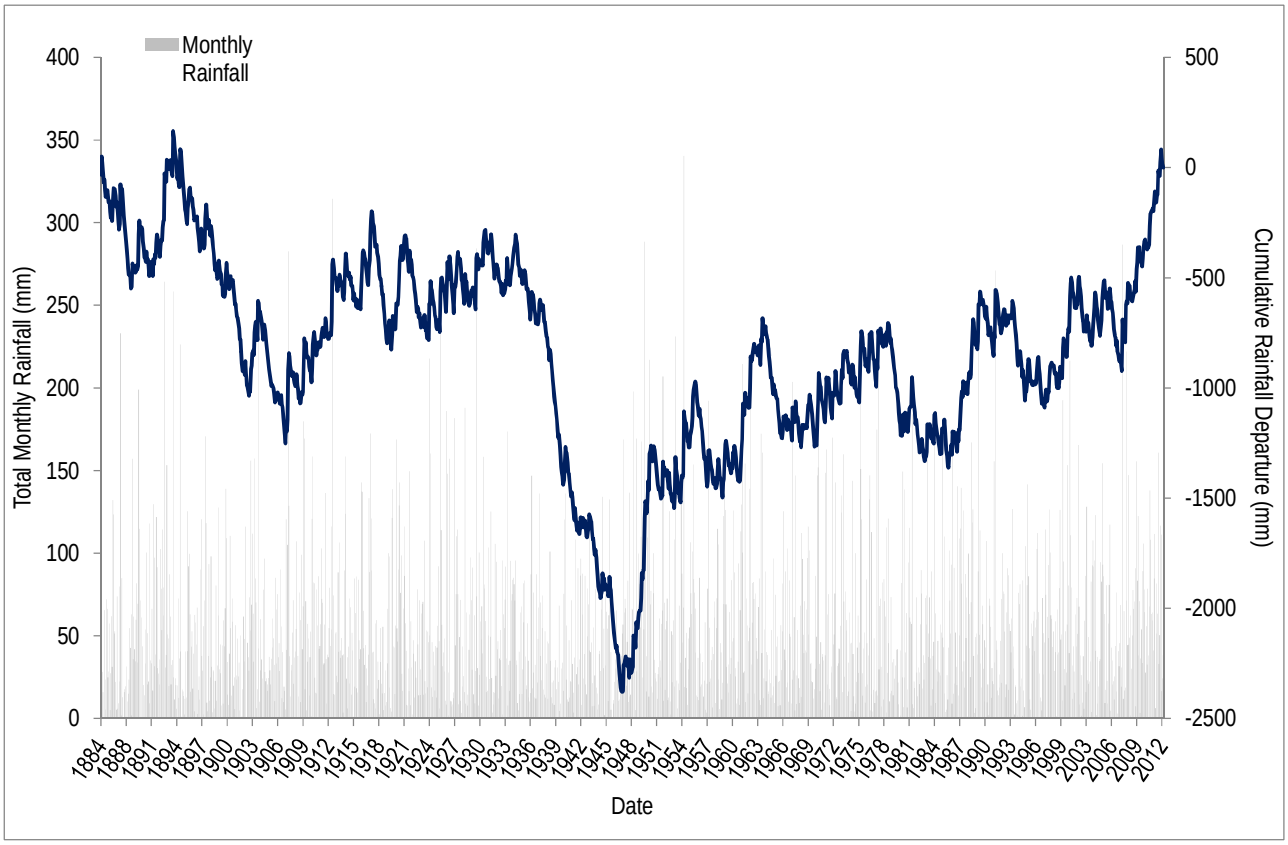
FIGURE No: 7

In order to place recent rainfall years into an historical context the Cumulative Rainfall Departure (CRD), which is a summation of the monthly departures of rainfall from the long-term average monthly rainfall, was calculated as follows:

$$CRD_n = CRD_{n-1} + (R_n - R_{av})$$

Where:	CRD_n	=	CRD for a given month
	CRD_{n-1}	=	CRD for a preceding month
	R_{av}	=	long-term average rainfall
	R_n	=	actual rainfall for given month

The average monthly rainfall used to produce the CRD graph was obtained from the BoM, Jerrys Plains Post Office (061086), which has a continuous record for the period 1884-2012. A positive slope in the CRD plot indicates periods of above average rainfall, whilst a negative slope indicates periods when rainfall is below average. The CRD from 1884-2012 shown on Figure 8 indicates that the Site area experienced a long period of generally above average rainfall from January 2007 until the present.



Source: BoM (2012)

Figure 8: Jerrys Plains Post Office (061086) Monthly Rainfall Data and CRD

8.0 Geology

8.1 Stratigraphy

The stratigraphic sequence across the Mt Arthur Coal Mine comprises two distinct units, namely a Permian coal seam sequence with an overburden and interburden consisting of lithic sandstone, interbedded with siltstone, tuffaceous claystone and mudstone. The Permian sediments are unconformably overlain by thin Quaternary alluvial deposits. The Quaternary alluvial deposits consist of sand and gravel along the creek valleys within the Mt Arthur Coal Mine, and in the alluvial floodplain of the Hunter River to the north.

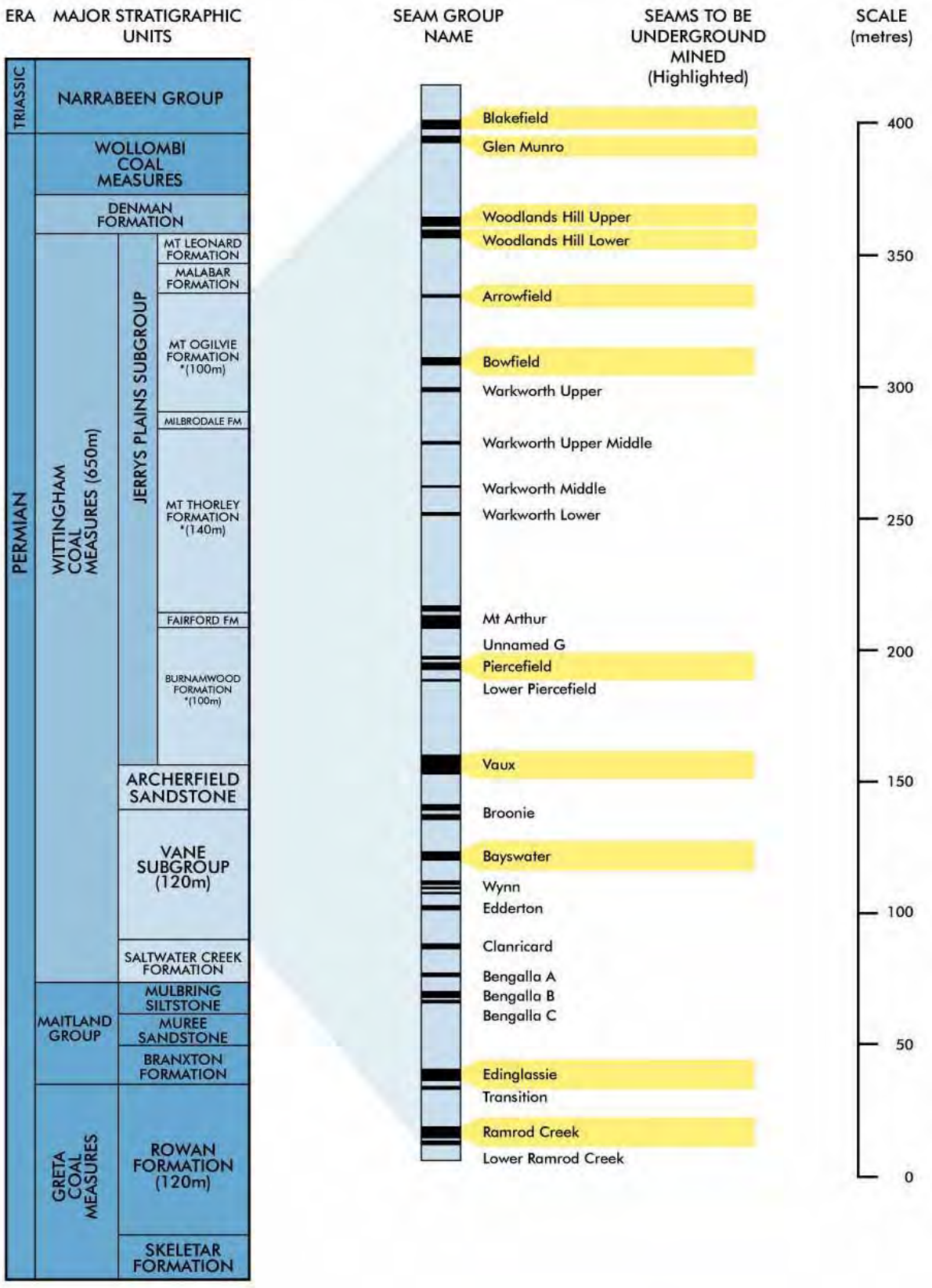
The Permian rocks form a regular layered sedimentary sequence dipping to the west-south-west consisting of the following two main units:

- The Wollombi Coal Measures that, within the Mt Arthur Coal Mine, contain uneconomic coal seams and are confined to isolated portions of elevated sections of the Mount Ogilvie area. These measures are typically above the groundwater table.
- The Wittingham Coal Measures that contain economic coal seams and underlie the whole of the Mt Arthur Coal Mine to a maximum depth of about 500 m.

The Wittingham Coal Measures which include the basal Saltwater Creek Formation are underlain by a thick, non-coal bearing sequence of siltstone, sandstone and mudstone known as the Maitland Group which in turn overlies the Greta Coal Measures. Both the Wittingham Coal Measures and the Maitland Group outcrop in the eastern part of the Site. The Greta Coal Measures outcrop at the closed Bayswater No. 2 Mine and at Drayton Mine where they are currently being mined. A general stratigraphic section for the Site area is given on Figure 9.

The coal seams within the Jerrys Plains and Vane Subgroups of the Wittingham Coal Measures are to be mined as part of the Modification. A summary of the seams and interburden and their average thicknesses are presented in Table 2. The data referring to the thickness of the seams and interburden are based on information received from HVEC. The total thickness of the coal measures is 200 to 220 m.

Igneous intrusions within the Site occur mainly as dolerite dykes generally 0.5 to 1 m in width. These intrusions selectively intrude the coal seams in localised areas. Occurrences of igneous sills, recorded at Mt Arthur South and in the upper seams of the MAU, are not expected to be significant in the Site (URS, 2000).



Source: HVEC.

Figure 9: Stratigraphic Column

Table 2: DETAILS OF SEAMS BEING MINED BY HVEC			
Seam Name	**Thickness (m)**		**Interburden to Underlying Seam (m)**
	Range	*Average*	*Average*
Blakefield	0.2-5.6	3.8	54
Glen Munro	0.2-5.6	2.7	34
Woodlands Hill	0.2-7.5	3.6	33
Arrowfield	0.1-3.7	2.3	20
Bowfield	0.4-4.7	2.5	14
Mt Arthur		4.5	5
Unnamed 1		< 1	10
Piercefield	0.4-5.4	2.3	26
Vaux	0.5-4.5	4	20
Broonie	1-1.5	1.3	13
Bayswater	0.5-4.8	2.8	10
Wynn		<1	5
Unnamed 2		1	5
Edderton		2	10
Clanricard	1.5-2.0	1.8	10
Bengalla	<3.5	2.5	10
Edinglassie	3.0-4.8	3.9[1]	30
Ramrod Creek	<8.5	6.5	-

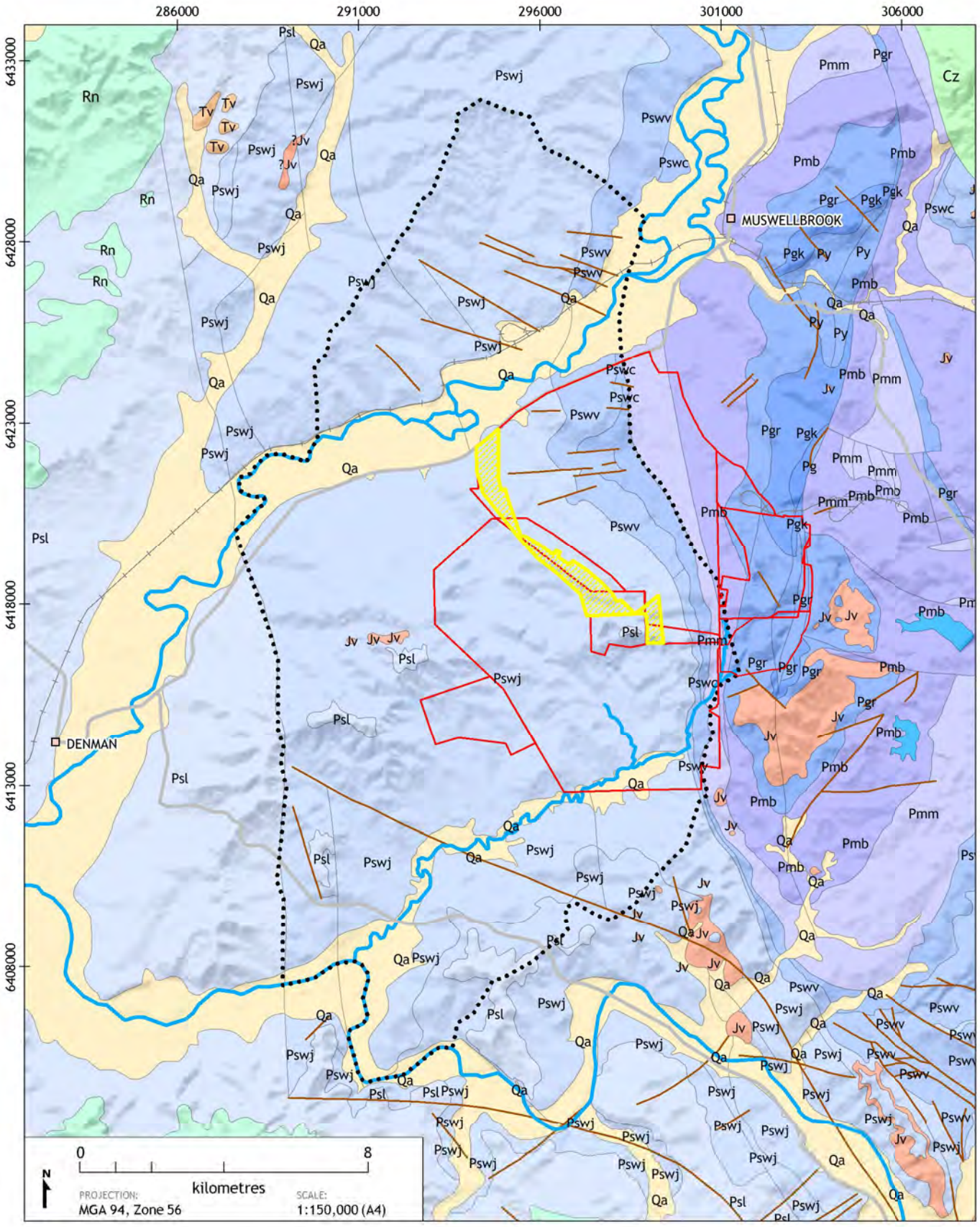
[1] Information received from HVEC.

The mapped 100,000 scale geology of the Site is shown in Figure 10. The geology map shows the distribution of the Quaternary Alluvium which is confined in 1 to 2 km strips associated with the Hunter River and its associated tributaries. The remainder of the area comprises Permian lithologies with minor outcrop of Jurassic aged volcanic rocks.

8.2 Structure

The Modification is located to the west of the Muswellbrook Anticline where the seams sub-crop (Figure 11). The coal seam sub-crop continues to the north of the Modification beneath the Quaternary Alluvium of the Hunter River. The Wittingham Coal Measures dip to the west-southwest towards the Calool Syncline.

The regional geological structure is dominated by a north-south trending monocline and open cut mining has generally been located to the north-east and east of the monocline but will extend to the west as part of the Modification.



LEGEND:

Mine Modification Area

Model Boundary

Mt Arthur Coal Mining & Coal Lease Boundary

100K Geology

- Qa - Quaternary Alluvium
- TV - Tertiary Basalt
- Rn - Hawkesbury Sandstone, Narrabeen G.
- Psl - Wollombi Coal Measures
- Pswj - Denman F., Jerrys Plains Subgroup
- Pswv - Archerfield Ss., Vane Subgroup
- Pswc - Saltwater Creek Formation
- Pmm - Mulbring Siltstone
- Pms - Muree Sandstone
- Pmb - Braxton Formation
- Pgr - Greta Coal Measures
- Pgk - Greta Coal Measures
- Cz - Tuff and Ignimbrite
- Water

Fault

Town

Road

Rail

River

Geology based on 1:100,000 Hunter Coalfield Regional Geology

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Geology Map and Major Structures

DATE: 23/1/2013

FIGURE No: 10

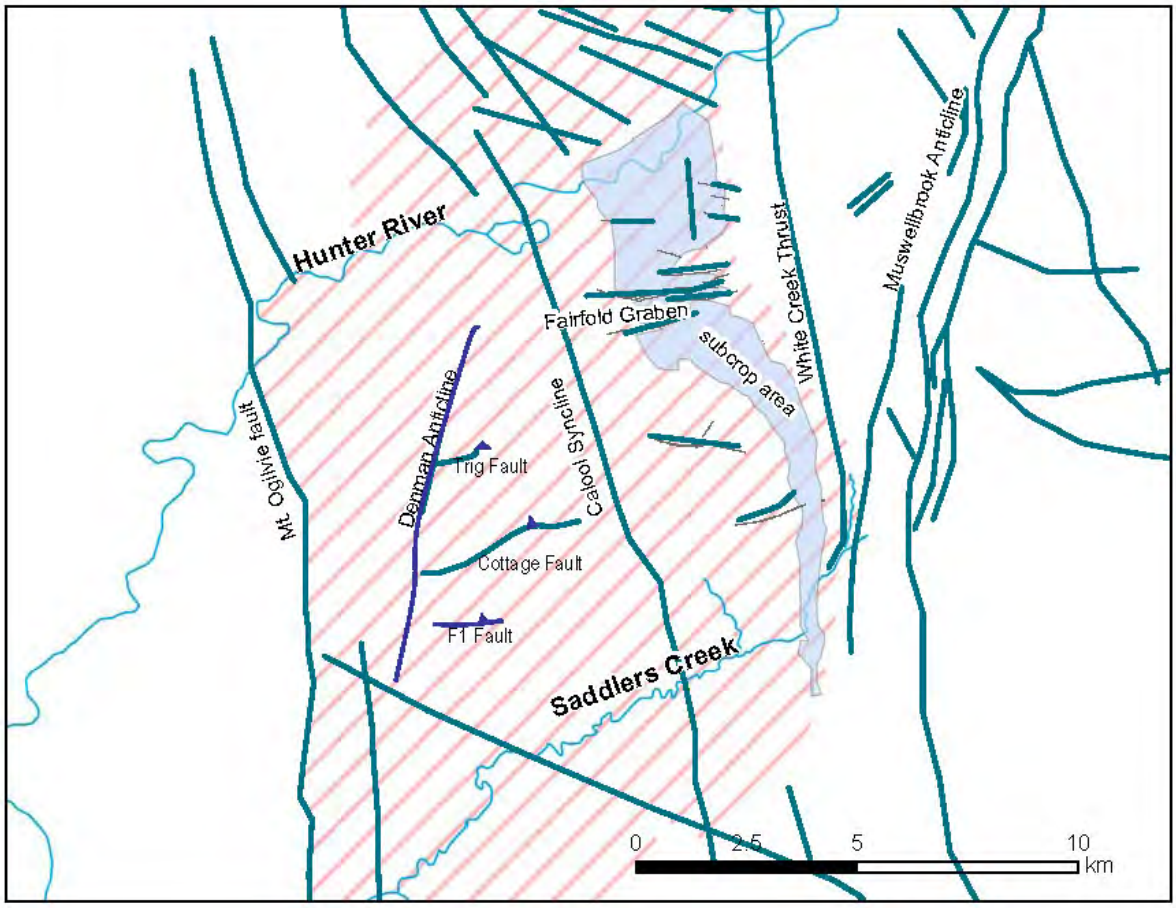


Figure 11: Overview of Main Faults and Structures within Mt Arthur Coal Mine and Surrounds

Major faulting within the Site area is infrequent, however several faults have been identified from the studies undertaken (Figure 11), including:

- An east-west trending graben structure: the Fairford Graben located in the central part of Mt Arthur Coal Mine Pit which varies in width from 750 to 1,000 m and which displaces coal seams by up to 110 m. North of the Fairford Graben, the dip of the seams varies between 2 and 10 degrees (º) with an average dip of about 8º. To the south, the dip varies between 2 to 20º.
- The northerly trending Mount Ogilvie Fault Zone in the west of the Modification, which is significant in that it exhibits a regional displacement (down-throw to the west) of 200 m. The Mount Ogilvie Fault forms a structural boundary to the west of the Mt Arthur Coal Mine.
- North-easterly trending faults including:
  - Trigg Fault which has a displacement varying from 0 m to about 40 m, east to west;
  - Cottage Fault which has a displacement varying from 0 m at the eastern (MacDonald's Pit) end up to 120 m at the western end; and
  - F1 Fault which has a displacement of 20 m to 45 m, east to west.
- The F4 Fault which strikes east-west from the current highwall beneath the Hunter River alluvium east-west.

8.3 Leakage from Faults

There is potential for leakage from the Hunter River alluvium from faults that may occur beneath the alluvium. The identified F4 fault strikes east-west from the current highwall beneath the Hunter River alluvium. In consideration of this, AGE was commissioned by HVEC to undertake a hydrogeological investigation of the F4 Fault to confirm or otherwise the risks to mining imposed by the fault. An interim report was prepared by AGE (2011) which provides a preliminary assessment of the fault based on the work undertaken. A summary of the work undertaken and conclusion reached is given below:

Available details from drill holes and other observations made within the current highwall alignment indicate that the F4 Fault:

- *is visible within the upper northern end section of the current highwall configuration with minor displacement observed;*
- *dips between 63° and 73° the south;*
- *exhibits multiple areas of displacement suggesting splay faulting and potentially a relatively complex structure;*
- *exhibits a vertical displacement which increases from less than 1m where exposed in the current highwall, up to 30m adjacent to Denman Road;*
- *contains areas of fault gouge and possible zones of brecciation, with sympathetic minor faulting interpreted in conjunction with the major fault alignment; and*
- *may contribute to the groundwater flows measured whilst drilling which ranged from 0.3L/sec to 3L/sec (measured over a V–notch weir).*

…

In May 2011, Mt Arthur Coal in conjunction with AGE commenced a drilling program to characterise the properties of the F4 Fault structure and the overlying Hunter River Alluvium. The objectives of this field investigation program were to:

- *define the structure and hydraulic conductivity of the fault zone within the field area;*
- *define the nature of the alluvial sediments; and*
- *establish a Vibrating Wire Piezometer (VWP) network for long-term monitoring of prominent coal seam aquifers and fault zones.*

…

To achieve these objectives, the scope of work for the field investigations included:

- *drilling three fault exploration holes to confirm the location and depth of the F4 Fault;*
- *packer testing at selected intervals within each drill hole; and*
- *installation of nested (multiple) VWPs in each exploration hole.*

A series of packer tests were conducted on the fault zones, interburden and coal seams. Analysis of this permeability testing indicates the interburden, F4 Fault Zone and Splay Fault Zone sequences to be of low to very low permeability, with the coal seam permeability at least one order of magnitude higher.

Based on these preliminary results, it would appear that the F4 Fault is highly unlikely to act as a conduit for groundwater flow from the alluvium.

9.0 HYDROGEOLOGICAL REGIME

9.1 Groundwater Use

A search of the NOW database of registered bores and wells within a radius of approximately 5 km from the Mr Arthur Coal Mine was undertaken. The data indicates that there are 50 registered bores within this radius as shown on Figure 12 and tabulated in Appendix 1. This compares to 32 bores found for a similar radius search in the AGE (2009) study. The registered bores include one bore licensed for domestic, two for stock and irrigation supply, 13 for stock and domestic only, 22 for stock supplies only, six for domestic, irrigation and stock, two for monitoring and four unknown.

Fifteen of the bores are thought to be in the Hunter River alluvium based on their location and depth. The remaining 35 bores are located in sandstone, conglomerate, siltstone or coal of the Permian strata. Sixteen of the bores are located on HVEC owned land (three in alluvium), five located on Bengalla Mine owned land (three in alluvium) and the remainder on privately-owned land of which nine are in alluvium.

The database gives an indication of groundwater usage in the vicinity of the Site. The data suggests that groundwater from the Permian groundwater systems is used primarily for stock use whereas those bores in the alluvial flats are used for a combination of irrigation, stock and domestic supply.

There are no registered bores in the alluvium of Saddlers Creek.

9.2 Conceptualisation Summary

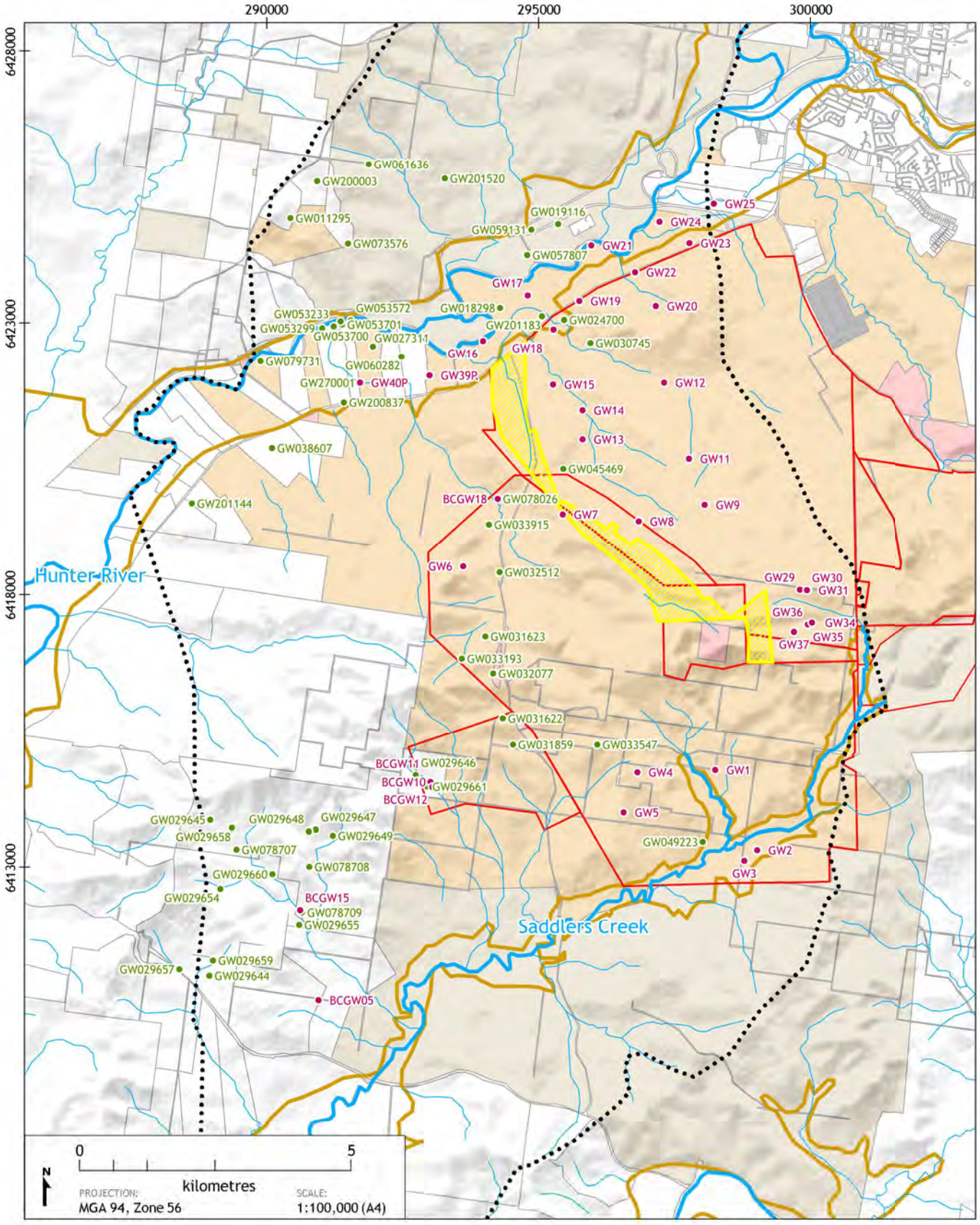
The conceptual groundwater model of the Modification was developed based on geological and topographical maps of the Site area, geological information provided by HVEC, hydraulic information and on the results of previous studies, namely MER (2007) and AGE (2009).

Alluvial deposits in the region are present along the Hunter River and also along Saddlers Creek. The Permian Wittingham Coal Measures are typically not considered an aquifer. While some coal seams have elevated hydraulic conductivities, the dominant interburden sections are of very low hydraulic conductivity. Only the weathered bedrock (regolith) directly below the ground surface may have a somewhat higher hydraulic conductivity due to weathering. Therefore, from a conceptual groundwater model perspective, the groundwater system in the Mt Arthur Coal Mine model area is considered to consist of three groundwater systems, including:

- alluvium along the Hunter River and Saddlers Creek;
- weathered bedrock (regolith); and
- the coal seams of the Permian Wittingham Coal Measures.

Recharge to the groundwater systems is assumed to occur over the entire model area. The rate of recharge over the alluvial deposits and areas of coal seam sub-crops is considered to be higher than over the areas covered by the overburden and interburden.

The following sections characterise the different groundwater systems and discuss the underlying data.



LEGEND:

- Mt Arthur Coal Mining & Coal Lease Boundary
- Mine Modification Area
- Model Boundary
- NOW Registered Bore
- Groundwater Monitoring Bore
- Alluvium
- River
- Creek
- Crown Land / The State of NSW
- HVEC Owned Land
- Industrial Zone
- Mine Owned Land
- Private Owned Land

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Monitoring Bore and NOW Registered Bore Location

DATE: 23/1/2013

FIGURE No: 12

9.3 Alluvium

9.3.1 Distribution

Deposits of unconsolidated silts, sand and minor fine gravels of mixed colluvial-alluvial origin occur in the valleys of the creeks and gullies within the model area. These deposits are thin and of limited extent, and hence do not have significant groundwater storage capacity. They may contain groundwater which has infiltrated from surface runoff following periods of heavy rainfall and discharge of this groundwater from the alluvium maintains baseflow in the creeks and gullies following rainfall. The alluvium however drains quickly and discharge/baseflow to the creeks is of short duration.

To better understand the nature of the alluvial sediments along Whites Creek and Fairford Creek, a series of test pits and boreholes were completed in 2009 (AGE, 2009). This investigation identified a narrow band of alluvium extending between 200 and 350 m to the south-east along Whites and Fairford Creeks respectively, and that in the down-gradient end of the creeks, the alluvium is saturated and in hydraulic connection with the Hunter River alluvium. The sediments in the upper part of the creeks however consist predominantly of silty to sandy clays which typically form an aquitard and hence do not readily transmit groundwater. The extent of these alluvial sediments along the Whites Creek and Fairford Creek drainage alignments is similar to that shown by MER (2007).

Farm dams have been constructed on many of the creeks within the model area indicating that the alluvium is both of very low permeability and is thin, otherwise the dams would leak and not retain water. Field investigations have shown that the upper part of the Saddlers Creek valley is in-filled with the less permeable unconsolidated silts.

In contrast, the alluvial deposits of the Hunter River to the immediate north of the Site are a significant source of groundwater. The distribution of the alluvium is shown on Figures 10 and 12. MER (2000) reviewed available data from existing stock and irrigation bores in the Hunter River alluvium and constructed five monitoring bores (MGW1-5). These were subsequently renamed by Mt Arthur Coal as GW16, GW17, GW21, GW24 and GW25. The data indicated that groundwater within the alluvial lands of the Hunter River occurs within the basal gravel sequence and overlying sands.

The Hunter River alluvium is up to 13 m thick and contains basal gravel varying between about 2.5 and 4 m in thickness. The material overlying the basal gravel consists predominantly of silt with minor clay. Water bearing sand lenses occur within the silt. The saturated thickness of the alluvium in bores GW16, 17, GW21, GW24 and GW25 ranged from 2 to 6 m (MER, 2000).

9.3.2 Hydraulic Parameters

Pumping tests on bores GW16, GW17, GW21, GW24 and GW25 by MER (2000) indicate that the basal gravel of the Hunter River alluvium has a moderate to high hydraulic conductivity in the range 5 metres per day (m/day) to 40 m/day, with a median value of 8.2 m/day. Values determined at other locations in the model area range from 2 m/day to more than 60 m/day. The data suggests a highly variable and anisotropic hydraulic conductivity distribution in the alluvium.

9.3.3 Yield

Due to the relatively thin saturated thickness of the alluvium, bore yields are generally quite low; the higher yielding bores being those with the greatest saturated thickness. MER (2000) undertook pumping tests on the five monitoring bores (GW16, GW17, GW21, GW24 and GW25) at rates of around 0.25 L/s, with the drawdown in individual bores varying between 0.01 and 0.97 m. Yields from larger diameter production bores within the alluvium are likely to be greater.

9.3.4 Groundwater Levels and Hydraulic Gradients

Groundwater levels in the Saddlers Creek and Hunter River alluvium have been recorded bi-monthly from February 2008 to present. The position of all monitoring bores is shown in Figure 12 with bores GW16, GW17, GW18, GW21, GW24 and GW25 monitoring the Hunter River alluvium and bores GW2 and GW3 monitoring the Saddlers Creek alluvium.

Generally water levels in the Hunter River and Saddlers Creek alluvium are approximately 8 to 10 m below ground level. Levels remained fairly static for the period 2008 to present. Groundwater levels are discussed in relation to post and current mining activities in Section 10.

There are no nested piezometers measuring both alluvial groundwater levels and those in the underlying Permian formations. Therefore no information is available on pre-mining vertical hydraulic gradients.

9.3.5 Regional and Local Recharge, Discharge and Groundwater Flow

Recharge to the alluvium is likely to occur from direct infiltration of rainfall, and runoff from elevated bedrock sub-crop areas. Apart from infiltration of rainfall and runoff from elevated areas, the alluvium along the Hunter River is potentially recharged during very dry periods from flow in the Hunter River. Release of water from Glenbawn Dam upstream of the Site maintains flow in the river.

Interflow may occur from thin, limited alluvial deposits associated with minor ephemeral streams, and this flow may lead to short lived perched groundwater bodies that drain rapidly to downstream alluvium, creeks and gullies.

Upward leakage of poorer quality water from the underlying coal measures also adds to recharge of the Hunter River alluvium, and to the Saddlers Creek baseflow.

MER (2000) states that groundwater within the alluvium indicates a shallow hydraulic gradient towards the Hunter River, and this is consistent with the regional hydraulic gradient. That is the hydraulic gradient from the edge of the alluvium appears to be consistent with that of the coal seams and with the overall gradient in the Northern Open Cut area. The alluvial water table also has a general downstream hydraulic gradient coinciding with the topographic gradient of the alluvium and flow of the Hunter River.

9.3.6 Water Quality

HVEC monitors groundwater quality of the Hunter River alluvium in monitoring bores GW16, GW17, GW21, GW24 and GW25. This has occurred since their installation in January 1999.

The data indicates that the groundwater quality, as reflected by the Electrical Conductivity (EC), is quite variable, in the range 1,500 to 9,370 microSiemens per centimetre (µS/cm). The EC range within individual bores is similarly quite large and probably reflects the dominant recharge source at the time, that is, recharge from the underlying coal measures resulting in poorer quality water, or recharge from rainfall or the river itself, resulting in slightly improved quality water.

The pH ranges from 6.7 to about 7.6, that is, from slightly acid to slightly alkaline.

Monitoring data indicates the surface water in Saddlers Creek is brackish and this is supported by observations made during a Site visit by AGE in December 2005. The brackish surface water indicates a potential discharge source from the underlying Permian coal measures.

A summary of laboratory analysis of samples collected from alluvial bores is presented in Table 3 below. The table shows indicative values prior to commencement of mining at the Northern Open Cut and more recent 2012 EC results.

Table 3 : GROUNDWATER QUALITY-ALLUVIUM

Location	Hunter River					
	Bore GW16		Bore GW21		Bore GW25	
	Mar. 1999	Jun. 2012	Mar. 1999	Jun. 2012	Mar. 1999	Jun. 2012
Electrical Conductivity (µS/cm)	3,810	3,480	3,111	1040	5,780	5,260
Sodium	440	-	390	-	840	-
Magnesium	140	-	86	-	160	-
Potassium	1.8	-	3.7	-	2.5	-
Calcium	145	-	110	-	145	-
Chloride	690	-	470	-	1,130	-
Bicarbonate	400	-	680	-	560	-
Iron	0.02	<0.05	0.05	0.14	0.03	0.4
Manganese	-	-	0.11	-	-	-
Phosphorus	0.2	-	0.1	-	0.2	-

Note: all results other than EC expressed in milligrams per litre mg/L.

The data are compared to Australian and New Zealand Environment Conservation Council (2000) guidelines for “livestock” and for “potable” (human consumption) use. Given that groundwater in the alluvium is unsuitable for human consumption in most locations due to salinity in that it exceeds 500 mg/L total dissolved solids (TDS) and has localised, relatively high iron concentrations, the environmental value has been classified as “primary industry”, with the main use being for irrigation and stock watering. The environmental value of localised areas, such as swamps or more deeply incised channels (if any) across the floodplain with permanent water holes, could be classified as “aquatic ecosystems”.

9.3.7 Groundwater Dependent Ecosystems

No groundwater dependent vegetation comprising GDEs occurs within the Modification Area or immediate surrounds (Hunter Eco, 2012).

9.4 Shallow Bedrock (Regolith)

The regolith or shallow bedrock groundwater systems comprises surficial soils and weathered bedrock. The depth of the profile is variable and depends on such factors as:

- depth of weathering; and
- extent and frequency of fracturing.

Interpretation of available data indicates that there is perched groundwater at the interface between the soil and bedrock, and zones of locally increased permeability caused by weathering of the bedrock. MER (2000) states that the transition of the surficial mixed colluvial-alluvial type deposits to underlying weathered coal measures is often difficult to define in areas where coarse clastics occur and the depth of weathering is significant.

MER (2007) states that the rainfall recharge to other shallow groundwater systems situated in elevated areas including the weathered rock zone or regolith, is often variable. The coal measures in these areas tend to weather to a relatively thin regolith (5 to 10 m thick), comprising mixed sandy, silty-clayey sediments. These silty-clay zones have poor transmission characteristics but the sandy areas offer increased potential for groundwater recharge.

The regolith acts as a potential temporary water store during sustained wet periods and provides a potential source for recharge to the underlying coal measures. However, the very low hydraulic conductivities of deeper strata and observed minimal change in water levels in deep monitoring bores throughout the region infers recharge to the underlying coal measures is limited (discussed further in Section 9.5). This differentiation in properties between the regolith and underlying coal measures can sometimes result in the presence of shallow springs, although few are noted within the Mt Arthur Coal Mine Site.

The conceptual groundwater model represents the shallow bedrock groundwater system as a zone of enhanced hydraulic conductivity compared to the Permian coal measures.

9.5 Permian

The Permian strata may be categorised into the following hydrogeological units:

- hydrogeologically “tight” and hence very low yielding to essentially dry sandstone and lesser siltstone that comprise the majority of the Permian interburden/overburden; and
- low to moderately permeable coal seams which are the prime water bearing strata within the Permian sequence.

9.5.1 Distribution

As discussed, the Permian deposits occur across the whole of the Site as a regular layered sedimentary sequence.

9.5.2 Hydraulic Parameters

Various tests including pump-out, variable head and packer tests have been undertaken in the past. Packer tests indicate that the hydraulic conductivity of the interburden varies between 5.2×10^{-3} m/day to 8.6×10^{-5} m/day, and that the coal seam hydraulic conductivity varies between 0.01 to 0.69 m/day. In contrast, pumping tests gave unusually high hydraulic conductivity values for the coal seams in the range of 2 to 20 m/day, which is more characteristic of a fine to coarse sand.

A reduction in the hydraulic conductivity of the coal seams with depth is observed in many coal mines. AGC (1984) developed an equation based on the interpretation of depth-dependent hydraulic conductivities of 17 seams in the Upper Hunter Valley as shown below:

$$k = k_o * e^{(-cz)}$$

where:

k	=	hydraulic conductivity [m/day]
k_o	=	reference hydraulic conductivity = 5 [m/day]
c	=	slope of trendline (0.046 for Hunter Valley coal seams)
z	=	depth [m]
e	=	base of the natural logarithm (approximately 2.71828182846)

Therefore even if very high hydraulic conductivities are indicated by the pumping tests within the sub-crop area, much lower values can be expected at greater depths.

Coal Operations Australia Limited (2000) states that laboratory permeability tests on core samples yielded a vertical hydraulic conductivity range of the interburden between 1.8×10^{-4} m/day and 1×10^{-7} m/day.

Applying the above equation allows prediction of the value of hydraulic conductivity of the interburden for different depths.

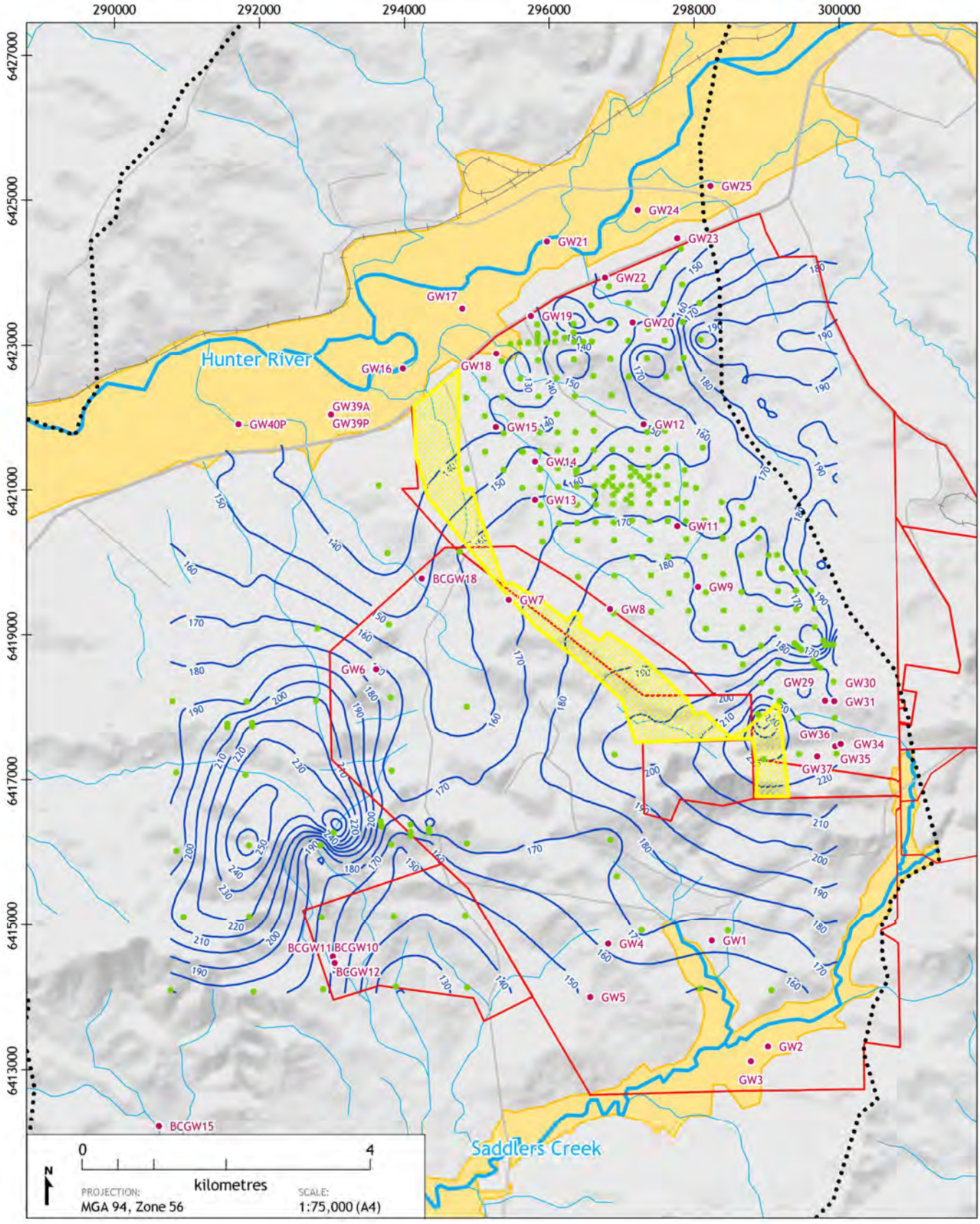
9.5.3 Yields

A number of hydraulic tests have been undertaken on various coal seams within the Mt Arthur Coal Mine study area in the past. The tests indicate that yields from individual bores within the coal seams are in the range of 1 to 3.3 L/s, which is considered to be high given the depth of the tested sections of the seam.

9.5.4 Groundwater Levels and Hydraulic Gradients

A groundwater level (potentiometric) surface contour map was developed by AGE (2009) from water levels measured by HVEC in open exploration holes, as well as in dedicated monitoring bores (Figure 13). The map indicates that the potentiometric surface is a subdued reflection of the topography, with a groundwater mound beneath the topographically elevated areas of the ridgeline between Mount Arthur and Mount Ogilvie, and a hydraulic gradient towards the Hunter River valley to the north, and Saddlers Creek to the south.

Groundwater levels and hydraulic gradients are discussed in Section 10, using available water level data for the current mine development.



LEGEND:

- Mt Arthur Coal Mining & Coal Lease Boundary
- Mine Modification Area
- Model Boundary
- Groundwater Level Contour Premining (mAHD)
- Groundwater Level Measurement
- Groundwater Monitoring Bore
- River
- Creek
- Alluvium
- Road/Track
- Rail

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Interpreted Groundwater Table

DATE: 23/1/2013

FIGURE No: 13

9.5.5 Regional and Local Recharge, Discharge and Groundwater Flow

Groundwater recharge is considered likely to occur by rainfall infiltration via the regolith. Groundwater flow occurs toward the lower lying areas where discharge occurs into the alluvial valleys and creeks/rivers.

9.5.6 Water Quality

Table 4 provides pre-mining water quality data from boreholes intersecting coal seams and from samples collected from a sump within a box cut. The table indicates that the TDS content ranges from about 1,750 to 7,760 mg/L and that the pH is generally alkaline at about 8. The data shows that groundwater in the Permian is of poor quality and is typical of coal seam water quality.

The general low yield and poor quality of the groundwater in the coal seams indicates that the environmental value can be classified as “primary industry” with the main potential use being for stock watering.

Table 4: PRE-MINING GROUNDWATER QUALITY-PERMIAN GROUNDWATER SYSTEMS

Location	Bore K15	Bore WB1	ID1014A (GW8)	ID1049 (GW12)	ID1030 (GW19)	Box Cut West
	Dec. 1980	Jan. 1981	Feb. 1999	Feb. 1999	Feb. 1999	Feb. 1999
pH (unit)	8.6	8.1	-	-	-	-
Electrical Conductivity (µS/cm)	8,950	7,005	-	-	-	-
Total Dissolved Solids	6,560	5,370	3,340	6,500	1,750	7,760
Hardness as $CaCO_3$	235	1,000	-	-	-	180
Sodium	2,440	1,640	860	1,500	350	2,100
Potassium	9	15	20	13.5	13	18.5
Calcium	39	95	72	155	36	17.5
Magnesium	32	190	245	380	38	460
Chloride	3,174	2,045	1,100	2,500	450	3,460
Bicarbonate	826	1,390	1,250	730	650	620
Sulfate	250	590	-	-	-	-
Iron	<0.01	<0.01	-	-	1.04	-
Manganese	<0.01	0.63	0.02	0.28	0.28	-
Nitrate	0.4	0.53	-	-	-	-
Phosphorus	-	-	0.2	0.3	0.2	0.2

Source: SKP (1981); MER (2000).

