

2015

Ecology Report for the Continuation of Rix's Creek Mine, Singleton LGA



October 2015

Report v4.4 to

Rix's Creek Pty Limited
New England Hwy
Singleton NSW 2330

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Cover image: Grassland derived from *Eucalyptus crebra* woodland, former Bowman property.

Report produced for:

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Executive Summary

Rix's Creek Mine (the Mine) of Rix's Creek Pty Limited, is owned and operated by Bloomfield Collieries Pty Limited (Bloomfield). The Mine is an open cut coal mine approximately 5 km north-west of Singleton in the Hunter Valley Coalfields of NSW, and currently produces approximately 1.5 million tonnes per annum (Mtpa) of product coal from its existing operations.

Bloomfield is seeking approval for the Rix's Creek Continuation of Mining Project (the Project), which relates to the continued operation of the existing open cut coal mine. The Project would allow the Mine to continue to operate as an open cut mine, accessed via its existing infrastructure facilities, which seeks to extend the life of the existing open cut mining operation at Rix's Creek until the year 2037.

Potential impacts on the ecology of the area have shown that the Project will have negligible effects. Surveys across the site have revealed the presence of two State-listed threatened communities (Central Hunter Grey Box-Ironbark Woodland; Hunter Lowlands Redgum Forest) totaling ~1.5 hectares, one Commonwealth-listed threatened community (Central Hunter Valley Eucalypt Forest and Woodland) totaling ~5.8 ha, one threatened fauna species (Squirrel Glider), and no threatened plants. Potential impacts on these threatened entities are manageable and acceptable, given the highly fragmented landscape in which the Project Area lies.

The assessment of impacts on ecology has been undertaken under two scenarios. In Scenario 1, the relevant NSW (ie: Section 94 *Threatened Species Conservation Act*; Section 5A *Environmental Planning & Assessment Act*; Section 220Z *Fisheries Management Act*) and Commonwealth (*Environment Protection and Biodiversity Conservation Act*) legislation have been addressed through 'seven-part tests' and referrals to assess potential impacts on threatened ecological communities and fauna known or expected within the proposed development area. A Referral to the Commonwealth (EPBC 2014/7348) has already deemed the project to be a non-controlled action under Part 7 of the EPBC Act. In Scenario 2, the Project Area has been assessed under the Upper Hunter Strategic Assessments (UHSA) bio-certification process being coordinated by OEH. Rix's Creek is a signatory to the UHSA and with approval of the Rix's Creek continuation project, offsets for the project will be provided in accordance with the Upper Hunter Biodiversity Plan, including contributing money to the Upper Hunter Offset Fund using the appropriate OEH calculators. Under the UHSA, the Project will generate 1400 ecosystem credits, and no species-credits.

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1.0 Introduction

1.1 Rix's Creek Continuation of Mining Project

This section provides an introduction to the Rix's Creek Mine, the proposed Rix's Creek Continuation of Mining Project (the Project), and the purpose and content of this report.

1.1.1 Overview

Rix's Creek Mine (the Mine) of Rix's Creek Pty Limited, is owned and operated by Bloomfield Collieries Pty Limited (Bloomfield). The Mine is an open cut coal mine approximately 5 km north-west of Singleton in the Hunter Valley Coalfields of NSW. The Mine currently produces approximately 1.5 million tonnes per annum (Mtpa) of product coal from its existing operations.

Bloomfield is seeking approval for the Rix's Creek Continuation of Mining Project (the Project), which relates to the continued operation of the existing open cut coal mine. The Project would allow the Mine to continue to operate as an open cut mine, accessed via its existing infrastructure facilities.

The Project seeks to extend the life of the existing open cut mining operation at Rix's Creek until approximately 2037. The continuation of mining operations will extend in a north-westerly direction and require a modification to Mine Lease 1432 for an out of pit dump. The continuation of operations will utilise the existing mine access, Coal Handling and Preparation Plant, coal stockpiling and rail facilities.

1.1.2 Proposed Development

The Project seeks to continue the existing mining operation at the Mine and to mine up to 4.5Mtpa Run of Mine (ROM) coal per year. Mining methods will be the same as those currently employed at the Mine, being multi-seam bench open cut techniques. ROM coal will continue to be processed onsite at the existing Coal Handling Preparation Plant (CHPP) which has capacity to accept the proposed increase in throughput. Product coal will then be transported by rail to the Port of Newcastle. It is estimated that the Mine could yield a total of 32 million saleable tonnes of coal at an overburden ratio of approximately 10.5:1 before coal seams are exhausted.

The components of the proposed development comprise:

- The ongoing use of, and future additions to, the existing mine fleet;
- Use of the existing mine infrastructure facilities including the CHPP;
- Continuation of operating hours - 24 hours a day 7 days a week;
- Use of existing and new rejects and tailings emplacements;
- Rail transport of product coal to the Port of Newcastle;
- Mine closure and rehabilitation; and
- Environmental management.

Figure 1 shows the location of the proposed development.

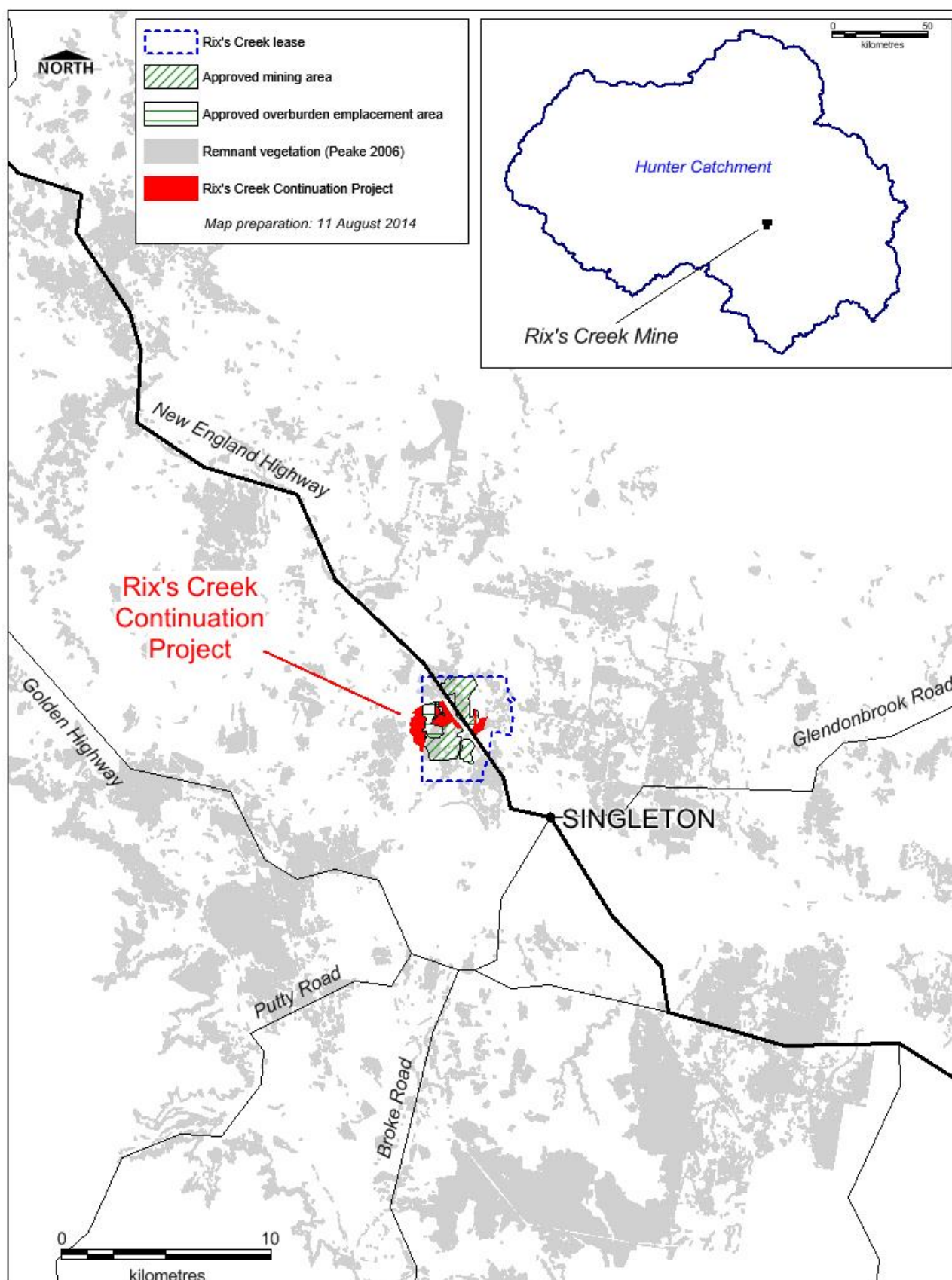


Figure 1 Location of the Rix's Creek mine: lease area, existing mine approvals and proposed Rix's Creek Continuation Project.

1.2 Proposed Operations Relevant to Ecology Impact Assessment

The Project has the potential to impact on a number of threatened flora and fauna species, as well as several endangered ecological communities. In order to assess these potential impacts, field surveys have been undertaken targeting significant species and communities within the direct impact areas. All surveys have been undertaken under the BCAM assessment methodology required for the Upper Hunter Strategic Assessments (UHSA), to which Rixs' Creek Mine is a signatory.

1.3 Purpose of this Report

1.1.3 Director-General's Requirements

The Rix's Creek Continuation of Mining Project Environmental Impact Statement has been prepared in accordance with Division 4.1, Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) which ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision-making process.

In preparing this Ecology assessment, the Director-General's Requirements (DGRs) issued for the Rix's Creek Continuation of Mining Project (SSD 13_6300) on 3 March 2014 have been addressed as required by Clause 75F of the EP&A Act. The key matters raised by the Director-General for consideration in the Ecology Impact Assessment are outlined in Table 1 along with a reference to where the requirements are addressed in the report.

Table 1 Director-Generals Requirements for Ecology

Director-Generals Requirements (Key Issues)	Section Addressed
Identification of existing vegetation within disturbance areas, and the ecological values of this habitat	Section 3 (Existing Environment) Section 4 (Impact Assessment)
Measures taken to avoid, reduce or mitigate impacts on biodiversity	Section 4 (Impact Assessment)
Accurate estimates of proposed vegetation clearing	Section 4 (Impact Assessment)
A detailed assessment of potential impacts of the development on any: (1) terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and (2) remnant vegetation, habitat corridors, and existing biodiversity offset areas.	Section 3 (Existing Environment) Section 4 (Impact Assessment)
A comprehensive offset strategy for the development including a justification of how the strategy would maintain or improve the biodiversity values of the region in the medium to long term.	Met through UHSA (see point below)
The obligation for a comprehensive biodiversity offset strategy may be met by contributing to the Upper Hunter Offsets Fund to be established under the Upper Hunter Strategic Assessment Framework. If this is proposed the EIS must include	
An assessment of impacts on NSW threatened species under the <i>Threatened Species Conservation Act 1995</i> (TSC Act) and matters of national environmental significance under the <i>Environment Protection and Biodiversity Conservation Act 2000</i> (EPBC Act),	Section 4 (Impact Assessment)
Use of the Biodiversity Certification Assessment Methodology (BCAM) and be consistent with the <i>draft Biodiversity Plan</i> for the Upper Hunter Strategic Assessment.	Section 4 (Impact Assessment)

1.1.4 Ecology Impact Assessment Objectives

The ecological assessment has been designed to target and assess the following ecological attributes:

- State-listed threatened flora and fauna (under the *TSC Act 1995*);
- Commonwealth-listed threatened flora and fauna (under the *EPBC Act 1999*);
- State-listed Threatened Ecological Communities (under the *TSC Act 1995*);
- Commonwealth-listed Threatened Ecological Communities (under the *EPBC Act 1999*);
- State-listed endangered populations (under the *TSC Act 1995*);

This report has been prepared based on data collected for the broader Upper Hunter Strategic Assessment being undertaken by the Office of Environment and Heritage (OEH). As such, advice received by OEH on threatened flora and fauna issues within the Upper Hunter has been adopted for the purpose of this assessment.

1.4 Report Structure

This report is structured as follows:

- Section 1.0 Introduction** – outlines the Project and presents the purpose of the report.
- Section 2.0 Methodology** – describes the methodology employed for the Ecology impact assessment
- Section 3.0 Existing Environment** – places the study area into context
- Section 4.0 Impact Assessment** – describes the potential impacts to flora and fauna resulting from the proposed Project.
- Section 5.0 Management and Monitoring** - provides a summary of environmental mitigation, management and monitoring responsibilities in relation to ecological management for the Project.
- Section 6.0 Conclusion.**

1.5 Personnel

Assessments undertaken for this report were completed by Stephen Bell (flora, *Eastcoast Flora Survey*), Michael Murray (fauna, *Forest Fauna Surveys Pty Ltd*) and Colin Driscoll (accredited assessor, *Hunter Eco*).

2. Methodology

Ecological impact assessment has been undertaken following the methods required for the UHSA, incorporating the BCAM methodology (NSW DECCW 2011). More broadly, the guidelines of Sivertsen (2010) have been adopted for general flora survey and classification of vegetation communities, which is consistent with numerous previous studies in the region. Other relevant guidelines are included in Section 2.1.2.

2.1 Legislation, Policy and Guidelines

2.1.1 Legislation

Legislation applicable to the assessment of potential impacts on biodiversity include:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- NSW *National Parks and Wildlife Act 1974*
- NSW *Threatened Species Conservation Act 1995*

Surveys and assessments have been designed to ensure that threatened flora, fauna and ecosystems (as listed on the relevant Acts) will be detected if present within the Project Area. Guideline documents listed in Section 2.1.1 have also been used in this process.

2.1.2 Policy and Guidelines

The following guidelines have been reviewed in relation to assessment of impacts on biodiversity:

- Principles for the use of biodiversity offsets in NSW (NSW OEH 2013)
- Interim policy on assessing and offsetting biodiversity impacts of Part 3A, State significant development and State significant infrastructure projects (NSW OEH 2014)
- Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (NSW DECC 2009)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (NSW DEC 2004)
- Threatened Species Assessment Guidelines: the Assessment of Significance (NSW DECC 2007a)
- BioBanking Assessment Methodology and Credit Calculator Operational Manual (NSW DECC 2008a)
- BioCertification Assessment Methodology (NSW DECCW 2011)
- NSW State Groundwater Dependent Ecosystem Policy (NSW DLWC 2002)
- Policy & Guidelines - Aquatic Habitat Management and Fish Conservation (NSW DPI 2013)
- Environmental Offsets Policy (Commonwealth SEWPaC 2012)
- Upper Hunter Strategic Assessment – Interim Policy (NSW DPI 2012)
- Commonwealth Matters of National Environmental Significance Guidelines (Commonwealth DoE 2013)

2.2 Study Area

Assessment of flora and fauna has been undertaken within the study area shown in **Figure 2** as Rix's Creek Continuation Project. In total, this area occupies 211.4 ha, including ~33 ha (15.6%) falling within previously

approved mining areas. As part of assessments undertaken for the UHSA (Bell 2014), a wider area has been surveyed and mapped, and data from that project has been used in the current assessment.

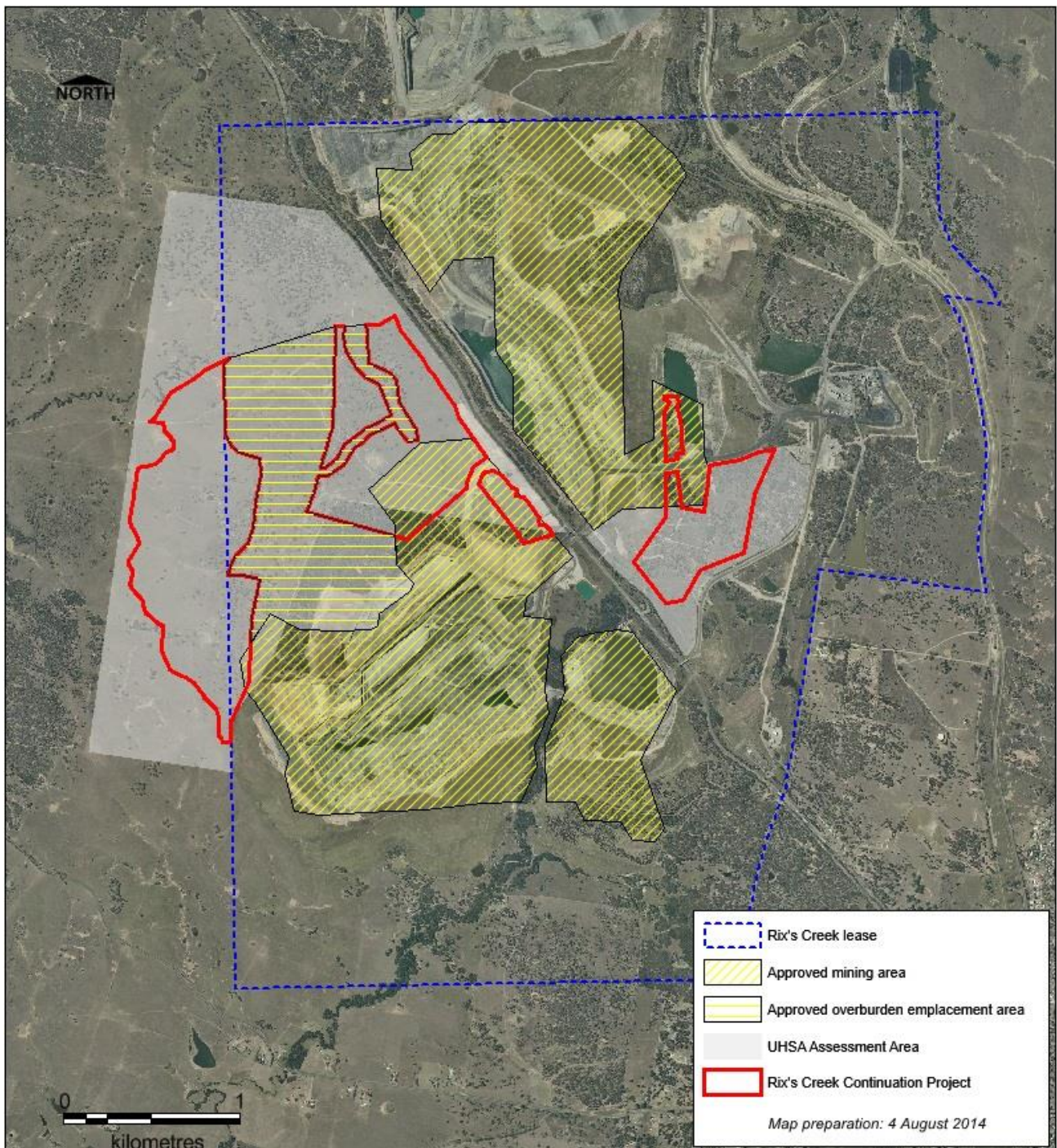


Figure 2 Study Area for the Rix's Creek Continuation Project, shown with existing lease boundary, approved mining/emplacement areas, and UHSA assessment areas.

