Appendix

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Biodiversity Impact Assessment

Continuation of Boggabri Coal Mine – Biodiversity Impact Assessment

October 2010

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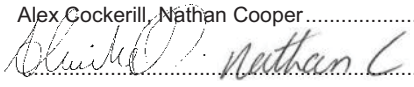
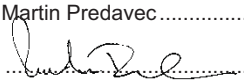
Signed: 

Reviewer: Martin Predavec

Signed: 

Approved by: Martin Predavec

Signed: 

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Glossary

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity – the variety of genes (or units of heredity) in any population ▪ species diversity – the variety of species ▪ ecosystem diversity – the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. For this study this is the NSW Brigalow Belt South bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Black-chinned Honeyeater	Refers to the eastern subspecies of Black-chinned Honeyeater (*Melithreptus gularis gularis*).
Brown Treecreeper	Refers to the eastern subspecies of Brown Treecreeper (*Climacteris picumnus victoriae*).
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under either the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* and both the state (Department of Environment, Climate Change and Water) and Federal (Department of the Environment, Water, Heritage and the Arts) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant state and Commonwealth legislation.
Department of Environment, Climate Change and Water	Broadly, the Department of Environment and Climate Change and Water (DECCW) works towards a healthy environment cared for and enjoyed by the whole NSW community; manages the state's natural resources, including biodiversity, soils and natural vegetation; manages natural and cultural heritage across the state's land and waters; acts to minimise the impacts of climate change; promotes sustainable consumption, resource use and waste management; regulates activities to protect the environment; and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making. The DECCW formed on 27 April 2007 incorporating the former NSW Department of Environment and Conservation in addition to some functions of the former Department of Natural Resources, Department of Energy, Utilities and Sustainability and The Greenhouse Office.
Department of the Environment and Heritage	The former name for the Commonwealth Department of the Environment, Water, Heritage and the Arts.
Department of the Environment and Water Resources	The former name for the Commonwealth Department of the Environment, Water, Heritage and the Arts.
Department of the Environment, Water, Heritage and the Arts	A former name (December 2007-September 2010) for the Commonwealth Department of Sustainability, Environment, Water, Population and Communities.
Department of Sustainability, Environment, Water, Population and Communities	The Commonwealth department responsible for the protection and conservation of Australia's natural environment and cultural heritage (September 2010-). The department develops and implements national policy, programs and legislation including administering the EPBC Act.
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.

Grey-crowned Babbler	Refers to the eastern subspecies of Grey-crowned Babbler (*Pomatostomus temporalis temporalis*).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Hooded Robin	Refers to the south-eastern form of Hooded Robin (*Melanodryas cucullata cucullata*).
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the *Threatened Species Conservation Act 1995,* the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Local population	The population that occurs within the Project Boundary, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by DECC 2007).
Locality	The area within a 10 km radius of the Project Boundary.
Migratory species	Species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*.
Project Boundary	The area to be directly or indirectly affected by the construction and/or operation of the Project. Detailed flora and fauna surveys were completed within the Project Boundary.
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, as well as all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Subject site	The area to be directly impacted by the construction and/or operation of the Project, i.e. the new part 3A proposed disturbance limit and nominal 30 m rail corridor.
Study area	The area encompassing the Project Boundary and the whole of the Leard State Forest.
Recovery plan	A plan prepared under the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999* to assist the recovery of a Threatened species, population or ecological community.
Significant	Important, weighty or more than ordinary as defined by (Department of Environment and Climate Change 2007).
Threatened biodiversity	Threatened species, populations or ecological communities as listed under either the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999*.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references DECC 2007).

Executive summary

Boggabri Coal is applying for approval to continue its open cut mining operations for a further 21 years. Project Approval is sought under Part 3A of the *Environmental Planning and Assessment Act 1979* to gain a single, contemporary planning approval for the continuation of its mining operations within the Project Boundary. Parsons Brinckerhoff was commissioned by Hanson Bailey on behalf of Boggabri Coal to undertake a detailed ecological assessment of impacts associated with the continuation of Boggabri Coal Mine. The specific aims of the report are as follows:

- Present the result of literature and database reviews.
- Present the results of surveys completed to date within the locality by Parsons Brinckerhoff (Parsons Brinckerhoff 2005b, 2008, 2009b), NPWS (Pennay, Michael 2001) and James B. Croft and Associates (1983).
- Identify and consider Threatened species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, NSW *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994* recorded in the Project Boundary or likely to be present therein.

The report examines the terrestrial and aquatic flora and fauna assemblages and their habitats within the Project Boundary and determines the biological impacts of the construction and operation of the Project. It also summarises the proposed mitigation measures as well as the assessments of significance required under Part 3A of the *Environmental Planning and Assessment Act 1979* and the *Environment Protection and Biodiversity Conservation Act 1999*.

The report has been prepared in accordance with the Environmental Assessment requirements issued by the Director-General of the NSW Department of Planning for the Project.

The Commonwealth Department of the Environment, Water, Heritage and the Arts has resolved that the Project is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* and will utilise a bilateral assessment process to assess the project. The Project requires the approval of the Commonwealth Minister for the Environment.

Methodology

The Project Boundary was comprehensively surveyed. The assessment included desk-based studies and a detailed field survey, including comprehensive flora and fauna survey effort conducted over five sampling periods in all four seasons within the Project Boundary. The flora surveys were conducted in accordance with the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (Department of Environment and Conservation 2004).

The flora survey effort included: stratification of vegetation communities; condition of vegetation communities using four criteria; flora quadrats within 400 m^2 (20 m X 20 m) quadrats (over 130 quadrats); random meander surveys in accordance with the technique described by (Cropper 1993) to maximise detection of general flora species and threatened and regionally significant flora species. A combination of parallel transects and random meanders were also conducted to identify the threatened cryptic orchid *Diuris tricolour* during its known flowering period in areas of potential habitat.

The comprehensive fauna survey work was conducted over two years with five survey periods encompassing all four seasons within and surrounding the Project Boundary. The survey work cumulated in over 4,102 trap nights and more than 473 person hours of fauna surveys. The survey effort was conducted over 20 fauna survey sites in four broad fauna habitat types. These surveys included: Microchiropteran bat surveys including anabat echolocation recordings and harp trapping; reptile and amphibian surveys including funnel and pitfall trapping, and active searches (diurnal and nocturnal); bird surveys (diurnal and nocturnal); small mammal surveys (spotlighting, Elliott and cage trapping for included arboreal), fauna habitat assessment; systematic hollow-bearing tree assessment; and systematic koala habitat assessment in accordance with Biolink (Biolink Ecological Consultants 2009).

Results

The majority of the Project Boundary within Leard State Forest comprises native forest and woodland communities with relatively few exotic species and high natural species diversity. However, these vegetation communities have often been structurally simplified, reflecting a history of disturbances consistent with forestry operations and thinning. The areas of the Project Boundary outside of Leard State Forest are characterised by highly disturbed communities affected by intensive agricultural land uses.

A total of 427 plants were recorded in the Project Boundary, of which 365 species (86 %) are native and two are threatened species of plant listed under the *Threatened Species Conservation Act 1995* or *Environment Protection and Biodiversity Conservation Act 1999*.

Four broad vegetation types were delineated and have been subsequently split into a total of fifteen distinct vegetation communities within the Project Boundary. Five vegetation communities have been identified as being commensurate with Threatened ecological communities listed under the *Threatened Species Conservation Act 1995* or *Environment Protection and Biodiversity Conservation Act 1999*.

Two critically endangered ecological communities and one endangered ecological community listed under the *Environment Protection and Biodiversity Conservation Act 1999* were recorded within the Project Boundary. Three endangered ecological communities listed under the *Threatened Species Conservation Act 1995* were recorded within the Project Boundary. One endangered ecological community listed under the *Fisheries Management Act 1994* was recorded within the Project Boundary.

A total of 194 species of animal were recorded in the Project Boundary during field surveys. These include six amphibians, 129 birds, 31 mammals and 28 reptile species. Of the species recorded 21 are listed as Threatened under the *Threatened Species Conservation Act 1995* and four are also listed as threatened under the *Environment Protection and Biodiversity Conservation Act* with a further two listed as Migratory under the *Environment Protection and Biodiversity Conservation Act*. In addition to these, three preliminary listed species under the *Threatened Species Conservation Act 1995* were recorded in the Project Boundary. Seven species of feral animal were observed in the Project Boundary including Common Starling, Fox, Brown Hare, Rabbit, Black Rat, Common House Mouse and Pig.

Impacts

In the absence of any amelioration, the Project would have a significant impact on the White Box, Yellow Box, Blakely's Red Gum Woodland ("Box Gum Woodland") as listed under the NSW *Threatened Species Conservation Act 1995* and the equivalent community listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act*. The Project will have a significant impact on

Threatened woodland birds and hollow-dependent microchiropteran bats within the locality and potentially the Regent Honeyeater.

Based on the findings of this study and in the absence of any aemelioration measures, the Project would have a substantial impact on the ecology of the local area. It would remove nearly 1385 ha of native vegetation, much of which is listed as Threatened under NSW and/or Commonwealth legislation. This vegetation also provides habitat for a range of Threatened species. The following is a summary of the impact of the Project on Threatened biodiversity within the Project Boundary:

- A total of four threatened species of plant and 33 threatened species and/or guilds of animal have been recorded or predicted likely to occur within the Project Boundary.
- Approximately 623.6 ha of Box-Gum Woodlands as listed under the *Environment Protection and Biodiversity Conservation Act* and *Threatened Species Conservation Act 1995* would be impacted.
- Approximately 0.3 ha Weeping Myall Woodlands as listed under the *Environment Protection and Biodiversity Conservation Act* and *Threatened Species Conservation Act 1995* would be impacted.
- Approximately 0.4 ha of Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern QLD as listed under the *Environment Protection and Biodiversity Conservation Act* and *Threatened Species Conservation Act 1995* would be impacted.
- Approximately 0.6 ha of Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River as listed under the *Fisheries Management Act 1994* would be impacted.

Amelioration package

A package of measures has been designed to ameliorate the ecological impacts of the Project. The approach is based upon the following hierarchy of principles of avoidance, mitigation and compensation described within the Draft Discussion Paper for the use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act* (DEWR, 2007):

- *"Avoid: to the extent possible, developments should be designed to avoid or minimise ecological impacts.*
- *Mitigate: where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the proposed development.*
- *Compensate: the residual impacts of the Project, following the implementation of mitigation measures, should be compensated for in some way to offset what would otherwise be a net loss of habitat."*

Avoidance

Avoiding environmental impacts has been considered where possible throughout the Project planning and design phases. Investigation of several Project alternatives and significant modification to the design of the Project has led to improved Biodiversity outcomes. These include:

- Comprehensive drilling program to further define the open cut resource boundary and limit surface disturbance where possible.

- Removal of the western drainage contour from the remnant Box Gum Woodland within Leard State Forest.
- Relocation of proposed mine site infrastructure to existing areas of disturbance.
- Diversion of water from east to west through rehabilitated land to avoid the construction of a large diversion channel.
- Utilisation of existing disturbance areas for the proposed rail corridor to avoid further clearance.

These measures reduce clearance of Box Gum Woodland vegetation by 55 ha. Further avoidance will be a principle aim during detailed design and construction.

Mitigation measures

The Project has an extensive rehabilitation program as part of the mine closure procedures. The majority of land cleared will be returned to forest and woodland. The restoration would be staged and has been designed with the intention of providing a self sustaining native forestry operation as well as maintaining pre-mining biodiversity values.

The existing Rehabilitation Management Plan should be updated to provide for the progressive rehabilitation of all mine disturbed areas to native vegetation. The key objectives of this plan are to restore, where possible, the pre-mining biodiversity within a safe and stable landform including 1019 ha of the Threatened Box-Gum Woodland and supplementary habitat features.

The following additional recommendations for mitigation are based on the findings of the report and will be adopted by the Project:

- Limit disturbance of native vegetation to the minimum necessary during construction and ahead of mining operations.
- Enhance the existing biodiversity management plan that contains detailed mitigation measures. This plan should include (but not be limited to) information such as protocols for vegetation clearing including inspection of hollows, feral animal and pest control, rehabilitation objectives, and further detailed design measures.
- Continue to implement a two stage clearing protocol for all hollow-bearing tree clearing. Mark all hollow-bearing trees to be felled and catalogue their species and approximate dimensions so that hollows or nest boxes can be affixed to similar standing trees located in offset, revegetation or rehabilitation areas.
- Revise and update the existing rehabilitation/revegetation management plan which should include (but not be limited to):
    - Planting a variety of locally occurring native species, including Acacia and Eucalyptus species to compensate for any impacts to habitat.
    - Increasing the overall vegetation cover.
    - Incorporating existing natural vegetation, where possible.
    - Establishing linkages with native vegetation remnants.
    - Focusing on riparian vegetation to protect waterways.

- Revise and update the existing flora and fauna monitoring plan for the Project. This plan should also include monitoring of exotic weeds and feral animals.
- Revise and update the existing sediment and erosion control plan which includes best practice erosion and sediment controls to be implemented in accordance with Volume 2D of Managing Urban Stormwater: soils and construction (Department of Environment and Climate Change 2008d).
- Design and construct the Namoi River crossings in accordance with the Industry & Investment NSW *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull & Witheridge 2003). Maintain fish passage at all times during the construction of the bridge over the Namoi River.
- Plant macrophytes (aquatic plants) along the stream banks within revegetation and rehabilitation areas to filter flow and enhance bank stability.

Compensatory habitat

A very carefully designed and robust offsets package is proposed to compensate for identified impacts and in the medium to long term improve ecological outcomes. The Boggabri Coal Biodiversity Offset Strategy identifies large patches of remnant vegetation in the locality of the Project Boundary. Field assessments confirm that these vegetation remnants contain high quality habitat and would create a valuable corridor for Threatened species in the region. Importantly, these areas would provide upfront mitigation of the Project's impacts on locally occurring biodiversity. A critical component of the strategy would be the restoration and establishment of a Regional East-West Wildlife Corridor linking the Leard State Forest with the Namoi River and large vegetation remnants to the west. The inclusion of these lands as potential biodiversity offsets would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented.

Conclusion

This assessment has found that there are large areas of nearby known habitats for all of the affected Threatened flora and fauna within the locality and region of the Project Boundary. It is recognised that the Project will significantly impact the habitat for these communities and species within the locality. However, the combined mitigation measures and Boggabri Coal Biodiversity Offset Strategy to be implemented over the life of the Project are likely to sufficiently ameliorate these impacts to the extent that no Threatened flora and fauna are likely to become extinct as a result of the Project.

1. Introduction

This report presents an ecological assessment of impacts associated with the continuation of Boggabri Coal Mine. The specific aims of the report are as follows:

- Present the result of literature and database reviews.
- Present the results of surveys completed to date within the locality by Parsons Brinckerhoff (Parsons Brinckerhoff 2005b, 2008, 2009b), NPWS (Pennay, Michael 2001) and James Croft and Associates (1983).
- Identify and consider Threatened species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and NSW *Threatened Species Conservation Act 1995* (TSC Act) recorded in the Project Boundary or likely to be present therein.

It examines the terrestrial and aquatic flora and fauna assemblages and their habitats within the Project Boundary and determines the biological impacts of the construction and operation of the Project.

It summarises the proposed mitigation measures as well as the assessments of significance required under the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the EPBC Act.

The report has been prepared in accordance with the Environmental Assessment (EA) requirements issued by the Director-General of the NSW Department of Planning (DoP) for the project. The project requires approval from the NSW Minister for Planning under Part 3A of the EP&A Act.

The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) has resolved that the Project is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will utilise DoP's assessment process to assess the project. The project requires approval from the Commonwealth Minister for the Environment.

1.1 Background to the Project

Boggabri Coal Pty Limited (Boggabri Coal) manages the Boggabri Coal Mine on behalf of Idemitsu Australia Resources Pty Limited. Boggabri Coal Mine is located within and adjacent to the Leard State Forest, 15 km north-east of the township of Boggabri, NSW within the Narrabri Local Government Area (LGA) (Figure 1-1).

Boggabri Coal is seeking a new Project Approval under the EP&A Act to continue its open cut coal mining and associated activities largely consistent with the approved operation.

The Project will consist of actions that are:

(a) within the area of Boggabri Existing

(b) within additional adjacent areas ('Boggabri Extension').

Current operations ('Boggabri Existing')

Boggabri Coal operates with Development Consent Departmental File Number (DFN) 79/1443(z)2, allowing for mining of up to 5 Million tonnes per annum (Mtpa) product coal for a period of 21 years from the date of granting of a mining lease. CL368 was granted on 15 November 1990 and as such DFN 79/1443(z) 2 expires on 14 November 2011.

The current operations involve open cut coal mining of up to 5 million tonnes per annum (Mtpa) of product coal within the area described in an Environmental Impact Statement (EIS) titled 'Boggabri Coal Project' dated 8 February 1988, which was prepared prior to the commencement of the operations. Mining Lease CL 368 was granted under the *Coal Mining Act 1973* NSW on 15 November 1990 authorising coal mining at the surface.

Boggabri Existing was assessed under the *Environment Protection (Impact of Projects) Act 1974* Cth (EPIP Act). Boggabri Existing was approved under NSW planning and environmental legislation in 1989 and is more completely described in the EIS.

Project ('Boggabri Extension')

Boggabri Extension will include coal extraction in the extension area (shown as 'Proposed Disturbance Limit (Boggabri Extension) on Figure 1-1) utilising associated mine infrastructure construction and operation which is within Boggabri Existing (see above). The Boggabri Extension includes an area of approximately 658 hectares and involves open cut mining operations in this area. In essence, Boggabri Extension is everything which is not described in the EIS.

1.1.1 Previous ecological assessments

Two significant ecological studies have previously been completed within the Project Boundary by (James B. Croft and Associates 1983) for the Boggabri Coal Mine Environmental Impact Statement 1987 (EIS) and (Pennay, Michael 2001) for the Brigalow Belt South Conservation Assessments. Details and significant findings of these studies are discussed briefly below.

The EIS for the Boggabri Coal Project included a detailed report on the Botany, Wildlife and Ecology of the Leard State Forest (James B. Croft and Associates 1983). This study included detailed flora sampling and vegetation mapping, mist netting, terrestrial and arboreal trapping during three seasonal sessions and opportunistic surveys. Threatened species recorded within the Project Boundary during these surveys consisted of:

- Barking Owl.
- Brown Treecreeper.
- Speckled Warbler.
- Eastern Long-eared Bat.
- Turquoise Parrot.

In addition, a possible sighting of the Rufus Bettong was tentatively recorded by this study; however this sighting remains unconfirmed and unlikely.

More recently, fauna survey work undertaken by the National Parks and Wildlife Service within Leard State Forest, was consulted as a source of survey information (Pennay, Michael 2001). These surveys included, harp trapping, terrestrial and arboreal trapping, pitfall trapping, targeted bird surveys and opportunistic surveys. Records of Threatened species from Fauna Survey Work within Leard State Forest are depicted on Figure 3-6 and listed below (Pennay, Michael 2001):

- Brown Treecreeper.
- Diamond Firetail.
- Turquoise Parrot.
- Grey-crowned Babbler.
- Speckled Warbler.
- Greater Long-eared Bat.

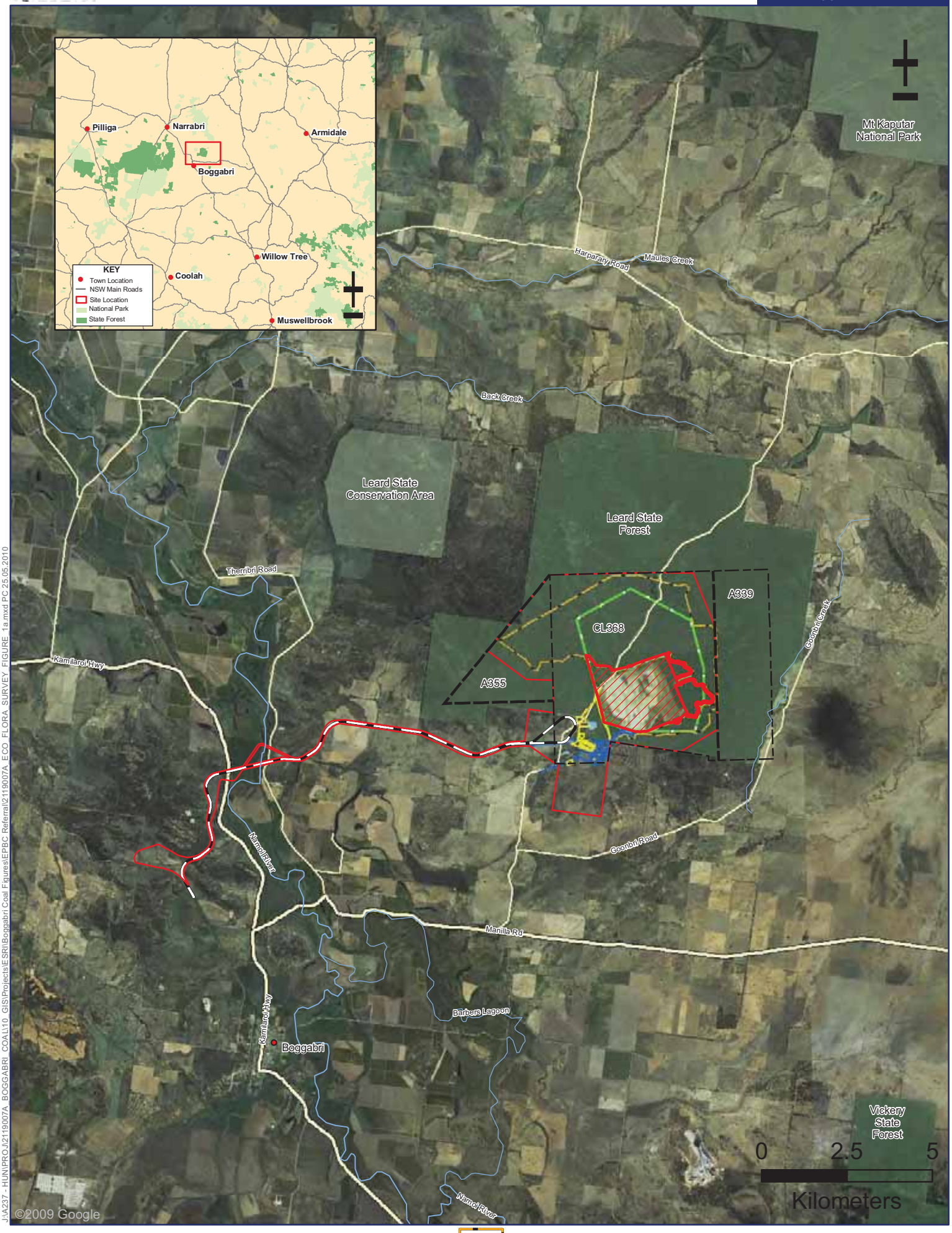
- Yellow-bellied Sheathtail Bat.
- Black-chinned Honeyeater.

1.2 Project details

Boggabri Coal is proposing to apply for approval to continue its open cut mining operations for a further 21 years. Project Approval is sought under Part 3A of the EP&A Act to gain a single, contemporary planning approval for the continuation of its mining operations within the Project Boundary (the Project).

The Project generally comprises the following:

- Continuation of mining operations via open cut methods to extract up to 7 Mtpa product coal to the Merriown seam.
- Open cut mining fleet including excavators and fleet of haul trucks, dozers, graders, water carts and other equipment with the flexibility to introduce a dragline as required utilising up to 500 employees.
- Modifications to existing and continuation of approved (but not yet constructed) infrastructure including:
  - Coal Handling and Preparation Plant (CPP).
  - Modifications to existing site infrastructure capacities including: Run of Mine (ROM) coal hopper, second crusher, stockpile area, coal loading facilities, water management and irrigation system.
  - Rail loop and 17 km rail line across the Namoi River and flood plain including overpasses across the Kamilaroi Highway, Therribri Road and Namoi River.
  - Minor widening of the existing coal haul road including overpasses across the Kamilaroi Highway, Therribri Road and Namoi River.
  - Upgrading and relocating site facilities including offices, car parking and maintenance sheds as and when required.
- Closing a section of Leard Forest Road.
- Upgrading the power supply capacity to 132 kilovolt (kV) high voltage lines suitable for dragline operations.



Town Location
Existing Infrastructure to 2011
Proposed New Infrastructure
Proposed Rail Loop
Namoi River
Project Boundary
Mine Tenements
Mine Disturbance to 2011
Proposed Disturbance Limit (Boggabri Extension)
EIS Mine Disturbance (Boggabri Existing)
Sediment Dam

Figure 1- Locality Plan

1.3 Legislative context

The Project will be assessed under Part 3A of the EP&A Act. Assessment under Part 3A is used for major Projects or Projects that are of state significance. Assessment of biodiversity and Threatened species under Part 3A planning process require consideration of Project Specific Director General Requirements and consideration of the draft *Guidelines for Threatened Species Assessment under Part 3A* (Department of Environment and Conservation 2005). These Guidelines state that the objective of the assessment process under Part 3A is to provide information to enable decision-makers to ensure that developments deliver the following environmental outcomes:

1. Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation).
2. Conserve biological diversity and promote ecologically sustainable development.
3. Protect areas of high conservation value (including areas of Critical Habitat).
4. Prevent the extinction of Threatened species.
5. Protect the long-term viability of local populations of a species, population or ecological community.
6. Protect aspects of the environment that are Matters of National Environmental Significance.

Further NSW legislation and planning policies relevant to the protection of biodiversity include:

- *Threatened Species Conservation Act 1995* (TSC Act).
- *Fisheries Management Act 1994* (FM Act).
- *National Parks and Wildlife Act 1974* (NP&W Act).
- *Water Management Act 2000*.
- *The Brigalow and Nandewar Community Conservation Area Act 2005* (BNC Act).
- *Brigalow and Nandewar Western Regional Assessments* (WRA).
- *State Environmental Planning Policy No 44 – Koala Habitat Protection.*

Although licences and approvals under these and other state Acts and policies are not required in addition to approval under Part 3A of the EP&A, consideration is required to the intent of these Acts.

The Commonwealth EPBC Act applies to the Project. Under the EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on matters of national environmental significance.

Under a bilateral agreement SEWPAC have accredited the NSW Part 3A assessment process, which DoP are using to assess the Project. The Commonwealth Minister for the Environment will utilise this process to make a determination for the Project.

1.4 Scope of report

The Director-General's environmental assessment requirements (DGRs 2009) for the Project (reference: MP09_0182) indicate that the assessment should consider biodiversity, including but not limited to:

- Measures taken to avoid impacts on biodiversity.
- Accurate estimates of vegetation clearing associated with the Project (including vegetation clearing undertaken or proposed to be undertaken under the current consent).

- A detailed assessment of the impacts of the Project on:
  - White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grassland and any other critically endangered ecological communities listed under the EPBC Act which may be impacted by the Project.
  - Weeping Myall Woodland and any other endangered ecological community listed under the EPBC Act which may be impacted by the Project.
  - Other threatened species, populations or ecological communities; critical habitats (including riparian habitat); and native vegetation generally.
  - And regionally significant remnant vegetation, or vegetation corridors.
- An offset strategy to ensure the Project maintains or improves the biodiversity values of the region in the medium to long term (in accordance with NSW and Federal policies).
- Native vegetation loss; weed infestation; habitat fragmentation; impacts to wildlife corridors including riparian corridors; and impacts to groundwater dependent communities, riparian and aquatic habitat.

With these objectives in mind, the aims of this Technical Report are to:

- Determine and describe the characteristics and condition of the vegetation communities and flora and fauna habitats within the Project Boundary.
- Determine the occurrence, or likelihood of occurrence, of Threatened species, populations and communities (biodiversity) listed under the TSC Act, FM Act and EPBC Act within the Project Boundary.
- Quantify the impacts of the Project on any threatened species, populations and communities identified.
- Undertake significance assessments for Threatened biodiversity that occur or have potential habitat within the Project Boundary to be impacted.
- Propose amelioration measures to mitigate impacts on the ecological values of the Project Boundary.

1.5 Structure of technical report

The structure and content of this Technical Report is as follows:

- Chapter 2 details the desk-based and field methods used in surveying the current environment.
- Chapter 3 describes the area within the Project Boundary and locality in terms of the existing environment, including vegetation communities, terrestrial and aquatic flora and fauna habitats and fauna, based on the results of the desk-based and field assessments.
- Chapter 4 describes the Threatened biodiversity and other species of conservation concern likely to occur within the Project Boundary based on those found within the vicinity of the Project and the nature of the habitats within the existing environment.
- Chapter 5 describes the potential impacts of the Project on the biological environment, including loss of vegetation and habitats and impacts on Threatened species.
- Chapter 6 describes mitigation measures recommended to be incorporated into the final design and construction program.
- Chapter 7 summarises the assessment of significance of the potential impacts following the requirements of the *EP&A Act 1979* (draft Guidelines for Threatened Species Assessment under Part 3A of the *EP&A Act 1979*) and the EPBC Act.

  Chapter 8 presents conclusions and recommendations.

2. Methods

This chapter details the desk-based and field methods used in surveying the current environment as well as the methods used to assess the significance of impacts.

2.1 Survey definitions

For the purpose of this report the following definitions apply:

- **Subject Site** – The extent of the Projects impacts. This includes the area of proposed disturbance in 'Boggabri Extension', remaining areas of proposed disturbance within 'Boggabri Existing', the proposed site infrastructure and rail loop, haulage corridor (Figure 1-1).
- **Project Boundary** – The subject site and adjoining areas within the Project Boundary and additionally areas of Leard State Forest not directly affected by the Project.
- **Region -** A bioregion defined in a national system of bioregionalisation. For this study this is the Brigalow Belt South, Namoi sub-region as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).

Location information for the Project is outlined in Table 2-1.

Table 2-1 Project location

Location information	Project Boundary
Bioregion	Brigalow Belt South, Namoi sub-region (Thackway & Cresswell 1995)
Local government area	Narrabri
Catchment Management Authority (CMA), subregion	Namoi CMA, Maules sub-catchment
Mitchell landscape	Bugaldie Uplands and Liverpool Plains landscape

2.2 Nomenclature

Names of plants used in this document follow Harden (Royal Botanic Gardens 2008, 2009) with updates from PlantNet (Department of Environment Climate Change 2009b). Scientific names are used in this report for species of plant. Scientific and common names are provided in plant lists in Appendix A and C.

Names of vegetation communities used in this report are based on those described by (Benson 2006), Planning NSW (2004), Wall (2004), for the BioBanking Vegetation Type Database (1990). They provide dominant species and structure of the community generally consistent with the methodology of Walker (Planning NSW 2004). Corresponding vegetation community types are also provided for the existing broad scale regional vegetation classification of the Brigalow Belt South (Department of Land and Water Conservation 2002a) and Leard State Forest (James B. Croft and Associates 1983), or Threatened community listings under the TSC Act and/or the EPBC Act (Department of the Environment Water Heritage and the Arts 2008a).

Names of vertebrates used in this document follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of the Environment, Water, Heritage and the Arts (Department of Environment and Climate Change 2008c, 2008b, 2009a) and as used in the Atlas of NSW Wildlife (Department of Environment and Climate Change 2009c). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendix B and D.

2.3 Contributors and qualifications

The contributors to the preparation of this report, their qualifications and roles are listed in Table 2-2.