Notes: Bore name in brackets e.g. (GW8) is new monitoring bore name adopted by HVEC.
All concentration in mg/L unless otherwise stated.
$CaCO_3$ = calcium carbonate.

10.0 IMPACT OF MINING TO DATE

This section provides an assessment of the current impact of open cut mining at the Mt Arthur Coal Mine on the groundwater resources of the Hunter River alluvium and the Permian coal measures. The assessment is based on an analysis of the groundwater monitoring data obtained from monitoring bores located around the Site. The depressurisation effects observed in Permian coal measures may also be used to infer hydraulic conditions for the groundwater system, a surrogate for nested piezometers within the three main hydro-stratigraphic units (alluvium, regolith, Permian). The monitoring bore locations are shown on Figures 12 and 13.

10.1 Impact of Mining on Hunter River Alluvium

10.1.1 Hydrographs

Monitoring of groundwater levels in the Hunter River alluvium to the immediate area north of the Northern Open Cut has been undertaken since January 1999. Monitoring has also been undertaken in the Permian coal measures from two bores located in the zone between the edge of the alluvium and the limit of current and proposed future mining. The bores monitored that are of relevance to this report are summarised in Table 5, their locations are shown on Figure 12, and the hydrographs are shown on Figure 14.

Table 5: MONITORING BORES ALONG THE HUNTER RIVER

Bore	Location		Elevation	Depth	Formation
	(mE)	(mN)	(mRL)	(mbGL)	
GW16	294,082.9	6,422,888.3	131.77	13	Alluvium
GW21	296,069.6	6,424,639.2	136.06	16	Alluvium
GW25	298,323.8	6,425,403.7	140.05	13	Alluvium
GW22	296,870.7	6,424,147.7	154.05	96.3	Permian
GW23	297,870.3	6,424,683.8	181.40	51.4	Permian

Note: mE = metres Easting
mN = metres Northing
mRL = metres relative level
mbGL = metres below ground level

The hydrographs of bores GW16, GW21 and GW25 indicate that alluvial groundwater levels have remained relatively constant since monitoring commenced in 1999. The fluctuations do not correspond to the CRD which would be expected of a predominantly rainfall recharged alluvial groundwater system. This indicates some buffering of the alluvial groundwater levels by the potentially interconnected Hunter River.

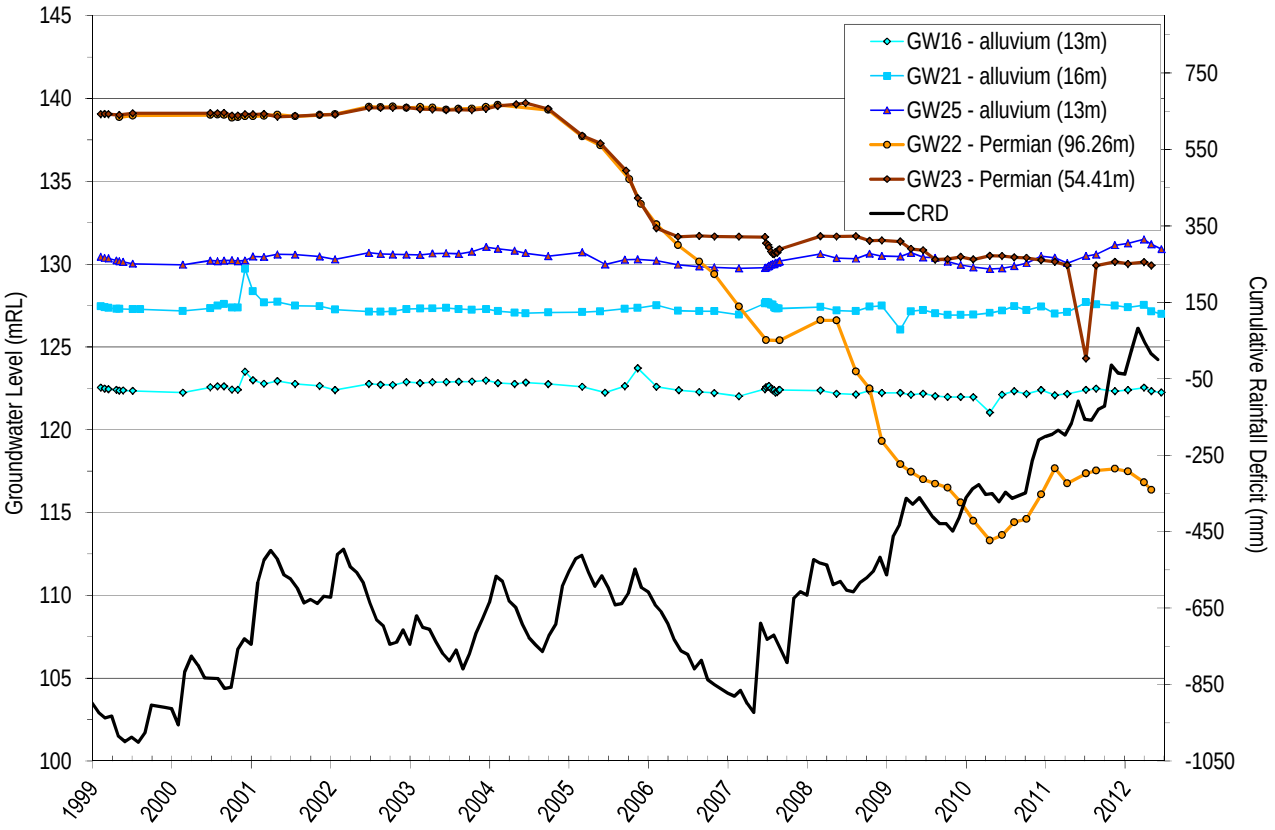


Figure 14: Hydrographs of Selected Monitoring Bores along the Hunter River

In contrast, the Permian coal measures show significant depressurisation with the piezometric surface declining by about 26 m in the deepest bore GW22 (96.3 m deep), until April 2010, with a recovery of about 4 m from that time until the present. There is also a decline of about 15 m in the shallower bore GW23 (54.4 m deep), commencing in mid-2004, with the most rapid decline of 5.7 m occurring since April 2011, although this has subsequently recovered during early 2012. Between 1999 and mid-2004, the potentiometric surface of the coal measures was at about 139 mRL, indicating groundwater discharge from the brackish Permian groundwater systems to the alluvium where the water table varies between 131 mRL (upstream at GW25) to 125 mRL (downstream at GW16). However, due to depressurisation, the potentiometric surface in GW22 and GW23 is currently at 117.3 mRL and 130 mRL respectively, which is lower than the alluvial water table surface, and the potential is for a reversal of groundwater flow from the alluvium to the Northern Open Cut.

The decline in the piezometric surface at the Permian monitoring bores commenced in 2004, and it was at this time that HVEC commenced box cutting in the northern area of the lease in preparation for mining the adjoining Macleans Hill. It is reported that the box cut was reasonably wet at the time of development. As discussed, the water table in the alluvium has remained static and the data suggests that there has been no impact on the alluvium as a consequence of depressurising the Permian coal measures.

10.1.2 Electrical Conductivity

Monitoring of EC of the alluvium and Permian coal measure groundwaters also occurs and is presented graphically in Figure 15. The EC indicates that the groundwater in the alluvial bores and in the Permian coal measure bores is of poor quality ranging from about 3,000 to 9,000 µS/cm (EC in GW21 ranges from about 1,000 to 5,000 µS/cm).

The base of the alluvium generally contains poor quality water potentially due to discharge from the coal seams, however if this were to be reversed, that is flow is from the alluvium to the pits as a result of depressurisation, it would be expected that the water quality at the base of the alluvium and in the Permian coal measure monitoring bores would improve, that is the EC would decrease. Figure 15 indicates that this may be occurring in the alluvial bores as shown by the trendlines of GW16, GW21 and GW25.

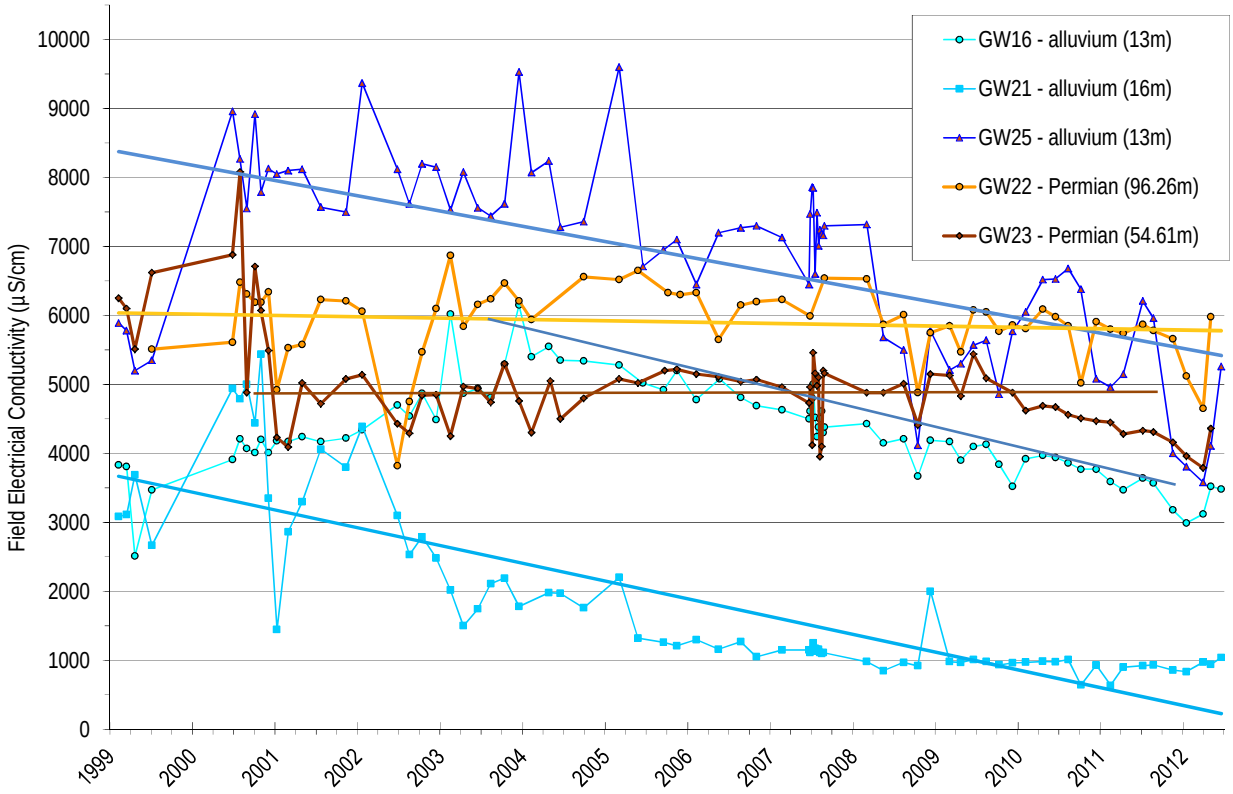


Figure 15: Electrical Conductivity Trends of Monitoring Bores

10.2 Impact of Mining on Saddlers Creek Alluvium

Two bores monitoring the Permian sequence below Saddlers Creek indicates that there is minor long term depressurisation to mid-2011 (approximately 3 m) of the Permian coal measures underlying the Saddlers Creek alluvium (Figure 16). The depressurisation is associated with mining at Saddlers Pit and provides broad confirmation of the modelling undertaken by AGE (2009) which indicates no drawdown in the alluvium of the creek, but states that there will be minor leakage from the alluvium due to depressurisation of the underlying Permian. Recovery is noted in water levels since mid-2011.

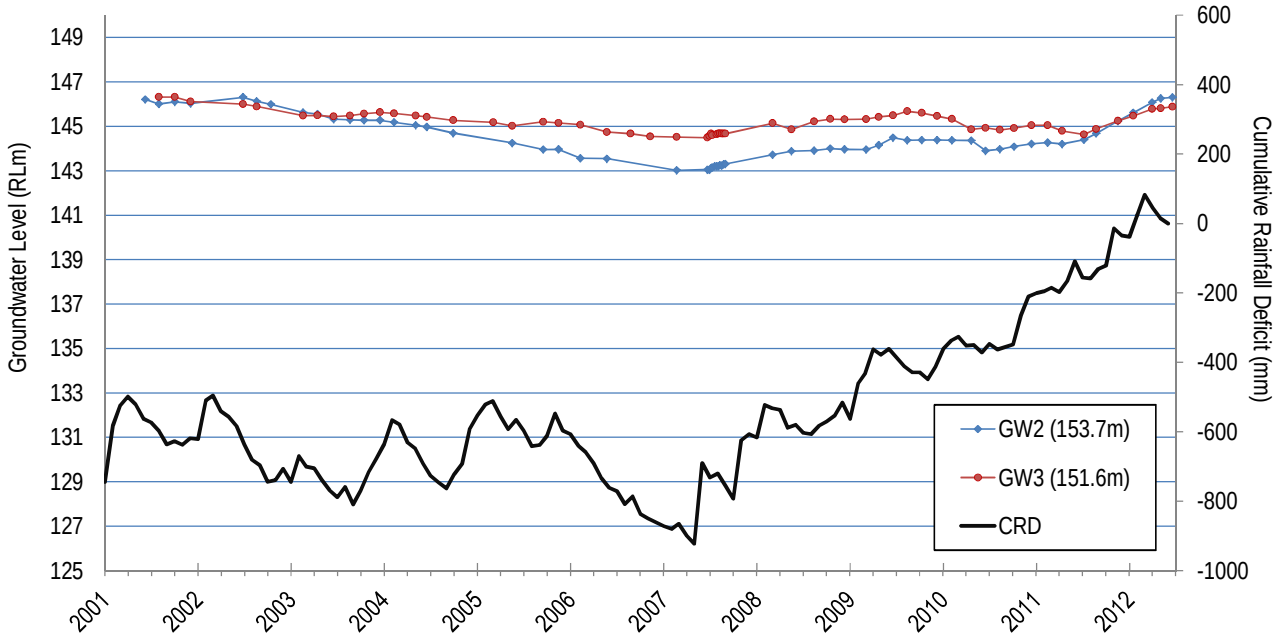


Figure 16: Hydrographs of Permian Coal Measures Monitoring Bores-Saddlers Creek

10.3 Impact of Mining on Permian Coal Measures

Depressurisation of the coal seams in the areas to the north-west and south-south-east of the current open cut mining operation is evident from the hydrographs of monitoring bores established in the Permian coal measures (Figures 17 and 18). Figure 17 indicates significant depressurisation in bores monitored ahead of the highwall advancement with groundwater levels/pressure declining by up to 70 m in bore GW8 and to a slightly lesser extent in bores GW13 and GW15[1]. It should be noted that Figure 17 indicates that there has been no decline of groundwater levels/pressure in bore GW7 (depth of which is unknown). It is suspected that this bore may have collapsed or is blocked.

Figure 18 indicates a similar decline in groundwater level/pressure in the south-south-east of up to 50 m. The hydrographs show some recovery before declining again and levelling out, suggesting that the pit has probably reached its maximum depth at this location. Bores GW35 and GW36 were destroyed by mining in June 2009 while no access was possible to GW37 from November 2011.

[1] No recent data is available for bore GW13 and GW15.

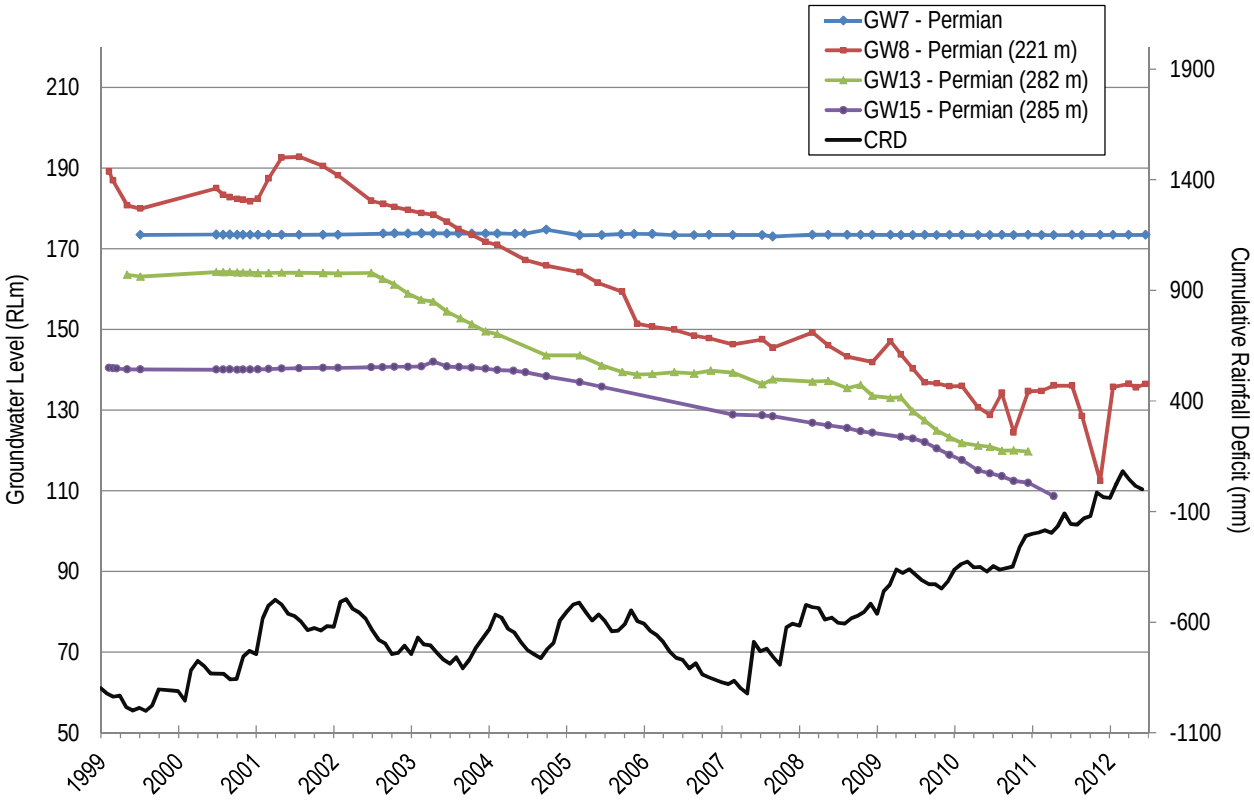


Figure 17: Hydrographs of Permian Coal Measures Monitoring Bores – North-West

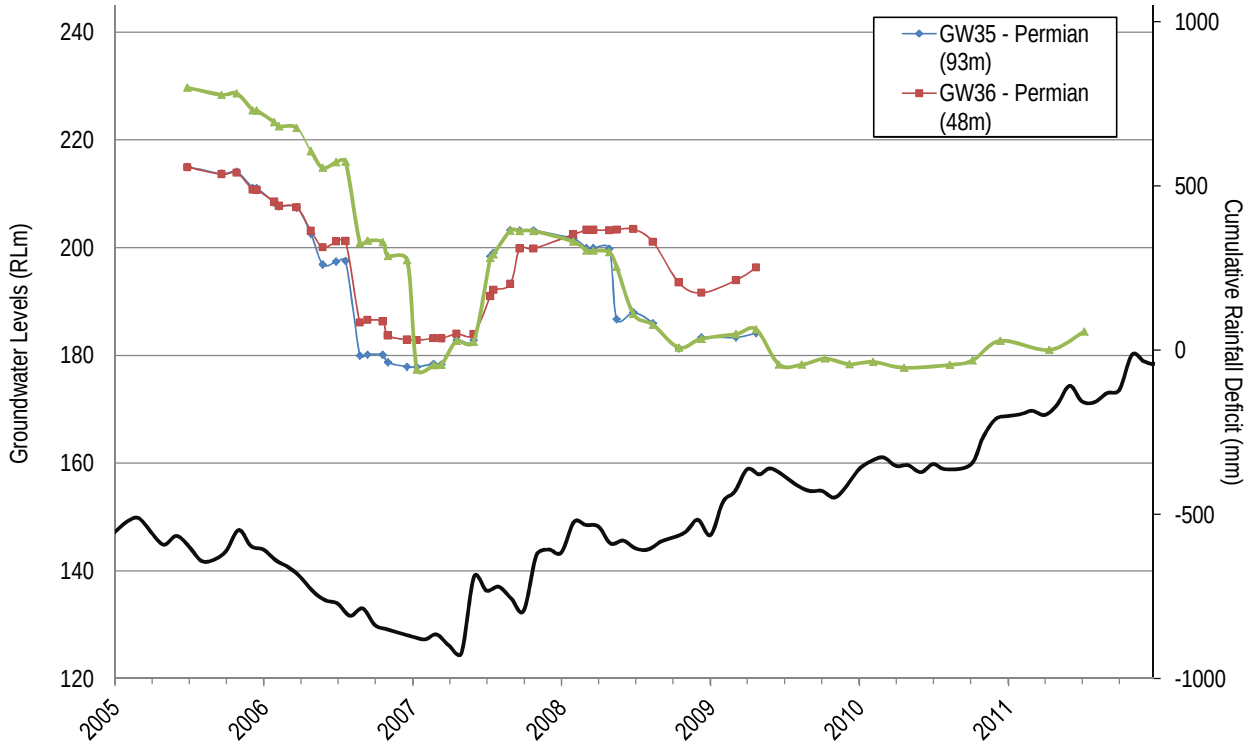


Figure 18: Hydrographs of Permian Coal Measures Monitoring Bores – South-East

10.4 Summary and Conclusions

Monitoring of groundwater levels and groundwater quality at the Mt Arthur Coal Mine since 1999 has shown changes on the groundwater regime of the Permian coal measures sequence of which the coal seams are the prime water bearing strata. Negligible change has been noted in groundwater levels within alluvium.

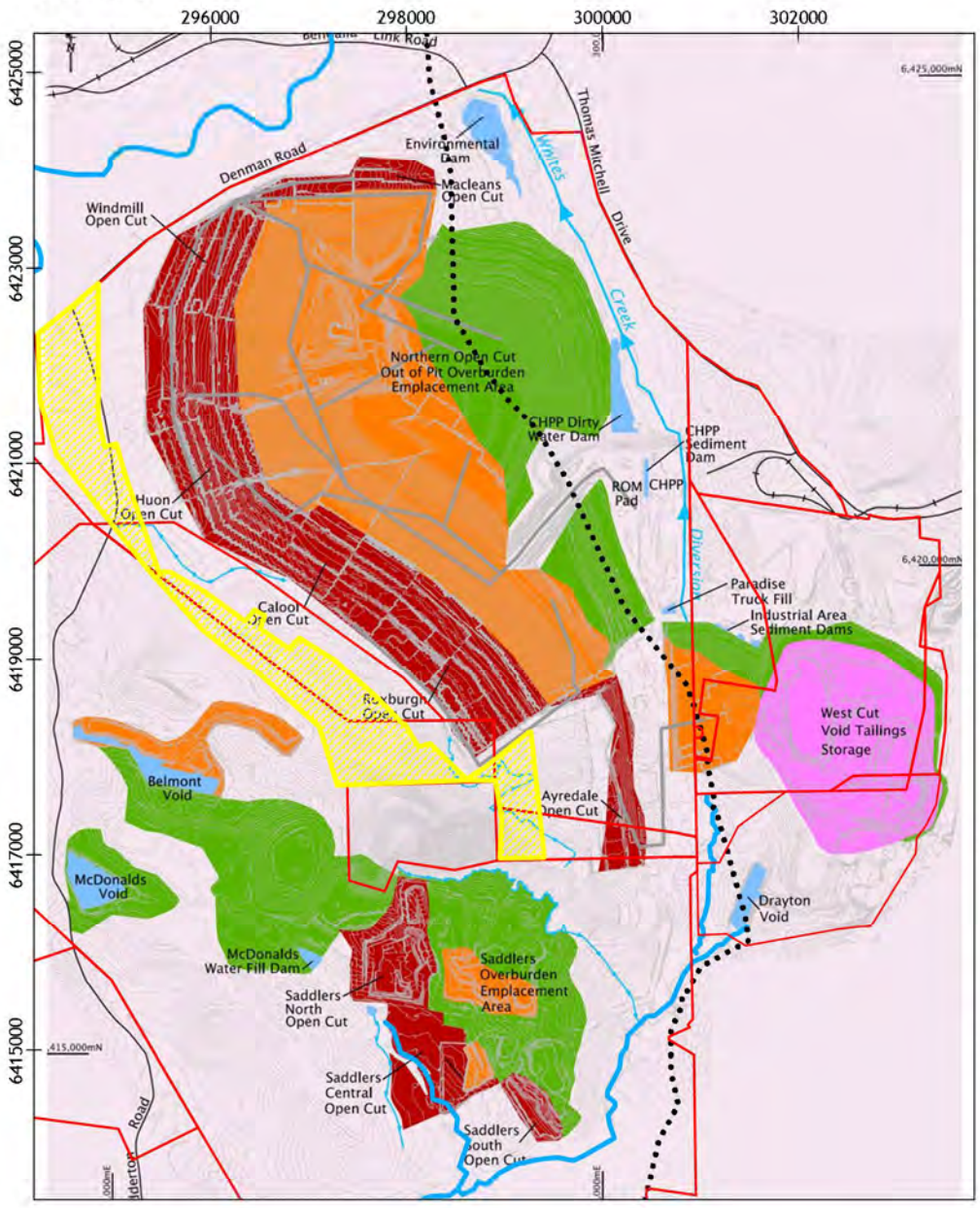
Monitoring has also confirmed the validity of the predictions of the numerical models, primarily the AGE (2009) model, which simulates the impact of open cut mining.

Monitoring has shown that the Permian coal measures are depressurised by open cut mining and the extent to which this is occurring, and as stated, confirms the model predictions. Monitoring has also shown that there is no impact on groundwater levels in the alluvium; however, the groundwater gradient beneath the alluvium has reversed as indicated by a slowly improving water quality at the base of the alluvium. That is there is no longer discharge from the coal seams to the alluvium in the vicinity of open cut mining, but leakage from the alluvium to the pit as a result of depressurisation. Again this confirms the model predictions of AGE (2009) which indicate that in 2012, the leakage rate from the alluvium is about 0.1ML/day (1.2L/s).

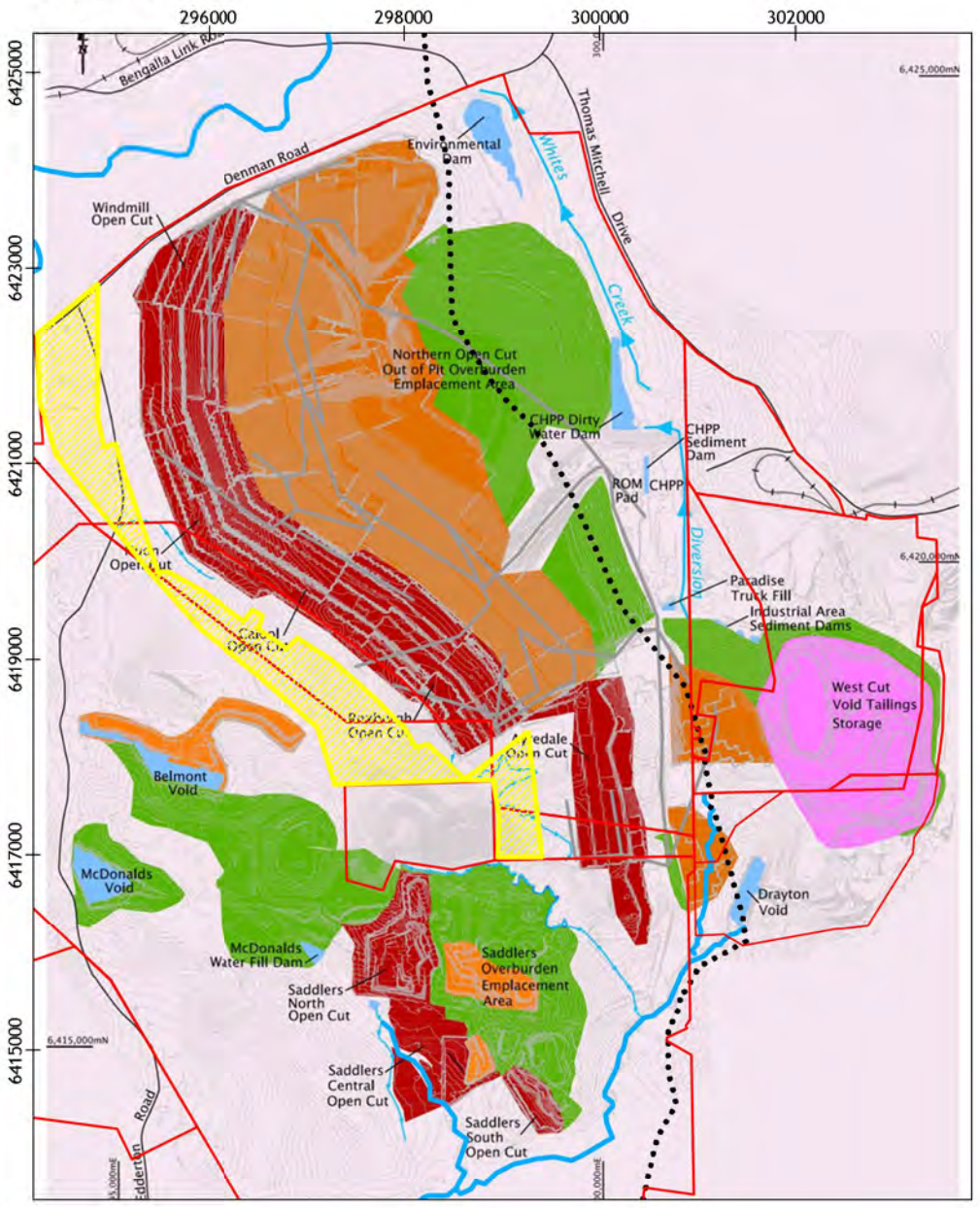
11.0 MINE PLAN

The previous mine consolidation study (AGE, 2009) included mine plans for the open cut operations up to Year 2022, including pit shells for Years 2011, 2016 and 2022. Updated mine plans were available for this study from HVEC for the mine Years 2016, 2018, 2022 and for the mine Modification period to Year 2026. This study included integrating the four new mine plans (2016 to 2026) into the existing model. The updated mine plan sequence is shown in Figure 19 with approximate active mining areas.

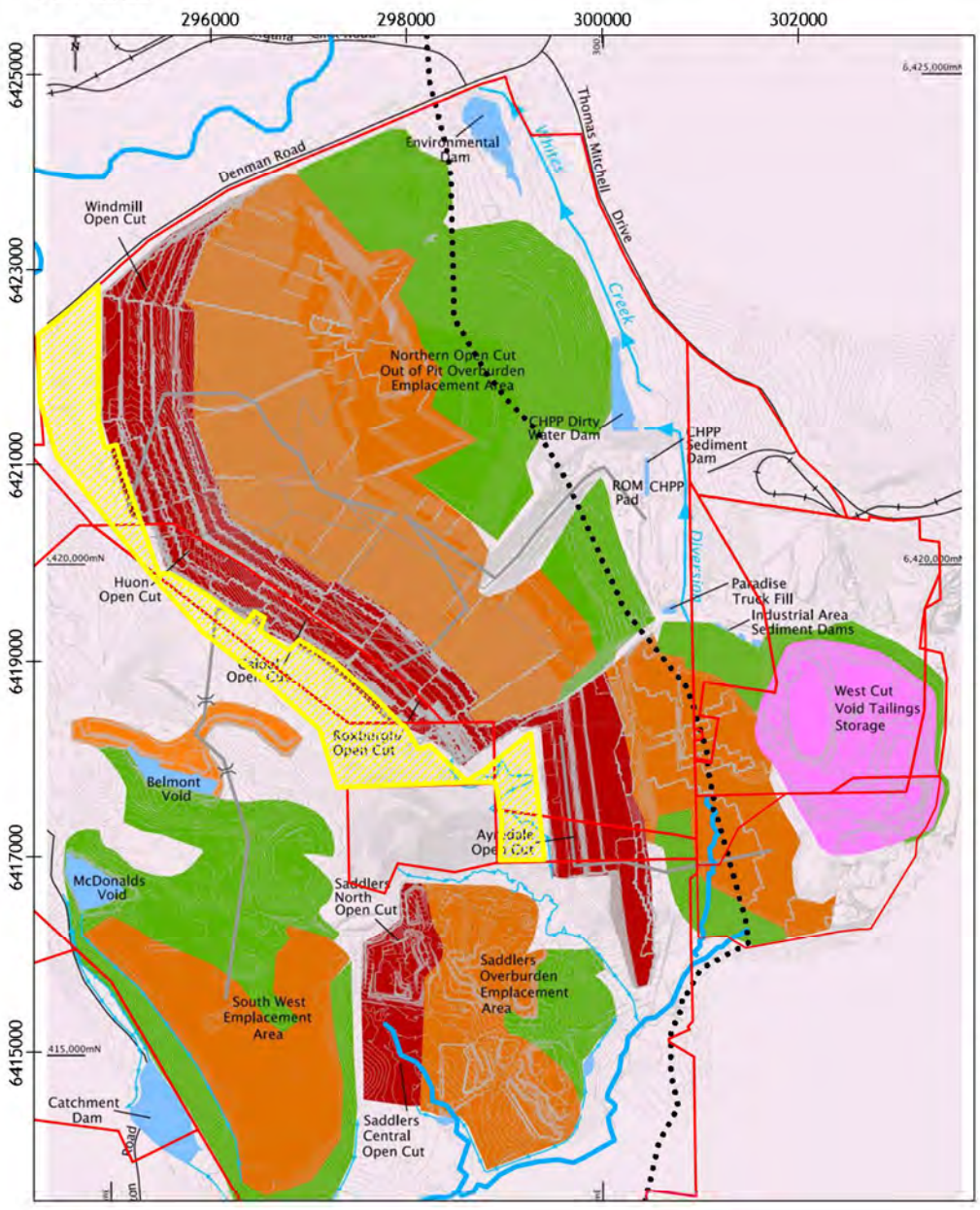
Year 2016



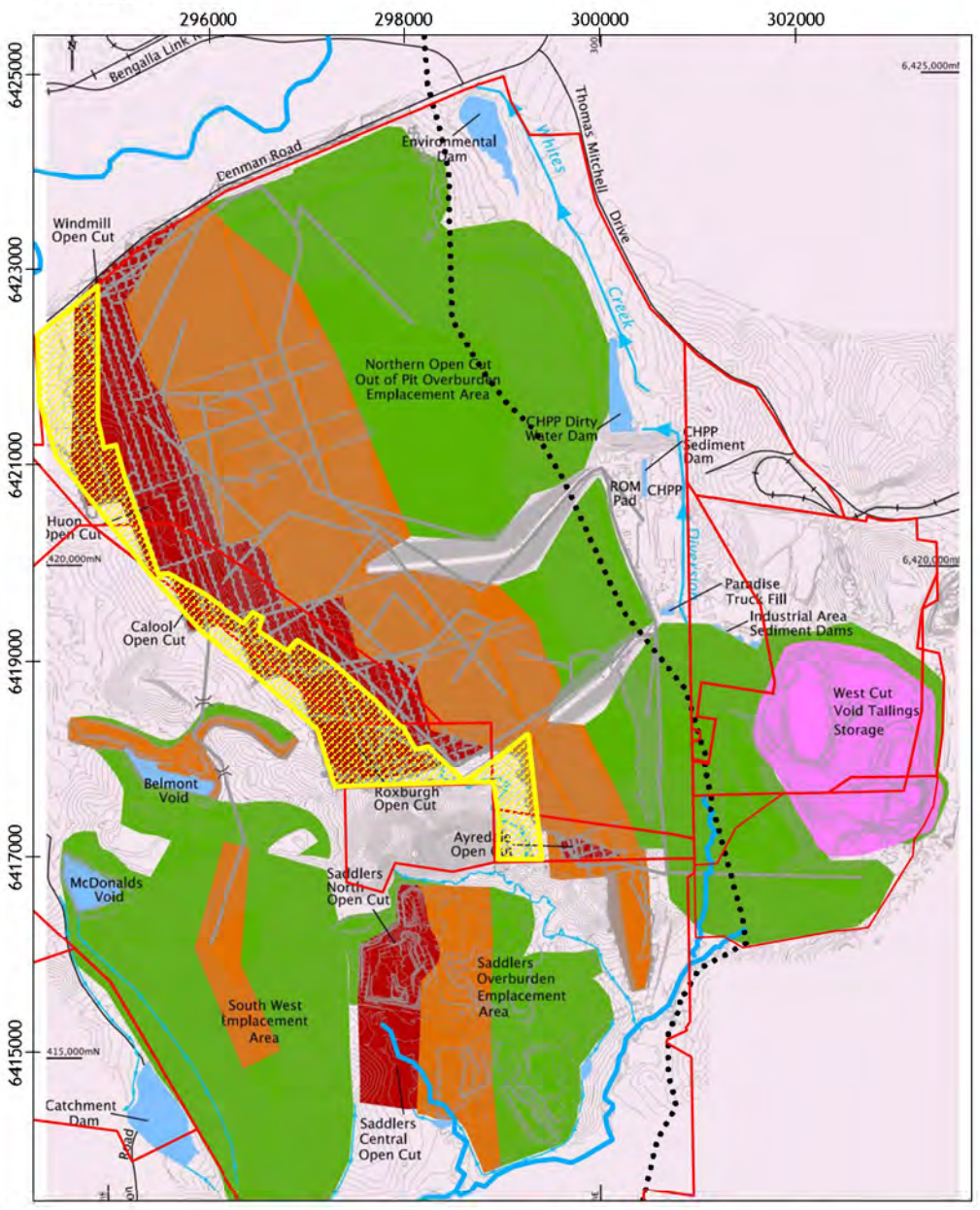
Year 2018



Year 2022



Year 2026



LEGEND:

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- River
- Haul Road
- Water Storage
- Active Mining
- Spoil
- Tailings Storage
- Rehabilitated
- Diversion/Drain
- Railway
- Road
- Culvert

N

PROJECTION:
MGA 94, Zone 56

SCALE:
1:75,000 (A3)

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Updated Mine Plan 2016 to 2026

DATE: 23/1/2013

FIGURE No: 19

Base maps sourced from "Gilbert and Associates" (2012)

12.0 NUMERICAL GROUNDWATER MODEL

12.1 Modelling Objectives

The numerical model for the Modification has been designed to answer the key study objectives, including:

- change in groundwater flux to and from the Hunter River alluvium due to the Modification;
- drawdowns in the piezometric surface due to the Modification;
- effects on local registered bores due to this drawdown; and
- prediction of pit inflows resulting from the Modification.

The objectives of the numerical model remain the same as those of the previous 2009 study (AGE, 2009) while including updated geometry for the Year 2016, 2018 and 2022 pits and inclusion of the mine Modification period to Year 2026.

The developed groundwater model is based on the calibrated model presented in AGE (2009) study. The calibrated parameter set of the previous 2009 model is consistent with this study. Current piezometric data post 2009 has been used to verify the predictive capability of the previous calibrated model.

12.2 Conceptual Model

During the AGE (2009) study, based on suggestions made by HVEC personnel, the Wittingham Coal Measures have been divided into three groups, which are treated as different groundwater systems in the model. From a conceptual groundwater model perspective, the Mt Arthur Coal Mine Site area is considered to consist of the following groundwater systems:

- alluvium along Hunter River and Saddlers Creek and an upper weathered bedrock zone;
- an upper Permian section of the Jerrys Plain Subgroup;
- a mid Permian section of the Jerrys Plain Subgroup (Burnamwood Formation); and
- a lower Permian section of the Vane Subgroup including the Archerfield Sandstone.

12.3 Model Development

The finite-element simulation package FEFLOW (Diersch, 2008) was used to simulate the impact of the mining operations on the groundwater regime. FEFLOW is a high-end groundwater flow package, capable of simulating two and three-dimensional density-coupled groundwater flow, mass and heat transport in saturated and unsaturated media. Since its creation in 1979, FEFLOW has been continuously improved. The FEFLOW source code is written in ANSI C/C++ and contains more than 1,300,000 lines. It is applied worldwide for groundwater related tasks within the mining sector.

FEFLOW was also used by AGE (2006a) for the simulation of the Northern Open Cut, simulation of the South Pit Extension (AGE, 2006b), by MER (2007) for simulation of the MAU Project, and by AGE (2009) for the Mt Arthur Coal Consolidation Project. The current model has been developed from these models.

12.3.1 Model Settings

The model was developed in FEFLOW using flow mode using both steady state and transient modes and also using the free and movable model setting. In this mode, the top slice is adjusted automatically to the elevation of the groundwater table. All other slices are distributed along the top and bottom of the saturated model layers, preserving the original material distribution. This so-called Best-Adaptation-to-Stratigraphic-Data (BASD) technique is also useful if applying drainage boundary conditions for the mine dewatering. The node, on which such a boundary condition is set, automatically moves to the corresponding elevation in the model. Running FEFLOW in this mode negates modelling instabilities associated with the simulation on the unsaturated zone.

The model was run using the SAMG solver with automated time stepping (for transient runs) with a convergence criteria set at 1×10^{-3}.

12.3.2 Model Geometry and Model Extents

The lateral extent of the groundwater flow model conforms to the hydrological boundaries described for the conceptual model (Figure 20). In agreement with the conceptual model, the numerical groundwater model is surrounded by “no flow” boundaries. While the northern and southern borders run along topographic watersheds which correspond to groundwater divides, which by definition are “no flow” boundaries, the western border was set along the Mount Ogilvie Fault, which with a displacement of 200 m is assumed to be a barrier to groundwater flow. The eastern boundary is formed by the outcrop of the low permeability Saltwater Creek Formation.

The mesh density varies laterally with the highest discretisation at the different mine sites (approximately 30 m cell size). The model mesh for this study was based on the mesh developed by AGE (2009). The mesh was subsequently refined in the Modification Area. The model contains 391,480 elements, up from 292,592 elements in the 2009 study.

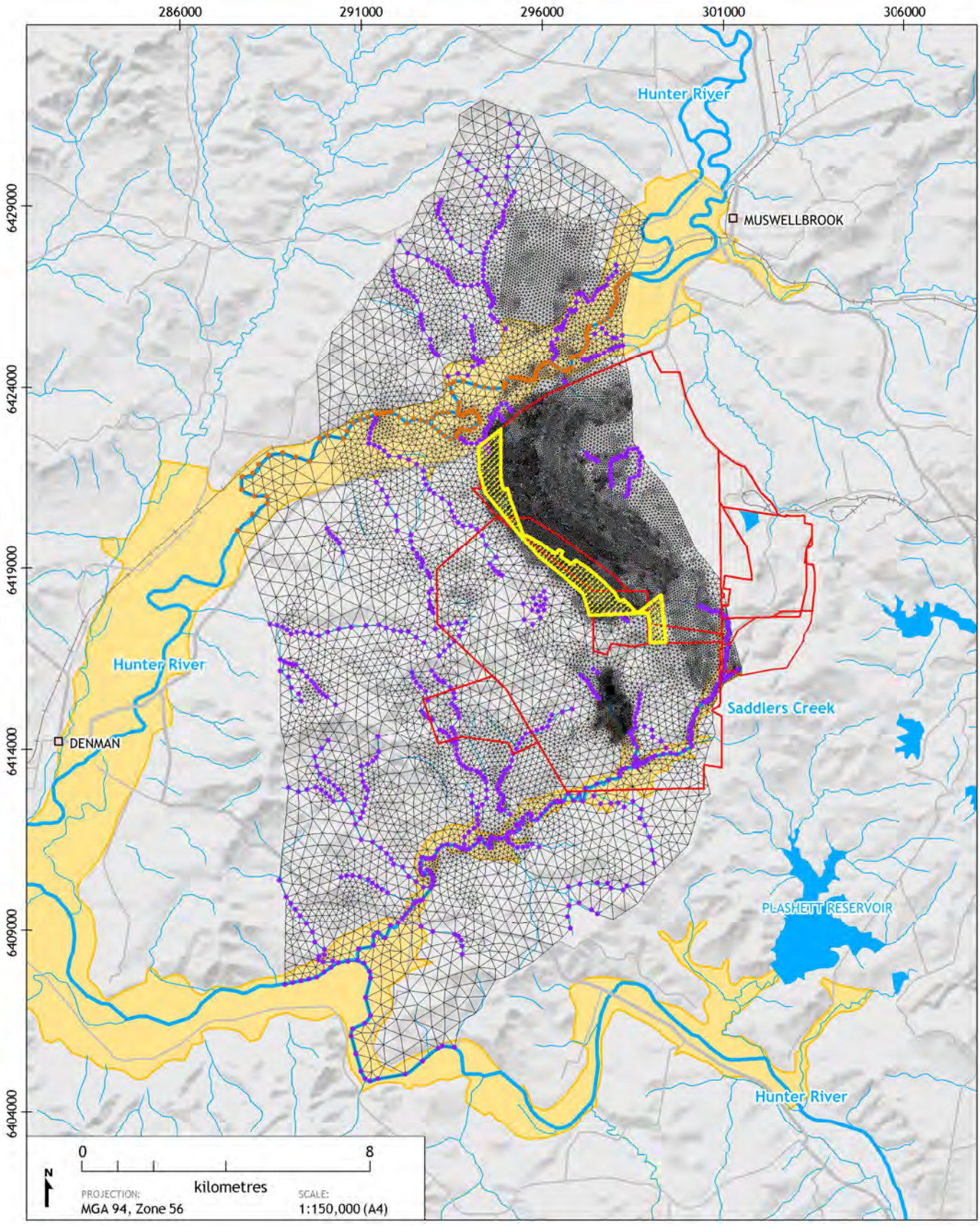
12.3.3 Boundary Conditions

The Hunter River to the north of the Modification is simulated as a fixed hydraulic head boundary (1st kind Dirichlet boundary condition). This boundary condition allows for the infiltration of surface water into the groundwater systems or drainage of the groundwater system, depending on the hydraulic gradient between the river and the surrounding model layers. The location of 1st kind boundaries representing the Hunter River are shown in Figure 20.

The creeks within the model domain are assumed to drain the thin alluvial deposits associated with the creeks. Recharge from these creeks is conceptually not thought of as major recharge source. Therefore drainage boundary conditions have been assigned in the model along the creek beds which do not allow infiltration of surface water into the alluvial deposits. These have been implemented using constrained fixed hydraulic head boundaries (1st kind Dirichlet boundary condition) with a constraint only letting water discharge from the boundary condition. The location of 1st kind boundaries representing the creeks (including Saddlers Creek) are shown in Figure 20.

12.3.4 Layers

The groundwater model represents the conceptual model of the mine Modification and consists of eight model layers representing six layers with different geo-hydraulic properties. The top or base of the layers has been defined from structure contours provided by HVEC with extrapolation to the model perimeter where the structure contours did not extend to the model boundaries.



LEGEND:

- Mt Arthur Coal Mining & Coal Lease Boundary
- Mine Modification Area
- Finite Element Mesh (FEM)
- 1st Kind Boundary Conditions Hunter River
- 1st Kind Boundary Conditions Creeks
- River
- Creek
- Reservoir/Lake
- Alluvium
- Town
- Road/Track
- Rail

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Model Area and Finite Element Mesh (FEM) and Boundary Conditions

DATE: 23/1/2013

FIGURE No: **20**

Due to model restrictions, each layer has to extend over the whole model domain even where the represented groundwater systems have sub-cropped or outcropped. However, due to the use of the free and movable function in FEFLOW to simulate units below the water table, much of these sub-crop zones are not simulated.

Layer 1

The top layer represents the alluvium along the Hunter River and Saddlers Creek as well as the weathered regolith zone outside these alluvial areas. The layer has a saturated thickness of 5 to 10 m. Its top is defined by the topographic surface.