2.3 Background Information Review

2.3.1 Database Searches

A search of the Biocertification Credit Calculator and the OEH BioNet database (which includes the Threatened Species Profile Database) was undertaken in June 2014, centred on Rix's Creek and limited to a 10x10 km area. Searches of flora databases maintained by *Eastcoast Flora Survey* were also undertaken for this project.

2.3.1 Review of Surrounding Developments

The Project Area is bounded on the north and south by existing coal mining activities carried out by Rix's Creek Mine, and to the east and west by open grazing lands. Streams drain to the south-west (6km) and west (4.5km) and into the Hunter River.

2.3.3 Review of Previous Studies

2.3.3.1 Flora

Few detailed and comprehensive studies on the vegetation of the Hunter Valley have been undertaken in the past. The Hunter Remnant Vegetation Project (Peake 2006) is the most current, and the mapping associated with that project included the Rix's Creek area. Three vegetation communities were depicted by Peake (2006) for the areas currently under investigation:

- Central Hunter Ironbark – Spotted Gum – Grey Box Forest
- Central Hunter Box – Ironbark Woodland
- Central Hunter Swamp Oak Forest

The Central Hunter Ironbark-Spotted Gum-Grey Box Forest (CHISGGBF) and the Central Hunter Box-Ironbark Woodland (CHBIW) have since been listed as Endangered Ecological Communities (EECs) on the NSW *Threatened Species Conservation Act 1995*. Floristically, the main distinguishing features between these two closely related communities are the co-dominance of *Corymbia maculata* in the CHISGGBF, and some differences in the understorey and ground layer species. Red Ironbark (*Eucalyptus fibrosa*) is included within the description for CHISGGBF, however this species is also a co-dominant and characteristic canopy species within the Lower Hunter Spotted Gum-Ironbark Forest EEC (LHSGIF). It is more plausible that portions of the CHISGGBF dominated by *Eucalyptus fibrosa* represent a dryer form of the LHSGIF, as detailed in Bell (2013b).

Somerville (2010) and Sivertsen et al. (2012) have presented regional-scale classification and mapping products in recent years, however these are of limited use at a local scale. More recently, three separate investigations have examined the vegetation within parts of the Rix's Creek lease (Bell 2012, 2013a, 2014). All three have used identical survey and assessment methods, with Bell (2014) also incorporating the BCAM methodology as part of the UHSA (NSW DECCW 2011). This current assessment utilizes the data and assessments presented in Bell (2014), but focuses only on the proposed disturbance areas.

2.3.3.2 Fauna

Unlike some other parts of NSW (eg: Greater Southern Sydney, NSW DECC 2007), there has been no comprehensive and thorough assessment of the native fauna of the Hunter Valley, despite the considerable amount of survey completed in support of development proposals throughout the region. All proposed developments are required to survey and assess the potential impact on threatened and protected fauna species, and such surveys have contributed heavily to current knowledge on population size and distribution of many fauna species. Special interest groups, such as the Hunter Bird Observers Club, produce an annual report on the birds of the Hunter Valley, which tracks changes in species abundance and distribution. For conservation reserves within the region, some comprehensive surveys have been completed (eg: NSW DEC 2005; NSW DECC 2008b).

Scotts and Drielsma (2003) and Wintle et. al. (2005) have modelled selected threatened fauna species across the lower Hunter Valley and North Coast of NSW, incorporating complex modelling algorithms to map predicted distributions. While such projects provide important information to assist conservation planning, they do not allow development of inventories for fauna presence in any particular locality.

In the absence of a comprehensive treatment of the Hunter Valley fauna, viewing of the OEH BioNet Atlas provides the next best alternative. For the Hunter-Central Rivers Catchment Management Area, a total of 849 fauna species have been recorded, including 143 species threatened in NSW and 44 threatened nationally. Records such as these can be used as a guide to the expected fauna likely to be present on any given site.

2.3.4 Review of Baseline Data

No baseline data has been utilised in this report.

2.3.5 Preliminary Field Work

Details of field work undertaken for the Ecology assessment are provided in Section 2.4.

2.3.6 Assumptions

No assumptions have been made in relation to the proposed development and its impact on flora and fauna.

2.4 Method of Impact Assessment

The assessment of potential impacts of the proposal has been undertaken within the OEH UHSA framework, and utilises the BCAM assessment methodology (NSW DECCW 2011). BCAM requires assessments to be structured around stratification of a Project Area into vegetation 'zones', based on vegetation type (community) and vegetation condition, and the collection of key condition data along replicated transects. Section 2.4.1 details the methods used to ensure that appropriate zones and data were selected and sampled.

2.4.1 Field Surveys

2.4.1.1 Stratification

Vegetation mapping (stratification) of the Project Area was undertaken initially through the collection of Rapid Data Points (RDP's), with the support of aerial photographic interpretation. RDP's are summaries of floristic information recorded at specific points in the field. At specific and regular locations, summaries of the vegetation are noted and waypointed in the GPS, and later transferred to the GIS for mapping. Information recorded includes:

- Canopy layer dominant species
- Shrub layer dominant species
- Ground layer dominant species
- Miscellaneous notes & condition

Vegetation polygons were digitised within a GIS directly on-screen to create vegetation zones, based on RDP data. Areas supporting similar suites of dominant species were mapped collectively as a single zone, and used to guide full floristic survey. Assessment of vegetation condition used the criteria detailed in Box 1 of Section 2.3 in BCAM (NSW DECCW 2011). Determination of the number of hectares of each derived vegetation zone was undertaken to assist in stratifying vegetation samples.

2.4.1.2 Vegetation & Habitat Classification

Using the vegetation strata (zone) map, vegetation sampling was undertaken within each stratum based on the minimum required as outlined by NSW DECCW (2011). **Table 2** shows how the allocation of sampling transects is undertaken.

Table 2 Minimum number of transects/plots required per zone area

Vegetation zone (ha)	Minimum number of transects/plots
0 – 10	1 transect/plot
> 10 – 25	2 transects/plots
> 25 – 50	3 transects/plots or 2 transects/plots if vegetation is in low condition
> 50 – 100	4 transects/plots or 3 transects/plots if vegetation is in low condition
> 100 – 250	5 transects/plots or 4 transects/plots if vegetation is in low condition
> 250 – 1000	6 transects/plots or 5 transects/plots if vegetation is in low condition. More transects/plots may be needed if the condition of the vegetation is variable across the zone.

In accordance with BCAM, vegetation sampling was undertaken along 50 x 20m transects selected randomly within vegetation zones. Within 20 x 20m quadrats at one end of each transect, all native and exotic vascular plant species were recorded to provide data on species richness, and modified Braun-Blanquet cover abundance scores (1-6 scale: 1 = <5% cover & uncommon; 2 = <5% cover & common; 3 = 6-25% cover; 4 = 26-50% cover; 5 = 51-75% cover; 6 = 76-100% cover) applied to each species. Along the full 50m length, a range of other condition features were recorded, as detailed in NSW DECCW (2011). These include such attributes as percentage cover estimates of canopy, mid-storey, grass and exotic species; number of trees with hollows; proportion of canopy regeneration; and total length of fallen logs.

Sample data on species richness and abundance was run through *Primer* (Clarke & Gorley 2006) to clarify identified strata and develop indicative species lists for each using the SIMPER module.

2.4.1.2 Threatened Flora

Targeted searches for the ten threatened flora species and three endangered populations potentially present were undertaken within the Project Area during May 2013 (in concert with map data collection for stratification), August 2013 & August 2014 (during floristic sampling), and September 2013 (targeted orchid survey). Field botanists (SB & CD) have a thorough knowledge of and experience in the detection of all potential taxa. Apart from terrestrial orchids, those threatened flora species potentially present within the Project Area can be detected with ease during standard field survey activities by experienced botanists, and do not require separate targeted survey.

Targeted survey for threatened terrestrial orchids (particularly *Diuris tricolor* & *Prasophyllum petilum*) has been completed only for the eastern section of the Project Area (on 23 September 2013), as during the assessment period cattle were still grazing across all other areas. Experience in other locations has shown that cattle presence and/or high macropod abundance severely impacts on the detection of terrestrial orchids, as these plants are a favoured food source (eg: Meers & Adams 2003; Leonard & Kirkpatrick 2004; Tuft et. al. 2011). The September timing of orchid survey coincided with the 2013 flowering of *Diuris* and *Prasophyllum* in the Muswellbrook area, when orchid presence would also be expected within the Project Area. During orchid survey in the eastern sections, parallel transects (30-50m separation distance) were walked across all grassland habitat, and the locations of any orchids detected recorded on GPS.

Flowering of *Cymbidium canaliculatum* is not essential for positive identification, and field surveys during May, August and September 2013 would not affect detection. The fruit, buds and juvenile leaves of all redgum eucalypts were inspected for the possible presence of *Eucalyptus glaucina*. All wetland bodies and creeklines supporting standing water were inspected for *Persicaria elatior* and *Maundia triglochinosoides*. If potential material of either species were noted (and not flowering), a return visit during flowering would occur to allow positive identification from close relatives.

2.4.1.3 Threatened Fauna

Under the BCAM methodology, ten fauna species required targeted survey within the Project Area ('species credit species'):

- Brush-tailed Phascogale
- Green-thighed Frog
- Squirrel Glider
- Eastern Pygmy Possum
- Pale-headed Snake
- Green and Golden Bell Frog
- Common Planigale
- Koala
- New Holland Mouse
- Large-footed Myotis

Only the first three species (Brush-tailed Phascogale, Green-thighed Frog & Squirrel Glider) were targeted during survey: the remaining seven species were discounted based on habitat, and addressed through the 'expert report' option available in BCAM. All other threatened fauna species potentially present could be predicted based on habitat ('ecosystem credit species'). Further comments on surveys for each of these threatened fauna species follow.

Brush-tailed Phascogale & Squirrel Glider Survey - Trapping for the Brush-tailed Phascogale and Squirrel Glider was conducted over 3 nights in October 2013. Two survey sites were established within larger remnants of open forest, Site FA1 near the existing Rix's Creek mine administration area, and FA2 on the southern side of the New England Highway in the Bowman property. At each site, 25 Elliott A traps (15 x 16 x 33cm) were set along a line transect. Each trap was spaced 15-20 metres apart, baited with a mixture of peanut butter, rolled oats and honey and set for three consecutive nights. Traps were inspected daily and any individuals captured were identified, weighed, sexed, measured and released at point of capture. All traps were placed at the base of trees or near fallen logs, as over 20 years of trapping in the Hunter (by MM) has returned better capture rates from traps in these situations than with tree-affixed sampling.

Two large wire cage traps were also set at each site for 3 nights, each trap baited with tinned sardines.

Stag watch observations were undertaken of suitable dead stags (old mature trees with hollows) or habitat trees at dusk on 2 evenings to detect emergence of tree hollow dependent fauna. At each site, 1 suitable habitat tree was observed from dusk to darkness for emergence of fauna.

Spotlight searches were also undertaken on foot for an approximate distance of 500 metres with a 1,000 lumen spotlight for a period of 60 minutes per transect. Each transect was surveyed once, searching for active or resting arboreal fauna. Details of spotlights searches is summarised below in **Table 3**.

One infra-red motion detection digital camera was installed at each fauna survey site to target the Brush-tailed Phascogale. Each camera was installed on Tuesday 8 October and retrieved on Monday 25 November 2013. The cameras monitored each site for 48 continuous nights, or 96 nights in total.

Table 3 Summary of targeted fauna survey completed.

Survey Details	FA1	FA2
Location	322615 E; 6399764 N	325319 E; 6400545 N
Trapping Survey Dates	10 -12 October 2013 (3 nights)	10 -12 October 2013 (3 nights)
Trapping Effort	25 Elliott A traps + 2 wire cage traps	25 Elliott A traps + 2 wire cage traps
Spotlight Time	18:45 – 20:10 (85 mins)	19:05 – 19:55 (50 mins)
Camera Locations	322594 E; 6399914 N	325483 E; 6400685 N
Date Camera Installed	10 October 2013	10 October 2013
Date Camera Removed	25 November 2013	25 November 2013
Duration of Camera Monitoring	48 nights	48 nights

Green-thighed Frog Survey - Initially, ortho-rectified aerial photographs of the Project Area were examined to identify potential habitat for the Green-thighed Frog. Habitats searched include larger water bodies such as farm dams, as well as forested habitat in proximity to suitable water bodies. Analysis of OEH wildlife atlas records were also undertaken to identify any local populations of the Green-thighed Frog in the mid-to upper Hunter Valley.

Potentially suitable dams identified from aerial photographs were plotted on GIS, and resultant polygons extracted for incorporation into hand-held GPS for ground validation. These water bodies were examined during the nocturnal searches for presence, or potential presence of the Green-thighed Frog.

Spotlight searches were also conducted for amphibians in suitable water bodies identified from GIS analysis described above. Searches were made for presence of suitable habitat or calling males around the perimeter of these dams.

Non-targeted Fauna addressed through Expert Report - Seven species (Green and Golden Bell Frog, Common Planigale, Pale-headed Snake, Eastern Pygmy Possum, Koala, New Holland Mouse, Large-footed Myotis) were not subjected to targeted survey, due to the following reasons (compiled by Michael Murray, fauna expert with ~25 years' experience in fauna surveying in the Hunter Valley):

Green and Golden Bell Frog

The evidence is now very strong that the primary driver of the decline of the Green and Golden Bell Frog throughout its range is the disease *Chytridiomycosis* rather than other factors such as habitat loss or degradation. Although the pattern of decline across its range since the early 1980's strongly supports this hypothesis, and disease is recognised in Management Plans (eg: NSW DECC 2007b) and the Commonwealths *Significant Impact Guidelines* (Commonwealth DEWHA 2009) as a threatening process to this species (and most endangered amphibians), it is only recently published work that has provided direct and compelling evidence that disease is the primary driver of decline.

This understanding of the role of *Chytridiomycosis* in the decline of the Bell Frog has important implications for the Upper Hunter population. The Upper Hunter population is one of only two inland populations of the Bell Frog that persist (NSW DECC 2007b), and lies at the edge of the boundary of the current inland distribution of the species. This suggests that the last known population at Ravensworth in 2008 lies at a point on an environmental gradient, close to which the species cannot currently persist. It is only rarely encountered, and when encountered, usually occurs in single digit numbers, despite reasonable survey frequencies and effort. The most recent Upper Hunter record was at Ravensworth North in 2008, in which only one adult animal was located. The low counts when animals are encountered in Upper Hunter surveys is also most concerning, and suggests that the Upper Hunter population is critically endangered, with a high, but as yet unquantified, probability of extinction in the near to medium term.

Supporting data for concern about the low numbers and population densities in the Upper Hunter comes from work by the University of Newcastle on the Sydney Olympic Park population. This currently persists with a population size in the order of 500-1,000 individuals. Survival of bell frogs at the Sydney Olympic site is much lower between years than expected (often as low as 10-20%) (Pickett et. al. 2014). This is despite the Sydney Olympic population being one of the largest persisting Bell Frog populations throughout the species current distribution. The probability of extinction in remnant Bell Frog populations, especially from stochastic events when numbers are low, is very high. Those findings indicate that the Upper Hunter population of the Green and Golden Bell Frog is at high risk of extinction. In order to persist, the frog needs to breed in significant numbers each year, population density needs to be high, and failure of breeding in one or two years can bring a population to the edge of extinction.

Within the Rix's Creek landholdings, none of the dams examined support essential habitat attributes for the Green and Golden Bell Frog, along with a number of additional frog species. Limited or no emergent

aquatic vegetation, such as reeds and rushes, was present in the majority of these dams. The Rix's Creek study area has been utilised for grazing for an extended period of time. Grazing has removed essential micro-habitats for frogs, with very limited presence of fringing aquatic or terrestrial vegetation around dam verges.

No habitat, consistent with other known sites where the Green and Golden Bell Frog has been recorded, occurs at the Rix's Creek site, and hence targeted survey was not carried out.

Common Planigale

The Common Planigale is a tiny carnivorous marsupial with a widespread distribution from coastal NSW to northern Australia. Within NSW, the species is known from Taree on the mid-north Coast to the Queensland border. However, there are a number of erroneous records of the species south from Taree, including the central coast (Munmorah SCA) and Wybong in the Upper Hunter (Australian Museum record). The Australian Museum record was investigated by MM in 1997, but the specimen has been lost whilst on loan to the University of Sydney. However, a closely related member, the Narrow-nosed Planigale *P. tenuirostris* has been captured on 6 occasions at Mt Owen Complex over the period 1995 – 2004. Electrophoretic analysis of one specimen was conducted by the South Australian Museum, which confirmed *P. tenuirostris* rather than *P. maculata*. Hence, it is likely the Wybong specimen (although lost) is *P. tenuirostris* which has been mis-identified. There is no reliable evidence of the Common Planigale within the Hunter Valley region.