Table 2-2 Contributors and their roles

Name	Qualification	Role
Alex Cockerill	BSc (Hons)	Botanist/Project Manager – biodiversity lead, field surveys and report preparation
Martin Predavec	BSc (Hons) PhD	Ecologist – technical review
Nathan Cooper	BEnvSc	Zoologist – field surveys and report preparation
Rob Gration	MWildMgt	Zoologist – field surveys and bat call identification
Josie Stokes	BSc (Hons)	Zoologist – field surveys
Debbie Landenberger	BSc (Hons)	Botanist – field surveys and report preparation
Lukas Clews	BSc MSc	Botanist – field surveys
Ben Jenner	BEnvSc (Hons)	Ecologist – field surveys
Haley Bates	BEnvSc	Environmental Scientist – field surveys
Joshua Robl	Technical Officer	GIS Operator – mapping
Dan Roberts	BSc (Hons), PhD	Aquatic Ecologist – field surveys and report preparation
Sharon Cummins	BSc (Hons), PhD	Aquatic Ecologist – invertebrate identification and report preparation
Shane Murray	BSc	Aquatic Ecologist – field survey
Nick Roberts	–	Aquatic Ecologist – field survey
Barbara Triggs – Dead Finish	–	Scat analysis
Royal Botanic Gardens, Sydney	–	Plant specimen identification

All work was carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the National Parks and Wildlife Regulations 2002 and Section 132C of the NP&W Act, and an Animal Research Authority issued by the Department of Primary Industries (Agriculture).

2.4 Literature and database review

2.4.1 Databases

Records of Threatened plants and animals recorded previously, or predicted to occur, in the Project locality or region, were obtained from various databases as detailed in Table 2-3. Where database searches revealed few records within the locality (10 km) searches were expanded to a 20 km radius. This was considered appropriate given the relative homogeneity of vegetation and fauna habitats within the region. The results of these database searches are presented in Appendix C and D.

Table 2-3 Databases searched for records of Threatened species

Database	Search date	Area searched	Reference
BioBanking Threatened Species Database	June 2009	Namoi CMA.	(Department of Environment and Climate Change 2009c)
Atlas of NSW Wildlife	20 April 2009	20 km buffer around the central point of the subject site.	(Department of Environment and Climate Change 2008b, 2009a)
Threatened species, populations and communities database	20 April 2009	Namoi Management Authority area, Liverpool Plains (Part B) CMA sub-region.	(Department of Environment and Climate Change 2009c)
Fisheries databases	20 April 2009	Namoi Management Authority area, Liverpool Plains (Part B) CMA sub-region.	(Department of Environment and Climate Change 2009b)
Bionet	20 April 2009	20 km buffer around the central point of the subject site.	(Department of Environment and Climate Change 2009b)
Birds Australia Database	17 April 2009	10 km buffer around the central point of the subject site.	Birds Australia (2008)
Protected Matters Search Tool	20 April 2009	20 km buffer around the central point of the subject site.	(Department of the Environment Water Heritage and the Arts 2009)

Note: Flora and fauna database searches were completed as a radius (generally 20 km) around the following central subject site coordinates; Easting: 227232 Northing: 6610892 UTM MGA56.

2.4.2 Previous surveys and assessment

Further records of Threatened biodiversity were obtained from various literature sources that are cited throughout this document. Of particular relevance to this technical paper are the previous ecological studies completed within the Project Boundary by (James B. Croft and Associates 1983) for the original Boggabri Coal Mine EIS and (Pennay, Michael 2001) for the Brigalow Belt South Conservation Assessments.

2.5 Terrestrial Field survey

Terrestrial surveys within the Project Boundary were carried out over five sessions covering all seasons (Table 2-4). The surveys sought primarily to assess the extent and condition of vegetation communities and potential flora and fauna habitat, with particular consideration given to species of conservation concern, such as Threatened and Migratory species or locally significant species.

Table 2-4 Field survey

Survey season	Survey dates
Summer	8-12 December 2008 19-30 January 2009
Autumn	24 March-3 April 2009
Winter	15-24 June 2009
Spring	17-25 September 2009

Survey effort and design considered the *Draft Survey Guidelines for Fauna Surveys in the Western Zone of New South Wales* (Ellis, M. 1998; Ellis, W. A. *et al.* 2000) and the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (*Working Draft*) (Department of Environment and Conservation 2004). Additionally, survey using a systematic grid-based Koala assessment in accordance with Biolink (Biolink ecological consultants 2009) was also completed. Details are presented in Sections 2.5.2 to 2.5.4 below.

2.5.1 Weather conditions

Weather conditions during field surveys were generally warm and dry (Appendix H). Initial summer surveys conducted in December 2008 followed a period of significant rainfall during late November, with weather conditions experienced during this survey period being warm and relatively dry. The second summer survey period conducted in January 2009 followed a period of hot dry weather. The survey period was hot and dry and included three days of moderate rainfall. Autumn surveys completed in late March/early April 2009, were undertaken during, and followed a period of warm dry weather, with the last three days of the survey period experiencing moderate to heavy rainfall. Winter survey, undertaken in June 2009, was completed following a period of light rainfall, with the survey period experiencing mild and relatively dry conditions. One day during the winter surveys experienced moderate rainfall. Spring surveys, conducted in September 2009, followed slight to moderate rainfall, with the survey period experiencing warm, dry and at times gusty weather conditions. Two days during the survey period experienced slight rainfall.

2.5.2 Terrestrial flora

Review of existing vegetation mapping and analysis of aerial photography

Vegetation within the Project Boundary and study area has been mapped previously at both a scale of 1:10,000 (James B. Croft and Associates 1983) and a scale of 1:50,000 (Department of Land and Water Conservation 2002a). While these studies provided useful information on the broad vegetation types within the locality and region, neither study covered the entire Project Boundary or was considered of a sufficiently high resolution.

The analysis of aerial photographs dated 3 May 2005 (Department of Lands, film number – 4909) identified past land use practices, disturbance and native vegetation regrowth, changes in vegetation structure and some key floristics throughout the Project Boundary. This provided a further split of vegetation into simple structural and disturbance classifications and provided for broad vegetation classification on parts of the Project Boundary not mapped by the previous studies.

The initial stratification of the sites vegetation communities for the detailed site specific surveys was based on the modification of the previously mapped vegetation communities, consideration of other relevant environmental layers (i.e. topography, geology) and findings of the aerial-photograph analysis.

Condition of vegetation communities

The vegetation condition was assessed using parameters such as intactness, diversity, history of disturbance, regeneration potential, weed invasion and health. Four condition scores, adapted from the Biometric Assessment Manual (2005) and Davidson et al. (NSW Department of Environment and Climate Change 2008), were used to summarise vegetation within the Project Boundary.

The four categories used to describe the condition of vegetation communities are summarised in Table 2-5.

Table 2-5 Vegetation condition categories

Condition class	General description	Exotic understorey % cover	Regeneration potential
Good	Vegetation that still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers.	<50% exotic species cover.	Multi-age recruitment of all observed canopy species present.
Moderate	Vegetation that generally still retains its structural integrity, but has been disturbed and has lost some components of its original species complement. Weed invasion can be significant in such remnants.	50-90% exotic species cover.	Recruitment of canopy species present.
Poor	Vegetation that has lost most of its species and is significantly modified structurally. Often such areas now have a discontinuous canopy of the original tree cover and very few shrubs. Exotic species, such as introduced pasture grasses or weeds, have replaced much of the indigenous ground cover. Environmental weeds are often co-dominant with the original indigenous species.	50-90% exotic species cover.	No recruitment of canopy.
Very poor	This vegetation exhibits the same high levels of disturbance exotic understorey composition as the 'poor 'condition vegetation; however the canopy cover has undergone significant further reductions. This condition class corresponds directly with 'low condition' vegetation, as defined by the BioMetric (version 2.0) (NSW Department of Environment and Climate Change 2008) for woody vegetation: *The over-storey percent foliage cover is <25% of the lower value of the over-storey percent foliage cover benchmark for that vegetation type* *AND* *<50% of vegetation in the ground layer is indigenous species or >90% is ploughed or fallow.*	<50% of vegetation cover In the ground layer is indigenous species or >90% is ploughed or fallow.	No recruitment of canopy.

Vegetation surveys

The floristic diversity and possible presence of Threatened species was assessed using a combination of random meander and plot-based 09 surveys in accordance with the Threatened *Biodiversity Survey and Assessment: Guidelines for Developments and Activities ts NSW* (Department of Environment and Conservation 2004).

Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (Cropper 1993), whereby the recorder walks in a random manner throughout the site recording all species observed, boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

The number of vegetation quadrats surveyed in the Project Boundary was initially determined in accordance with the suggested minimum survey effort specified by the *Threatened Biodiversity Survey and Assessment Guidelines* (Department of Environment and Conservation 2004) (Table 2-6).

Table 2-6 Suggested survey technique and effort for plant quadrats

Survey technique	Suggested minimum effort per stratification unit	Information recorded
Quadrat	1 quadrat for areas less than 2 ha	Floristics, structure, Threatened species
	2 quadrat for area 2-50 ha	
	3 quadrats for areas 51-250 ha	
	5 quadrats for areas 251-500 ha	
	10 quadrats for areas 501-1,000 ha, plus one additional quadrat for each extra 100 ha thereof	

Source: *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (James B. Croft and Associates 1983).

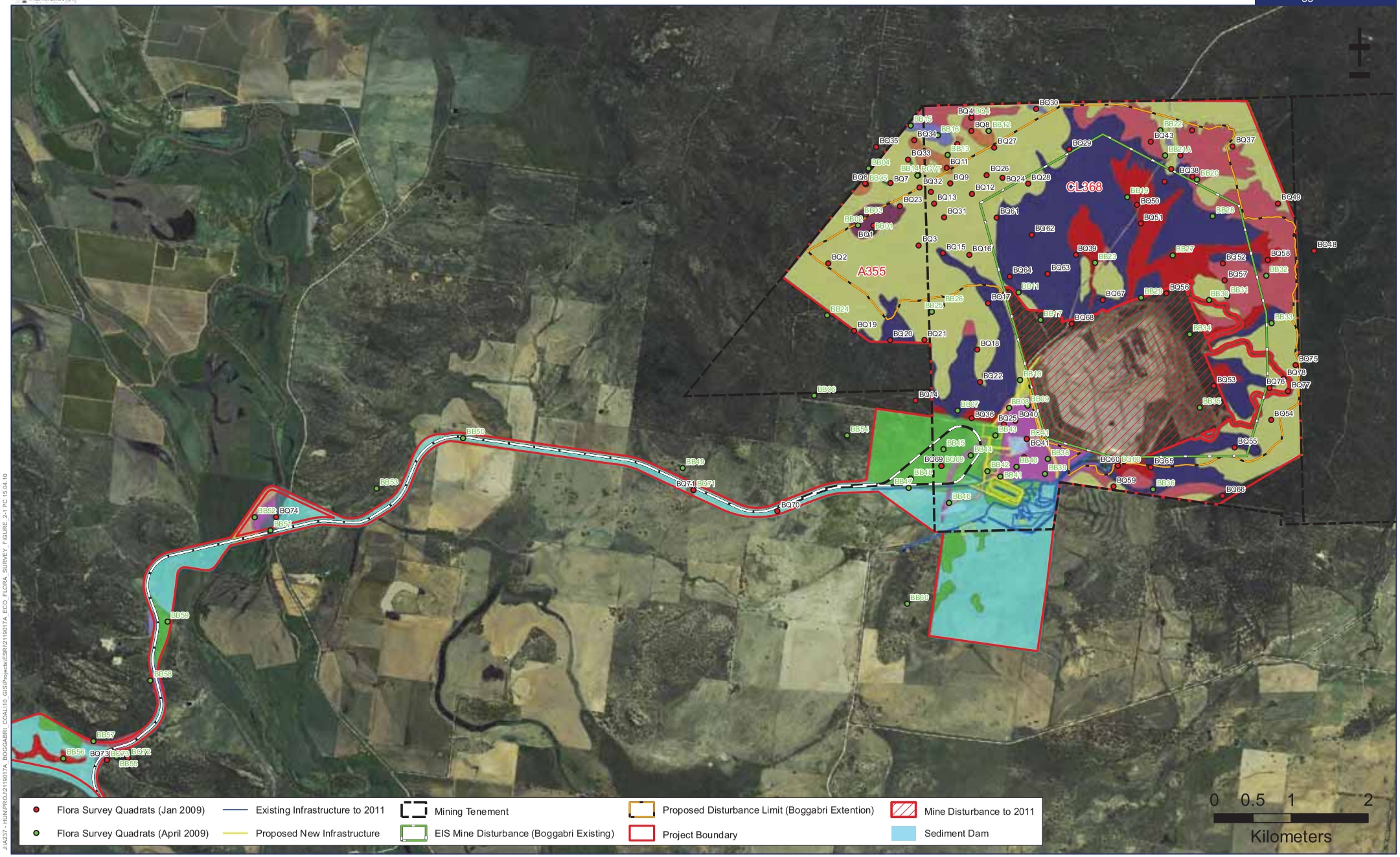
Stratification of the site for flora survey effort was initially based on distinct vegetation communities identified by Aerial Photograph Interpretation and the existing vegetation mapping (James B. Croft and Associates 1983) and (Department of Land and Water Conservation 2002a). To assist with potential future offsetting calculations and to provide detailed condition information, additional vegetation quadrats were sampled within the Project Boundary in April. This vegetation sampling was completed in accordance with the Biometric (version 2.0) field methodology (Department of Environment Climate Change 2009a) and (NSW Department of Environment and Climate Change 2008).

A summary of the quadrats sampled per vegetation stratification unit is provided in Table 2-7. The locations of quadrats are shown in Figure 2-1.

Table 2-7 Stratification units and number of quadrats surveyed

Stratification unit	Area within Project Boundary (hectare)	Suggested minimum effort per stratification unit[1]	Number of quadrats surveyed
Yellow Box – Blakely's Red Gum grassy woodland	17.5	2	4
White Box – White Cypress Pine grassy woodland	216.2	3	13
White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest	651.4	10	25
Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland	86.4	3	10
Weeping Myall grassy open woodland	1.5	1	1
White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest	263.9	5	12
Narrow-leaved Ironbark – White Cypress Pine shrubby open forest	955.3	10	35
Silver-leaved Ironbark heathy woodland	21.1	2	5
Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest	20.8	2	4
Dwyer's Red Gum woodland	21.7	2	7
Native Olive dry gully forest	0.8	1	2
River Red Gum riparian woodlands and forests	9	2	2
White Box – Blakely's Red Gum – Melaleuca riparian forest	0.8	1	2
Derived native grassland	178.4	3	8
Plains grassland	1	1	2
Exotic grassland	315.4	5	2
Total	**2,761**	**51**	**134**

Note: 1 – Suggested minimum effort per stratification unit as per the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (Department of Environment and Conservation 2004).



Identified Vegetation Communites within study area

- Silver-leaved Ironbark heathy woodland
- Derived native grassland
- Dwyer's Red Gum woodland
- Exotic grassland
- Narrow-leaved Ironbark - Brown Bloodwood -White Cypress Pine shrubby open forest
- Narrow-leaved Ironbark - White Cypress Pine shrubby open forest
- Native Olive dry gully forest
- Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland
- Plains Grassland
- River Red Gum riparian woodlands and forests
- Weeping Myall grassy open woodland
- White Box – Narrow-leaved Ironbark - White Cypress Pine grassy open forest
- White Box – Narrow-leaved Ironbark - White Cypress Pine shrubby open forest
- White Box – White Cypress Pine grassy woodland
- White Box- Blakely's Red Gum - Melaleuca riparian forest
- Yellow Box - Blakely's Red Gum grassy woodland

Figure 2-1 - Location of Flora Quadrats

The following information was recorded for each 400 m^2 quadrat sampled:

- location (easting–northing grid type WGS 84, Zone 55)
- stratification
- canopy regeneration
- dominant canopy species
- condition
- hollow bearing trees (number and hollow size)
- length of fallen timber
- all species observed
- cover abundance of each species.

The cover abundance estimate was based on a modified Braun-Blanquet 1-6 scale assigned to each vascular plant species recorded. The cover abundance values for each 1-6 classes are provided in Table 2-8.

Table 2-8 Cover abundance scale 1-6

Class	Cover abundance
1	Less than 5% – Sparse 1 individual
2	Less than 5% – More than 1 individual
3	5-25%
4	26-50%
5	51-75%
6	76-100%

This sampling also involved collation of detailed structural information on percent foliage cover within each for the following layers:

- canopy
- mid – storey
- groundcover – grasses
- groundcover – shrubs
- groundcover – other
- exotic cover.

Identification of Box-Gum Woodlands

'Box-Gum Woodlands' is terminology used within this report to describe vegetation communities corresponding with the Threatened ecological community, White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland listed as critically endangered under the EPBC Act and White Box, Yellow Box, Blakely's Red Gum Woodland listed as an Endangered Ecological Community under the TSC Act.

These listings largely cover the same ecological communities; however, there are slight differences relating to the determination of the size and condition of remnant patches. The differences in the two listings and the identification methods used to determine Box-Gum Woodlands within this report are described in detail in Appendix I.

Targeted floral survey

Targeted searches were completed for Threatened species considered to have a moderate or higher likelihood of occurrence within the Project Boundary based on findings of the previous preliminary assessments, database reviews and desktop assessments (Appendix C). Targeted surveys consisted of random meanders within the preferred habitat types throughout the Project Boundary. Species targeted specifically by the surveys are listed in Table 2-9.

Table 2-9 Threatened flora species targeted for survey

Species	Status	Habitat	Survey
Digitaria porrecta[#]	Endangered (EPBC Act) Endangered (TSC Act)	In NSW it occurs in north western slopes and north western plains subdivisions (Royal Botanic Gardens 2009) where it grows in native grassland, woodlands or open forest with a grassy understorey, on richer soils. It is often found along roadsides and travelling stock routes where there is light grazing and occasional fire.	Random meander and plot-based 20 surveys were completed throughout the following vegetation communities: ▪ Yellow Box – Blakely's Red Gum grassy woodland. ▪ White Box – White Cypress Pine grassy woodland. ▪ White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest. ▪ Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland. ▪ Weeping Myall grassy open woodland. ▪ River Red Gum riparian woodlands and forests. ▪ White Box – Blakely's Red Gum – Melaleuca riparian forest. ▪ Derived native grassland. ▪ Plains grassland.
Diuris tricolor[#]	Vulnerable (EPBC Act) Vulnerable (TSC Act)	Grows in sclerophyll forest among grass, often with Callitris (Royal Botanic Gardens 2009) or in grassy Callitris woodland (Bishop 2000). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Soils include gritty orange-brown loam on granite, shallow red loamy sand on stony porphyry, skeletal lateritic soil and alluvial grey silty loam. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats (NSW Scientific Committee 2007).	An initial survey of a known reference site was completed to confirm the species was flowering (September 2009). The species was specifically targeted during its known flowering period using parallel transects and random meanders through the following vegetation communities: ▪ Yellow Box – Blakely's Red Gum grassy woodland. ▪ White Box – White Cypress Pine grassy woodland. ▪ White Box – Narrow-leaved Ironbark – White

Species	Status	Habitat	Survey
			Cypress Pine grassy open forest. ▪ White Box – Narrow-leaved Ironbark – White Cypress Pine Shrubby open forest. ▪ Silver-leaved Ironbark heathy woodland. ▪ Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland. ▪ Weeping Myall grassy open woodland. ▪ Derived native grassland. ▪ Narrow-leaved Ironbark – White Cypress Pine shrubby open forest.
Cadellia pentastylis	Endangered (EPBC Act) Endangered (TSC Act)	Occurs west of Tenterfield and north from Terry Hie Hie (Royal Botanic Gardens 2005). Grows mainly in vine thickets or dry rainforest, and more rarely occurs in woodlands. It is a relict rainforest species and tends to favour upper and mid slope positions, often with a northerly aspect. It commonly occurs on sandy-loam to clay soils of low to medium fertility. It can occur in pure stands or in a mixed community on the slopes of residual sandstone ranges and scarps (NSW National Parks and Wildlife Service 2006).	Random meander and plot-based (quadrat) surveys were completed throughout the following vegetation communities: ▪ Native Olive dry gully forest. ▪ Narrow-leaved Ironbark – White Cypress Pine shrubby open forest.

Note: # – This species has been identified for potential delisting under the EPBC Act.

2.5.3 Terrestrial fauna

Habitat mapping

Fauna habitat assessment was based on vegetation mapping. Habitats were delineated by grouping vegetation communities according to their structure, geomorphological characteristics and/or moisture regimes (i.e. characteristics that determine the type of fauna likely to use them).

Condition of terrestrial fauna habitats

Fauna habitats were assessed by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation; the structure and composition of the litter layer; and other habitat attributes important for feeding, roosting and breeding. Indirect evidence of faunal activity, such as scats, diggings and scratch marks was also recorded. The criteria used to evaluate the condition of habitat values is summarised in Table 2-10.

Table 2-10 Categories used to describe fauna habitats

Category	Description
Good	A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
Moderate	Some fauna habitat components are often missing (for example, old-growth trees, fallen timber); linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
Poor	Many fauna habitat elements in low quality remnants have been lost, including old-growth trees (for example due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

Habitat assessment

Fauna habitat assessments were undertaken in 21 locations in the Project Boundary (20 m x 50 m area). Habitat assessments aimed to collect relevant data pertinent to fauna. Features assessed at each location are described in Table 2-11. Hollow-bearing tree assessments were undertaken in a 20 m x 50 m area at each survey site, whereby all observable hollows were recorded and assigned a size class.

Table 2-11 Fauna habitat features assessed

General features	Overstorey/Hollow features	Other features	Fauna tracks/signs	If water body present
Site number	Dominant vegetation	Artificial habitat features	Koala scats	Waterbody type
Easting	Dominant overstorey species	Significant flowering events	Fauna scats	Level of permanence
Northing	Senescence in canopy (percent cover and health)	Midstorey (>2 m) cover (percent cover)	Squirrel/Sugar Glider chews	Fringing composition
Evidence of disturbance	Hollows high trunk (size and number)	Significant species for fauna (e.g. food)	Scratches and worn areas on trees	Riparian vegetation
Evidence of clearing	Hollows mid trunk (size and number)	Understorey (<2 m) cover	Potential Large Forest Owl roost trees	Condition of water body
Erosion	Hollows low trunk (size and number)	Groundcover vegetation (percent)	Miscellaneous fauna traces	
Evidence of fire	Fire scar hollows (size and number)	Groundcover leaf litter (percent)		
Epicormic growth	Limb hollows(size and number)	Fallen logs (Length)		
Other disturbance	Stags	Size of hollows in fallen logs (if any)		
		Rocks		

Systematic quantitative assessment of hollow tree resources within the Project Boundary

The majority of Threatened fauna species recorded within the Project Boundary or with potential habitat utilise hollow trees for important breeding and roosting. Therefore, a systematic, quantitative assessment of hollow tree resources was conducted to identify the type and density of hollow tree resources within the Project Boundary.

A systematic (regular) grid-based sampling protocol was completed, with 500 m sampling intervals assessed within the Project Boundary and 1,000 m sampling intervals assessed within the remaining Project Boundary (Figure 2-4). Sampling was undertaken using 20 x 50 m (Gibbons *et al.* 2008) area at each sampling point, whereby the number of hollows and sizes of hollows were recorded from all trees within the defined area. Tree hollow sizes were based on visual estimates and categorised into the following size classes:

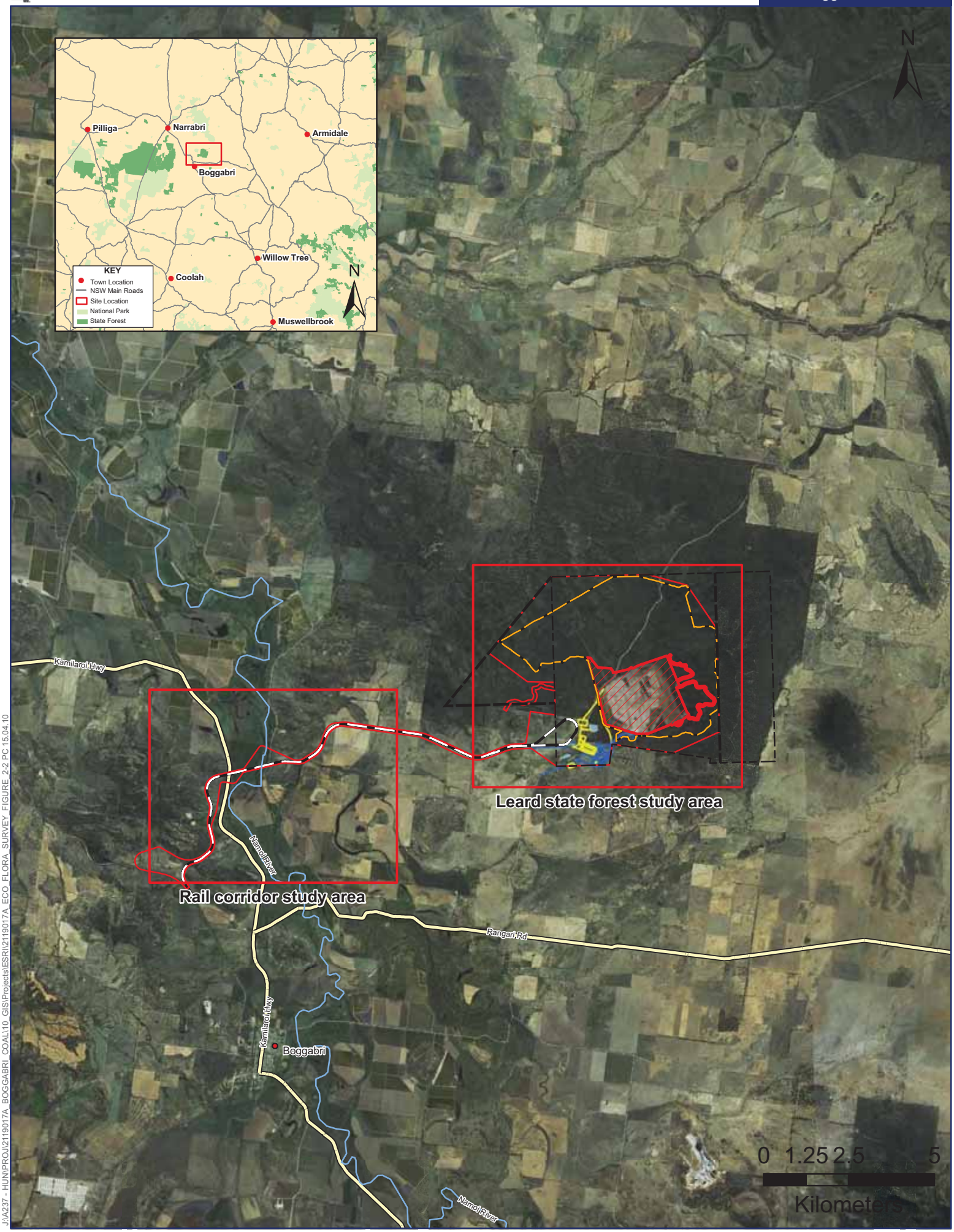
- <5 cm.
- 5-10 cm.
- 11-15 cm.
- 16-20 cm.
- 21-25 cm.
- 26-30 cm.
- >30 cm.

Hollow-bearing tree assessments were also undertaken at survey sites S1 to S18 (during habitat assessment), utilising the methodology as described above.

Vertebrate survey

Terrestrial vertebrate surveys (January, March/April and September 2009) within the Project Boundary were carried out as described below and where applicable, followed the methodology detailed in NSW Threatened Species Survey and Assessment Draft Guidelines (Working Draft) (Department of Environment and Conservation 2004). Figure 2-2 identifies the general fauna survey area, while detailed survey locations are depicted in Figures 2-3a and 2-3d. Survey sites were chosen to represent the range of different habitat types within the Project Boundary (e.g. Grassy Woodland on fertile soils) and to give a broad spatial spread and coverage. The results of the targeted surveys and observations are presented in Appendix B.

The presence of faunal species in the Project Boundary was also determined through opportunistic records throughout the survey periods, while habitat assessments were used to determine suitable habitat for Threatened species. Although recording Threatened species during field surveys can confirm their presence in an area, a lack of Threatened species does not necessarily indicate the absence of the species from the site when suitable habitat is present. By the very nature of their rarity, Threatened species are often difficult to detect. Suitable habitat is, therefore, a most important factor to consider when determining the potential presence of Threatened species.