Layers 2, 3 and 4

Three layers are included in the overburden between the base of alluvium (Layer 1) and the upper Wittingham Coal Measures (Layer 5). Multiple layers were used to represent a better vertical discretisation of the model. The base of Layer 4 represents the top of the Mt Arthur Coal Seam. Structure contours for this model slice are shown in Figure 21.

Layers 5 and 6

These layers represent the upper section of the Wittingham Coal Measures between the top of the Mt Arthur Coal Seam and the floor of the Bayswater Coal Seam. Its thickness is derived from contour maps of the seam geometry of the Mt Arthur and Bayswater Coal Seams as provided by HVEC. The thickness of these layers is up to 100 m within the Site area. The unit sub-crops in the eastern part of the Site area. Structure contours for the base of Layer 6 are shown in Figure 22.

Layer 7

This layer represents the lower unit of the mined section of the Wittingham Coal Measures. Its bottom is defined by the base of the Ramrod Creek Coal Seam (the top of the Saltwater Creek Formation). This layer has a thickness of up to 120 m within the model domain. Structure contours for this model slice are shown in Figure 23.

Layer 8

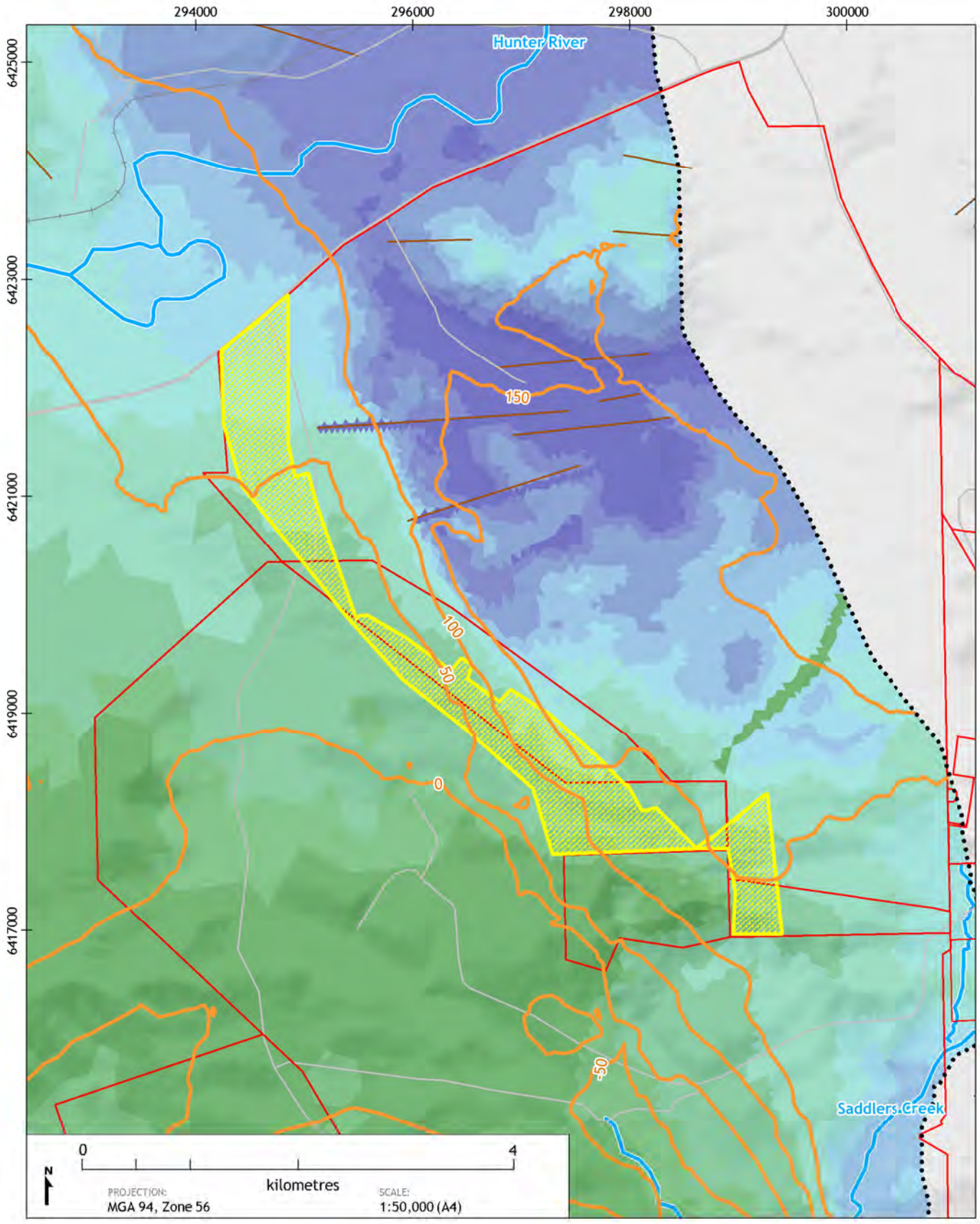
This layer, the base of the model, has been added representing the relatively impermeable Saltwater Creek Formation in order to prevent dry-out of finite elements during the dewatering of the Ramrod Creek Seam.

Figure 24 shows the three-dimensional model mesh with the initial hydraulic head distribution.

12.3.5 Hydraulic Parameters

The top model layer (Layer 1) represents the alluvium along the Hunter River, the creeks and the zone of weathered bedrock. A horizontal hydraulic conductivity of 8 m/day was assigned to the alluvium associated with the Hunter River, consistent with data presented in MER (2000). MER (2007) states that for the MAU model:

> *The alluvium is assumed to exhibit homogeneity and isotropy, even though data suggests stratification of unconsolidated sands, silts and clays. … adoption of a uniform conductivity is considered to represent a conservative approach in determining potential leakage from the alluvium*.



LEGEND:

Horizontal Hydraulic Conductivity m/d

- 0.189 to 0.864
- 0.152 to 0.189
- 0.101 to 0.152
- 0.078 to 0.101
- 0.057 to 0.078
- 0.031 to 0.057
- 0.01 to 0.031
- 0.002 to 0.01
- 0.001 to 0.002
- 0 to 0.001

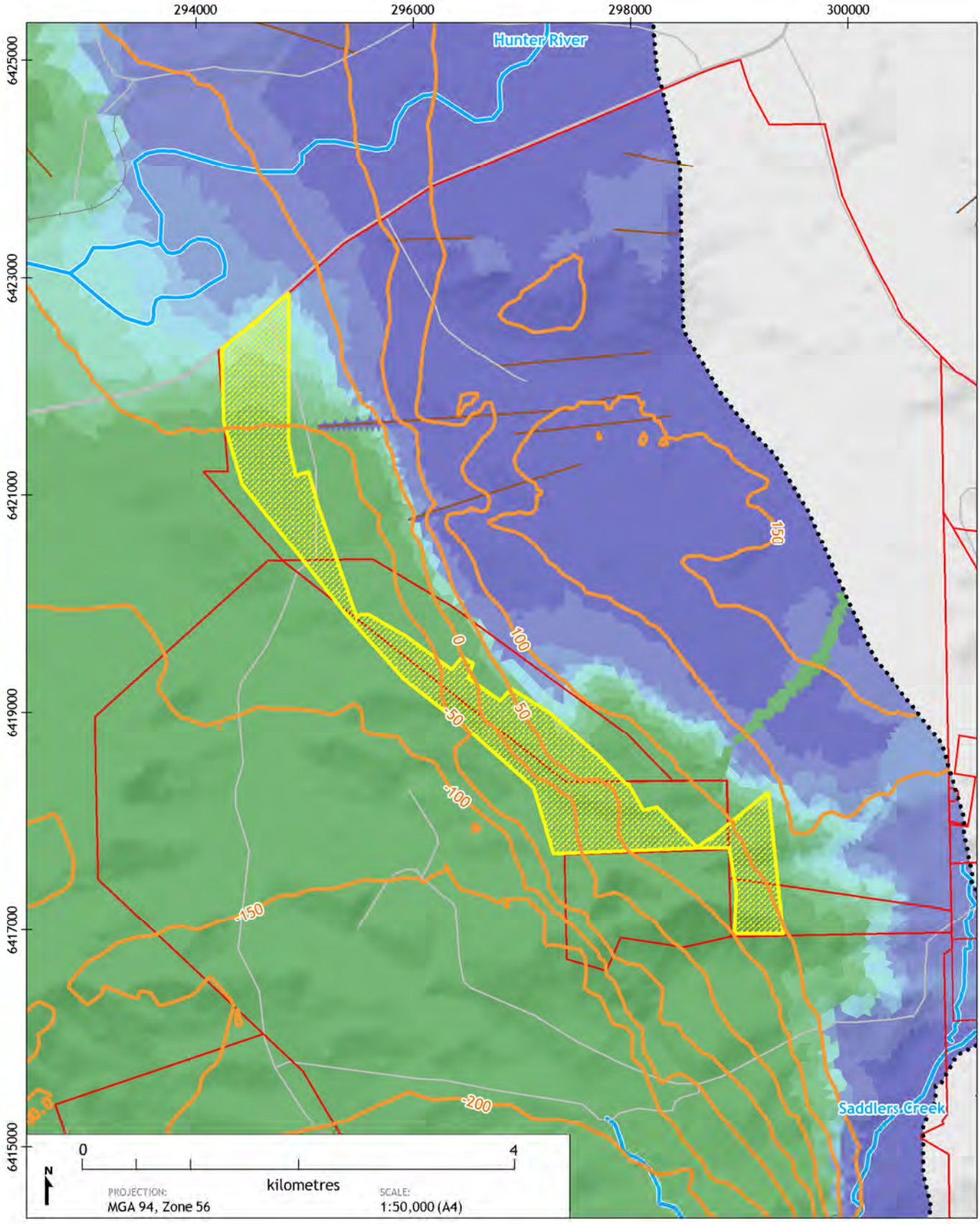
- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- Slice 5 Elevation (mAHD)
- Fault
- Road/Track
- Rail
- River

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Structure Contours of base of Layer 4 (top Mt Arthur Seam) and Hydraulic Conductivity Distribution

DATE: 23/1/2013

FIGURE No: 21



LEGEND:

Horizontal Hydraulic Conductivity m/d

- 0.043 to 0.864
- 0.011 to 0.043
- 0.007 to 0.011
- 0.006 to 0.007
- 0.005 to 0.006
- 0.004 to 0.005
- 0.003 to 0.004
- 0.002 to 0.003
- 0.001 to 0.002
- 0 to 0.001

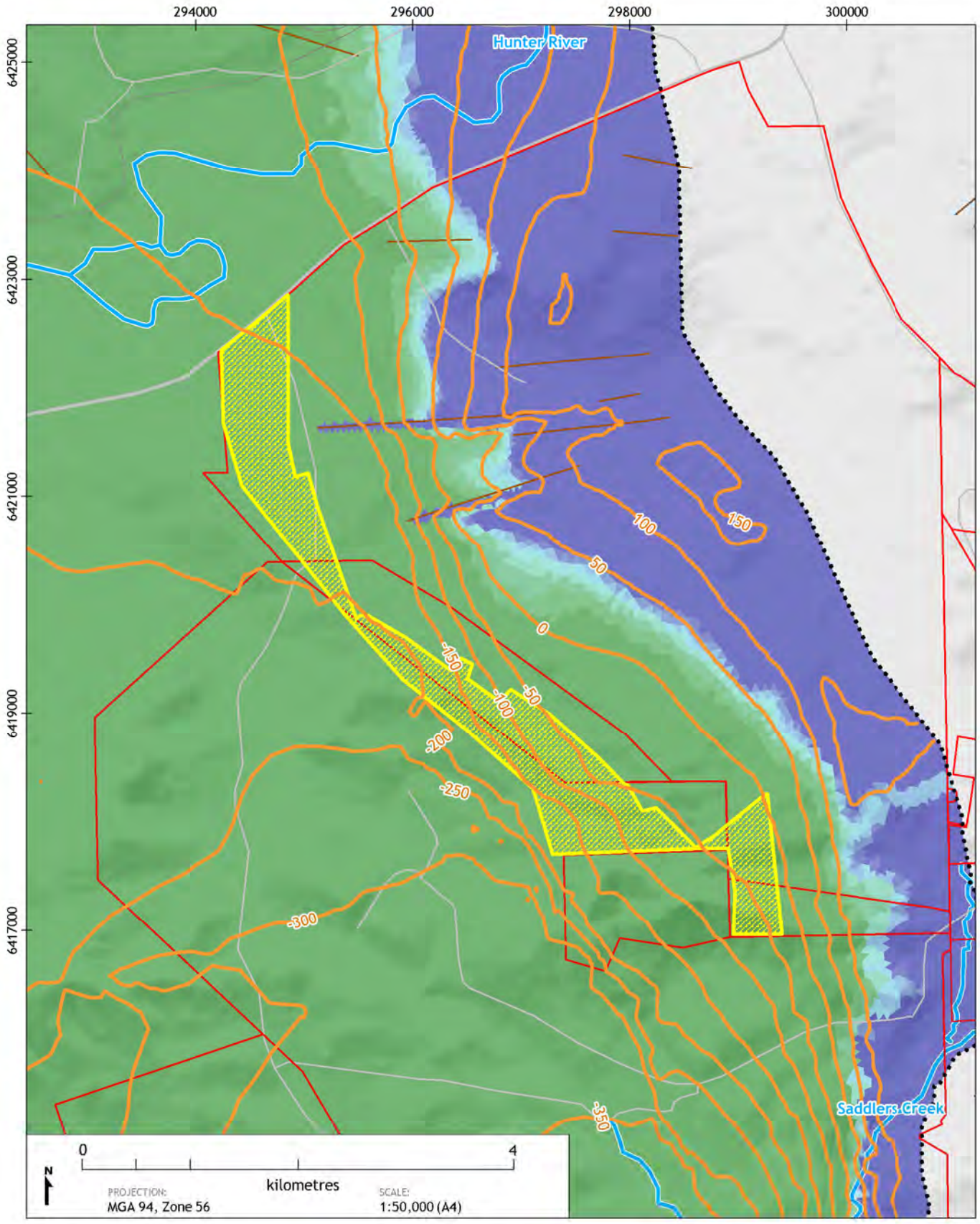
- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- Slice 7 Elevation (mAHD)
- Fault
- Road/Track
- Rail
- River

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Structure Contours of base of Layer 6 (Bayswater Seam) and Hydraulic Conductivity Distribution

DATE: 23/1/2013

FIGURE No: 22



LEGEND:

Horizontal Hydraulic Conductivity m/d

- 0.009 to 0.864
- 0.008 to 0.009
- 0.007 to 0.008
- 0.006 to 0.007
- 0.005 to 0.006
- 0.004 to 0.005
- 0.003 to 0.004
- 0.002 to 0.003
- 0.001 to 0.002
- 0 to 0.001

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- Slice 8 Elevation (mAHD)
- Fault
- Road/Track
- Rail
- River

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Structure Contours of base of Layer 7 (Base Ramrod Seam) and Hydraulic Conductivity Distribution

DATE: 23/1/2013

FIGURE No: 23

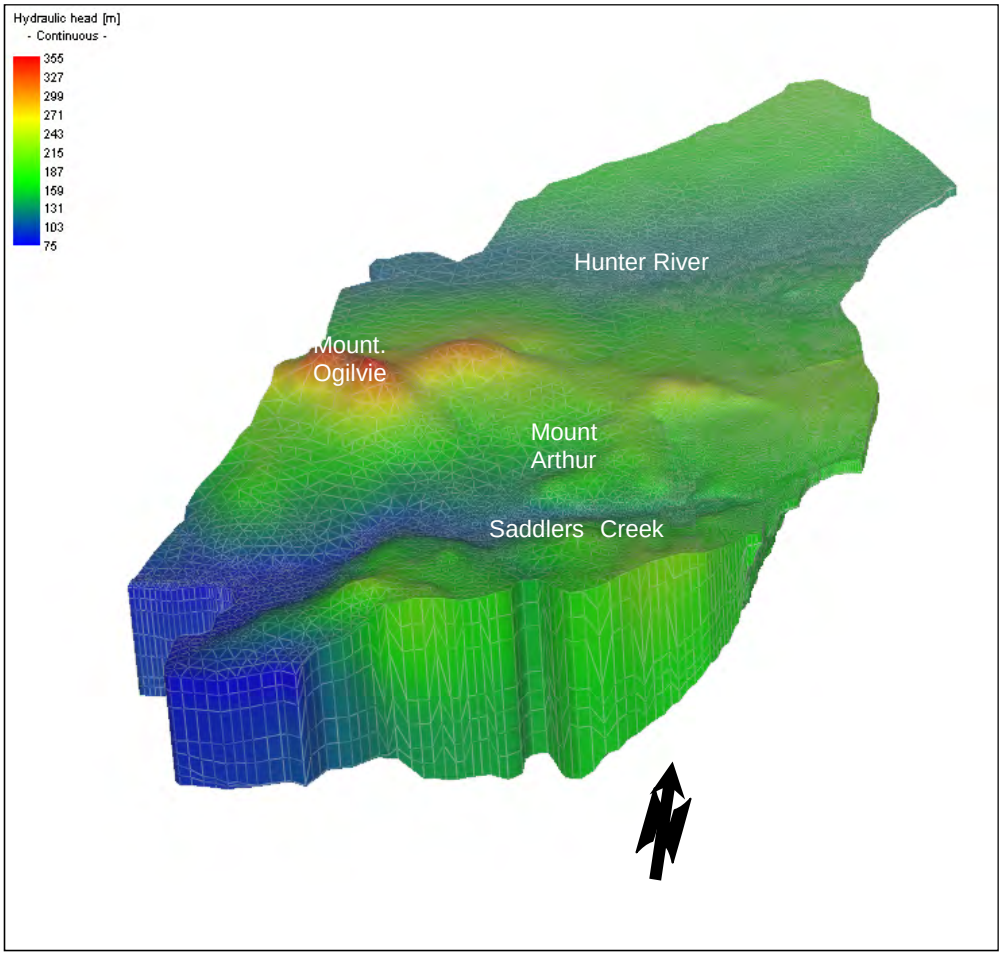


Figure 24: Three-Dimensional Model Mesh

However, in the current model, the vertical hydraulic conductivity within the alluvium has been reduced from 8 m/day to 0.2 m/day to take into account the silt and clay layers. This vertical hydraulic conductivity is still significantly higher than the hydraulic conductivity of the underlying bedrock groundwater systems, and is considered conservative in that the model does not account for the likely occurrence of a weathered, clay rich transition zone at the base of alluvium that may inhibit leakage.

The weathered bedrock (regolith) is assumed to have a hydraulic conductivity at least one order of magnitude higher than the underlying Permian coal measures. The alluvium of Saddlers Creek, which consists of the fine grained material, was assigned hydraulic properties similar to those of the weathered bedrock.

Layers 2, 3 and 4 represent the overburden of the Mt Arthur Coal Seam, that is, from the base of the alluvium or regolith to the top of the Mt Arthur Coal Seam. This group consists of very low conductivity siltstones and sandstones and thin Warkworth Coal Seams of the Mt Thorley Formation. Horizontal hydraulic distribution for Layer 4 is shown in Figure 21.

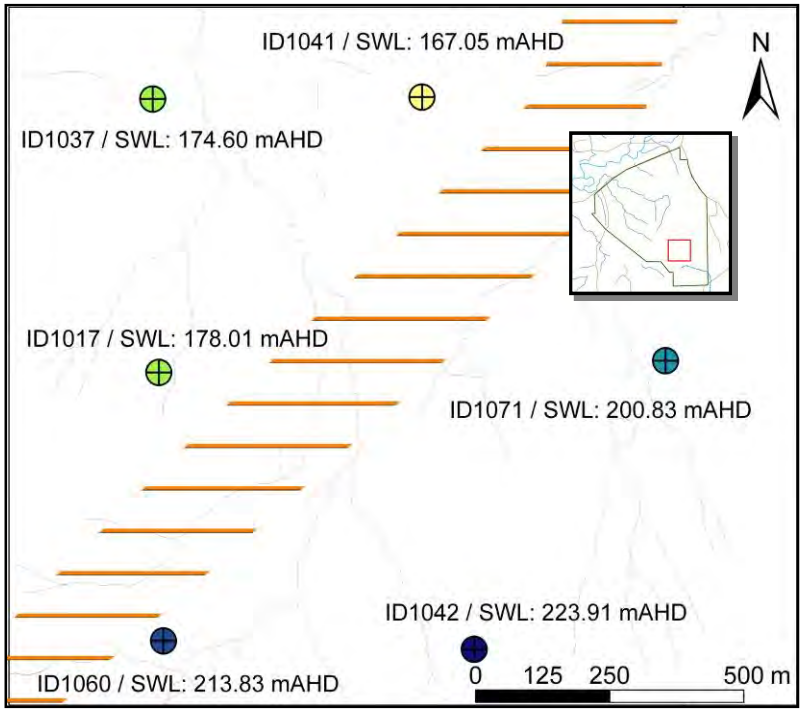
Model Layers 5 and 6 represent the coal seams and interburden between and including the Mt Arthur and Bayswater Coal Seams. Horizontal hydraulic distribution for Layer 6 is shown in Figure 22.

Model Layer 7 represents the section of the Wittingham Coal Measures from the base of the Bayswater Coal Seam to the floor of the basal Ramrod Creek Coal Seam. Horizontal hydraulic distribution for this layer is shown in Figure 23.

The underlying Saltwater Creek Formation represents the base of the groundwater flow model since this formation is considered to be impermeable. Nevertheless, this formation has been added to the model as a 100 m thick "dummy layer" of very low hydraulic conductivity. This allowed for the simulation of dewatering of the Ramrod Creek Coal Seam due to mining to the base of this seam. This also provided numerical stability to the model.

The hydraulic conductivity of each model layer was calculated as the weighted sum of the interburden and coal seam permeabilities. The applied weighting factor was the thickness of the interburden and the coal seams within each model layer. The hydraulic conductivity was reduced continuously with depth by applying the formulas for the change of hydraulic conductivity with depth as discussed in Section 9.5.2. Only model Layer 8, representing the Saltwater Creek Formation, was assigned a uniform hydraulic conductivity of 8.64×10^{-7} m/day. This is a very low hydraulic conductivity value representative of unfractured metamorphic and igneous rocks, shales or unweathered marine clays.

The area in the vicinity of the Fairford Graben was represented in the model by assigning high conductivity zones of 0.6 m/day along the fault lines. Another structure was identified during data review and model calibration in the southern part of the Northern Open Cut where two groups of adjacent groundwater monitoring bores show differences in groundwater elevation of up to 57 m (Figure 25). In order to simulate such a steep hydraulic gradient, a north-east/south-west striking fracture with a reduced hydraulic conductivity of 8.6×10^{-4} m/day was assigned in the groundwater model. This fracture feature has no impact on the groundwater inflow into the pits as it is excavated during the first years of operation of the currently approved Northern Open Cut.



Note: low conductivity area is hatched.

Figure 25: Assumed Low Conductivity Zone with Nearby Monitoring Bores

A long section showing the hydraulic conductivity distribution with depth and along the Fairford Graben is shown on Figure 26.

As discussed, the model does not account for a potentially weathered, clay rich, low permeability transition zone between the base of alluvium and unweathered bedrock that would reduce leakage from the alluvium to the depressurised bedrock groundwater systems.

Storativity has been calculated based on the thickness of the coal seams and the interburden within each model layer and assuming a storativity of the coal seams and the interburden of 0.5 percent (%) and 0.005 % respectively. A uniform storage compressibility value of 5 x 10^{-6} per metre was applied in the model.

12.3.6 Recharge and Discharge

Only rainfall sourced recharge was used as an external input to the model domain. The dense natural drainage network at the Site suggests most of the rainfall discharges as surface run-off. There is only a relatively low rate of recharge to the groundwater system on the relatively high to moderate hill slopes of the model area due to this high percentage of surface run-off, whereas on the floodplains, the rate of recharge is significantly higher.

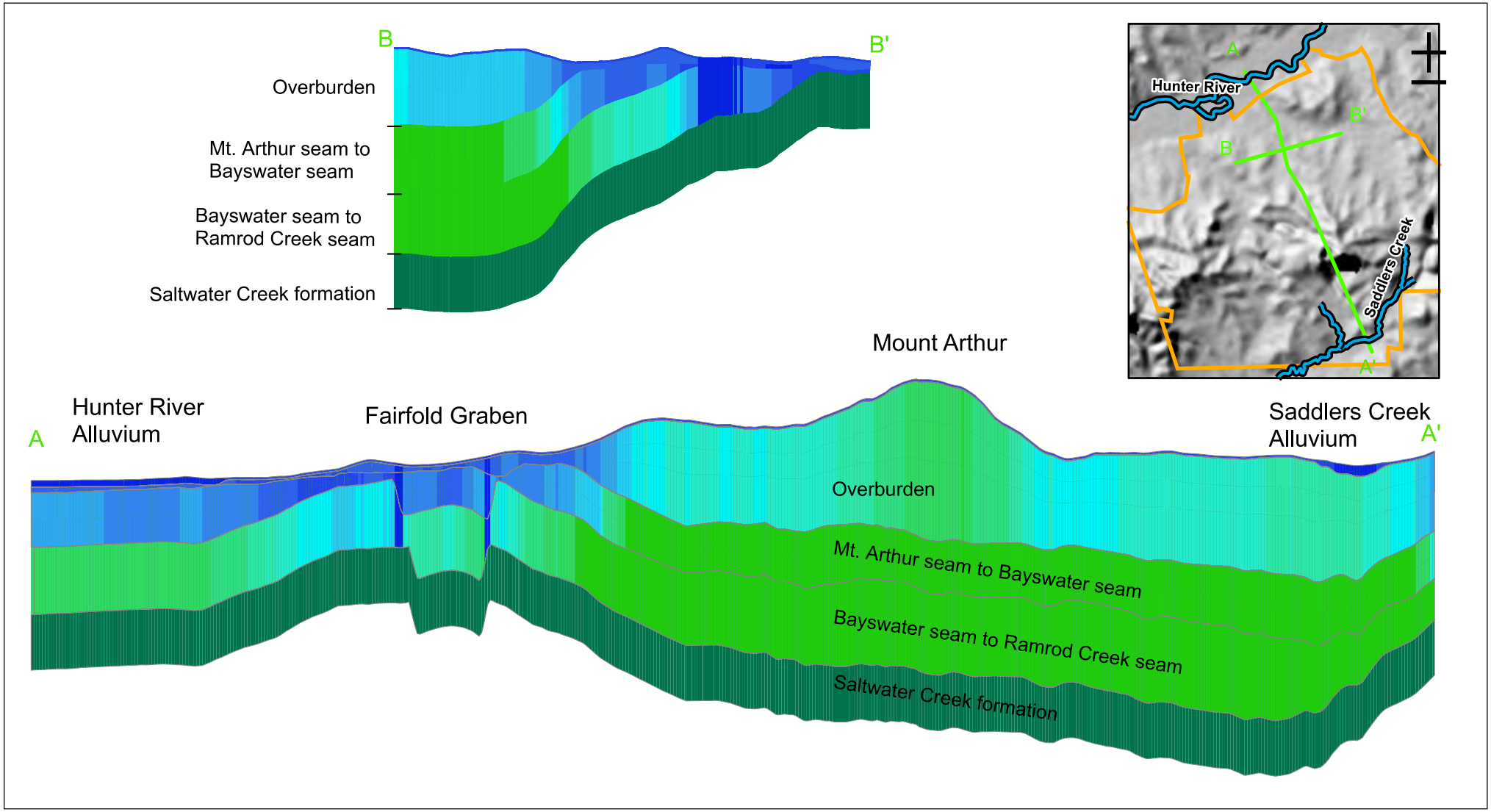
Areas of known coal seam sub-crop are believed to receive more recharge than remaining areas and it became apparent during calibration of the model that coal seam sub-crop areas are likely to receive as much as 2.4% or 15 mm/year of the average annual rainfall as recharge, even in the areas of steeper slopes.

The highest recharge is expected over the permeable alluvium of the Hunter River. It was assumed in the model that the recharge over these alluvial areas is 10% of the average annual rainfall, that is, a recharge rate of 60 mm/year. The rate of recharge in the model to the remaining areas was assumed to be:

- areas with gradient < 5%, recharge is 1% or 6mm/year of the annual average rainfall; and
- hilly regions with gradient >5%, recharge is 0.4% or 2.4 mm/year of the annual average rainfall.

The distribution of recharge used in development of the model is shown on Figure 27.

A summary of the hydraulic parameters specified in the model is presented in Table 6.



LEGEND: **Hydraulic Conductivity (m/day)**

<1e-6	- 1e-2
- 1e-4	- 2e-2
- 2e-4	- 5e-2
- 5e-4	- 0.1
- 1e-3	- 0.2
- 2e-3	- 0.5
- 5e-3	>0.5

0m
100m
200m
vertical exaggeration 5x

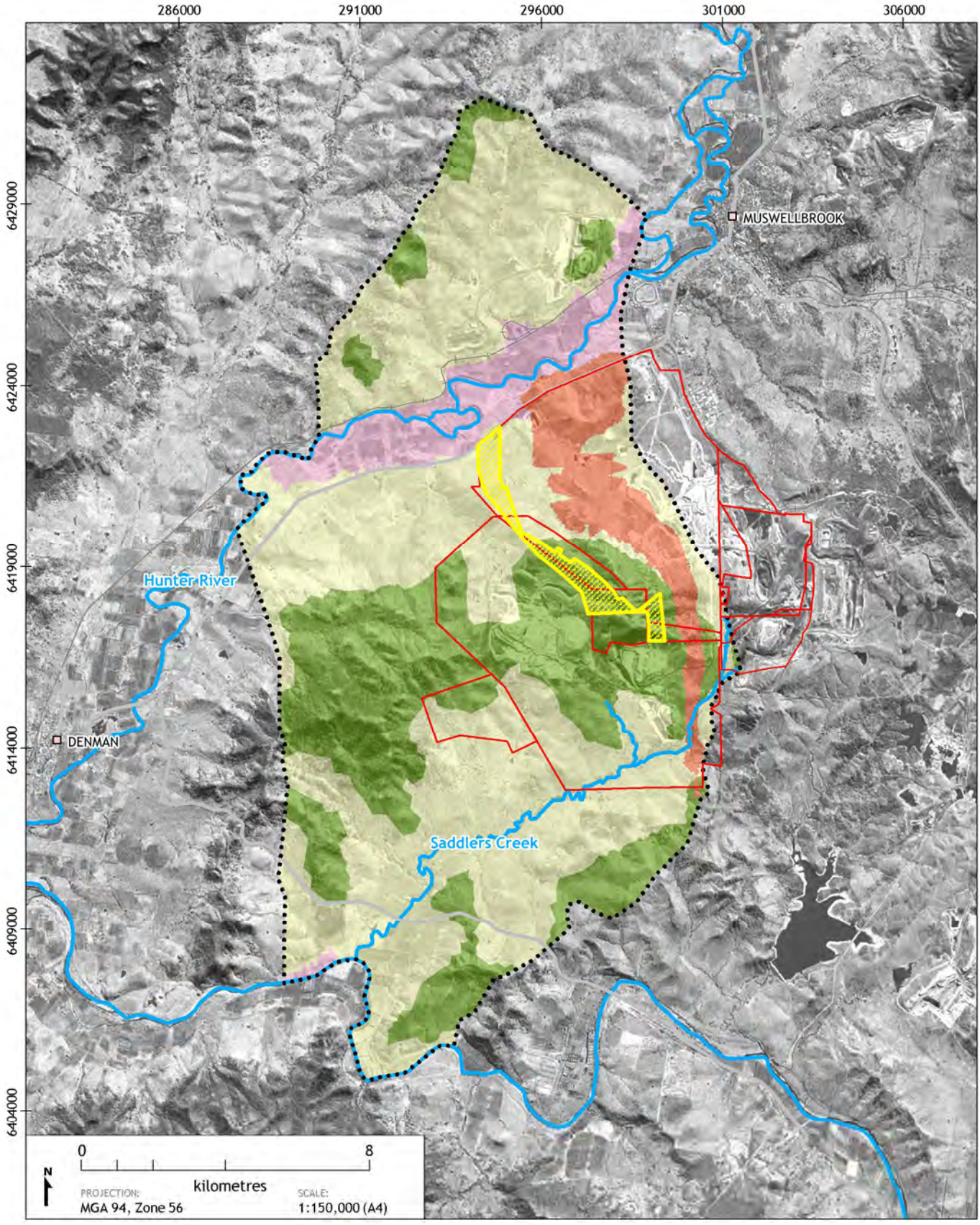
0 500 1,000 2,000 3,000m

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assessment (G1602)

Long Sections - Hydraulic Conductivity

DATE: 23/1/2013

FIGURE No: **26**



LEGEND:

Groundwater Recharge Zones

- Hunter River alluvium, 60mm/year
- Subcrop areas =< 15mm/year
- Gently sloping areas, 6mm/year
- Steep Mountain slopes, 2.4mm/year

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- Town
- Road
- Rail
- River

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Recharge Distribution

DATE: 23/1/2013

FIGURE No: 27

Table 6: SUMMARY OF GROUNDWATER MODEL PARAMETERS

Model Layer	Layer Name	Feature/Parameter	Value
1	Alluvium and Weathered zone	distribution	Alluvium along Hunter River and Saddlers Creek, weathered zone over the entire model area
		top	Interpolated from topographic data
		base	Weathered zone 5 m thick, Hunter River alluvium 6 m saturated thickness, Saddlers Creek deducted from topographic map
		horizontal hydraulic conductivity	8.2 m/day Hunter River Alluvium, 0.4 m/day Upper Saddlers Creek and weathered zone
		vertical hydraulic conductivity	0.2 m/day
		storativity	0.2 Hunter River alluvium, 0.01 elsewhere
		storage coefficient	$5 \times 10^{-6} m^{-1}$
		recharge	Hunter River alluvium 60 mm/year (10% of average annual rainfall), remaining area 2.4 mm/year to 15mm/year (0.4% to 2.4% of average annual rainfall), depending on slope of topography
2, 3 & 4	Overburden Weathered zone to Mt Arthur Seam	distribution	Entire model area
		top	Base of Layer 1
		base	Top of Mt Arthur Coal Seam
		horizontal hydraulic conductivity	0.01 m/day to 0.6 m/day (along Fairford Faults) in the area of the Northern Open Cut, 5.6×10^{-5} m/day to 0.2 m/day elsewhere
		vertical hydraulic conductivity	20% of horizontal hydraulic conductivity
		storativity	10^{-4}
		storage coefficient	$5 \times 10^{-6} m^{-1}$
		thickness	Up to 180 m at western border of lease area
5 & 6	Mt Arthur Seam to Bayswater Seam	distribution	Entire model area
		top	Top of Mt Arthur Coal Seam
		base	Floor of Bayswater Coal Seam
		horizontal hydraulic conductivity	1.6×10^{-4} m/day to 0.6 m/day (along Fairford Faults)
		vertical hydraulic conductivity	20% of horizontal hydraulic conductivity
		storativity	10^{-4}
		storage coefficient	$5 \times 10^{-6} m^{-1}$
		thickness	Up to 100 m at western border of lease area
7	Bayswater Seam to Ramrod Creek Seam	distribution	Entire model area
		top	Floor of Bayswater Coal Seam
		base	Base of Ramrod Creek Coal Seam
		horizontal hydraulic conductivity	1.8×10^{-4} m/day to 0.6m/day (along Fairford Faults)
		vertical hydraulic conductivity	20% of horizontal hydraulic conductivity
		storativity	10^{-4}
		storage coefficient	$5 \times 10^{-6} m^{-1}$
		thickness	Around 120m at western border of lease area
8	Saltwater Creek Formation	distribution	Entire model area
		top	Base of Ramrod Creek Coal Seam
		base	100 m below top
		horizontal hydraulic conductivity	8.6×10^{-7} m/day
		vertical hydraulic conductivity	10% of horizontal hydraulic conductivity
		storativity	10^{-4}
		storage coefficient	$5 \times 10^{-6} m^{-1}$
		thickness	100 m (uniform)

12.4 Model Calibration

As stated in Anderson & Woessner (1992), "calibration of a groundwater flow model refers to a demonstration that the model is capable of producing field measured heads and flows which are the calibration values. Calibration is accomplished by finding a set of parameters, boundary conditions and stresses that produce simulated heads and fluxes that match field measured values within an acceptable range of error".

The objective of model calibration was to reproduce the estimated steady state groundwater levels in the Site area and allow simulation of the impact of the Modification on the groundwater regime. The calibration presented in this report was carried out for the AGE (2009) study, no further calibration was carried for this Modification study. Section 12.7 discusses the predictive model verification used to justify using the existing AGE (2009) calibration.

The accuracy of the model calibration depends on the quality of calibration parameters and the data defining the model domain such as geometry, boundaries, hydraulic properties and stresses imposed on the groundwater systems. It is considered that the horizontal and vertical extent of the model and model boundaries are sufficiently well defined to calibrate the groundwater model. Calibration was achieved from the rainfall recharge rate distribution shown on Figure 27 and adjusting hydraulic conductivity values.

For the steady state model calibration, groundwater measurements from the years 1999 to 2003 were available from groundwater monitoring bores within the Site area. The most recent data prior to commencement of mining activities within the Northern Open Cut were selected as calibration targets. It was assumed that the water levels in the selected monitoring bores were representative of the long-term average (steady state) groundwater levels, as no impact from the mining operation was assumed to have occurred at that time.

The steady-state calibration is shown in Table 7 and as a scatter plot in Figure 28. Figure 29 shows the resulting calibrated groundwater table for steady state conditions.

Table 7: STEADY STATE MODEL CALIBRATION RESULTS

Bore ID	Simulated Water Level Elevation (mRL)	Observed Water Level Elevation (mRL, pre-mining)	Difference (m)
GW1	161.59	166.47	4.88
GW2	145.85	146.13	0.28
GW3	145.61	143.96	-1.65
GW4	175.48	170.63	-4.85
GW5	171.62	175.27	3.65
GW6	206.77	196.40	-10.37
GW7	173.68	173.43	-0.24
GW8	182.22	177.26	-4.96
GW9	182.67	179.66	-3.01
GW10	218.58	210.67	-7.91
GW12	147.80	146.79	-1.01
GW13	161.60	155.40	-6.20
GW15	140.61	141.94	1.33
GW16	122.69	122.67	-0.02
GW17	124.49	126.83	2.34
GW19	137.29	131.51	-5.78
GW20	143.21	144.32	1.11
GW21	127.18	127.59	0.40

Table 7: STEADY STATE MODEL CALIBRATION RESULTS			
Bore ID	**Simulated Water Level Elevation (mRL)**	**Observed Water Level Elevation (mRL, pre-mining)**	**Difference (m)**
GW22	139.39	133.53	-5.86
GW23	139.45	133.37	-6.08
GW24	129.59	130.37	0.78

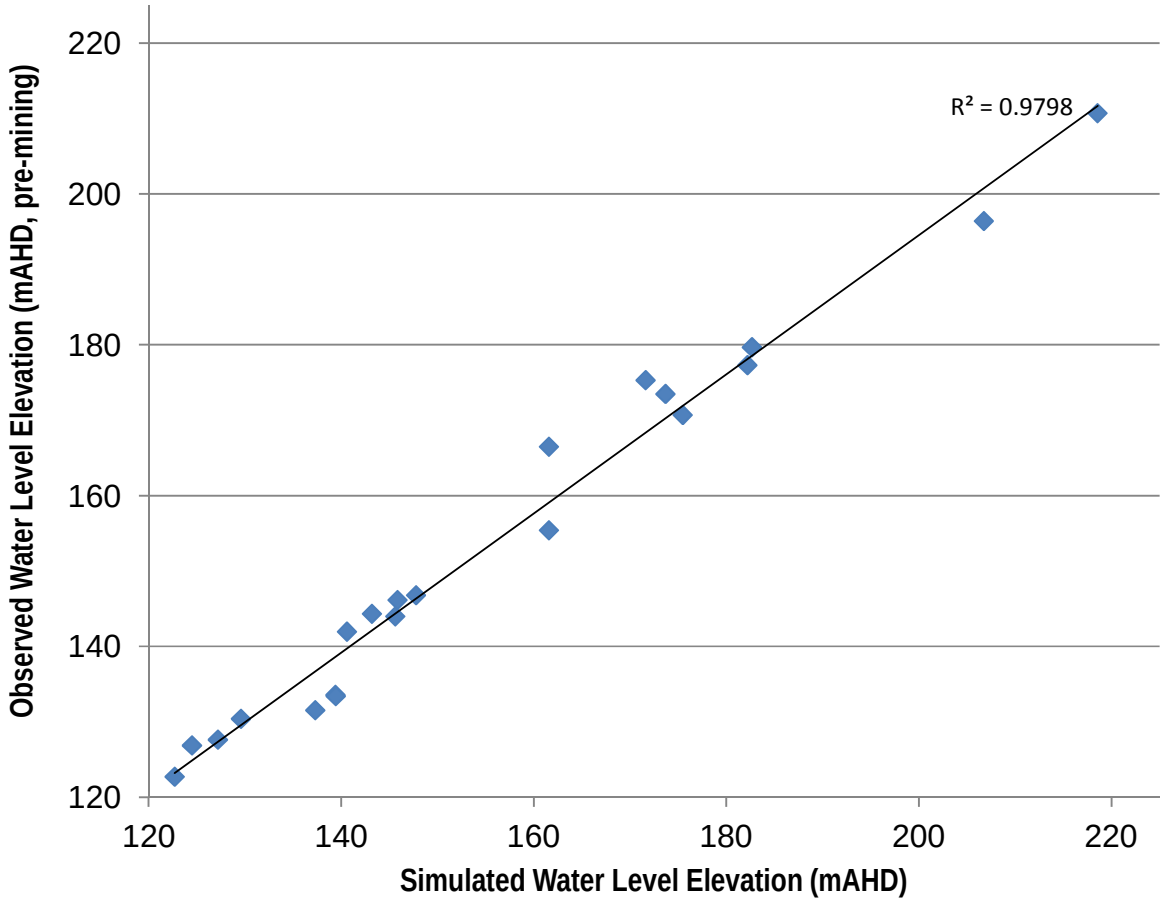
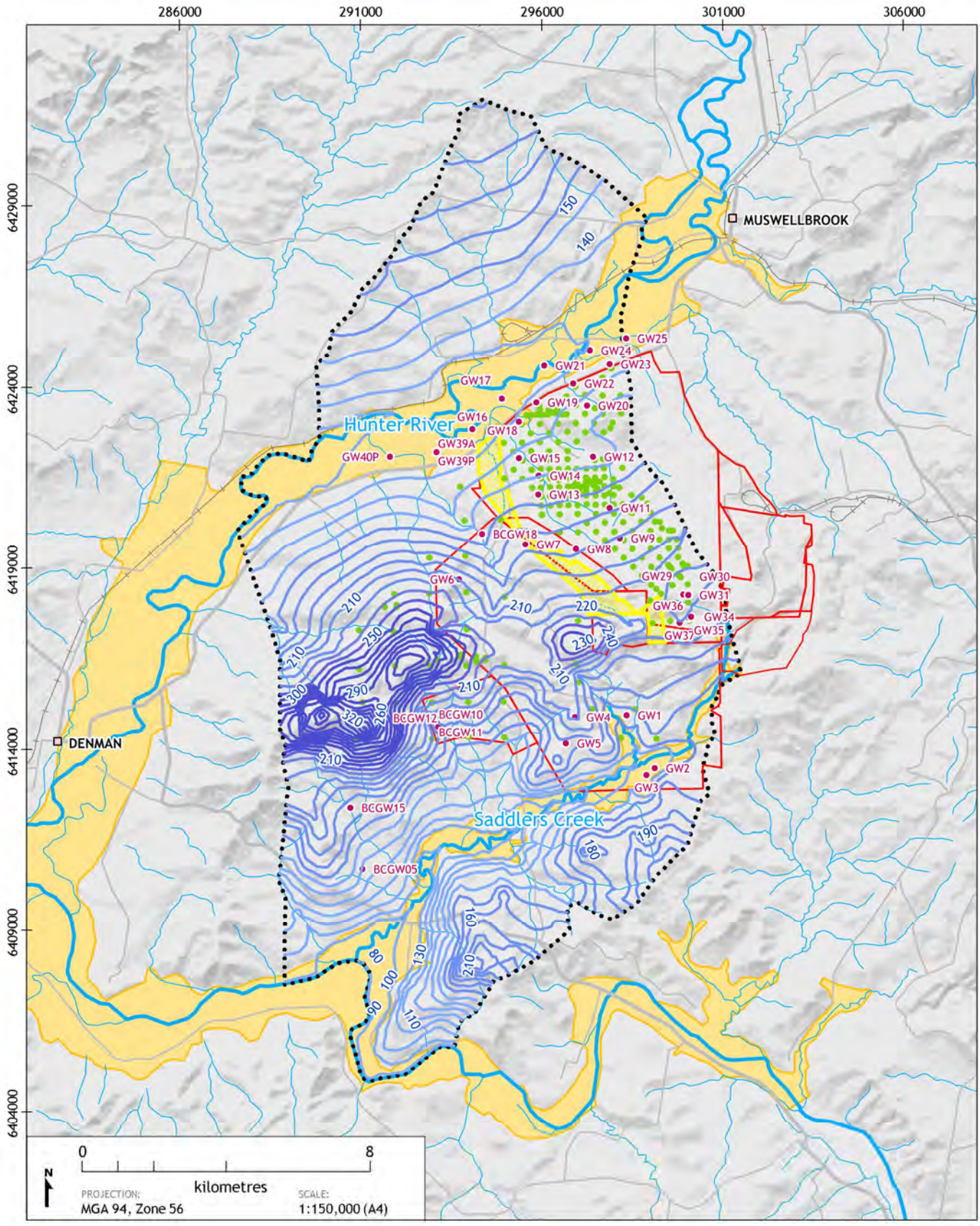


Figure 28: Calibrated Steady State Observed vs. Modelled Heads Scatter Plot



LEGEND:

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary

Simulated Pre-Mining Steady-State Groundwater Level Contours (mAHD)

- 240 to 350
- 230 to 240
- 220 to 230
- 160 to 220
- to 160

- Groundwater Level Measurement
- Groundwater Monitoring Bore
- River
- Creek
- Alluvium
- Road/Track
- Rail

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Calibrated Steady State Water Table Contours

DATE: 23/1/2013

FIGURE No: 29

An objective method to evaluate the calibration of the model is to examine the statistical parameters associated with the calibration. One such method is by measurement of the error between the modelled and observed (measured) water levels. A root mean square (RMS) expressed as:

$$RMS = \left[\frac{1}{n} \sum_{i=1}^{n} \sum (h_o - h_m)^2 \right]^{0.5}$$

where: n = number of measurements
h_o = observed water level
h_m = simulated water level

is considered to be the best measure of error, if errors are normally distributed.

The RMS error calculated for the calibrated model is 4.5 m. The maximum acceptable value for the calibration criterion depends on the magnitude of the change in heads over the model domain. If the ratio of the RMS error to the total head loss in the system is small, the errors are only a small part of the overall model response (Anderson and Woessner, 1992). The total head loss within the model area where the observation targets are distributed is 130 m, so therefore the ratio of RMS to the total head loss is 3.5% referred to as scaled RMS (SRMS).

This error is considered to be acceptable and it is thought that calibration of the model is accomplished in that the simulated heads match field measured values within an acceptable range of error. Barnett *et al.* (2012) suggests a target of <5% SRMS as a target for model calibration. The calibrated steady state model meets this criteria.

This is supported by a mass balance error of 1.5%, that is, the difference between calculated inflows and outflows to the model at the completion of the calibration run expressed as a percentage of discrepancy, as discussed in Section 12.6. This is slightly higher but close to a target of 1% suggested by Barnett *et al*. (2012).

12.5 Calibrated Model Validation

Calibration of the model was validated by using a second set of groundwater level measurements. The purpose of the validation is to confirm that the steady state calibrated model is representative of the real-world groundwater regime.