Pale-headed Snake

The Pale-headed Snake is an arboreal nocturnal snake which occupies a range of habitats from wet sclerophyll to dry eucalypt forests and woodlands. Its range extends from the Hunter River north to Cape York Peninsula (Cogger 1994). The habitat preference for the species is poorly known, with a possible preference for riparian habitat and possibly mature ironbark trees.

The only known record of this species from coastal parts of the Hunter Valley is Gloucester NSW, with no records in the Port Stephens to southern Lake Macquarie LGA's (Australian Museum records). Within the Upper Hunter region, no known records exist for the species based on OEH Atlas searches, Australian Museum records or extensive fauna surveys of the lower and upper hunter valley. No evidence of the species has been detected at the nearby Integra Open Cut, Mt Owen Complex and Ravensworth Open Cut Mines despite extensive clearing of habitat, including trees with hollows (M. Murray, pers. obs.). The potential occurrence of this species at Rix's Creek open cut is extremely low, based on limited suitable habitat and absence of regional records, and consequently has not been targeted during survey.

Eastern Pygmy Possum

The Eastern Pygmy Possum is found in a wide range of habitat from rainforest, dry sclerophyll forest and heath, being distributed in a coastal and near coastal band from south-eastern Queensland to the south-eastern corner of South Australia, and Tasmania. Within the Hunter Valley, the species is known from the Watagan Ranges and coastal heath. There appears to be a strong association of the species with abundance of *Banksia* species in the Hunter region. Within the Upper Hunter Valley, the majority of habitats supporting this species have historically been cleared. Within the Rix's Creek open cut, no habitat supporting forest communities with *Banksia* understory occurs, nor at any other local sites that have been systematically surveyed in the past 20 years (M. Murray, pers. obs.). Intensive survey effort at the Mt Owen Complex since 1995, which includes pitfall trapping (the preferred technique for detection

of this species), has failed to record evidence of this species. The only suitable habitat in the Upper Hunter likely to support the Eastern Pygmy Possum is the Warkworth Sands Woodland community. It is not known if previous surveys targeting the Eastern Pygmy Possum have been conducted at this site, but no records have been documented to date.

No habitat suitable for the Eastern Pygmy Possum exists at the Rix's Creek open cut mine.

Koala

Incidental assessment for Koala at Rix's Creek included direct and indirect observations and habitat type specific for this species, including presence of preferred food trees listed on Schedule 2 of SEPP44. No observations of individual Koala's were recorded during diurnal and nocturnal searches. In addition, no evidence of preferred food trees were observed, with the dominant tree species being Narrow-leaved Ironbark *Eucalyptus crebra* and Grey Box *E. molucanna*. No habitat suitable for Koala was recorded in the study area, and no presence of individuals was observed.

New Holland Mouse

The New Holland Mouse has previously been recorded at one location in the mid Hunter Valley at Mt Owen Complex. This species was recorded at that site in regeneration habitat for 2 consecutive years in 2004 and 2005. No evidence of the species has been recorded at Mt Owen since this period (M. Murray, pers. obs.). The evidence from trapping surveys suggests this species has a preference for well-advanced regeneration habitat. No such habitat exists in the study area assessed at Rix's Creek, and hence the potential occurrence of this species at Rix's Creek is very limited.

Large-footed Myotis

The Large-footed Myotis has been recorded along riparian habitat including the lower reaches of Betty's Creek near the Mt Owen Complex (M. Murray, pers. obs.). No riparian habitat occurs within the Rix's Creek study area. Several large farm dams occur within the study area, although their considerable distance from suitable riparian habitat suggests the Large-footed Myotis is unlikely to traverse across this large area of unsuitable habitat to forage above the surface of these dams. No targeted survey was considered necessary for this species.

2.4.2 Assumptions

As part of assessments undertaken for the UHSA process, areas of vegetation dominated by *Eucalyptus crebra* (PCT1605) have been determined by OEH to not represent any NSW Threatened Ecological Community (TEC) for the purposes of the UHSA. This position has been adopted as part of the current EIS to maintain consistency with the UHSA, despite previous assessments of vegetation within the Rix's Creek lease including such vegetation as *Central Hunter Ironbark – Spotted Gum – Grey Box Forest* (Bell 2012, 2013a).

Likewise, OEH determined as part of the UHSA process that derived grasslands were of low condition, and did not conform to any listed NSW TEC in the UHSA assessment area. This is despite evidence indicating that regeneration of such grassland areas back into woodlands and forests would invariably result in vegetation akin to one or more TEC. To maintain consistency, however, derived grassland areas within the current assessment have been excluded from any significance rating, unless they have a site value score of more than 34 according to BCAM.

3. Existing Environment

3.1 Study Area Context

The study area is located within the Hunter River catchment and the Sydney Basin bioregion of Thackway & Cresswell (1995). It also falls within the *Hunter* sub-region of the Hunter-Central Rivers Catchment Management Authority, and the *Central Hunter Foothills* Mitchell landscape (Mitchell 2003). Following a long history of agriculture, much of the Hunter Valley is now actively mined for its coal resources.

3.2 Database Search Results

3.2.1 Flora

A search of the Biocertification Credit Calculator and the OEH BioNet database (which includes the Threatened Species Profile Database), centred on Rix's Creek and limited to a 10x10 km area, returned 58 threatened flora species and 4 threatened plant populations. **Table 4 & 5** summarise these entities, together with comments on likelihood of occurrence within the Project Area. Only *Ozothamnus tessellatus*, *Maundia triglochinosoides*, *Eucalyptus glaucina*, *Diuris pedunculata*, *Diuris tricolor*, *Prasophyllumpetilum*, *Persicaria elatior* and *Persoonia pauciflora* are considered potentially present within the Project Area. Endangered Populations of *Acacia pendula*, *Cymbidium canaliculatum* and *Eucalyptus camaldulensis* also potentially occur in the Project Area. Note that there is considerable evidence to suggest that *Acacia pendula* has never naturally occurred within the Hunter catchment (Bell & Driscoll 2014), but until a change is made to the legislation concerning this species, assessment is still required.

Table 4 Threatened plants potentially present within the Project Area (BioNet June 2014 & Biocertification Credit Calculator).

Family	Species	NSW	C'lth	Comment
Apocynaceae	<i>Cynanchum elegans</i>	E1,P	E	No habitat likely
Asteraceae	<i>Ozothamnus tessellatus</i>	V,P	V	Possible
	<i>Rutidosis heterogama</i>	V,P	V	No habitat likely
Elaeocarpaceae	<i>Tetratheca juncea</i>	V,P	V	No habitat likely
Euphorbiaceae	<i>Chamaesyce psammogeton</i>	E1,P		No habitat likely
	<i>Monotaxis macrophylla</i>	E1,P		No habitat likely
Fabaceae (Faboideae)	<i>Pultenaea maritima</i>	V,P		No habitat likely
Fabaceae (Mimosoideae)	<i>Acacia bynoeana</i>	E1,P	V	No habitat likely
Juncaginaceae	<i>Maundia triglochinosoides</i>	V,P		Possible
Lamiaceae	<i>Prostanthera cineolifera</i>	V,P	V	No habitat likely
	<i>Prostanthera cryptandroides subsp. cryptandroides</i>	V,P	V	No habitat likely
Myrtaceae	<i>Angophora inopina</i>	V,P	V	No habitat likely
	<i>Callistemon linearifolius</i>	V,P,3		No habitat likely
	<i>Eucalyptus camfieldii</i>	V,P	V	No habitat likely
	<i>Eucalyptus castrensis</i>	E1,P		No habitat likely

Family	Species	NSW	C'lth	Comment
	<i>Eucalyptus fracta</i>	V,P		No habitat likely
	<i>Eucalyptus glaucina</i>	V,P	V	Possible
	<i>Eucalyptus parramattensis subsp. decadens</i>	V,P	V	No habitat likely
	<i>Eucalyptus pumila</i>	V,P	V	No habitat likely
	<i>Melaleuca biconvexa</i>	V,P	V	No habitat likely
	<i>Melaleuca groveana</i>	V,P		No habitat likely
	<i>Syzygium paniculatum</i>	E1,P	V	No habitat likely
Orchidaceae	<i>Corybas dowlingii</i>			No habitat likely
	<i>Cryptostylis hunteriana</i>	V,P,2	V	No habitat likely
	<i>Diuris pedunculata</i>	E1,P,2	E	Possible
	<i>Diuris praecox</i>	V,P,2	V	No habitat likely
	<i>Diuris tricolor</i>	V,P,2		Possible
	<i>Prasophyllum petilum</i>	P	CE	Possible
	<i>Pterostylis gibbosa</i>	E1,P,2	E	No habitat likely
Polygonaceae	<i>Persicaria elatior</i>	V,P	V	Possible
Proteaceae	<i>Grevillea parviflora subsp. parviflora</i>	V,P	V	No habitat likely
	<i>Persoonia pauciflora</i>	E4A,P,3	CE	Possible
Rhamnaceae	<i>Pomaderris bodalla</i>	V,P		No habitat likely
	<i>Pomaderris queenslandica</i>	E1,P		No habitat likely
	<i>Pomaderris reperta</i>	E4A,P	CE	No habitat likely
Rubiaceae	<i>Asperula asthenes</i>	V,P	V	No habitat likely
	<i>Philothea ericifolia</i>	P	V	No habitat likely
Zannichelliaceae	<i>Zannichellia palustris</i>	E1,P		No habitat likely

Table 5 Endangered Populations potentially present within the Project Area (BioNet June 2014 & Biocertification Credit Calculator).

Endangered Population	Comment
<i>Acacia pendula</i> population in the Hunter catchment	Possible
<i>Eucalyptus camaldulensis</i> population in the Hunter catchment	Possible
<i>Cymbidium canaliculatum</i> population in the Hunter Catchment	Possible
<i>Leionema lamprophyllum</i> subsp. <i>obovatum</i> population in the Hunter Catchment	No habitat likely

Monotaxis macrophylla is included as a potential species for the Hunter Valley, but it is highly unlikely that this species occurs on the floor of the valley. Halford & Henderson (2002) indicated that *Monotaxis macrophylla* occurs in widely spaced locations throughout New South Wales, in a range of habitats. The few records from the Hunter Valley include those reported by Gibson (2002) for Crypt Hill and in the Martindale area (Bell & Holzinger 2015), both in rugged sandstone terrain in north-western Wollemi National Park. At both locations the species was flowering profusely following fire disturbance. There are no other records of *Monotaxis macrophylla* shown in BioNet for the Hunter Valley, with the next nearest location being in the Pilliga (~300km away). As a fire-response annual, this species is unlikely to be detected within the Project Area in the absence of fire.

3.2.2 Fauna

A search of the Biocertification Credit Calculator and the OEH BioNet database (which includes the Threatened Species Profile Database), centred on Rix's Creek and limited to a 10x10 km area, returned sixteen threatened fauna species as potentially present. **Table 6** summarises these species, together with comments on likelihood of occurrence within the Project Area. Under the BCAM methodology, ten species are 'species credit species' and require targeted survey (or addressed through expert report). All other species are ecosystem credit species, and can be predicted on habitat.

Table 6 Threatened fauna potentially present within the Project Area (BioNet June 2014 & Biocertification Credit Calculator). * = 'species credit species' under BCAM.

Common Name	Species	NSW	C'lth	Comment
Speckled Warbler	<i>Chthonicola sagittata</i>	V		Possible
Grey-crowned Babbler (eastern subsp)	<i>Pomatostomus temporalis temporalis</i>	V		Possible
*Green and Golden Bell Frog	<i>Litoria aurea</i>	E	V	Unlikely
*Green-thighed Frog	<i>Litoria brevipalmata</i>	V		Unlikely
*Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	V		Unlikely
*Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	V		Possible
*Koala	<i>Phascolarctos cinereus</i>	V	V	Unlikely
*Eastern Pygmy Possum	<i>Cercartetus nanus</i>	V		Unlikely
*Squirrel Glider	<i>Petaurus norfolcensis</i>	V		Possible
*Common Planigale	<i>Planigale maculata</i>	V		Unlikely
*New Holland Mouse	<i>Pseudomys novaehollandiae</i>	V	V	Unlikely
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V	E	Possible
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	Possible
*Large-footed Myotis	<i>Myotis adversus</i>	V		Unlikely
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V		Possible
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V		Possible

4.0 Impact Assessment

4.1 Results

4.1.1 Vegetation Zones

Over 280 RDPs were collected across the UHSA assessment area, and 98 within the Project Area (**Figure 4**). These were used to formulate vegetation zones based on dominant species and overall condition. Ground layer vegetation at all RDP was dominated by native grass and herb species (eg: *Aristida ramosa*, *Cymbopogon refractus*, *Poa labillardieri*, *Aristida vagans*, *Cynodon dactylon*, *Chloris ventricosa*, *Sporobolus creber*), although exotic species were also present (eg: *Anagalis arvensis*, *Senecio madagascariensis*, *Paspalum dilatatum*, *Gomphocarpus fruticosus*).

Following BCAM definitions, all forested areas were considered of moderate-to-good condition because:

- >50% of ground layer vegetation was native (both biomass & diversity);
- <90% of ground layer vegetation was cleared.

On advice from OEH, Derived Native Grasslands were deemed to be 'low condition'. Given the agricultural history of the Project Area and the relatively consistent composition of the ground layer vegetation, stratification into vegetation zones was heavily guided by remnant canopy species. Dominant canopy species were used to stratify into seven vegetation zones:

- Zone 1: *Angophora floribunda*/ *Eucalyptus tereticornis*
- Zone 2: *Allocasuarina luehmannii*
- Zone 3: *Casuarina glauca*
- Zone 4: *Eucalyptus crebra*
- Zone 5: *Eucalyptus moluccana*
- Zone 6: *Corymbia maculata*
- Zone 7: Derived Native Grasslands

Table 7 shows how these vegetation zones relate to NSW Plant Community Types (PCTs), required under the BCAM. Allocation to PCTs was driven primarily by canopy composition, but with reference to understorey and ground species where they were present. Regional knowledge of vegetation types, based on extensive numerical analysis of plot data over many years, was also used in support. Note that, for the sake of credit calculations, Derived Native Grasslands (Zone 7) were linked solely to PCT1605 (Zone 4), as this type was by far the most expansive of all communities identified.

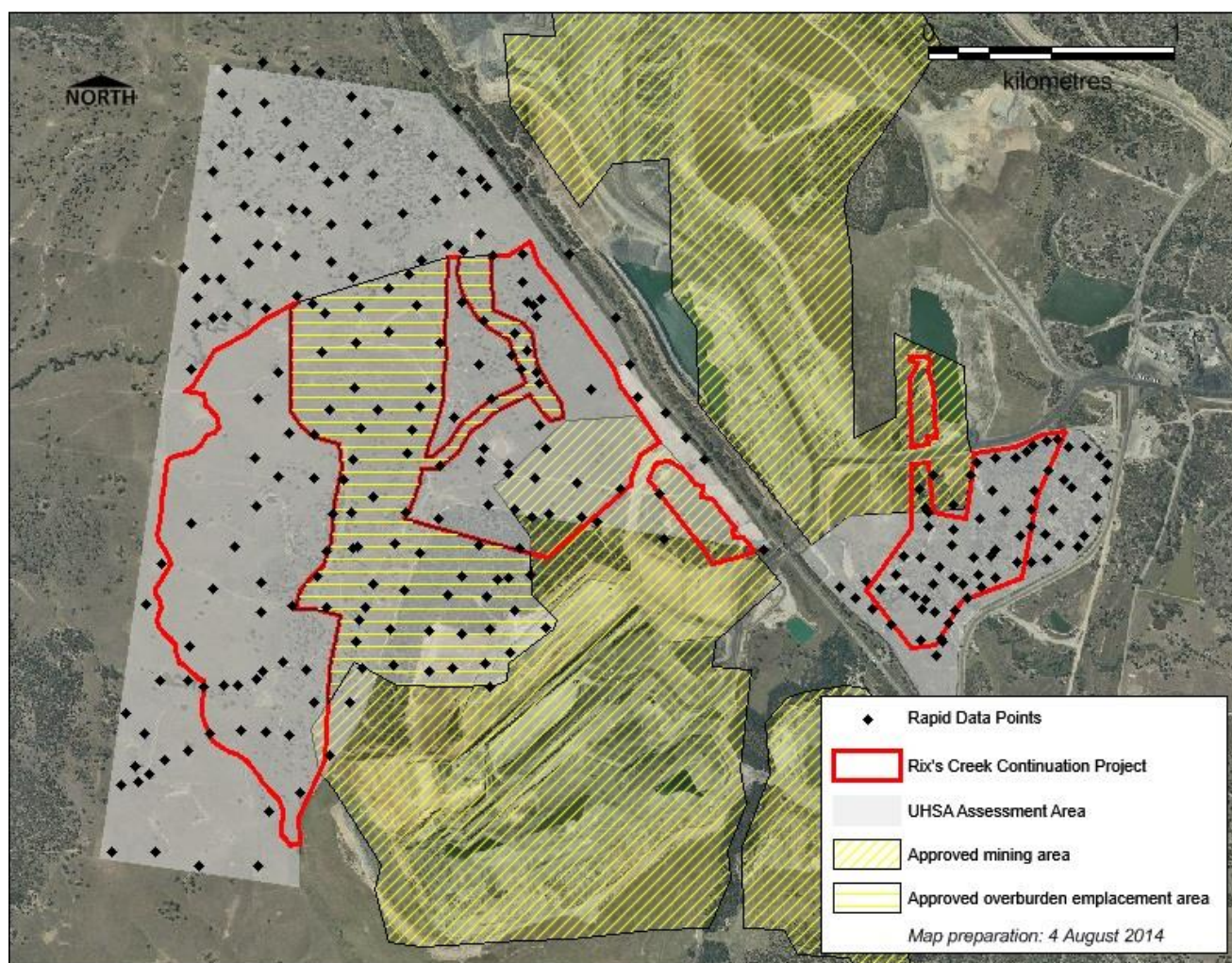


Figure 4 Distribution of Rapid Data Points within the Project Area.