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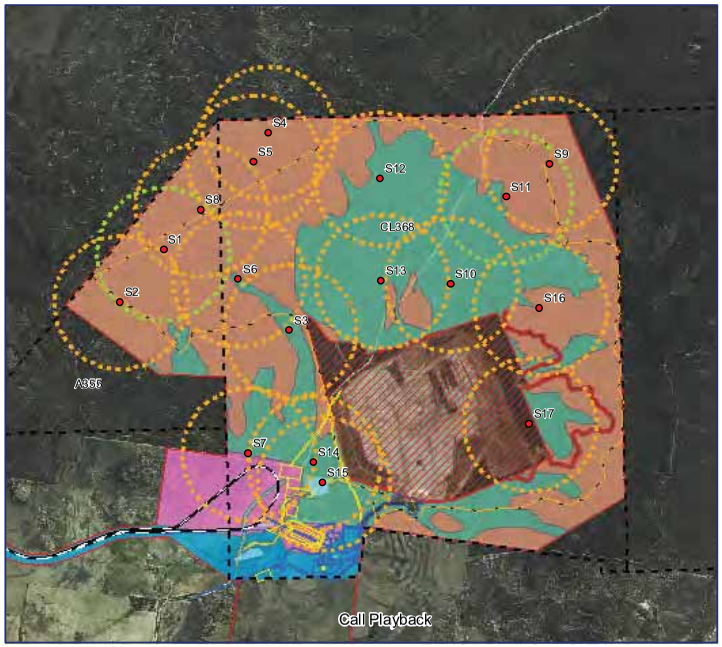
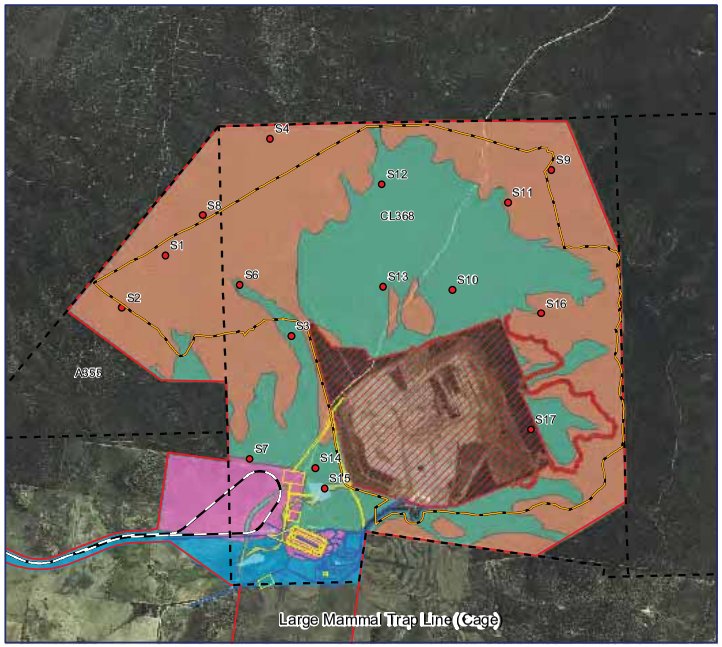
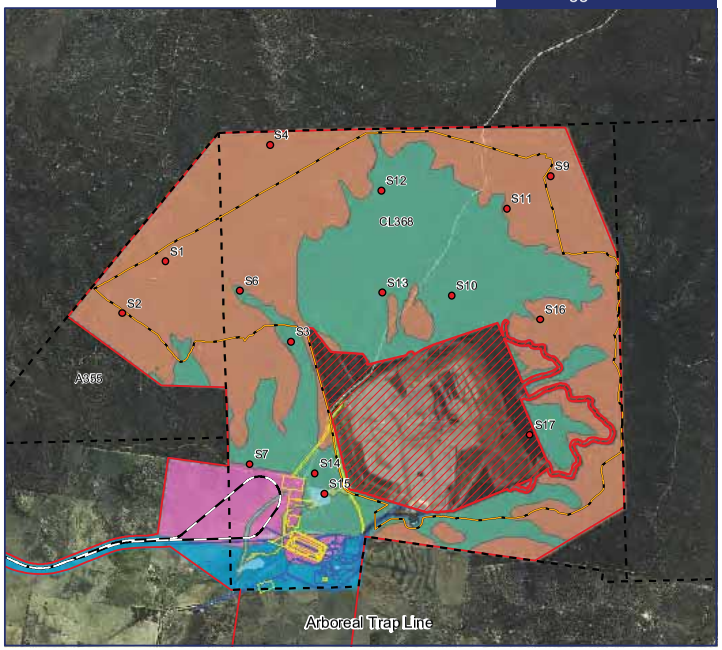
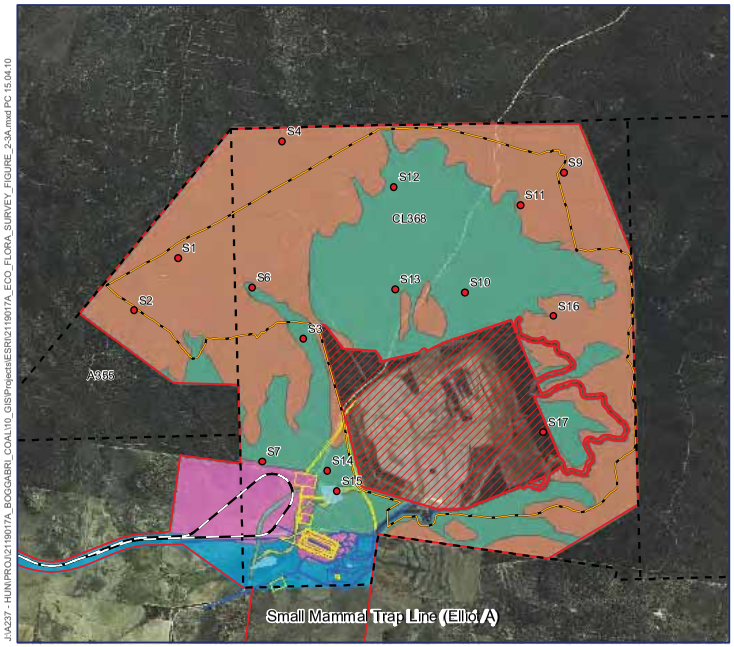
Town Location
Namoi River
Existing Infrastructure to 2011
Proposed New Infrastructure
Mine Tenement
Proposed Disturbance Limit (Boggabri Extention)
Project Boundary
Mine Disturbance to 2011
Sediment Dam

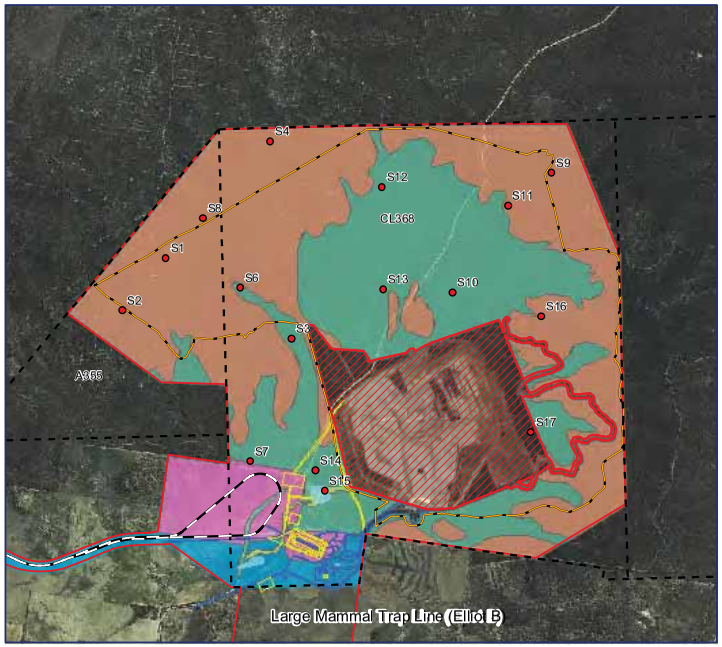
Figure 2-2 - Fauna Survey Study areas

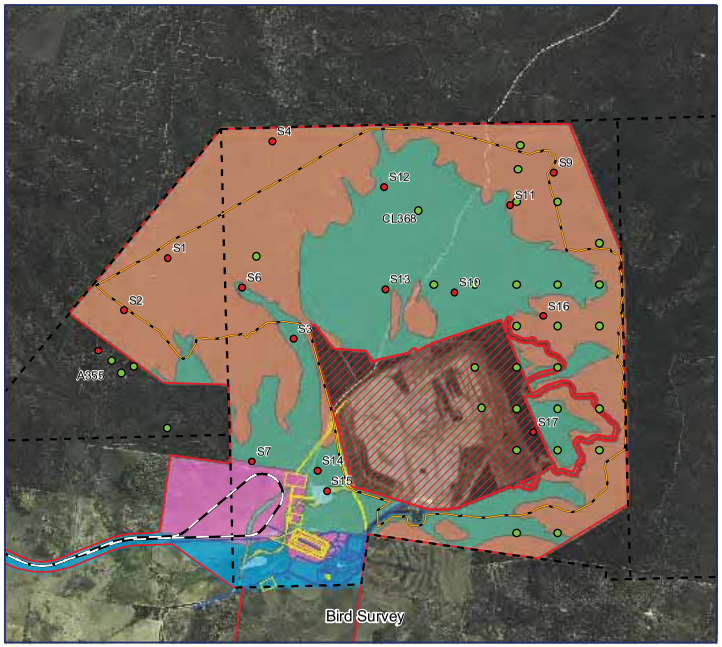












- Targeted Survey
- Survey Location
- Existing Infrastructure to 2011
- Proposed New Infrastructure
- Sediment Dam
- Extent of call playback (800m buffer)
- Targeted Masked Owl survey (extent of call playback)
- Mine Tenement
- Project Boundary
- Mine Disturbance to 2011
- Proposed Disturbance Limit (Boggabri Extention)

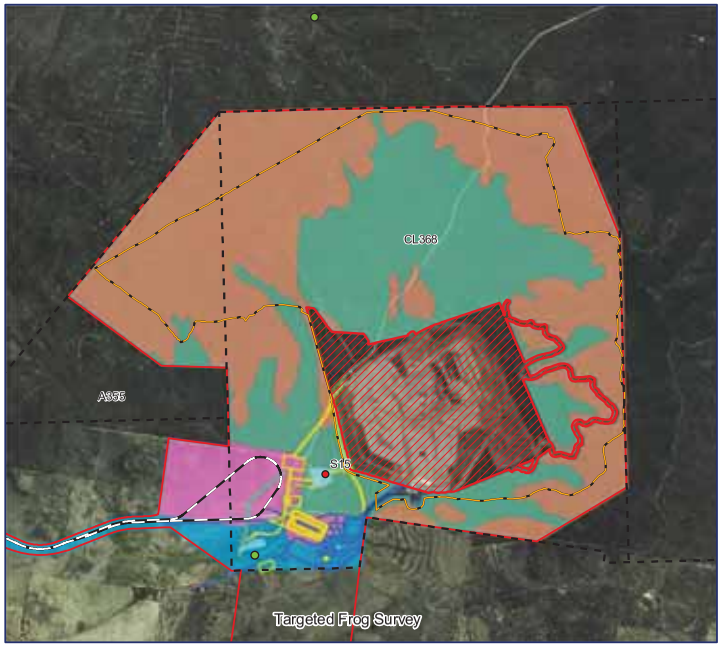
Fauna Habitat Areas

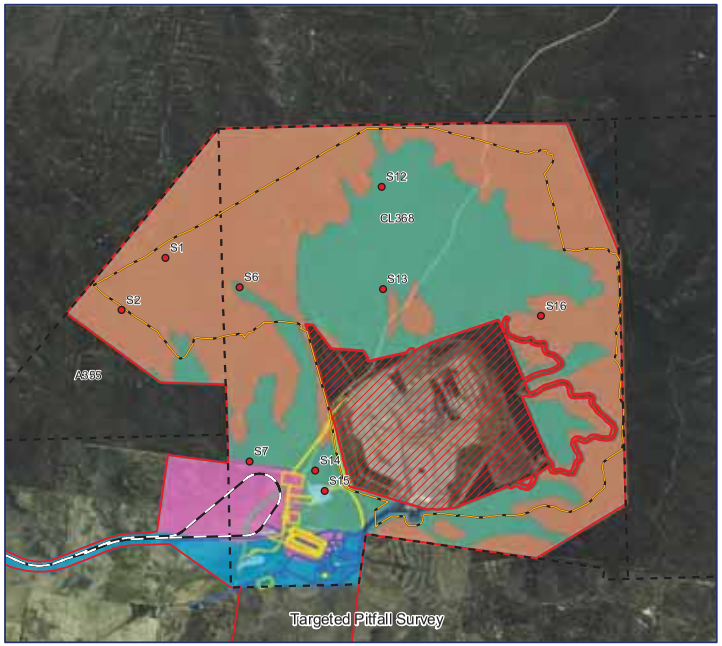
- Native Grassland
- Shrubby Woodlands/Open Forest on skeletal soils
- Riverine Woodland
- Grassy Woodlands on fertile soils
- Exotic Grassland

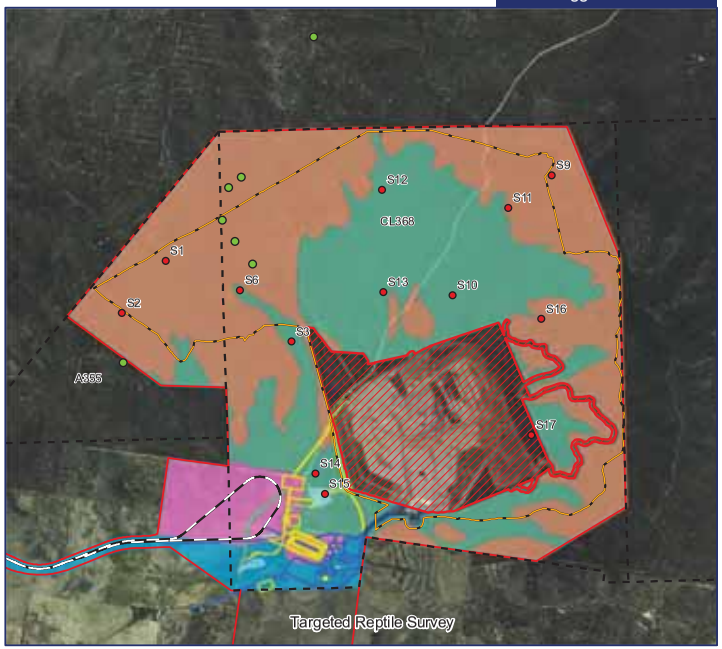
0 0.5 1 2

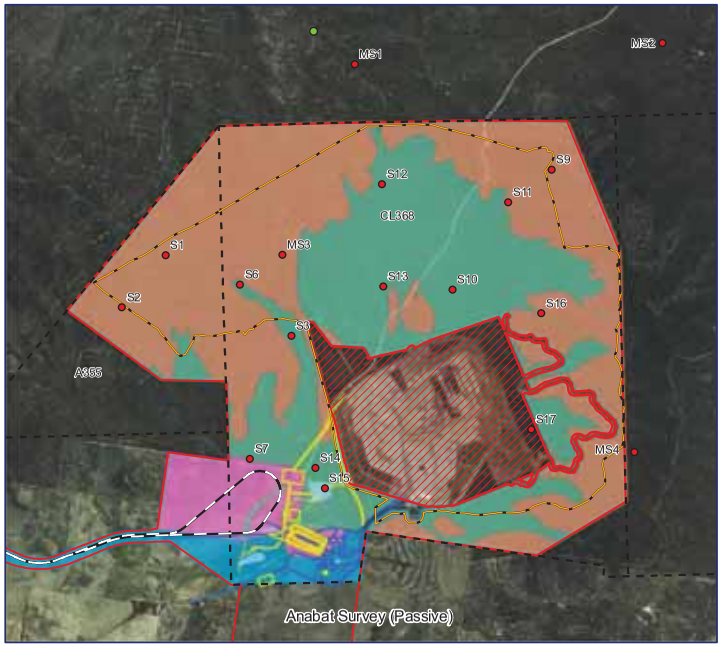
Kilometers

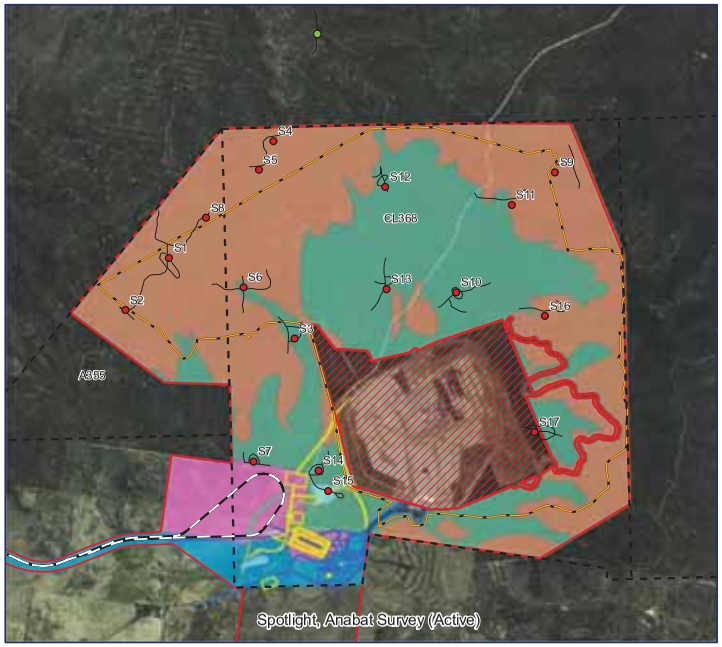
Figure 2-3A Fauna survey effort (Leard State Forest study area)











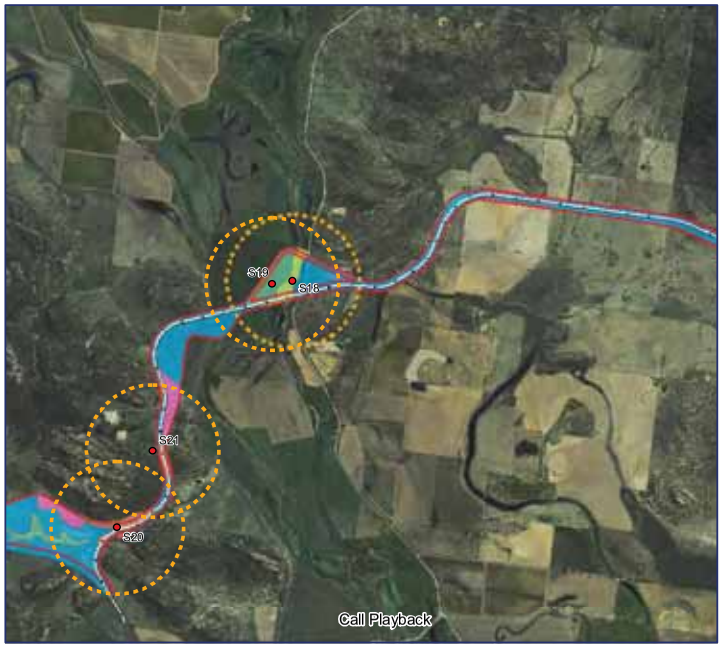
- Targeted Survey
- Survey Location
- Spotlight Transect
- Existing Infrastructure to 2011
- Proposed New Infrastructure
- Mine Tenement
- Project Boundary
- Mine Disturbance to 2011
- Proposed Disturbance Limit (Boggabri Extention)
- Sediment Dam

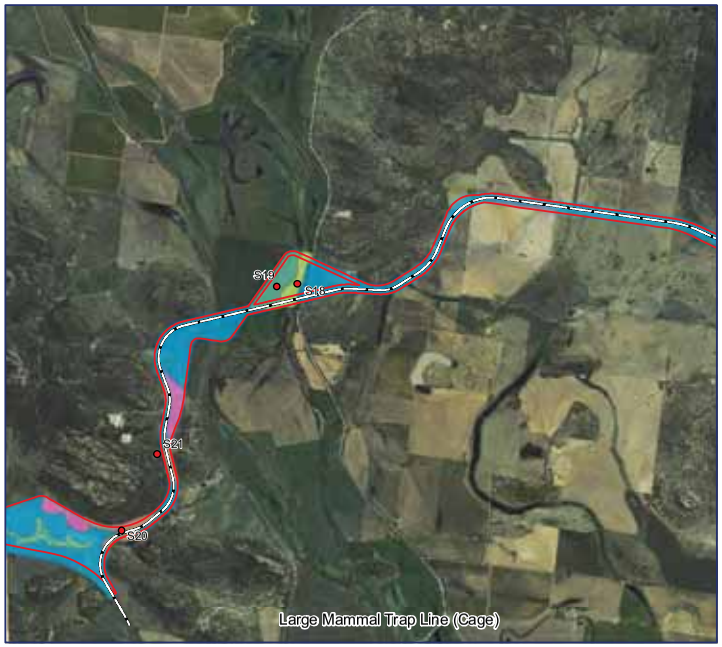
Fauna Habitat Areas

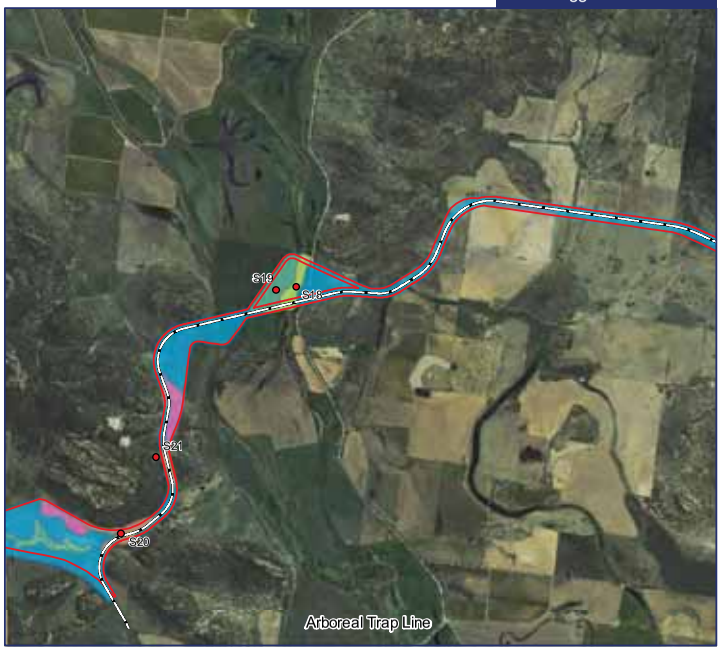
- Exotic Grassland
- Grassy Woodlands on fertile soils
- Riverine Woodland
- Shrubby Woodlands/Open Forest on skeletal soils
- Native Grassland

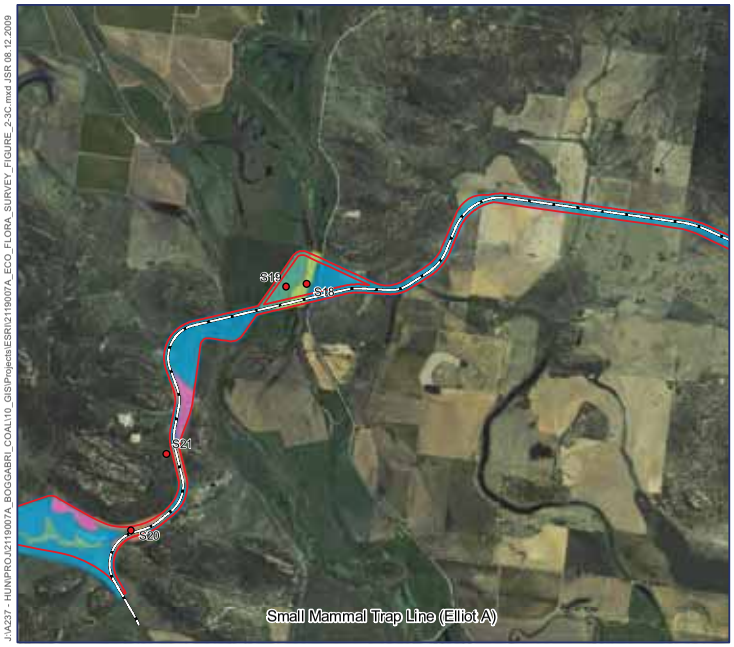
0 0.5 1 2
Kilometers

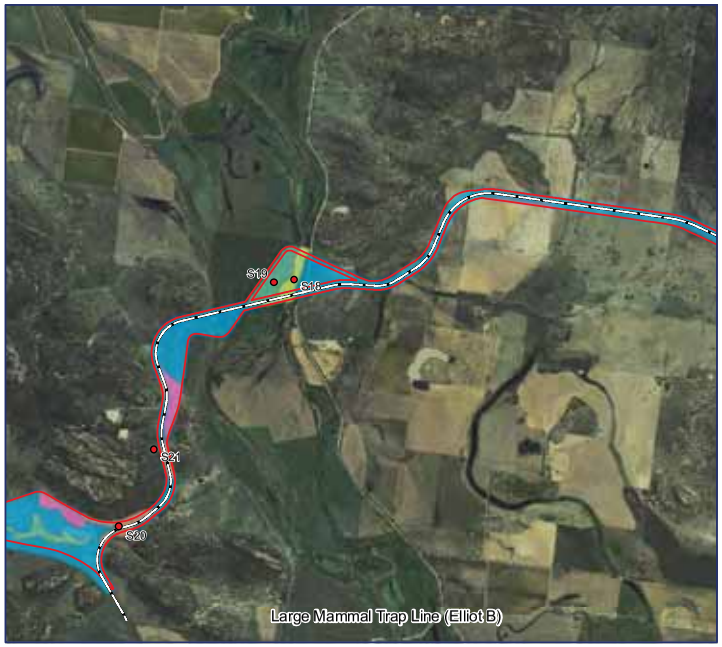
Figure 2-3B - Fauna survey effort (Leard State Forest study area)

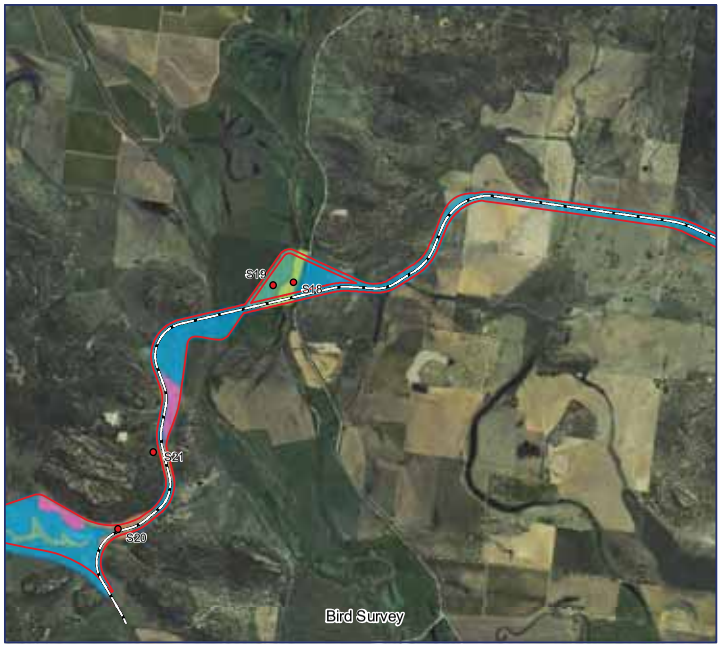












Project Boundary

Survey Location

Extent of call playback (800m buffer)

Fauna Habitat Areas

Native Grassland

Shrubby Woodlands/Open Forest on skeletal soils

Riverine Woodland

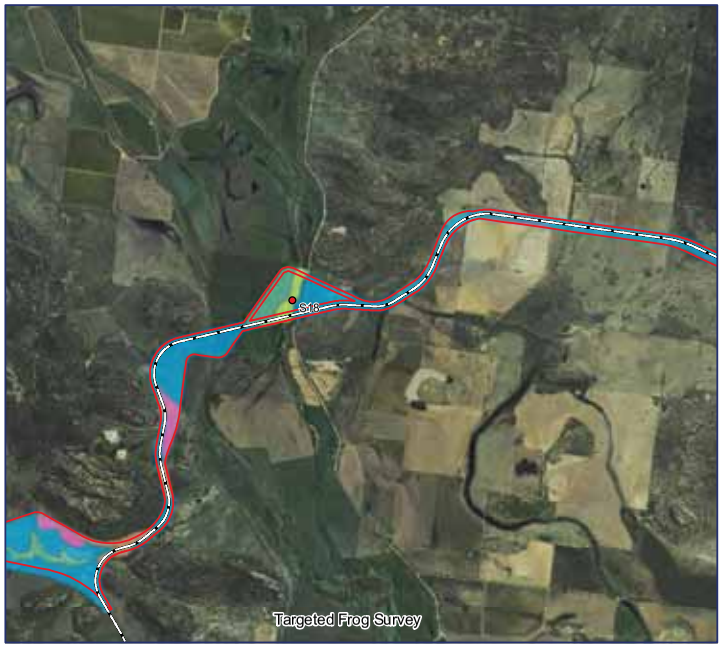
Grassy Woodlands on fertile soils

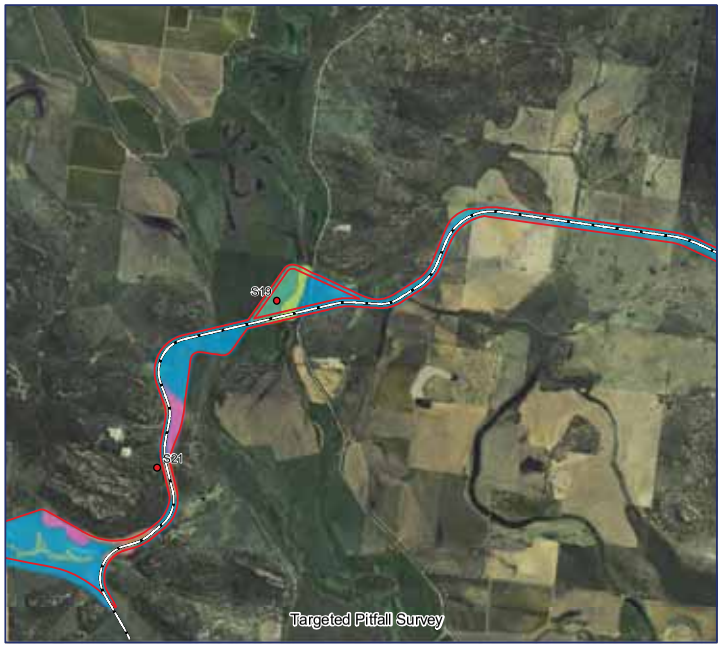
Exotic Grassland

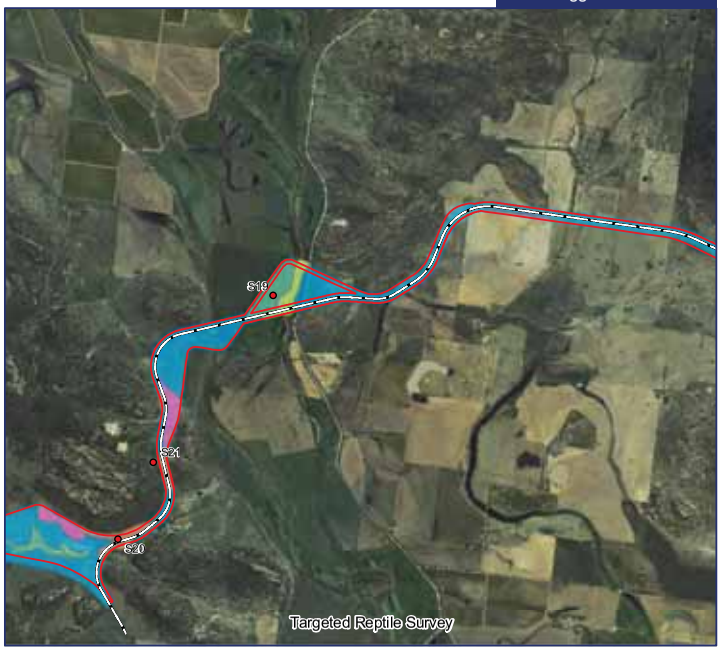
0 0.5 1 2

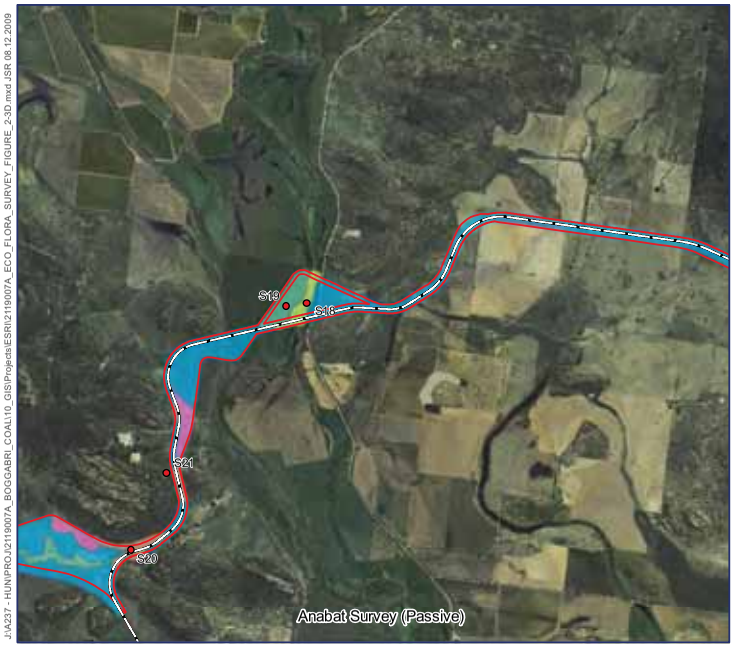
Kilometers

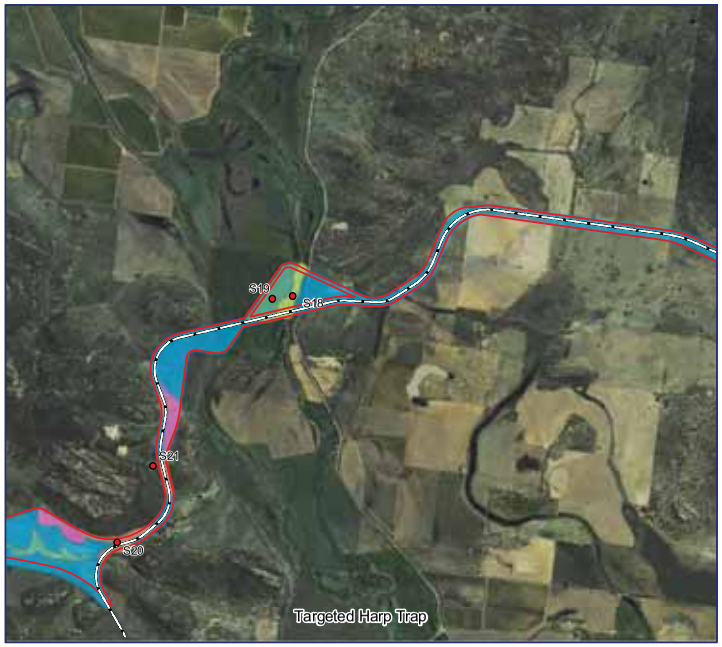
Figure 2-3C - Fauna survey effort (Namoi River and rail corridor study area)

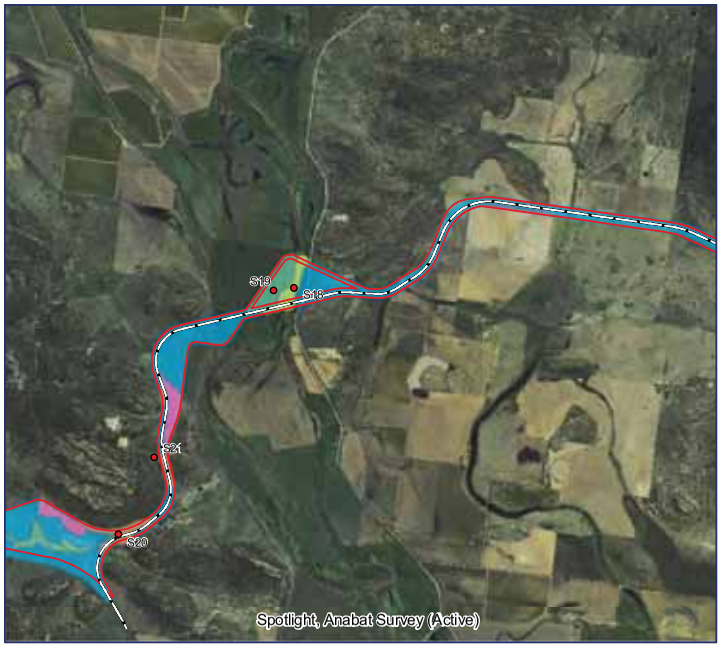












Project Boundary

Survey Location

Fauna Habitat Areas

- Native Grassland
- Shrubby Woodlands/Open Forest on skeletal soils
- Riverine Woodland
- Grassy Woodlands on fertile soils
- Exotic Grassland

0 0.5 1 2

Kilometers

Figure 2-3D - Fauna survey effort (Namoi River and rail corridor study area)

Small mammal trapping

Small to medium sized mammals were surveyed using a number of live trapping methods. Live capture/release methods included Elliott type A and B traps for small ground-dwelling mammals, Elliott type B traps for small arboreal mammals and wire cage traps for larger ground-dwelling mammals.