Groundwater measurements were provided for a larger number of bores for the years 1998 and 1999. This data set was used to create the contour plan of the interpreted groundwater table shown on Figure 13, and as reference data for the validation of the model calibration.

For validation, only those water level measurements collected in years 1998 and 1999 across the whole of the area within the wider mine area were considered where the final depth of the monitoring bore was known. An additional condition was that at least one week must have passed between the completion of drilling of the bore and the water level measurement in order to allow a reasonable accuracy of the measurement. Appendix 2 presents a summary of the validation results and the bore locations are shown on Figure 29.

Similar to model calibration, the selected performance measure for testing the validity of the model is the RMS error. The error was 7.2 m or SRMS of 5.5% in respect to the total head loss of 130 m for the observed model domain. The validation shows that the model responds sufficiently well to different sets of observed groundwater levels. The higher RMS value can be explained by the greater number of observations, the different year of observation, and generally lower accuracy of water level measurements.

12.6 Pre-Mining Groundwater Balance

The steady state water balance of the calibrated model is shown in Table 8, and the breakdown of the simulated total losses to the different creeks and river is shown in Table 9.

Table 8: MODEL STEADY STATE WATER BUDGET

Model Component	Flow Rate (m^3/day)
River Leakage	-5,885
Recharge	5,974
Difference between Inflow and Outflow from the Model Domain	89
Percent Discrepancy (%)	1.5%

Note: m^3/day = cubic metres per day

Table 9: SIMULATED GROUNDWATER DISCHARGE TO THE CREEKS AND HUNTER RIVER

Creek/River	Discharge (m^3/day)
Hunter River	-3,580
Saddlers Creek	-1,080
Secondary Creeks	-1,225
Total	-5,885

Model simulation runs indicate steady state groundwater losses to the Hunter River of about 3,580 m^3/day (3.58 ML/day) and to Saddlers Creek of about 1,080 m^3/day (1.08 ML/day). The Hunter River is the main sink for groundwater within the region, followed by Saddlers Creek.

12.7 Predictive Model Verification

The calibrated model was verified against currently available transient groundwater level data sets, which are available to mid-2012. This was carried out to test the predictive capability of the model prior to simulating the Modification and also to test whether model recalibration would be required. Data available for the verification included 45 monitoring bores; of which 35 bores had coordinates within the model domain. Construction details are available for a number of bores, although it is generally known whether bores are monitoring alluvium or Permian coal measures. Appendix 3 shows the observed versus modelled hydrographs for 25 bores, with their location shown in Figure 12. Based on available data the model predicted heads for the most appropriate model slice are displayed.

Selected hydrographs were plotted against observed data for a series of bores associated with the Quaternary Alluvium (Figure 30). Bores within the Hunter River alluvium (GW16 and GW21) show a good comparison between simulated and observed data, that is remaining fairly static. GW23 is located in the Permian coal measures between the Northern Open Cut and the Hunter River alluvium and shows a slight under prediction in simulated drawdown (3 m). The simulation of water levels within the Permian coal measures below Saddlers Creek (GW02) is closely aligned with observed data.

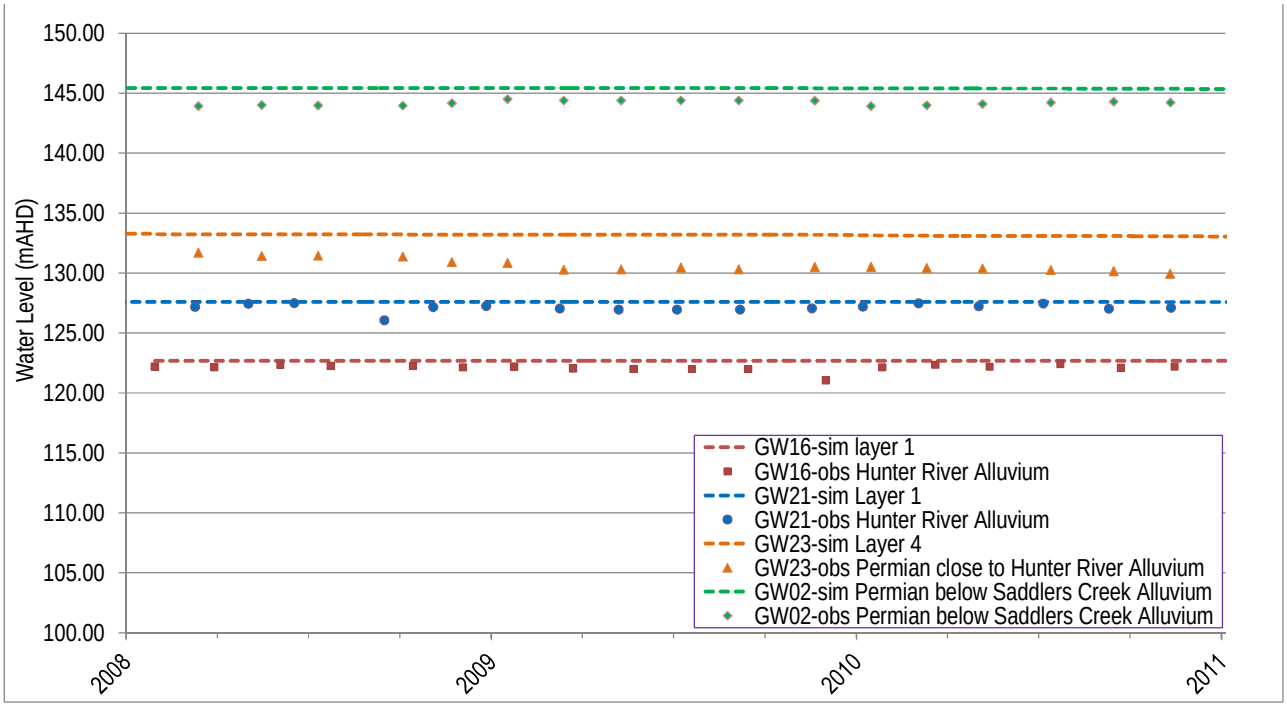


Figure 30: Transient Verification Hydrographs Associated with Alluvium

A selection of hydrographs from bores within the Permian strata to the west and south of the Northern Open Cut area is shown in Figure 31. The simulated hydrographs show that the model under predicts depressurisation in some bores west of the pit (GW07 and GW13), whilst over predicting depressurisation in GW37 to the south of the Northern Open Cut.

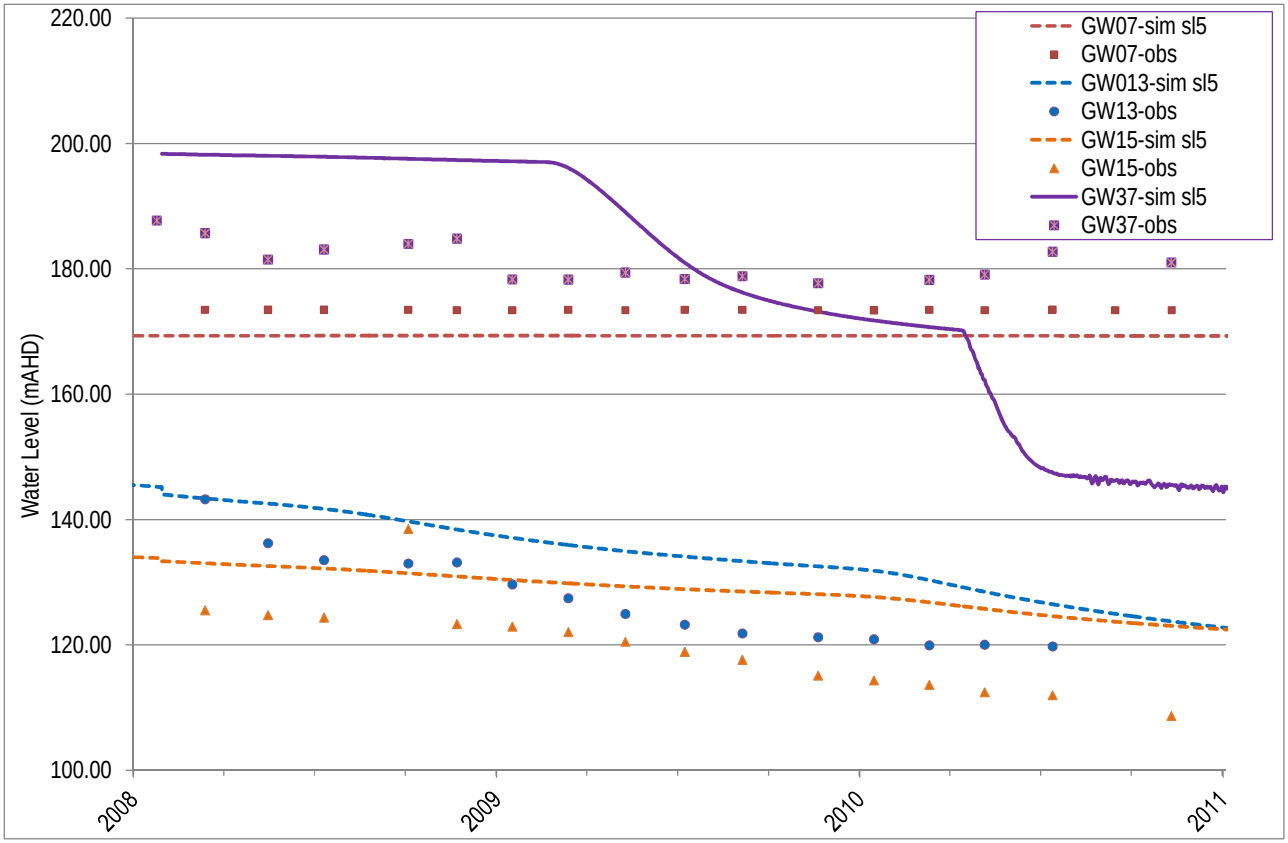


Figure 31: Transient Verification Hydrographs Associated Permian Coal Measures West and South of the Modification

The model results for the entire verification (Appendix 3) show reasonable predictions for bores both unaffected and affected by mine depressurisation. For example Appendix 3 GW13 shows an excellent drawdown trend compared to observed data. Where absolute values are not predicted by the model, major trends are simulated. These trends are considered more important than absolute levels when assessing changes in alluvium flux due to mining.

The BCGW series bores located in the MAU area have been included in Appendix 3. As can be seen in these hydrographs, the simulated effects of approved underground mining can be seen in model Slice 5 data. As the underground operations have not commenced, no drawdown is evident in observed data.

12.7.1 Verification Summary

Transient model verification was carried out to access the predictive capability of the model in the context of the Modification. Model verification suggests an adequate predictive capability of the previous study (AGE, 2009) for the Mt Arthur Coal Consolidation Project. The existing steady state calibration as documented in Section 12.4 is considered appropriate for use in the Modification study.

13.0 PREDICTIVE SIMULATIONS

The model developed for the Mt Arthur Coal Consolidation Project (AGE, 2009) was used as a basis for this study. Mine plans used in this previous study were accurate up to Year 2016, with new mine plans supplied by HVEC for the Northern Open Cut for Years 2016, 2018, 2022 and 2026 (Section 11).

The scope for the predictive simulation has been developed to meet the study objectives and align closely with results from the previous AGE (2009) modelling study. Results from the mine Modification period from Years 2022 to 2026 have been compared throughout this section to the previous model (which ran to 2022). This has been carried out so that additional effects from the Modification can be assessed against the impacts predicted for the current approvals. These results include:

- extension of the zone of depressurisation/drawdown to the west;
- minor changes in leakage rates from the alluvial lands of the Hunter River;
- minor loss of groundwater yield at existing bore locations; and
- change in groundwater quality.

The Mt Arthur Coal Mine and the Bengalla Mine to the north of the Hunter River were simulated in the model.

13.1 Predictive Model Strategy

The finite element model mesh was refined in the immediate vicinity of the Modification (Section 12.3.2). Heads were integrated from the previous modelling study for 2016 as an initial head for this study. Following the integration of new mine pit shells, the updated Modification model was run for the period 2016 to 2026. Predictive models were run in transient mode with adaptive time stepping with a 10-day time step maximum.

13.1.1 Mt Arthur North Pit Modification

Active open cut areas were simulated using transfer boundary conditions (3rd kind Cauchy boundary condition). In general, transfer boundary conditions represent a reference hydraulic head outside the model domain, for instance the water level of a lake. Water exchange with the model is controlled by the hydraulic gradient between the boundary condition and the groundwater elevation, and by a percolation layer between the groundwater body and the reference hydraulic head. The percolation layer is expressed as a constant factor and can be set so that it only allows water to be removed from the model domain, that is by drainage, if the hydraulic head at a node is above a nominated groundwater level.

In the case of the Northern Open Cut for Years 2016 to 2026, the elevations of the pit floors (the deepest seam mined being the Ramrod Creek Coal Seam) was the nominated elevation of the boundary condition. The drainage boundary conditions also covered areas of the mine, where only seams above the Ramrod Creek Coal Seam were mined. The elevation at each boundary condition node varied in accordance with progress of the mine as shown on the mine plans for the Modification (Section 11).

It should be noted that pit backfilling is not simulated in the predictive model. During predictive runs, groundwater is allowed to seep at the previously mined face (irrespective of backfilling). In reality as the Northern Open Cut extends west, previously mined areas are backfilled with spoil (Figure 19). This may overestimate the cone of depression (particularly to the east) from mining, as it is expected there will be some groundwater level recovery in the backfilled pit areas. However, this recovery is likely to be minor as the high permeability of the backfilled spoil will still channel seepage to the lower elevation pit areas.

13.1.2 Mt Arthur Coal Mines

The approved MAU mine was modelled using time-constant transfer boundary conditions. The boundary conditions describing the drainage elevations were exported from the existing MER (2007) groundwater model and assigned manually at different time stages with the simulated progress of mining (Years 2016-2018 and 2018-2022). Boundary conditions previously modelled for Year 2022 were applied to the Modification period to Year 2026. The MER (2007) model explicitly modelled the mined coal seams as five different layers, while the current model groups the coal seams and the interburden into three layers as described in Section 12.3.4. To take account of the different drainage levels, the drainage boundary conditions in the current model are distributed on numerical model slices. By applying the BASD technique (Section 12.3.1), the numerical slices are automatically mapped at the correct elevation during the simulation run.

In addition to the drainage elevations, the groundwater model takes into account the effects of subsidence and fracturing within the overburden. The overburden of the underground mined areas are simultaneously applied with a relatively high vertical hydraulic conductivity of 8.6×10^{-3} m/day at the time of mining. This is also in agreement with the MER (2007) model.

The approved Saddlers Pit to the south of the Modification has also been modelled using time-constant boundary conditions. These boundary conditions remain consistent with the AGE (2009) study. The Saddlers Pit is assumed to run to the end of the Modification period (2026).

13.1.3 Surrounding Mines

The currently approved Bengalla Mine and Bengalla Wantana Extension, located to the north of the Northern Open Cut and the Hunter River, were modelled using time variable transfer boundary conditions. The Bengalla Mine extracts coal to the Edderton Seam and boundary conditions have been generated using publically available data in environmental approval documents (AGE, 2007). These boundary conditions were set consistent with AGE (2009) with mine operations ending at the Bengalla Mine in 2017.

It is understood that DGRs have been issued for application SSD-5170 for the Bengalla Continuation Project for a 24 year period (Hansen Bailey, 2012). The Bengalla Continuation Project has not been simulated in this study as there is a lack of publicly available data. The Bengalla Continuation Project, if approved, is likely to have minimal effect on Mt Arthur Coal Mine operations due to the extension area moving away from both the Mt Arthur Coal Mine and Hunter River to the west, following the dip of the coal seams. Maximum impact from the Bengalla Mine is expected where the mine operations are closest to the Northern Open Cut and the Hunter River Alluvium and therefore the cumulative hydraulic impact on the Hunter River alluvium associated with the Bengalla Continuation Project would likely be less than that associated with the current Bengalla Mine operations.

The approved Mt Pleasant Mine (EMGA Mitchell McLennan, 2010) directly to the north of the Bengalla Mine has not been included in this model. Effects of the Mt Pleasant Mine, if modelled, are not expected to be material in comparison to those occurring due to the Bengalla Mine. Therefore, it is assessed that the simulation of the current Bengalla Mine is sufficient for this assessment to determine cumulative effects of Mt Arthur Coal Mine operations on the Hunter River alluvium.

The currently approved Drayton Mine (AGE, 2006c) has not been simulated in this model. This mining operation located to the east of the model boundary extracts coal from geological formations that are below the low permeability Saltwater Creek Formation (which is the lowermost layer in the Modification model). Drawdown and depressurisation from these mine developments are unlikely to transfer through to the coals measures mined at the Northern Open Cut. Consistent with AGE (2009) a no flow boundary is applied in the model to represent this conceptualisation.

Groundwater impacts of the proposed Drayton South Coal Project have been assessed by AGE (2012). In regard to impacts on the Hunter River Alluvium associated with Drayton South Coal Project, AGE (2012) states:

> *… it has been determined that the Project will not have any measurable impact on the Hunter River alluvial aquifer …*

Given the above, cumulative impacts to the Hunter River Alluvium predicted to result from the Modification are not expected to change in consideration of the Drayton South Coal Project.

In regard to impacts on Saddlers Creek Alluvium associated with Drayton South Coal Project, AGE (2012) states:

> *Seepage fluxes determined at the cessation of mining indicate the net upward flux would reduce to about 0.19 ML/day, and would continue to decline to about 0.1 ML/day, over a period of 150 years after the cessation of mining.*

Further, in regard to cumulative impacts to Saddlers Creek Alluvium associated with Drayton South Coal Project and the currently approved Mt Arthur Coal Mine, AGE (2012) states:

> *The remaining influx to the Saddlers Creek alluvium along the same 6 km section (~0.12 ML/day) may therefore be reduced to zero as a result of the Project.*

As discussed in Section 13.4, the Modification would not result in an increase in flux from Saddlers Creek Alluvium. On this basis, cumulative impacts to Saddlers Creek associated with the proposed Drayton South Coal Project resulting from the Modification are not expected to change.

13.2 Depressurisation/Drawdown – Regional Impact

Open cut mining together with modelled underground mining will result in a cumulative depressurisation of the coal seams and water bearing layers in the interburden within the immediate area of mining activities. Depressurisation, that is, the cone of depression (drawdown) in the piezometric surface/water table will migrate out from the highwall of the pit as mining progresses to the west and north and as the pit becomes deeper.

The cumulative drawdown in the water table at Year 2026 as a result of the Modification is shown in Figure 32. This figure shows the combined drawdown of all modelled pits (MAN, Bengalla and Saddlers Pits) and the MAU operations[2]. The cone of depression south of the Hunter River is, to a large part, the result of the dewatering in the northern and central parts of the Northern Open Cut and the MAU Project.

A variant of the predictive model was run to show the drawdown of the Modification only. The MAU, Bengalla Pit and Saddlers Pit were removed for this run. The model was run for the same period as the model used to assess cumulative impacts (2016 to 2026). A comparison was made between the drawdown at Year 2022 and Year 2026 to demonstrate the extent of water level change due to the Modification only. Figure 33 shows the additional drawdown resulting from the Modification.

The cone of depression extends partially into the Hunter River alluvium but does not extend under the Hunter River. The drawdown caused by the Mt Arthur Coal Mine impacts the whole south-eastern part of the model area to the south of Saddlers Creek.

In summary the extent of additional drawdown resulting from the Modification is shown in Figure 33, where the impact area from this activity can be seen to extend to the north and west of the mine leases but is completely within HVEC owned land, with the exception of a small portion of crown land.

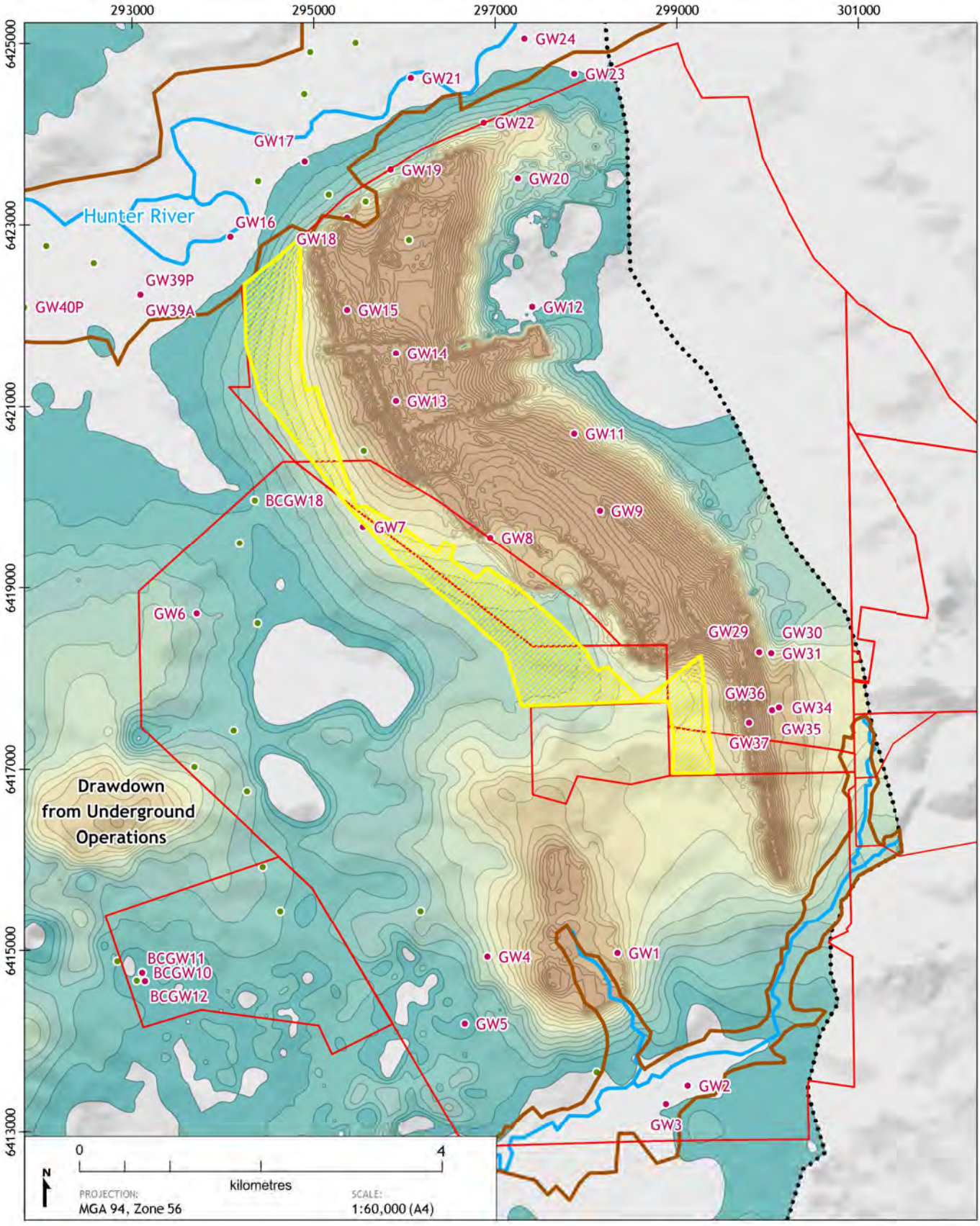
13.3 Pit Inflows

The majority of groundwater inflow occurs to the Northern Open Cut together with the South Pit Extension (Table 10). The results have been plotted against results from the 2009 study (AGE, 2009) for comparison (Figure 34). Inclusion of the updated mine plans and the associated model mesh refinement for Years 2016 to 2022 has had minimal impact on the predicted pit inflows and the results are comparable over this period. Northern Open Cut Pit inflows peak around Year 2016 and reduce after Year 2022. Inflows continue to reduce over the Modification period to Year 2026. Inflows to the open cut pit can be seen to increase at Year 2026 as a result of the Modification, although during mid-2026, they stabilise around 2.16 ML/day (25 L/s).

Table 10: PREDICTED AVERAGE INFLOW TO THE PITS (ML/day)

Project Years	MAN Pit	South Pit	Saddlers Pit	TOTAL
2016	2.33	0.15	0.13	2.61
2017	1.94	0.16	0.13	2.22
2018	2.04	0.16	0.13	2.33
2019	1.77	0.21	0.12	2.10
2020	1.96	0.18	0.16	2.30
2021	1.94	0.18	0.15	2.27
2022	1.90	0.19	0.15	2.24
2023	1.79	0.19	0.13	2.11
2024	1.81	0.20	0.12	2.13
2025	1.63	0.20	0.12	1.95
2026	2.16	0.21	0.12	2.50

[2] It should be noted the drawdown noted around MAU operations differs from the figure present in AGE (2009), which only presents drawdowns associated with open pit mining operations.



LEGEND:

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- NOW Registered Bore
- Groundwater Monitoring Bore
- Alluvium
- River

Water Table Drawdown at Year 2026 (m)

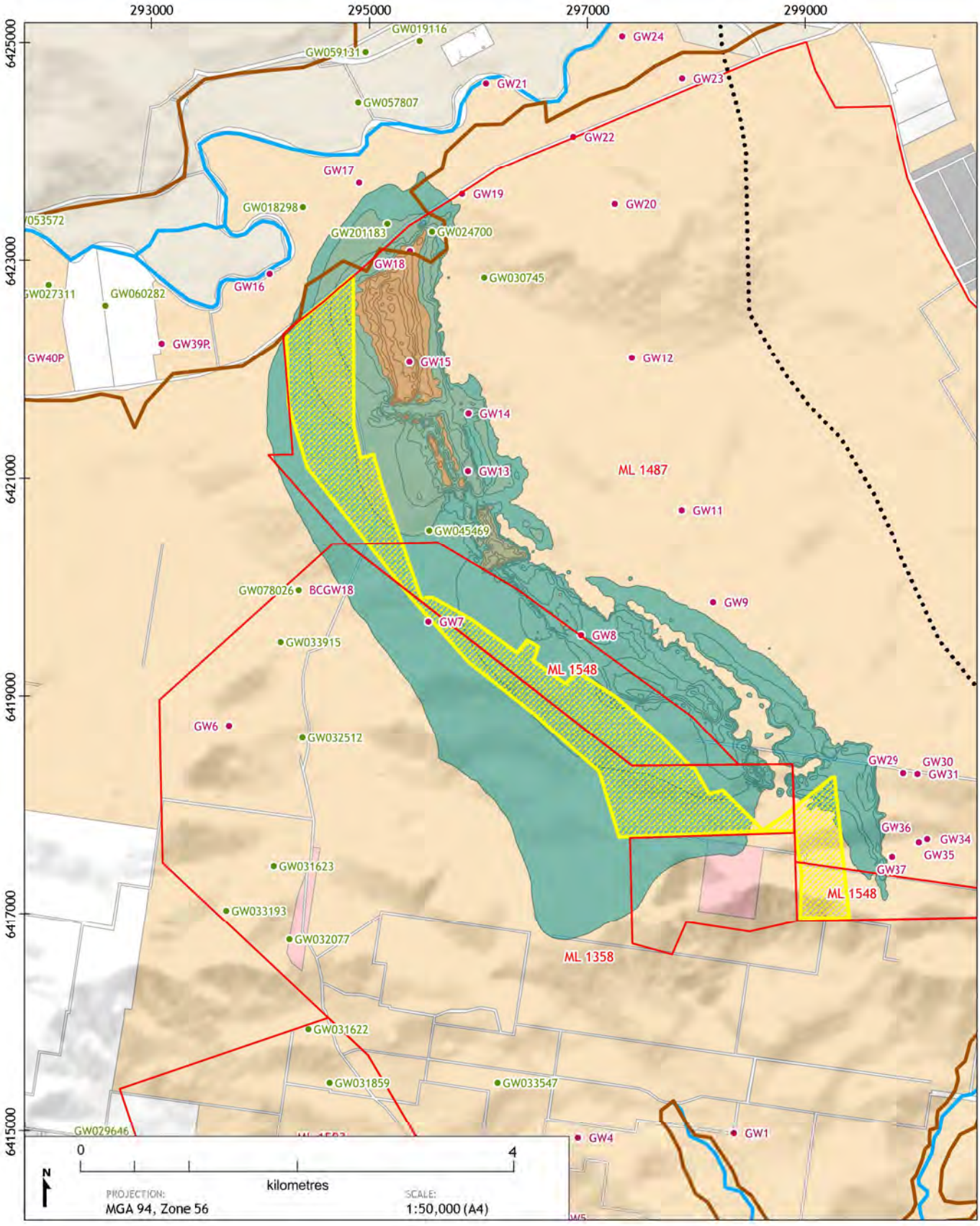
2	42
7	47
12	52
17	57
22	62
27	67
32	72
37	77 to 197

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Water Table Drawdown at Year 2026

DATE: 23/1/2013

FIGURE No: **32**



LEGEND:

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- NOW Registered Bore
- Groundwater Monitoring Bore
- Alluvium
- River

- Crown Land / The State of NSW
- HVEC Owned Land
- Industrial Zone
- Mine Owned Land
- Private Owned Land

Water Table Drawdown (m)

- 2 to 5
- 5 to 10
- 10 to 20
- 20 to 30
- 30 to 90

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Drawdown Associated with the Mine Modification

DATE: 23/1/2013

FIGURE No: 33

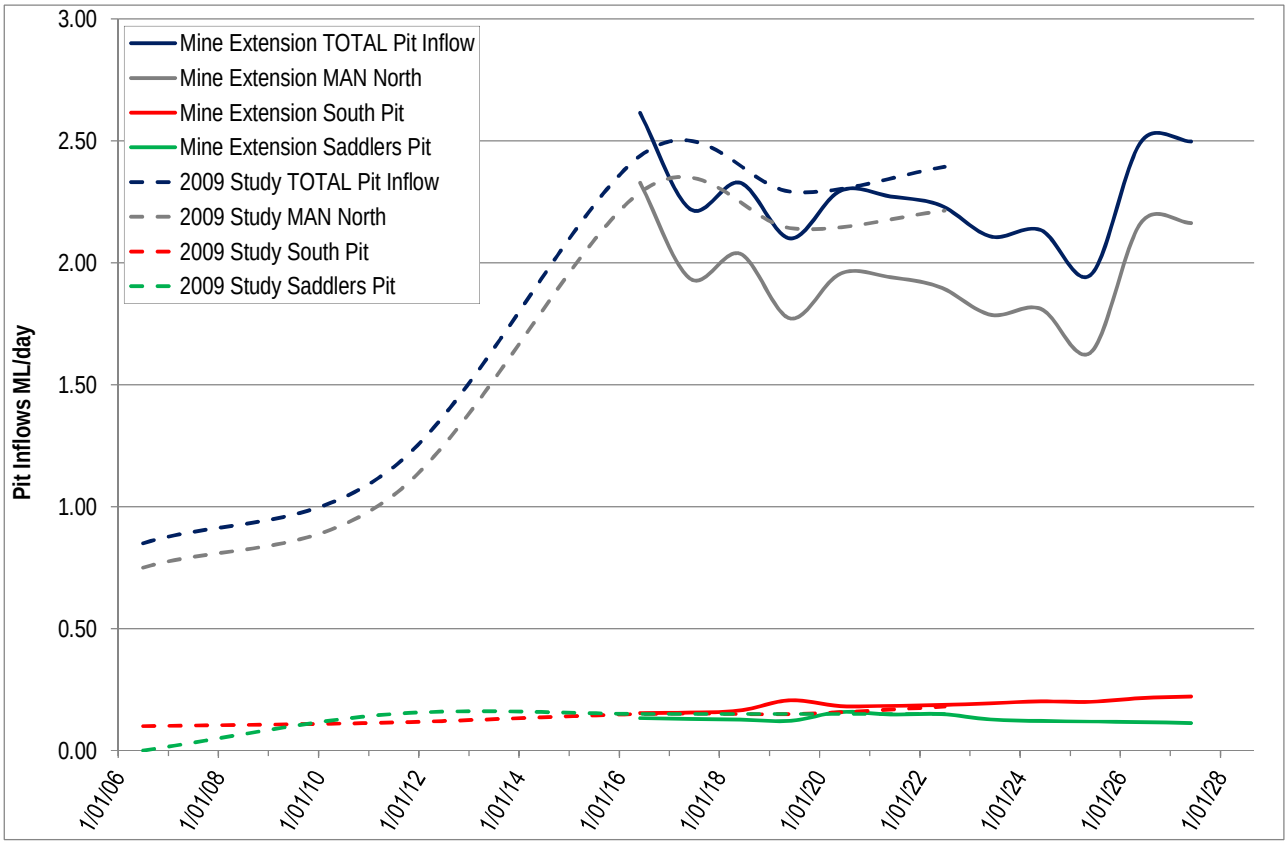


Figure 34: Prediction of Groundwater Inflow into the Pits

The sudden increase in pit inflows in Year 2026 are a result of the instantaneous pit modification at a single time step in the model. In reality pit modification will result in gradual increase in pit inflows, hence the increase in pit inflows are not expected to be as sudden as modelled, rather spread out over the 4-year Modification period.

From Table 10 it can be seen that the maximum total average pit inflow predicted for the Modification period (i.e. Years 2022 to 2026) is approximately 2.50 ML/day. Comparatively, the maximum total average inflow for the approved pit predicted by the updated model, (Year 2016) is approximately 2.6 ML/day (Table 10). Therefore, the Modification would not result in an increase of maximum total average pit inflow.

Not all of this predicted pit inflow will need to be managed or available for mine operations in the pit. The actual volume of water pumped from the mine is likely to be less than the volumes predicted as some water will be removed as moisture with the coal and some lost through evaporation. At least 3% to 5% of this water will be exported with the product coal. Further water loss can be expected by evaporation from the pit floor and coal face seepage with meteorological data indicating that the mean daily evaporation rate from the pit floor can be as high as 3 mm/day. This amounts to an average water loss of about 300 L/day from each 100 square metres of exposed pit floor and wall area.

The differences in pit inflows simulated by the AGE (2009) study and those simulated for this study, illustrated in Figure 34, are a result of both refinement of the model mesh within the Modification Area and incorporation of the newly available mine plan data (from 2016). The incorporation of the newly available mine plan data has resulted in minor differences between the timing of mine development simulated in the AGE (2009) study and this study. These differences are due to the inclusion of the updated mine plan data only and is not a material result of the Modification.

13.4 Leakage of Groundwater from Alluvium

As discussed previously, recharge of the alluvium occurs by rainfall infiltration and upward leakage from the Permian coal seams that sub-crop beneath the alluvium, the latter being responsible for the generally brackish to saline groundwaters at the base of the alluvium. Mining in the area will reduce the rate of the groundwater discharge from the Permian coal measures to the alluvium of the Hunter River and Saddlers Creek. The groundwater salinity measured within the alluvial monitoring bores suggests a reduction in Permian coal measure discharge is occurring, with a corresponding reduction in bore salinity (Section 10.1.2).

Under natural conditions, groundwater flows from the northern part of the Mt Arthur Coal Mine area towards the Hunter River (and south to Saddler Creek); however, with mining at the Northern Open Cut and depressurisation of the Permian coal measures, this groundwater flow will be reduced and with time, will be reversed on a local scale.

Flow path analysis (Figure 35) shows the direction of groundwater flow to a series of points (seeds) simulated along the Hunter River Alluvial/Permian boundaries. To the west, particle tracks flow from the MAU area to discharge to the alluvium (the pre-mining situation), while to the east in the vicinity of the Northern Open Cut, particle tracks move from the alluvium in the direction of the Northern Open Cut. An approximate 4 km length of the Hunter River alluvium and 2.5 km length of the Saddlers Creek alluvium is affected by Mt Arthur Coal Mine open pit operations. These affected alluvial reaches noted from particle tracking correspond with areas of drawdown and depressurisation in the alluvium. It should be noted that the particle tracking includes the cumulative effects of mining prior to Year 2022 as well as the Modification period from 2022 to 2026.

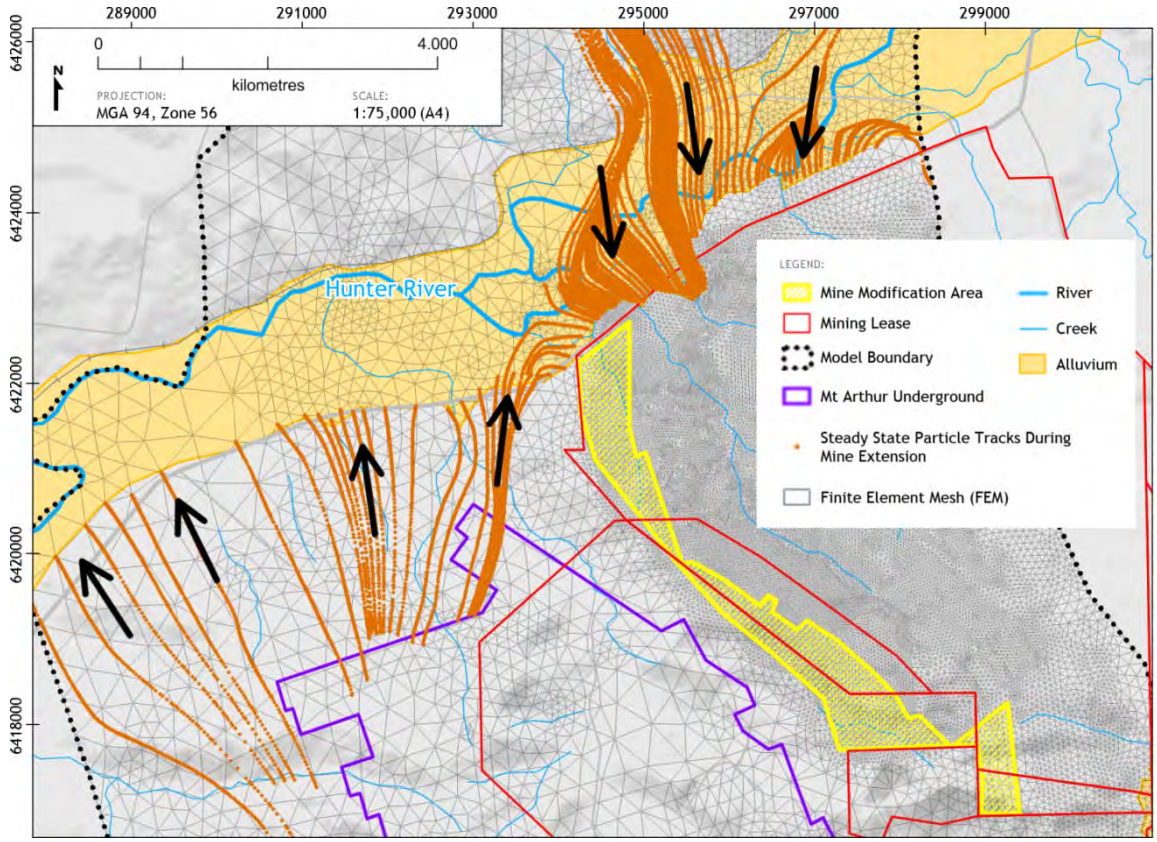


Figure 35: Flow Path Analysis from the Hunter River Alluvium

Flux between the Modification and the MAU to and from the Hunter River and Saddlers Creek alluvium are shown in Table 11 and, as with pit inflows, the fluxes are plotted against AGE (2009) data for comparison in Figure 36.

Table 11: PREDICTED FLUX TO AND FROM ALLUVIUM (ML/day)

Project Years	Hunter River to the Northern Open Cut	Hunter River to MAU	Saddlers Creek to Northern Open Cut	Saddlers Creek to MAU
2016	0.634	-0.247	0.007	-0.048
2017	0.634	-0.235	0.008	-0.032
2018	0.647	-0.233	0.008	-0.029
2019	0.675	-0.236	0.009	-0.034
2020	0.667	-0.234	0.009	-0.027
2021	0.675	-0.226	0.010	-0.026
2022	0.690	-0.220	0.010	-0.025
2023	0.707	-0.210	0.010	-0.027
2024	0.722	-0.196	0.010	-0.027
2025	0.713	-0.182	0.010	-0.027
2026	0.718	-0.171	0.010	-0.027

Note: negative flux in this table is from Permian coal measures to alluvium.

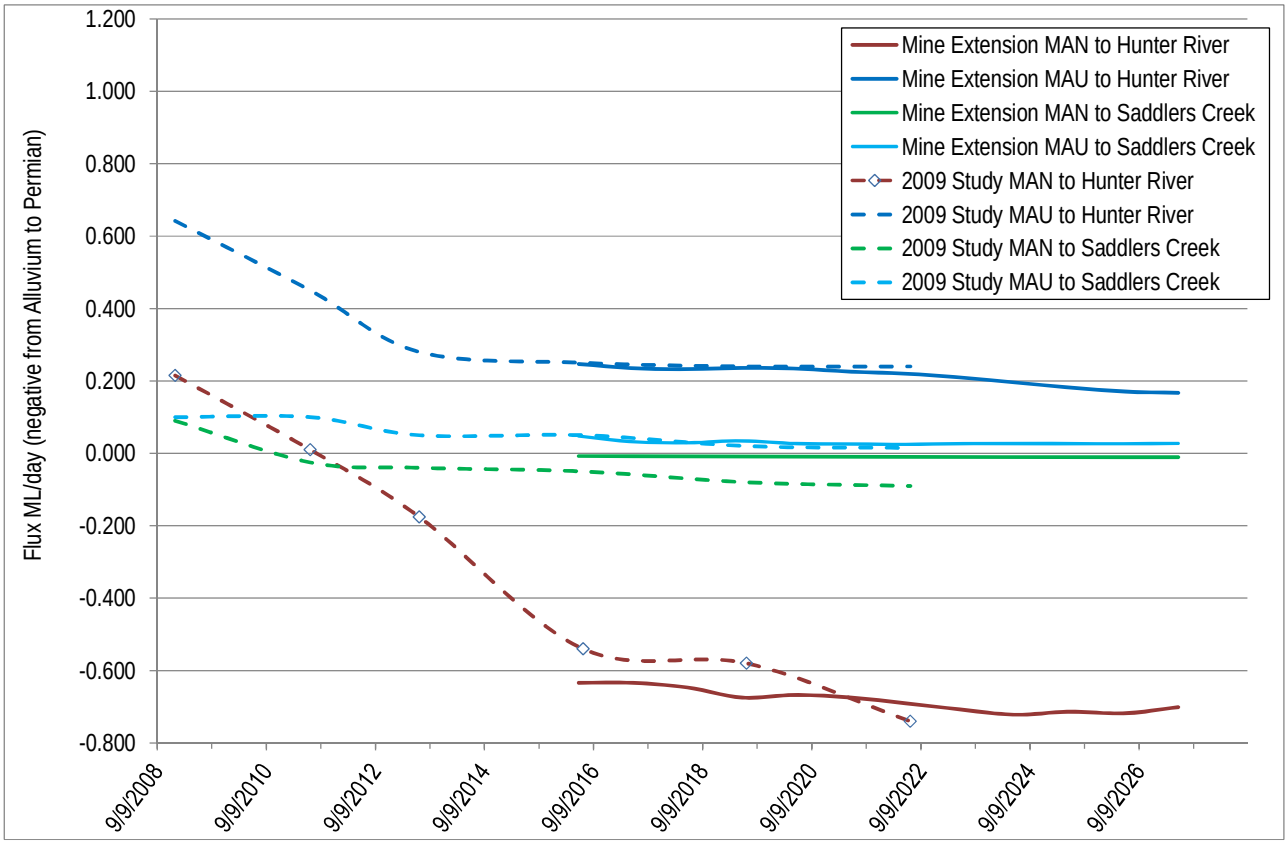


Figure 36: Groundwater Seepage Rates to/from Hunter River and Saddlers Creek Alluvium

Flux from the Hunter River alluvium to the Permian coal measures predicted by the updated model for the approved mining extent (Years 2016 to 2022) is comparable to that predicted by AGE (2009) and is between 0.63 ML/day (7.3 L/s) to 0.69 ML/day (7.9 L/s). Flux from the alluvium remains fairly stable for the Modification period (Years 2022 to 2026) between 0.69 ML/day (7.9 L/s) and 0.72 ML/day (8.3 L/s). Flux from the Hunter River alluvium appears to reach a "quasi-equilibrium" by Year 2022, with the major changes in flux occurring prior to Year 2016 as the Northern Open Cut passes at it closest point to the alluvium.

From Table 11, it can be seen that the maximum flux from the Hunter River alluvium for the Modification period (i.e. Years 2022 to 2026) is approximately 0.72 ML/day. Comparatively, the maximum flux from the Hunter River alluvium predicted by the updated model for the currently approved mining extent (2022) is approximately 0.69 ML/day. On this basis, the flux from the Hunter River is predicted to increase by approximately 0.03 ML/day due to the Modification.

It can also be seen from Table 11 that the maximum flux from Saddlers Creek alluvium to the open pit for the Modification period (i.e. Years 2022 to 2026) is approximately 0.01 ML/day. The maximum flux from Saddlers Creek alluvium to the open pit predicted by the updated model for the approved mining extent (Years 2016 to 2022) is also 0.01 ML/day. On this basis, the Modification would not result in an increase in flux from Saddlers Creek alluvium.

For consistency and comparison to the AGE (2009) study, fluxes between the MAU and alluvium have been included in Table 11 and Figure 36. These remain positive (from Permian coal measures to alluvium), although reduce through the simulation.

As shown in Figure 36, AGE (2009) predicted the maximum flux from the Hunter River alluvium to be approximately 0.74 ML/day for the approved mining extent. The differences in Permian and alluvial flux simulated by the AGE (2009) study and those simulated for this study, illustrated in Figure 36, are a result of both refinement of the model mesh within the Modification Area and incorporation of the newly available mine plan data. The incorporation of the newly available mine plan data has resulted in minor differences between the timing of mine development simulated in the AGE (2009) study and this study. These differences are due to the inclusion of the updated mine plan data only and is not a material result of the Modification.

The volume of leakage from the alluvium to the Permian strata reported in this section is considered a worst case scenario. The model assumes direct hydraulic connection between the base of alluvium and bedrock, that is, the model does not account for the likely occurrence of a weathered clay rich transition zone at the base of alluvium that inhibits leakage.

It should be noted that water quality at the base of the Hunter River alluvium is anticipated to improve in the area of predicted water level change as groundwater discharge from the Permian groundwater systems decline.

13.5 Leakage from Faults

Apart from general leakage due to depressurisation of the coal seam beneath the base of the alluvium, there is also potential for leakage from faults that may occur beneath the alluvium. Fairford Graben was simulated in the model by assigning high conductivity zones of 0.6 m/day along the fault lines. No other faults were simulated in the model. If other faults are identified in the Site area and strike beneath the alluvium and are likely to present a risk with respect to groundwater inflow from the alluvium or to pit wall stability, they will be investigated (consistent with the investigation undertaken for the F4 [Section 8.3]), and if considered to present a risk, mitigation options will be identified and implemented, as per the Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments:

> *Mt Arthur Coal will continue to monitor hydro-geomorphological conditions and scrutinise for evidence of any groundwater ingress or endwall instability indicators as it progresses the previously approved mining towards the Hunter River Alluvials. Mining (other than that already approved in the MAN EIS) will not extend beyond a nominal 150 m buffer zone from the Hunter River Alluvials until agreement is reached with NOW regarding the installation of a lower permeability barrier along the point of connections of mining and the alluvium or other appropriate safeguards.*

13.6 Impact on Groundwater Users

Drawdown of the piezometric surface of the coal seams and of the water table of the shallow alluvial and regolith has the potential to impact existing groundwater users. These potential impacts are discussed in the following sections.

13.6.1 Loss of Yield from Existing Bores

Depressurisation and leakage as a result of mining may result in a lowering of water table/piezometric levels in those existing bores that are used for irrigation, stock and domestic water supplies where these facilities lie within the radius of the cone of depression. As discussed in Section 9.1, existing bores were identified from a search of the NOW database, these are shown on Figure 32 against Year 2026 drawdowns and in Figure 33 against the drawdown impact zone associated with the mine Modification. The potential drawdown for all bores at Year 2026 (the maximum) is tabulated in Appendix 1 along with the drawdown associated with the mine Modification period.