Table 7 Equivalency between vegetation zones and NSW PCTs.

Vegetation Zone	PCT	PCT Description
Zone 1	1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter
Zone 2	1692	Bull Oak grassy woodland of the central Hunter Valley
Zone 3	1731	Swamp Oak; Weeping Grass grassy riparian forest of the Hunter Valley
Zone 4	1605	Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter
Zone 5	1748	Grey Box grassy open forest of the Central and Lower Hunter Valley
Zone 6	1602	Spotted Gum; Narrow-leaved Ironbark shrub; grass open forest of the central and lower Hunter
Zone 7	1605	Derived Native Grassland: Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter

Note: Zone 1 = *Angophora floribunda/ Eucalyptus tereticornis*; Zone 2 = *Allocasuarina luehmannii*; Zone 3 = *Casuarina glauca*; Zone 4 = *Eucalyptus crebra*; Zone 5 = *Eucalyptus moluccana*; Zone 6 = *Corymbia maculata*; Zone 7 = Derived Native Grassland.

4.1.2 Vegetation Sampling

Figure 5 shows the location of sampling transects within the vegetation zones identified for the Project Area. All transects fall within the *Hunter* sub-region of the Hunter-Central Rivers CMA, and the *Central Hunter Foothills* Mitchell landscape (Mitchell 2003). In total, 14 transects were completed. **Table 8** justifies the extent of sampling effort against the minimum required in BCAM (NSW DECCW 2011). Floristic data is included in Appendix 1, and representative photographs of each vegetation zone are shown in Appendix 2.

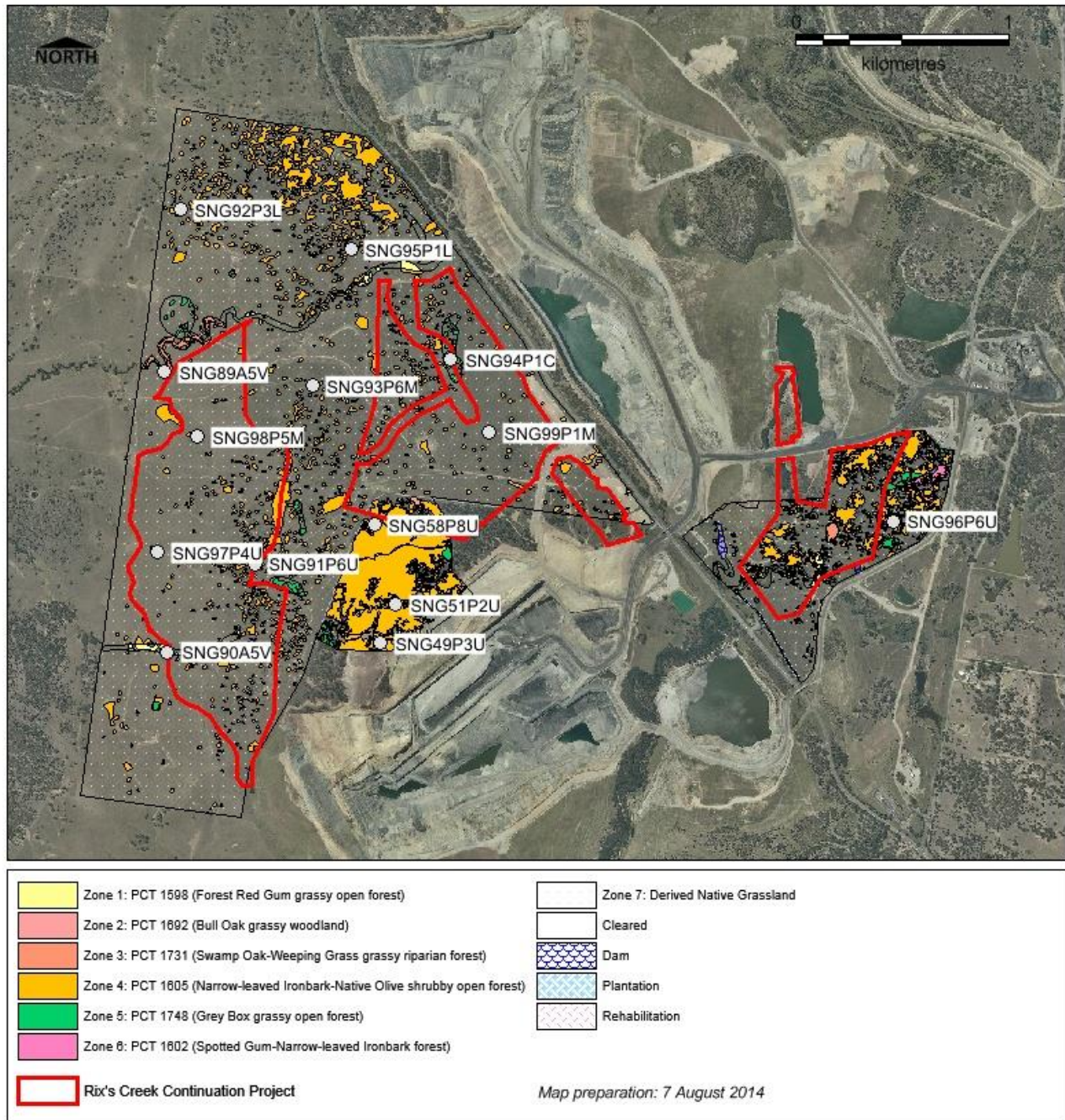


Figure 5 Transect locations (with identification number shown in Table 10) and vegetation zones in the UHSA and Project Areas. Note that Zone 2 occurs only at Transect SNG49 and is obscured from view.

Table 8 Sampling effort (BCAM transects) within the UHSA and Project Areas.

PCT	PCT1598	PCT1692	PCT1731	PCT1605	PCT1748	PCT1602	PCT1605	
Zone	<i>A. floribunda/ E. tereticornis</i>	<i>Allocasuarina luehmannii</i>	<i>Casuarina glauca</i>	<i>Eucalyptus crebra</i>	<i>Eucalyptus moluccana</i>	<i>Corymbia maculata</i>	DNG	Total
Zone No.	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	
Extent (ha) within UHSA area	2.1	0.3	1.5	76	3.6	0.8	454	539
Extent (ha) within Project Area	0.8	0.1	0.4	18.3	0.6	0	52.2	72
Minimum transects *	1	1	1	2	1	0	3	9
Completed transects	1	1	1	5	1	1	4	14

* for the Project Area, as required under BCAM. DNG = Derived Native Grasslands

Non-metric Multi-Dimensional Scaling (nMDS) undertaken in *Primer* confirms the vegetation zones and PCTs identified for the Project Area (**Figure 6**), showing grouping of component sample plots. A summary of the key indicative plant species defining each PCT for the Project Area is shown in **Table 9**.

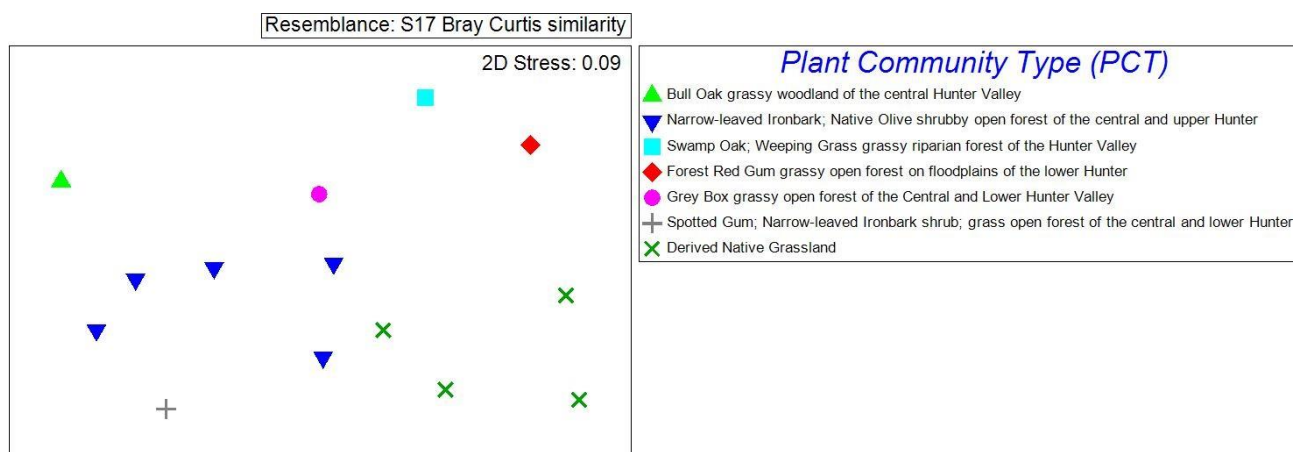


Figure 6 nMDS of sample data, Rix's Creek. Weed species included.

Table 9 Floristic summary of defined PCTs, Rix's Creek.

PCT	Canopy	Mid	Ground
1598	<i>Eucalyptus tereticornis</i> , <i>Angophora floribunda</i> , <i>Eucalyptus moluccana</i>	<i>Olea europaea</i> subsp. <i>cuspidata</i>	<i>Cynodon dactylon</i> , <i>Sporobolus creber</i> , <i>Anagalis arvensis</i> , <i>Oxalis exilis</i> , <i>Modiola carolina</i> , <i>Aristida ramosa</i> , <i>Spergularia rubra</i> , <i>Paspalum dilatatum</i> , <i>Plantago lanceolata</i> , <i>Cirsium vulgare</i> , <i>Leptinella filicula</i> , <i>Cyclosporum leptophyllum</i> , <i>Asperula conferta</i> , <i>Sida rhombifolia</i> , <i>Dichondra repens</i>
1602	<i>Corymbia maculata</i> , <i>Eucalyptus crebra</i>	<i>Eucalyptus crebra</i> , <i>Daviesia</i>	<i>Bothriochloa decipiens</i> var. <i>decipiens</i> , <i>Eremophila debilis</i> , <i>Calotis cuneifolia</i> , <i>Aristida ramosa</i> , <i>Senecio</i>

PCT	Canopy	Mid	Ground
		<i>genistifolia</i>	<i>madagascariensis</i> , <i>Laxmannia gracilis</i> , <i>Glycine tabacina</i> , <i>Paspalidium distans</i> , <i>Cymbopogon refractus</i> , <i>Cheilanthes sieberi</i> subsp. <i>sieberi</i> , <i>Dianella revoluta</i> var. <i>revoluta</i> , <i>Calocephalus citreus</i> , <i>Lomandra multiflora</i> subsp. <i>multiflora</i> , <i>Hypochaeris radicata</i> , <i>Dichondra repens</i> , <i>Brunoniella australis</i> , <i>Chrysocephalum semipapposum</i> , <i>Lomandra confertifolia</i> subsp. <i>pallida</i>
1605	<i>Eucalyptus crebra</i>	<i>Gomphocarpus fruticosus</i>	<i>Aristida ramosa</i> , <i>Cymbopogon refractus</i> , <i>Eragrostis leptostachya</i> , <i>Bothriochloa decipiens</i> var. <i>decipiens</i> , <i>Chrysocephalum semipapposum</i> , <i>Glycine tabacina</i> , <i>Calotis cuneifolia</i> , <i>Senecio madagascariensis</i> , <i>Sporobolus creber</i> , <i>Veronica plebeian</i> , <i>Cheilanthes sieberi</i> subsp. <i>sieberi</i> , <i>Anagallis arvensis</i> , <i>Sida rhombifolia</i> , <i>Lomandra confertifolia</i> subsp. <i>pallida</i> , <i>Austrostipa scabra</i> subsp. <i>falcata</i> , <i>Brunoniella australis</i> , <i>Dichondra repens</i> , <i>Eremophila debilis</i> , <i>Plantago lanceolata</i>
1605 DNG	-	-	<i>Sporobolus creber</i> , <i>Cymbopogon refractus</i> , <i>Aristida ramosa</i> , <i>Bothriochloa decipiens</i> var. <i>decipiens</i> , <i>Chloris ventricosa</i> , <i>Cheilanthes sieberi</i> subsp. <i>sieberi</i> , <i>Eragrostis leptostachya</i> , <i>Glycine tabacina</i> , <i>Senecio madagascariensis</i> , <i>Cotula australis</i> , <i>Cynodon dactylon</i> , <i>Trifolium campestre</i> , <i>Cirsium vulgare</i> , <i>Plantago lanceolatus</i>
1692	<i>Eucalyptus crebra</i>	<i>Allocasuarina luehmannii</i>	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i> , <i>Lomandra multiflora</i> subsp. <i>multiflora</i> , <i>Brunoniella australis</i> , <i>Einadia nutans</i> subsp. <i>linifolia</i> , <i>Microlaena stipoides</i> var. <i>stipoides</i> , <i>Calotis cuneifolia</i> , <i>Eragrostis leptostachya</i>
1731	<i>Casuarina glauca</i>	-	<i>Austrostipa verticillata</i> , <i>Plantago lanceolata</i> , <i>Oxalis exilis</i> , <i>Leptinella filicula</i> , <i>Veronica plebeia</i> , <i>Eragrostis leptostachya</i> , <i>Enchylaena tomentosa</i> , <i>Sonchus oleraceus</i> , <i>Dichondra repens</i> , <i>Eragrostis sororia</i> , <i>Sporobolus creber</i> , <i>Chloris ventricosa</i> , <i>Cheilanthes distans</i> , <i>Poa labillardierei</i> var. <i>labillardierei</i>
1748	<i>Eucalyptus moluccana</i>	-	<i>Chloris ventricosa</i> , <i>Chrysocephalum semipapposum</i> , <i>Cynodon dactylon</i> , <i>Calotis lappulacea</i> , <i>Paspalidium distans</i> , <i>Sonchus oleraceus</i> , <i>Glycine tabacina</i> , <i>Brunoniella australis</i> , <i>Dichondra repens</i> , <i>Austrostipa scabra</i> subsp. <i>falcata</i> , <i>Leptinella filicula</i> , <i>Centaurium erythraea</i> , <i>Eragrostis leptostachya</i> , <i>Calotis cuneifolia</i> , <i>Bothriochloa decipiens</i> var. <i>decipiens</i> , <i>Maireana enchylaenoides</i> , <i>Carex inversa</i> , <i>Anagallis arvensis</i> , <i>Sida rhombifolia</i> , <i>Microlaena stipoides</i> var. <i>stipoides</i>

Note: **PCT1598** = Forest Red Gum grassy open forest on floodplains of the lower Hunter. **PCT1602** = Spotted Gum; Narrow-leaved Ironbark shrub; grass open forest of the central and lower Hunter. **PCT1605** = Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter. **PCT1692** = Bull Oak grassy woodland of the central Hunter Valley. **PCT1731** = Swamp Oak; Weeping Grass grassy riparian forest of the Hunter Valley. **PCT1748** = Grey Box grassy open forest of the Central and Lower Hunter Valley.

4.1.3 Habitat Attributes of Zones

Table 10 summarises the habitat attributes collated for each of the seven vegetation zones delineated.

Table 10 Habitat attributes of delineated vegetation zones, Rix's Creek.

Zone	PCT	Plot	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL
Zone 1	1598	SNG90	18	26.5	0	100	0	0	4	2	25	6
Zone 2	1692	SNG49	32	18	0	8	0	6	0	0	50	8
Zone 3	1731	SNG89	25	12.5	0	98	0	2	10	3	100	44
Zone 4	1605	SNG51	50	11	0	48	1.4	20	0	0	100	22
		SNG58	49	11.5	0	44	38	30	2	0	100	14
		SNG91	41	9	5	82	2	2	0	1	100	10
		SNG92	33	12	0	96	0	1	0	2	50	35
		SNG95	28	4.5	11.5	100	0	16	0	0	100	0
Zone 5	1748	SNG94	35	20	0	100	12	0	0	1	0	3
Zone 6	1602	SNG96	33	19	0	46	0	10	4	0	33	2
Zone 7	1605	SNG93	20	0.5	4.2	90	0	0	0	1	100	4
		SNG97	21	0	0	80	0	34	94	0	0	0
		SNG98	11	0	0	82	0	10	100	0	0	0
		SNG99	25	0	0	96	0	36	24	0	0	7

Key: PCT = Plant Community Type; NPS = Native Plant Species (number); NOS = Native Over Storey cover (%); NMS = Native Mid Storey cover (%); NGCG = Native Ground Cover (Grass) (%); NGCS = Native Ground Cover (Shrubs) (%); NGCO = Native Ground Cover (Other) (%); EPC = Exotic Plant Cover (%); NTH = Native Trees with Hollows (number); OR = Overstorey Regeneration (proportion); FL = Fallen Logs (m).

4.1.4 Threatened Flora

Appendix 1 lists all vascular plant species recorded during the survey. No threatened flora species were noted, and no threatened terrestrial orchids were recorded within the surveyed eastern portions of the Project Area. Targeted orchid surveys undertaken previously on other adjacent lands owned by Rix's Creek also failed to record any threatened species (Bell 2012). All threatened flora species are species credit taxa, and none are predicted by habitat.

As is indicated in **Figure 4**, extensive survey of the Project Area has been undertaken, and it is unlikely that any threatened flora have been overlooked.

4.1.5 Threatened Fauna

Figure 7 shows the potential habitat present for threatened fauna within the UHSA and Project Areas. Species requiring targeted field survey are detailed in Section 4.1.5.1. Within the Project Area, limited potential habitat exists for threatened amphibians (~4ha), while threatened birds and mammals potentially occur across ~207ha.