Elliott type A traps were placed at 10 m intervals along five transect lines in survey sites S1-S4, S6-S7 and S9-S21 (five Elliott traps per transect). Traps were baited with standard bait mixture (rolled oats, peanut butter and honey) and were operated over a four-night period at each site (Figure 2-3a and 2-3c). A total of 100 trap nights were recorded at each of the 19 sites.

Elliott type B traps were placed at 10 m intervals along one transect in survey sites S1-S4 and S6-S21 (10 Elliott traps per transect). A total of 40 trap nights were recorded at each of the 20 sites.

Elliott type B traps were secured on tree-mounted brackets and set approximately 3 m above ground level in suitable habitat/hollow-bearing trees. Ten tree-mounted traps were set in survey sites S1-S4, S6 and S7. Six tree-mounted traps were set in survey sites S9-S21 (Figure 2-3a and Figure 2-3c). Each trap was baited with a standard bait mixture, while a mixture of honey and water was sprayed onto the trunk of the tree above the tree-mounted Elliott trap as a lure. Elliott traps were operated over a four-night period at each site, with 40 trap nights recorded at each of survey sites S1-S4, S6 and S7. A total of 24 trap nights were recorded at each of survey sites S9-S21.

Wire cage traps located at survey sites S1-S4 and S6-S21 were baited with standard bait (chicken legs/necks) and were located in the vicinity of Elliott trap lines. Six traps were located at each of 20 survey sites with a total of 24 trap-nights recorded at each survey site over a four-night trapping period (Table 2-12 and Appendix G).

All traps were checked each morning with captured animals identified to species level and released at the site of capture. Introduced species, such as House Mouse, were euthanized onsite adhering to licence requirements. All live trapping followed guidelines and policies for wildlife research as set by the Animal Research Review Panel (Australian Government 2004).

Spotlighting

Spotlighting was used to target arboreal, flying and large ground-dwelling mammals, as well as nocturnal birds, reptiles and amphibians. Spotlighting was done after dusk at 21 sites (survey sites S1-S21) across the Project Boundary (Figure 2-3b and Figure 2-3d). At least one person hour of survey effort was undertaken at each site on foot using two 100 watt vari-beam spotlights (Table 2-12 and Appendix G). The speed of the spotlight surveys was approximately 1 km per hour. Surveys concentrated on areas that contained suitable habitat for nocturnal species, with sighted animals identified to the species level.

Call playback

Call playback was used to survey for the Barking Owl, Powerful Owl, Masked Owl, Squirrel Glider and Koala using the methods of Kavanagh (Kavanagh & Debus 1994) and Debus (Debus 1995). Call playback was done after dusk at 21 sites within the Project Boundary (Figure 2-3a and Figure 2-3c). Masked Owl has anecdotally been recorded in Leard State Forest (David Robertson 2009). As the Masked Owl has significantly greater detectability during its core breeding season, a further two sites were surveyed during winter (Figure 2-3a). For each survey, an initial listening period of 10 to 15 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animals in the immediate vicinity. The calls of the target species were then played intermittently for five minutes (Squirrel Glider, Barking Owl, Powerful Owl, Masked Owl and

Koala, respectively) followed by a 10 minute listening period. After the calls were played, another 10 minutes of spotlighting was done in the vicinity to check for animals attracted by the calls, but not vocalising. Calls from Stewart (Pennay, M. *et al.* 2004; Stewart 1998) were broadcast using an MP3 player and amplified through a megaphone. Surveys were conducted at various times, from one to three hours after dusk (Table 2-12 and Appendix G).

Microchiropteran bat surveys

Ultrasonic Anabat Bat detection (Anabat SD1 CF Bat Detector – Titley Electronics, Ballina) was used to record and identify the echolocation calls of microchiropterans foraging across 18 sites in the Project Boundary (Figure 2-3b and Figure 2-3d). Survey sites S1-S7 were surveyed using only active monitoring methods, whilst survey sites S9-S18 and S20 were surveyed using a combination of passive and active monitoring. Passive monitoring of survey sites was achieved by setting Anabat bat detectors to record throughout the night. Active monitoring of survey sites was performed during spotlight events at nominated sites across the Project Boundary, whereby an Anabat detector was used to track the animals and record their calls while actively spotlighting. Bat call analysis was undertaken by Rob Gration of Parsons Brinckerhoff, with the presentation of data (Appendix F) following guidelines of the Australasian Bat Society. Bat calls of New South Wales western slopes and plains region (Pennay, M. *et al.* 2004) was used as a reference collection for bat call identification. Furthermore, reference calls from Little Forest Bat, Inland Broad-nosed Bat, Southern Broad-nosed Bat and Eastern Cave Bat were collected from captured specimens.

Harp traps were used to trap foraging microchiropterans. Harp traps were located at sites within the Project Boundary that had the potential to be used as fly-ways by foraging microchiropterans. Ten sites within the Project Boundary were targeted with harp traps set in each location for two consecutive nights (Figure 2-3b and Figure 2-3d). A further four sites within the Project Boundary were targeted, with harp traps set in each location for three consecutive nights (S18-S21). Harp traps were checked each evening following spotlighting events and again the following day during morning hours. Microchiropteran species caught by harp traps, were identified to species level, sexed, weighed and forearm measurement recorded. Microchiropterans caught before evening harp trap checks were released the same night, while those caught after the evening check were contained until the following evening for release. Reference calls for Inland Broad-nosed Bat, Greater Broad-nosed Bat and Little Forest Bat were collected during the March/April 2009 survey, while reference calls for Eastern Cave Bat and Little Forest bat were collected during the September 2009 survey. A bat chirp board, a product of Nevada Bat Technology, was also used in conjunction with the harp trap. Bat chirp boards, which simulate a bat call sequence, was attached to a harp trap on the last evening at each survey location to potentially increase capture rates.

Diurnal bird surveys

Bird surveys were undertaken at 19 sites within the Project Boundary during December 2008 to March/April 2009 surveys (Figure 2-3a and Figure 2-3c). An extra four sites (MS1-MS4), occurring on the periphery of the Project Boundary were surveyed in January 2009 as part of the Boggabri Coal Ecological Monitoring Program (Parsons Brinckerhoff 2005a). Winter bird surveys (June) were undertaken at 24 sites, targeting potential Threatened, Migratory and nomadic species including Regent Honeyeater, Superb Parrot and Swift Parrot. These surveys were conducted to specifically to coincide with the winter flowering resources of *E. albens*. Bird surveys were completed by actively walking through nominated sites (transect) over a period of 20 minutes and recording all birds observed or heard.

Five bird surveys, completed during spring surveys in September 2009 (Figure 2-3a, Figure 2-3c and Appendix G), were completed by actively walking through nominated sites (transect) with all birds observed in an initial five minute period recorded. Only new species of bird were recorded in subsequent five minute periods, with the process continued until two consecutive five minute periods had recorded no new species. All birds were identified to the species level, either through direct observation or identification of calls. Bird surveys were undertaken during different times of the day, but generally occurred during the morning or late afternoon.

Reptile surveys

Reptile surveys were undertaken at 21 sites within the Project Boundary that showed potential habitat for this group (Figure 2-3b, Figure 2-3d and Appendix G). The survey included turning over suitable ground debris, such as fallen timber, sheets of iron and exposed rocks and either visually identifying reptiles or collecting by hand for identification. All ground debris was then returned to its original positions. Reptile surveys were undertaken over a 20 minute period at each location.

Frog surveys

Frog surveys were undertaken at four sites (S15, S18, Supp2 and Supp13) within the Project Boundary that provided potential habitat (Figure 2-3b and Figure 2-3d). Frogs were surveyed by walking through the area of potential habitat at night, for a period of 20 minutes, while looking for active frogs and eyeshine. Frogs were identified to the species level by call recognition or from captured specimens. Frogs were also surveyed during spotlight events and opportunistically across the Project Boundary.

Sloane's Froglet is a particularly cryptic amphibian species that occupies floodplain depressions and semi-permanent water along the major inland rivers of the region, including the Namoi River. Sloane's Froglet is known to be more vocal and responsive to call playback during its winter breeding season after heavy rain fall events and may lie relatively dormant outside of this time.

Targeted surveys for this species were conducted from 20 June 2009 to 22 June 2009 following rainfall (approximately <10 mm). Frogs were surveyed using two methods, specifically, targeted habitat searches and frog call playback.

Targeted searches were completed by walking through the area of potential habitat, while looking for active frogs and eye-shine. A minimum of one 200 m transect per water body/inundated area was completed and repeated on two separate nights. Any frog species was identified to the species level by call recognition or from captured specimens.

Call playback was used in an attempt to stimulate male frogs to call by playing their call at potential breeding sites. Calls were broadcast using an MP3 player and amplified through a megaphone.

Frog surveys were conducted in accordance with the Hygiene protocol for the control of disease in frogs (NSW National Parks and Wildlife Service 2001) and followed the methodology detailed in *Threatened Species survey and assessment guidelines: field survey and methods for fauna-Amphibians* (NSW Department of Environment 2009) and *NSW Threatened Species Survey and Assessment Draft Guidelines (Working Draft)* (Department of Environment and Conservation 2004).

Funnel and pitfall trapping

Funnel traps, supplemented with pitfall traps were used in conjunction with drift fences, to target amphibians, reptiles and small ground dwelling mammals. Funnel traps consisted of a fabric mesh with both ends forming an inward-directed cone. Pitfall traps consisted of rolled sheets of tin, which were buried in the ground with the lip flush with the ground's surface. Six funnel traps

and two pitfall traps were generally used at each of 10 survey locations where this technique was carried out in the Project Boundary. Surveys were carried out over a period of four nights with 320 trap nights recorded in the Project Boundary. Trap lines were checked during morning hours with trapped specimens recorded to species level and released.

Systematic Koala habitat and activity assessment within Leard State Forest

A systematic (regular) grid-based sampling protocol, generally in accordance with methods developed by Biolink ecological consultants in a koala habitat utilisation pilot study (Biolink ecological consultants 2009) was completed to assist in identifying Koala habitat areas throughout Leard State Forest. The grid-based sampling protocol included 500 m sampling intervals within the Project Boundary and 1,000 m sampling intervals within the remaining Leard State Forest (Figure 3-6). Regular grid-based sampling was undertaken using the Spot Assessment Technique (SAT) methodology at each sampling point.

The SAT methodology involved actively searching the ground between the dripline of the canopy and the trunk of 20 trees for Koala scats at each sampling interval, where no food trees or insufficient numbers of food trees were recorded at a survey location, appropriate habitat trees were assessed. For the western slopes and plains Koala management area, as outlined in the approved Koala recovery plan (Department of Environment and Climate Change 2008a), the following food tree species were recorded within the Project Boundary:

- *Eucalyptus camaldulensis.*
- *E. populnea.*
- *E. pilligaensis.*
- *E. melliodora.*
- *E. albens.*
- *E. dwyeri.*
- *E. blakelyi.*

Two scat samples were positively identified during field surveys, with a further 10 samples sent to Barbara Triggs (Dead Finish, Victoria) for identification.

Koala scat searches were also completed at survey sites (S1 to S18) where primary or secondary food tree species were recorded. Scat searches where completed using SAT methodology described above.

Koala habitat modelling

A simple raster-based modelling methodology adapted from the Biolink ecological consultants koala habitat utilisation pilot study (Biolink ecological consultants 2009) was applied for modelling potential koala habitat areas in the Project Boundary. Potential habitat areas were based on surveyed locations of observable koalas and koala scats. These were introduced as site coordinates in ArcGIS and each site was assigned a grade of perceived activity level of koalas in the surrounding area, represented as a percentage. These locations were subjected to regularised splining using the spline tool in ESRI's ArcGIS modelling extension 'Spatial Analyst'. The settings in the spline tool had a 0.1 weighting and a 12 nearest neighbour data points per region, as per the (Biolink ecological consultants 2009) analysis. The result of this raster interpolation created a smooth predicative raster surface, displaying potential areas of koala activity in the study area.

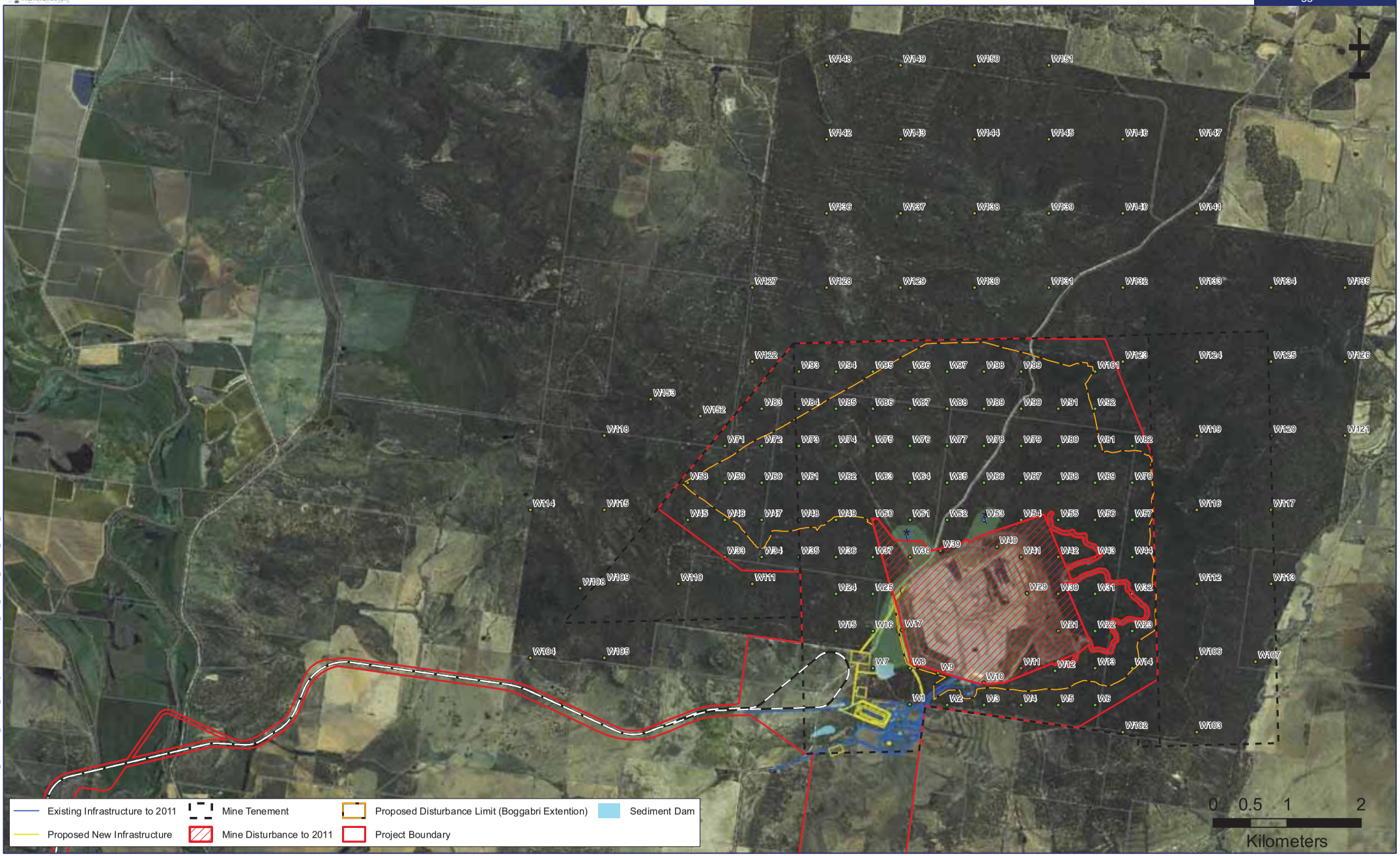


Figure 2- 4 - Systematic grid-based Koala and hollow-bearing tree survey

2.5.4 Survey fauna effort

A summary of all fauna survey effort within the Project Boundary is shown in Table 2-12.The locations of the survey sites are shown in Figure 2-3a to 2-3d and Figure 2-4. Please refer to Appendix G for a detailed breakdown of survey effort for December 2008, January 2009, March/April 2009, June 2009 and September 2009.

Table 2-12 Total fauna survey effort

Survey method	Grassy Woodland on fertile soils		Shrubby Woodland/Open Forest on skeletal soils		Riverine Woodland		Total effort in Project Boundary
	Number of locations	Total effort	Number of locations	Total effort	Number of locations	Total effort	
Elliott B (Arboreal)		264 trap nights	8	216 trap nights	3	72 trap nights	552 trap nights
Elliott B (Terrestrial)	9	360 trap nights	8	320 trap nights	3	120 trap nights	800 trap nights
Elliott A (Terrestrial)	9	900 trap nights	7	700 trap nights	3	300 trap nights	1900 trap nights
Cage trapping	9	216 trap nights	8	192 trap nights	3	72 trap nights	480 trap nights
Funnel/pitfall traps	6	168 trap nights	4	136 trap nights	1	24 trap nights	336 trap nights
Harp trap	6	13 trap nights	5	11 trap nights	3	10 trap nights	34 trap nights
Anabat survey[1]	8	69 hours	6	56 hours	2	26 hours	151 hours
Spotlighting	9	9 hours	9	15 hours	3	3.5 hours	27.5 hours
Owl call playback	9	4.5 hours	8	10 hours	3	2 hour	16.5 hours
Bird survey	24	10.75 hours	21	10.2 hours	2	1.7 hours	22.5 hours
Reptile survey	8	5.3 hours	12	8.7hours	2	1.3 hours	15 hours
Amphibian survey	1	40 minutes	1	40 minutes	2	4hr 20 minutes	5.4 hours
Habitat assessment	8	4 hours	8	3.5 hours	2	1 hour	8.5 hours
Koala scat assessment	69	49.75 hours	91	66.75 hours	2	1 hour	117.5 hours
Hollow-bearing tree assessment	61	45.75 hours	85	63.75	N/A	N/A	109.5 hours

Note: 1 – Anabat survey included passive and active monitoring.

2.6 Aquatic surveys

2.6.1 Aquatic field sampling

Field surveys were completed by *Bio-analysis Pty Ltd* in August 2009 to quantify the physico-chemical water quality, assemblages of macroinvertebrates and fish at a number of spatial scales. The key aquatic habitats within the Project Boundary were associated with the Namoi River and its floodplain and as such surveys focused on the location of the proposed crossing over the Namoi River and at one location upstream and one location downstream of the proposed works, two randomly nested sites were sampled. At the time of the surveys all of the minor ephemeral streams within the proposed open cut disturbance area were dry with the only permanent water associated with artificial drainage contours and dams. An additional location was also sampled within the only significant permanent aquatic habitat within the proposed open cut disturbance area. This was a small farm dam immediately downstream of the proposed open cut disturbance.

All collections of macroinvertebrates and fish were done in accordance with Section 37, of the NSW Fisheries Management Act 1994, using Scientific Collection Permit Number P03/0032(B), and NSW Agriculture, Animal Research Authority Care and Ethics Certificate of Approval Number 03/2445.

Water quality

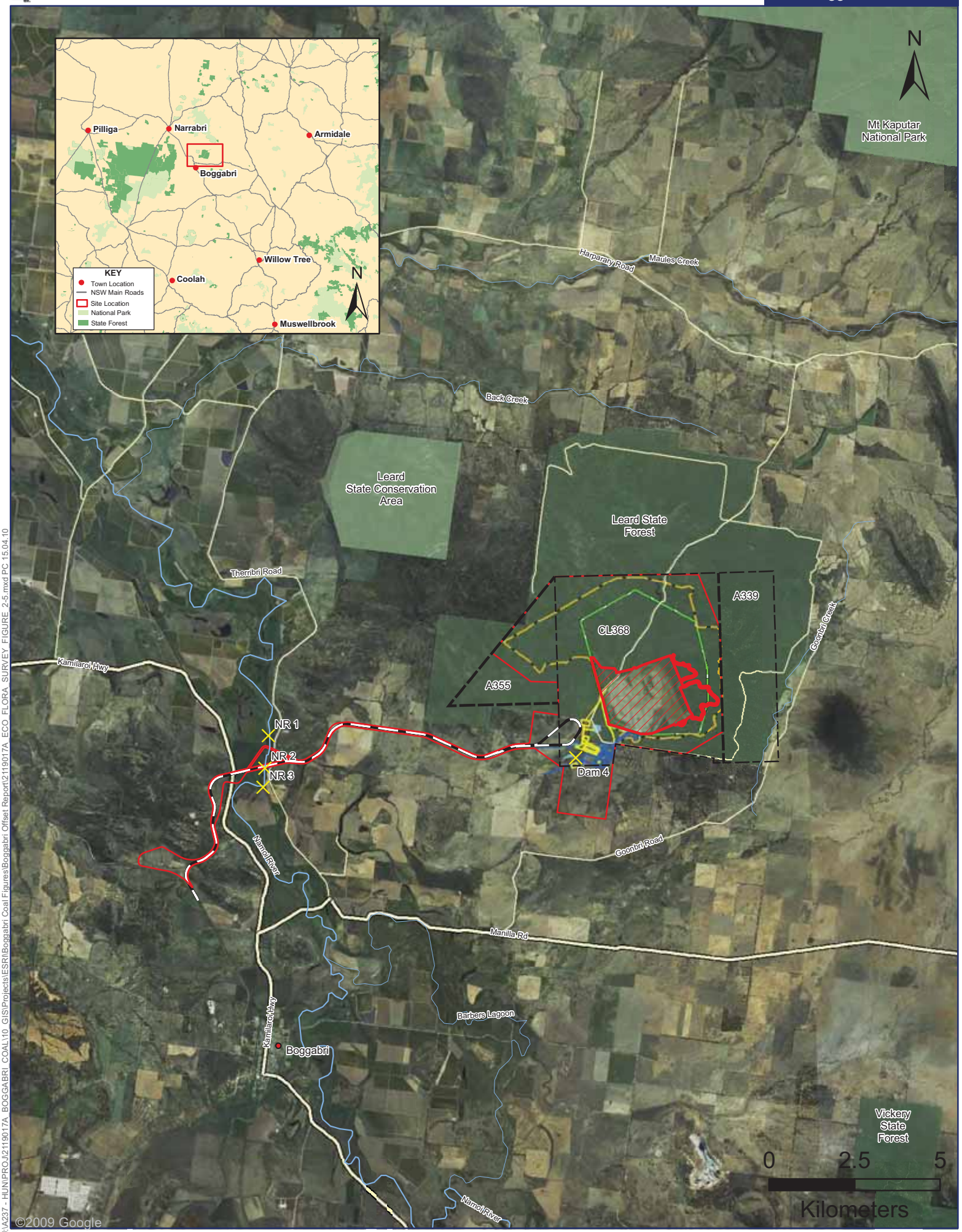
Within each site, three replicate readings of physico-chemical water quality variables were recorded using a YEOKAL 611 data logger. The variables included; temperature, conductivity, pH, dissolved oxygen and turbidity.

Macroinvertebrate

At each site, three replicate macroinvertebrate samples were collected using timed 1-minute sweeps of all habitats (edge, riffle, pools, etc.), using a 250 x 250 cm (250 µm) dip net. The contents of the net were placed into plastic trays filled with fresh water and the macroinvertebrates sorted and placed into pre-labelled plastic sample containers filled with 70% alcohol. The samples were sorted to family level and counted in the laboratory using an ISSCO M400 stereomicroscope.

Assemblages of fish

Also within each site, three replicate samples of the assemblages of fish were collected using a Smith-Root 15C Electrofisher backpack unit. The Electrofisher was used to stun the fish in open water and in submerged and emergent aquatic vegetation. Three minutes of electrofishing effort per replicate was used. All stunned fish were collected using a dip net and placed into plastic trays filled with water. Fish were identified and counted in the trays and then released back into the water once sampling at a site was completed.



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- Town Location
- Existing Infrastructure to 2011
- Proposed New Infrastructure
- Namoi River
- Mine Tenements
- Mine Disturbance to 2011
- Project Boundary
- Proposed Disturbance Limit (Boggabri Extension)
- EIS Mine Disturbance (Boggabri Existing)
- Proposed Rail Loop
- Sediment Dam

Figure 2-5 Aquatic Survey sites

2.6.2 Laboratory and statistics analysis

Where appropriate, both univariate (ANOVA – GMAV) and multivariate (PRIMER) statistical routines were used to analyse the data. Student Newman Kuels (SNK) tests were used to identify where differences were detected in the ANOVA (Underwood 1981). Multivariate statistical techniques were used to examine patterns in assemblages using the PRIMER software package (Plymouth Marine Laboratories, UK). Multivariate methods such as PRIMER allow comparisons of two (or more) samples based on the degree to which these samples share particular species, at comparable levels of abundance. Non-metric multidimensional scaling (nMDS) ordinations were used to graphically illustrate relationships between samples. The significance of any apparent differences among sites was determined using ANOSIM (analysis of similarities). A SIMPER (similarity of percentages) procedure was used to examine the contribution of taxa to the similarities (or dissimilarities) among sites (Clarke & Warwick 1994).

The SIGNAL biotic index (Chessman 2001, 2003) was used to assign average pollution sensitivity grades to each of the sites using the macroinvertebrate data. An average SIGNAL value was calculated for each site by summing the sensitivity grades assigned to each macroinvertebrate family and dividing by the number of families at each site. SIGNAL values range from 1 (most tolerant to pollution) to 10 (most sensitive to pollution). Average SIGNAL values greater than 6 indicate clean water, whilst between 5 and 6 the water quality is doubtful or mildly polluted. SIGNAL values between 4 and 5 indicate moderate pollution, whilst a value less than 4 indicates severe pollution.

2.7 Landscape context

Landscape context is the condition and nature of vegetation and habitats within and surrounding the Project Boundary. Many processes in a patch of vegetation are linked to processes in the surrounding landscape (Lindenmayer & Burgman 2005). The quality (including the long-term survival) of vegetation is dependent on a suite of factors that influence the patch or stand, including its position in the vegetated landscape (Todd 2003).The assessment of landscape context included inspection of the following information within both the Project Boundary and the surrounding landscape, defined as 10 km from the Project Boundary:

- Aerial photographs.
- Digital elevation model.
- Mitchell Landscapes (NSW National Parks and Wildlife Service 2002b).
- Remnant vegetation patch and derived grassland mapping (Keith 2006).

Extensive analysis of the landscape context was not possible since the broad-scale vegetation mapping does not cover the entire Project Boundary. However, analysis of remnant patch size within the Project Boundary was determined using the broad scale remnant vegetation and derived native grassland cover mapping for NSW (Keith 2006).

2.8 Likelihood of occurrence

For this study, likelihood of occurrence of Threatened species recorded or predicted to occur in the locality is defined in Table 2-13.

Table 2-13 Likelihood of occurrence of threatened species

Likelihood	Description
Low	Species considered to have a **low likelihood of occurrence** include species not recorded during the field surveys that fit one or more of the following criteria: ▪ Have not been recorded previously in the Project Boundary and surrounds and for which the Project Boundary is beyond the current distribution range. ▪ Rely on specific habitat types or resources that are not present in the Project Boundary. ▪ Are considered locally extinct. ▪ Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
Moderate	Species considered to have a **moderate likelihood of occurrence** include species not recorded during the field surveys that fit one or more of the following criteria: ▪ Have infrequently been recorded previously in the Project Boundary and surrounds. ▪ Use habitat types or resources that are present in the Project Boundary, although generally in a poor or modified condition. ▪ Are unlikely to maintain sedentary populations, however, may seasonally use resources within the Project Boundary opportunistically during variable seasons or migration. ▪ Are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
High	Species considered to have a **high likelihood of occurrence** include species recorded during the field surveys or species not recorded that fit one or more of the following criteria: ▪ Have frequently been recorded previously in the Project Boundary and surrounds. ▪ Use habitat types or resources that are present in the Project Boundary that are abundant and/or in good condition within the Project Boundary. ▪ Are known or likely to maintain resident populations surrounding the Project Boundary. ▪ Are known or likely to visit the site during regular seasonal movements or migration.

2.9 Limitations

The conclusions in this report are based on data acquired for the site from previous ecological surveys within the Project Boundary (James B. Croft and Associates 1983), (Pennay, M. 2002), and the current survey data, collected over five sampling periods encompassing all four seasons. The survey effort undertaken during the current survey maximised the optimal time for detecting the majority of flora and fauna species which may be utilising the Project Boundary.

Targeted surveys for cryptic threatened flora species such as *Diuris tricolor,* were undertaken during the flowering period to maximise detection of this cryptic orchid.