Bores where additional drawdown can be attributed to mine Modification project have been highlighted orange in Appendix 1. These three bores (GW024700, GW045469 and GW201183) are all located on HVEC owned land with bore GW201183 located outside of the mine tenements, although this bore is only used for monitoring purposes.

As documented in Section 9.1 the updated bore search produced a number of bores not included in the AGE (2009) study, these are noted in Appendix 1. Eight of these additional bores show impact from mining activities, although according to the findings of this study, this impact is not directly attributable to the Modification. As documented in AGE (2009), impact is predicted to be greater for bores constructed within the Permian/regolith strata, rather than bores constructed within alluvium.

Notwithstanding the negligible effects due to the Modification noted in surrounding private bores, consistent with the Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments:

> *In the event of interruption to water supply resulting from the Project, an alternative water supply will be provided, until such interruption ceases.*

13.6.2 Impact of the Placement of Overburden on Saddlers Creek Alluvium

The Modification includes the placement of overburden in an upper section of Saddlers Creek Alluvium; the area is shown in Figure 2. The placement of this overburden has not been specifically modelled in this study. The soil profile in this area is moderately drained in the topsoil, becoming poorly drained thereafter (GSS Environmental, 2012). The mapping of soil within this area includes depositional sediments associated with the creek flow, however, due to limited size and poor texture and structural characteristics, these alluvial are not commonly associated with good agricultural land (GSS Environmental, 2012). Therefore, it is expected that any rainfall that is captured and may infiltrate into the overburden is likely to emerge at the base of the overburden as minor seep, rather than infiltrate to alluvium or weathered bedrock.

13.6.3 Groundwater Dependent Ecosystems

No groundwater dependent vegetation comprising GDEs occurs within the Modification Area or immediate surrounds (Hunter Eco, 2012). The regolith and Permian formations are topographically elevated and it is unlikely that the alluvial areas will be impacted from the mine.

13.7 Groundwater Recovery

Groundwater level recovery in the final void following cessation of mining has been simulated using a modified version of the FEFLOW groundwater model developed for the Modification.

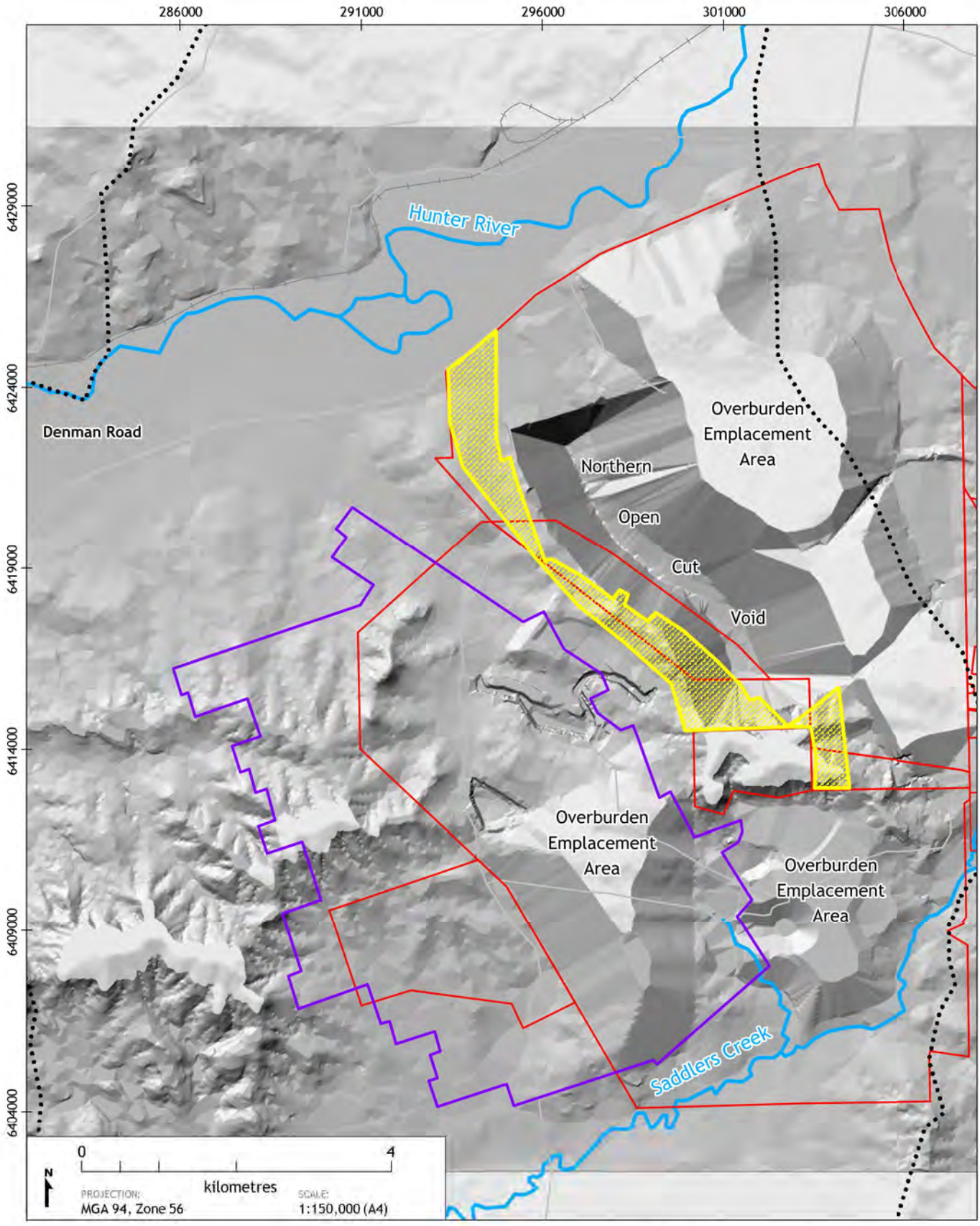
13.7.1 Surface Water Study Final Void Fill Calculations

The surface water study for the Modification also addressed final void recovery using water balance techniques and estimates of pit lake groundwater inflows supplied by AGE (Gilbert & Associates, 2012). The study by Gilbert and Associates (2012) presents an excellent comparison to the recovery modelling discussed here. The results of the surface water study show a period of rapid lake fill (Years 0 – 20) to a level of -20 mRL (170 m below the pit lake spill point), followed by a gradual filling period from Year 20 to Year 500. The surface water study presents a final void level of 15 mRL (135 m below the pit lake spill point).

13.7.2 Recovery Groundwater Modelling Build

The final backfilled pit and spoil landform (final landform) is shown as a shaded relief image in Figure 37. Using this final landform, the following process was used to develop the recovery model:

- The calibrated model and scenario model results presented in previous sections of this report were used as a starting point to recovery model development. All parameterisation and settings remain the same as previously discussed in this report, unless otherwise as stated in this section.
- Drawdown at year 2026 (cessation of mining) from scenario modelling was used as the starting heads (as shown in Figure 32 for one model layer) for the recovery model development.
- The complete final landform (including spoil) above the original land surface (as shown in Figure 37) was integrated to form a new ground surface within the model as Slice 1.
- Spoil:
    - Although spoil was not simulated during the dewatering simulation, it was deemed necessary to include spoil in this simulation which is to run up to 500 years post closure.
    - Increased horizontal and vertical hydraulic conductivity was applied to the spoil at 1 m/day to represent increased permeability over in-situ material. This also represents the general isotropic permeability of spoil over the relatively anisotropic (layered) permeability of coal seams, overburden and interburden.
    - Storage properties for spoil were set at 5%.
    - Increased recharge to the spoil was initially set at 5% of rainfall, believed to be an upper bound of increased recharge potential. In subsequent scenarios, this recharge to the spoil was reduced to 2.5% of rainfall to take into account increased evapotranspiration that is expected over the spoil pile. Both of these recharge values are a net increase in recharge compared with the predictive pit dewatering model.
    - In backfilled mined areas, spoil hydraulic conductivity and storage parameters were set in all model layers to the base of Layer 7 (base of the Ramrod Coal Seam), while in areas of spoil overlying previously unmined formations, spoil parameterisation was only set for Layer 1.



LEGEND:

- Mine Modification Area
- Mt Arthur Coal Mining & Coal Lease Boundary
- Model Boundary
- Mt Arthur Underground
- Town
- Road/Track
- Rail
- River

Mt Arthur Coal Open Cut Modification
Groundwater Impact Assesment (G1602)

Closure Landform

DATE: 23/1/2013

FIGURE No: 37

- Pit Lake:
  - The final void pit lake was simulated by applying a high permeability void within the model environment. The original ground surface was used as a top of this void, with the final void (as shown in Figure 37) used as a base to this zone. Hydraulic conductivity was set at 1,000 m/day and storage properties set at 99% to represent the open void. Using a high permeability/storage zone for a pit lake within FEFLOW maintains stability in the model and allows pit lake level to be monitored via an observation node measuring the water table (a surrogate for pit lake level).
  - The pit lake void was developed in the model in an area representative of the three-dimensional void shown in Figure 37. Hence the area of the void was smallest at the base (Layer 7) and increased in size toward the surface layers to represent the inverted cone shape of the final pit structure.
  - Recharge to the final void pit lake was modified to simulate a simple water budget of incident rainfall (645 mm/year) minus evaporation (1,642 mm/year) which equates to 997 mm/year water deficit from the pit lake. A second scenario was run to simulate increased run-off to the pit at essentially 75% of 997 mm/year, which equates to 747 mm/year of water taken from the pit lake. These evaporation rates were implemented in FEFLOW using the Inflow/Outflow on top setting.

- Model Settings
  - To increase numerical stability, the recovery model was run in Phreatic mode in FEFLOW (versus Free and Movable for the calibrated model). As a result of this, the top slice of the model is maintained as per the ground surface (and the elevated spoil piles).
  - The top slice of the model was set as a seepage face, hence any water that may seep from the spoil would be rejected from the model as seepage.
  - The modified model was then run using year 2026 starting heads, initially this was run to make sure the final landform was dewatered and formed a stable starting condition to the recovery modelling. Dewatering to the final landform was run using the same settings as scenario dewatering modelling (i.e. through implementation of 3rd kind boundary conditions at the pit face). The result of this short dewatering run “bridged the gap” between the final 2026 modelled pit and the final landform dewatered surface.

A schematic cross-section through the final pit lake model (in the vicinity of the pit) is shown in Figure 38. The final pit lake void is represented in red, the spoil pile above ground and in previously mined areas is represented in orange, the unmodified model layers representing overburden, interburden and coal seams are represented in yellow. The blue area in this schematic represents the low permeability Saltwater Creek Formation. It should be noted that during the long-term recovery runs (>100 years) an upward hydraulic gradient was observed from the Saltwater Creek Formation below the pit void area. Conceptually the Saltwater Creek Formation is described through this report as an aquitard. To mitigate any long-term effects in the recovery model from upward leakage from this aquitard, hydraulic conductivity was reduced further in this model layer compared to the previously calibrated model.

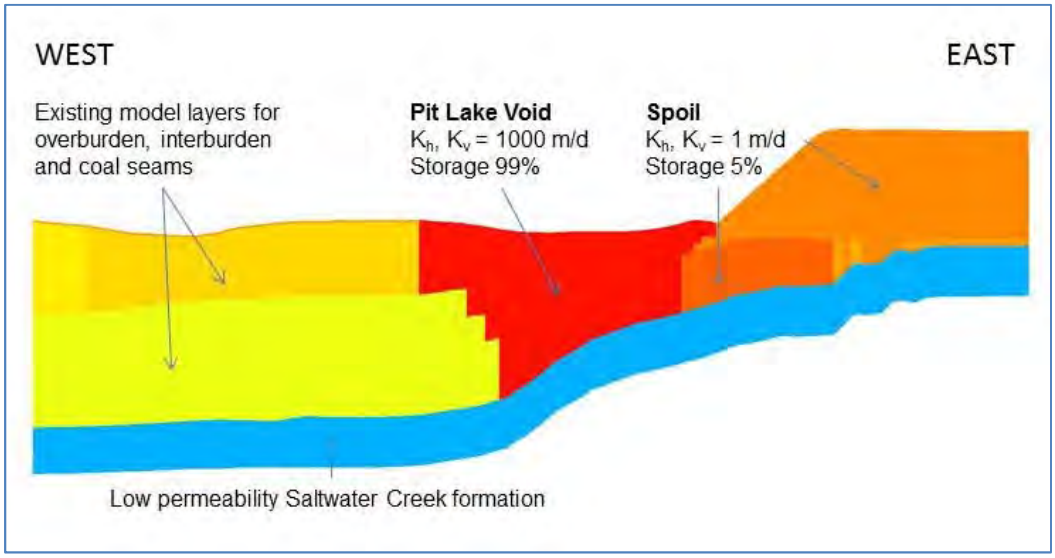


Figure 38: Schematic of the Final Void Recovery Model

13.7.3 Recovery Groundwater Modelling Scenarios

The modified final landform model was run for a period of 500 years to simulate pit lake level recovery. Four scenarios were carried out as described in Table 12. The range of scenarios is thought to include the possible range of combinations effecting evaporation from the pit lake and additional recharge to spoil, representing a base-level sensitivity analysis. The transient results are shown in Figure 39 compared against a final pit lake spill point of 150 mRL and also against the Hunter River boundary condition elevation which ranges between 120 mRL to 135 mRL (in the vicinity of the pit). Pit lake levels at year 200 and year 500 are also noted in Table 12. The simulation also showed that the groundwater system would recover over time with substantial recovery to levels similar, or above those within the pit lake.

Table 12: PIT LAKE RECOVERY MODEL SCENARIOS

Scenario	Pit Lake Evaporation (mm)	Spoil Recharge (% of rainfall)	Final Lake Level at 200 Years (mRL)	Final Lake Level at 500 Years (mRL)
1	-747	5	48 (102 m from spill)	59 (91 m from spill)
2	-997	5	45 (105 m from spill)	55 (95 m from spill)
3	-997	2.5	41 (109 m from spill)	45 (105 m from spill)
4	-747	2.5	48 (102 m from spill)	59 (91 m from spill)

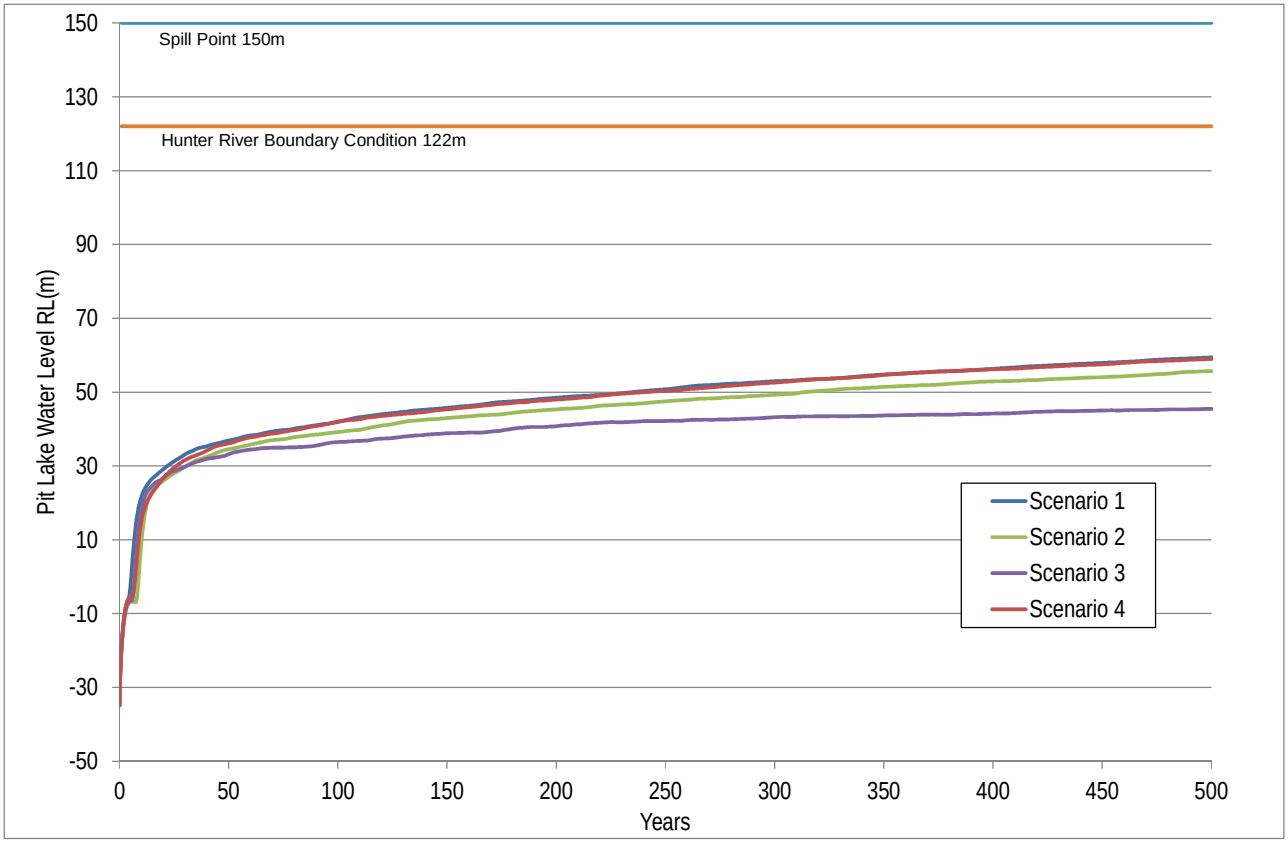


Figure 39: Pit Lake Recovery Levels

The shape of the lake level fill curves are comparable between Figure 39 and results from the surface water study (Gilbert & Associates, 2012). Both fill rapidly to year 20 with a reduction in the fill rate after this time - shown as a gradual recovery in Figure 39 from year 20 to year 500. Results from the simulation show final pit lakes in the range of 45 mRL to 59 mRL or between 105 m to 91 m from the final spill point. All scenario results show final lake level well below the Hunter River Boundary condition, outlining that groundwater discharge from the pit lake to this boundary is highly unlikely to occur.

While final lake levels from recovery groundwater modelling are higher (30 m - 44 m) than those presented by the surface water study, the results are generally consistent. It is noted that both approaches for predicting final lake water levels (i.e. development of a water balance versus numerical groundwater model predictions) conclude that the final lake water level is well below the groundwater discharge point (i.e. Hunter River elevation) and the potential pit spill level. The slightly higher final lake level predicted by the groundwater model can possibly be attributed to extra recharge introduced through spoil in this simulation, which was not included in the surface water study. The modelling results suggest that the final void pit lake will behave as a “sink” in the local groundwater environment, suggesting a very low probability of discharge from the final pit lake to the wider groundwater environment in the post closure situation.

14.0 WATER QUALITY

Groundwater monitoring data suggests, based on bore EC results, a lowering of salinity in alluvial monitoring bores directly to the north of the Northern Open Cut (Section 10.1.2). It is likely this change is due to a reduction in groundwater flux of more saline groundwater from the Permian Coal Measures to the alluvium, resulting from pit dewatering. The Modification modelling predicts a continued dewatering in the mine pit area, suggesting an ongoing “sink” in the local Permian coal measures. Due to this ongoing sink in the Permian coal measures, there is not expected to be significant migration or deterioration in groundwater quality resulting from the Modification.

15.0 WATER LICENSING

Licensing under the HURAWSP is required to account for any loss of flow to the alluvium resulting from the Modification. The HURAWSP is discussed in Section 4.3.2. Details of the current groundwater licences held by HVEC are summarised in Table 13.

Table 13: GROUNDWATER LICENCE SUMMARY

Licence Number	Licence Volume (ML/annum)	Issue Date	Expiry Date
Licence under the Water Management Act 2000			
WAL18175	13	16/11/2011	Perpetuity
WAL18141	104	25/07/2011	Perpetuity
WAL18247	247	25/07/2011	Perpetuity
Licences under the Water Act 1912			
20BL171995	750	5/11/2008	4/11/2013
20BL168155	750	28/05/2007	27/05/2017
20BL171156	150	13/03/2007	Perpetuity
20BL170620	250	5/12/2011	4/12/2016

Source: BHP Billiton Ltd (2011).
ML/annum = megalitres per annum.

The maximum predicted annual groundwater volumes required to be licensed for the approved operations and for the Modification are summarised in Table 14.

Table 14: LICENSING REQUIREMENT SUMMARY

Relevant Legislation	Groundwater Source	Predicted Maximum Annual Licensing Requirements (ML/annum)		
		Approved	Incremental Increase due to the Modification	Total Including the Modification
HURAWSP	Hunter River Alluvium	252[1]	12[2]	264
Water Act	Porous Rock	1,270[3]	No Increase[4]	1,270

[1] Based on the maximum simulated average flux from the Hunter River Alluvium for the approved operations predicted by the current model.

[2] Based on the maximum simulated average flux from the Hunter River Alluvium predicted for the Modification.

[3] Based on the maximum simulated average pit inflow and corresponding underground mine inflow for the approved operations predicted by the current model.

[4] Based on the maximum simulated average pit inflow and corresponding underground mine inflow predicted for the Modification.

Table 13 indicates that HVEC currently hold licence entitlements of 364 ML/annum for the HURAWSP and 1,900 ML/annum for water extracted from porous rock. Table 14 shows that the Modification will result in an additional 12 ML/annum from the Hunter River Alluvium and no increase in water extracted from porous rock. In addition the Modification would not result in an increase in water extracted from Saddlers Creek alluvium (Section 13.4). Therefore adequate licences are available to account for the potential incremental increase in take of water associated with the Modification. If required, HVEC would transfer water entitlements between water management zones in order to adequately licence groundwater extraction.

The post-closure annual licensing requirements are expected to be less than the licensing requirements during operation. Post-closure licensing requirements would be refined as mining progresses.

16.0 CLIMATE CHANGE

Current assessments for climate change in the region of the Modification range from (Commonwealth Scientific and Industrial Research Organisation, 2012):

- 10th percentile: -15% rainfall (-96 mm/year) and +3% evapotranspiration (+49 mm/year);
- 50th percentile: -3.5% rainfall (-22 mm/year) and +6% evapotranspiration (98 mm/year); and
- 90th percentile: +7.5% rainfall (+48 mm/year) and +10% evapotranspiration (164 mm/year).

This suggests a slight decrease in potential recharge to the system and therefore potential cumulative impacts to the groundwater system associated with the Modification and climate change. However, as the Modification is not predicted to result in significant impacts relative to impacts of the currently approved mining, and in the context of the four-year Modification period, the simulation of the effect of climate change is not considered to be warranted within the numerical model.

17.0 ASSESSMENT AGAINST GUIDELINES

The model and report has been assessed against the Australian Modelling Guidelines (Barnett et al., 2012). The guidelines discuss model confidence level classifications (Class 1, Class 2 or Class 3 in order of increasing confidence). These are summarised as follows:

- Class 1 – The model meets the lowest level of classification.
- Class 2 – The study meets the majority of Class 2 confidence levels other than mass balance closure <1% (1.5% in the steady state model) and a lack of baseflow estimates.
- Class 3 – The study meets a large number of the Class 3 confidence level confidence levels but lacks in the following areas:
    - Spatial distribution of bore logs and associated stratigraphic interpretations clearly define aquifer geometry. While these are adequate to meet the study objectives they may not meet Class 3 standards for aquifer geometry definition across the entire model domain.
    - Streamflow and stage measurements are not available with reliable baseflow estimates at a number of points.
    - Seasonal fluctuations are not adequately replicated, although with little seasonal fluctuations in Permian Coal Measures these may not be relevant.
    - The model is not calibrated to measured fluxes (only heads) although boundary fluxes were checked against plausible values.
    - The Length of predictive model is excessive compared to length of calibration period as only steady calibration was carried out. The same point is valid for models where predictive time frames are greater than three times the duration of the transient calibration and temporal discretisation in the predictive model is the same as that used in calibration.

The impact assessment model and report is assessed as having a Class 2 confidence level classification but also meets many of the Class 3 level criteria. The study generally meets the compliance checklist of the guidelines but does lack in the areas relating to sensitivity and uncertainty analysis. The lack of sensitivity and uncertainty does not detract from the model being used as a predicative tool. This conclusion is supported by verification of the 2009 calibrated model against available transient groundwater level data. In consideration of the above, the current study (model and report) is deemed fit for purpose to simulate the impact of the Modification.

18.0 LIMITATIONS AND ASSUMPTIONS

Development, calibration and the results of predictive simulations from any groundwater model is based on available data characterising the groundwater system under investigation. It is not possible to collect all the data characterising the whole groundwater system in detail and therefore various assumptions have to be made during development of the groundwater model. A number of assumptions were made during development of the groundwater model described in this report and these assumptions together with their impact on the simulation results are discussed below.

Since the simulated groundwater systems sub-crop along the eastern border of the groundwater model, it is assumed that they are hydraulically separated from the groundwater regime east of the Modification. The impact of such an assumption on the simulation results is such that the cone of depression caused by the Northern Open Cut cannot extend beyond the eastern boundary. It also implies that the Bayswater No. 2 and Drayton Mine have no impact within the mine Modification Area.

The conceptual model assumes that the hydraulic properties of the numerous Permian coal seams present within the mine Modification can be represented by three major layers. The hydraulic properties of a number of coal seams present within these layers were merged with the properties of the interburden. This simplification may lead to underestimation of the extent and the velocity of development of the cone of depression. This is because the cone of depression in coal seams that have relatively higher hydraulic conductivity is likely to develop somewhat quicker than in the less permeable interburden. However, the chosen approach is considered to be acceptable since the cone of depression is limited in extent and the period of the simulated mine development is sufficiently long enough to compensate for any major difference between the development of the cone of depression in the coal seams and in the interburden.

With respect to the Modification model, all information and data relating to the MAU used in the current model has been extracted from the corresponding numerical groundwater flow model of the underground mine (MER, 2007). Nonetheless, some discrepancies occur in the interpretation of the results regarding the hydraulic impact of the underground mine. This may be due to the different settings of the outer boundaries. Where the MER model extended the model domain beyond the Mount Ogilvie Fault, the current model uses this structural feature as model boundary, reducing the available volume for dewatering. This leads to a prediction of a somewhat higher impact on the Saddlers Creek and Hunter River alluvium, even though the general assessment remains similar. The MAU conditions used for Year 2022 have been extended to the mine Modification period (2026) for this study.

The model predicts transient mine impacts using time constant conditions representing recharge and river flow. This approach is common place for a model of this complexity with the need to model more complex transient recharge and climatic data beyond the scope and objectives of the model.

Progressive backfilling of the pits with spoil has not been simulated in the predictive simulations. This is likely to slightly over-predict the extent of depressurisation from mining, particularly in areas mined first to the east of the Northern Open Cut.

In the predictive scenarios, the Bengalla Mine is simulated to cease operation in 2017. It is understood there is a current application by Coal and Allied Pty Ltd to extend the Bengalla Mine operations beyond this date; however, this has not been simulated within the model. Previous modelling (AGE, 2009) of the Bengalla Mine Pit (pre 2017) at its closest position to the Hunter River, showed no connection of depressurisation or drawdown beneath the Hunter River from the Bengalla Mine Pit to the Northern Open Cut. Further mine expansion at Bengalla Mine is likely to occur down-dip and away from both the Northern Open Cut and Hunter River alluvium. The lack of previous interconnection and the likely progression of the mine from the alluvium are deemed adequate reasoning to not include the Bengalla Mine expansion in the current mine Modification model.

Further, the model does not simulate the approved Mt Pleasant and Drayton Mines or the proposed Drayton South Coal Project. Simulation of these mines was not considered necessary to quantify the cumulative impact of the Modification and justification for this is provided in Section 13.1.3.

19.0 CONCLUSIONS

This study has included an update of the conceptualisation and numerical groundwater model of the Mt Arthur Coal Mine to include current groundwater level and quality information, updated mine plans and a simulation of the proposed mine Modification period from Years 2022 to 2026. The earlier calibrated model proved accurate in its predictive capability when verified against a transient data set.

The scope of this study included an assessment of change in the alluvium groundwater level and quality, the impacts on groundwater users from the Modification, and prediction of inflows to the open pit operations.

Relatively small changes in leakage from and drawdown in the alluvium are noted from this study. Very little change was also noted in pit inflows compared to the previously approved mine operations. On-going drawdown is noted in Permian coal measures from both the mine Modification and simulated approved underground operations.

Results suggest that the largest impacts on groundwater users occur around the 2016 period, with operations till 2022 having already been approved for operation. It is thought that effects are the largest at this time to alluvial groundwater users (2016) due to mining activities being at their nearest to the Hunter River alluvium, with the ongoing mine Modification slightly further away from the alluvium, hence reduced impacts on the alluvial system after 2016. It is also assessed that following the initial dewatering, a quasi-steady state has developed in the groundwater environment for the period of the mine Modification.

Although the effects based on this study on the Hunter River Alluvium and private bore users of the Modification were assessed to be minor, in accordance with the Project Approval for the Mt Arthur Coal Mine – Open Cut Consolidation Project Statement of Commitments:

- *Mt Arthur Coal will undertake a census of privately owned groundwater bores to ascertain their current usage and provide a baseline against which to compare any future impacts. In the event of interruption to water supply resulting from the Project, an alternative water supply will be provided, until such interruption ceases.*

- *Mt Arthur Coal will continue to monitor hydro-geomorphological conditions and scrutinise for evidence of any groundwater ingress or endwall instability indicators as it progresses the previously approved mining towards the Hunter River Alluvials. Mining (other than that already approved in the MAN EIS) will not extend beyond a nominal 150m buffer zone from the Hunter River Alluvials until agreement is reached with NOW regarding the installation of a lower permeability barrier along the point of connections of mining and the alluvium or other appropriate safeguards.*

These safeguards are consistent with AGE (2009), the approved current mining operations and are appropriate to cover any inherent uncertainty in modelled predictions in this study.

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21.0 GLOSSARY

Alluvium - Sediment (gravel, sand, silt, clay) transported by water (i.e. deposits in a stream channel or floodplain).

Aquiclude - A low-permeability unit that forms either the upper or lower boundary of a groundwater flow system.

Aquifer - Rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, Confined - An aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

Aquifer, Perched - A region in the unsaturated zone where the soil may be locally saturated because it overlies a low-permeability unit.

Aquifer, Semi-confined - An aquifer confined by a low-permeability layer that permits water to slowly flow through it. During pumping of the aquifer, recharge to the aquifer can occur across the confining layer. Also known as a leaky artesian or leaky confined aquifer.

Aquifer, Unconfined - An aquifer in which there are no confining beds between the zone of saturation and the surface. There will be a water table in an unconfined aquifer. Water-table aquifer is a synonym.

Aquitard - A low-permeability unit than can store ground water and also transmit it slowly from one aquifer to another.

Colluvium - Sediment (gravel, sand, silt, clay) transported by gravity (i.e. deposits at the base of a slope).

Cone of Depression - The depression in the water table around a well or excavation defining the area of influence of the well. Also known as cone of influence.

Drawdown - A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping of ground water from wells or excavations.

Falling/Rising Head Test - A test made by the instantaneous addition, or removal, of a known volume of water to or from a well. The subsequent well recovery is measured.

Head - sum of datum level, elevation head and pressure head which in unconfined aquifers is equal to the groundwater elevation.

Hydraulic Conductivity - A measure of the rate at which water moves through a soil/rock mass. It is the volume of water that moves within a unit of time under a unit hydraulic gradient through a unit cross-sectional area that is perpendicular to the direction of flow.

Hydraulic Gradient - The change in total head with a change in distance in a given direction. The direction is that which yields a maximum rate of decrease in head.

Infiltration - The flow of water downward from the land surface into and through the upper soil layers.

Model Calibration - The process by which the independent variables of a digital computer model are varied in order to calibrate a dependent variable such as a head against a known value such as a water-table map.

Packer Test - An aquifer test performed in an open borehole to determine rock permeability; the segment of the borehole to be tested is sealed off from the rest of the borehole by inflating seals, called packers, both above and below the segment.

Piezometer - A non-pumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface. A piezometer generally has a short well screen through which water can enter.

Porosity - The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

Potentiometric Surface - A surface that represents the level to which water will rise in tightly cased wells. If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The water table is a particular potentiometric surface for an unconfined aquifer.

Pumping Test - A test made by pumping a well for a period of time and observing the response/change in hydraulic head in the aquifer in order to determine aquifer hydraulic characteristics.

Slug Test - A test made by the instantaneous addition, or removal, of a known volume of water to or from a well. The subsequent well recovery is measured and analysed to provide a permeability value.

Specific Yield - The ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil. Gravity drainage may take many months to occur.

Storativity - The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer, per unit change in head.

Transmissivity - A measure of the rate at which water moves through an aquifer of unit width under a unit hydraulic gradient.

Unsaturated Zone - The zone between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched ground water, may exist in the unsaturated zone. Also called zone of aeration and vadose zone.

Water Budget - An evaluation of all the sources of supply and the corresponding discharges with respect to an aquifer or a drainage basin.

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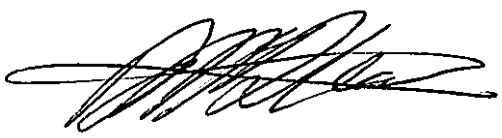
Reviewed by:



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Appendix 1

REGISTERED BORE SUMMARY

Registration No.	License No.	Drilled	mE	mN	Depth (m)	SWL (m)	Yield (L/s)	Salinity (ppm)	Aquifer	Use/Comments	Owner	Cumulative Drawdown at year 2022	Drawdown greater than 2m due to Modification	Discussed in the 2009 study
GW011295	20WA212203	1955	290536	6425144	29	6.9			Permian	STOCK	Private Owned Land	4.5	-	Yes
GW018298	20CA208185	1960	294391	6423498	9.1	7.9			Alluvium	IRRIGATION STOCK	HVEC Owned Land	<1	-	Yes
GW019116	20CA212202	1951	295459	6425029	11.9				Alluvium	IRRIGATION STOCK	Mine Owned Land	1.1	-	Yes
GW024700	NA	1979	295573	6423275					Alluvium	UNKOWN	HVEC Owned Land	31.3	15.8	Yes
GW027311	20CA207877	1967	292056	6422787	11.6	9.4	1.5		Alluvium	DOMESTIC IRRIGATION STOCK	Private Owned Land	<1	-	Yes
GW029644	20BL023940	1920	289048	6411215	28.7				Permian	DOMESTIC STOCK	Private Owned Land	<1	-	No
GW029645	20BL023939	1969	289066	6414082	18.3				Permian	STOCK	Private Owned Land	3.6	-	No
GW029646	20BL023938	1914	292841	6414900	9.1				Permian	STOCK	Private Owned Land	9.0	-	Yes
GW029647	20BL023417	1914	291005	6413906	36.6				Permian	DOMESTIC STOCK	Private Owned Land	10.8	-	Yes
GW029648	20BL023418	1912	290875	6413873	31.1				Permian	DOMESTIC STOCK	Private Owned Land	10.5	-	Yes
GW029649	20BL023419	1912	291321	6413790	25.9				Permian	DOMESTIC STOCK	Private Owned Land	11.3	-	No
GW029654	20BL023411	1921	289250	6412822	95.1				Permian	STOCK	Private Owned Land	<1	-	No
GW029655	20BL023405	1936	290702	6412144	25.3				Permian	STOCK	Private Owned Land	1.5	-	No
GW029658	20BL023408	1957	289462	6413936	55.8				Permian	STOCK	Private Owned Land	2.6	-	No
GW029659	20BL023407	1936	289121	6411494	74.7				Permian	DOMESTIC STOCK	Private Owned Land	<1	-	No
GW029660	20BL023412	1938	290211	6413089	74.7	39.6	0.5		Permian	STOCK	Private Owned Land	1.7	-	Yes
GW029661	20BL023406	1914	293054	6414688	42.7				Permian	STOCK	Private Owned Land	2.8	-	Yes
GW030745	NA	1979	296052	6422854	220				Permian	UNKOWN	HVEC Owned Land	126.6	-	Yes
GW031622	20BL024276	1969	294440	6415949	91.4	28.7	0.4		Permian	STOCK	HVEC Owned Land	13.3	-	Yes
GW031623	20BL023652	1969	294122	6417453	38.1	18.3	2.3		Permian	STOCK	HVEC Owned Land	12.8	-	Yes
GW031859	20BL024674	1969	294633	6415460	61	22.9	0.68		Permian	STOCK	HVEC Owned Land	12.3	-	Yes
GW032077	20BL024716	1969	294266	6416778	53.3	28.7	1.5		Permian	STOCK	HVEC Owned Land	17.0	-	Yes
GW032512	20BL024338	1969	294386	6418629	33.5				Permian	STOCK	HVEC Owned Land	5.9	-	Yes
GW033193	20BL026154	1971	293686	6417043	46.9	12.8	0.9		Permian	STOCK	HVEC Owned Land	27.2	-	Yes
GW033547	40BL026898	1972	296176	6415461	12	4.3			Permian	STOCK	HVEC Owned Land	18.1	-	Yes
GW033915	20BL024261	1971	294185	6419509	39.6	21.0	0.3		Permian	STOCK	HVEC Owned Land	8.0	-	Yes
GW038607	20BL029567	1973	290205	6420916	13.4	11.5	0.4		Permian	STOCK	Private Owned Land	<1	-	No
GW045469	20BL103870	1976	295550	6420532	49.1	33.1	0.3		Permian	STOCK	HVEC Owned Land	60.0	4.0	Yes
GW049223	20BL106334	1979	298120	6413682	67.1		0.6		Permian	STOCK	HVEC Owned Land	1.2	-	Yes
GW053233	20CA208013	1981	291336	6423158	11.2				Alluvium	DOMESTIC IRRIGATION STOCK	Private Owned Land	<1	-	Yes
GW053299	20WA207634	1981	291127	6423123	10.1	2.5		3000	Alluvium	DOMESTIC STOCK	Private Owned Land	<1	-	Yes
GW053572	20CA207877	1981	291651	6423266	10.5	8.0		1000	Alluvium	DOMESTIC IRRIGATION STOCK	Private Owned Land	<1	-	Yes
GW053700	20BL120419	1981	291465	6423253	8	6.0			Alluvium	DOMESTIC STOCK	Private Owned Land	<1	-	Yes
GW053701	20WA207640	1981	291492	6423192	8.4			3000	Alluvium	DOMESTIC STOCK	Private Owned Land	<1	-	Yes
GW057807	20CA207901	1981	294895	6424463	10	7.0	15.2		Alluvium	DOMESTIC IRRIGATION STOCK	Mine Owned Land	<1	-	Yes
GW059131	20BL119201	1981	294964	6424927	11.6			3000	Alluvium	DOMESTIC IRRIGATION STOCK	Mine Owned Land	2.2	-	Yes
GW060282	20BL119795		292578	6422598	14.9				Alluvium	DOMESTIC IRRIGATION STOCK	Private Owned Land	<1	-	No
GW061636	20BL133914	1986	291981	6426129	42.7				Permian	DOMESTIC STOCK	Mine Owned Land	6.4	-	No
GW073576	20BL166372	1995	291596	6424675	20				Permian	DOMESTIC STOCK	Private Owned Land	3.5	-	Yes

Registration No.	License No.	Drilled	mE	mN	Depth (m)	SWL (m)	Yield (L/s)	Salinity (ppm)	Aquifer	Use/Comments	Owner	Cumulative Drawdown at year 2022	Drawdown greater than 2m due to Modification	Discussed in the 2009 study
GW078026	NA	2000	294351	6419981	0				Permian	UNKOWN	HVEC Owned Land	5.6	-	No
GW078707	20BL167441		289548	6413537	43		13		Permian	STOCK	Private Owned Land	3.4	-	Yes
GW078708	20BL167442		290888	6413226	43				Permian	STOCK	Private Owned Land	2.8	-	Yes
GW078709	20BL167443		290749	6412391	50				Permian	STOCK	Private Owned Land	1.3	-	Yes
GW079731	20WA207724		289989	6422513	10		1		Alluvium	DOMESTIC STOCK	HVEC Owned Land	<1	-	No
GW200003	20BL166521		291033	6425814	21				Permian	DOMESTIC STOCK	Private Owned Land	5.9	-	No
GW200837	20BL172265	2009	291518	6421752	15	9	0.5		Alluvium	DOMESTIC	Private Owned Land	<1	-	No
GW201144	20BL170860	2009	288730	6419900	70	32	0.6		Permian	DOMESTIC STOCK	Private Owned Land	1.1	-	No
GW201183	20BL172665	2011	295165	6423349	282	12		5938	Permian	MONITORING BORE	HVEC Owned Land	10.3	4.7	No
GW201520	20BL172816	2011	293375	6425866	48	35	0.08		Permian	MONITORING BORE	Mine Owned Land	5.2	-	No
GW270001	20WA212203	1955	291815	6422117	13.8				Alluvium	UNKOWN	Private Owned Land	<1	-	No

Note: Shaded bores represents bore potentially effect due the mine Modification only.

m = metre.
L/s = litres per second.
ppm = parts per million.
mE = metres easting.
mN = metres northing.

Appendix 2

VALIDATION RESULTS

MODEL VALIDATION RESULTS						
SITE ID	Location		End Depth (m)	Water Level (mRL)		Difference Observed-Simulated (m)
	(mE)	(mN)		Observed	Simulated	
ID1024	296997	6420498	28.34	174.39	167.48	6.91
ID1017	299021	6419032	32.31	178.01	194.26	-16.25
ID1023	298026	6419516	-1.8	182.32	182.87	-0.55
ID1025	297495	6420504	49.05	178.08	169.11	8.97
ID1028	298003	6420008	32.32	178.75	177.98	0.77
ID1011	296502	6419986	-62.13	177.53	171.02	6.51
ID1014A	296993	6419486	-33.54	185.9	179.15	6.75
ID1032	297005	6419997	2.91	182.91	172.61	10.30
ID1026	297715	6422748	151.57	167.86	151.20	16.66
ID1027	297898	6422863	159.36	166.75	152.69	14.06
ID1029	297919	6424515	126.84	139.25	136.24	3.01
ID1030	295938	6423477	-47.39	137.53	134.06	3.47
ID1035	295472	6421967	-136.35	139.65	143.32	-3.67
ID1031	296975	6421495	30.64	166.63	152.51	14.12
ID1037	299010	6419539	73.72	174.6	189.16	-14.56
ID1033	295957	6422477	-38.02	139.73	140.29	-0.56
ID1038	300040	6418053	148.06	219.31	210.98	8.33
ID1039	298994	6420533	160.13	167.27	178.61	-11.34
ID1041	299512	6419542	126.41	167.05	192.35	-25.30
ID1043	297871	6421069	105.65	167.54	163.09	4.45
ID1046	300065	6417546	135.64	221.17	208.87	12.30
ID1048	297696	6422008	116.25	151.56	148.09	3.47
ID1051A	298774	6420726	145.92	177.7	174.00	3.70
ID1040	296494	6420486	-28.13	174.87	165.63	9.24
ID1044	297994	6420514	70.29	175.08	171.36	3.72
ID1054	295948	6422977	-53.9	139	137.18	1.82
ID1056	296948	6422997	96.32	145.46	143.41	2.05
ID1058	296985	6420996	55.99	164.9	159.71	5.19
ID1042	299610	6418518	66.75	223.91	210.78	13.13
ID1052	297513	6419505	-10.67	184.51	182.12	2.39
ID1053	299552	6417539	11.48	224.5	208.66	15.84
ID1055	299065	6417471	-54.89	230.84	208.56	22.28
ID1040A	296494	6420486	127.86	175.02	165.63	9.39
ID1057	296457	6422485	27.2	143.11	141.75	1.36
ID1064	295457	6422468	-112.03	141.75	138.76	2.99
ID1056A	296945	6422997	134.84	143.31	143.28	0.03
ID1057A	296459	6422484	124.85	140.58	141.51	-0.93
ID1060	299030	6418534	-3.63	213.83	208.16	5.67
ID1065	298511	6419522	24.63	180.3	185.49	-5.19
ID1066	296939	6423496	75.68	153.52	140.63	12.89
ID1067	296439	6423484	9.78	178.63	137.68	40.95
ID1068	296007	6420473	-159.49	170.9	163.67	7.23
ID1069A	295976	6421475	30.78	156.56	151.09	5.47

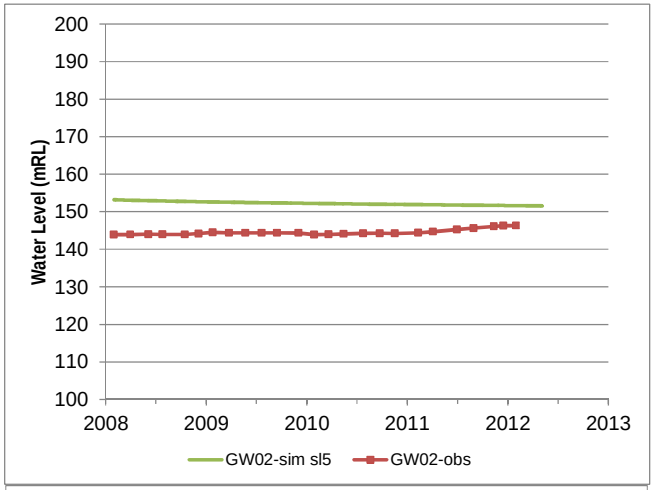
MODEL VALIDATION RESULTS						
SITE ID	Location		End Depth (m)	Water Level (mRL)		Difference Observed-Simulated (m)
	(mE)	(mN)		Observed	Simulated	
ID1068A	296011	6420472	-48.71	167.27	163.70	3.57
ID1070	297957	6423011	163.24	169.29	153.86	15.43
ID1071	299967	6419054	182.73	200.83	209.71	-8.88
IR2001	296480	6421236	-19.26	160.44	156.19	4.25
IR2002	296476	6421456	-32.65	161.55	153.52	8.03
IR2003	296477	6421427	-26.57	160.53	153.94	6.59
ID1072	297428	6423996	86.02	139	139.09	-0.09
IR2005	296226	6421482	-54.59	156.46	152.12	4.34
IR2006	297226	6421500	64.07	158.67	153.20	5.47
IR2008	297471	6421755	52.45	158.5	150.66	7.84
IR2007	297726	6421510	94.47	166.42	155.15	11.27
IR2009	296235	6420981	-67.97	157.53	157.43	0.10
ID1073	297739	6420759	76.59	171.72	166.16	5.56
ID1074	297729	6421260	113.4	166.61	159.46	7.15
ID1075	298242	6420768	105.98	166.96	169.15	-2.19
IR2004	295972	6421727	-42.83	152.72	148.65	4.07
ID1069	295976	6421477	-87.23	156.48	151.06	5.42
ID1102	296242	6420731	-47.24	171.76	160.72	11.04
IR2019	295991	6420727	-132.24	166.86	160.04	6.82
ID1101	296221	6421732	2.13	142.91	149.08	-6.17
IR2010	296469	6421737	44.18	141.56	149.60	-8.04
IR2012	296727	6421489	-10.2	161.45	153.38	8.07
IR2013	296981	6421244	34.96	163.53	157.62	5.91
ID1096	297747	6420260	41.24	178.32	173.93	4.39
IR2018	296493	6420736	2.16	170.81	161.87	8.94
ID1103	296741	6420741	32.95	173.68	162.50	11.18
IR2011	296974	6421747	78.93	158.82	150.11	8.71
IR2014	297481	6421254	91.43	165.91	158.71	7.20
IR2015	297736	6421007	88.79	167.44	163.00	4.44
IR2016	297233	6421002	59.08	168.03	160.59	7.44
IR2017	296717	6422007	68.05	142.9	146.66	-3.76
IR2021	297990	6420764	89.3	168.7	167.70	1.00
IR2023	297980	6421264	126.21	162.51	161.44	1.07
IR2024	297489	6420756	62.85	168.95	165.20	3.75
IR2025	296748	6420987	-19.67	161.48	159.22	2.26
ID1107	296712	6422242	73.99	144.22	144.60	-0.38
ID1111	296203	6422732	-17.68	139.75	139.70	0.05

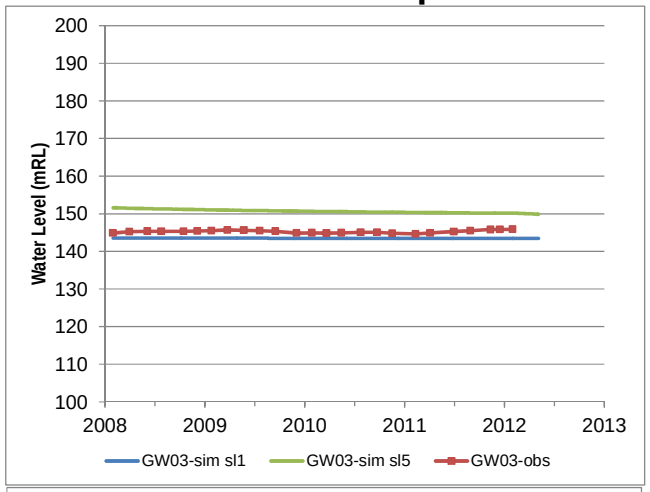
mE = metres easting.
mN = metres northing.
mRL = metres relative level.
m = metre.