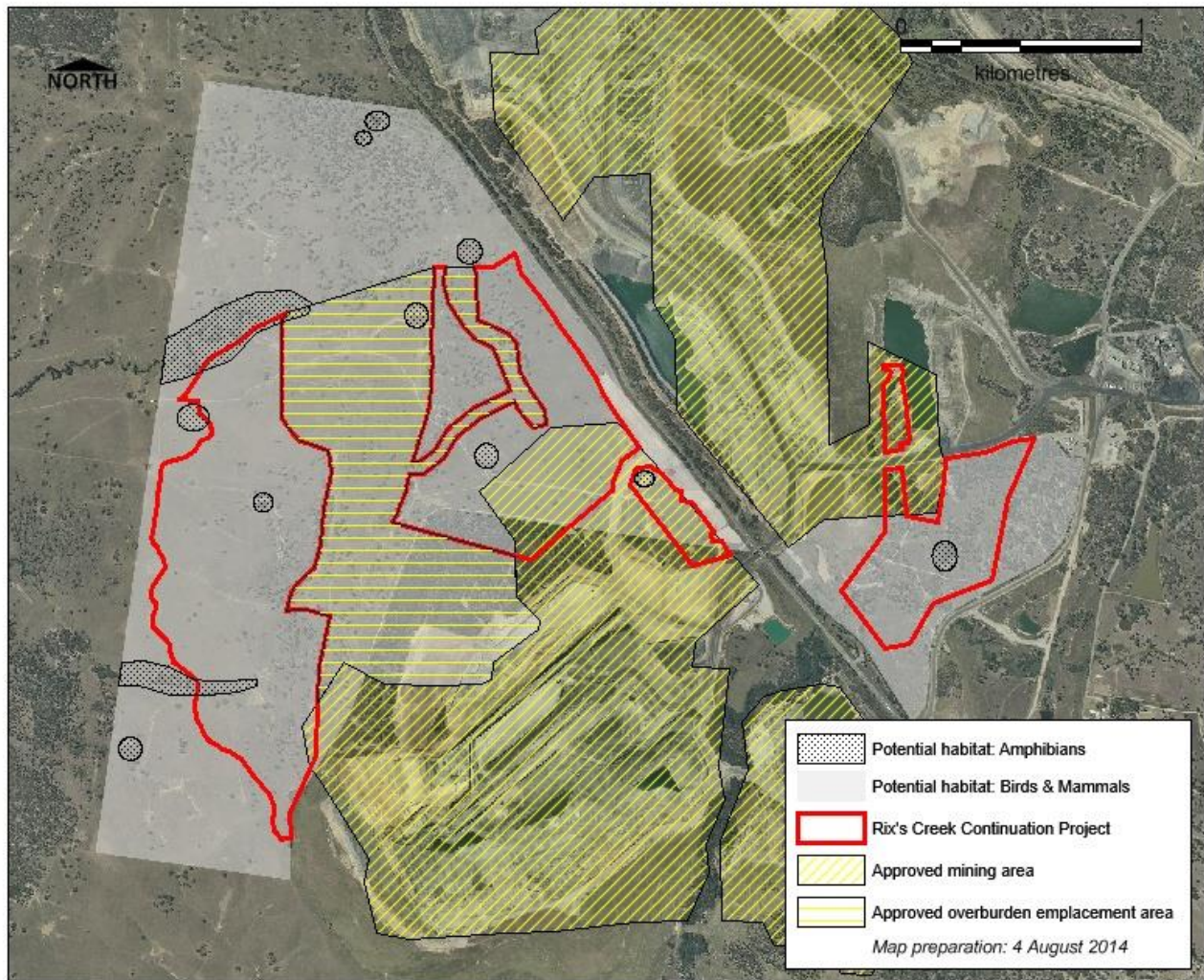


Figure 7 Potential habitat for threatened fauna within the UHSA and Project Areas. ‘Amphibians’ include Green and Golden Bell Frog & Green-thighed Frog: ‘Birds & Mammals’ include Speckled Warbler, Grey-crowned Babbler, Spotted-tailed Quoll, Brush-tailed Phascogale, Squirrel Glider, Grey-headed Flying Fox, Eastern Freetail-bat & Eastern Bentwing-bat.

4.1.5.1 Targeted Survey

The location of fauna survey and camera monitoring sites within the UHSA and Project Areas is presented in **Figure 8**.

Brush-tailed Phascogale & Squirrel Glider - Neither the Brush-tailed Phascogale nor Squirrel Glider were captured by Elliott or cage trapping at either fauna survey site in October 2013. Two fauna species were captured during the survey, a Striped Skink *Ctenotus robustus* and the introduced House Mouse *Mus musculus*.

Stag watch observations detected the presence of one arboreal mammal species, the Common Brushtail Possum *Trichosurus vulpecula*. One individual was observed to emerge from a large dead stag at Site FA1. In contrast, very few large mature trees were present at Site FA2, and no stag watching was conducted as a consequence.

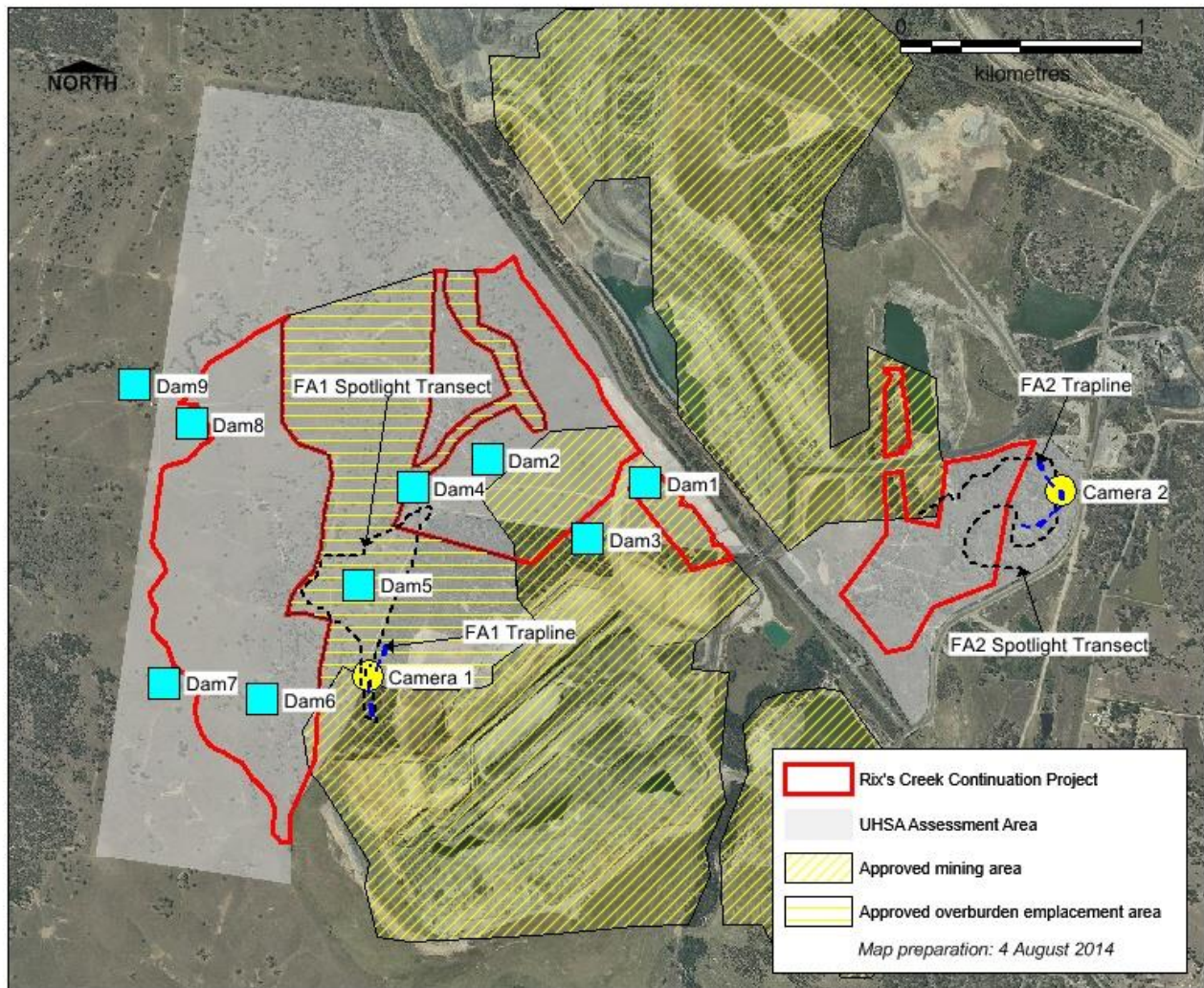


Figure 8 Fauna survey site locations within the UHSA and Project Areas.

One male Squirrel Glider was observed foraging in a mature Narrow-leaved Ironbark (*Eucalyptus crebra*) at Site FA1 during spotlight searches (see **Figure 9**), outside of the Project Area and within the approved mining area. This species was not detected at Site FA2 but suitable habitat exists to suggest its likely presence in most of the forested remnant vegetation in the Project Area. Spotlight searches also revealed the presence of the Common Brushtail Possum at Site FA1, where a total of 11 individuals were observed. The high density of Brushtail Possums, and presence of Squirrel Glider at this site is attributed to the abundance of mature habitat trees with hollows. In contrast, no possums or gliders were observed at Site FA2, which supported a lower abundance of natural hollows.

The infra-red cameras recorded fauna activity over 48 continuous nights per site, or 96 nights in total. A summary of fauna species detected by this methodology is presented in **Table 11**. The Brush-tailed Phascogale was not detected by any of the fauna survey techniques employed. The likely presence of this species within the Project Area is discussed further in Section 6.2.

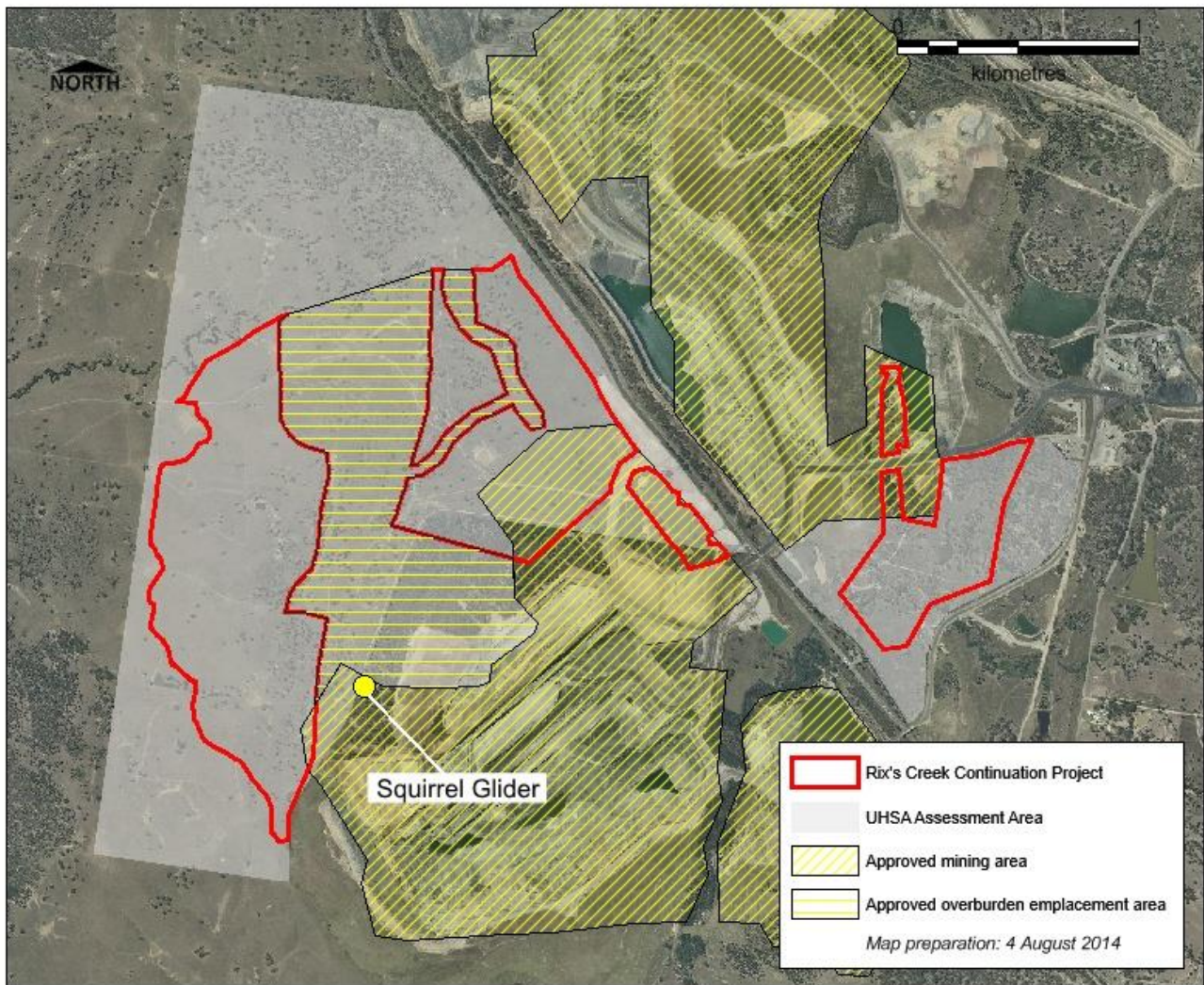


Figure 9 Location of threatened fauna recorded within the UHSA and Project Areas.

Table 11 Results of remote camera monitoring.

Fauna Species	FA1	FA2
Common Brushtail Possum	11 photographs	
Eastern Grey Kangaroo	8 photographs	5 photographs
Red-necked Wallaby	16 photographs	
Swamp Wallaby	3 photographs	
European Hare	3 photographs	
Red Fox	3 photographs	
TOTAL	44 photographs	5 photographs

Green-thighed Frog Assessment - Initially, potential habitat for the Green-thighed Frog was identified from recent aerial photographs of the Project Area. A total of 10 large farm dams (see **Figure 6**) were selected for investigation, as well as any nearby habitat that might comprise potential habitat for the species. However, it must be recognised from the outset that the species is unknown from the mid to upper Hunter Valley, with known records of the species restricted to locations including Mt. Tomalpin near Kurri Kurri, Watagan

Mountains on the Central Coast, and Nerong Waterholes and Bulahdelah State Forest to the north-east. Additionally, the species is very difficult to detect, only calling on a limited number of nights following specific rainfall events. No rainfall events were recorded during the survey in October 2013. The entire Hunter Valley was experiencing a long period of no rainfall, with no rainfall recorded between June and November 2013. Microhabitat conditions at Rix's Creek were very dry, although many of the dams examined contained water.

No evidence of the Green-thighed Frog was recorded during the nocturnal searches, although 3 species, the Broad-palmed Frog *Litoria latopalmata*, Spotted Grass Frog *Limnodynastes tasmaniensis* and Common Eastern Froglet *Crinia signifera* were heard calling, or observed foraging around the perimeter of several dams.

4.1.5.2 Other Species Predicted to Occur by Habitat

Figure 7 above shows the potential habitat for other fauna species predicted to occur by habitat. As noted in Section 2.4.1, it is unlikely that any of these are present within the Project Area (Michael Murray, Forest Fauna Surveys P/L).

4.1.6 Threatened Populations

No populations of threatened flora or fauna were recorded within the Project Area.

4.1.7 Threatened Communities

Table 12 provides NSW and Commonwealth Threatened Ecological Community (TEC) equivalents for all defined vegetation zones within the UHSA and Project Areas. Two NSW and one Commonwealth TEC will be affected by the proposal. **Figure 10** shows the geographical distribution of TECs within the Project Area.

4.1.7.1 New South Wales TECs

Within NSW legislation, three of the seven zones are considered TECs under BCAM, although in total only 1.42 ha of the full 211 ha (0.7%) Project Area comprises TEC. Two TECs are present:

- Hunter Lowlands Redgum Forest: 0.8 ha
- Central Hunter Grey Box-Ironbark Woodland: 0.62 ha

OEH advised (via telephone in mid-2014) that PCT 1605 (*Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter*), the most widespread PCT within the Project Area, is not considered to form part of any listed NSW TEC. This advice may have originated from a note describing the TEC status of the equivalent MU087 in the Greater Hunter Mapping Project as 'to be assessed', but it is currently unclear. In addition, many areas of Derived Native Grassland with scattered timber may arguably not qualify as TEC: regeneration of these grassland areas may ultimately lead to forest and woodland that equate to listed TECs. Given that the UHSA process is to plan for the next 25 years of coal mining in the Hunter, it may be assumed that lands currently supporting good quality derived grasslands will, under correct management, return to their respective TECs. Under this rationale, grasslands that can be shown to have been derived from existing TECs may qualify as TEC. An alternative view is that by maintaining current

management practices (ie: continual cattle grazing), derived grasslands will remain in their present state, and may be excluded from TEC status in perpetuity. For the purposes of the UHSA, OEH advise that Derived Native Grasslands do not form part of any of the applicable NSW TECs within the Project Area.

Table 12 Equivalency between vegetation zones and NSW and Commonwealth Threatened Ecological Communities (TECs).

NSW Plant Community Type		NSW TECs	Commonwealth TECs
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	Hunter Lowlands Redgum Forest EEC	-
1602	Spotted Gum; Narrow-leaved Ironbark shrub; grass open forest of the central and lower Hunter	Central Hunter Ironbark-Spotted Gum-Grey Box Forest EEC [absent from Project Area]	-
1605	Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter	-	Central Hunter Valley Eucalypt Forest and Woodland CEEC
1692	Bull Oak grassy woodland of the central Hunter Valley	-	Central Hunter Valley Eucalypt Forest and Woodland CEEC
1731	Swamp Oak; Weeping Grass grassy riparian forest of the Hunter Valley	-	-
1748	Grey Box grassy open forest of the Central and Lower Hunter Valley	Central Hunter Grey Box-Ironbark Woodland EEC	Central Hunter Valley Eucalypt Forest and Woodland CEEC
1605	Derived Native Grasslands: Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter	-	-

4.1.7.2 Commonwealth TECs

The recently listed (May 2015) Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered ecological community (CHVEFW CEEC) is present within the Project Area (see **Table 12**). Following the approved conservation advice for this community relating to distributional, structural, compositional and condition characteristics, only 5.8 ha (2.8%) of the Project Area supports CHVEFW CEEC (see further detail in Section 4.3.3). In practical terms, only those patches of vegetation dominated by either *Eucalyptus crebra*, *E. moluccana* or *Allocasuarina luehmannii*, and that are ≥ 0.5 ha in size qualify as CHVEFW CEEC. The four qualifying patches (ranging from 0.73 to 2.63 ha in size) are shown in Figure 10. The two western patches (totaling 3.8 ha) lie adjacent to previously approved mining and/or overburden emplacement areas, and hence offer no habitat connectivity and negligible other conservation benefits. All stands comprise young regrowth forest dominated by *Eucalyptus crebra* over resilient native grasses such as *Aristida ramosa* and *A. vagans*, and a number of herbaceous weeds.