Environmental field surveys can be merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. Also, it should be recognised that site conditions, including the presence of Threatened species, can change with time. However, it is considered that due to the large survey effort, undertaken over five sampling periods and all four seasons, suitable coverage within the Project Boundary is considered to have been accomplished.

3. Description of the existing environment

3.1 Existing Regional Conservation Assessments

3.1.1 Brigalow and Nandewar Western Regional Assessment

The Project is located within an area that has previously been assessed at a broad scale under the Brigalow and Nandewar Western Regional Assessments (WRA). In 1999, the NSW Government initiated a regional assessment of western NSW to guide future planning and encourage partnerships to protect the environment.

The former Resource and Conservation Assessment Council (RACAC) coordinated the assessment, and involved key NSW agencies representing forests, conservation, planning, Aboriginal interests, minerals and natural resources. The assessment included detailed scientific analysis and consultation with timber operators, conservation groups, Aboriginal stakeholders, minerals and gas industries, local communities and local government.

The aims of the Brigalow and Nandewar assessments were to deliver:

- adequate and complete core data layers to inform regional land use planning, conservation and resource management
- enhanced partnerships between core agencies and interest groups concerned with natural resources and ecological sustainability, to increase sharing of information and to reduce duplication
- the identification of a comprehensive, adequate and representative network of protected and managed areas.

Informed by the information collected during the WRAs, NSW Government's decision in 2005 to conserve 350,000 ha of woodlands in the Brigalow and Nandewar bioregions through the *Brigalow and Nandewar Community Conservation Area Act 2005* provided a regional approach to the protection of important conservation values with an aim of long-term sustainability of the region's important timber, gas, minerals and apiary sectors.

The Boggabri Coal Project is largely restricted to Leard State Forest, which was not identified for conservation in the regional assessments.

3.1.2 Brigalow and Nandewar Community Conservation Area Agreement

The *Brigalow and Nandewar Community Conservation Area Act 2005* (BNC Act) provides for the Brigalow and Nandewar Community Conservation Area Agreement (BNC Agreement) within the Project's Bioregion.

This BNC Agreement incorporates multiple-use protected areas, designed to allow for improved conservation outcomes, while providing for the sustainable use of natural resources. The intent of the BNC Agreement is to provide:

- permanent conservation of land, their natural systems and biodiversity
- protection of areas of natural and cultural heritage significance to Aboriginal people
- continuation of forestry, exploration, mining, petroleum production and other uses in an ecologically sustainable manner within nominated zones
- strong involvement by local communities in the management of land zoned within the Community Conservation Area (CCA).

Within the CCA there are four dedicated management zones that have defined purposes allowing multiple uses (Table 3-1).

Table 3-1 BNC Agreement Management Zones

Zone	Project Boundary
1	Zone 1 is reserved as national park under the NP&W Act for the purposes of conservation and recreation.
2	Zone 2 is reserved as Aboriginal Area under the NP&W Act for the purposes of conservation and Aboriginal culture.
3	Zone 3 is reserved as state conservation area under the NP&W Act for the purposes of conservation, recreation and exploration, mining and petroleum production.
4	Zone 4 is dedicated as State Forest under the *Forestry Act 1916* for the purposes of forestry, recreation and mineral extraction.

The Project mining area is located within the Leard State Forest identified for management under Zone 4. This zone has been specifically set aside for forestry and mineral extraction.

3.2 Landscape context

3.2.1 Bioregion

The Project Boundary is located in the Brigalow Belt South bioregion. This region covers an area of approximately 27,196,933 ha encompassing the towns of Baradine, Binnaway, Coonabarabran, Dubbo, Gunnedah, Merriwa, Moree and Narrabri (NSW National Parks and Wildlife Service 2003). The region also includes a significant proportion of NSW major rivers: MacIntyre, Gwydir, Namoi, Castlereagh, Goulburn, Talbragar and Macquarie Rivers, with their catchments forming an integral part of the Murray–Darling River System (NSW National Parks and Wildlife Service 2003).

The region forms the southern extremity of the Brigalow Belt, however is not dominated by Brigalow (*Acacia harpophylla*). According to the baseline surveys that supported the Brigalow Nandewar Conservation Agreement, the signature trees that occur throughout the Brigalow Belt South bioregion are White Box, White Cypress Pines and various Ironbarks. These species also dominate the communities that occur in the area of impact of the Project.

Geologically the region consists of landscapes derived from both extensive basalt flows and quartz sandstones and consequently has very variable soils and vegetation depending on the local rock type or sediment source. Geologically the bioregion's bedrock comprises horizontally bedded Jurassic and Triassic quartz sandstone and shale with limited areas of conglomerate or basalts. The landscape is dominated by Quaternary sediments in the form of alluvial fans and outwash slopes composed of coarser sediment, that fan out at slightly steeper angles. The relative distribution of sediment from basalt or sandstone has a major impact on soil quality and vegetation (NSW National Parks and Wildlife Service 2003).

A number of threatened ecological communities, plants and animals are restricted to the bioregion. With over 3,190,400 ha or 60.85% of the regions vegetation being cleared, the majority of threatened species records tend to be concentrated in the major reserves and state forests. The Brigalow Belt Bioregion has only limited areas of conservation-oriented tenures: together, they occupy about 155,353 ha or 2.91% of its area (NSW National Parks and Wildlife Service 2003). These reserves are made up of nineteen National Parks and Nature Reserves. About 10.6% of the bioregion is managed as State Forests. Nine Flora Reserves, occupying 4,091 ha (0.008%) also occur in the bioregion. Several State Forests occur within the region; including Leard, Vickery, Kelvin, Kerringle, Bibblewindi and Pilliga East.

While the Project Boundary does not cross through any estate managed by the Department of Environment, Climate Change and Water, The Leard State Conservation Area is located approximately 3 km to the north-west of the Project Boundary. The Project Boundary encompasses a significant portion of Leard State Forest (Figure 3-1).

Mount Kaputar National Park and the Pilliga Nature Reserve are the largest areas conserved within the Brigalow Belt South bioregion and occur approximately 27 km to the north and 50 km to the south-west of the Project Boundary respectively. These areas occupy approximately 1,207 ha (not including area within the Nandewar bioregion for Mt Kaputar) and 80,239 ha respectively (Resource and Conservation Assessment Council 2000). Recently gazetted Killarney (1,858 ha) and Leard (1,176 ha) State Conservation Areas occur also nearby in the bioregion.

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Project Boundary
Town Location
State Forest
National Park

Figure 3-1 - National Park and State Forest Estate within the locality region

Mount Kaputar National Park occurs approximately 27 km to the north of the Project Boundary and comprises a total area of approximately 50,000 ha, of which approximately 1,207 ha occurs in the Brigalow Belt South Bioregion (NSW National Parks and Wildlife Service 2006). Over 600 species of plant have been recorded in this reserve, of which 17 species are listed as Rare or Threatened Plants (ROTAPs). There are eight plants recorded in this park listed as Threatened under the TSC Act, seven are endemic species to Mt Kaputar NP and three new unnamed flora species. Over 260 species of vertebrate fauna have also been recorded in the park.

Pilliga Nature Reserve is located approximately 50 km to the south-west of the Project Boundary on the north-west slopes and plains of the Great Dividing Range. The nature reserve occupies approximately 80,000 ha and to the north and west adjoins significant areas of State Forest, including Pilliga East State Forest. These areas provide continuous uninterrupted habitat, which is commonly referred to as the Pilliga Scrub, which is the largest remaining dry sclerophyll forest west of the Great Dividing Range in NSW (NSW National Parks & Wildlife Service 2002). Pilliga Nature Reserve provide important refuge for Threatened species of animal, including Glossy Black-cockatoo, Regent Honeyeater, Pilliga Mouse, Spotted-tailed Quoll and Koala (Table 3-1).

In particular the natural heritage values associated with the Pilliga Scrub (encompassing the majority of the Pilliga Nature Reserve) include:

- largest area of native vegetation remaining in central NSW and the largest tract of inland plains forest in Australia
- diverse vegetation communities
- several species of rare or Threatened plant.

Habitat for several species of Threatened fauna (Resource and Conservation Assessment Council 2000). A number of Threatened species have also been recorded (Table 3-2) in Kerringle and Vickery State Forests, which are located approximately 44 km to the south-west and 15 km to the south-east of the Project Boundary respectively. Cumulatively these reserves play an important role in the landscape as fragmented vegetated links within the bioregion.

Table 3-2 Threatened species recorded in surrounding public estate

Scientific name	Common name	TSC[1]	EPBC[2]	Pilliga Nature Reserve and Pilliga East State Forest	Mount Kaputar National Park	Vickery State Forest	Kerringle State Forest
Litoria booroolongensis	Booroolong Frog	E	E		●		
Botaurus poiciloptilus	Australasian Bittern	V[3]		●			
Burhinus grallarius	Bush-stone Curlew	E		●			
Climacteris picumnus	Brown Treecreeper	V		●	●	●	●
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		●			●
Glossopsitta pusilla	Little Lorikeet	V		●			
Grantiella picta	Painted Honeyeater	V		●	●		
Hamirostra melanosternon	Black-breasted Buzzard	V		●			
Hieraaetus morphnoides	Little Eagle	V		●			
Lathamus discolor	Swift Parrot	E	E	●			
Leipoa ocellata	Malleefowl	E	V	●			
Lophoictinia isura	Square-tailed Kite	V		●	●		
Melanodryas cucullata cucullata	Hooded Robin	V		●	●	●	
Melithreptus gularis gularis	Black-chinned Honeyeater	V		●	●		
Neophema pulchella	Turquoise Parrot	V		●	●	●	
Ninox connivens	Barking Owl	V					●
Pachycephala inornata	Gilberts Whistler	V		●			
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V		●	●	●	●
Pyrrholaemus saggitatus	Speckled Warbler	V		●	●	●	●
Stagonopleura guttata	Diamond Firetail	V		●	●		
Xanthomyza phrygia	Regent Honeyeater	E[4]	E	●	●		
Aepyprymnus rufescens	Rufous Bettong	V		●			
Cercartetus nanus	Eastern Pygmy-possum	V		●			
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	●	●		
Chalinolobus picatus	Little Pied Bat	V			●	●	
Dasyurus maculatus	Spotted-tailed Quoll	V	E	●	●		
Macropus dorsalis	Black Striped Wallaby	E		●			●
Miniopterus australis	Little Bent-wing Bat	V			●		
Miniopterus schreibersii	Common Bent-wing Bat	V			●		

Scientific name	Common name	TSC[1]	EPBC[2]	Pilliga Nature Reserve and Pilliga East State Forest	Mount Kaputar National Park	Vickery State Forest	Kerringle State Forest
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V			●		
Nyctophilus timoriensis	Greater long-eared Bat (south-eastern form)	V	V	●	●		
Petaurus norfolcensis	Squirrel Glider	V		●	●		
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V		●		
Phascolarctos cinereus	Koala	V		●	●	●	●
Pseudomys pilligaensis	Pilliga Mouse	V	V	●			
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V		●	●	●	
Vespadelus troughtoni	Eastern Cave Bat	V		●			
Boronia ruppii	n/a	E			●		
Cadellia pentastylis	Ooline	V	V		●		
Diuris aeqalis	Double-tail Orchid	E	V		●		
Eriostemon ericifolius	n/a	V		●			
Eucalyptus rubida bardigerorum	Candlebark	V	V		●		
Goodenia macbarronii	n/a	V		●			
Haloragis exalata exalata	n/a	V			●		
Homoranthus prolixus	n/a	V	V	●			
Grammitis stenophylla	n/a	E			●		
Hakea pulvinifera	n/a	E	E		●		
Muehlenbeckia costata	n/a	V			●		
Rulingia procumbens	n/a	V	V	●			

Notes: Data from BioNet (Department of Environment and Climate Change 2009b), Pilliga Nature Reserve Plan of Management (NSW National Parks & Wildlife Service 2002), Mount Kaputar National Park Plan of Management (NSW National Parks and Wildlife Service 2006) and Vertebrate Fauna Survey, Analysis and Modelling Projects, Brigalow Belt South Stage 2 (Resource and Conservation Assessment Council 2000).

1 V = Vulnerable, E1 = Endangered – TSC Act.

2 V = Vulnerable, E = Endangered – EPBC Act.

3 Australian Bittern preliminary listing to Endangered – TSC Act.

4 Regent Honeyeater preliminary listing to Critically Endangered – TSC Act.

3.2.2 Mitchell landscapes

Landscapes (Mitchell) of NSW (NSW National Parks and Wildlife Service 2002b) outlines a system of ecosystem classification mapped at the 1:250,000 scale, based on a combination of soils, topography and vegetation. The Project Boundary falls on the transition between the Bugaldie uplands and Liverpool plains landscapes.

These landscapes are described below based on the descriptions by the NSW National Parks and Wildlife Service (NSW Department of Environment and Climate Change 2008), including an estimation of clearing across the landscape. Clearing estimates are derived from the Mitchell landscapes percentage cleared estimates for CMA database. Under the vegetation assessment tool (BioMetric version 2.0) (NSW Department of Environment and Climate Change 2008), a landscape that is greater than 70% cleared is considered to be over-cleared.

Bugaldie uplands

Bugaldie uplands landscape dominates the majority of Leard State Forest, the hills to the west of the Highway and other elevated topography throughout the Project Boundary. This landscape is characterised by stony ridges on Jurassic quartz sandstone with some conglomerate, shale and occasional interbedded basaltic volcanic rocks with a general elevation of 350 to 490 m. The soils are texture-contrast with harsh clay subsoils and deep uniform or gradational yellow-brown sands on the valley floors. The vegetation contains patches of *Eucalyptus viridis* and *Eucalyptus dumosa*, clumps of *Acacia concurrens* and *Acacia cheelii* amongst red ironbark *Eucalyptus sideroxylon* and black cypress pine *Callitris endlicheri* with shrubby understorey including *Grevillea floribunda*, *Prostanthera* sp., *Stypandra glauca* and *Cheilanthes sieberi* on ridges and stony slopes. *Eucalyptus crebra*, *Eucalyptus macrorhyncha*, *Callitris endlicheri*, *Corymbia trachyphloia* and rough *Angophora floribunda* on the sandy flats, *Eucalyptus albens* and *Ficus rubiginosa* on the volcanics.

Liverpool plains

The Liverpool plains landscape is restricted to areas immediately adjoining and associated with the Namoi River and its floodplain. This landscape is characterised by Tertiary basalts over Jurassic quartz sandstones and alluvial sediments derived from these with a general elevation 350 to 760 m. The soils are stony black or red-brown loam and clay loam on basalt ridges and slopes, while the vegetation is typified by *Eucalyptus albens*, *Callitris glaucophyll*a, *Brachychiton populneus*, *Angophora floribunda*, *Dodonaea viscosa* and grasses on ridges. *Callitris endlicheri*, *Ficus rubiginosa*, *Alphitonia excelsa*, *Eremophila mitchellii*, *Geijera parviflora*, *Alectryon oleifolium* and *Atalaya hemiglauca* on lower slopes.

3.2.3 Surrounding land uses

The Project Boundary is located within the Leard state forest. The Leard State Forest covers an area of 8,134 ha, the majority of which is natural vegetation. A largely agricultural landscape, comprising primarily sheep and wheat activities dominates the surrounding area to the north, south, east and west. Part of the Leard State Forest was gazetted in 2005 as Leard State Conservation Area and is located 3 km to the north-west of Leard State Forest. This reserve encompasses approximately 1,176 ha and was gazetted as part of the BNC Act. Three vegetation assemblages have been mapped within this reserve by Croft *et al* (Drayton & Primack 1996; Renjifo 1999) being Ironbark, White Box and Pilliga Box/Brimble Box/Belah.

The majority of the Project Boundary has been disturbed by previous landuse commonly associated with forest operations, including clearing, weed invasions, altered natural drainage and edge effects. However these disturbances appear to have been relatively minor and have not

significantly affected natural species diversity. As is common of forestry operations, the canopy layer lacks multiple age class structure. Other land uses include cattle grazing and exploration drilling. Mineral extraction associated with the current Boggabri mine has recently become the principle land use immediately to the west of the subject site.

Within the broader locality the principle land uses are mineral extraction and rural activities, including pasture improvement, cropping and grazing.

3.2.4 Patch sizes

The size of a remnant patch of vegetation can play an important role in its long-term viability (Gilfedder & Kirkpatrick 1998; Lonsdale 1999; Parkes *et al.* 2003), with larger patches generally having a better prognosis for long-term survival than smaller remnants more susceptible to disturbances (Drayton & Primack 1996; Renjifo 1999). A number of factors are thought to contribute to this, including:

- 'Edge effects', both biotic and abiotic (i.e. the ratio of patch perimeter to patch interior area is higher in fragmented landscapes (Saunders *et al*. 1991)).
- Species-area relationships (i.e. large areas tend to support more species than smaller ones (Burbidge *et al*. 1997)).
- Size of resident populations, which decreases with decreasing patch size (Zanette *et al*. 2000).
- Larger areas are more likely to retain refuges for susceptible species in or after disturbances, such as fires, floods or droughts (Lindenmayer & Burgman 2005).

Analysis of remnant patch size within the Project Boundary was determined using the broad scale 1:100,000 remnant vegetation and derived native grassland cover mapping for NSW (Keith 2006) (refer to Figure 3-5). Within the locality the majority (45%) of remnant patches of vegetation consist of a size less than 10 hectares (Figure 3-2).

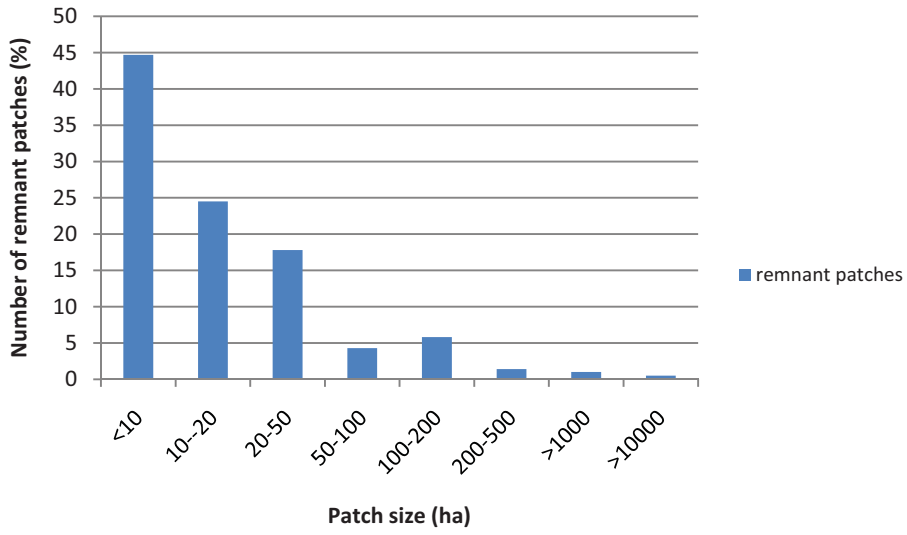


Figure 3-2 Patches of remnant vegetation in the locality

However, these small patches comprise only a very small amount of the total vegetation cover within the landscape (Figure 3-3). The locality is domianted by one very large patch greater than 10,000 ha that acounts for approximatley 70% of remnant vegetation cover (Figure 3-3). This patch, which encompasses the Leard State Forest, Leard State Conservation Area and adjoining remnant vegetation totals approximately 29,374 ha.

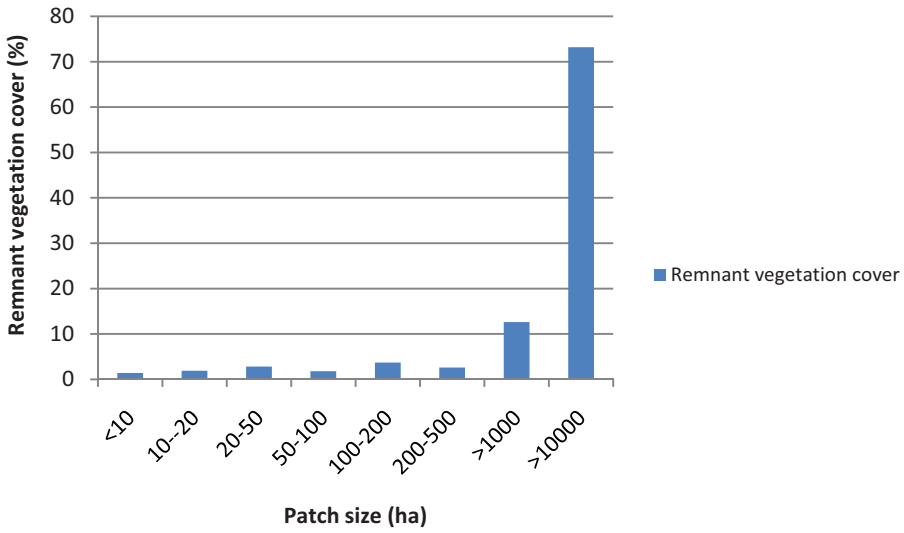


Figure 3-3 Patches of remnant vegetation and percent vegetation cover in the locality

Given the size of this patch in the context of the highly cleared landscape in the locality, it is considered this patch is likely to play an important role to the long term viability of the local biodiversity.

3.2.5 Neighbourhood

The degree to which remnant vegetation is connected to other areas of native vegetation often influences the regenerative capacity of a site, and therefore, its long-term viability. In the longer term, populations may 'move' across the landscape, taking advantage of short-term changes that provide suitable habitat, at the same time as other local changes decrease their ability to survive at sites of current occupation (Morgan 1998). Their ability to occupy newly-suitable sites depends on the ability of individuals, or their propagules, to arrive at the newly-suitable site, and hence, depends on the connectivity between sites (Parkes *et al.* 2003).

Connections through the landscape may be physical linkages, such as with adjacent blocks of vegetation, or more narrow links, such as corridors. Alternatively, connections may not be through physical linkages, but may be due to dispersal of both plants and animals between blocks of native vegetation that are separated from one another (Parkes *et al.* 2003).

A number of studies have shown that woodland species of animal require a certain level of vegetation cover within the landscape. For example, (Reid 2000) suggests that declining woodland birds drop out when native cover in the landscape falls below 30%. Similarly, (McIntyre *et al.* 2000) (Wilson & Lindenmayer 1995) suggest a minimum 30% woodland cover is required to maintain ecological sustainability on grazed properties. (Radford & Bennett 2007; Wilson & Lindenmayer 1995) suggest that there is a sharp decline in the species richness of woodland birds in landscapes with a habitat cover less than 10%.

While large areas of the landscape within the locality (10 km) of the Project have been significantly impacted by agricultural land uses, the significant size of the remnant vegetation patch associated with the Leard State Forest provides for approximately 50% of the landscape being vegetated (Figure 3-4). Based on the threshold limits for woodland birds suggested by Bennett and Radford (2004), the locality is currently capable of maintaining viable populations of woodland birds.

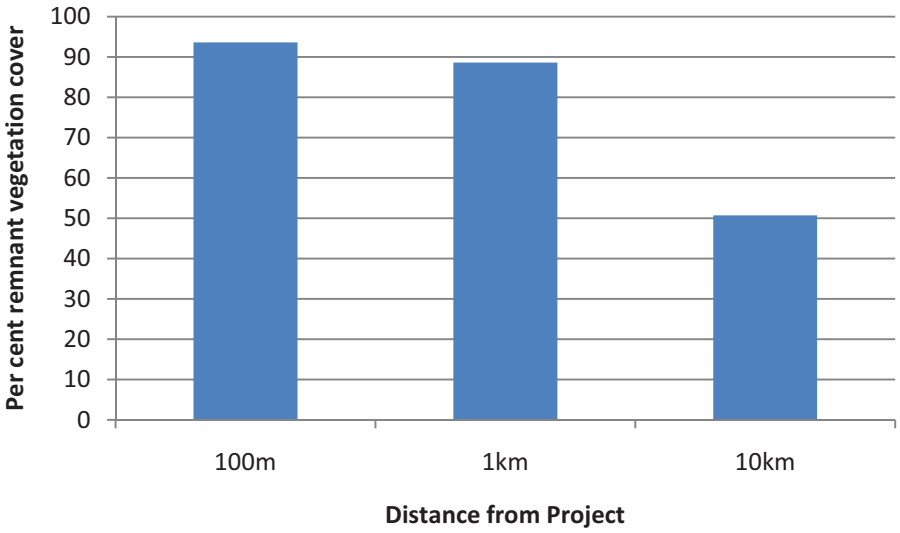
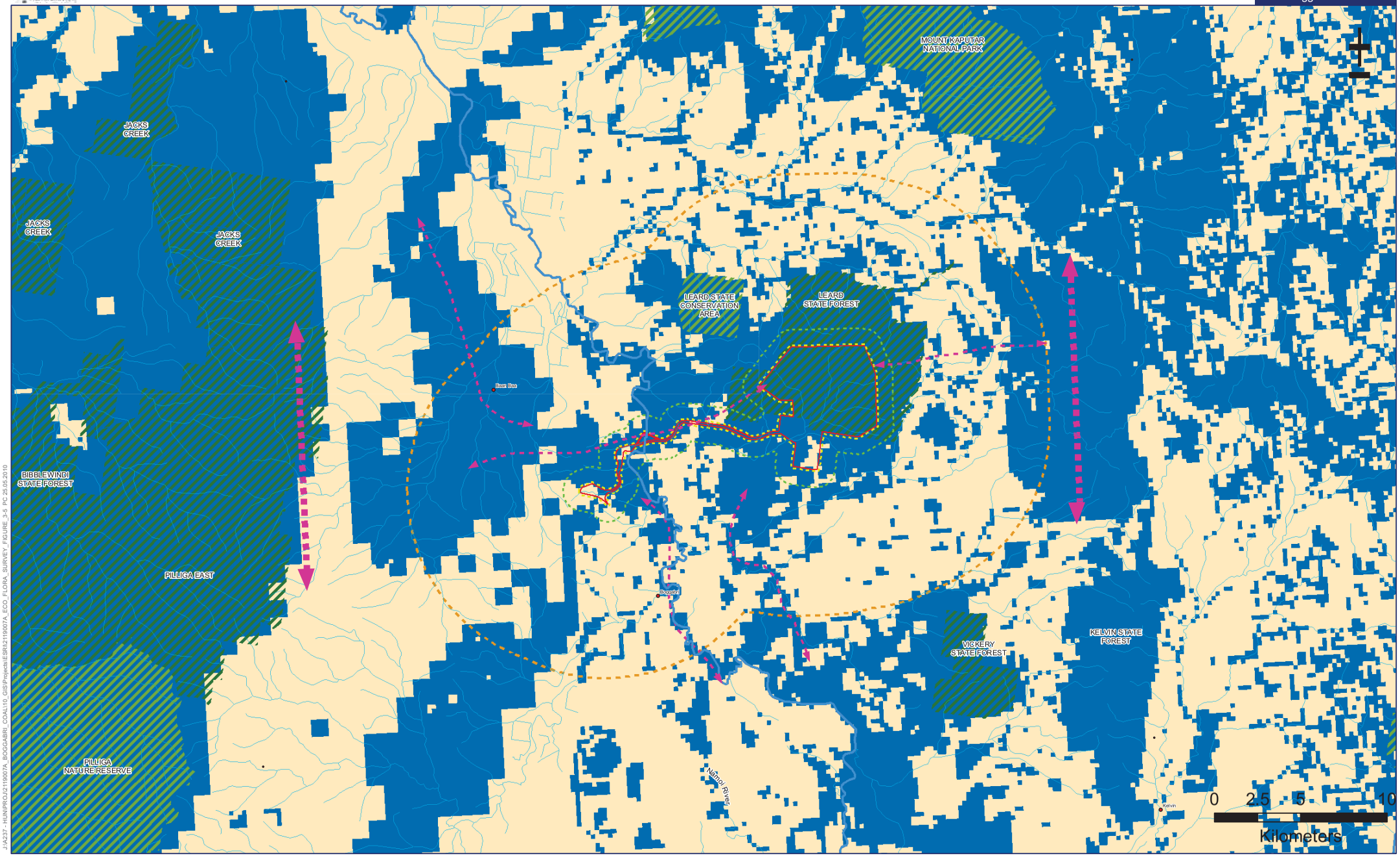


Figure 3-4 Percent remnant vegetation cover surrounding the Project

This reoccurring pattern within agricultural landscapes of significantly reduced vegetation cover places an upper limit on the size that populations can achieve, regardless of the distribution of the vegetation. Further fragmentation of the remaining vegetation can only reduce the population sizes in the region for woodland dependent species. Conversely, the loss of vegetation in the region has meant that species able to use farmland and grassland environments have increased amounts of habitat available.



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- Town Location
- Water Bodies
- Minor Corridor
- Major Corridor
- 100m Buffer
- 1Km Buffer
- 10km Buffer
- Project Boundary
- State Forest
- National Park
- Remnant vegetation patch and derived grassland (Keith and Simpson 2006)

Figure 3-5 - Remnant Vegetation Within the locality

3.2.6 Corridors and connectivity

Wildlife corridors can be defined as 'retained and/or restored systems of (linear) habitat which, at a minimum enhance connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation' (Wilson & Lindenmayer 1995). Corridors can assist ecological functioning at a variety of spatial and temporal scales, from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions.

Corridors serve a number of different functions in terms of biodiversity conservation including:

- Providing increased foraging area for wide-ranging species.
- Providing cover for movement between habitat patches, particularly for cover-dependent species and species with poor dispersal ability and enhancing the movement of animals through sub-optimal habitats.
- Reducing genetic isolation.
- Facilitating access to a mix of habitats and successional stages to those species that require them for different activities (for example, foraging or breeding).
- Providing refuge from disturbances such as fire.
- Providing habitat in itself.
- Linking wildlife populations and maintaining immigration and recolonisation between otherwise isolated patches. This in turn may help reduce the risk of population extinction (Bennett 1990; Wilson & Lindenmayer 1995).

How species use a corridor network depends largely on the home and activity ranges of the species, their habitat requirements and the ecological characteristics of the corridor. For example, some large or mobile species may make direct movements through a corridor network, moving from one patch of habitat to another. These direct movements may be on the scale of a foraging expedition or a migration (Bennett 1990). Other species may have movements by single individuals punctuated by pauses in the corridor, which can last anything from a small foraging or resting bout to weeks and even months. If the corridor contains sufficient resources to maintain a population, then continuity through the corridor may be through gene flow through the resident population (Bennett 1990; Wilson & Lindenmayer 1995).

Vegetation within the region of the Project is generally highly fragmented, with large expanses of cleared land. However, the remnant vegetation within the Project Boundary is significantly connected with the surrounding vegetation of Leard State forest to the north east and west. This patch provides a number of local corridors with partial connectivity to the Leard State Conservation Area and Namoi riverine corridor in the west and the Nandewar Range in the east (Figure 3-5).

Given the width and condition of the vegetation within the Project Boundary and Leard State Forest, it is highly likely that these areas are used by a range of species as part of a wider corridor network.

3.2.7 Summary of landscape context

The analysis of the landscape context presented above indicates that the Project Boundary lies within a large relatively intact remnant patch of vegetation surrounded by a landscape that has been modified significantly through anthropogenic disturbance, including cropping, grazing and other developments.

The pattern of vegetation clearing and modification within the locality of the Project has increased the significance of the remnant vegetation within the Project Boundary, both in terms of its

conservation value (the majority of the vegetation within the Project Boundary is listed as an Endangered Ecological Community) and its role in the broad-scale corridor network.