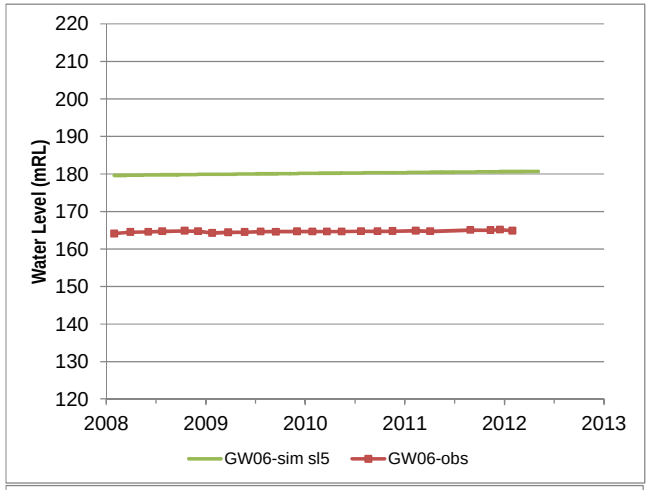
Appendix 3

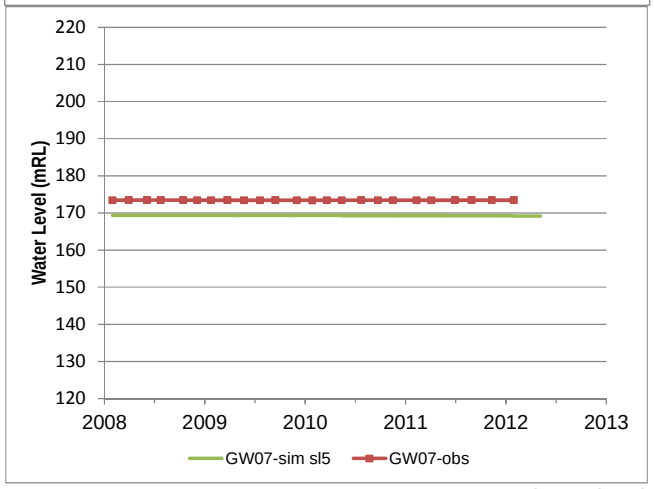
Model Verification Hydrographs

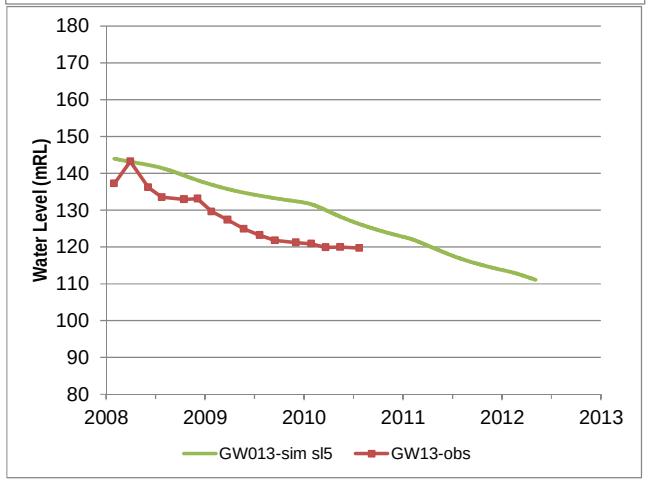
Bores in Mt Arthur Open Pit Area

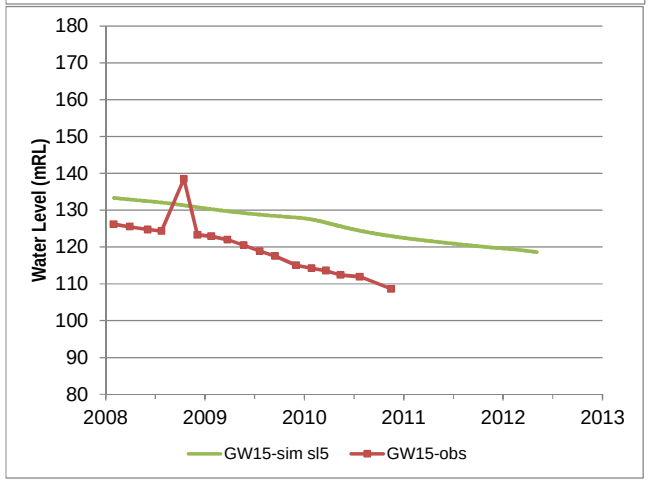






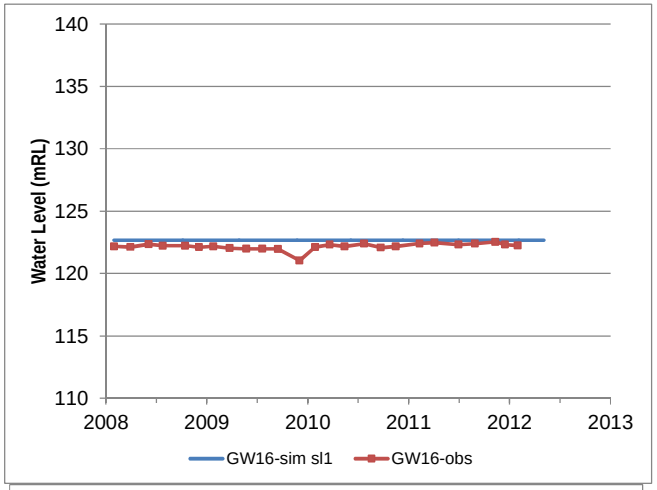


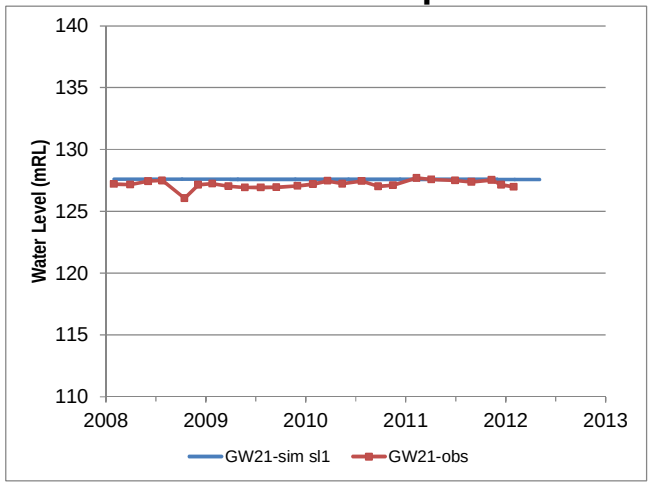


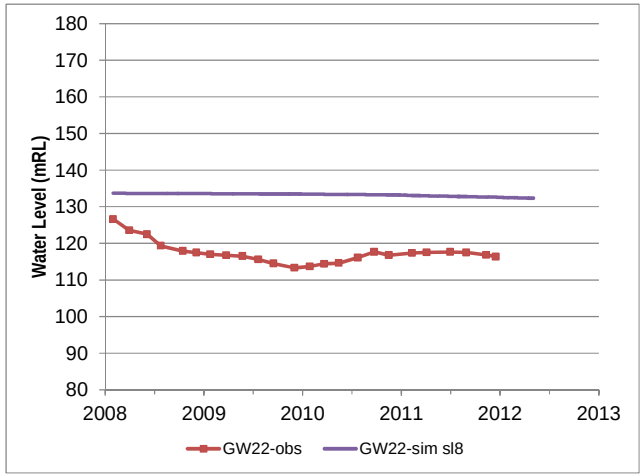


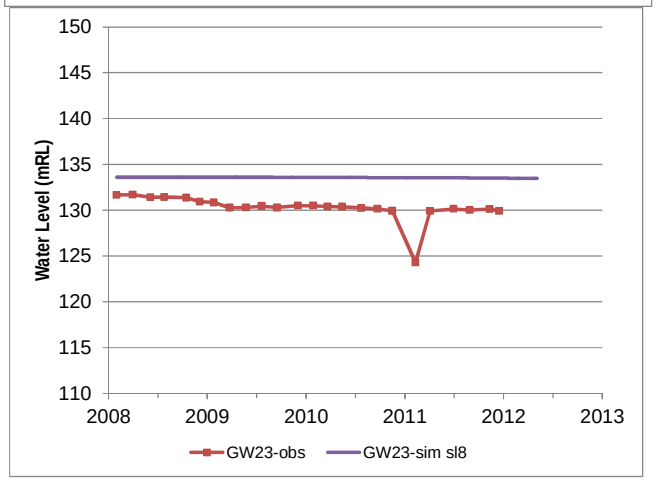
Notes: sim –simulated piezometric head, obs –observed piezometric head, sl –model slice number

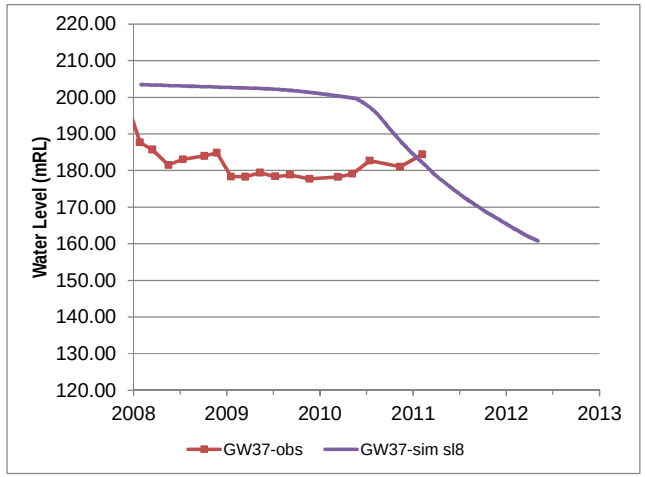
Bores in Mt Arthur Open Pit Area

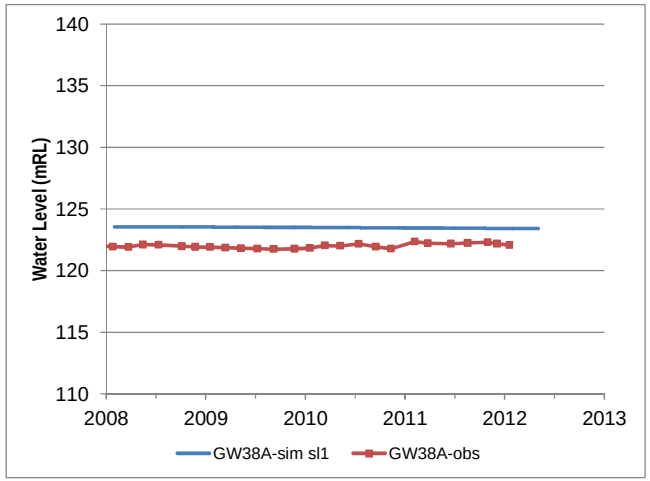






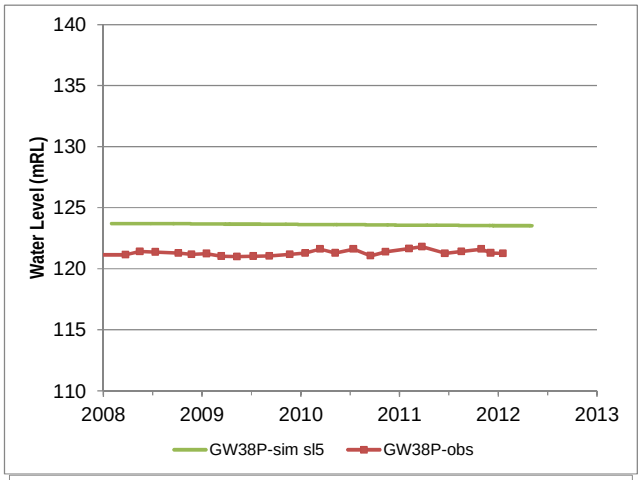


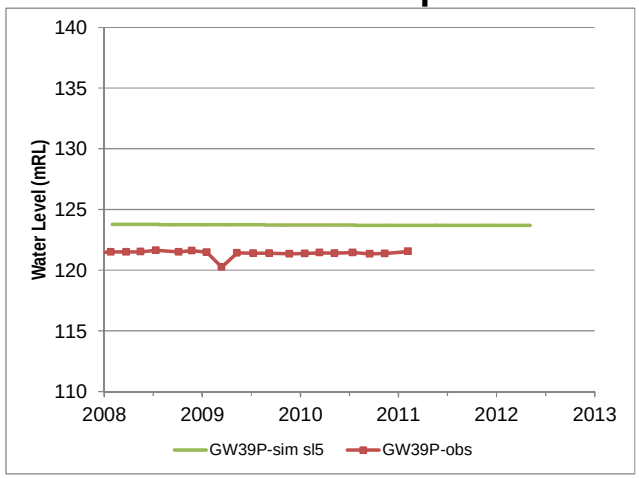


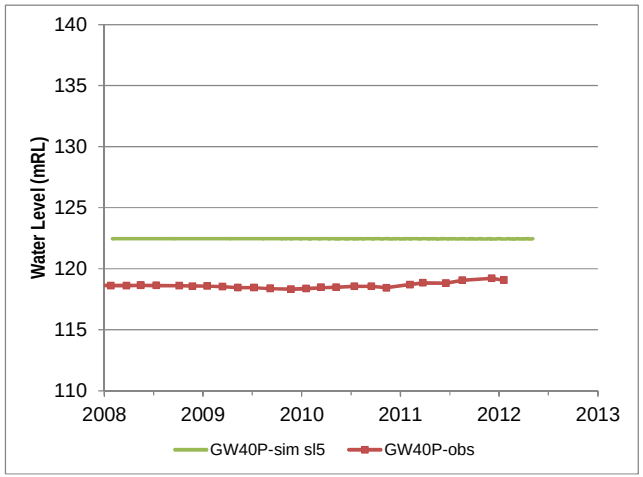


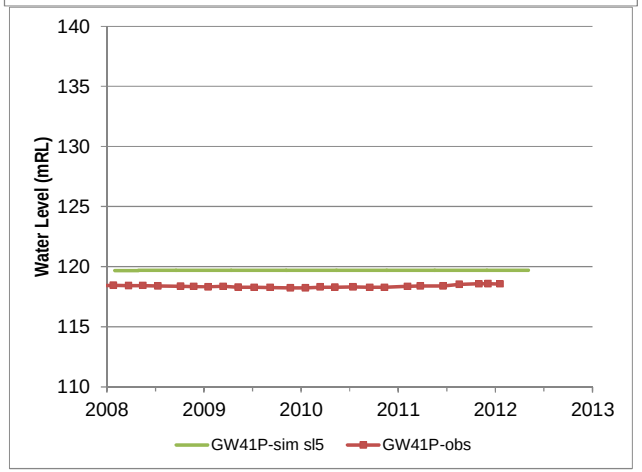
Notes: sim –simulated piezometric head, obs –observed piezometric head, sl –model slice number

Bores in Mt Arthur Open Pit Area



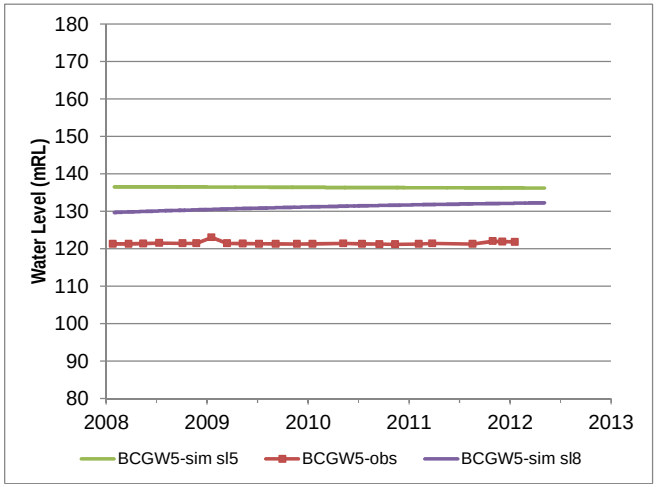


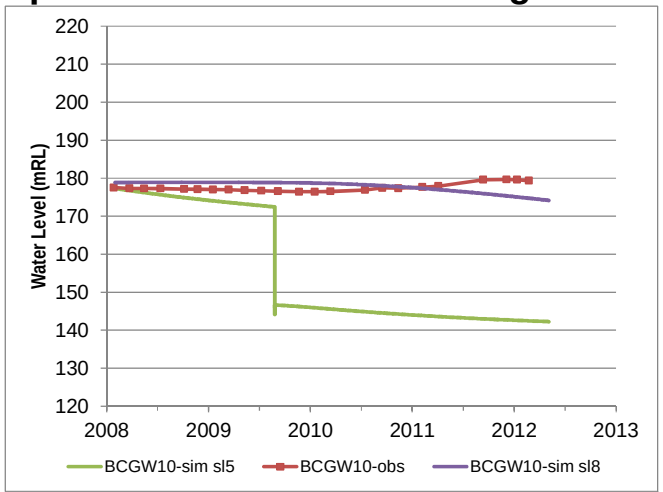


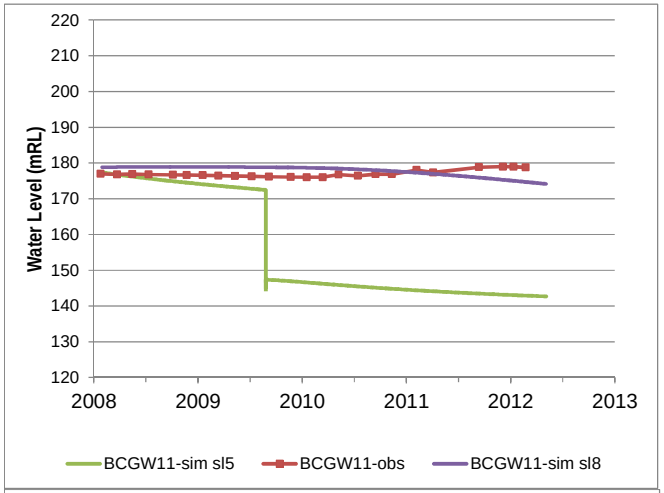


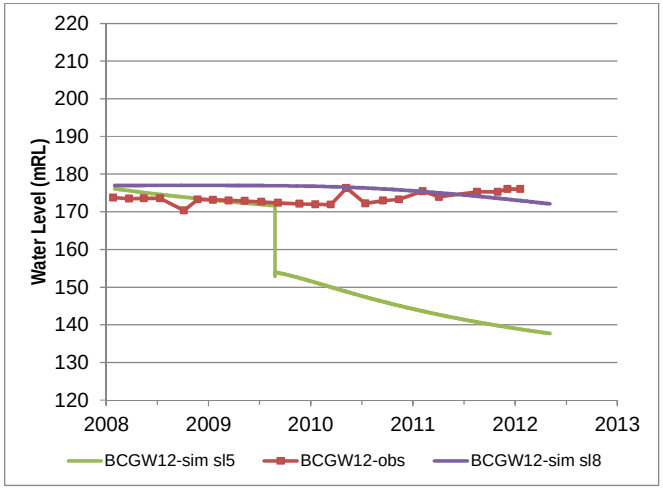
Notes: sim –simulated piezometric head, obs –observed piezometric head, sl –model slice number

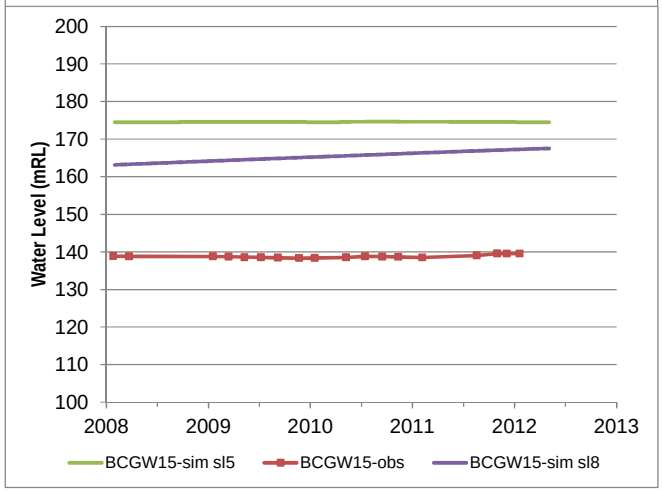
Deep Bores in Mt Arthur Underground Area

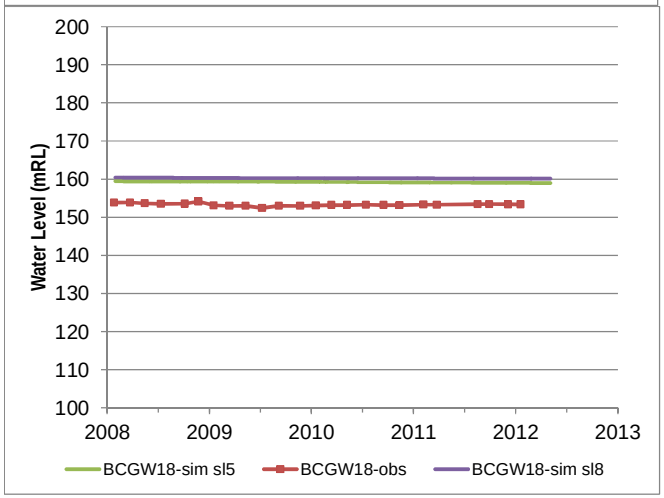






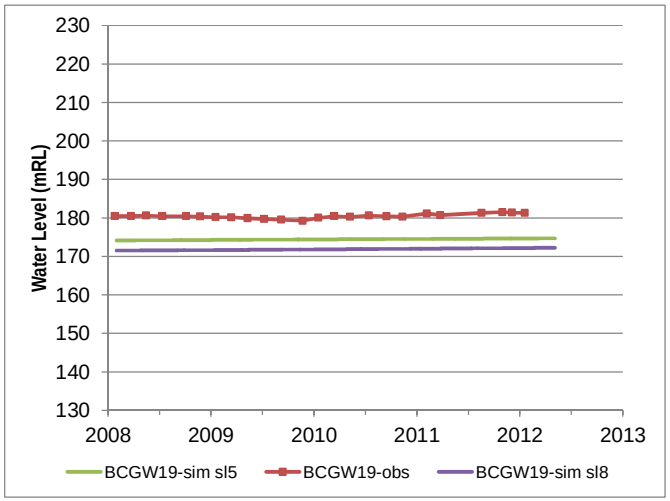


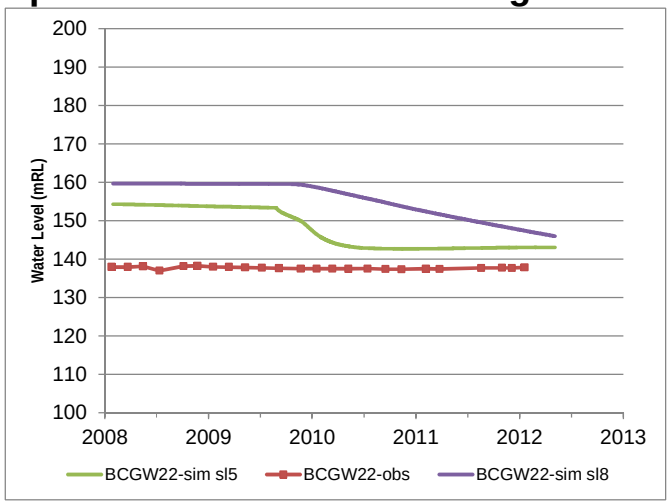


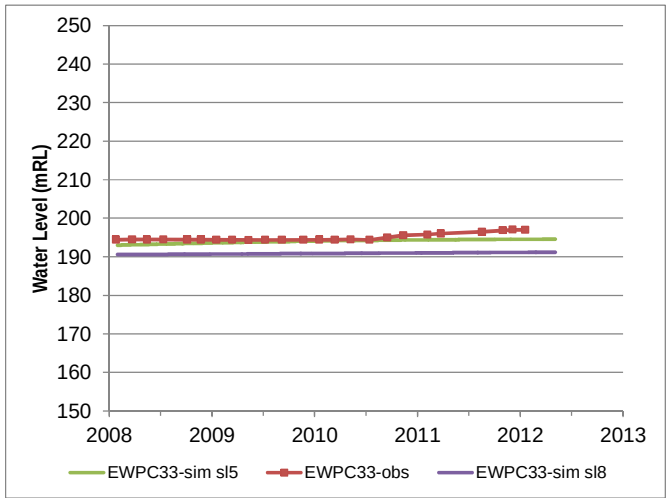


Notes: sim –simulated piezometric head, obs –observed piezometric head, sl –model slice number

Deep Bores in Mt Arthur Underground Area







Notes: sim –simulated piezometric head, obs –observed piezometric head, sl –model slice number

ATTACHMENT D

SUMMARY OF POTENTIAL IMPACTS OF THE ACTION ON WATER RESOURCES

	Surface Water Resources	Groundwater Resources	
Water Resource	**Hunter River**	**Hunter River Alluvium**	**Permian Porous Rock**
Relevant Legislative Instrument	*Water Sharing Plan for the Hunter Regulated River Water Source 2003*[1]	*Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009*	*Water Act, 1912*
HVEC Licensing Entitlements	4,122 ML/annum General Security 700 ML/annum High Security	364 ML/annum	1,900 ML/annum
Productivity	-	Highly Productive	Less Productive
Water Quality	Generally acceptable for irrigation and stock water purposes.	Variable salinity, but highly used for agricultural purposes.	Poor quality, considered typical of coal seam quality.
Summary of Existing Impacts from the Mt Arthur Coal Mine[2]	The Mt Arthur Coal Mine is wholly within the Hunter River catchment, which has a catchment area of approximately 22,000 km^2. The catchment areas of Quarry Creek, Fairford Creek, Whites Creek, Ramrod Creek and a small unnamed tributary have been reduced by the development of open cut pits which form part of the Mt Arthur Coal Mine.	Historical and ongoing mining within the Mt Arthur Coal Mine area (including surrounding mining operations) has resulted in depressurisation of the Permian coal measures. This depressurisation has resulted in localised changes to the groundwater gradient beneath the alluvium with discharge from the coal seams to the alluvium reversed to leakage from the alluvium to the coal seams in the vicinity of open cut mining.	
Summary of Potential Modification Impacts	• No significant impacts on the hydrological characteristics of the Hunter River. • No significant changes in the water quality, integrity of hydrological or hydrogeological connections or changes in the area or extent of the Hunter River. • No lowering of the beneficial use category. • The Action is not expected to result in an increase in long-term average salinity in the Hunter River. • No significant impact on the water quality of the Hunter River. • While the Action would result in an increased reliance on extraction from the Hunter River, this extraction is predicted to be within the limits of currently licensed volumes.	• No significant impacts on the hydrological characteristics of the Hunter River alluvial aquifer. • No significant changes in the water quality, integrity of hydrological or hydrogeological connections or changes in the area or extent of the Hunter River alluvial aquifer. • No potential impacts on culturally significant sites as a result of the Action. • No potential impacts on groundwater dependent ecosystems as a result of the Action. • No lowering of the beneficial use category. • No significant impact on the water quality of the Hunter River alluvial aquifer. • No privately owned bores associated with the Hunter River alluvial aquifer would experience a decline greater than 2 m. • A minor 12 ML/annum incremental increase in water take from the Hunter River alluvial aquifer associated with the Action.	• No significant impacts on the hydrological characteristics of the Permian porous rock aquifer. • No significant changes in the water quality, integrity of hydrological or hydrogeological connections or changes in the area or extent of the Permian porous rock aquifer. • No lowering of the beneficial use category. • The Action would result in an ongoing groundwater sink in the Permian coal measures and therefore there is not expected to be any significant migration or deterioration in groundwater quality as a result of the Action. • No privately owned bores associated with the Permian Porous Rock aquifer would experience a decline greater than 2 m. • No increase in water take from the Permian porous rock associated with the Action.

	Surface Water Resources	Groundwater Resources	
Water Resource	**Hunter River**	**Hunter River Alluvium**	**Permian Porous Rock**
Summary of Potential Mitigation and Management Measures	The water management systems at the Mt Arthur Coal Mine would continue to be developed in accordance with best management practice. Any controlled releases from the Mt Arthur Coal Mine would be made in accordance with the Environmental Protection Licence and the requirements of the Hunter River Salinity Trading Scheme.	The *Surface and Groundwater Response Plan* would be reviewed and, if necessary, revised to incorporate the Action. Notwithstanding the negligible effects due to the Action predicted at surrounding private bores, consistent with the Project Approval (09_0062) for the Mt Arthur Coal Mine, in the event of interruption to water supply resulting from the Action, an alternative water supply will be provided, until such interruption ceases. Notwithstanding the minor impacts to the Hunter River alluvium associated with the Action, HVEC would install a lower permeability barrier for any open cut operations within 150 m of Hunter River alluvium.	
Significance of Potential Impacts	**The Action would not have a significant impact on the Hunter River.**	**The Action would not have a significant impact on the Hunter River alluvial aquifer.**	**The Action would not have a significant impact on the Permian Porous Rock aquifer.**

[1] Within the Hunter Regulated River Water Source (Zone 1) (i.e. all of the Hunter Regulated River Water Source upstream of the junction of the Hunter River and Glennies Creek).

[2] Those impacts not associated with the Action.

ATTACHMENT E

MT ARTHUR COAL MINE PROJECT APPROVAL 09_0062

Project Approval

Section 75J of the *Environmental Planning & Assessment Act 1979*

As delegate of the Minister for Planning and Infrastructure under delegation executed on 14 September 2011, the Planning Assessment Commission approves the modification of the project approval referred to in Schedule 1, as set out in Schedule 2, Schedule 3 and Schedule 4.

Mr Paul Forward
Chair of the Commission

Mr Joe Woodward PSM
Member of the Commission

These conditions are required to:

- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the ongoing environmental management of the project.

Sydney 26 September 2014

SCHEDULE 1

Application Number:	09_0062
Proponent:	Hunter Valley Energy Coal Pty Ltd
Approval Authority:	Minister for Planning
Land:	See Appendix 1
Project:	Mt Arthur Coal Mine – Open Cut Consolidation Project

TABLE OF CONTENTS

DEFINITIONS

Annual review	The review required by condition 3 of schedule 5
ARTC	The Australian Rail Track Corporation Ltd
BCA	Building Code of Australia
Biodiversity offset strategy	The conservation and enhancement program described in the EA, and shown in Appendix 7
Blast misfire	The failure of one or more holes in a blast pattern to initiate
CCC	Community Consultative Committee
Conditions of this approval	Conditions contained in schedules 1 to 5
Council	Muswellbrook Shire Council
Day	The period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays
Department	The NSW Department of Planning and Environment (a) the Environmental Assessment titled *Mt Arthur Coal Consolidation Project Environmental Assessment* (6 volumes), prepared by Hansen Bailey and dated November 2009, including the Response to Submissions dated February 2010; and (b) the Environmental Assessment titled *Mt Arthur Coal Open Cut Modification - Environmental Assessment* (2 volumes), prepared by Resource Strategies Pty Ltd and dated April 2013, including the Response to Submissions dated September 2013
DRE	Division of Resources and Energy, within the Department of Trade and Investment, Regional Infrastructure and Services.
EPA	Environmental Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPL	Environment Protection Licence issued under the POEO Act
Evening	The period from 6pm to 10pm
Feasible	Feasible relates to engineering considerations and what is practical to build or implement
Heritage Branch	Heritage Branch of OEH
Incident	A set of circumstances that: • causes, or threatens to cause, material harm to the environment; and/or • breaches or exceeds the limits or performance measures/criteria in this approval
Land	In general, the definition of land is consistent with the definition in the EP&A Act. However, in relation to the noise and air quality conditions in schedules 3 and 4 of this approval it means the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this approval
Material harm to the environment	Harm to the environment is material if it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial
Mining operations	Includes the removal of overburden and all coal extraction, processing, handling, storage and transportation activities carried out on site
Minister	Minister for Planning, or delegate
Mitigation	Activities associated with reducing the impacts of the project, prior to or during those impacts occurring
MSB	Mine Subsidence Board
Mt Arthur mine complex	The combined operations of the project (including the former Mt Arthur North mine, Bayswater No. 2 mine, Bayswater No. 3 mine and the South Pit Extension Project), and the Mt Arthur Underground Project
Mt Arthur Underground Project	The underground mining operations approved under MP 06_0091
Night	The period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and Public Holidays
NOW	NSW Office of Water
OEH	NSW Office of Environment and Heritage
POEO Act	*Protection of the Environment Operations Act 1997*
Previous EAs	The previous environmental impact assessments for open cut operations at the Mt Arthur mine complex, as listed in Appendix 3
Privately-owned land	Land that is not owned by a public agency or a mining company (or its subsidiary)
Project	The development as described in the project application and EA, and to the extent not covered by these, the Previous EAs
Proponent	Hunter Valley Energy Coal Pty Limited, or its successors in title
Public Infrastructure	Any infrastructure that provides services to the general public, such as roads, railways, water supply, drainage, sewerage, gas supply, electricity, telephone, telecommunications, etc.
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements

Rehabilitation	The treatment or management of land disturbed by the project for the purpose of establishing a safe, stable and non-polluting environment
RFS	Rural Fire Services
RMS	Roads and Maritime Services
ROM	Run of Mine
Secretary	Secretary of the Department, or nominee
Site	The land referred to in schedule 1, and listed in Appendix 1

SCHEDULE 2
ADMINISTRATIVE CONDITIONS

OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT

1. In addition to meeting the specific performance criteria established under this approval, the Proponent shall implement all reasonable and feasible measures to prevent and/or minimise any material harm to the environment that may result from the construction, operation, or rehabilitation of the project.

TERMS OF APPROVAL

2. The Proponent shall carry out the project generally in accordance with the:
   (a) EA; and
   (b) conditions of this approval.

   Note: The general layout of the project is shown in Appendix 2.

3. If there is any inconsistency between the above documents, the most recent document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.

4. The Proponent shall comply with any reasonable requirement/s of the Secretary arising from:
   (a) any reports, strategies, plans, programs, reviews, audits or correspondence that are submitted in accordance with this approval;
   (b) any reports, reviews or audits commissioned by the Department regarding compliance with this approval; and
   (c) the implementation of any actions or measures contained in these documents.

LIMITS ON APPROVAL

5. Mining operations for the project may take place until 30 June 2026.

   Note: Under this approval, the Proponent is required to rehabilitate the site and perform additional undertakings to the satisfaction of the Secretary and NSW Trade & Investment. Consequently this approval will continue to apply in all other respects other than the right to conduct mining operations until the rehabilitation of the site and these additional undertakings have been carried out satisfactorily.

6. The Proponent shall not extract more than:
   (a) 32 million tonnes of ROM coal from the open cut mining operations on the site in a financial year; and
   (b) 36 million tonnes of ROM coal from the Mt Arthur mine complex in a financial year.

7. The Proponent shall:
   (a) not transport coal from the site by road (except in an emergency situation and with the prior approval of the Secretary in consultation with Council); and
   (b) restrict coal transport on the Antiene rail spur to a maximum of:
      - 27 million tonnes of product coal in a financial year; and
      - 30 train movements a day,

      for the Mt Arthur mine complex, except under an agreement with the Drayton Mine to use some of its approved capacity, and where a copy of this agreement has been provided to the Secretary.

   Note: For the avoidance of doubt, each train entering and exiting the site is classified as 2 train movements, and a day refers to the 24 hours from midnight to midnight the next day.

SURRENDER OF CONSENTS

8. By the end of September 2011, or as otherwise agreed by the Secretary, the Proponent shall surrender all existing development consents/approvals for the project in accordance with sections 75YA and 104A of the EP&A Act, and to the satisfaction of the Secretary.

   Notes:
   - *This approval will apply to all components of the Mt Arthur mine complex's open cut operations from the date of approval. The existing management and monitoring plans/strategies/programs/protocols/ committees for the project will continue to apply until the approval of the comparable plan/strategy/program/ protocol/committee under this approval;*
   - *The existing approvals are identified in Appendix 3.*

STRUCTURAL ADEQUACY

9. The Proponent shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA and MSB.

Notes:

- *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for the proposed building works;*
- *Part 8 of the EP&A Regulation sets out the requirements for the certification of the project;*
- *The project is located in the Muswellbrook Mine Subsidence District. Under Section 15 of the Mine Subsidence Compensation Act 1961, the Proponent is required to obtain the MSB's approval before constructing any improvements on the site.*

DEMOLITION

10. The Proponent shall ensure that all demolition work is carried out in accordance with *AS 2601-2001: The Demolition of Structures,* or its latest version.

PROTECTION OF PUBLIC INFRASTRUCTURE

11. Unless the Proponent and the applicable authority agree otherwise, the Proponent shall:
    (a) repair, or pay the full costs associated with repairing, any public infrastructure that is damaged by the project; and
    (b) relocate, or pay the full costs associated with relocating, any public infrastructure that needs to be relocated as a result of the project,

    except where such works have been compensated through the *Mining Act 1992* or the planning agreement referred to in condition 14 below.

    Note: This condition does not apply to any damage to public infrastructure subject to compensation payable under the Mine Subsidence Compensation Act 1961, or to damage to roads caused as a result of general road usage.

OPERATION OF PLANT AND EQUIPMENT

12. The Proponent shall ensure that all plant and equipment used at the site, and equipment used offsite to monitor the performance of the Mt Arthur mine complex, is:
    (a) maintained in a proper and efficient condition; and
    (b) operated in a proper and efficient manner.

STAGED SUBMISSION OF STRATEGIES, PLANS AND PROGRAMS

13. With the approval of the Secretary, the Proponent may:
    (a) submit any strategy, plan or program required by this approval on a progressive basis; and
    (b) combine any strategy, plan or program required by this approval with any similar strategy, plan or program for the Mt Arthur Underground Project.

    Note: For the avoidance of doubt, existing approved management plans, strategies or monitoring programs for the open cut operations of the Mt Arthur mine complex will continue to apply until the approval of a similar plan, strategy or program under this approval, or until the surrender of existing approvals (see condition 8 above).

PLANNING AGREEMENT

14. The Proponent shall comply with the planning agreement with Council executed on 24 June 2011 for the life of the Mt Arthur mine complex, as summarised in Appendix 9. If there is any dispute between the Proponent and Council about the implementation of the planning agreement, then either of the parties may refer the matter to the Secretary for resolution.

ACCESS TO LAND

15. If any mining company in the area is investigating the potential to use infrastructure associated with the project, such as the Antiene rail spur, on commercial terms in order to avoid the costs and environmental impacts of constructing new infrastructure for its project, the Proponent shall consult with the company about the potential to reach a mutually acceptable agreement to the satisfaction of the Secretary.

SCHEDULE 3
ENVIRONMENTAL PERFORMANCE CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from an owner of the land listed in Table 1, the Proponent shall acquire the land in accordance with the procedures in conditions 7-8 of schedule 4.

Table 1: Land subject to acquisition upon request

Receiver No.[1]	***Receiver***	***Acquisition Basis***
6	Private landholder	**Air quality**
28[2]	Private landholder	Air quality
29[2]	Private landholder	Air quality
101[3]	Private landholder	Noise
102	Private landholder	Noise
203, 204	Private landholder	Air quality
206	Private landholder	Air quality
209, 210, 211	Private landholder	Air quality, Noise
226	Private landholder	Air quality
241	Private landholder	Air quality
264[4]	Private landholder	Air quality

Notes:
1 To interpret the locations referred to in Table 1, see the applicable figure in Appendix 4.
2 These receivers shall maintain their rights to acquisition upon request until 31 December 2016, when the EA predicts that the project will comply with the relevant acquisition criteria at these properties.
3 The Proponent is only required to acquire this property if acquisition is no longer reasonably achievable under the approval for the Drayton mine.
4 The Proponent is only required to acquire this property if acquisition is not reasonably achievable under a separate approval for the Bengalla mine.

NOISE

Impact Assessment Criteria

2. The Proponent shall ensure that the noise generated by the Mt Arthur mine complex does not exceed the criteria in Table 2 at any residence on privately-owned land, except where such exceedances were predicted in the EA.

Table 2: Noise Impact Assessment Criteria dB(A)

Location	***Day*** ($L_{Aeq\ (15min)}$)	***Evening*** ($L_{Aeq\ (15min)}$)	***Night*** ($L_{Aeq\ (15min)}$)	***Night*** ($L_{A1\ (1\ min)}$)
A – Antiene Estate	37	40	38	45
B – Skellatar Stock Route, Thomas Mitchell Drive, Denman Road East	39	38	37	45
C – Racecourse Road	41	40	39	45
D – Denman Road North-west, Roxburgh Vineyard (north-east), Roxburgh Road	37	36	35	45
E – South Muswellbrook	39	39	39	45
F – Denman Road West, Roxburgh Vineyard (west)	37	36	35	45
G – East Antiene	41	40	39	45
H – South of Mine	35	35	35	45

Note: To interpret the locations referred to Table 2, see the applicable figures in Appendix 4 and Appendix 5.

Noise generated by the Mt Arthur mine complex is to be measured in accordance with the relevant requirements of the *NSW Industrial Noise Policy*. Appendix 10 sets out the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

However, these criteria do not apply if the Proponent has an agreement with the owner/s of the relevant residence or land to generate higher noise levels, and the Proponent has advised the Department in writing of the terms of this agreement.

3. Deleted

4. Deleted

5. Deleted

Traffic Noise Criteria

6. The Proponent shall take all reasonable and feasible measures to ensure that the traffic noise generated by the Mt Arthur mine complex does not exceed the traffic noise impact assessment criteria in Table 3.

Table 3: Traffic noise criteria dB(A)

Road	***Day/Evening*** $L_{Aeq\ (1\ hour)}$	***Night*** $L_{Aeq\ (1\ hour)}$
Thomas Mitchell Drive, Denman Road (east of Thomas Mitchell Drive)	60	55
Denman Road (west of Thomas Mitchell Drive)	55	50

Note: Traffic noise generated by the Mt Arthur mine complex is to be measured in accordance with the relevant procedures in the EPA's Road Noise Policy (2011), or its latest version.

Additional Noise Mitigation Measures

7. Upon receiving a written request from the owner of any residence:
   (a) on the noise affected land listed in Table 1 (unless the landowner has requested acquisition under this approval); and
   (b) on the land listed in Table 4,

   the Proponent shall implement reasonable and feasible noise mitigation measures (such as double glazing, insulation, and/or air conditioning) at any residence in consultation with the owner.

   If within 3 months of receiving this request from the landowner, the Proponent and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

Table 4: Land subject to additional noise mitigation upon request

Receiver No.[1]	***Receiver***
6[2]	Private landholder
94	Private landholder
97[2]	Private landholder
98[2]	Private landholder
99[2]	Private landholder (2 residences)
100	Private landholder
204	Private landholder
206	Private landholder
226	Private landholder

Notes:
1 To interpret the locations referred to in Table 4, see the applicable figure in Appendix 4.
2 These receivers shall maintain their rights to mitigation upon request until 31 December 2016, when the EA predicts that the project will comply with the relevant criteria at these properties.

Operating Conditions

8. The Proponent shall:
   (a) implement best noise management practice, which includes implementing all reasonable and feasible noise mitigation measures to minimise the operational, road and rail noise of the Mt Arthur mine complex;
   (b) operate a comprehensive noise management system on site that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day to day planning of mining operations, and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this approval;
   (c) minimise the noise impacts of the project during meteorological conditions when the noise limits in this approval do not apply (see Appendix 10);
   (d) co-ordinate noise management at the Mt Arthur mine complex with the noise management at the Drayton and Bengalla mines to minimise cumulative noise impacts; and
   (e) carry out monthly attended monitoring in accordance with Appendix 10 (unless otherwise agreed with the Secretary), to determine whether the Mt Arthur mine complex is complying with the relevant conditions of this approval,

   to the satisfaction of the Secretary.

Noise Management Plan

9. The Proponent shall prepare and implement a Noise Management Plan for the Mt Arthur mine complex to the satisfaction of the Secretary. This plan must:
   (a) describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions in this approval;
   (b) describe the proposed noise management system in detail; and
   (c) include a monitoring program that:
      - evaluates and reports on:
        - the effectiveness of the noise management system;
        - compliance against the noise criteria in this approval; and
        - compliance against the noise operating conditions;
      - includes a program to calibrate and validate the real-time noise monitoring results with the attended monitoring results over time (so the real-time noise monitoring program can be used as a better indicator of compliance with the noise criteria in this approval and trigger for further attended monitoring); and
      - defines what constitutes a noise incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents.

BLASTING

Impact Assessment Criteria

10. The Proponent shall ensure that blasts on site do not cause exceedances of the criteria in Table 5.

Table 5: Blasting impact assessment criteria

Location	***Airblast overpressure (dB(Lin Peak))***	***Ground vibration (mm/s)***	***Allowable exceedance***
Residence on privately owned land	120	10	0%
	115	5	5% of the total number of blasts in a financial year
Public infrastructure	-	50	0%

However, these criteria do not apply if the Proponent has a written agreement with the relevant owner to exceed these criteria, and has advised the Department in writing of the terms of this agreement.

Note: An alternative limit for public infrastructure may be determined by the Secretary ~~I~~n accordance with the structural design methodology in AS 2187.2-2006, or another methodology acceptable to the Secretary.

Blasting Hours

11. The Proponent shall only carry out blasting on site between 8am and 5pm Monday to Saturday inclusive. No blasting is allowed on Sundays, public holidays, or at any other time without the written approval of the Secretary.

Blasting Frequency

12. The Proponent may carry out a maximum of:
    (a) 3 blasts a day;
    (b) 4 blasts a day, on a maximum of 12 days each financial year; and
    (c) 12 blasts a week, averaged over a financial year,
    on the site.

    This condition does not apply to blasts that generate ground vibration of 0.5 mm/s or less at any residence on privately-owned land, blast misfires or blasts required to ensure the safety of the mine, its workers or the general public.

    Notes:
    - *For the purposes of this condition, a blast refers to a single blast event, which may involve a number of individual blasts fired in quick succession in a discrete area of the mine.*
    - *For the avoidance of doubt, should an additional blast be required after a blast misfire, this additional blast and the blast misfire are counted as a single blast.*
    - *In circumstances of recurring unfavourable weather conditions (following planned but not completed blast events), to avoid excess explosive sleep times and minimise any potential environmental impacts, the Proponent may seek agreement from the Secretary for additional blasts to be fired on a given day.*

Property Inspections

13. Deleted

14. If the Proponent receives a written request from the owner of any privately-owned land within 3 kilometres of any approved open cut mining pit on site for a property inspection to establish the baseline condition of any buildings and/or structures on his/her land, or to have a previous property inspection updated, then within 2 months of receiving this request the Proponent shall:
    (a) commission a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties to:
        - establish the baseline condition of any buildings and other structures on the land, or update the previous property inspection report; and
        - identify measures that should be implemented to minimise the potential blasting impacts of the project on these buildings and/or structures; and
    (b) give the landowner a copy of the new or updated property inspection report.