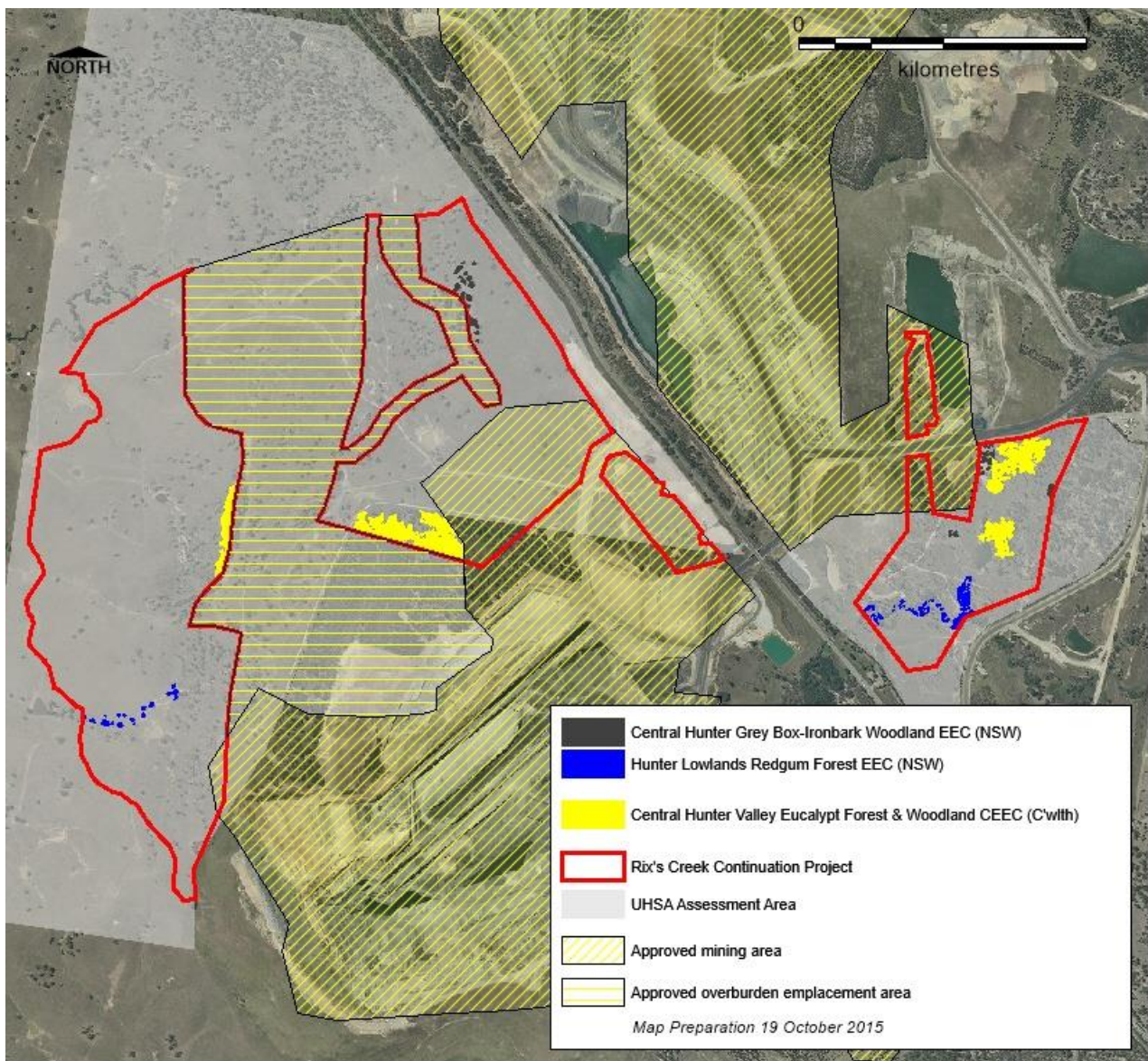


Figure 10 Threatened Ecological Communities within the Project Area.

4.1.8 Landscape & Connectivity Assessment

Figure 11 and **Table 13** show nearby remnant areas to the Project Area within a 2000 ha assessment circle, detailing the size of habitat patches present. Remnant stands of woodland are limited (maximum size of 74 ha, approximately half of which is already approved for mining), but extensive areas of derived native grassland with scattered trees are present.

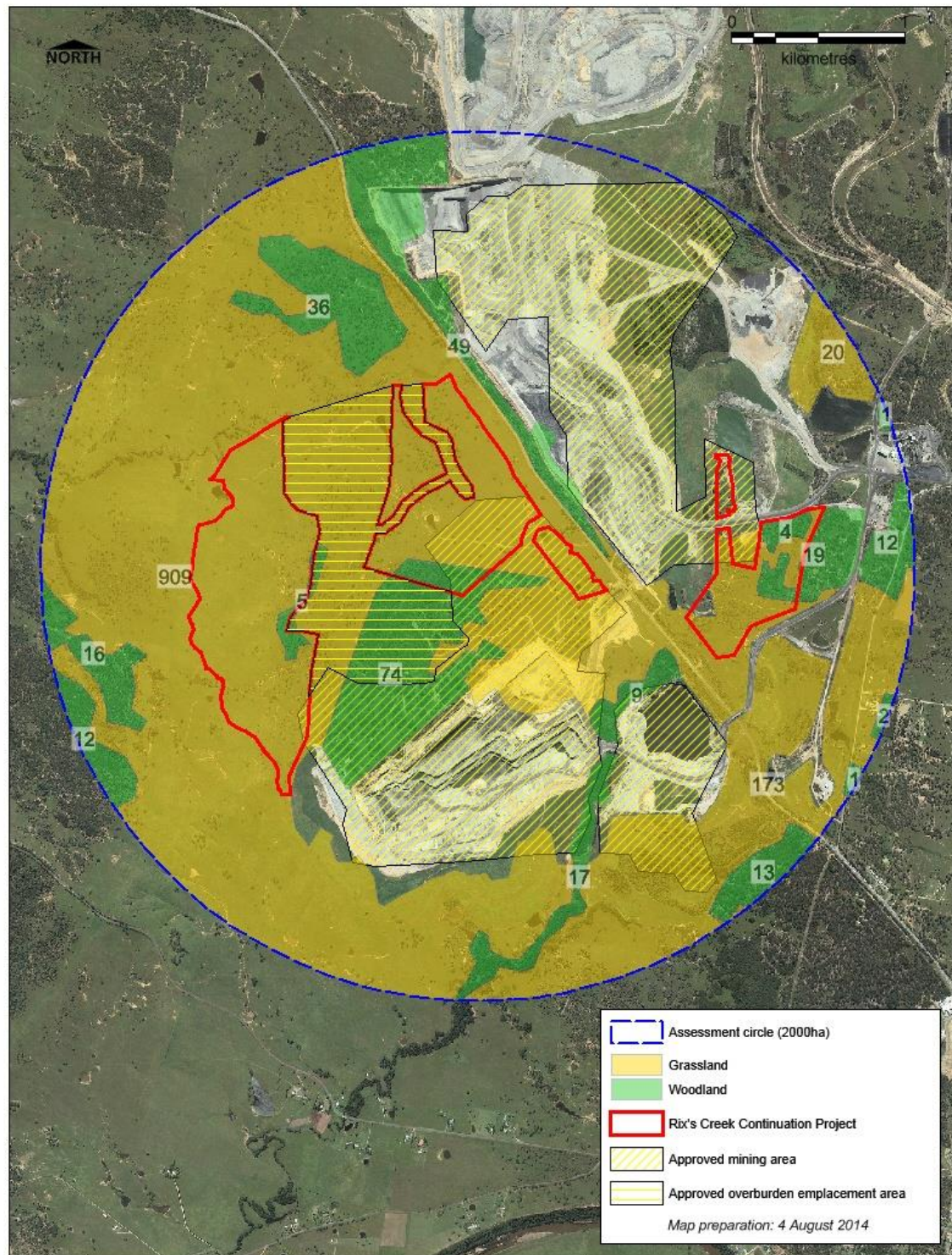


Figure 11 Connectivity assessment within a 2000 ha assessment circle, Rix's Creek. Numbers represent total hectares within each unit.

Table 13 Extent of Woodland and Grassland within assessment circle.

Stratified Remnant	Area (ha)	Condition
Woodland	74	Moderate-Good
	49	Moderate-Good
	36	Moderate-Good
	19	Moderate-Good
	17	Moderate-Good
	16	Moderate-Good
	13	Moderate-Good
	12	Moderate-Good
	12	Moderate-Good
	9	Moderate-Good
	5	Moderate-Good
	4	Moderate-Good
	2	Moderate-Good
	1	Moderate-Good
Total	269	
Grassland	909	Low
	173	Low
	20	Low
Total	1102	

Table 14 provides a summary of the Landscape Value Assessment and the relevant scores for each attribute. For the Project Area, the Local biodiversity link is the 3rd order stream (minor creeks); there is no State or Regional biodiversity link applicable.

Table 14 Summary of landscape value assessment.

Attribute	Before Clearance		Score	After Clearance		
	Within 2000ha assessment circle	Within Project Area		Change after clearance (ha)	% Change after clearance	Score
Native vegetation cover (ha)	269	17.6	7	251.4	6.5% loss	3.5
Connectivity value			6			
Adjacent remnant area			10*			

* based on 75% clearance of *Central Hunter Foothills* Mitchell Landscape

4.2 Potential Impacts

The following actions have or will be undertaken to avoid, reduce and mitigate impacts on biodiversity:

- **Avoid** – wherever possible, retention of vegetation and habitat forms part of mine planning and the siting of supporting infrastructure. Mining will only occur in the highly disturbed grazing lands, and there will be no disturbance of the northern section of the coal resource, north of Deadman's Gully.
- **Reduce** – reduction of impacts on biodiversity will be met through the staged removal of vegetation and habitat, together with inspection of habitat trees before and during tree felling operations.

Stockpiling of suitable hollow bearing trees will allow reinstatement of these habitat attributes in rehabilitated lands. The out-of-pit overburden dump will be on highly disturbed grazing land in the west of the site, and will minimize potential air quality impacts on residential areas of Singleton to the east.

- Mitigate – mitigation of impacts on biodiversity will be met through implementation of the UHSA and the associated purchase of ecosystem credits. Rehabilitation commitments will include the planting of tree species characteristic of the disturbed communities.

Under the terms of reference for the UHSA, OEH are required to address potential impacts within both operational and cumulative contexts as part of the *Biodiversity Plan for Coal Mining in the Upper Hunter Valley*. Assessment of potential impacts will be undertaken collectively across all participating mines prior to certification of lands. In the event that the UHSA has not been certified in time for determination of the Rix's Creek Continuation Project, a brief outline of potential impacts is presented below.

The Project proposes to remove 17.6 ha of native vegetation, together with 52.2 ha of derived native grassland. Of this, 0.8 ha of State-listed Hunter Lowlands Redgum Forest EEC, 1.62 ha of State-listed Central Hunter Grey Box-Ironbark Woodland EEC, and 5.8 ha of Commonwealth-listed Central Hunter Valley Eucalypt Forest & Woodland CEEC will be removed. Within the context of the Project Area, NSW endangered ecological communities comprise only 1.2%, and Commonwealth-listed endangered ecological communities only 2.8%, of the 211 ha planned for disturbance. Assessment of the potential impact on these TECs is included in Section 4.3. All of the derived grassland areas have been grazed by cattle for many decades, and are consequently dominated by the more hardy grass species such as *Sporobolus creber*, *Aristida ramosa*, *Aristida vagans* and *Cymbopogon refractus*.

The Squirrel Glider was the only threatened fauna species recorded or expected to be present within the Project Area. This species is hollow-dependent, and it is possible that some minor displacement of individuals within the Project Area may occur following the removal of older mature trees (see Section 4.2.1).

4.2.1 Operational Impacts

During the operational phase of the mine, there is some potential for displacement of individuals of the hollow-dependent and threatened Squirrel Glider. To mitigate potential impacts on this species, it is proposed that an experienced and qualified fauna ecologist be on site to inspect potential den sites and aid in the transferal of any individuals located during tree clearing operations (see Section 5).

No other impacts on threatened flora or fauna are expected during the operational phase.

4.2.2 Cumulative Impacts

The Singleton-Muswellbrook portion of the Hunter Valley currently supports approximately 18 active coal mines, all situated within a predominantly agricultural landscape. Current operations for Rix's Creek lie adjacent to the north and south-east of the Project Area, while Camberwell and Mt Owen mines lie further to the north and north-west. Collectively, the cumulative impacts of all of these mines on biodiversity are substantial, involving the loss of habitat, breeding and feeding sites, and reduced options for the dispersal of offspring. Relative to the larger mines in the district, the extent of habitat loss for flora and fauna under the Project is minimal.

4.3 Assessment of Impacts

As required under relevant NSW legislation (ie: Section 94 *Threatened Species Conservation Act*; Section 5A *Environmental Planning & Assessment Act*; Section 220Z *Fisheries Management Act*), 'seven-part tests' are required to assess potential impacts on threatened ecological communities and/or flora and fauna known or expected within a proposed development area. Seven-part tests have been undertaken in the event that the Upper Hunter Strategic Assessment bio-certification process is not finalized in time for the Rix's Creek Continuation Project to be determined.

Seven-part tests are required for:

- Squirrel Glider
- Central Hunter Grey Box – Ironbark Woodland
- Hunter Lowlands Redgum Forest

For Matters of National Environmental Significance under Commonwealth legislation, a Referral to the Commonwealth Government is required to ascertain whether or not the proposed action will be a controlled action, and therefore require further assessment under the EPBC Act. Such a Referral has already been deemed by the Commonwealth Department of Environment to not constitute a controlled action (EPBC Referral 2014/7348).

4.3.1 Seven-part Test

Squirrel Glider

For the purpose of this impact assessment, the Project area is separated into 3 habitat patches. These habitat patches are referred to as the eastern, central and western patch. The eastern patch supports a regrowth forest dominated by a mix of eucalypt tree species, including Spotted Gum, Narrow-leaved Ironbark, and scattered Grey Box and Swamp Oak. Understorey vegetation is generally absent, and dominated by grasses at ground layer. Habitat trees occur at very sparse in this eastern patch.

The majority of the central, and all of the western patch, supports scattered mature Narrow-leaved Ironbark trees. Understorey plant species are generally absent, and ground layer vegetation dominated by grasses. Habitat tree density is high in the central and western patch, as many mature trees with hollows are present.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,***

Factors associated with the proposed action which may disrupt the life cycle of the Squirrel Glider include clearing of foraging resources, fragmentation of habitat, isolation of populations and removal of den trees as roost and breeding sites.

Foraging

Within the majority of the western and central patches of the Project Area, the foraging habitat of the Squirrel Glider is low quality. Foraging resources is restricted to the canopy layer, with very low diversity of trees species. The lack of tree species diversity will influence the abundance and duration of foraging resources for the Squirrel Glider, such as pollen, nectar and invertebrates.

In contrast, the small patch of remnant habitat in the most eastern part of the Project Area supports more diverse forest type, with a mixed age stand of Narrow-leaved Ironbark and Spotted Gum, with scattered Grey Box and Swamp Oak trees. Understorey vegetation is generally absent, with groundlayer vegetation dominated by grasses. The diversity of tree species provide increased duration of abundance of pollen and nectar, as each species of tree will flower at differing times of the year. The presence of exfoliating bark tree species, such as Grey Box and Spotted Gum, will also provide periods of the year with higher abundance of invertebrates for the Squirrel Glider.

Breeding

The Squirrel Glider is dependent upon mature trees with hollows to provide shelter and breeding sites. Within the western and central patches, the density of habitat trees is higher than the eastern patch, however, habitat quality is low. In contrast, the eastern patch provides higher quality foraging habitat, but low quality breeding habitat for the Squirrel Glider. The proposed action would result in a loss of potential or actual den sites for the species.

Fragmentation

The vegetation within the Project Area is highly fragmented, with low density of canopy trees in the western and central patches, and large areas of adjoining land cleared of remnant forest vegetation. However, despite the high degree of habitat fragmentation within this part of the Project Area, suitable connectivity exists to adjoining remnant vegetation to the north and south-west of the western and central patches. There is no connectivity between the central and eastern forest patches within the Project Area. The eastern patch is also highly fragmented, but suitable connectivity exists to remnant habitat further to the east of this patch. Gaps in tree canopy cover occur due to vehicular roads and tracks, and past clearing of native vegetation within the area.

The presence of connectivity between the Squirrel Glider population in the Project Area, and adjoining habitat patches outside the proposed disturbance area and study area, indicate the local Squirrel Glider population is not isolated. The loss of habitat under the proposed Action, whilst contributing to loss of habitat, will not in itself have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,***

The Squirrel Glider within the Project Area is not part of an endangered population.

- (c) *in the case of an endangered ecological community, whether the action proposed:***

- (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

The Squirrel Glider is not an endangered ecological community.