3.3 Vegetation communities

3.3.1 Existing broad scale vegetation mapping of Leard State Forest

A report on the Botany, Wildlife and Ecology of Leard State Forest (James B. Croft and Associates 1983) for the Boggabri Coal initial Environmental Impact Assessment has mapped eight vegetation communities within Leard State Forest/Leard State Conservation Area. Detailed field validation of this broad mapping was used in the identification of the Project Boundary's vegetation communities. A list of the vegetation communities identified within the EIS are listed in Table 3-3 next to the corresponding vegetation community identified within this current survey, while vegetation mapping of Leard State Forest is provided in Figure 3-6.

Existing Infrastructure to 2011
Proposed New Infrastructure
Mine Tenant Boundary
Project Boundary
Mine Disturbance to 2011
Sediment Dam

Vegetation Communities

Ironbark, White Box Cypress Pine
Pilliga Box, Bimble Box, Belah
White Box, Cypress Pine
Silver-leafed Ironbark, Cypress Pine
Ironbark
White Box
Red Gum, Cypress Pine
Ironbark, Cypress Pine

Figure 3-6 - Vegetation communities of Leard State Forest (Croft and Associates 1979)

3.3.2 Department of Land and Water Conservation Vegetation Mapping

The NSW Department of Land Water and Conservation (Department of Land and Water Conservation 2002a) have also completed a broad scale vegetation mapping Project in 2002 that involved the production of four 1:100,000 vegetation map sheets of Bellata, Gravesend, Boggabri and Horton.

This study identified sixteen vegetation communities within the Boggabri Map sheet of which eight vegetation communities have been mapped as occurring within the Project Boundary. A list of the vegetation communities identified within the Department of Land and Water Conservation vegetation mapping (Department of Land and Water Conservation 2002a) are listed in Table 3-3 next to the corresponding vegetation community identified within this survey.

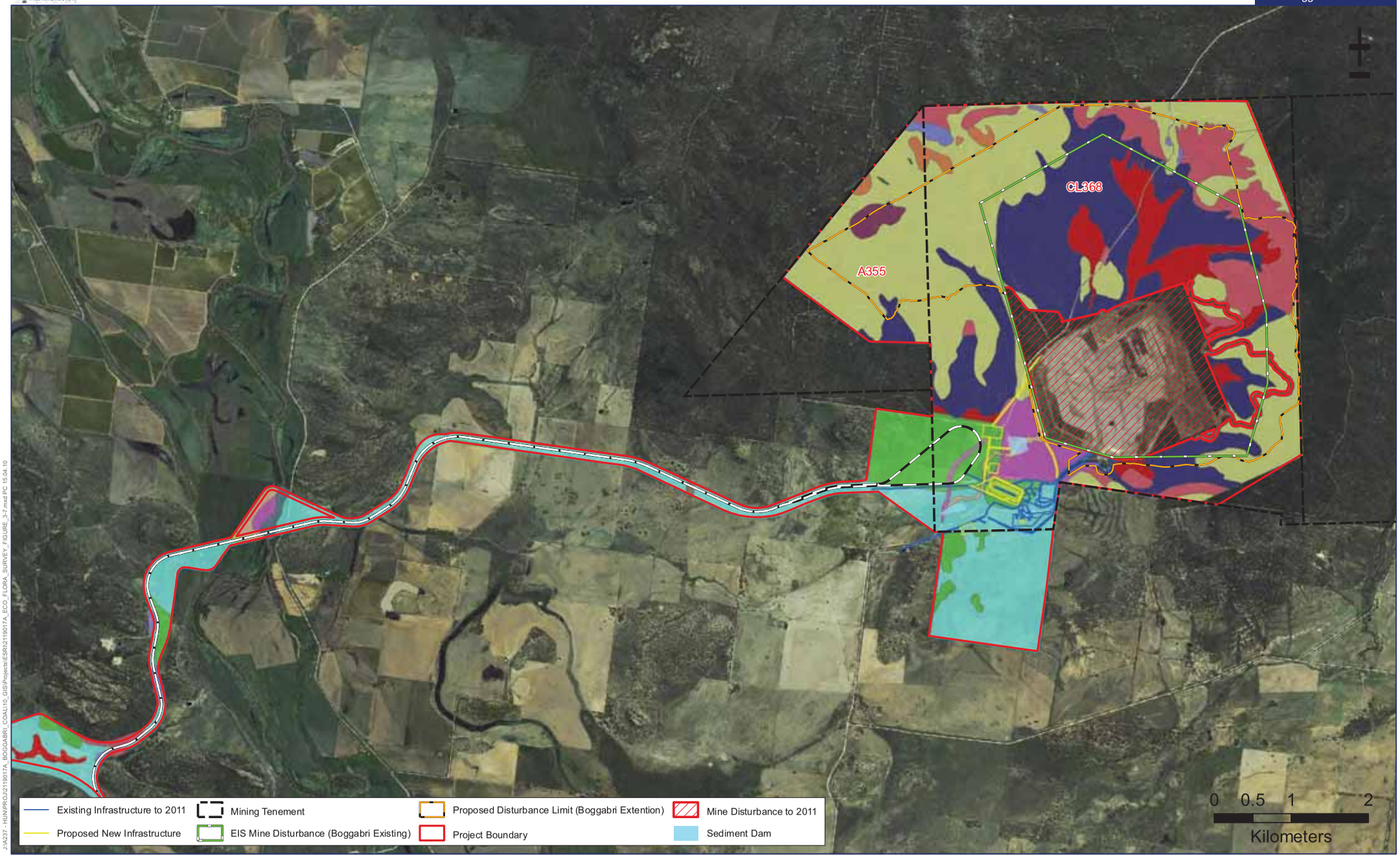
3.3.3 Field identified vegetation communities (PB 2009)

The majority of the Project Boundary within Leard State Forest is dominated by remnant vegetation communities with relatively few exotic species and high natural species diversity. However, these vegetation communities have often been structurally simplified, reflecting a history of disturbances consistent with forestry operations and thinning. The areas of the Project Boundary outside of Leard State Forest are characterised by highly disturbed communities affected by intensive agricultural land uses.

The detailed field surveys identified four broad vegetation groups:

- Grassy Woodlands on fertile soils.
- Shrubby Woodland/Open Forest on skeletal soils.
- Riverine Woodlands.
- Grasslands.

These broad vegetation types have been subsequently split into a total of fifteen distinct vegetation communities within the Project Boundary (Figure 3-7). Detailed summaries of the species recorded in each vegetation community are provided in Table 3-3 and Sections 3.2.3 to 3.2.9. Three endangered ecological communities, White Box, Yellow Box, Blakely's Red Gum Woodland, Plains Grass grassland on basaltic black earth soils mainly on the Liverpool Plains in the Brigalow Belt South Bioregion and Weeping Myall Woodland were identified within the Project Boundary.



Identified Vegetation Communites within study area

- Silver-leaved Ironbark heathy woodland
- Derived native grassland
- Dwyer's Red Gum woodland
- Exotic grassland
- Narrow-leaved Ironbark - Brown Bloodwood -White Cypress Pine shrubby open forest
- Narrow-leaved Ironbark - White Cypress Pine shrubby open forest
- Native Olive dry gully forest
- Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland
- Plains Grassland
- River Red Gum riparian woodlands and forests
- Weeping Myall grassy open woodland
- White Box – Narrow-leaved Ironbark - White Cypress Pine grassy open forest
- White Box – Narrow-leaved Ironbark - White Cypress Pine shrubby open forest
- White Box – White Cypress Pine grassy woodland
- White Box- Blakely's Red Gum - Melaleuca riparian forest
- Yellow Box - Blakely's Red Gum grassy woodland

Figure 3-7 - Vegetation Communites (PB 2009)

Table 3-3 Vegetation communities identified within the Project Boundary

Vegetation community name	Description	Corresponding Threatened ecological community[1]	Corresponding Leard State Forest vegetation Association (James B. Croft and Associates 1983)	Corresponding broad vegetation community NSW Department of Land and Water Conservation (2002)	Corresponding broad vegetation community Brigalow Belt South Bioregion (Planning 2004)	Corresponding community within Vegetation Type Database (DECC 2009)
Grassy Woodlands on fertile soils						
White Box – White Cypress Pine grassy woodland	Grassy woodland, dominated by *E. albens,* and occasionally *E. blakelyi* on lower footslopes and flats. The shrub layer was sparse with occasions of isolated dense pioneer species including *Dodonaea* spp., *Geijera parviflora, Cassinia* spp and *Acacia* spp. The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Cyperus gracilis, Austrodanthonia racemosa, Bothriochloa macra, Desmodium brachypodum, Aristida ramose, Calotis spp., Vittadinia spp., Chloris truncata* and *Cymbopogon refractus.* Occurs on fertile loamy-clay basalt derived soils on slopes, drainage lines and alluvial plains.	Box-Gum Woodlands (TSC Act and EPBC Act)	5. White Box and 2. White Box/White Cypress Pine	1c. Slopes Grassy Woodlands – *Eucalyptus albens/Eucalyptus melanophloia/Callitris glaucophylla.*	22. Eastern cypress grass/herb woodland – *Callitris glaucophylla/Austrodanthonia racemosa/Calotis lappulacea.*	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions.
White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest	Grassy woodland, dominated by *E. albens* and *E. crebra* on lower and mid slopes and flats. The shrub layer was generally sparse with occasions of isolated dense pioneer species including *Pimelea neo-anglica*, *Dodonaea* spp., *Beyeria viscosa*, *Cassinia* spp and *Acacia* spp. The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Austrostipa scabra, Cyperus gracilis, Austrodanthonia racemosa, Desmodium, Aristida ramosa, Calotis spp., Vittadinia spp., Cymbopogon refractus. Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.* Occurs usually on basalt, but often on sandstone where there is basalt influence and may occur on other substrates. This community is upslope of the adjoining White Box – White Cypress Pine grassy woodland.	Box-Gum Woodlands (TSC Act and EPBC Act)	4. Ironbark and 3. Ironbark/White Box/Cypress Pine	1b. White Cypress (*Callitris glaucophylla)* and Ironbark (*Eucalyptus crebra) Forests – Callitris glaucophylla/Eucalyptus crebra/Eucalyptus albens.*	A combination of the following two vegetation communities: 22. Eastern cypress grass/herb woodland – *Callitris glaucophylla/Austrodanthonia racemosa/Calotis lappulacea.* 25. Basalt slopes box woodland – *Eucalyptus. albens/ Poa sieberiana/Cassinia quinquefaria.*	White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions.
Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland	Grassy woodland/open forest, dominated by *Eucalyptus pilligaensis* and *Eucalyptus populnea subsp. bimbil* with a dense subcanopy of *Callitris glaucophylla, Allocasuarina luehmannii* on alluvial flats and plains of peneplains or plains landforms. The native understorey was dominated mainly by *Geijera parviflora, Cassinia aculeate* and *Acacia deanei.* over a mixture of grasses, sedges and a range of small herbs including *Enchylaena tomentosa, Einadia nutans subsp. linifolia, Austrostipa scabra subsp. scabra, Austrostipa verticillata, Calotis cuneifolia, Vittadinia cervicularis var. cervicularis.*	–	6. Pilliga Box/Bimble Box/Belah	3d. Dry Scrub – *Eucalyptus albens/Eucalyptus populnea/Eucalyptus pilligaensis/Callitris glaucophylla.*	68. Pilliga cypress/box herb woodland – *Callitris glaucophylla/E. populnea/Enchylaena tomentose.*	Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Benson 88).

Vegetation community name	Description	Corresponding Threatened ecological community[1]	Corresponding Leard State Forest vegetation Association (James B. Croft and Associates 1983)	Corresponding broad vegetation community NSW Department of Land and Water Conservation (2002)	Corresponding broad vegetation community Brigalow Belt South Bioregion (Planning 2004)	Corresponding community within Vegetation Type Database (DECC 2009)
Weeping Myall open woodland	Disturbed Open Woodland, dominated by *Acacia pendula* on flats and undulating rises. The native understorey was dominated mainly by *Cassinia aculeate* and *Acacia deanei.* over a mixture of grasses, sedges and a range of small herbs including *Sclerolaena muricata Maireana* sp., *Enchylaena tomentosa, Einadia nutans subsp. linifolia, Chloris truncata* and *Austrostipa scabra subsp. scabra.* Occurs on dark black clay soil flats or undulating rises on broad alluvial plains or outer floodplains that rarely flood.	Weeping Myall Woodland (TSC Act and EPBC Act)	–	4b. Myall (*Acacia pendula)* Woodlands.	180. Clay plain acacia woodland – *Acacia pendula/Astrebla lappacea.*	Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions (Benson 27).
Shrubby Woodland/Open Forest on skeletal soils						
White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest	Shrubby woodland, dominated by *E. albens* and *E. crebra* with a dense subcanopy of *Callitris glaucophylla* on mid slopes. The shrub layer was dense with dominant species including *Notelaea microcarpa var. microcarpa Olearia elliptica Geijera parviflora, Dodonaea viscosa subsp. angustifolia Bursaria spinosa subsp. spinosa Pimelea neo-anglica*, *Beyeria viscosa*, *Cassinia* spp and *Acacia* spp. The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Austrostipa scabra, Cyperus gracilis, Austrodanthonia racemosa, Desmodium, Aristida ramosa, Calotis spp., Vittadinia spp., Cymbopogon refractus. Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.* Occurs usually on skeletal soil basalt derived soils over conglomerate. This community is generally upslope of the adjoining White Box – Narrow-leaved Ironbark - White Cypress Pine grassy open forest.	–	3. Ironbark/White Box/Cypress Pine	1b. White Cypress (*Callitris glaucophylla)* and Ironbark (*Eucalyptus crebra) Forests – Callitris glaucophylla/Eucalyptus crebra/Eucalyptus albens.*	28. Eastern shrubby cypress/box woodland – *Callitris glaucophylla/E. albens/Notelaea macrocarpa.*	Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion.

Vegetation community name	Description	Corresponding Threatened ecological community[1]	Corresponding Leard State Forest vegetation Association (James B. Croft and Associates 1983)	Corresponding broad vegetation community NSW Department of Land and Water Conservation (2002)	Corresponding broad vegetation community Brigalow Belt South Bioregion (Planning 2004)	Corresponding community within Vegetation Type Database (DECC 2009)
White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest	Shrubby woodland, dominated *E. crebra* with occasional subdomant *Eucalyptus dwyeri* and with a dense subcanopy of *Callitris glaucophylla* on mid – upper slopes. The shrub layer was dense with dominant species including *Acacia leiocalyx, Acacia cheelii, Melichrus urceolatus, Canthium odoratum, Notelaea microcarpa var. macrocarpa, Olearia elliptica, Dodonaea viscosa subsp. angustifolia Bursaria spinosa subsp. spinosa Pimelea neo-anglica*, *Cassinia* spp and *Acacia* spp. The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Aristida ramosa Austrostipa scabra,* Pomax umbellata Desmodium brachypodum, *Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.* Occurs usually on skeletal soil basalt derived soils over conglomerate. This community is generally upslope of the adjoining White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest.	–	1. Ironbark/ Cypress Pine	1b. White Cypress (*Callitris glaucophylla)* and Ironbark (*Eucalyptus crebra)* Forests – *Callitris glaucophylla/Eucalyptus crebra/Eucalyptus albens.*	33. Eastern grassy cypress woodland – *C. glaucophylla/Austrostipa scabra/Aristida benthamii.*	White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion.
Silver-leaved Ironbark heathy woodland	Shrubby woodland, dominated *E. melanophloia* and *E. crebra* with a dense subcanopy of *Callitris glaucophylla* on upper slopes. The shrub layer was moderate to sparse with dominant species including *Acacia leiocalyx, Acacia cheelii, Melichrus urceolatus, Notelaea microcarpa var. macrocarpa, Dodonaea viscosa subsp. angustifolia.* The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Aristida ramosa Pomax umbellata Austrostipa scabra, Desmodium brachypodum, Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.* Occurs usually on skeletal soil basalt derived soils over conglomerate. This community is generally upslope of the adjoining White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest.	–	7. Silver-leafed Ironbark/Cypress Pine	1c. Slopes Grassy Woodlands – *Eucalyptus albens/Eucalyptus melanophloia/Callitris glaucophylla.*	32. Eastern shrubby ironbark/cypress woodland – *E. melanophloia/Callitris glaucophylla/Notelaea macrocarpa.*	White Cypress Pine – White Box – Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion.

Vegetation community name	Description	Corresponding Threatened ecological community[1]	Corresponding Leard State Forest vegetation Association (James B. Croft and Associates 1983)	Corresponding broad vegetation community NSW Department of Land and Water Conservation (2002)	Corresponding broad vegetation community Brigalow Belt South Bioregion (Planning 2004)	Corresponding community within Vegetation Type Database (DECC 2009)
Narrow-leaved Ironbark – pine – Brown Bloodwood shrub/grass open forest	Shrubby woodland, dominated *E. crebra* and *Corymbia trachyphloia subsp. amphistomatica* with occasional E dwyeri and a dense subcanopy of *Callitris glaucophylla* on upper slopes. The shrub layer was moderate to sparse with dominant species including *Melichrus urceolatus, Notelaea microcarpa var. macrocarpa, Hovea lanceolata Olearia elliptica, Dodonaea viscosa subsp. angustifolia.* The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Joycea pallida Dichelachne micrantha Austrostipa scabra, , Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Lepidosperma laterale*, *Goodenia hederacea subsp. hederacea* and *Cheilanthes sieberi subsp. seeberi.* Occurs usually on skeletal sedimentary soil derived from sandstone and conglomerate. This community is restricted to an area of steep south-easterly aspect upper slope.	–	1. Ironbark/ Cypress Pine	2a. Shrubby Sandstone Forests – *Callitris endicheri/Eucalyptus crebra/E. dealbata/Corymbia trachyphloia*.	61. Basalt shrubby ironbark woodland – *E. crebra/Olearia elliptica*.	Narrow-leaved Ironbark – pine – Brown Bloodwood shrub/grass open forest in the north west of the Nandewar Bioregion.
Dwyer's Red Gum woodland	Shrubby woodland, dominated *Eucalyptus dwyeri* and *E. crebra* and a dense subcanopy of *Acacia cheelii, Callitris endlicheri and C. glaucophylla* on upper slopes. The shrub layer was moderate to sparse with dominant species including *Melichrus urceolatus, Beyeria viscose, Notelaea microcarpa var. macrocarpa, Hovea lanceolata Olearia elliptica, Dodonaea viscosa subsp. angustifolia.* The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Joycea pallida Dichelachne micrantha Austrostipa scabra, , Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Lepidosperma laterale*, *Goodenia hederacea subsp. hederacea* and *Cheilanthes sieberi subsp. sieberi.* Occurs usually on skeletal sedimentary soil derived from sandstone and conglomerate. This community is restricted to steep upper slopes with a southern aspect.	–	1. Ironbark/ Cypress Pine	2a Shrubby Sandstone Forests – *Callitris endicheri/Eucalyptus crebra/E. dealbata/Corymbia trachyphloia*.	61. Basalt shrubby ironbark woodland – *E. crebra/Olearia elliptica*.	Dwyer's Red Gum woodland on siliceous substrates in the Brigalow Belt South Bioregion [NA 138].

Vegetation community name	Description	Corresponding Threatened ecological community[1]	Corresponding Leard State Forest vegetation Association (James B. Croft and Associates 1983)	Corresponding broad vegetation community NSW Department of Land and Water Conservation (2002)	Corresponding broad vegetation community Brigalow Belt South Bioregion (Planning 2004)	Corresponding community within Vegetation Type Database (DECC 2009)
Native Olive Dry Gully Forest	Dense shrubby Open Forest/Scrub, dominated by *Notelaea microcarpa var. microcarpa, Alphitonia excelsa Solanum sp, Canthium oleifolium, Coolibah (Acacia salicina), Ventilago viminalis, Wild Quince (Alectryon subdentatus), Red Ash (Alphitonia excelsa).* The shrub layer was moderate with dominant species including *Jasminum lineare Notelaea microcarpa var. macrocarpa, Olearia elliptica, Dodonaea viscosa subsp. angustifolia.* The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Oplismenus aemulus, Microlaena stipoides var. stipoides, Dichondra species A, Pellaea calidirupium, Adiantum sp* . Occurs within two small sections of sheltered rocky gullies and slopes with skeletal conglomerate.	–		3c. Dry Rainforest –*Notelaea microcarpa/Pittosporum undulatum/Ficus rubiginosa.*	61. Basalt shrubby ironbark woodland – *E. crebra/Olearia elliptica.*	Rusty Fig – Wild Quince – Native Olive dry rainforest of rocky areas of the Nandewar Bioregion.
Riverine Woodlands						
River Red Gum riverine woodlands and forests	Grassy woodland, dominated by *E. camaldulensis and occasionally E. mellidora* on river banks and adjacent flats along major watercourses. The native understorey was dominated mainly by a mixture of grasses, sedges and a range of small herbs including *Cynodon dactylon Carex inversa* and *C. appressa*, *Cyperus* sp., *Eleocharis* sp. Shrubs may be absent in heavily grazed and eroded areas. Occurs on alluvial sandy loam soils.	–	–	4c. Floodplain Woodlands – *Eucalyptus camaldulensis, E. populnea, E. microcarpa* and *E. mellidora.*	158. Northern floodplain woodland – *E. camaldulensis/Leptochloa digitata/Cynodon dactylon.*	River Red Gum riverine woodlands and forests in the Nandewar and Brigalow Belt South Bioregions.
Yellow Box – Blakely's Red Gum grassy woodland	Grassy Woodland up to 20 m in height dominated by *E. blakelyi* with occasional *E. melliodora* restricted to minor drainage lines and adjoining flats. The shrub layer was sparse to moderate with rare occurrences *Dodonaea spp.*, and *Acacia deanei.* The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Chloris truncata, Bothriochloa macra, Microlaena stipoides var. stipoides, Lomandra longifolia, Austrostipa verticillata.* Occurs on fertile loamy soils associated with drainage lines and alluvial plains.	Box-Gum Woodlands (TSC Act and EPBC Act)	8. Red Gum/ Cypress Pine	1d. Footslopes Woodland – *Eucalyptus melliodora/Angophora floribunda/Eucalyptus blakelyi.*	18. Eastern angophora herb woodland – *Angophora floribunda/Geranium solanderi.*	Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion.

Vegetation community name	Description	Corresponding Threatened ecological community[1]	Corresponding Leard State Forest vegetation Association (James B. Croft and Associates 1983)	Corresponding broad vegetation community NSW Department of Land and Water Conservation (2002)	Corresponding broad vegetation community Brigalow Belt South Bioregion (Planning 2004)	Corresponding community within Vegetation Type Database (DECC 2009)
White Box – Melaleuca riverine forest	Grassy woodland, dominated by *Melaleuca bracteata* and occasionally *Eucalyptus albens* on creek banks and adjacent flats. The native understorey was dominated mainly by *Melaleuca bracteata Acacia deanei* over a mixture of grasses, sedges and a range of small herbs including *Oplismenus aemulus, Microlaena stipoides var. stipoides, Austrostipa verticillata, Dichondra repens, Carex inversa* and *C. appressa*, *Cyperus* sp., *Eleocharis* sp. Shrubs may be absent in heavily grazed and eroded areas. Occurs on alluvial sandy loam soils.	–	–	4f. River Oak (*Casuarina cunninghamiana)* and Black Tea Tree (*Melaleuca bracteata)* Riparian Woodlands.	49. Riparian melaleuca woodland – *Melaleuca bracteate*.	River Oak riparian woodland of the Brigalow Belt South and Nandewar Bioregions (Benson 84).
Grasslands						
Derived Native Grassland	Derived Native Grassland would have once been Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland. The native understorey was dominated mainly by a mixture of grasses, sedges and a range of small herbs including *Austrostipa verticillata, Einadia nutans subsp. nutans, Austrostipa scabra, Elymus scaber, Austrodanthonia sp*. Occurs on texture contrast red or brown earths or grey clay soils.	–	–	1e. Slopes Grasslands – *Bothriochloa decipiens, Austrostipa verticillata, Austrostipa scabra*.	68. Pilliga cypress/box herb woodland - *Callitris glaucophylla/E. populnea/Enchylaena tomentosa* and a combination of 171. Grassland - *Austrostipa verticillata/Rhagodia spinescens* This community is highly disturbed and thus has elements of both these broadly mapped vegetation communities.	Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone. (Low Condition).
Plains Grassland	Tall tussock closed or open grassland with scattered trees <10% canopy cover comprising *Eucalyptus melliodora, Eucalyptus populnea subsp. bimbil, Eucalyptus albens*. The native understorey was dominated mainly by a mixture of grasses, sedges and a range of small herbs including; *Austrostipa aristiglumis, Dichanthium sericeum subsp. sericeum, Panicum queenslandicum var. queenslandicum, Sclerolaena muricata, Austrodanthonia bipartita, Aristida leptopoda, Leiocarpa panaetioides, Vittadinia cuneata, Carex inverse.* Occurs on deep, black alluvial cracking clay-loam (black earths) soils derived from basalt.	Native Vegetation on Cracking Clay Soils of the Liverpool Plains (TSC Act) and the Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld (EPBC Act).	–	3g. Black Earth Grasslands – *Austrostipa aristiglumis/Aristida leptopoda*.		Plains Grass grassland on basaltic black earth soils mainly on the Liverpool Plains in the Brigalow Belt South Bioregion (Benson 102).
Exotic grassland	Highly disturbed low tussock closed or open grassland. The understorey is dominated by exotic and cultivate native pasture grass and exotic herbs. The dominant species include *Aristida ramosa, Enchylaena tomentosa, Galenia pubescens, Paspalum dilatatum, Chloris gayana, Lolium perenne, Cynodon dactylon, Trifolium repens, Senecio madagascariensis, Pennisetum clandestinum, Cirsium vulgare, Sida rhombifolia* and *Brassica sp*. Occurs on texture contrast red or brown earths or grey clay soils.	–	–	5a Man-Made Features.	–	NA

Note: 1 – The Critically Endangered Ecological Community, White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland as described under the EPBC Act has condition criteria as described in Section 4.

3.3.4 Grassy Woodlands on fertile soils

White Box – White Cypress Pine grassy woodland

This community is consistent with Box-Gum Woodlands listed as an endangered ecological community under the TSC Act, and Box-Gum Woodlands, listed as critically endangered under the EPBC Act.

White Box – White Cypress Pine grassy woodland was present as woodland up to 20 m in height dominated by a *Eucalyptus albens* canopy with 15-30% foliage cover (Photograph 3-1). It occurred on the lower slopes and alluvial plains mainly on sedimentary substrates (Figure 3-7).

Photograph 3-1 White Box – White Cypress Pine grassy woodland within the Project Boundary

This vegetation community was recorded on the lower slopes and depression on the floodplain throughout the southern portion of the Project Boundary and as isolated remnants within the proposed rail loop.

The age classes of the canopy *Eucalyptus albens* within the Project Boundary was predominantly limited to semi-mature regrowth resulting from past logging. Very few large hollow-bearing trees were recorded. A sub canopy of *Callitris glaucophylla* was also present.

The shrub layer throughout most of the community was generally sparse (15-25% cover), dominated by the species *Acacia decora, Beyeria viscosa, Geijera parviflora, Cassinia* spp and *Dodonaea viscosa.* While isolated areas of dense shrub cover (approximately 30-50% cover) were observed, these were typically associated with past logging disturbances or minor topographic features such as drainage lines. The groundcover typically contained 50-60% cover and was dominated by a diverse range of grasses and herbs including, *Cyperus gracilis, Austrodanthonia racemosa, Bothriochloa macra, Desmodium brachypodum, Aristida ramosa, Calotis cuneifolia, Brunoniella australis, Swainsona galegifolia, Austrostipa spp*. *Vittadinia cuneata, Dichondra repens* and *Lomandra multiflora*.

The White Box – White Cypress Pine Woodland in the Project Boundary was in moderate to good condition, with high native species diversity and low weed density. While the majority of the community has been subjected to forestry operations in the past only minor changes in structure were observed, minor clearing associated with existing access tracks was also observed. The edge effects along the adjoining roads were the main source of current disturbance.

White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest

This community is consistent with Box-Gum Woodlands listed as an endangered ecological community under the TSC Act, and Box-Gum Woodlands, listed as critically endangered under the EPBC Act.

White Box – Narrow-leaved Ironbark – White Cypress Pine grassy woodland had a percent canopy cover of 20-35%, up to 20 m in height and dominated by *Eucalyptus albens* and *E. crebra* (Photograph 3-2). It occurred on the lower slopes and alluvial plains mainly on sedimentary substrates (Figure 3-7).

Photograph 3-2 White Box – Narrow-leaved Ironbark – White Cypress Pine grassy woodland within the Project Boundary

This vegetation community was recorded on the lower to mid slopes, particularly west of Leard State Forest Road. It occurred usually on basalt derived soils, or other sedimentary substrates where there is basalt influence. This community is generally upslope of the adjoining White Box – White Cypress Pine grassy woodland.

The age classes of the canopy *Eucalyptus albens* and *E. crebra*, was largely limited to semi-mature regrowth as a result of past logging. Very few large hollow-bearing trees were recorded. A moderately dense sub canopy of *Callitris glaucophylla* was also present.

The shrub layer was generally sparse (15-25% cover), with occasions of isolated dense pioneer species including *Pimelea neo-anglica*, *Dodonaea* spp., *Beyeria viscosa*, *Cassinia* spp. and *Acacia* spp. The groundcover typically contained 40-60% cover and was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Austrostipa scabra, Austrodanthonia racemosa, Chrysocephalum semipapposum, Aristida ramosa, Calotis* spp.,

Vittadinia spp.*, Cymbopogon refractus, Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.*

The White Box – Narrow-leaved Ironbark – White Cypress Pine grassy woodland in the Project Boundary was in moderate to good condition, with high native species diversity and low weed density. The majority of the community has been subjected to forestry operations in the past, while minor clearing associated with existing access tracks was also observed. The edge effects along the adjoining roads were the main source of disturbance within this community.

Pilliga Box – Poplar Box – White Cypress Pine grassy woodland

Pilliga Box – Poplar Box – White Cypress Pine grassy woodland was a woodland community up to 25 m in height dominated by *Eucalyptus pilligaensis* and *Eucalyptus populnea subsp. bimbil* with a dense subcanopy (50-75% cover) of *Casuarina cristata* ssp*. cristata, Callitris glaucophylla* and *Allocasuarina luehmannii*.

Within the Project Boundary this community consisted predominantly of a large remnant patch on the southern perimeter of Leard State Forest associated with alluvial flats and plains of peneplains (Photograph 3-3). There was also a narrow remnant of semi-continuous canopy and isolated trees along Leard State Forest road corridor and adjoining paddocks (Figure 3-7).

Photograph 3-3 Pilliga Box – Poplar Box – White Cypress Pine grassy woodland in the Project Boundary

This community shares similar habitat conditions with the adjoining White Box – White Cypress Pine grassy woodland and Blakely's Red Gum – Yellow Box grassy woodland. The dominant eucalypts ranged in age from older hollow-bearing (habitat) trees to young regrowth within the road reserves.

The native understorey was dominated mainly by sparse (5-20% cover) shrub layer dominated by *Geijera parviflora, Cassinia aculeata* and *Acacia deanei*. over a dense (60-85% cover) mixture of grasses, sedges and a range of small herbs including *Enchylaena tomentosa, Einadia nutans*

subsp. linifolia, Austrostipa scabra subsp*. scabra, Austrostipa verticillata, Calotis cuneifolia and Vittadinia cervicularis* var*. cervicularis*.