    If there is a dispute over the selection of the suitably qualified, experienced and independent person, or the Proponent or the landowner disagrees with the findings of the property inspection report, either party may refer the matter to the Secretary for resolution.

Property Investigations

15. If any landowner of privately-owned land within 3 kilometres of any approved open cut mining pit on site (including the whole of the Racecourse Road area and the area southwest of Skellatar Stock Route), or on any other land where the Secretary agrees that a property inspection is warranted claims that buildings and/or structures on his/her land have been damaged as a result of blasting on the site, then the Proponent shall within 3 months of receiving this claim:
    (a) commission a suitably qualified, experienced and independent person, whose appointment is acceptable to both parties, to investigate the claim; and
    (b) give the landowner a copy of the property investigation report.

    If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Proponent shall repair the damage to the satisfaction of the Secretary.

    If there is a dispute over the selection of the suitably qualified, experienced and independent person, or the Proponent or the landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Secretary for resolution.

Operating Conditions

16. During mining operations on site, the Proponent shall:
    (a) implement best blasting practice to:
        - protect the safety of people and livestock in the area surrounding blasting operations;
        - protect public or private infrastructure/property in the area surrounding blasting operations from blasting damage; and
        - minimise the dust and fume emissions from blasting at the Mt Arthur mine complex;
    (b) ensure that blasting on the site does not damage heritage sites, including Edinglassie, Rous Lench, and Balmoral;
    (c) co-ordinate the timing of blasting on site with the timing of blasting at the Drayton and Bengalla coal mines to minimise the potential cumulative blasting impacts of the three mines; and

(d) operate a suitable system to enable the general public and surrounding landowners and tenants to get up-to-date information on the proposed blasting schedule on site,

to the satisfaction of the Secretary.

16A. The Proponent shall not undertake blasting on site within 500 metres of any public road or any land outside the site not owned by the Proponent unless the Proponent has:

(a) demonstrated to the satisfaction of the Secretary that the blasting can be carried out closer to the infrastructure or land without compromising the safety of people or livestock or damaging the infrastructure and/or other buildings and structures; and

(b) updated the Blast Management Plan to include the specific measures that would be implemented while blasting is being carried out within 500 metres of the infrastructure or land; or

(c) a written agreement with the relevant infrastructure owner or landowner to allow blasting to be carried out closer to the infrastructure or land, and the Proponent has advised the Department in writing of the terms of this agreement.

Blast Management Plan

17. The Proponent shall prepare and implement a Blast Management Plan for the project to the satisfaction of the Secretary. This plan must:

(a) describe the measures that would be implemented to ensure compliance with the blast criteria and operating conditions of this approval, including:
- detailed demonstration that blasting within the blast control area shown in Appendix 5 can be undertaken in a manner that will meet the blast impact assessment criteria in Table 5 at all times; and
- a detailed blast fume management strategy to minimise and manage blast fumes;

(b) include a road closure management plan, prepared in consultation with the applicable roads authority, that includes provisions for:
- minimising the duration of closures, both on a per event basis and weekly basis;
- avoiding peak traffic periods as far as practicable; and
- coordinating with neighbouring mines to minimise the cumulative effect of road closures;

(c) include a blast monitoring program for evaluating and reporting on compliance with the blasting criteria and operating conditions of this approval; and

(d) Include the requirement for Mt Arthur Coal to actively participate in Muswellbrook Council's online blasting portal.

AIR QUALITY

Odour

18. The Proponent shall ensure that no offensive odours are emitted from the site, as defined under the POEO Act.

19. Deleted

Impact Assessment Criteria

20. The Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the project do not cause exceedances of the criteria listed in Tables 6, 7 and 8 at any residence on privately-owned land (except for air quality affected land listed in Table 1).

Table 6: Long term impact assessment criteria for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Total suspended particulate (TSP) matter	Annual	[a] 90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 µg/m^3

Table 7: Short term impact assessment criterion for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 50 µg/m^3

Table 8: Long term impact assessment criteria for deposited dust

Pollutant	***Averaging period***	***Maximum increase in deposited dust level***	***Maximum total deposited dust level***
[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 6-8:
a Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources);
b Incremental impact (i.e. incremental increase in concentrations due to the project on its own);
c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and
d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.

Air Quality Acquisition Criteria

21. If particulate matter emissions generated by the Mt Arthur mine complex exceed the criteria, or contribute to the exceedances of the relevant cumulative criteria, in Tables 9, 10 and 11 at any residence on privately-owned land then upon receiving a written request for acquisition from the landowner, the Proponent shall acquire the land in accordance with the procedures in conditions 7-8 of schedule 4.

Table 9: Long term land acquisition criteria for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Total suspended particulate (TSP) matter	Annual	[a] 90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 µg/m^3

Table 10: Short term land acquisition criteria for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 150 µg/m^3
Particulate matter < 10 µm (PM_{10})	24 hour	[b] 50 µg/m^3

Table 11: Long term land acquisition criteria for deposited dust

Pollutant	***Averaging period***	***Maximum increase in deposited dust level***	***Maximum total deposited dust level***
[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes to Tables 9-11
a Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources);
b Incremental impact (i.e. incremental increase in concentrations due to the project on its own);
c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and
d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.

If the air quality acquisition criteria in Tables 9, 10 and 11 are being exceeded, and more than one mine is responsible for this non-compliance, then the Proponent shall, together with the relevant mine/s acquire the land on as equitable a basis as possible with the relevant mine/s, in accordance with the procedures in conditions 7-8 of schedule 4.

If the Proponent cannot agree on the arrangements for the acquisition of the land with the relevant mine/s within 3 months of the written request from the landowner, then the Proponent must refer the matter to the Secretary for resolution.

Additional Air Quality Mitigation Measures

22. Upon receiving a written request from the owner of any residences:
    (a) on the air quality affected land listed in Table 1; and
    (b) on the land listed in Table 12,
    the Proponent shall implement reasonable and feasible dust mitigation measures (such as a first-flush roof system, internal or external air filters and/or air conditioning) at the residence in consultation with the owner.

    If within 3 months of receiving this request from the owner, the Proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

Table 12: Land subject to additional air quality mitigation upon request

Receiver No.[1]	***Receiver***
91[2]	Private landholder
94[2]	Private landholder
187	Private landholder
200	Private landholder
201	Private landholder

Notes:
1 To interpret the locations referred to in Table 12, see the applicable figure in Appendix 4.
2 These receivers shall maintain their rights to mitigation upon request until 31 December 2016, when the EA predicts that the project will comply with the relevant criteria at these properties.

Mine-owned Land

22A. The Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the Mt Arthur mine complex do not cause exceedances of the criteria listed in Tables 9, 10 and 11 at any occupied residence on mine-owned land (including land owned by another mining company) unless:
(a) the tenant and landowner (if the residence is owned by another mining company) have been notified of any health risks associated with such exceedances in accordance with the notification requirements under schedule 4 of this approval;
(b) the tenant of any land owned by the Proponent can terminate their tenancy agreement without penalty at any time, subject to giving reasonable notice and cause;
(c) air quality monitoring is regularly undertaken to inform the tenant or landowner (if the residence is owned by another mining company) of the particulate emissions at the residence; and
(d) data from this monitoring is presented to the tenant and landowner in an appropriate format for a medical practitioner to assist the tenant and landowner in making informed decisions on the health risks associated with occupying the property,
to the satisfaction of the Secretary.

Operating Conditions

23. The Proponent shall:
(a) implement best practice air quality management, including all reasonable and feasible measures to minimise offsite odour, fume and dust emissions of the Mt Arthur mine complex;
(b) implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site;
(c) minimise any visible air pollution generated by the Mt Arthur mine complex;
(d) minimise the surface disturbance on the site;
(e) operate a comprehensive air quality management system that uses a combination of predictive meteorological forecasting and real-time air quality monitoring data to guide the day to day planning of mining operations and the implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this approval;
(f) minimise the air quality impacts of the project during adverse meteorological conditions and extraordinary events (see Note d above under Table 8); and
(g) co-ordinate air quality management at the Mt Arthur mine complex with air quality management at the Drayton, Mangoola and Bengalla mines to minimise cumulative air quality impacts,
to the satisfaction of the Secretary.

Air Quality Management Plan

24. The Proponent shall prepare and implement an Air Quality Management Plan for the Mt Arthur mine complex to the satisfaction of the Secretary. This plan must:
(a) describe the measures that would be implemented to ensure compliance with the relevant air quality criteria and operating conditions of this approval:
(b) describe the air quality management system;
(c) include an air quality monitoring program that:
- adequately supports the air quality management system;
- evaluates and reports on the:
  - the effectiveness of the air quality management system;
  - compliance with the air quality criteria;
  - compliance with the air quality operating conditions; and
- defines what constitutes an air quality incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any air quality incidents.

METEOROLOGICAL MONITORING

25. During the life of the project, the Proponent shall ensure that there is a suitable meteorological station in the vicinity of the site that:
    (a) complies with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South Wales* guideline; and
    (b) is capable of continuous real-time measurement of temperature lapse rate in accordance with the *NSW Industrial Noise Policy*, unless a suitable alternative is approved by the Secretary following consultation with the EPA.

SOIL AND WATER

Water Supply

26. The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations to match its available water supply, to the satisfaction of the Secretary.

    Note: The Proponent is required to obtain all necessary water licences and approvals for the project under the Water Act 1912 and/or Water Management Act 2000.

Water Pollution

27. Unless an EPL or the EPA authorises otherwise, the Proponent shall comply with Section 120 of the POEO Act and the *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002*.

Hunter River and Saddlers Creek Alluvials

28. The Proponent shall not undertake any open cut mining operations within 150 metres of the Hunter River alluvials and Saddlers Creek alluvials that has not been granted approval under previous consents/approvals for Mt Arthur mine complex without the prior written approval of the Secretary. In seeking this approval the Proponent shall demonstrate, to the satisfaction of the Secretary in consultation with NOW, that adequate safeguards have been incorporated into the Surface and Ground Water Response Plan (see condition 34 below) to minimise, prevent or offset groundwater leakage from the alluvial aquifers.

    Note: The alluvial aquifers and 150 metre buffers are shown conceptually in Appendix 6.

Site Water Management Plan

29. The Proponent shall prepare and implement a Water Management Plan for the Mt Arthur mine complex to the satisfaction of the Secretary. This plan must:
    (a) be prepared in consultation with NOW and the EPA; and
    (b) include a:
        - Site Water Balance;
        - Erosion and Sediment Control Plan;
        - Surface Water Monitoring Program;
        - Groundwater Monitoring Program; and
        - Surface and Ground Water Response Plan.

30. The Site Water Balance must:
    (a) include details of:
        - sources and security of water supply;
        - water use on site;
        - water management on site;
        - any off-site water transfers;
        - reporting procedures; and
    (b) investigate and implement all reasonable and feasible measures to minimise water use by the Mt Arthur mine complex.

31. The Erosion and Sediment Control Plan must:
    (a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004* (Landcom), or its latest version;
    (b) identify activities that could cause soil erosion, generate sediment or affect flooding;
    (c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk;
    (d) describe the location, function, and capacity of erosion and sediment control structures and flood management structures; and
    (e) describe what measures would be implemented to maintain the structures over time.

32. The Surface Water Monitoring Program must include:
    (a) detailed baseline data on surface water flows and quality in creeks and other waterbodies that could potentially be affected by the project;
    (b) surface water and stream health impact assessment criteria;
    (c) a program to monitor and assess:
        - surface water flows and quality;
        - impacts on water users;
        - stream health;
        - channel stability,

        in Quarry Creek, Fairford Creek, Whites Creek (and the Whites Creek diversion), Saddlers Creek, Ramrod Creek and other unnamed creeks; and
    (d) reporting procedures for the results of the monitoring program.

33. The Groundwater Monitoring Program must include:
    (a) detailed baseline data of groundwater levels, yield and quality in the region, and privately-owned groundwater bores, that could be affected by the project;
    (b) groundwater impact assessment criteria;
    (c) a program to monitor:
        - groundwater inflows to the mining operations;
        - impacts on regional aquifers;
        - impacts on the groundwater supply of potentially affected landowners;
        - impacts on the Hunter River and Saddlers Creek alluvial aquifers; and
        - impacts on any groundwater dependent ecosystems and riparian vegetation;
    (d) procedures for the verification of the groundwater model; and
    (e) reporting procedures for the results of the monitoring program and model verification.

34. The Surface and Ground Water Response Plan must describe the measures and/or procedures that would be implemented to:
    (a) investigate, notify and mitigate any exceedances of the surface water, stream health and groundwater impact assessment criteria;
    (b) compensate landowners of privately-owned land whose water supply is adversely affected by the project, including provision of an alternative supply of water to the affected landowner that is equivalent to the loss attributed to the project;
    (c) minimise, prevent or offset potential groundwater leakage from the Hunter River and Saddlers Creek alluvial aquifers; and
    (d) mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation.

Site Contamination

35. The Proponent shall prepare and implement a Remedial Action Plan for the former Bayswater No. 2 infrastructure area to the satisfaction of the Secretary. The Remedial Action Plan shall be prepared by a suitably qualified consultant, in accordance with the *Contaminated Land Management Act 1997* and applicable EPA guidelines, and be submitted to the Secretary for approval prior to undertaking any overburden placement in this area.

BIODIVERSITY

Biodiversity Offsets

36. The Proponent shall implement the biodiversity offset strategy as outlined in Table 13 and as generally described in the EA (and shown in Appendix 7), to the satisfaction of the Secretary.

Table 13: Biodiversity Offset Strategy

Area	***Offset Type***	***Minimum Size (hectares)***
Mt Arthur Conservation Area	Existing vegetation	105
Saddlers Creek Conservation Area	Existing vegetation and vegetation to be established	131
Thomas Mitchell Drive Off-site Offset Area	Existing vegetation and vegetation to be established	495
Thomas Mitchell Drive On-site Offset Area	Existing vegetation and vegetation to be established	222
Roxburgh Road 'Constable' Offset Area	Existing vegetation and vegetation to be established	110

Additional Off-site Offset Area[1]	Existing vegetation and vegetation to be established	250
Middle Deep Creek Offset Area	Existing vegetation and vegetation to be established	410
Rehabilitation Area[2]	Vegetation to be established	2,642
Total[3]		**4,365**

[1] *Refer to condition 37.*

[2] *Refer to the rehabilitation plan in Appendix 7.*

[3] *In accordance with Condition 13 of Schedule 2, the Proponent may manage the 4,365 ha of offsets for the Project, in conjunction with the 449 ha of additional offsets required under the separate Mt Arthur Underground Project.*

37. By the end of 31 December 2014, unless otherwise agreed by the Secretary, the Proponent shall revise the offset strategy to identify the Additional Off-site Offset Area presented in Table 13 above. The revised strategy shall be prepared in consultation with OEH, and to the satisfaction of the Secretary.

Note: The 250 hectare size for the Additional Off-site Offset Area identified in Table 13 above is to be taken as a minimum only. The actual size of the offset shall:

- *be determined in consultation with OEH, and together with the other offset areas listed in Table 13, shall fully offset the biodiversity impacts of the project; and*
- *be adjusted to fully offset the biodiversity values that would be lost if any land within the biodiversity offset strategy identified in Table 13 is excised for the provision of public utilities or services, such as the Muswellbrook Sewage Treatment Plant.*

38. The Proponent shall ensure that the offset strategy and/or rehabilitation strategy is focused on the re-establishment of:
    (a) significant and/or threatened plant communities, including:
        - Upper Hunter White Box – Ironbark Grassy Woodland;
        - Central Hunter Box – Ironbark Woodland;
        - Central Hunter Ironbark – Spotted Gum - Grey Box Forest;
        - Narrabeen Footslopes Slaty Box Woodland;
        - Hunter Floodplain Red Gum Woodland Complex;
        - White Box Yellow Box Blakely's Red Gum Woodland;
        - Hunter Lowlands Red Gum Forest; and
    (b) significant and/or threatened plant species, including:
        - River Red Gum (*Eucalyptus camaldulensis*);
        - Pine Donkey Orchid (*Diuris tricolor*);
        - Tiger Orchid *(Cymbidium canaliculatum)*;
        - Weeping Myall (*Acacia pendula*); and
    (c) habitat for significant and/or threatened animal species.

Long Term Security of Offsets

39. The Proponent shall make suitable arrangements to provide appropriate long term security for the:
    (a) biodiversity offset areas by 31 March 2015, unless otherwise agreed with the Secretary; and
    (b) re-established woodland in the Rehabilitation Area at least 2 years prior to the completion of open cut mining activities associated with the project,

    to the satisfaction of the Secretary and, with respect to the Thomas Mitchell Drive off-site offset area identified in Table 13 above, consult with Council.

Biodiversity Management Plan

40. The Proponent shall prepare and implement a Biodiversity Management Plan for the project to the satisfaction of the Secretary. This plan must:
    (a) be prepared in consultation with OEH and Council, and be submitted to the Secretary for approval by the end of March 2015, unless otherwise agreed with the Secretary;
    (b) describe how the implementation of the offset strategy would be integrated with the overall rehabilitation of the site (see below);
    (c) include:
        (i) a description of the short, medium, and long term measures that would be implemented to:
            - implement the offset strategy; and
            - manage the remnant vegetation and habitat on the site and in the offset areas;
        (ii) detailed performance and completion criteria for the implementation of the offset strategy;
        (iii) a detailed description of the measures that would be implemented over the next 3 years, including the procedures to be implemented for:

- implementing revegetation and regeneration within the disturbance areas and offset areas, including establishment of canopy, sub-canopy (if relevant), understorey and ground strata;
- protecting vegetation and soil outside the disturbance areas;
- rehabilitating creeks and drainage lines that occur on the site, both inside and outside the disturbance areas (such as the White's Creek Diversion), to ensure no net loss of aquatic habitat;
- managing salinity;
- conserving and reusing topsoil;
- undertaking pre-clearance surveys;
- managing impacts on fauna;
- landscaping the site and along public roads (including Thomas Mitchell Drive, Denman Road, Edderton Road and Roxburgh Road) to minimise visual and lighting impacts;
- collecting and propagating seed;
- salvaging and reusing material from the site for habitat enhancement;
- salvaging, transplanting and/or propagating threatened flora and native grassland, in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Vallee *et al.*, 2004);
- controlling weeds and feral pests;
- managing grazing and agriculture;
- controlling access; and
- bushfire management;

(iv) a program to monitor the effectiveness of these measures, and progress against the performance and completion criteria;

(v) a description of the potential risks to successful revegetation, and a description of the contingency measures that would be implemented to mitigate these risks; and

(vi) details of who would be responsible for monitoring, reviewing, and implementing the plan.

Conservation Bond

41. Within 6 months of the approval of the Biodiversity Management Plan, the Proponent shall lodge a conservation and biodiversity bond with the Department to ensure that the biodiversity offset strategy is implemented in accordance with the performance and completion criteria of the Biodiversity Management Plan. The sum of the bond shall be determined by:

(a) calculating the full cost of implementing the biodiversity offset strategy (other than land acquisition costs); and

(b) employing a suitably qualified quantity surveyor to verify the calculated costs,

to the satisfaction of the Secretary.

The calculation of the Conservation Bond must be submitted to the Department for approval at least 1 month prior to lodgement of the final bond.

If the offset strategy is completed generally in accordance with the completion criteria in the Biodiversity Management Plan to the satisfaction of the Secretary, the Secretary will release the bond.

If the offset strategy is not completed generally in accordance with the completion criteria in the Biodiversity Management Plan, the Secretary will call in all, or part of, the conservation bond, and arrange for the satisfactory completion of the relevant works.

Notes:

- *Alternative funding arrangements for long term management of the biodiversity offset strategy, such as provision of capital and management funding as agreed by OEH as part of a Biobanking Agreement or transfer to conservation reserve estate (or any other mechanism agreed with OEH) can be used to reduce the liability of the conservation and biodiversity bond.*
- *The sum of the bond may be reviewed in conjunction with any revision to the biodiversity offset strategy or the completion of major milestones within the approved plan.*

REHABILITATION

Rehabilitation Objectives

41A. The Proponent shall rehabilitate the site to the satisfaction of the DRE. The rehabilitation must comply with the objectives in Table 14, and be consistent with the rehabilitation plan shown in Appendix 7 and the final landform plan shown in Appendix 8.

Table 14: Rehabilitation Objectives

Feature	*Objective*
Mine site (as a whole)	• Safe, stable and non-polluting • Final landforms designed to incorporate natural micro-relief and natural drainage lines to integrate with surrounding landforms
Final voids	• Designed as long term groundwater sinks and to maximise groundwater flows across back-filled pits to the final void • Minimise to the greatest extent practicable: o the size and depth of final voids o the drainage catchment of final voids o any high wall instability risk o risk of flood interaction.
Agricultural land	• Rehabilitate at least 33 hectares of Class II agricultural capability land in the area identified in the rehabilitation plan (see Appendix 7) • Rehabilitate other areas identified for agricultural use in the rehabilitation plan to sufficient agricultural capability to support grazing
Revegetation areas	• Restore at least 2,642 hectares of self-sustaining woodland ecosystems in accordance with the rehabilitation plan, including at least 500 hectares of White Box Yellow Box Blakely's Red Gum Woodland.
Creek diversions and realignments	• Flows to mimic pre-development flows for all flood events up to and including the 1 in 100 year ARI • Incorporate erosion control measures based on vegetation and engineering revetments • Incorporate structures for aquatic habitat • Revegetate with suitable native species
Surface infrastructure	• To be decommissioned and removed, unless NSW Trade & Investment agrees otherwise.
Community	• Ensure public safety • Minimise the adverse socio-economic effects associated with mine closure.

Note: The rehabilitation plan for the site is shown in Appendix 7.

Rehabilitation Strategy

42. The Proponent shall prepare a revised Rehabilitation Strategy for the Mt Arthur mine complex to the satisfaction of the Secretary. This strategy must:
    (a) be prepared in consultation with the DRE and Council, and be submitted to the Secretary for approval by the end of September 2015, unless otherwise agreed with the Secretary;
    (b) investigate options for:
        - increasing the area to be rehabilitated to woodland on the site;
        - reducing the size of final voids on site; and
        - beneficial future land use of disturbed areas, including voids;
    (c) describe and justify the proposed rehabilitation plan for the site, including the final landform and land use; and
    (d) include detailed rehabilitation objectives for the site that comply with and build on the objectives in Table 14.

Note: The strategy should build on the rehabilitation plan in Appendix 7.

Progressive Rehabilitation

43. The Proponent shall carry out rehabilitation progressively, that is, as soon as reasonably practicable following disturbance (particularly on the face of emplacements that are visible off-site). Interim stabilisation measures must be implemented where reasonable and feasible to control dust emissions in disturbed areas that are not active and which are not ready for final rehabilitation.

Note: It is accepted that parts of the site that are progressively rehabilitated may be subject to further disturbance in future.

Rehabilitation Management Plan

44. The Proponent shall prepare and implement a Rehabilitation Management Plan for the Mt Arthur mine complex to the satisfaction of the DRE. This plan must:
    (a) submitted to NSW Trade & Investment for approval by 30 September 2015;
    (b) be prepared in consultation with the Department, NOW, OEH and Council;
    (c) be prepared in accordance with relevant NSW Trade & Investment guidelines;

(d) describe how the rehabilitation of the site would be integrated with the implementation of the biodiversity offset strategy;
(e) include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the site, and triggering remedial action (if necessary);
(f) describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval, and address all aspects of rehabilitation including mine closure, final landform including final voids, and final land use;
(g) include interim rehabilitation where necessary to minimise the area exposed for dust generation;
(h) include a research program that seeks to improve the understanding and application of rehabilitation techniques and methods in the Hunter Valley;
(i) include a program to monitor, independently audit and report on the effectiveness of the measures, and progress against the detailed performance and completion criteria; and
(j) build to the maximum extent practicable on other management plans required under this approval.

HERITAGE

Aboriginal Heritage Management Plan

45. The Proponent shall prepare and implement an Aboriginal Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must:
(a) be prepared in consultation with OEH, the Aboriginal community, Council and relevant landowners;
(b) include the following for the management of Aboriginal heritage on-site:
- a plan of management for the Thomas Mitchell Drive Offsite Offset Area (identified in Condition 36); and
- a program/procedures for:
  - salvage, excavation and/or management of Aboriginal sites and potential archaeological deposits within the project disturbance area;
  - protection and monitoring of Aboriginal sites outside the project disturbance area, including the scarred trees and axe grinding grooves identified on the site;
  - managing the discovery of any new Aboriginal objects or skeletal remains during the project;
  - maintaining and managing access to archaeological sites by the Aboriginal community;
  - ongoing consultation and involvement of the Aboriginal communities in the conservation and management of Aboriginal cultural heritage on the site; and
  - management of the “Fairford 1” site in situ, including reasonable and feasible measures to mitigate impacts on this site, until an agreement can be reached with relevant Aboriginal stakeholders and OEH, for its salvage and relocation.

Historic Heritage Management Plan

45A. The Proponent shall prepare and implement a Historic Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must:
(a) be prepared in consultation with the Heritage Branch, Council, local historical organisations and relevant landowners;
(b) include the following for the management of other historic heritage on site:
- conservation management plans for the Edinglassie and Rous Lench homesteads;
- a detailed plan for the relocation of the Beer Homestead, including provision for a landscape study to determine the most appropriate location and an architectural report to determine the most sympathetic method for relocation; and
- a program/procedures for:
  - photographic and archival recording of potentially affected heritage items;
  - protection and monitoring of heritage items outside the project disturbance area;
  - monitoring, notifying and managing the effects of blasting on potentially affected heritage items; and
  - additional archaeological excavation and/or recording of any significant heritage items requiring demolition.

TRANSPORT

Monitoring of Coal Transport

46. The Proponent shall keep records of the:
(a) amount of coal transported from the site in each financial year;
(b) number of coal haulage train movements generated by the Mt Arthur mine complex (on a daily basis); and
(c) make these records available on its website at the end of each financial year.

Road Upgrades and Maintenance

47. The Proponent shall:
    (a) contribute to the upgrade and maintenance of Thomas Mitchell Drive, proportionate to its impact (based on usage) on that infrastructure, in accordance with the Contributions Study prepared by GHD titled, "*Thomas Mitchell Drive Contributions Study, December 2014*" (or its latest version), unless otherwise agreed by the Secretary;
    (b) upgrade the Thomas Mitchell Drive/New England Highway intersection to the satisfaction of the applicable roads authority, by the end of June 2011 unless otherwise agreed by the roads authority;
    (c) upgrade the Thomas Mitchell Drive/Denman Road intersection to the satisfaction of the applicable roads authority, by the end of December 2017, unless otherwise agreed by the Secretary;
    (d) realign Edderton Road and its intersection with Denman Road prior to mining within 200 metres of the road, to the satisfaction of Council and the RMS;
    (e) upgrade the intersection of Edderton Road and the secondary site access road to the satisfaction of Council prior to using this road for deliveries to the relocated explosives facility; and
    (f) maintain reasonable access to the summit of Mt Arthur for emergency services and legitimate users on a 24 hour per day basis, except for temporary closures as required for blasting.

    The road or intersection upgrades referred to in this condition may be satisfied through funding the required upgrades, subject to the agreement of the applicable roads authority, and subject to providing the funding such that the upgrades can be completed within the stated timeframe.

    For Thomas Mitchell Drive, the contributions must:
    (a) be paid to Council within three months of the GHD contributions study being issued by the Department for the upgrade works; and
    (b) be paid to Council in accordance with the maintenance schedule established in accordance with the Contributions Study during the life of the project,

    unless otherwise agreed with Council.

    If there is any dispute between the Proponent and Council or the RMS in relation to the funding or completion of the upgrades, then any of the parties may refer the matter to the Secretary for resolution.

    Note:
    - *In making a determination about the applicable upgrade and maintenance contributions for Thomas Mitchell Drive, the Secretary shall take into account the contributions already paid and currently required to be paid towards the upgrade and maintenance of the local road network surrounding Muswellbrook under this approval and the planning agreement executed on 24 June 2011, and summarised in Appendix 9.*
    - *For clarity it is noted that while the Proponent is required to upgrade the Thomas Mitchell Drive/Denman Road intersection in accordance with Condition 47 (c), it may receive contributions from other mining companies toward the cost of accelerating this upgrade, in proportion to the respective impacts of these other mine/s on this intersection, as identified in the Contributions Study prepared by GHD titled "Thomas Mitchell Drive Contributions Study, December 2014" (or its latest version), unless otherwise agreed with the Secretary.*

Railway Crossing

48. The Proponent shall implement all reasonable and feasible measures to minimise blocking the railway crossing on Antiene Railway Station Road, to the satisfaction of the Secretary.

Rail Loop Duplication

48A. The Proponent shall ensure that the rail loop duplication is undertaken in consultation with the ARTC and relevant infrastructure/land owners (including Council), and constructed to meet relevant standards and network interface requirements, to the satisfaction of ARTC.

48B. The Proponent shall prepare and implement a Construction Management Plan for the rail loop duplication and associated bridge widening to the satisfaction of the Secretary. This plan must be prepared in consultation with Council and ARTC, and must be submitted to the Secretary for approval prior to the commencement of construction activities for the rail duplication and associated bridge. The plan must describe how public safety and access to Thomas Mitchell Drive would be maintained during the construction period.

VISUAL

Mining Operations Additional Visual Impact Mitigation

49. By the end of December 2014, the Proponent shall revise the *Visual Impacts Management Report* prepared by AECOM in May 2011, to the satisfaction of the Secretary. The revised report must:
    (a) identify the privately-owned land that is likely to experience significant visual impacts during the project; and

(b) describe (in general terms) the additional mitigation measures that could be implemented to reduce the visibility of the mine from these properties.

Notes:

- *The additional visual impact mitigation measures should be aimed at reducing the visibility of the mine from significantly affected residences or areas on privately-owned land subject to tourist and/or general public access or areas on the Woodlands thoroughbred horse stud with views of the project, and do not necessarily require measures to reduce visibility of the mine from other locations on affected properties. The additional visual impact mitigation measures do not necessarily have to include measures on the affected property itself (i.e. the additional measures may consist of measures outside the affected property boundary that provide an effective reduction in visual impacts).*
- *Except in exceptional circumstances, the Secretary will not require additional visual impact mitigation to be undertaken for residences that are more than 5 kilometres from the mining operations.*

50. Within 3 months of the Secretary approving this report, the Proponent shall advise all owners of privately-owned land identified in the report that they are entitled to additional mitigation measures to reduce the visibility of the mine from their properties.

51. Upon receiving a written request from an owner of privately-owned land identified in this report, or upon receiving a direction from the Secretary regarding any other privately-owned land, the Proponent shall implement additional visual impact mitigation measures (such as landscaping treatments or vegetation screens) in consultation with the landowner, and to the satisfaction of the Secretary.

These mitigation measures must be reasonable and feasible, and must be implemented within a reasonable timeframe.

If within 3 months of receiving this request from the owner, the Proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

Visual Amenity and Lighting

52. The Proponent shall:
    (a) implement all reasonable and feasible measures to mitigate visual and off-site lighting impacts of the project;
    (b) ensure no outdoor lights shine above the horizontal; and
    (c) ensure that all external lighting associated with the project complies with relevant Australian Standards, including *Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting*,

    to the satisfaction of the Secretary.

WASTE

53. The Proponent shall:
    (a) minimise and monitor the waste generated by the project;
    (b) ensure that the waste generated by the project is appropriately stored, handled and disposed of;
    (c) manage on-site sewage treatment and disposal in accordance with the requirements of Council; and
    (d) report on waste management and minimisation in the Annual Review,

    to the satisfaction of the Secretary.

BUSHFIRE MANAGEMENT

54. The Proponent shall:
    (a) ensure that the project is suitably equipped to respond to any fires on site; and
    (b) assist the RFS and emergency services as much as practicable if there is a fire in the vicinity of the site.

SCHEDULE 4
ADDITIONAL PROCEDURES

NOTIFICATION OF LANDOWNERS

1. By the end of September 2014, the Proponent shall ensure that the owners of the land listed in:
   (a) Table 1 of schedule 3 have been notified in writing that they have the right to require the Proponent to acquire their land at any stage during the project;
   (b) Table 1 (noise affected land) and Table 4 of schedule 3 have been notified in writing that they are entitled to ask the Proponent to install additional noise mitigation measures at their residence at any stage during the project; and
   (c) Table 1 (air quality affected land) and Table 12 of schedule 3 have been notified in writing that they are entitled to ask the Proponent to install additional air quality mitigation measures at their residence at any stage during the project.

2. If the results of the monitoring required in schedule 3 identify that impacts generated by the project are greater than the relevant impact assessment criteria, except where a negotiated agreement has been entered into in relation to that impact, then the Proponent shall, within 2 weeks of obtaining the monitoring results notify the Secretary, the affected landowners and tenants (including tenants of mine-owned properties) accordingly, and provide regular monitoring results to each of these parties until the results show that the project is complying with the criteria in schedule 3.

3. The Proponent shall send a copy of the NSW Health fact sheet entitled "Mine Dust and You" (as may be updated from time to time) to all landowners and/or existing or future tenants (including tenants of mine owned properties) of properties where:
   (a) the predictions in the EA identify that the dust emissions generated by the project are likely to be greater than the air quality land acquisition criteria in schedule 3; and
   (b) monitoring results identify that the mine is exceeding the air quality land acquisition criteria in schedule 3, with such notice to be provided within 2 weeks of identifying the exceedance.

3A. The Proponent shall ensure that any receiver identified in condition 1 of schedule 4 is notified in writing of any change in the status of their acquisition or mitigation rights, at least 12 months prior to this change occurring, to the satisfaction of the Secretary.

INDEPENDENT REVIEW

4. If a landowner of privately-owned land considers the project to be exceeding the impact assessment criteria in schedule 3, then he/she may ask the Secretary in writing for an independent review of the impacts of the project on his/her land.

   If the Secretary is satisfied that an independent review is warranted, the Proponent shall within 2 months of the Secretary's decision:
   (a) Commission and fund a suitably qualified, experienced and independent expert, whose appointment has been approved by the Secretary, to:
      - consult with the landowner to determine his/her concerns;
      - conduct monitoring to determine whether the project is complying with the relevant impact assessment criteria in schedule 3; and
      - if the project is not complying with these criteria then:
         - o determine if the more than one mine is responsible for the exceedance, and if so the relative share of each mine regarding the impact on the land;
         - o identify the measures that could be implemented to ensure compliance with the relevant criteria; and
   (b) give the Secretary and landowner a copy of the independent review.

5. If the independent review determines that the project is complying with the relevant impact assessment criteria in schedule 3, then the Proponent may discontinue the independent review with the approval of the Secretary.

   If the independent review determines that the project is not complying with the relevant impact assessment criteria in schedule 3, and that the project is primarily responsible for this non-compliance, then the Proponent shall:
   (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent expert, and conduct further monitoring until the project complies with the relevant criteria; or
   (b) secure a written agreement with the landowner to allow exceedances of the relevant impact assessment criteria,

   to the satisfaction of the Secretary.

   If the measures referred to in (a) do not achieve compliance with the air quality acquisition criteria in schedule 3, and the Proponent cannot secure a written agreement with the landowner to allow these exceedances within 3 months, then upon receiving a written request from the landowner, the

Proponent shall acquire all or part of the landowner's land in accordance with the procedures in conditions 7-8 below.

6. If the independent review determines that the relevant impact assessment criteria in schedule 3 are being exceeded, but that more than one mine is responsible for this non-compliance, then the Proponent shall, together with the relevant mine/s:
   (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent expert, and conduct further monitoring until there is compliance with the relevant criteria; or
   (b) secure a written agreement with the landowner and other relevant mines to allow exceedances of the relevant impact assessment criteria in schedule 3,

   to the satisfaction of the Secretary.

   If the measures referred to in (a) do not achieve compliance with the air quality acquisition criteria in schedule 3, and the Proponent together with the relevant mine/s cannot secure a written agreement with the landowner to allow these exceedances within 3 months, then upon receiving a written request from the landowner, the Proponent shall acquire all or part of the landowner's land on as equitable a basis as possible with the relevant mine/s, in accordance with the procedures in conditions 7-8 below.

LAND ACQUISITION

7. Within 3 months of receiving a written request from a landowner with acquisition rights, the Proponent shall make a binding written offer to the landowner based on:
   (a) the current market value of the landowner's interest in the property at the date of this written request, as if the property was unaffected by the project, having regard to the:
      - existing and permissible use of the land, in accordance with the applicable planning instruments at the date of the written request; and
      - presence of improvements on the property and/or any approved building or structure which has been physically commenced at the date of the landowner's written request, and is due to be completed subsequent to that date, but excluding any improvements that have resulted from the implementation of the 'additional noise mitigation measures' in condition 7 of schedule 3, or 'additional air quality mitigation measures' in condition 22 of schedule 3;
   (b) the reasonable costs associated with:
      - relocating within the Muswellbrook, Singleton or Scone local government area, or to any other local government area determined by the Secretary; and
      - obtaining legal advice and expert advice for determining the acquisition price of the land, and the terms upon which it is to be acquired; and
   (c) reasonable compensation for any disturbance caused by the land acquisition process.

   However, if at the end of this period, the Proponent and landowner cannot agree on the acquisition price of the land and/or the terms upon which the land is to be acquired, then either party may refer the matter to the Secretary for resolution.

   Upon receiving such a request, the Secretary shall request the President of the NSW Division of the Australian Property Institute to appoint a qualified independent valuer to:
   - consider submissions from both parties;
   - determine a fair and reasonable acquisition price for the land and/or the terms upon which the land is to be acquired, having regard to the matters referred to in paragraphs (a)-(c) above;
   - prepare a detailed report setting out the reasons for any determination; and
   - provide a copy of the report to both parties.

   Within 14 days of receiving the independent valuer's report, the Proponent shall make a binding written offer to the landowner to purchase the land at a price not less than the independent valuer's determination.

   However, if either party disputes the independent valuer's determination, then within 14 days of receiving the independent valuer's report, they may refer the matter to the Secretary for review. Any request for a review must be accompanied by a detailed report setting out the reasons why the party disputes the independent valuer's determination. Following consultation with the independent valuer and both parties, the Secretary shall determine a fair and reasonable acquisition price for the land, having regard to the matters referred to in paragraphs (a)-(c) above, the independent valuer's report, and the detailed report of the party that disputes the independent valuer's determination. Within 14 days of this determination, the Proponent shall make a binding written offer to the landowner to purchase the land at a price not less than the Secretary's determination.

   If the landowner refuses to accept the Proponent's binding written offer under this condition within 6 months of the offer being made, then the Proponent's obligations to acquire the land shall cease, unless the Secretary determines otherwise.

8. The Proponent shall pay all reasonable costs associated with the land acquisition process described in condition 7 above, including the costs associated with obtaining Council approval for any plan of subdivision (where permissible), and registration of this plan at the Office of the Registrar-General.

SCHEDULE 5
ENVIRONMENTAL MANAGEMENT, REPORTING AND AUDITING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Secretary. The strategy must:
   (a) provide the strategic framework for environmental management of the project;
   (b) identify the statutory approvals that apply to the project;
   (c) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project;
   (d) describe the procedures that would be implemented to:
      - keep the local community and relevant agencies informed about the operation and environmental performance of the project;
      - receive, handle, respond to, and record complaints;
      - resolve any disputes that may arise during the course of the project;
      - respond to any non-compliance;
      - respond to emergencies; and
   (e) include:
      - copies of the various strategies, plans and programs that are required under the conditions of this approval once they have been approved; and
      - a clear plan depicting all the monitoring to be carried out in relation to the project.

Management Plan Requirements

2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:
   (a) detailed baseline data;
   (b) a description of:
      - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
      - any relevant limits or performance measures/criteria;
      - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;
   (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
   (d) a program to monitor and report on the:
      - impacts and environmental performance of the project;
      - effectiveness of any management measures (see c above);
   (e) a contingency plan to manage any unpredicted impacts and their consequences;
   (f) a program to investigate and implement ways to improve the environmental performance of the project over time;
   (g) a protocol for managing and reporting any:
      - incidents;
      - complaints;
      - non-compliances with statutory requirements; and
      - exceedances of the impact assessment criteria and/or performance criteria; and
   (h) a protocol for periodic review of the plan.

Annual Review

3. By the end of June each year, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must:
   (a) describe the works that were carried out in the past year, and the works that are proposed to be carried out over the next year;
   (b) include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the
      - the relevant statutory requirements, limits or performance measures/criteria;
      - the monitoring results of previous years; and
      - the relevant predictions in the EA;
   (c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
   (d) identify any trends in the monitoring data over the life of the project;
   (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and
   (f) describe what measures will be implemented over the next year to improve the environmental performance of the project.

Revision of Strategies, Plans and Programs

4. Within 3 months of:
   (a) the submission of an annual review under condition 3 above;
   (b) the submission of an incident report under condition 7 below;
   (c) the submission of an audit under condition 9 below; or
   (d) any modification to the conditions of this approval,

   the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within four weeks of the review the revised document must be submitted to the Secretary for approval.

   Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.

Community Consultative Committee

5. The Proponent shall establish and operate a CCC for the project to the satisfaction of the Secretary. This CCC must be established by the end of March 2011 and be operated in general accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects* (Department of Planning, 2007, or its latest version).

   Notes:
   - *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval.*
   - *In accordance with the Guideline, the Committee should comprise an independent chair and appropriate representation from the Proponent, affected councils and the general community.*

Management of Cumulative Impacts

6. In conjunction with the owners of the nearby Drayton and Bengalla mines, the Proponent shall use its best endeavours to minimise the cumulative impacts of the project on the surrounding area to the satisfaction of the Secretary.

   Note: Nothing in this approval is to be construed as requiring the Proponent to act in a manner which is contrary to the Trade Practices Act 1974.

REPORTING

Incident Reporting

7. The Proponent shall immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident, the Proponent shall provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

Regular Reporting

8. The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval, and to the satisfaction of the Secretary.

INDEPENDENT ENVIRONMENTAL AUDIT

9. By the end of June 2014, and every 3 years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
   (a) be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary;
   (b) include consultation with the relevant agencies;
   (c) assess the environmental performance of the project and assess whether it is complying with the requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals);
   (d) review the adequacy of strategies, plans or programs required under the abovementioned approvals; and
   (e) recommend appropriate measures or actions to improve the environmental performance of the project, and/or any assessment, plan or program required under the abovementioned approvals.

   Notes:
   - *This audit team must be led by a suitably qualified auditor and include experts in surface water, groundwater and any other fields specified by the Secretary.*
   - *The audits should be coordinated with similar auditing requirements for the Mt Arthur Underground Project.*

10. Within 6 weeks of the completion of this audit, or as otherwise agreed by the Secretary, the Proponent shall submit a copy of the audit report to the Secretary, together with its response to any recommendations contained in the audit report.

ACCESS TO INFORMATION

11. From the end of December 2010, the Proponent shall:
    (a) make the following information publicly available on its website:
        - a copy of all current statutory approvals for the project;
        - a copy of the current environmental management strategy and associated plans and programs;
        - a summary of the monitoring results of the project, which have been reported in accordance with the various plans and programs approved under the conditions of this approval;
        - a complaints register, which is to be updated on a monthly basis;
        - a copy of the minutes of CCC meetings;
        - a copy of any Annual Reviews (over the last 5 years);
        - a copy of any Independent Environmental Audit, and the Proponent's response to the recommendations in any audit;
        - any other matter required by the Secretary; and

    (b) keep this information up to date,

    to the satisfaction of the Secretary.