(d) in relation to the habitat of a threatened species, population or ecological community:

- (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

- (i) The proposed Action intends to remove 17.6 ha of treed habitat as part of the proposal, within a total disturbance footprint of 211.4 ha.
- (ii) The area of habitat to be removed by the proposed Action would not result in further isolation or fragmentation of habitat to that already existent across the local landscape. The large corridor of regrowth forest present between the western and central patches is already approved as an overburden emplacement area as part of existing operations. In the eastern patch, no loss of connectivity or fragmentation will occur to adjoining patches of habitat for the Squirrel Glider.
- (iii) Within the western and central patches of Squirrel Glider habitat, the habitat quality is rated as low, due to very low diversity of tree species and absence of understorey vegetation. The quality of habitat in the eastern patch is considered higher in value for the Squirrel Glider, but has very low density of mature trees with hollows to provide breeding and sheltering habitat. Overall, the loss of 17.6 hectares of treed habitat will not significantly impact upon the local Squirrel Glider population, and will not contribute to a long-term decrease in viability of the local population.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has yet been declared for the Squirrel Glider under Part 3 Division 1 of the *Threatened Species Conservation Act 1995*.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

There is no recovery plan for the Squirrel Glider. The Office of Environment and Heritage has prepared Priority Action Statements (PAS) to promote the recovery of the Squirrel Glider, and the abatement of key threatening processes in New South Wales. These PAS are currently under review, and are likely to be repealed from the Act. However, the Priority Action Statement identifies a number of broad strategies to help the Squirrel Glider recover in New South Wales. Two priority actions applicable to the proposed Action are presented below:

- (1) Ensure the largest hollow bearing trees (including dead trees) are given highest priority for retention in PVP assessments and other environmental planning instruments, or other land assessment tools.
- (2) Delineate boundaries of populations to identify the extent to which populations are interconnected (to determine propensity to move across cleared land).

Given that suitable habitat is contiguous with the Project Area, it is not considered that strategies outlined in the PAS are required to be implemented, which will assist with recovery of the species in NSW.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action constitutes or contributes to several potential key threatening processes, including;

- Clearing of native vegetation - The proposed Action would result in loss of 17.6 hectares of treed habitat suitable for the Squirrel Glider.
- Loss of hollow-bearing trees - The clearing of habitat in the western and central patches will result in loss of hollow-bearing trees suitable for the Squirrel Glider. Whilst this loss may occur, a significant number of mature habitat trees with hollows would be retained between the western and central patches, and also to the north of these two areas.
- Removal of dead wood and dead trees - Dead stags standing in the open paddocks, and also amongst the treed areas, may provide sheltering habitat for the Squirrel Glider.

The loss of foraging and sheltering habitat for the Squirrel Glider by the proposed Action would increase the impact of these key threatening processes on the local population. However, these impacts are not considered to significantly affect the local population to the degree that its long term viability is reduced.

Central Hunter Grey Box - Ironbark Woodland

A total of 0.62 ha of *Central Hunter Grey Box – Ironbark Woodland* EEC (CHGBIW) is present within the Project Area and is subject to clearing.

- (a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,**

CHGBIW is not a threatened species.

- (b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,**

CHGBIW is not an endangered population.

- (c) in the case of an endangered ecological community, whether the action proposed:**

- (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

(i) CHGBIW occupies 0.62 ha of the Project Area. In his study of the vegetation of the central Hunter Valley, Peake (2006) mapped 14,818 ha of CHGBIW, representing around 24% of all remnant vegetation that he studied. Areas of CHGBIW to be removed under the proposal equates to 0.004% of the mapped distribution of this community, as at 2006.

(ii) The 0.6 ha of CHGBIW to be removed as a result of the proposed action will not substantially or adversely impact on the local occurrence of this community, and CHGBIW will not be placed at risk of extinction.

- (d) in relation to the habitat of a threatened species, population or ecological community:**

- (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

(i) A total of 0.6 ha of CHGBIW will be removed for the proposed action, representing 0.004% of the total mapped Hunter Valley distribution of Peake (2006).

- (ii) Stands of CHGBIW within the proposed disturbance area are already highly fragmented as a result of past clearing associated with grazing activities, and do not form a contiguous stand of vegetated forest. Consequently, the proposed action will not fragment or isolate areas of CHGBIW.
- (iii) CHGBIW was one of the most widespread communities defined in the study of Peake (2006), comprising 24% of all remnant vegetation studied. Removal of 0.004% of this vegetation type under the proposed action is insignificant.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

No critical habitat has yet been declared for CHGBIW under Part 3 Division 1 of the *Threatened Species Conservation Act 1995*.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

There is no recovery plan, threat abatement plan or priority action statement (PAS) prepared specific to CHGBIW.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action constitutes or contributes to several potential key threatening processes, including;

- Anthropogenic climate change
- Clearing of native vegetation
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidate*)
- Invasion of native plant communities by exotic perennial grasses
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees

Hunter Lowlands Redgum Forest

A total of 0.8 ha of *Hunter Lowlands Redgum Forest* EEC (HLRF) is present within the Project Area and is subject to clearing.

- (a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,**

HLRF is not a threatened species.

- (b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,**

HLRF is not an endangered population.

- (c) in the case of an endangered ecological community, whether the action proposed:**

- (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

(i) HLRF occupies 0.8 ha of the Project Area. In his study of the vegetation of the central Hunter Valley, Peake (2006) mapped 147 ha of HLRF, representing around 0.3% of all remnant vegetation that he studied. NSWNPWS (2000) mapped approximately 7000 ha of HLRF within the Lower Hunter. Areas of HLRF to be removed under the proposal equates to 0.001% of the mapped distribution of this community.

(ii) The 0.8 ha of HLRF to be removed as a result of the proposed action will not substantially or adversely impact on the local occurrence of this community, and HLRF will not be placed at risk of extinction.

- (d) in relation to the habitat of a threatened species, population or ecological community:**

- (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

(i) A total of 0.8 ha of HLRF will be removed for the proposed action, representing 0.001% of the total mapped Hunter Valley distribution of Peake (2006) and NSWNPWS (2000).

(ii) Stands of HLRF within the proposed disturbance area are already highly fragmented as a result of past clearing associated with grazing activities, and do not form a contiguous stand

of vegetated forest. Consequently, the proposed action will not fragment or isolate areas of HLRF.

- (iii) HLRF is very highly fragmented within the Hunter Valley, due to a long history of agricultural activities within its habitat. Stands of any substantial size are rare, and those present within the Project Area consist of individual trees scattered along highly disturbed drainage lines. Removal of 0.001% of this vegetation type under the proposed action is insignificant.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),*

No critical habitat has yet been declared for HLRF under Part 3 Division 1 of the *Threatened Species Conservation Act 1995*.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,*

There is no recovery plan, threat abatement plan or priority action statement (PAS) prepared specific to HLRF.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

The proposed action constitutes or contributes to several potential key threatening processes, including;

- Anthropogenic climate change
- Clearing of native vegetation
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)
- Invasion of native plant communities by exotic perennial grasses
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees

4.3.2 Biodiversity Certification Credit Calculations

4.3.2.1 Credits for Vegetation Zones

Table 15 summarises the ecosystem credits calculated for the Project Area. In total, 1400 ecosystem credits are generated for the proposal.

4.3.2.2 Credits for Species

No species-credit species were detected within the Project Area.

Table 15 Ecosystem Credit Summary for the Project Area.

Vegetation		Vegetation Certified (ha)	No. of Credits Required
Type	HU812: Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.8	33
	HU816: Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	0	0
	HU819: Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	18.3	502
	HU819: Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter (DNG_Low)	52.2	838
	HU906: Bull Oak grassy woodland of the central Hunter Valley	0.1	2
	HU945: Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	0.4	11
	HU962: Grey Box grassy open forest of the Central and Lower Hunter Valley	0.6	14
	Total	72.4	1400
Class	Coastal Floodplain Wetlands	0.8	33
	Coastal Swamp Forests	0.4	11
	Coastal Valley Grassy Woodlands	0.1	2
	Hunter-Macleay Dry Sclerophyll Forests	0.6	14
	North-west Slopes Dry Sclerophyll Woodlands	70.5	1340
	Total	72.4	1400
Formation	Dry sclerophyll forests (shrub/grass sub-formation)	71.1	1354
	Forested wetlands	1.2	44
	Grassy woodlands	0.1	2
	Total	72.4	1400

4.3.3 Matters of National Environmental Significance

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), actions that have, or are likely to have, a significant impact on a Matter of National Environmental Significance (MNES) require approval from the Federal Minister for the Environment. No flora or fauna present within the Project Area are considered to be a MNES under the EPBC Act. However, several listed migratory species do occur within the mid to Upper Hunter Valley region. These species include those listed below in **Table 16**. All listed Migratory species are widespread and abundant, with habitat well represented in the lower and upper Hunter Valley region.

Table 16 Migratory bird species known from the mid-upper Hunter Valley.

Listed Migratory Species (EPBC Act)	Habitat	Recorded at Rix's Creek	Mid-Upper Hunter Record
Cattle Egret	Grasslands, wetlands	No	Yes
Great Egret	Wetlands, riparian areas	No	Yes
Rainbow Bee-eater	Open Forest	No	Yes
Latham's Snipe	Wetlands, creek lines	No	Yes
White-throated Needletail	Aerial space	No	Yes
Fork-tailed Swift	Aerial space	No	Yes

The recently listed (May 2015) Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered ecological community (CHVEFW CEEC) is present across the Project Area. The key diagnostic factors for this community to be present, and their application to the current Project Area, are that the site:

- lies within the Hunter River catchment (the Project Area falls within the Hunter catchment);
- typically occurs on lower hillslopes and low ridges, or valley floors in undulating country; on soils derived from Permian sedimentary rocks (the Project Area largely occurs on such landscapes of Permian geology);
- does not occur on alluvial flats, river terraces, aeolian sands, Triassic sediments, or escarpments (the Project Area occurs largely on landscape features other than these);
- is woodland or forest, with a projected canopy cover of trees of 10% or more; or with a native tree density of at least 10 native tree stems per 0.5 ha (at least 20 native tree stems/ha) that are at least one metre in height (parts of the Project Area support woodland or forest above these thresholds);
- has a canopy dominated by one or more of the following four eucalypt species: *Eucalyptus crebra* (narrow-leaved ironbark), *Corymbia maculata* (spotted gum), *E. dawsonii* (slaty gum) and *E. moluccana* (grey box); OR a fifth species, *Allocasuarina luehmannii* (bulloak, buloke) dominates in combination with one or more of the above four eucalypt species, in sites previously dominated by one or more of the above four eucalypt species (the Project Area supports vegetation dominated by *Eucalyptus crebra*, *E. moluccana* and *Allocasuarina luehmannii*);
- *Allocasuarina torulosa* (forest oak/ she-oak, rose she-oak/oak), *Eucalyptus acmenoides* (white mahogany) and *E. fibrosa* (red/broad-leaved ironbark) are largely absent from the canopy of a patch (small areas of *E. fibrosa* are present within the Project Area, otherwise other species are absent);
- supports a ground layer (although it may vary in development and composition), as a sparse to thick layer of native grasses and other native herbs and/or native shrubs (the Project Area, although formerly grazing land, is dominated by native grasses and herbs over much of it).

Additional diagnostic characteristics are also provided in the conservation advice for this community, and incorporate the **exclusion** of derived native grasslands where there is a gap in or at the edge of a wooded patch, or a gap connecting two wooded patches across a short distance (i.e. 30 m). This therefore excludes the 52 ha of derived grassland areas present within the Project Area from the CHVEFW CEEC.

Consequently, in total 19 ha of the Project Area supports vegetation meeting these key distributional, structural and compositional diagnostic characteristics of CHVEFW CEEC. However, for consideration as the CHVEFW CEEC, the above factors *must* be present in combination with the minimum condition thresholds for moderate to high quality. These minimum thresholds relate primarily to patch size and extent of native perennial species in the understorey.

Within the Project Area, there are no patches of CHVEFW-affiliated vegetation ≥ 5 ha in size, and consequently Condition Class A (High quality condition) does not apply. There are four patches ≥ 0.5 ha in

size (range 0.73 to 2.63 ha), each of which supports at least 70% cover native perennial species in each layer, and at least 12 native understorey species, signifying vegetation of High Condition under Class B. There are no other patches of vegetation within the Project Area that qualify as CHVEFW CEEC, as all others fall below the 0.5 ha lower threshold.

In total, these four qualifying patches comprise 5.8 ha (or 2.8%) of CHVEFW CEEC within the Project Area, which under the proposal will require removal. Following the guidelines for assessing significance (Commonwealth Department of Environment 2013), an action such as this that will “reduce the extent of an ecological community” will consequently require a Referral to the Commonwealth. Although a Referral has already been made and assessed for the proposal (prior to listing of CHVEFW; EPBC Referral 2014/7348 deemed a non-controlled action), a new Referral is likely to address the loss of 5.8 ha of the newly listed CHVEFW CEEC. However, given the very small patch size of this community within the proposed disturbance area (four patches ranging from 0.73 to 2.63 ha), the regrowth nature and lack of connectivity these patches show with the wider locality, it is expected that the proposal would have an insignificant impact on the CHVEFW CEEC and therefore would again be deemed a non-controlled action.

5.0 Management & Monitoring

5.1 Cumulative Impacts on Ecology

Cumulative impacts refer to the additive or compounding impacts of successive developments on habitat and wildlife. Individually, the impacts from a single development may be minor or insignificant, but when considered in context with surrounding developments, these can be substantial. The Hunter Valley is particularly prone to the cumulative effects of development on the native ecology, principally through the rise in coal mining approvals over the last decade. In relation to the Rixs Creek Continuation Project, existing mine activity lies immediately adjacent to the south and north. Elsewhere, the majority of existing mines occur in a north-westerly band extending from Broke to Muswellbrook, and are well distant from Rix's Creek (>7km).

Habitats within the Project Area are already highly fragmented and play a limited role in connectivity and wildlife dispersal. The vast majority of land is Derived Native Grassland with widely scattered trees, providing habitat principally for woodland and grassland birds.

To manage potential impacts relating to cumulative disturbances, the staging of the mining process will allow for the gradual dispersal of wildlife into surrounding lands, and the ongoing development of rehabilitated areas on lands already mined. Consequently, it is envisaged that the cumulative impacts on wildlife will be negligible, and no monitoring is considered necessary.

5.2 Management of Wildlife during Clearing

During the clearing of native vegetation, there is potential for native fauna to be displaced from habitat. To negate any adverse impacts on wildlife, significant ecological features associated with standing and dead timber will be assessed and monitored. Pre-clearance surveys by a qualified and experienced fauna consultant will be undertaken at the time of clearing, to ensure that displaced wildlife is removed or relocated. Significant ecological features include hollow-bearing trees and other habitat trees, fallen timber, hollow logs or stumps at ground level, and rocky boulders.

Hollow dependent fauna are more likely to be utilizing tree hollows for breeding purposes between the months of September to February. Consequently, the most appropriate times for the felling of trees is between March and August. In situations where tree felling is required outside of this period, careful inspection of hollows will be undertaken by a qualified fauna ecologist prior to and immediately after tree felling.

Felled trees supporting hollows and suitable for relocation will be stockpiled for later use in rehabilitation activities.

6.0 Discussion and Conclusion

6.1 Ecology of the Rix's Creek Continuation Project

The proposal to mine an additional 211 hectares of land immediately adjacent to the existing mining activities of Rix's Creek, and to extend the life of the current mine until approximately 2037, will have negligible impacts on the ecology of the area. Surveys across the site have revealed the presence of two State-listed threatened communities (Central Hunter Grey Box-Ironbark Woodland; Hunter Lowlands Redgum Forest) totaling ~1.5 hectares, one Commonwealth-listed threatened community (Central Hunter Valley Eucalypt Forest and Woodland) totaling ~5.8 ha, one threatened fauna species (Squirrel Glider), and no threatened plants.

The bulk of the Project Area supports Derived Native Grassland across landscapes formerly forested by Ironbark (*Eucalyptus crebra*), and which have been used for grazing over many decades. Advice received from OEH during the UHSA process indicated that this Ironbark-dominated vegetation (PCT 1605: *Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter*) did not form part of any State-listed TEC in the Hunter Valley, and consequently is deemed of lowered significance. From a Commonwealth perspective, these grasslands are also excluded from Commonwealth-listed communities.

6.2 Derived Native Grassland

There is some argument that grassland areas that can be shown to have been derived from TECs should be considered as such for planning purposes. Many offset properties in the Hunter that have been purchased by mining companies and managed for conservation aim to return TECs to these lands, often as a requirement of consent conditions. Under the UHSA process, which plans for the next 25 years of coal mining, it is logical to consider moderate to good condition derived grassland as TEC wherever they occur. The development of a canopy in these grasslands will occur naturally over time: Semple and Koen (2003), for example, showed that eucalypt regeneration in grassy woodlands would occur more effectively in the better condition grasslands than those dominated by exotic species.

State threatened species legislation (*TSC Act 1995*) does not specifically address whether or not derived grasslands are included within TECs, and there is little guidance or advice on when a regenerating grassland area should be considered TEC. How tall and at what density do regenerating eucalypts, for example, need to be before derived grassland is considered Central Hunter Ironbark - Spotted Gum - Grey Box Forest EEC? Over a 25 year period, most grasslands with scattered paddock trees and the removal of cattle grazing would support impressive stands of timber, and if assessed at that time would easily qualify as TEC. Understandably, it may be sensible to consider all derived grasslands of moderate-good condition as TEC. However, under the current UHSA process, no derived grasslands are considered by OEH to represent listed TECs in the Hunter, and this view is adopted in the current assessment.

6.3 Targeted Fauna Species Occurrence

6.3.1 Brush-tailed Phascogale

The Project Area and surrounds supports habitat suitable for the Brush-tailed Phascogale, in the form of habitat trees with hollows, and areas of foraging habitat. This species is known from nearby locations, such as Integra Open Cut offset areas near Glennies Creek, and Mt Owen Complex at Hebden (unpubl. data). However, at both locations, the Phascogale has only rarely been observed and is difficult to detect consistently. For instance, it was captured at Mt Owen during surveys in 2004, but has not been detected at this site since then despite annual monitoring for the species over the period 2008 – 2013. The species was observed in nest boxes at Mt Owen in one year (2010), but has not been found during the period 1995 – 2009, and 2011 – 2013. Survey effort at both locations targeting this species has included tree and ground based trapping, installation and annual inspection of nest boxes specific to the species, spotlight searches and remote camera monitoring.