Some of the isolated paddock and roadside patches were highly disturbed by past land uses, including, grazing and other agricultural practices. These disturbances have fragmented the vegetation community and modified the floristic composition and structure.

While the majority of patches of this community were in moderate condition, with a mix of native and exotic groundcover species, most contained large areas dominated by native species. Many of the exotic species observed were 'pasture improvement' species used to improve soil conditions and/or provide feed for grazing stock in the adjoining pastures. The most abundant exotic species within the community were; *Cirsium vulgare Chloris gayana*, *Conyza albida, Lepidium africanum, Verbena officinalis, Hypochaeris radicata* and *Paspalum urvillei.*

Weeping Myall Open Grassy Woodland

This community is consistent with Weeping Myall Woodland listed as an Endangered Ecological Community under the TSC Act and the EPBC Act.

Weeping Myall Open Grassy Woodland is a disturbed open woodland community up to 10 m high dominated by *Acacia pendula* (Photograph 3-4).

Within the Project Boundary this community consisted of a small (<2 ha) isolated patch within the central portion of the rail loop corridor on black clay soil flats and undulating rises of the broad alluvial plain Figure 3-7).

Photograph 3-4 Weeping Myall Woodland in the Project Boundary

This community consisted of an apparently single age cohort of mature *Acacia pendula.* There were no hollow bearing trees or recruitment cohorts observed.

The shrub layer throughout most of the community was sparse (<5%), with only isolated *Acacia spp.* The groundcover was densely cover (60-75% cover) by a diverse range of chenopods, grasses and herbs including; *Sclerolaena muricata, Maireana* sp., *Enchylaena tomentosa, Einadia nutans* subsp*. linifolia, Chloris truncata and Austrostipa scabra* subsp*. scabra.*

The Weeping Myall Open Woodland in the Project Boundary was in poor condition, with moderate native species diversity and weed density. The majority of the community has been subjected to past land uses, including, grazing and other agricultural practices resulting in significant loss in the native diversity and cover, while edge effects along the adjoining haul road were also a source of disturbance.

3.3.5 Shrubby Woodland/Open Forest on skeletal soils

White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest

White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest was an open forest community with canopy cover of 30-35%, up to 20 m in height and dominated by *Eucalyptus albens* and *E. crebra.* A moderately dense (40%) sub canopy of *Callitris glaucophylla* was also present throughout (Photograph 3-5).

This community contains a number of characteristic species, including the canopy species *Eucalyptus albens* of the Critically Endangered Ecological Community, Box-Gum Woodlands as listed under the EPBC Act and Endangered Ecological Community Box-Gum Woodlands community listed under the TSC Act. However, was excluded from the classification due to the following reasons:

- It contained a continuous shrub layer with greater than 30% foliage cover comprising a mixture of non-pioneer shrub species (i.e. it was not grassy) (Gibbons & Boak 2000).
- It was restricted to steep, skeletal, rocky soils of low fertility.

Photograph 3-5 White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest within the Project Boundary

This vegetation community was recorded throughout the Project Boundary on the mid-upper slopes usually on skeletal soils over conglomerate This community is generally upslope of the adjoining White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest (Figure 3-7).

The age classes of the canopy *E. crebra*, was predominately limited to semi-mature regrowth from past logging. Very few large hollow-bearing trees were recorded. The shrub layer was

continuous and dense (40-65% cover) with dominant species including; *Notelaea microcarpa var. macrocarpa, Olearia elliptica, Geijera parviflora, Dodonaea viscosa subsp. angustifolia Bursaria spinosa subsp. spinosa, Pimelea neo-anglica, Beyeria viscosa, Cassinia spp and Acacia* spp.

The groundcover was sparse to moderately dense cover (40-60%), made up of diverse range of grasses forbs and sedges including *Austrostipa scabra, Cyperus gracilis, Austrodanthonia racemosa, Desmodium brachypodum, Aristida ramosa, Calotis* spp., *Vittadinia* spp., *Cymbopogon refractus, Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.*

The White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest in the Project Boundary was in good condition, with high native species diversity and low weed density. The majority of the community has been subjected to forest operations in the past, while minor clearing associated with existing access tracks was also observed. The edge effects along the adjoining roads were the main source of disturbance.

White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest

White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest was an open forest community with canopy cover of 30-35%, and up to 22 m in height and dominated *E. crebra* with occasional subdominants *Eucalyptus dealbata and E. dwyeri* and a dense (50-70% cover) sub canopy of *Callitris glaucophylla* (Figure 3-7).

Photograph 3-6 Narrow-leaved Ironbark – White Cypress Pine shrubby open forest within the Project Boundary

This vegetation community was recorded throughout the Project Boundary on the upper slopes usually on skeletal soils over conglomerate. This community was generally upslope of the adjoining White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest.

The age classes of the canopy *E. crebra*, was predominately limited to semi-mature regrowth from past logging. Very few large hollow-bearing trees were recorded. A sub canopy of *Callitris glaucophylla* was also present.

The shrub layer was generally dense (35-60% cover) with dominant species including; *Acacia leiocalyx, Acacia cheelii, Melichrus urceolatus, Canthium odoratum, Notelaea microcarpa var. macrocarpa, Olearia elliptica, Dodonaea viscosa subsp. angustifolia Bursaria spinosa subsp. spinosa Pimelea neo-anglica, Cassinia* spp and *Acacia* spp.

The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Aristida ramosa Austrostipa scabra, Pomax umbellata Desmodium brachypodum, Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.*

The Narrow-leaved Ironbark – White Cypress Pine shrubby open forest in the Project Boundary was in moderate to good condition, with high native species diversity and low weed density. The majority of the community has been subjected to forest operations in the past, while minor clearing associated with existing access tracks was also observed. The edge effects along the adjoining roads were the main source of disturbance.

Silver-leaved Ironbark shrubby woodland

Silver-leaved Ironbark shrubby woodland was a woodland community with canopy cover of 20-25%, up to 18 m in height and dominated by *Eucalyptus melanophloia* and *E. crebra* with a dense (>50% cover) sub canopy of *Callitris glaucophylla* on upper slopes (Photograph 3-7).

Photograph 3-7 Silver-leaved Ironbark shrubby woodland within the Project Boundary

This vegetation community was recorded as a number of small patches within the Leard State Forest on the upper south easterly facing slopes, usually on skeletal soils over conglomerate. This community was generally adjoining the Narrow-leaved Ironbark – White Cypress Pine shrubby open forest.

This community shares similar conditions with the adjoining Narrow-leaved Ironbark – White Cypress Pine shrubby woodland. The dominant eucalypts ranged in age from older hollow-bearing (habitat) trees to young regrowth within the road reserves.

The shrub layer was generally dense (50-75% cover) with dominant species including *Acacia cheelii, Melichrus urceolatus, Canthium odoratum, Notelaea microcarpa* var*. macrocarpa, Dodonaea viscosa subsp. angustifolia* and *Cassinia* spp.

The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Aristida ramosa Austrostipa scabra, Pomax umbellata Desmodium brachypodum, Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Cheilanthes distans* and *Rostellularia adscendens* ssp *adscendens* var *pogonanthera.*

The Silver-leaved Ironbark shrubby woodland in the Project Boundary was in moderate to good condition, with high native species diversity and low weed density. The majority of the community has been subjected to forest operations in the past, while clearing associated with existing access tracks was also observed. Edge effects along the adjoining roads were the main source of disturbance.

Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest

Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest was an open forest with canopy cover of 30-40%, up to 20 m in height and dominated *Eucalyptus crebra* and *Corymbia trachyphloia subsp. amphistomatica* with occasional *E. dwyeri* and a dense sub canopy of *Callitris glaucophylla* (Photograph 3-8).

Photograph 3-8 Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest

This vegetation community was restricted to a small patch on an upper south-eastern facing slope over skeletal sedimentary soils. This community is generally upslope of the adjoining Narrow-leaved Ironbark – White Cypress Pine shrubby open forest.

This community shares similar conditions with the adjoining Narrow-leaved Ironbark – White Cypress Pine shrubby woodland. The dominant eucalypts ranged in age from older hollow-bearing (habitat) trees to young regrowth within the road reserves.

The shrub layer was moderate to sparse with dominant species including *Melichrus urceolatus, Notelaea microcarpa* var*. macrocarpa, Pultenaea sp?* and *Hovea lanceolata.*

The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Joycea pallida Dichelachne micrantha Austrostipa scabra, , Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Lepidosperma laterale, Goodenia hederacea subsp. hederacea* and *Cheilanthes sieberi subsp. sieberi.*

The Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest in the Project Boundary was in good condition, with high native species diversity and low weed density. The majority of the community has been subjected to forest operations in the past, while minor clearing associated with existing access tracks was also observed. The edge effects along the adjoining roads were the main source of disturbance.

Dwyer's Red Gum woodland

Dwyer's Red Gum woodland was a woodland with canopy cover of 15-25%, up to 15 m in height and dominated by *Eucalyptus dwyeri* and *E. crebra* and a dense (>60% cover) sub canopy of *Acacia cheelii, Callitris endlicheri an C. glaucophylla* (Photograph 3-9).

Photograph 3-9 Dwyer's Red Gum woodland within the Project Boundary

This vegetation community was restricted to a small number of patches on the upper slopes and ridges over skeletal conglomerate soils. This community is generally upslope of the adjoining Narrow-leaved Ironbark – White Cypress Pine shrubby open forest.

This community shares similar habitat conditions with the adjoining Narrow-leaved Ironbark – White Cypress Pine shrubby woodland. The dominant eucalypts ranged in age from semi-mature trees to young regrowth.

The shrub layer was moderate to sparse with dominant species including *Melichrus urceolatus, Notelaea microcarpa* var*. macrocarpa* and *Cassinia* spp*.*

The groundcover was made up of diverse range of grasses intermingled with a range of forbs and sedges including *Joycea pallida, Dichelachne micrantha, Pomax umbellata, Austrostipa scabra, Austrodanthonia racemosa, Aristida ramosa, Calotis spp., Lepidosperma laterale, Goodenia hederacea subsp. hederacea* and *Cheilanthes sieberi subsp. sieberi*.

The Dwyer's Red Gum woodland in the Project Boundary was in moderate to good condition, with high native species diversity and low weed density. The majority of the community has been subjected to forest operations in the past, while minor clearing associated with existing access tracks was also observed. The edge effects along the adjoining roads were the main source of disturbance.

Native Olive dry gully forest

Native Olive dry gully forest is a dense open forest to scrub with a canopy cover of 50-70%, up to 15 m in height and dominated by dominated by *Notelaea microcarpa* var*. microcarpa, Alphitonia excelsa* and *Canthium oleifolium* (Photograph 3-10).

Photograph 3-10 Native Olive dry gully forest within the Project Boundary

This vegetation community was restricted to two very small south facing sections of a sheltered rocky gullies and slopes over skeletal conglomerate.

The shrub layer throughout most of the community was dense, dominated by the species; *Jasminum lineare, Notelaea microcarpa* var*. macrocarpa, Olearia elliptica* and *Dodonaea viscosa subsp. angustifolia*.

The groundcover was made up of diverse range of grasses intermingled with a range of forbs and ferns including; *Oplismenus aemulus, Microlaena stipoides* var*. stipoides,* and *Dichondra sp.*

The Native Olive dry gully forest in the Project Boundary was in good condition, with high native species diversity and low weed density. The only disturbances within this community were likely to be associated with edge effects from forest operations in the past.

3.3.6 Riverine woodlands

River Red Gum riverine woodland

River Red Gum riverine woodland was a woodland with a variable canopy cover of 10-25%, up to 25 m in height dominated by *E. camaldulensis* (River Red Gum).

Within the Project Boundary this community was typically comprised of a disturbed open woodland within the floodplain depressions and dry billabongs surrounding the Namoi River (Photograph 3-11).

Photograph 3-11 River Red Gum riverine woodland

A range of age classes of *E. camaldulensis* occurred within in the Project Boundary, including large hollow-bearing trees as well as patches of *E. camaldulensis* regrowth within the creek channel.

There was no shrub layer within this community. The groundcover on the creek banks and floodplains was dominated by a mixture of native and exotic rushes and sedges, pasture improvement species and weeds, including *Cynodon dactylon, Carex inversa and C. appressa, Cyperus sp., Eleocharis sp, Hordeum leporinum, Vulpia myuros, Lythrum hyssopifolia, Lolium perenne, Conium maculatum, Vicia sativa subsp. nigra, Xanthium occidentale, Phalaris aquatica* and *Bromus molliformis*. The tops of the banks of the Namoi River had severe weed infestations from *Vicia sativa subsp. nigra* (Vetch) in some areas.

Pools and sediment deposits within the active creek channel were dominated by sedges, rushes and aquatic species, including *Persicaria decipiens, Phragmites australis, Carex appressa, Juncus usitatus* and *Triglochin procera.*

The riparian variation of this community was affected by a range of disturbances, including grazing livestock and past clearing for pasture improvements. The condition of this community was typically poor.

Yellow Box – Blakely's Red Gum grassy woodland

This community is consistent with Box-Gum Woodlands listed as an endangered ecological community under the TSC Act, and Box-Gum Woodlands, listed as critically endangered under the EPBC Act.

Yellow Box – Blakely's Red Gum grassy woodland was a woodland community with a canopy cover of 25%, up to 25 m in height dominated by *E. blakelyi* and occasionally *E. melliodora* and *E. albens*.

The community consisted of small, narrow pocket remnants of semi-continuous canopy (Figure 3-7), typically associated with minor ephemeral creek lines and fertile soils on lower slopes and plains (Photograph 3-12).

Photograph 3-12 Yellow Box – Blakely's Red Gum grassy woodland within the Project Boundary

The age classes of the canopy *E. blakelyi* and occasionally *E. melliodora* within the Project Boundary, was predominately limited to semi-mature regrowth from past logging. Very few large hollow-bearing trees were recorded.

The shrub layer throughout most of the community was moderate (20-30% cover), dominated by the species *Acacia deanei,* and *Dodonaea spp.* The groundcover was dominated by a diverse range of grasses and herbs intermingled with a range of forbs and sedges including *Chloris truncata ,Bothriochloa macra, Microlaena stipoides var. stipoides, Lomandra longifolia, Austrostipa verticillata*.

The remnants of the Yellow Box – Blakely's Red Gum grassy woodland in the vegetated areas of Leard State Forest were in moderate condition, with high native species diversity and low weed density. The areas of this community within the predominantly cleared paddocks south of Leard State Forest were considered to be of low condition due to the significantly greater weed density. The majority of the community has been subjected to forest operations in the past, while minor clearing associated with existing access tracks and the construction of Boggabri Coal Mines clean water diversion drain. Areas of this community within the predominantly cleared paddocks

south of Leard State Forest have been subjected to a wide range of agricultural disturbances, including, clearing, grazing, pasture improvements, construction of agricultural infrastructure and exotic weed infestations. The edge effects along the Leard State Forest road were also a source of disturbance.

This community is consistent with White Box Yellow Box Blakely's Red Gum Woodland community listed as an Endangered Ecological Community under the TSC Act, and White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands, which are listed as Critically Endangered under the EPBC Act.

White Box – Melaleuca riverine forest

This community contains a number characteristic species, including the canopy species *Eucalyptus albens* of the Critically Endangered Ecological Community, White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland as listed under the EPBC Act and Endangered Ecological Community listed under TSC Act. However, it was excluded from the classification due to the following reasons:

- It contained a continuous shrub layer with greater than 30% foliage cover comprising a mixture of non-pioneer shrub species (i.e. it was not grassy) (Department of Environment and Climate Change 2008e).

White Box – Melaleuca riverine forest was a dense open forest community with canopy cover of 50-60%, up to 18 m in height dominated by *Melaleuca bracteata* and occasionally *Eucalyptus albens* and *Callitris glaucophylla*. The community consisted of a small, narrow remnant of continuous canopy typically associated with a minor ephemeral creek line west of the Kamilaroi Highway (Figure 3-7 and Photograph 3-13).

Photograph 3-13 White Box – Melaleuca riverine forest within the Project Boundary

The age classes of the canopy *Melaleuca bracteata* within the Project Boundary were predominately limited to semi-mature regrowth from past clearing. Very few large hollow-bearing trees were recorded.

The native understorey was dominated mainly by *Melaleuca bracteata, Acacia deanei, Melia azedarach,* and occasionally *Notelaea macrocarpa, Bursaria spinosa, Olearia elliptica* over a mixture of grasses, sedges and a range of small herbs including; *Oplismenus aemulus, Microlaena stipoides var. stipoides, Dichondra species A, Carex inversa and C. appressa, Cyperus sp. ,* and *Eleocharis sp*. The vine *Clematis aristidea* was dominant in a few of the open areas of the creekline where past clearing had occurred.

The White Box – Melaleuca riverine forest was in moderate condition, with moderate native species diversity and weed density. This community has been subjected to a wide range of agricultural disturbances, including, clearing, grazing, pasture improvements, construction of agricultural infrastructure and exotic weed infestations. The weeds became dominant on the edges of the community where it adjoined the Exotic Grassland community. The edge effects from the adjoining haul road were also a source of disturbance.

3.3.7 Grasslands

Derived native grassland

The Derived Grassland is a disturbed vegetation community that occurs immediately adjoining the remnant Pilliga Box – Poplar Box – White Cypress Pine grassy woodland vegetation of Leard State Forest, associated with areas of recent clearing for agricultural land uses and Boggabri Coal Mine. Given the floristic composition and presence of regrowth Poplar Box – White Cypress Pine it is considered likely that this community would have comprised the Pilliga Box – Poplar Box – White Cypress Pine grassy woodland prior to the clearing.

The majority of this community was dominated by a variety of exotic and cultivated native pasture grasses and exotic herbs (Photograph 3-14). The majority of the canopy and shrub layer within this community had been previously cleared and its condition class was considered to be poor. Isolated paddock trees of *Eucalyptus populnea subsp. bimbil* were scattered throughout this community. The dominant understorey species observed include*: Enchylaena tomentosa, Einadia nutans subsp. linifolia, Austrostipa scabra* subsp*. scabra, Austrostipa verticillata, Calotis cuneifolia, Vittadinia cervicularis* var*. cervicularis*.

Photograph 3-14 Derived Native Grassland to the south of Leard State Forest

Plains grassland

This community is consistent with Native Vegetation on Cracking Clay Soils of the Liverpool Plains listed as an Endangered Ecological Community under the TSC Act and the Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld listed as critically endangered ecological community under the EPBC Act.

The Plains Grassland is a natural grassland vegetation community that occurs within the Namoi Floodplains on deep alluvial and black alluvial cracking clay-loam (black earths) soils derived from basalt soils (Photograph 3-15).

Photograph 3-15 Plains Grassland adjoining the Namoi floodplain

It typically comprised tall tussock closed grassland with scattered trees <10% canopy cover comprising *Eucalyptus melliodora, Eucalyptus populnea subsp. Bimbil* and *Eucalyptus albens.*

The native understorey was dominated mainly by a mixture of grasses, sedges and a range of small herbs including; *Austrostipa aristiglumis, Dichanthium sericeum subsp. sericeum, Panicum queenslandicum var. queenslandicum, Sclerolaena muricata, Austrodanthonia sp, Aristida leptopoda, Leiocarpa panaetioides, Vittadinia cuneata, Daucus glochidiatus* and *Carex inversa.* Occasional occurrences of weed species were found including; *Vachellia farnesiana* (Syn *Acacia farnesiana*) and pasture weeds such as *Bromus molliformis, Brassica sp.* and *Stachys arvensis*.

The plains grassland is currently being grazed and contains some minor pasture weed incursions, particularly where it adjoins the exotic pasture vegetation. Some minor impacts from runoff and sediment/erosion associated with existing haul road are currently occurring, however it was considered to have a condition class of moderate.

Exotic grassland

The Exotic Grassland is a highly disturbed vegetation community that occurs throughout the southern portions of the Project Boundary and along the majority of the existing haul route associated with areas impacted by a history of agricultural activities. This community no longer resembles any local native remnant vegetation communities. The condition of the community is

very poor due to the absence of any canopy or shrublayer, with the dominance of exotic and cultivated native pasture weeds.

The majority of this community was dominated by a variety of exotic and cultivated native pasture grasses, and exotic herbs. The dominant species observed include*; Aristida ramosa, Enchylaena tomentosa, Galenia pubescens, Paspalum dilatatum, Chloris gayana, Lolium perenne, Cynodon dactylon, Trifolium repens, Senecio madagascariensis, Pennisetum clandestinum, Cirsium vulgare, Sida rhombifolia* and *Brassica sp.*

3.4 Terrestrial fauna habitats

The suitability, size and configuration of the fauna habitats correlated broadly with the structure, floristic and quality of the local and regional vegetation types, as described in Table 3-5. Fauna habitats, particularly those located in Leard State Forest, provided habitat for a range of woodland birds, mammals (particularly microchiropteran bats) and reptiles and were in moderate to good condition.

Habitat features recorded in the Project Boundary generally include those associated with Grassy Woodland on fertile soils, Shrubby Woodlands/Open Forest on skeletal soils, Riverine Woodland and Grassland. The habitats and species associations are discussed in Sections 3.3.1 to 3.3.4. Specific habitat attributes of each community type are described in further detail in Table 3-4. The locations of broad habitat types are shown in Figure 3-8.

Table 3-4 Fauna habitat with corresponding vegetation description

Fauna habitat description	Corresponding vegetation community (Table 3-5)
Grassy Woodland on fertile soils	White Box – White Cypress Pines grassy woodland, White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest, Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland, Weeping Myall grassy open woodland.
Shrubby Woodlands/Open Forest on skeletal soils	White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest, Narrow-leaved Ironbark – White Cypress Pine shrubby open forest, Silver-leaved Ironbark heathy woodland, Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest, Dwyer's Red Gum woodland, Native Olive dry gully forest.
Riverine Woodland	Yellow Box – Blakely's Red Gum grassy woodland, River Red Gum riparian woodlands and forests, White Box – Blakely's Red Gum – Melaleuca riparian forest.
Grassland	Derived native grassland, Exotic grassland.

3.4.1 Grassy Woodlands on fertile soils

Grassy Woodlands on fertile soils occurred as stands of low to moderately disturbed vegetation on the mid to lower slopes and flats. Given the presence of numerous tree hollows and the role of remnant vegetation in providing connectivity amongst the surrounding cleared landscape, Grassy Woodlands on fertile soils in the Project Boundary was considered to have moderate to good value for fauna. As with the majority of vegetation in Leard State Forest, this habitat has been structurally simplified as a result of previous disturbance regimes, however, the paucity of such vegetation at a landscape scale suggests that it is likely to provide important resources for native fauna at a landscape scale.

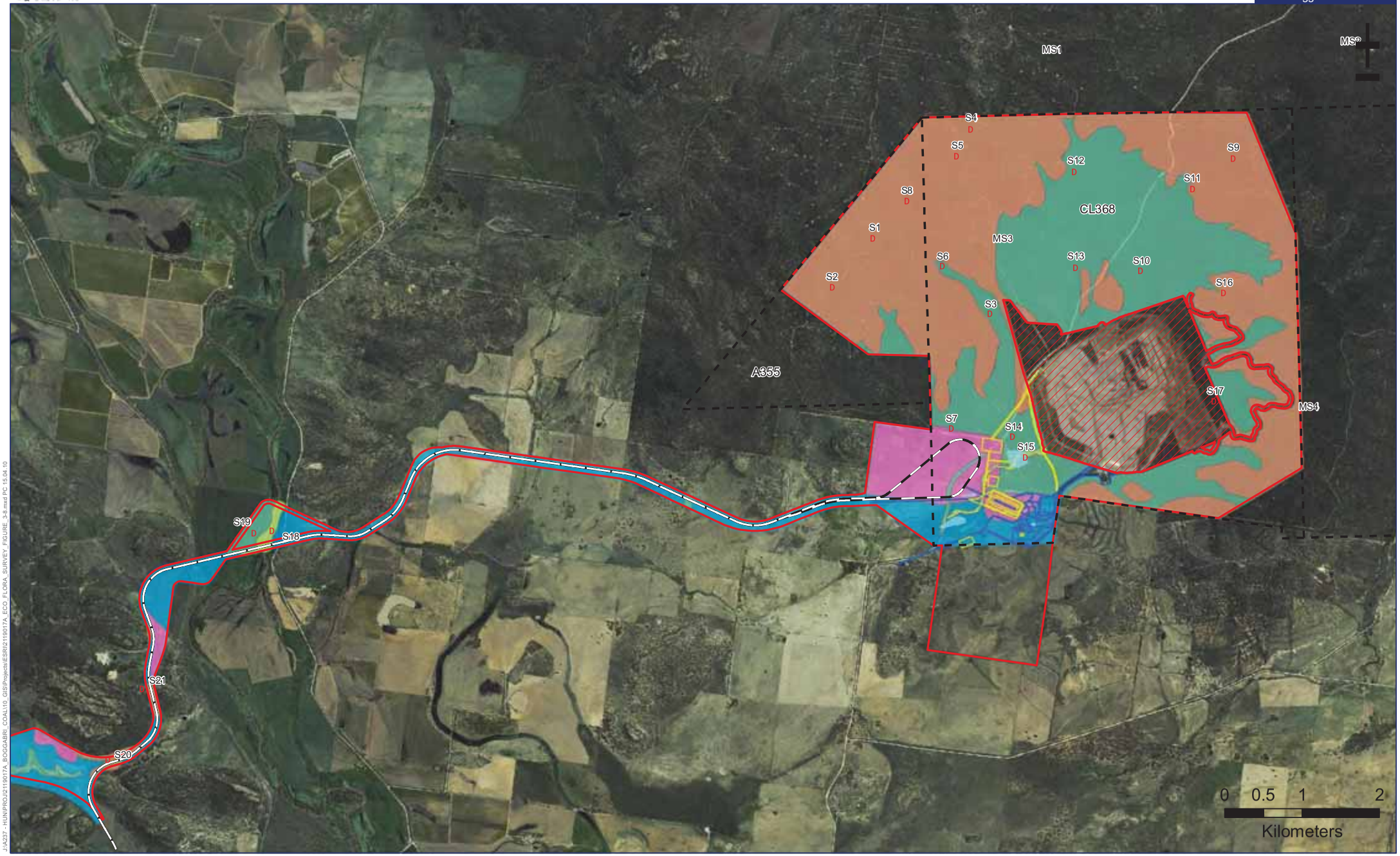
Grassy Woodlands on fertile soils habitat in the Project Boundary provided a variety of tree hollows (Table 3-6) and stags suitable as nesting opportunities for birds, nesting dens for arboreal mammals and roosting habitat for microchiropteran bats. A diverse ground cover of grasses together with forbs and sedges, decorticating bark (*E. albens*) and fallen timber provided

microhabitat features for certain species of reptile and birds (Photograph 3-16, 3-17 and Figure 3-8).

Species recorded in such habitats within the Project Boundary included Turquoise Parrot, Brown Treecreeper, Barking Owl, Fuscous Honeyeater, Spiny-cheeked Honeyeater, Thick-tailed Gecko, Yellow-faced Whip Snake, Sugar Glider and Koala.

Photograph 3-16 Grassy Woodland on Fertile Soils at survey site S7

Photograph 3-17 Grassy Woodland on Fertile Soils at survey site S6



Fauna Habitat Areas

- Shrubby Woodlands/Open Forest on skeletal soils
- Riverine Woodland on skeletal soils
- Native Grassland
- Grassy Woodlands on fertile soils
- Exotic Grassland

- D Survey Location
- Existing Infrastructure to 2011
- Proposed New Infrastructure
- Mine Tenement Boundary
- Project Boundary
- Mine Disturbance to 2011
- Sediment Dam

Figure 3-8 - Fauna Habitat Types

3.4.2 Shrubby Woodlands/Open Forest on skeletal soils

Shrubby Woodlands/Open Forest on skeletal soils occurred as stands of low to moderately disturbed vegetation on the mid to upper slopes. Canopy species were generally dominated by *E. albens* and *E. crebra* with sub-dominate and sub-canopy species (in parts) including *E. dwyeri* and *Callitris glaucophylla* (Photograph 3-18 and Figure 3-8).

Shrubby Woodlands/Open Forest on skeletal soils habitat within the Project Boundary provided a variety of tree hollows (although at a lower degree than Grassy Woodlands on fertile soils habitat) (Table 3-5) and stags suitable as nesting opportunities for birds, nesting dens for arboreal mammals and roosting habitat for microchiropteran bats. A moderate shrubby understorey was generally recorded within this habitat along with forbs and sedges. Decorticating bark was recorded from *E. albens* and *E. dwyeri*. Other microhabitat features recorded within this habitat included moderate fallen timber and partially imbedded rocks/rock outcrops, which provided adequate shelter and foraging area for reptiles.

Species recorded in such habitats within the Project Boundary included Speckled Warbler, Black-chinned Honeyeater, Southern Boobook, Bynoe's Gecko and Basalt Snake lizard. One arboreal mammal, Common Brushtail Possum, was recorded within this habitat association.

Photograph 3-18 Shrubby Woodlands/Open Forest on skeletal soils at survey site S16

3.4.3 Riverine woodland

Riverine Woodland occurred at survey sites S15, S18 and S20 (Photograph 3-19, Photograph 3-20 and Figure 3-8). While many of the gully lines/drainage lines in the Project Boundary were dry at the time of survey, the Namoi River at survey site S18 and water diversion channels at S15 contained flowing water and man made wetlands respectively.

Survey site S18 was situated in the riparian zone of the Namoi River and contained senescent River Red Gums in an otherwise modified agricultural landscape. River Red Gums provided tree hollows for a range of birds, roosting habitat for microchiropteran bats and possible dens for

arboreal mammals. A small to medium sized soak was recorded on the banks of the Namoi River, which provided suitable habitat for amphibian species including the Threatened Sloane's Toadlet.

Survey site S15 occurred along a minor drainage channel with a canopy (to 25 m) consisting primarily of Blakely's Red Gum and Yellow Box. This habitat had moderate shrub cover and a high diversity of grasses, forbs and sedges. Survey site S20 was situated along the western extremity of the proposed rail corridor and consisted of a dense layer of Melaleuca trees along a natural drainage line.

These habitats were observed to be in moderate condition and provided resources for common species of amphibian, avifauna and mammal, with species such as Peron's Tree Frog, Broad-palmed Frog, Long-thumbed Frog, Australian Ringneck, Olive-backed Oriole and Eastern Grey Kangaroo.

Photograph 3-19 Partially flooded Riverine Woodland at survey site S15

Photograph 3-20 Riverine Woodland at survey site S18

3.4.4 Grassland

Grazed pasture comprised the majority of the habitats surrounding Leard State Forest. These areas provided limited habitat and were highly disturbed from grazing and other agricultural practices that have removed native understorey and groundcover vegetation.

The majority of this habitat type was considered to be poor or very poor in condition with an exception of the natural grassland community (Plains Grassland) and better areas of Derived Grassland associated with more recent clearing adjoining Leard State Forest.

However, within such environments, isolated paddock trees can play an important role. Remnant trees in paddocks can be important in agricultural landscapes for the conservation of fauna, providing habitat to a range of fauna and maintaining connectivity between larger patches of vegetation (Department of Environment and Climate Change 2008e). Very few paddock trees were observed within this habitat type. Furthermore, such habitat within the Project Boundary has values associated with foraging resources for a range of species in the form of seeds, insects and rodents. Species observed in this habitat included Spotted Harrier, Richards Pipit, Black-shouldered Kite, Short-beaked Echidna and Rabbit.