APPENDIX 1
SCHEDULE OF LAND

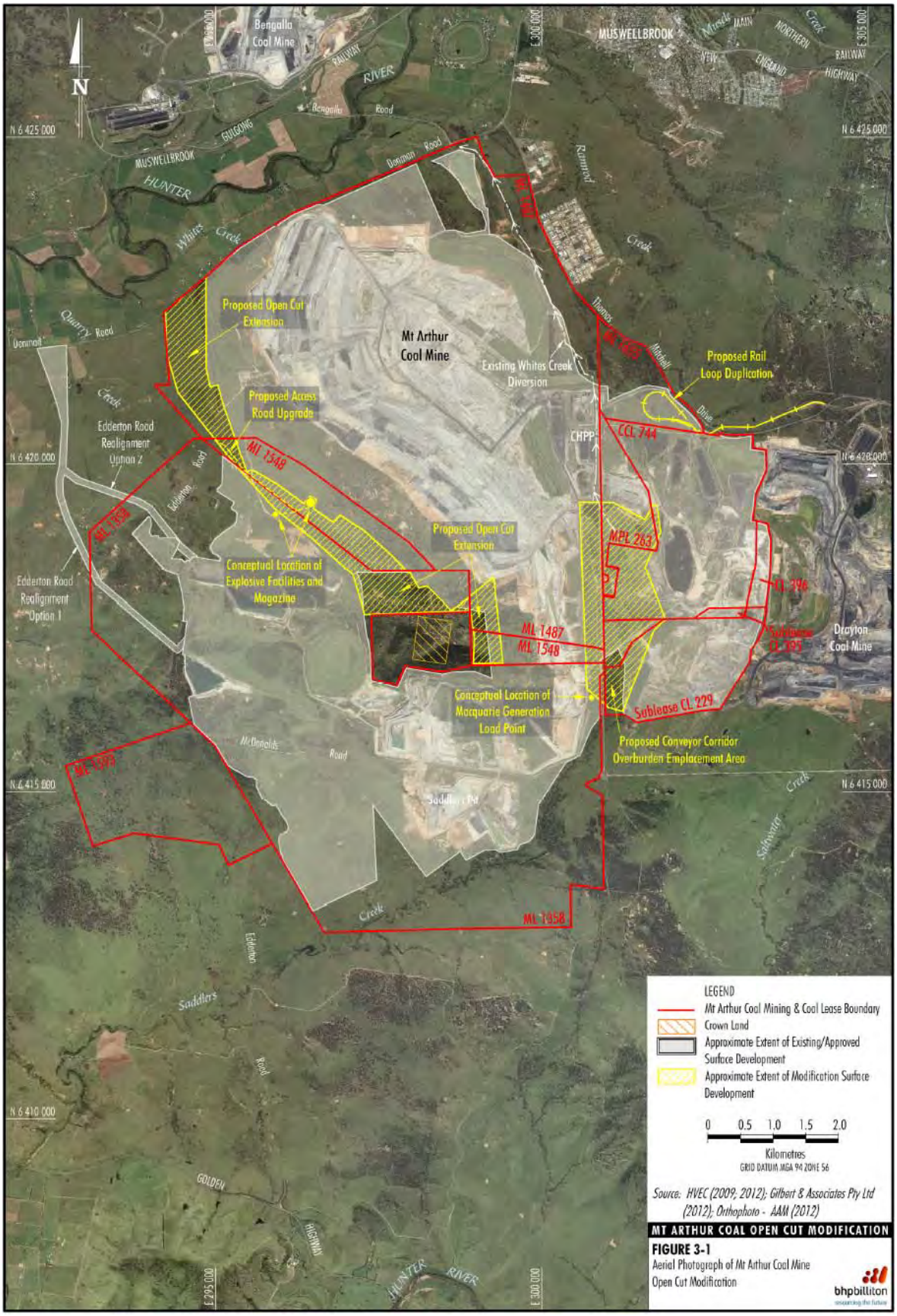
MT ARTHUR COAL OPEN CUT MODIFICATION
ATTACHMENT A TO REQUEST TO MODIFY A MAJOR PROJECT FORM

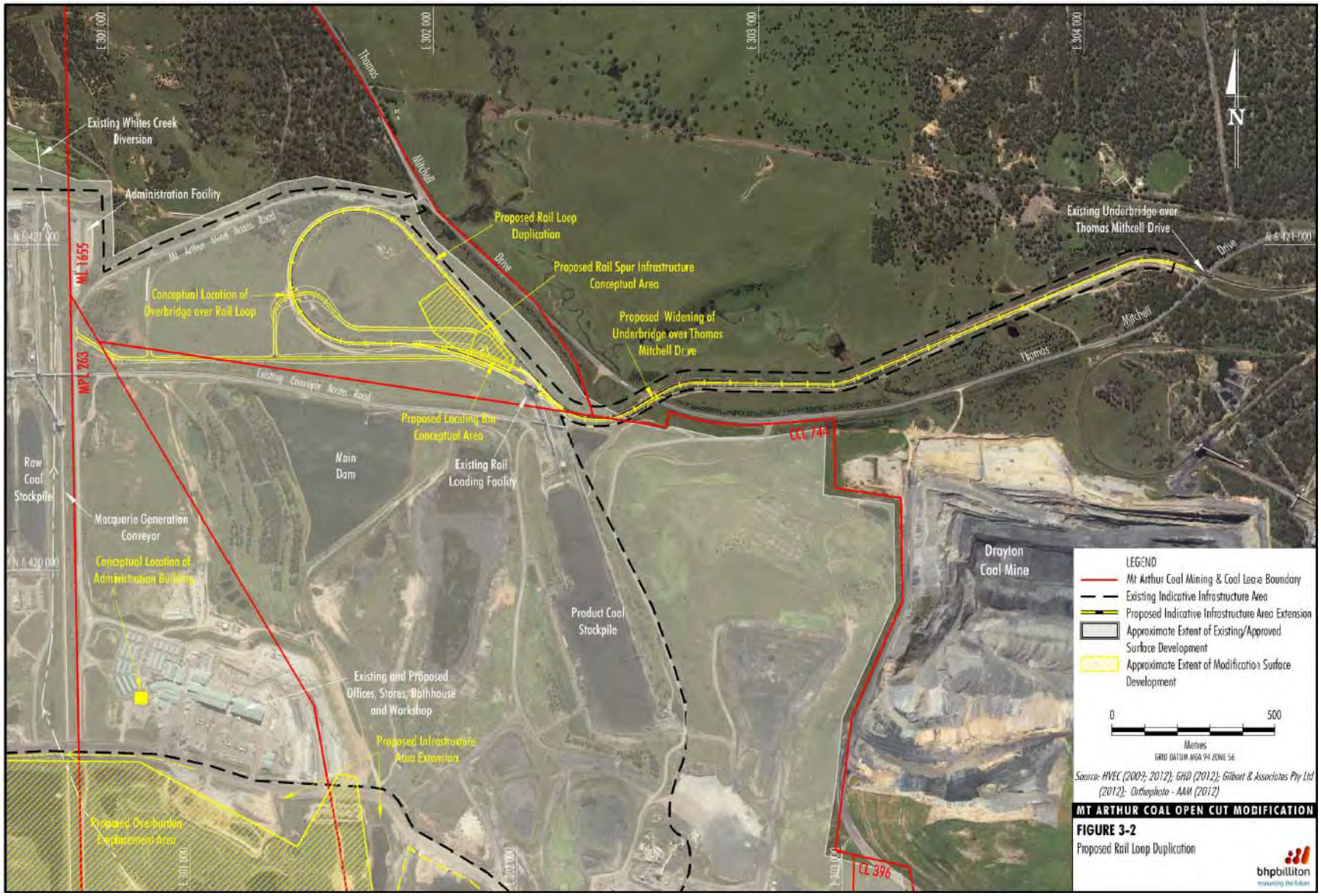
Property Ownership within EA Boundary		
Ownership	**Lot**	**DP**
Anglo Coal (Drayton Management) Pty Limited	321	625513
Anglo Coal (Drayton Management) Pty Limited	3	701496
Anglo Coal (Drayton Management) Pty Limited	4	701496
Anglo Coal (Drayton Management) Pty Limited	6	701496
Anglo Coal (Drayton Management) Pty Limited	8	843635
Anglo Coal (Drayton Management) Pty Limited	64	850818
Anglo Coal (Drayton Management) Pty Limited	65	850818
Anglo Coal (Drayton Management) Pty Limited	1	1004725
Anglo Coal (Drayton Management) Pty Limited	22	1018587
Anglo Coal (Drayton Management) Pty Limited	180	812852
Crown	2	48776
Crown	3	48776
Crown	4	48776
Crown	5	48776
Crown	6	48776
Crown	7	48776
Crown	8	48776
Crown	7003	93323
Crown	11	632691
Crown	160	722249
Crown	1	752486
Crown	85	752500
Crown	10	793428
Crown	1	532672
Crown	108	43392
Crown	1	47302
Freehold (Private Landholding)	4	6090
Freehold (Private Landholding)	1	34397
Freehold (Private Landholding)	2	34397
Freehold (Energy Australia)	1	223018
Freehold (Muswellbrook Council)	112	633293
Freehold (Private Landholding)	1	752441
Freehold (Private Landholding)	97	752441
Freehold (Private Landholding)	98	752441
Freehold (Private Landholding)	102	752441
Freehold (Private Landholding)	1	956112
Freehold (Private Landholding)	68	752500
Freehold (Private Landholding)	69	752500
Freehold (Private Landholding)	70	752500
Freehold-(Private Landholding)	71	752500
Hunter Valley Energy Coal Limited	5	726248
Hunter Valley Energy Coal Limited	111	633293
Hunter Valley Energy Coal Limited	1	1090735
Hunter Valley Energy Coal Limited	2	1090735
Hunter Valley Energy Coal Limited	3	1090735
Hunter Valley Energy Coal Limited	4	1090735
Hunter Valley Energy Coal Limited	5	1090735
Hunter Valley Energy Coal Limited	6	1090735
Hunter Valley Energy Coal Limited	8	26211
Hunter Valley Energy Coal Limited	9	26211
Hunter Valley Energy Coal Limited	10	26211
Hunter Valley Energy Coal Limited	1	27346

Property Ownership within EA Boundary		
Ownership	**Lot**	**DP**
Hunter Valley Energy Coal Limited	2	27346
Hunter Valley Energy Coal Limited	3	27346
Hunter Valley Energy Coal Limited	4	27346
Hunter Valley Energy Coal Limited	5	27346
Hunter Valley Energy Coal Limited	6	27346
Hunter Valley Energy Coal Limited	7	27346
Hunter Valley Energy Coal Limited	8	27346
Hunter Valley Energy Coal Limited	11	27346
Hunter Valley Energy Coal Limited	12	27346
Hunter Valley Energy Coal Limited	13	27346
Hunter Valley Energy Coal Limited	14	27346
Hunter Valley Energy Coal Limited	15	27346
Hunter Valley Energy Coal Limited	16	27346
Hunter Valley Energy Coal Limited	1	29950
Hunter Valley Energy Coal Limited	2	29950
Hunter Valley Energy Coal Limited	3	29950
Hunter Valley Energy Coal Limited	4	29950
Hunter Valley Energy Coal Limited	5	29950
Hunter Valley Energy Coal Limited	6	29950
Hunter Valley Energy Coal Limited	7	29950
Hunter Valley Energy Coal Limited	8	29950
Hunter Valley Energy Coal Limited	9	29950
Hunter Valley Energy Coal Limited	10	29950
Hunter Valley Energy Coal Limited	11	29950
Hunter Valley Energy Coal Limited	12	29950
Hunter Valley Energy Coal Limited	1	101142
Hunter Valley Energy Coal Limited	1	113689
Hunter Valley Energy Coal Limited	1	133634
Hunter Valley Energy Coal Limited	2	133634
Hunter Valley Energy Coal Limited	1	204369
Hunter Valley Energy Coal Limited	4	204369
Hunter Valley Energy Coal Limited	13	228159
Hunter Valley Energy Coal Limited	115	246348
Hunter Valley Energy Coal Limited	111	246348
Hunter Valley Energy Coal Limited	112	246348
Hunter Valley Energy Coal Limited	113	246348
Hunter Valley Energy Coal Limited	114	246348
Hunter Valley Energy Coal Limited	4	247064
Hunter Valley Energy Coal Limited	1	249536
Hunter Valley Energy Coal Limited	2	249536
Hunter Valley Energy Coal Limited	3	249536
Hunter Valley Energy Coal Limited	4	249536
Hunter Valley Energy Coal Limited	5	249536
Hunter Valley Energy Coal Limited	6	249536
Hunter Valley Energy Coal Limited	1	308136
Hunter Valley Energy Coal Limited	1	372862
Hunter Valley Energy Coal Limited	1	385720
Hunter Valley Energy Coal Limited	2	385720
Hunter Valley Energy Coal Limited	2	387021
Hunter Valley Energy Coal Limited	3	387021
Hunter Valley Energy Coal Limited	4	390143
Hunter Valley Energy Coal Limited	1	403081
Hunter Valley Energy Coal Limited	A	407349
Hunter Valley Energy Coal Limited	C	407349

Property Ownership within EA Boundary		
Ownership	**Lot**	**DP**
Hunter Valley Energy Coal Limited	1	503827
Hunter Valley Energy Coal Limited	111	514759
Hunter Valley Energy Coal Limited	112	514759
Hunter Valley Energy Coal Limited	1	515936
Hunter Valley Energy Coal Limited	2	515936
Hunter Valley Energy Coal Limited	11	526344
Hunter Valley Energy Coal Limited	20	550431
Hunter Valley Energy Coal Limited	1	573259
Hunter Valley Energy Coal Limited	2	573259
Hunter Valley Energy Coal Limited	121	575515
Hunter Valley Energy Coal Limited	122	575515
Hunter Valley Energy Coal Limited	123	575515
Hunter Valley Energy Coal Limited	124	575515
Hunter Valley Energy Coal Limited	2	601359
Hunter Valley Energy Coal Limited	10	632691
Hunter Valley Energy Coal Limited	9	655749
Hunter Valley Energy Coal Limited	159	722249
Hunter Valley Energy Coal Limited	110	727767
Hunter Valley Energy Coal Limited	63	752449
Hunter Valley Energy Coal Limited	49	752500
Hunter Valley Energy Coal Limited	83	752500
Hunter Valley Energy Coal Limited	154	752500
Hunter Valley Energy Coal Limited	166	752503
Hunter Valley Energy Coal Limited	30	787702
Hunter Valley Energy Coal Limited	604	802124
Hunter Valley Energy Coal Limited	605	802124
Hunter Valley Energy Coal Limited	607	802124
Hunter Valley Energy Coal Limited	1	806149
Hunter Valley Energy Coal Limited	2	806149
Hunter Valley Energy Coal Limited	201	842045
Hunter Valley Energy Coal Limited	1	843634
Hunter Valley Energy Coal Limited	2	843634
Hunter Valley Energy Coal Limited	3	843634
Hunter Valley Energy Coal Limited	4	843634
Hunter Valley Energy Coal Limited	6	843635
Hunter Valley Energy Coal Limited	7	843635
Hunter Valley Energy Coal Limited	9	843635
Hunter Valley Energy Coal Limited	66	850818
Hunter Valley Energy Coal Limited	21	1018587
Hunter Valley Energy Coal Limited	113	1078759
Hunter Valley Energy Coal Limited	115	1078759
Macquarie Generation	1	790994
Macquarie Generation	181	812852
Macquarie Generation	46	241179
Macquarie Generation	45	241179
Macquarie Generation	44	241179
Macquarie Generation	1	556370
Macquarie Generation	1	238862
Macquarie Generation	PT5	752486
Macquarie Generation	PT2	752486
Macquarie Generation	22	241179

APPENDIX 2
PROJECT LAYOUT PLANS




E 301 000
E 302 000
E 303 000
E 304 000
N 6 421 000
N 6 420 000
Existing Whites Creek Diversion
Administration Facility
Mt Arthur Mine Access Road
ML 1655
MPL 263
Conceptual Location of Overbridge over Rail Loop
Proposed Rail Loop Duplication
Proposed Rail Spur Infrastructure Conceptual Area
Proposed Widening of Underbridge over Thomas Mitchell Drive
Existing Underbridge over Thomas Mitchell Drive
Thomas Mitchell Drive
Existing Conveyor Access Road
Proposed Loading Bin Conceptual Area
Existing Rail Loading Facility
Main Dam
Raw Coal Stockpile
Macquarie Generation Conveyor
Conceptual Location of Administration Building
Product Coal Stockpile
Existing and Proposed Offices, Stores, Bathhouse and Workshop
Proposed Infrastructure Area Extension
Proposed Overburden Emplacement Area
CCL 744
CL 396
Drayton Coal Mine
N
LEGEND
Mt Arthur Coal Mining & Coal Lease Boundary
Existing Indicative Infrastructure Area
Proposed Indicative Infrastructure Area Extension
Approximate Extent of Existing/Approved Surface Development
Approximate Extent of Modification Surface Development
0
500
Metres
GRID DATUM MGA 94 ZONE 56
Source: HVEC (2009; 2012); GHD (2012); Gilbert & Associates Pty Ltd (2012); Orthophoto - AAM (2012)
MT ARTHUR COAL OPEN CUT MODIFICATION
FIGURE 3-2
Proposed Rail Loop Duplication
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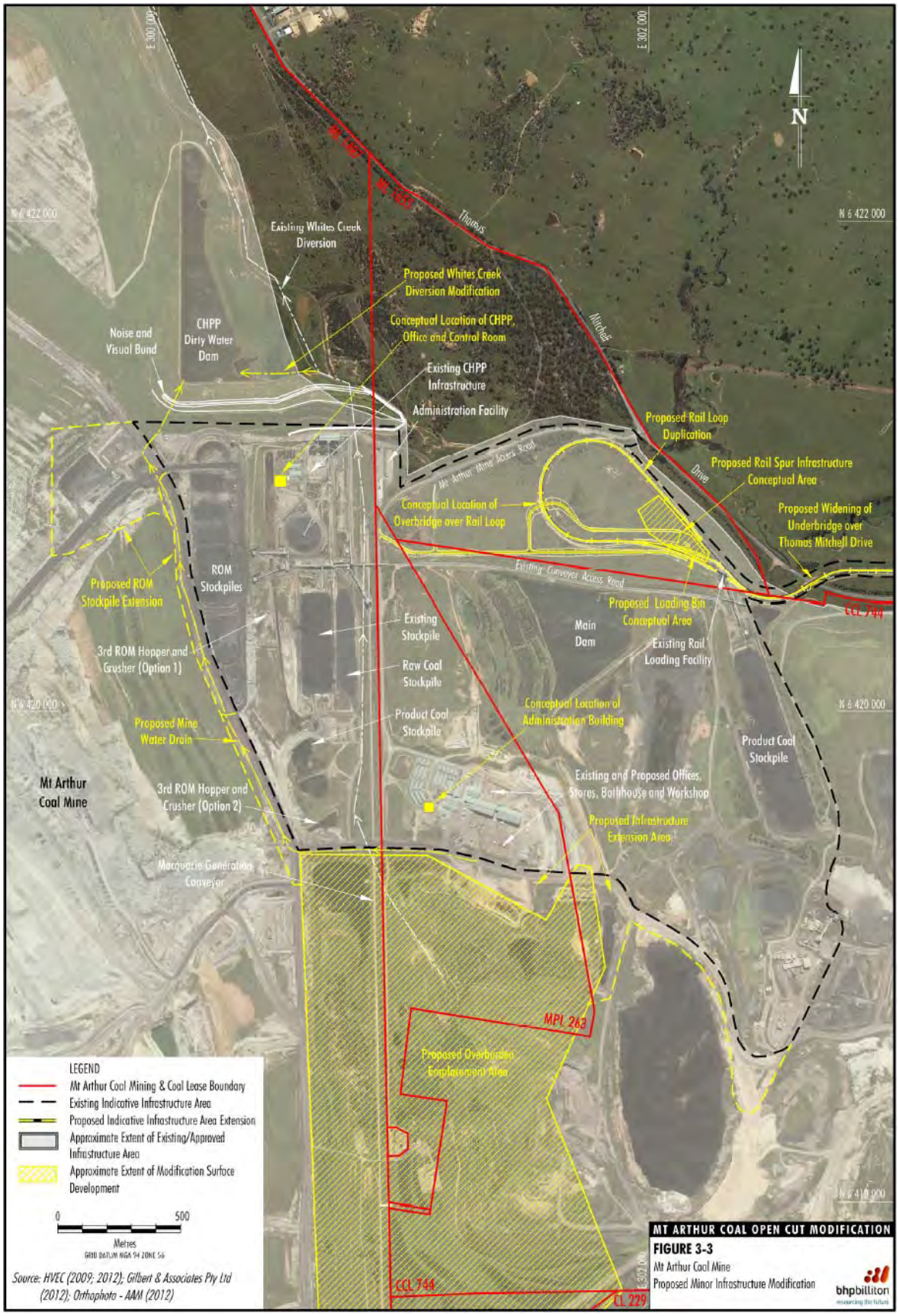
E 300 000
E 302 000
N 6 422 000
N 6 420 000
N 6 418 000
N
Existing Whites Creek Diversion
Proposed Whites Creek Diversion Modification
Conceptual Location of CHPP, Office and Control Room
Noise and Visual Bund
CHPP Dirty Water Dam
Existing CHPP Infrastructure
Administration Facility
Thomas
Mitchell
Proposed Rail Loop Duplication
Proposed Rail Spur Infrastructure Conceptual Area
Mt Arthur Mine Access Road
Drive
Conceptual Location of Overbridge over Rail Loop
Proposed Widening of Underbridge over Thomas Mitchell Drive
Existing Conveyor Access Road
CCL 744
Proposed ROM Stockpile Extension
ROM Stockpiles
Proposed Loading Bin Conceptual Area
Existing Stockpile
Main Dam
Existing Rail Loading Facility
3rd ROM Hopper and Crusher (Option 1)
Raw Coal Stockpile
Product Coal Stockpile
Conceptual Location of Administration Building
Proposed Mine Water Drain
Product Coal Stockpile
Mt Arthur Coal Mine
3rd ROM Hopper and Crusher (Option 2)
Existing and Proposed Offices, Stores, Bathhouse and Workshop
Proposed Infrastructure Extension Area
Macquarie Generation Conveyor
MPL 263
Proposed Overburden Emplacement Area
CCL 744
CL 229
LEGEND
Mt Arthur Coal Mining & Coal Lease Boundary
Existing Indicative Infrastructure Area
Proposed Indicative Infrastructure Area Extension
Approximate Extent of Existing/Approved Infrastructure Area
Approximate Extent of Modification Surface Development
0
500
Metres
GRID DATUM MGA 94 ZONE 56
Source: HVEC (2009; 2012); Gilbert & Associates Pty Ltd (2012); Orthophoto - AAM (2012)
MT ARTHUR COAL OPEN CUT MODIFICATION
FIGURE 3-3
Mt Arthur Coal Mine
Proposed Minor Infrastructure Modification
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APPENDIX 3
PREVIOUS EAs

Mt Arthur North Mine
Development Application 144-05-2000 and Environmental Impact Statement titled *The Mt Arthur North Coal Project*, dated April 2000, and prepared by URS Australia, as amended by the following:

- Submissions to the Commission of Inquiry; and
- the 2002 modification application, including the plans titled *Mount Arthur North Industrial Area Facilities – General Arrangement*, prepared by Sinclair Knight Merz, dated 26 November 2002.

South Pit Extension Project
Project Application 06_0108 and Environmental Assessment titled *Proposed South Pit Extension Project*, dated July 2007, including the response to submissions dated November 2007.

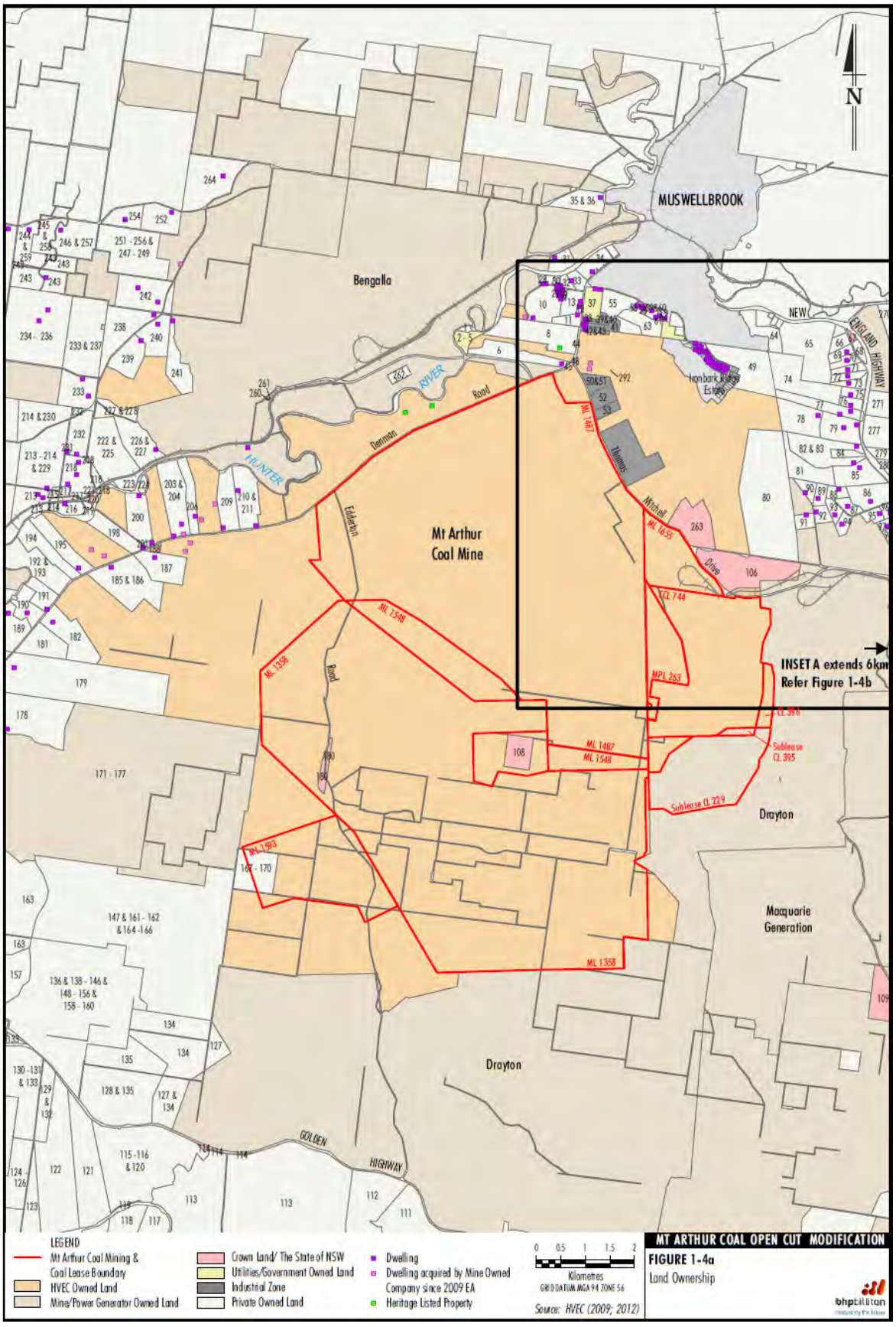
Bayswater No.3 Mine
Development Application 210/93 and Environmental Impact Statement dated November 1993, and prepared by Resource Planning Pty Ltd, as amended by the following:

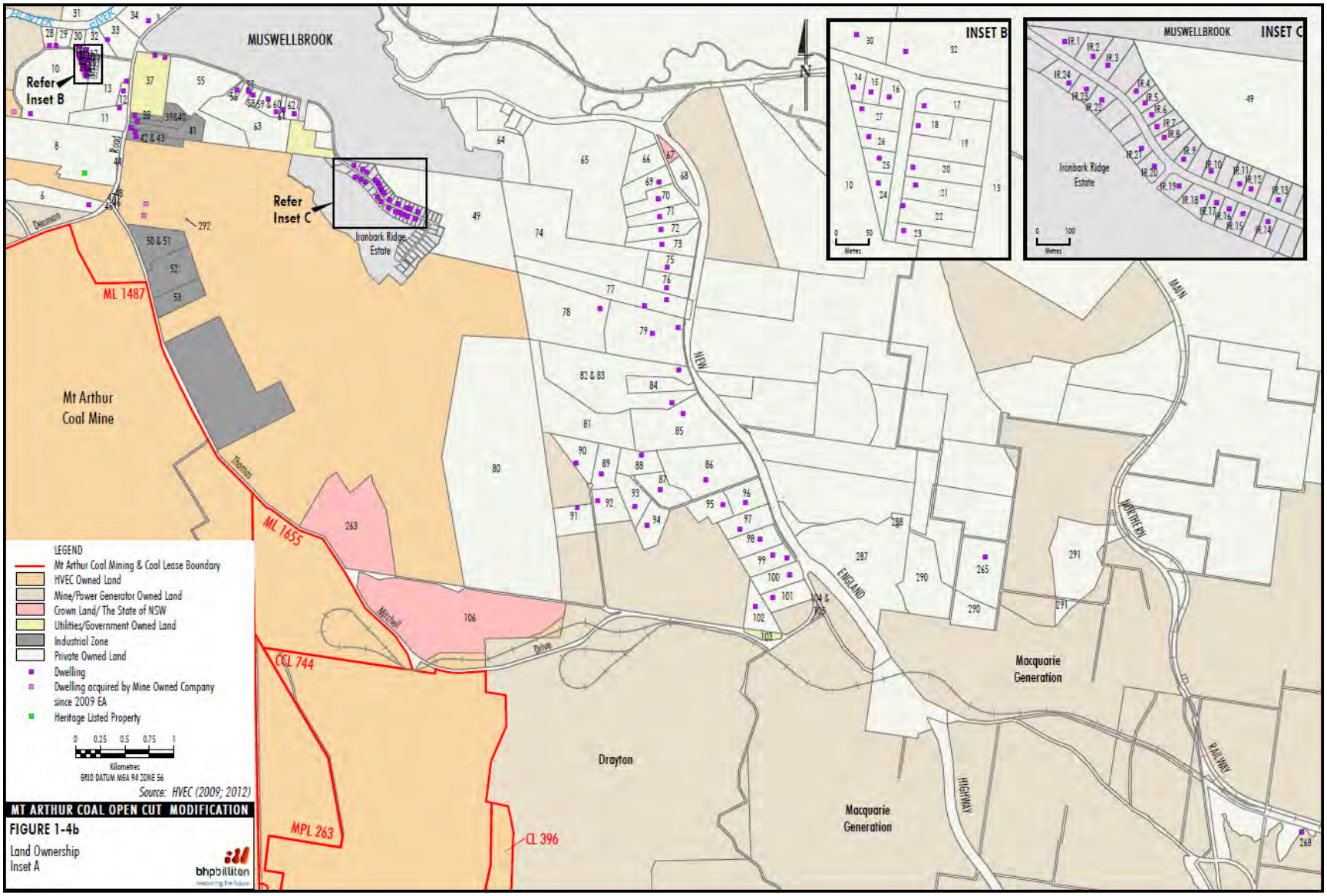
- Submissions to the Commission of Inquiry;
- the modification application and accompanying Statement of Environmental Effects, dated September 1999; and
- the modification application and accompanying Statement of Environmental Effects, dated 1 March 2001.

Bayswater Rail Loading Facility and Rail Loop
Development Application 105-04-00 and Environmental Impact Statement dated March 2000, and prepared by Umwelt (Australia) Pty Ltd.

Bayswater Coal Preparation Plant
Development Application 24/97 and Environmental Impact Statement dated April 1997, and prepared by Umwelt (Australia) Pty Ltd.

APPENDIX 4
RECEIVER LOCATION PLANS




MUSWELLBROOK
Refer Inset B
Refer Inset C
Ironbark Ridge Estate
INSET B
INSET C
MUSWELLBROOK
Ironbark Ridge Estate
ML 1487
ML 1655
CCL 744
MPL 263
CL 396
Mt Arthur Coal Mine
Drayton
Macquarie Generation
Macquarie Generation
HUNTER RIVER
Denman Road
Thomas Mitchell Drive
NEW ENGLAND HIGHWAY
MAIN NORTHERN RAILWAY
LEGEND
Mt Arthur Coal Mining & Coal Lease Boundary
HVEC Owned Land
Mine/Power Generator Owned Land
Crown Land/ The State of NSW
Utilities/Government Owned Land
Industrial Zone
Private Owned Land
Dwelling
Dwelling acquired by Mine Owned Company since 2009 EA
Heritage Listed Property
0 0.25 0.5 0.75 1
Kilometres
GRID DATUM MGA 94 ZONE 56
Source: HVEC (2009; 2012)
MT ARTHUR COAL OPEN CUT MODIFICATION
FIGURE 1-4b
Land Ownership
Inset A
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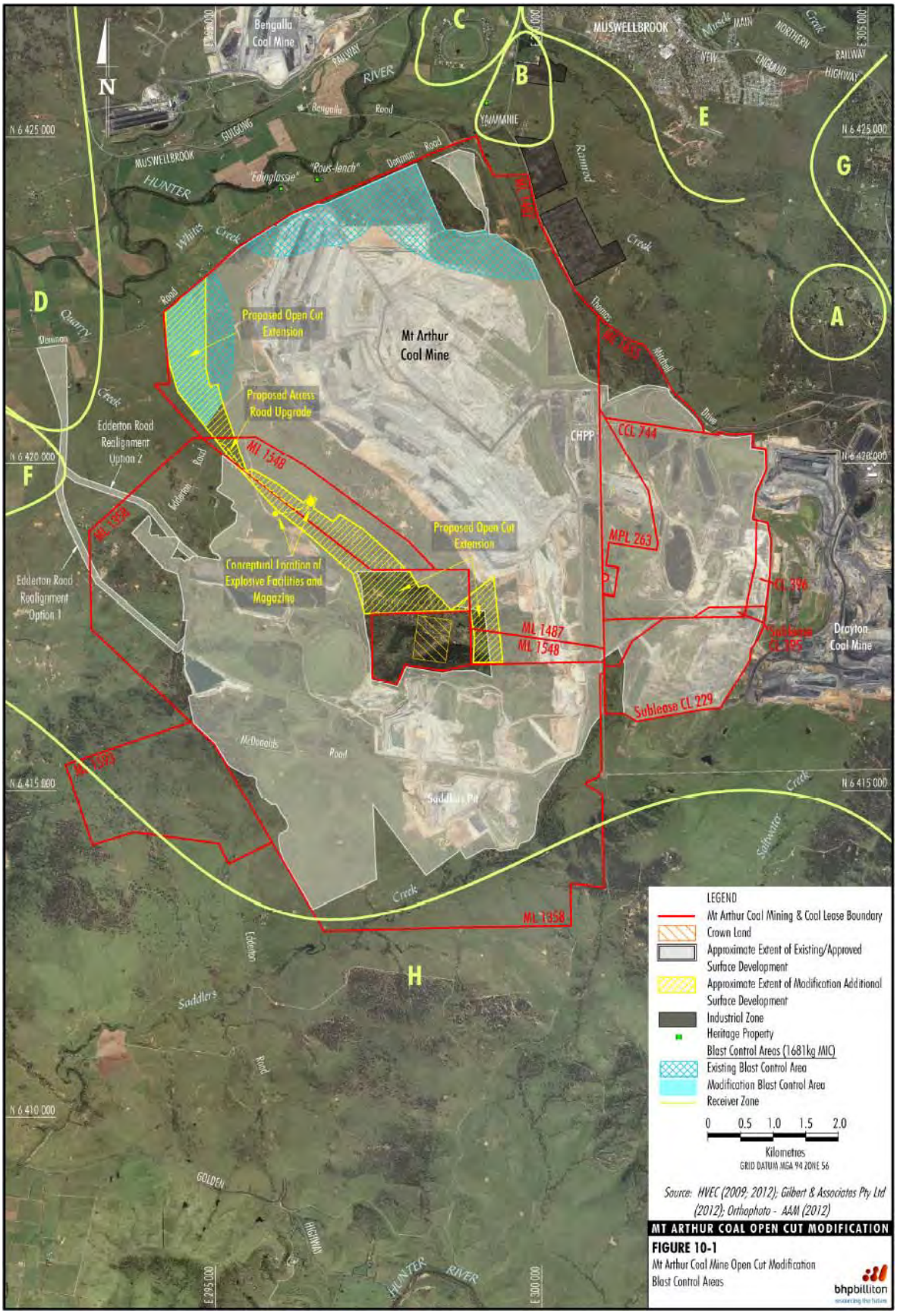
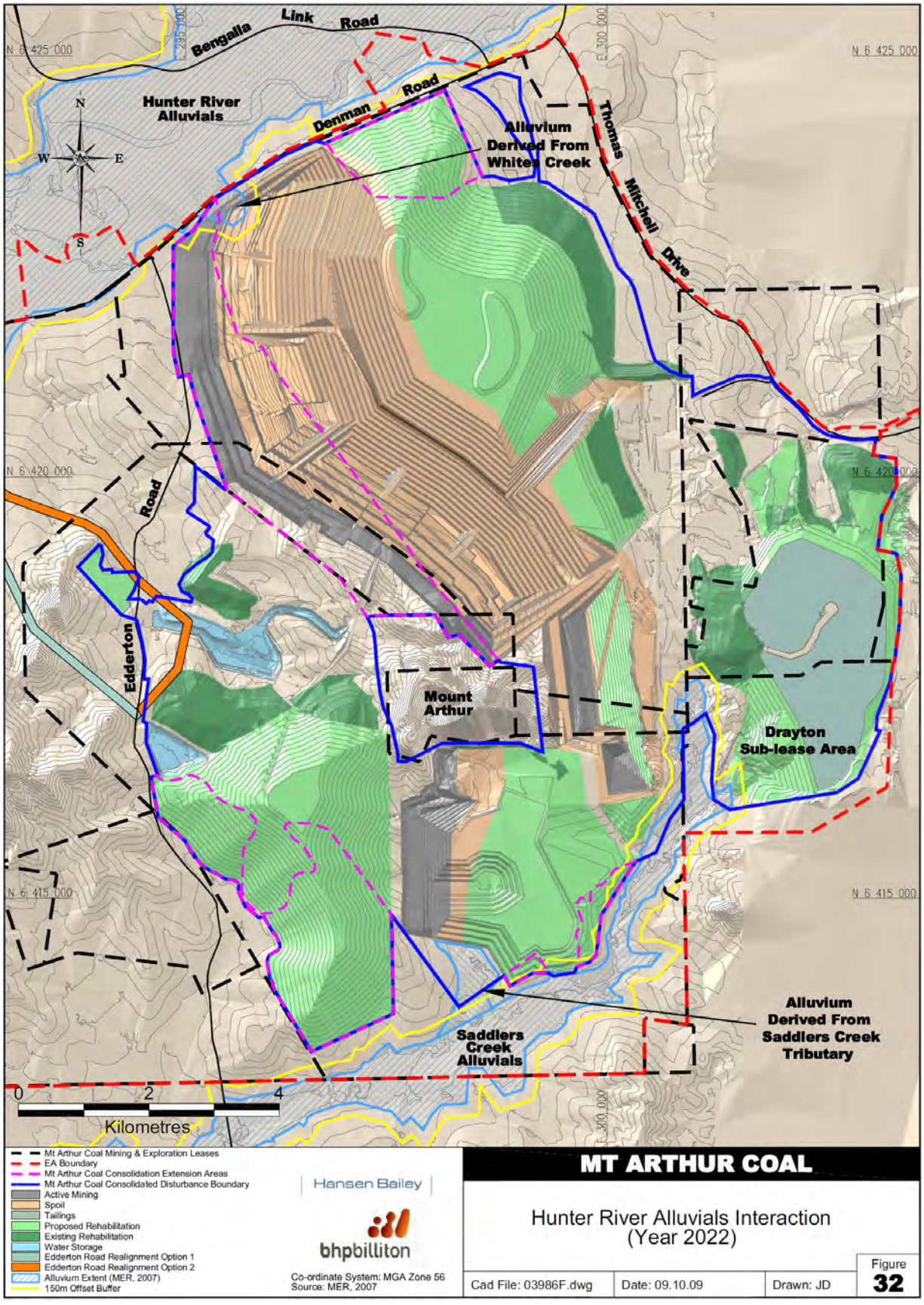
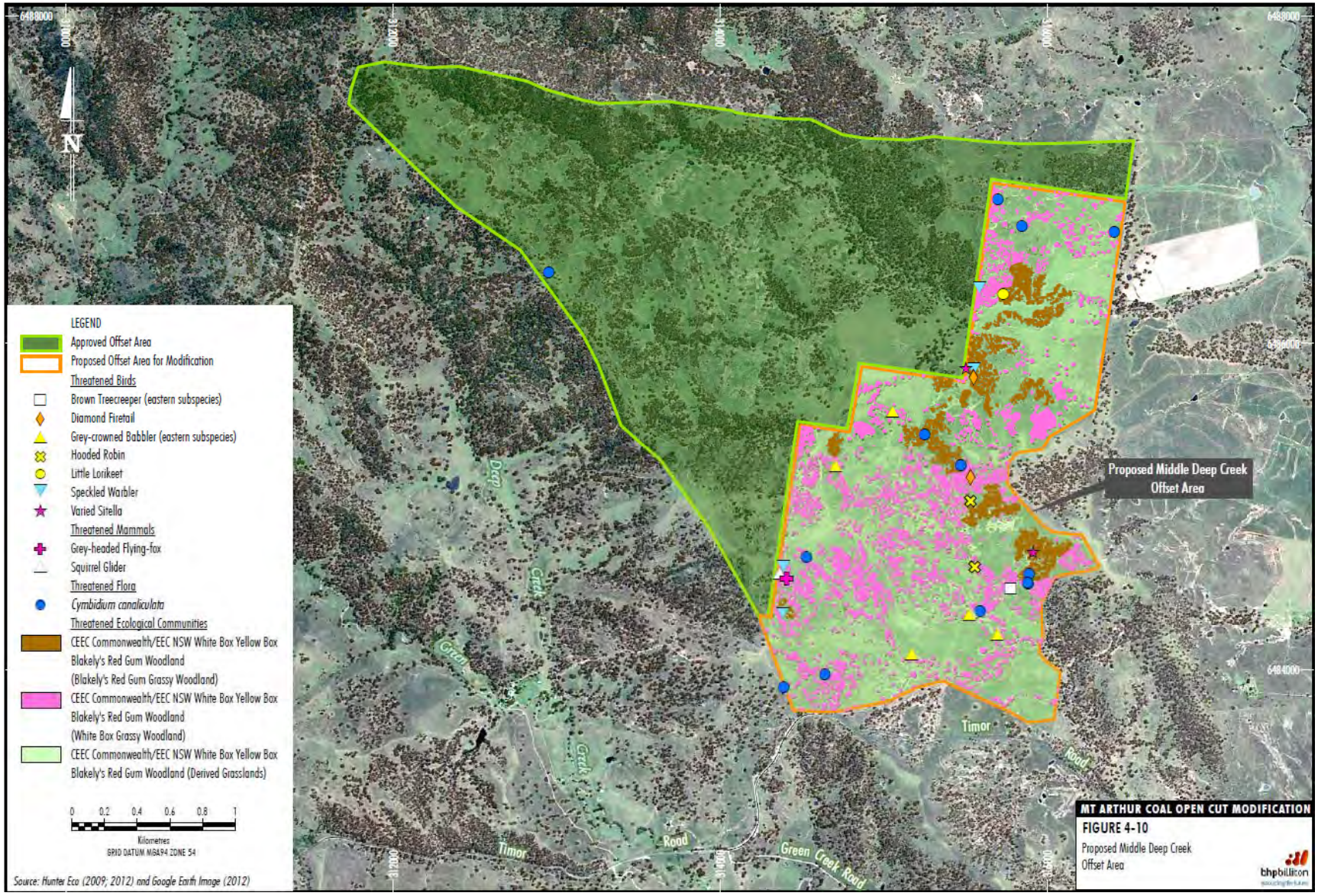
APPENDIX 5
BLAST CONTROL AREA



APPENDIX 6
HUNTER RIVER AND SADDLERS CREEK ALLUVIALS



APPENDIX 7
BIODIVERSITY OFFSET STRATEGY AND REHABILITATION PLAN


LEGEND
Approved Offset Area
Proposed Offset Area for Modification
Threatened Birds
Brown Treecreeper (eastern subspecies)
Diamond Firetail
Grey-crowned Babbler (eastern subspecies)
Hooded Robin
Little Lorikeet
Speckled Warbler
Varied Sitella
Threatened Mammals
Grey-headed Flying-fox
Squirrel Glider
Threatened Flora
Cymbidium canaliculata
Threatened Ecological Communities
CEEC Commonwealth/EEC NSW White Box Yellow Box Blakely's Red Gum Woodland (Blakely's Red Gum Grassy Woodland)
CEEC Commonwealth/EEC NSW White Box Yellow Box Blakely's Red Gum Woodland (White Box Grassy Woodland)
CEEC Commonwealth/EEC NSW White Box Yellow Box Blakely's Red Gum Woodland (Derived Grasslands)
0 0.2 0.4 0.6 0.8 1
Kilometres
GRID DATUM MGA94 ZONE 54
Source: Hunter Eco (2009; 2012) and Google Earth Image (2012)
N
Proposed Middle Deep Creek Offset Area
Deep Creek
Green Creek
Timor Road
Green Creek Road
6488000
6484000
MT ARTHUR COAL OPEN CUT MODIFICATION
FIGURE 4-10
Proposed Middle Deep Creek Offset Area
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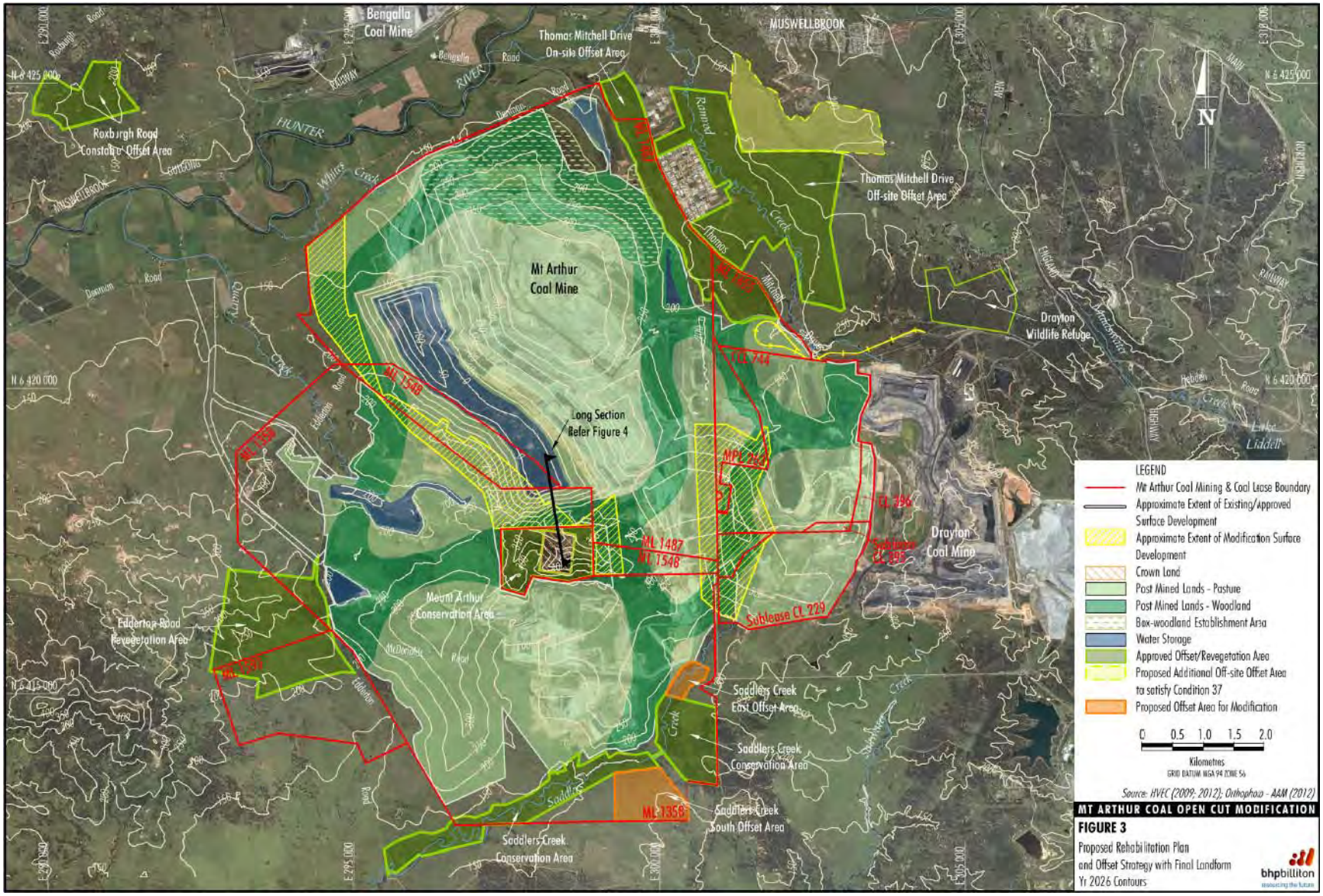
APPENDIX 8
FINAL LANDFORM PLAN



APPENDIX 9
GENERAL TERMS OF THE PLANNING AGREEMENT

Funding Area	Proponent Contribution	Notes / Funding Time Frame
Thomas Mitchell Drive Upgrade	$3,000,000, plus $4,060,000 capital	The total contribution of $7,060,000 will be payable in yearly instalments to match execution of the works. The $4,060,000 capital will be repayable to the Proponent by Council from contributions from other projects/developments, in accordance with the terms of the planning agreement.
Thomas Mitchell Drive Maintenance	$120,000 per annum (max.)	Contributions to start at year 2 of the completion of the Thomas Mitchell Drive upgrade works (contributions to be staged if the upgrade works are staged).
Mt Arthur Coal Community Fund	$500,000 per annum	Contributions to start on commencement of construction.
Council Environmental Assessment	$20,000 per annum	Contributions to start on commencement of construction.

APPENDIX 10
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in Table 2 of Schedule 3 are to apply under all meteorological conditions except the following:
   (a) during periods of rain or hail;
   (b) average wind speed at microphone height exceeds 5 m/s;
   (c) wind speeds greater than 3 m/s measured at 10 m above ground level; or
   (d) temperature inversion conditions greater than 3°C/100 m, or alternatively stability class F and G.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station on or in the vicinity of the site.

Compliance Monitoring

3. Attended monitoring is to be used to determine compliance with the relevant conditions of this Approval.

4. This monitoring must be carried out at least once a month (but at least two weeks apart), unless the Secretary directs otherwise.

   Note: The Secretary may direct that the frequency of attended monitoring increase or decrease at any time during the life of the project.

5. Unless otherwise agreed with the Secretary, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the *NSW Industrial Noise Policy* (as amended from time to time), in particular the requirements relating to:
   (a) monitoring locations for the collection of representative noise data;
   (b) meteorological conditions during which collection of noise data is not appropriate;
   (c) equipment used to collect noise date, and conformity with Australian Standards relevant to such equipment; and
   (d) modifications to noise data collected including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.

Mt Arthur Coal

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resourcing the future

Attachment E –
Letter Confirming No Public Comments Received on Preliminary Documentation

Mt Arthur Coal

bhpbilliton
resourcing the future

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Muswellbrook NSW 2333 Australia
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Muswellbrook NSW 2333 Australia
Tel +61 2 6544 5800 Fax +61 2 6544 5801
bhpbilliton.com

29 May 2016

Ms Corinne Lawless
Assessments NSW North
Environment Standards Division
Department of the Environment
PO Box 787, Canberra 2601

Dear Corinne

MT ARTHUR COAL MINE OPEN CUT MODIFICATION (2014/7377) – PERIOD FOR PUBLIC COMMENT CLOSED – NO COMMENTS RECIEVED

In accordance with s 95B (3) of the *Environmental Protection and Biodiversity Conservation Act 1999*, Hunter Valley Energy Coal Pty Ltd advises that no comments were received during the public comment period which ended on the 6 May 2016.

Yours sincerely

p.p.

Sarah Bailey
Approvals - Mt Arthur Coal