Elsewhere, this species has not been detected at a number of additional locations in the mid- to upper Hunter Valley where seemingly suitable habitat exists (Mangoola Coal near Wybong, Ravensworth Operations site & offsets, Glendell Mine, Liddell Open Cut, Singleton Army Range), despite suitable survey techniques to target the species.

The Brush-tailed Phascogale is not considered to be present within the Project Area for a number of reasons:

- many parts of the Hunter Valley floor, including the Project Area, have been cleared of native vegetation and habitat for an extended period of time. Remnant stands of native vegetation comprise small isolated pockets interspersed with large areas of unsuitable habitat,
- the Hunter Valley floor supports a very high density of introduced predators, impacting significantly on population viability of the species, and;
- the New England Highway represents a major risk for movement of Phascogales across the landscape, due to the very high traffic volumes, particularly at night.

6.3.2 Squirrel Glider

The Project Area and surrounds supports only marginal habitat suitable for the Squirrel Glider, with an abundance of mature trees with hollows, and small stands of remnant forest. However, for the majority of the remnant vegetation assessed, understorey plant species diversity is low, particularly manna producing *Acacia* plant species, to provide additional foraging resources for the species. The main foraging resource for the Squirrel Glider at Rixs Creek is nectar and pollen during flowering of eucalypt tree species, and canopy invertebrates. This habitat type is characteristic of other known locations of the species in the mid- and upper Hunter Valley, where grazing has substantially modified or removed understorey plant species that would otherwise provide foraging resources for the species. The Upper Hunter populations of the Squirrel Glider occur at much lower densities, and utilise much larger home ranges, than locations where foraging resources and floristic diversity is high (M. Murray, unpubl. data).

The Squirrel Glider is already known from the general locality, being recorded at the nearby Integra Open Cut, at Singleton Heights near the Caltex service station, and wider afield at Mt Owen Complex and

Ravensworth Operations (M. Murray, unpubl. data). Sufficient connectivity for the Squirrel Glider is present across this highly modified landscape, to enable foraging and dispersal movements. Persistence of the Squirrel Glider populations in the mid- to upper Hunter Valley, in contrast to the Brush-tailed Phascogale, is attributed to the Squirrel Glider not traversing across open ground between forested stands, and hence being less vulnerable to ground predators.

6.3.3 Green-thighed Frog

The Green-thighed Frog breeds within ephemeral pools partly or wholly within rainforest or wet sclerophyll forest, although there are a small number of sites within dry sclerophyll forest (Lemckert et. al. 2006). Natural depressions adjacent to streams (e.g. old billabongs) are the most commonly used calling sites recorded for the Green-thighed Frog. Males do however, also call and breed at artificial water bodies with close to half (12 of 27) of the sites being human excavated hollows or flooded road verges. In a large regional survey of the species in NSW, all but one Green-thighed Frog calling site was located within 100 m of a tract of natural vegetation greater than 20 ha and none was found in largely cleared (>50%) grazing lands or within entirely urban areas. This is likely to be due to their preference for low shrubs and leaf litter as shelter (Lemckert et. al. 2006).

Within the Project Area, none of the dams examined support essential habitat attributes for the Green-thighed Frog, or several other additional frog species. Limited or no emergent aquatic vegetation, such as reeds and rushes, was present in the majority of these dams. The Project Area has been utilised for grazing for an extended period of time, which has removed essential micro-habitats for frogs, with very limited presence of fringing aquatic or terrestrial vegetation around dam verges.

No habitat, consistent with other known sites where the Green-thighed Frog has been recorded, occurs at the Rix's Creek site. Examination of records of frog monitoring at three additional sites in the mid-Hunter Valley (Integra Open Cut at Camberwell, Mt Owen Complex at Hebden, & Ravensworth Operations at Ravensworth) have failed to record the presence of the Green-thighed Frog (M. Murray, unpubl. data). The Mt Owen location has been monitored extensively for frogs since 1994, and supports very similar habitats to Rix's Creek. Based on the habitat requirements of the Green-thighed Frog, known locations of the species, and extent of frog monitoring in the mid- to upper Hunter Valley, there is no likely indicator to suggest its possible presence at Rix's Creek.

6.4 Assessment of Impacts

The assessment of impacts on ecology for the Continuation Project has been undertaken under two scenarios. In Scenario 1 (Section 4.3.1), the relevant NSW (ie: Section 94 *Threatened Species Conservation Act*; Section 5A *Environmental Planning & Assessment Act*; Section 220Z *Fisheries Management Act*) and Commonwealth (*Environment Protection and Biodiversity Conservation Act*) legislation have been addressed through 'seven-part tests' and referrals to assess potential impacts on threatened ecological communities and/or flora and fauna known or expected within a proposed development area. A Referral to the Commonwealth (EPBC 2014/7348) has already deemed the project to be a non-controlled action under Part 7 of the EPBC Act. In Scenario 2 (Section 4.3.2), the Project Area has been assessed under the Upper Hunter Strategic Assessments bio-certification process being coordinated by OEH. Rix's Creek is a signatory to the UHSA and with approval of the Rix's Creek continuation project, offsets for the project will be

provided in accordance with the Upper Hunter Biodiversity Plan, including contributing money to the Upper Hunter Offset Fund using the appropriate OEH calculators.

As this assessment has been completed during a transitional phase between Scenarios 1 and 2, each of which require slightly different methodologies and survey priorities, it is inevitable that some inconsistencies in outcomes is obtained. However, it is considered that the scale of ecological impacts that will result from this proposal are insignificant and perfectly manageable, given the relatively small area of disturbance proposed.

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Appendix 1 - Flora Species

All plant species recorded within the 14 transects (locations shown in **Figure 4**). A '1' in the body of the table indicates presence of that species within that transect. * = exotic or non-endemic species.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	SNG89	SNG90	SNG49	SNG51	SNG58	SNG91	SNG92	SNG93	SNG94	SNG95	SNG96	SNG97	SNG98	SNG99
<i>Abutilon oxycarpum</i>						1								
<i>Acacia amblygona</i>			1	1	1	1								
<i>Acacia decora</i>				1										
<i>Acacia paradoxa</i>					1									
<i>Acacia parvipinnula</i>				1										
<i>Ajuga australis</i>						1								
<i>Allocasuarina luehmannii</i>			1	1	1	1								
<i>Anagallis arvensis</i> *	1	1	1			1	1	1	1	1		1	1	1
<i>Angophora floribunda</i>		1												
<i>Aristida ramosa</i>		1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Aristida vagans</i>						1				1	1			
<i>Arthropodium minus</i>				1										
<i>Arthropodium sp. B</i>			1		1	1			1					
<i>Asperula conferta</i>		1		1	1				1	1		1		
<i>Atriplex semibaccata</i>									1					
<i>Austrodanthonia racemosa</i> var. <i>racemosa</i>			1											1
<i>Austrodanthonia setacea</i>						1								
<i>Austrodanthonia tenuior</i>				1	1							1		
<i>Austrostipa scabra</i> subsp. <i>falcata</i>				1	1	1	1		1		1			
<i>Austrostipa verticillata</i>	1													
<i>Axonopus fissifolius</i> *							1							
<i>Boerhavia dominii</i>						1								
<i>Bothriochloa decipiens</i> var. <i>decipiens</i>	1	1		1	1	1	1	1	1	1	1	1	1	1
<i>Briza minor</i> *										1				1
<i>Brunoniella australis</i>			1	1	1	1	1		1		1			
<i>Calocephalus citreus</i>				1	1	1					1			
<i>Calotis cuneifolia</i>	1		1	1	1	1	1		1	1	1			
<i>Calotis lappulacea</i>				1	1	1			1					

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	SNG89	SNG90	SNG49	SNG51	SNG58	SNG91	SNG92	SNG93	SNG94	SNG95	SNG96	SNG97	SNG98	SNG99
<i>Carex inversa</i>									1			1		1
<i>Cassinia arcuata</i>				1										
<i>Casuarina glauca</i>	1													
<i>Centaurium erythraea</i> *									1					
<i>Cerastium glomeratum</i> *												1	1	
<i>Cheilanthes distans</i>	1			1	1	1								
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>			1		1	1	1	1		1	1			1
<i>Chloris truncata</i>			1	1	1								1	
<i>Chloris ventricosa</i>	1					1	1	1	1		1	1		1
<i>Chrysocephalum semipapposum</i>		1		1	1	1	1	1	1	1	1		1	1
<i>Cirsium vulgare</i> *	1	1					1		1			1	1	1
<i>Conyza bonariensis</i> *				1								1	1	1
<i>Corymbia maculata</i>											1			
<i>Cotula australis</i>												1	1	
<i>Cryptandra amara</i> var. <i>amara</i>											1			
<i>Cyclospermum leptophyllum</i> *		1												
<i>Cymbonotus lawsonianus</i>	1				1		1					1		
<i>Cymbopogon refractus</i>		1	1	1	1	1	1	1		1	1			1
<i>Cynodon dactylon</i>	1	1					1	1	1			1	1	1
<i>Cynoglossum australe</i>						1								
<i>Cyperus aggregatus</i> *	1													
<i>Cyperus gracilis</i>				1										
<i>Daviesia genistifolia</i>				1							1			
<i>Daviesia ulicifolia</i> subsp. <i>ulicifolia</i>														1
<i>Desmodium brachypodum</i>				1	1	1	1							
<i>Desmodium gunnii</i>											1			
<i>Desmodium varians</i>			1	1										
<i>Dianella longifolia</i> var. <i>longifolia</i>					1	1					1			
<i>Dianella revoluta</i> var. <i>revoluta</i>			1	1	1						1			
<i>Dianella tasmanica</i>			1	1	1									
<i>Dichelachne micrantha</i>				1						1				1
<i>Dichondra repens</i>	1	1	1	1	1	1	1		1		1	1		
<i>Digitaria coenicol</i>														1
<i>Digitaria diffusa</i>								1		1				
<i>Echinopogon caespitosus</i> var.					1						1			

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Species	SNG89	SNG90	SNG49	SNG51	SNG58	SNG91	SNG92	SNG93	SNG94	SNG95	SNG96	SNG97	SNG98	SNG99
<i>caespitosus</i>														
<i>Echinopogon ovatus</i>		1		1		1		1		1	1			
<i>Einadia hastata</i>	1				1									
<i>Einadia nutans subsp. linifolia</i>	1		1	1	1	1	1		1					
<i>Enchylaena tomentosa</i>	1								1					
<i>Enteropogon acicularis</i>				1	1									
<i>Epaltes australis</i>	1													
<i>Eragrostis brownii</i>														1
<i>Eragrostis cilianensis</i> *													1	
<i>Eragrostis leptostachya</i>	1		1	1	1	1	1	1	1	1		1	1	1
<i>Eragrostis sororia</i>	1							1		1				
<i>Eremophila debilis</i>	1		1	1	1	1	1		1	1	1			
<i>Erodium cicutarium</i> *												1		
<i>Eucalyptus crebra</i>			1	1	1	1	1	1		1	1			
<i>Eucalyptus moluccana</i>		1					1		1		1			
<i>Eucalyptus tereticornis</i>		1												
<i>Euchiton sphaericus</i>			1											
<i>Evolvulus alsinoides var. decumbens</i>					1									
<i>Facelis retusa</i> *	1							1		1				
<i>Fimbristylis dichotoma</i>				1				1	1	1				1
<i>Facelis retusa</i> *													1	
<i>Foeniculum vulgare</i> *												1		
<i>Galenia pubescens</i> *	1						1		1					
<i>Gamochaeta purpurea</i> *													1	1
<i>Geranium solanderi var. solanderi</i>		1					1			1		1		1
<i>Glossocardia bidens</i>				1										
<i>Glycine clandestina</i>					1		1	1			1	1		
<i>Glycine tabacina</i>				1	1	1	1	1	1	1	1	1	1	
<i>Gomphocarpus fruticosus</i> *				1	1	1	1	1	1	1	1			
<i>Hypochaeris microcephala var. albiflora</i> *								1						
<i>Hypochaeris radicata</i> *										1	1			
<i>Indigofera australis</i>						1								
<i>Juncus subsecundus</i>														1
<i>Juncus usitatus</i>							1			1				
<i>Lagenophora stipitata</i>			1						1					

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	SNG89	SNG90	SNG49	SNG51	SNG58	SNG91	SNG92	SNG93	SNG94	SNG95	SNG96	SNG97	SNG98	SNG99
<i>Lamium amplexicaule</i> *													1	
<i>Laxmannia gracilis</i>									1		1			
<i>Lepidium africanum</i> *							1							
<i>Lepidium bonariensis</i> *												1	1	
<i>Leptinella filicula</i> *	1	1					1		1					
<i>Linum trigynum</i> *		1				1	1							
<i>Lomandra confertifolia</i> subsp. <i>pallida</i>			1	1	1	1	1		1	1	1			1
<i>Lomandra filiformis</i> subsp. <i>coriacea</i>		1	1											
<i>Lomandra multiflora</i> subsp. <i>multiflora</i>			1	1	1			1		1	1			1
<i>Lycium ferocissimum</i> *	1													
<i>Maireana enchylaenoides</i>									1		1			
<i>Maireana microphylla</i>												1		
<i>Maytenus silvestris</i>			1											
<i>Medicago</i> spp. *									1	1				
<i>Melinis repens</i> *						1		1						
<i>Mentha satureioides</i>									1	1		1		1
<i>Microlaena stipoides</i> var. <i>stipoides</i>	1		1		1		1		1	1				1
<i>Minuria leptophylla</i>				1										
<i>Modiola caroliniana</i> *		1					1					1		
<i>Myoporum montanum</i>				1	1									
<i>Olea europaea</i> subsp. <i>cuspidata</i> *		1												
<i>Opuntia aurantiaca</i> *					1									
<i>Opuntia humifusa</i> *			1	1	1	1								
<i>Opuntia stricta</i> var. <i>stricta</i> *					1									
<i>Oxalis exilis</i>	1	1				1								
<i>Oxalis perennans</i>							1	1	1	1		1		
<i>Panicum effusum</i>				1						1	1	1	1	1
<i>Paronychia brasiliiana</i> *								1						
<i>Paspalidium distans</i>			1		1				1		1			
<i>Paspalum dilatatum</i> *	1	1						1		1		1		1
<i>Pennisetum clandestinum</i> *		1												
<i>Pimelea curviflora</i> var. <i>sericea</i>						1								
<i>Plantago debilis</i>							1							
<i>Plantago lanceolata</i> *	1	1				1	1	1	1	1		1	1	1
<i>Plantago myosuroides</i> subsp. <i>myosuroides</i> *								1						

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	SNG89	SNG90	SNG49	SNG51	SNG58	SNG91	SNG92	SNG93	SNG94	SNG95	SNG96	SNG97	SNG98	SNG99
<i>Poa labillardierei</i> var. <i>labillardierei</i>	1		1				1	1		1				1
<i>Pratia purpurascens</i>	1	1	1	1	1	1			1					
<i>Pterostylis</i> spp.			1											
<i>Pultenaea microphylla</i>				1										
<i>Romulea rosea</i> var. <i>australis</i> *												1	1	1
<i>Rumex brownii</i>														1
<i>Scleria mackaviensis</i>									1					
<i>Senecio madagascariensis</i> *	1	1			1	1	1	1	1	1	1	1	1	1
<i>Setaria parviflora</i> *	1							1						1
<i>Sida corrugata</i>				1	1	1	1					1		
<i>Sida rhombifolia</i> *	1	1				1	1	1	1	1		1		1
<i>Solanum cinereum</i>	1	1					1		1			1		
<i>Solanum nigrum</i> *	1							1			1			
<i>Solanum prinophyllum</i>				1	1									
<i>Soliva sessilis</i> *								1						
<i>Sonchus oleraceus</i> *	1					1			1					1
<i>Spergularia rubra</i> *		1												
<i>Sporobolus creber</i>	1	1			1	1	1	1		1		1	1	1
<i>Stachys arvensis</i> *												1		
<i>Stackhousia muricata</i>			1	1	1	1								
<i>Tagetes minuta</i> *												1		
<i>Taraxacum officinale</i> *														1
<i>Templetonia stenophylla</i>				1	1						1			
<i>Themeda australis</i>			1	1	1	1	1							
<i>Trifolium campestre</i> *												1	1	
<i>Trifolium repens</i> *										1		1	1	
<i>Trifolium</i> spp. *	1	1						1						
<i>Urtica incise</i>	1													
<i>Verbena rigida</i> var. <i>rigida</i> *		1												
<i>Vernonia cinerea</i> var. <i>cinerea</i>				1										
<i>Veronica plebeian</i>	1		1		1	1	1	1	1	1	1			
<i>Wahlenbergia communis</i>				1	1				1					
<i>Wahlenbergia</i> spp.						1								
<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>												1		

Appendix 2 - Photographs of Vegetation Zones

Zone 1: Forest Red Gum grassy open forest on floodplains of the lower Hunter (PCT 1598)



Zone 2: Bull Oak grassy woodland of the central Hunter Valley (PCT 1692)



Zone 3: Swamp Oak; Weeping Grass grassy riparian forest of the Hunter Valley (PCT 1731)



Zone 4: Narrow-leaved Ironbark; Native Olive shrubby open forest of the central and upper Hunter (PCT 1605)



Zone 5: Grey Box grassy open forest of the Central and Lower Hunter Valley (PCT 1748)



Zone 6: Spotted Gum; Narrow-leaved Ironbark shrub; grass open forest of the central and lower Hunter (PCT 1602)



Zone 7: Derived Native Grasslands