3.4.5 Fauna microhabitats

Table 3-5 describes fauna microhabitats that were recorded during habitat assessments in each fauna stratification unit.

Table 3-5 Description of microhabitat features in the Project Boundary

Microhabitat attributes	Fauna habitat stratification			
	Grassy Woodland on fertile soils (S3, S6, S7, S10, S12-S14, S17, S19)	**Shrubby Woodland/Open Forest on skeletal soils (S1, S2, S4, S5, S8, S9, S11, S16, S21)**	**Riverine Woodland (S15, S18, S20)**	**Grassland (S19)**
Upper canopy	Upper canopy to 20 m in height dominated by *E. albens* and *E. crebra* with a sub-canopy of *Callitris glaucophylla.* An average diameter at breast height (DBH) greater than 0.5 m was recorded in this habitat. An average crown cover across this habitat was estimated at approximately 60%. A canopy cover of *E. pilligaensis* and *E. populnea* and a dense sub-canopy of *C. glaucophylla* and *Allocasuarina luehmannii* were recorded at survey site S14. A light scattering of mistletoe plants was recorded within the upper canopy across this habitat.	Upper canopy to 20 m in height. Dominant canopy species varied across the stud area where this habitat was recorded but generally consisted of *E. crebra, E. dwyeri, E. albens, E. melanophloia* and *Notelaea macrocarpa* (in dry gullies). An average crown cover across this habitat was estimated at approximately 65%. A light scattering of mistletoe plants was recorded within the upper canopy across this habitat.	Upper canopy to 20 m in height dominated by *E. blakelyi* and occasional *E. melliodora* at survey site S15. *E. camaldulensis* and occasionally *E. bridgesiana* were recorded at survey site S18. An average DBH greater than 0.6 m was recorded in this habitat. An average crown cover across this habitat was estimated at approximately 70%.	Generally absent. Isolated paddock trees only.
Shrub layer	Generally sparse, however, *Dodonaea* spp., *Cassinia* spp., and *Acacia* spp. were recorded.	Shrub layer was sparse to dense across this habitat with species including *Notelaea macrocarpa, Bursaria spinosa, Dodonaea* spp., *Cassinia* spp., and *Acacia* spp. recorded.	At survey site S18 shrubs may be absent in heavily grazed and eroded areas. Survey site S15 contained a sparse to moderate shrub layer with rare occurrences of *Dodonaea* spp., and *Acacia deanei*.	Generally absent.
Grasses, herbs, forbs, sedges and rushes	The groundcover was generally dominated by diverse range of grasses with forbs and sedges including *Cyperus gracilis, Aristida ramosa, Cymbopogon refractus* and	The groundcover was generally dominated by diverse range of grasses with forbs and sedges including *Austrodanthonia racemosa, Cheilanthes distans* and *Rostellularia adscendens.*	The groundcover was generally dominated by a diverse range of grasses with forbs and sedges including *Chloris truncata, Bothriochloa macra, Lomandra longifolia* and *Austrostipa*	The groundcover was generally dominated by diverse range of grasses and herbs including; *Austrostipa aristiglumis, Dichanthium sericeum, Panicum*

Microhabitat attributes	Fauna habitat stratification			
	Grassy Woodland on fertile soils (S3, S6, S7, S10, S12-S14, S17, S19)	**Shrubby Woodland/Open Forest on skeletal soils (S1, S2, S4, S5, S8, S9, S11, S16, S21)**	**Riverine Woodland (S15, S18, S20)**	**Grassland (S19)**
	Austrostipa scabra.		*verticillata.*	*queenslandicum var. queenslandicum, Sclerolaena muricata, Austrodanthonia sp, Aristida leptopoda* and *Carex inversa.*
Leaf litter	Leaf litter varied across this habitat but was generally 1-2 cm deep with a percent coverage ranging from 30 to 70%.	Leaf litter varied across this habitat but was generally <1 cm deep with a percent coverage ranging from 20 to 40%.		Leaf litter varied across this habitat but contained areas of dense grass clumps with a percent coverage ranging from 30 to 70%.
Fallen timber	A moderate amount of fallen timber was present in this habitat, with sizes ranging from 50 to 300 mm.	A moderate amount of fallen timber was present in this habitat, with sizes ranging from 50 to 300 mm.	A sparse to moderate amount of fallen timber was present in this habitat, with sizes ranging from 50 to 300 mm.	Generally absent.
Tree hollows and stags	Numerous small (<5-10 cm diameter), medium sized (10-20 cm diameter) and large sized (20->30 cm diameter) tree hollows were recorded within this habitat (Table 3-6). A sparse number of hollow-bearing stags were recorded within this habitat.	Numerous small (<5-10 cm diameter) and medium sized (10-20 cm diameter) tree hollows were recorded within this habitat. Large tree hollows (20->30 cm diameter) were sparse except for survey site S9, which recorded 9 (Table 3-6). A sparse number of hollow-bearing stags were recorded within this habitat.	Numerous small (<5-10 cm diameter), medium sized (10-20 cm diameter) and large sized (20->30 cm diameter) tree hollows were recorded within this habitat (Table 3-6).	Generally absent.
Rocks and rock shelves	Generally absent.	Partially embedded rocks and rock outcrops generally occurred on the mid to upper slopes. This habitat provided important resources for reptiles including the Basalt Snake Lizard, Burtons Legless Lizard and Bynoe's Gecko.	Generally absent.	Generally absent. Large cracks within the clay soils provide shelter for small reptiles, amphibians and mammals.
Drainage lines and	Drainage lines encountered in the	Drainage lines encountered in the	The Namoi River at survey site S18	

Microhabitat attributes	Fauna habitat stratification			
	Grassy Woodland on fertile soils (S3, S6, S7, S10, S12-S14, S17, S19)	**Shrubby Woodland/Open Forest on skeletal soils (S1, S2, S4, S5, S8, S9, S11, S16, S21)**	**Riverine Woodland (S15, S18, S20)**	**Grassland (S19)**
water bodies	Project Boundary were dry during field surveys.	Project Boundary were dry during field surveys. One dam located at supplementary site Supp2 (occurring outside the Project Boundary) contained suitable habitat of moderate value for native fauna.	contained flowing water, while soaks were recorded on its banks. Survey site S15 contained standing water in a man-made wetland (Photograph 3-16). Collectively these water bodies contained moderate habitat for amphibians and avifauna.	
Overall condition	Moderate.	Moderate.	Moderate.	Moderate.

3.5 Quantitative assessment of hollow tree resources within Leard State Forest

The majority of Threatened fauna species recorded within the Project Boundary or considered to have potential habitat, utilise hollow trees for important breeding and roosting. As such, a systematic quantitative assessment of hollow tree resources was conducted to identify the type and density of hollow tree resources within the Project Boundary.

Sampling was undertaken using a 20 x 50 m area at each sampling point (Figure 2-4), whereby the number of hollows and sizes of hollows were recorded from all trees within the defined area. Tree hollow sizes were based on visual estimates and categorised into size classes as per Section 2.5.3.

Ninety-four survey sites were assessed in the Project Boundary and 52 survey sites were assessed within the remaining study area (a combined total of 146 survey sites) (Figure 2-4). A further two sites associated with Riverine Woodland were assessed during habitat assessments to account for the lack of sites assessed in this fauna habitat during the regularised grid-based sampling design. Figure 3-9 depicts the range of tree hollow sizes and total number recorded during systematic quantitative assessment utilising a regularised grid-based pattern to ascertain sampling locations. The information suggests a distribution of hollow size/abundance for a structurally modified remnant patch of vegetation with a history of logging activity, whereby the majority of hollows observed were within the small (<15 cm) size classes with relatively few large (>25 cm) hollows.

While many attributes of tree hollows may be selected by hollow using species, such as hollow depth, entrance size and hollow type (Goldingay 2009), hollows are more likely to occur and be used by wildlife in large trees that are many decades or even centuries old (Goldingay 2009). The size of the hollow entrance utilised varies for many species, whereby entrance size is related to the body length of individuals (Goldingay 2009). While smaller species of bird and bat were observed to utilise hollow tree resources within the Project Boundary including Little Lorikeet, Brown Treecreeper and Gould's Wattled Bat, large hollows were generally observed to be scarce within the Project Boundary. However, large species of bird including Barking Owl and Southern Boobook would utilise such limiting resources within the Project Boundary.

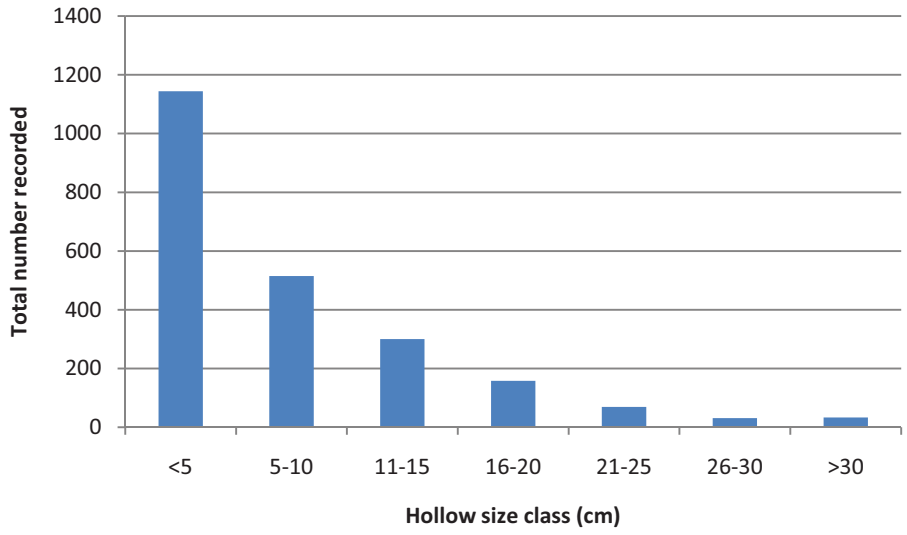


Figure 3-9 Hollow sizes and total number recorded within the Project Boundary

Information gathered from quantitative assessment regarding hollow tree resources within the Project Boundary, was used to calculate hollows per hectare for basic fauna habitats described in the Project Boundary (Figure 3-10 and Table 3-6).

Table 3-6 Average hollows/hectare for basic fauna habitats

	Average hollows/hectare in size classes (cm)								
Fauna habitat type	**<5**	**5-10**	**11-15**	**16-20**	**21-25**	**26-30**	**>30**	**Average hollows/ hectare**	**Number of survey sites**
Grassy woodland on fertile soils	81	42	25	13	4	3	3	170	51
Shrubby woodlands/open forest on skeletal soils	76	29	17	9	5	2	0	139	95
Riverine Woodland	75	80	70	50	10	N/A	65	315	2

Grassy Woodlands on fertile soils fauna habitat on average contained 18% more hollows than shrubby woodlands/open forest on skeletal soils fauna habitat. Furthermore, on average, more hollows were recorded in each hollow size class for Grassy woodlands on fertile soils habitat compared to shrubby woodlands/open forest on skeletal soils habitat. Importantly, no hollows >30 cm (generally considered suitable for large forest owls) were recorded in Shrubby Woodlands/open forest on skeletal soils habitat. This trend is likely to reflect the hollow development of different tree species, with *Eucalyptus albens* typically producing larger tree hollows than *E. crebra*. The information collected suggests the hollow density within most size classes is relatively consistent throughout the Project Boundary (Figure 3-10). Importantly, this indicates large areas of similar density hollow resources would be available outside the subject site.

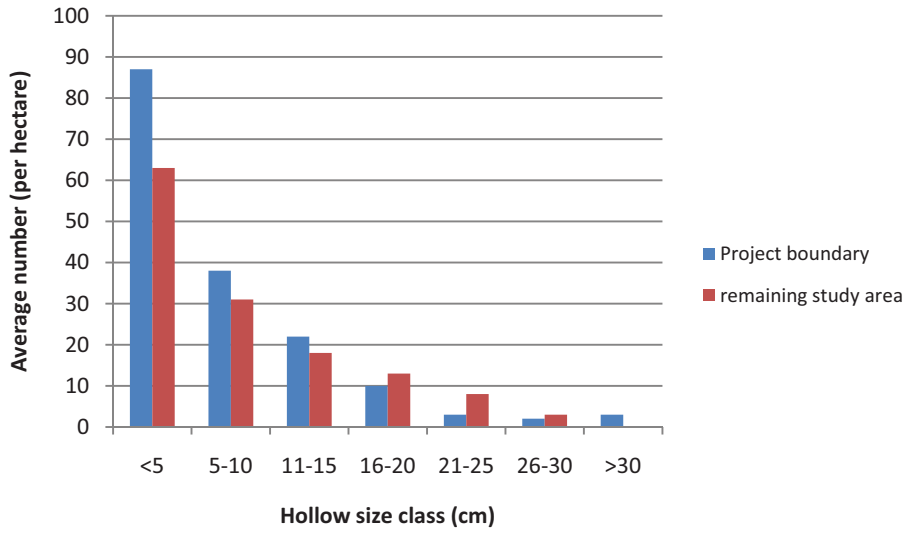


Figure 3-10 Hollow break down within Project Boundary and remaining Project Boundary

3.6 Systematic Koala habitat assessment

Ninety-four survey sites were sampled within the Project Boundary and 52 survey sites were assessed within the remaining study area. A further 20 survey sites were assessed within the Project Boundary during March/April 2009. A total of 2,858 trees were assessed, comprising nine

species of *Eucalyptus* and one species of non-eucalypt (Figure 3-11). The most common tree species sampled were *E. crebra*, *E. albens* and *E. pilligaensis*.

Evidence of habitat use by Koalas (i.e. presence of Koala scats) was recorded in 3% (five of 166 survey sites) of the sampled sites. Koala activity within these sites was typically low, ranging from <5 to 20%, with a mean activity score (active sites only) of 11%.

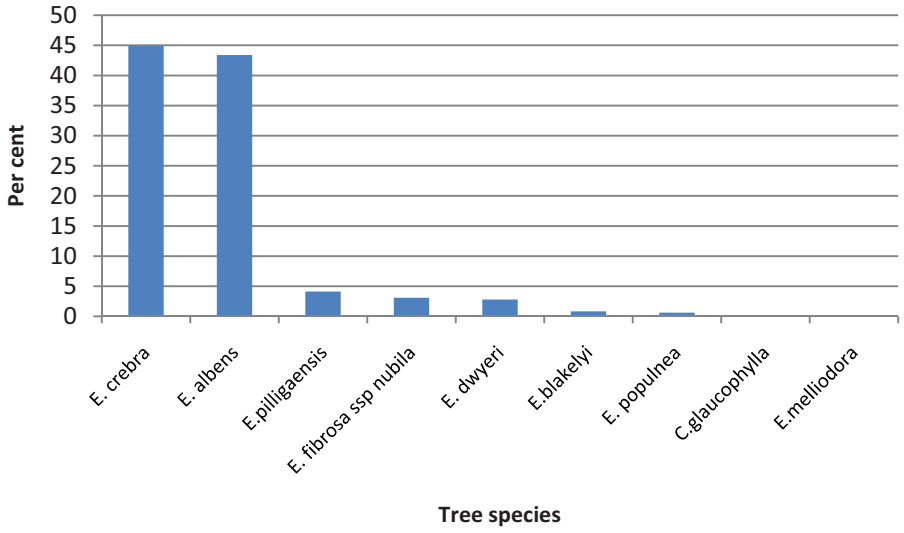


Figure 3-11 Percentage of total trees searched for Koala scats

The information collected identified similar densities of tree species recorded within the Project Boundary and remaining study area with the exception of two species, *Eucalyptus pilligaensis* and *E. fibrosa* ssp *nubila* (Figure 3-12). Both of these species are restricted to particular geologies within the locality.

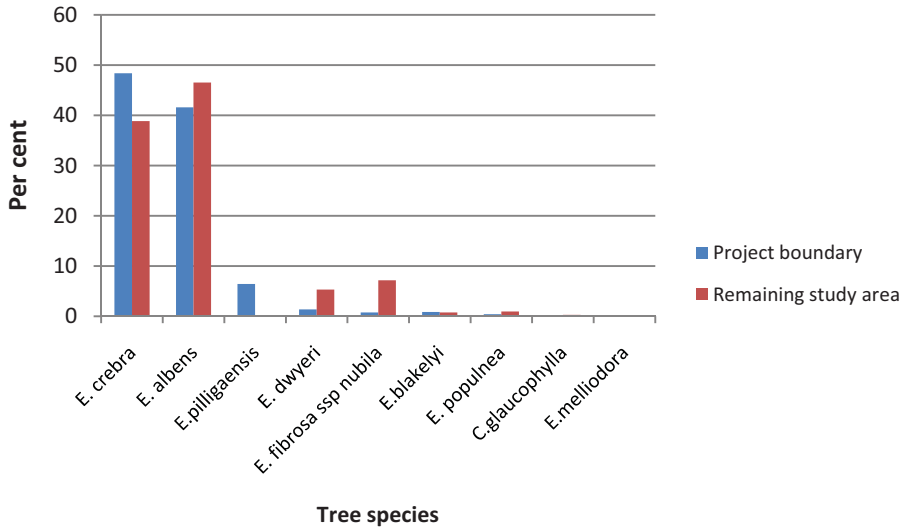


Figure 3-12 Percentage of tree species searched: comparison of Project Boundary and remaining study area

Koala scats were observed under four species of *Eucalyptus* including *E. crebra*, *E. albens*, *E. pilligaensis* and *E. blakelyi* (Figure 3-13). One Koala was observed at survey location W53 (Figure 2-4) during systematic searches for this species. Another Koala was recorded opportunistically during the course of other survey efforts (Figure 2-4) during March/April 2009.

No records of Koala habitat use occurred outside the Project Boundary (i.e. remaining study area in Leard State Forest).

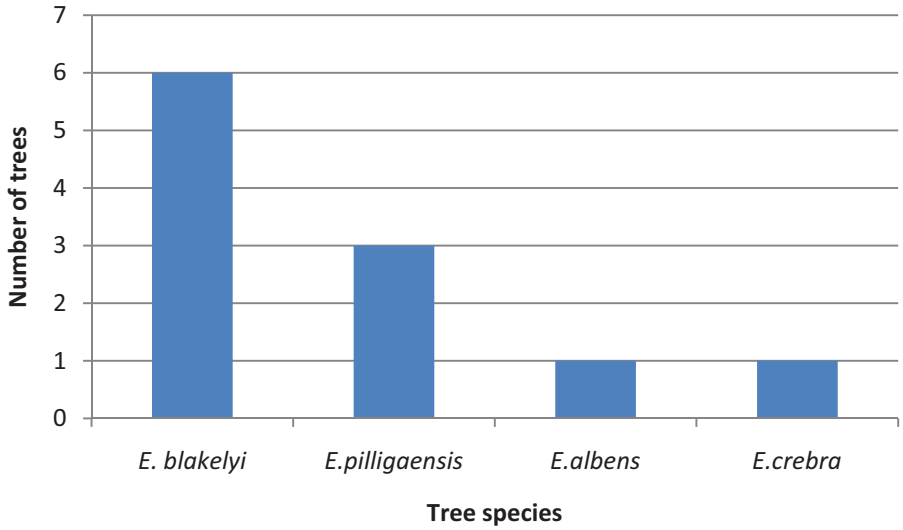
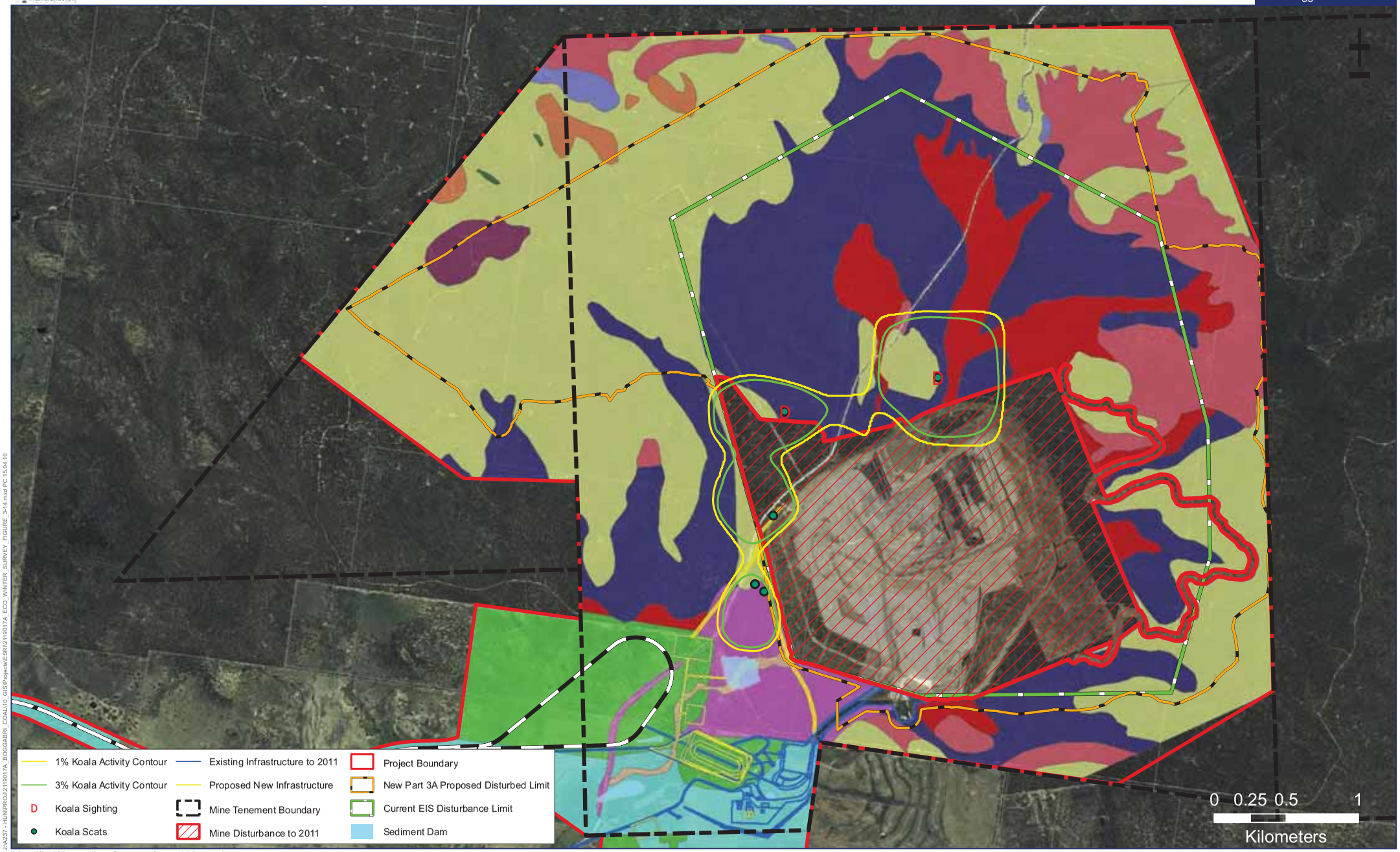


Figure 3-13 Number of trees recorded with Koala scats

Within that part of study area encompassing Leard State Forest, only secondary food tree species for the western slopes and plains Koala management area (Department of Environment and Climate Change 2008e) were recorded. Data analysis and habitat mapping following systematic koala habitat searches indicate a low population density and low habitat utilisation centred on an area of habitat bounding the northern and western limit of the current mining void (Figure 3-14). Analysis of data also inferred *E. blakelyi* as the dominant feed tree species utilised within the Project Boundary. However, seven secondary food tree species were recorded throughout the Project Boundary including *E. populnea*, *E. pilligaensis*, *E. melliodora*, *E. albens*, *E. dwyeri*, *E. dealbata* and *E. blakelyi*.

In addition, a small section of Riverine Woodland occurring within the Project Boundary along the proposed rail alignment (survey site S18), was the only section in the Project Boundary that contained *E. camaldulensis*, which is listed as a primary food tree species for the western slopes and plains Koala management area (Department of Environment and Climate Change 2008e). No Koalas or habitat use was observed in this area during extensive field surveys.

Figure 3-14 shows modelled Koala activity within the Project Boundary. 'Core Koala habitat' refers to areas with a 3% or greater activity level. These areas were mapped based on the location of two individual Koala's observed during field surveys. The remaining area within the Project Boundary and encompassing the Leard State Forest is considered to be 'potential Koala habitat', as it contains >15% feed tree species listed under Schedule 2 of *State Environmental Planning Policy No. 44 – Koala Habitat Protection.* An assessment under this policy has not been undertaken for the Project, as project's being assessed under Part 3A of the EP&A Act are exempt from it. Potential impacts to Koala's have been assessed under the TSC Act, reflecting the Koala's threatened species status under this act (refer to Appendix E and Section 6.0).



Identified Vegetation Communites within study area

- Blue-leaved Ironbark heathy woodland
- Derived native grassland
- Dwyer's Red Gum woodland
- Exotic grassland
- Narrow-leaved Ironbark - Brown Bloodwood -White Cypress Pine shrubby open forest
- Narrow-leaved Ironbark - White Cypress Pine shrubby open forest
- Native Olive dry gully forest
- Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland
- Plains Grassland
- River Red Gum riparian woodlands and forests
- Weeping Myall grassy open woodland
- White Box – Narrow-leaved Ironbark - White Cypress Pine grassy open forest
- White Box – Narrow-leaved Ironbark - White Cypress Pine shrubby open forest
- White Box – White Cypress Pine grassy woodland
- White Box- Blakely's Red Gum - Melaleuca riparian forest
- Yellow Box - Blakely's Red Gum grassy woodland

Figure 3-14 - Modelled Koala activity

3.7 Aquatic habitats

Riparian habitats within the Project Boundary were generally associated with Riverine Woodland as described in Section 3.3.3. Farm dams and mine dams were generally associated with grassland habitat in the Project Boundary. Collectively these habitats contained moderate habitat for native fauna, particularly amphibians and avifauna. Specific habitat attributes for Riverine Woodland surveyed within the Project Boundary is summarised in Table 3-5.

The Namoi River is included within the determination for the aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River. The riparian vegetation of River Red Gum riparian woodlands and forests which occurs on the banks of the Namoi River is highly disturbed from clearing and exotic weed incursions, with the remaining riparian vegetation containing limited habitat for aquatic fauna.

The aquatic habitat in the Project Boundary was found to be very poor. An assessment of the condition of the Namoi River by (Thoms 1999) identified the following as major contributors to the generally moderate to poor riverine condition that prevails: degradation of the riparian zone, or complete lack of riparian zone; channel morphology impacts such as bank instability, riverbed instability, and aggradation of sediments, morphological and biological effects of dams and river regulation; poor land management practices; poor water quality, mainly because of high total phosphorus, turbidity and salinity levels, and localised incidence of pesticide contamination; poor native fisheries, with low species diversity and abundance, especially in upland areas due to the presence of barriers to fish migration.

(Thoms 1999) also reported that in the Namoi River, Bony herring, *Nematalosa erebi*, Murray cod, golden perch, silver perch, spangled grunter and Australian smelt were known to be migratory and that weirs and dams that block fish migrations have undoubtedly contributed significantly to the decline of native fish.

There were few aquatic instream macrophytes recorded within the river and the aquatic habitat was generally poor due to anthropogenic disturbances, which included cattle and loss of riparian streambank vegetation (Photograph 3-21 to Photograph 3-24 for each location). Aquatic macrophytes are important components of riverine systems and studies of aquatic macrophytes and the association between macroinvertebrates and fish have emphasised the role of structural complexity in determining the composition of assemblages ((Cummins 1997); (Pusey 1996).The native aquatic organisms that inhabit rivers, streams and wetlands in Australia have adapted to millions of years of cycles of drought and flood, which provide natural variability to river ecosystems. The variation in water flows helps to maintain the natural biodiversity within the aquatic ecosystem. River regulation, water consumption and pollution from development all threaten these ecosystems by reducing this variability (Harris & Gehrke 1997).

3.7.1 Water quality

In general, the physico-chemical water quality data indicated that all sites were within the (ANZECC 2000) guidelines for freshwaters (Table 3-7). The water temperature ranged from 15.5 to 22.4°C, pH ranged from 7.1 to 8.7, conductivity ranged from 351 – 749 µs/cm, dissolved oxygen (DO) concentrations ranged from 8.9 to 10.2 mg/L. The dissolved oxygen levels in the Dam location ranged from 1.3 to 3.9 mg/L. The turbidity (54.6 – 368.3 NTU) at all sites reflected the muddy nature of the water as a result of recent rainfall at the time of sampling. There were very few aquatic macrophytes within the river at the time of sampling and the aquatic habitat was generally poor due to anthropogenic disturbances, which included cattle and loss of riparian streambank vegetation (Photograph 3-21 to Photograph 3-24 for each location).

Table 3-7 Mean (+ SE) measurements of water quality variables recorded at each site within the four locations sampled (NR1 – Downstream, NR2 – Crossing, NR3 – Upstream, S – Site)

Location	NR1		NR2		NR3		DAM	
Site	S1	S2	S1	S2	S1	S2	S1	S2
Temp (°C)	15.5(0.0)	15.5(0.0)	16.6(0.0)	16.2(0.0)	16.7(0.0)	16.8(0.0)	20.7(0.0)	22.4(0.0)
pH	7.6(0.0)	7.6(0.0)	7.2(0.0)	7.2(0.0)	7.4(0.0)	7.1(0.0)	8.7(0.0)	8.2(0.0)
Cond (µ/s)	352(0.0)	352(0.0)	351(2.0)	351(0.0)	352(0.0)	351(0.0)	749(0.4)	724(0.0)
DO (mg/L)	8.9(0.0)	9.0(0.0)	9.9(0.0)	9.6(0.0)	10.2(0.0)	9.1(0.0)	3.9(0.1)	1.3(0.0)
Turb (NTU)	54.6(0.8)	62.7(0.9)	106.8(1.7)	107.7(2.1)	66.1(8.4)	57.0(1.1)	350.0(0.0)	368.3(4.9)

Photograph 3-21 Downstream location NR1 on the Namoi River

Photograph 3-22 Crossing location NR2 on the Namoi River

Photograph 3-23 Upstream location NR3 on the Namoi River

Photograph 3-24 Dam location

3.7.2 Macroinvertebrates

A total of 923 individuals from 22 macroinvertebrate taxon (not including the dipteran pupae) were collected from the sites sampled. The most abundant macroinvertebrate taxon was the Corixidae (388 individuals) followed by the Atyidae (141 individuals), Dytiscidae (116 individuals) and the Hydrophilidae (98 individuals). The introduced fish, *Gambusia holbrooki*, was recorded (total of 21 individuals) at Location 1 (7 individuals), Location 2 (11 individuals) and Location 3 (3 individuals) on the Namoi River (NR). No individuals of *Gambusia* were collected in the dam.

The total abundance of macroinvertebrates and the number of taxa were compared among locations (random factor) and among sites (nested factor) using analysis of variance. There were no significant differences detected in the total abundance (number of individuals) and total richness (number of taxa) of aquatic macroinvertebrates at any scale (Table 3-8, Figures 3-14 and 3-15). Overall, fewer individuals were collected at the DAM compared to the other locations sampled (Figure 3-15). Mean abundance and diversity of macroinvertebrates was greatest at Location 1 on NR compared to the other locations sampled (Figure 3-15 and Figure 3-16).

The ANOSIM test (Global *R*: 0.037) found no significant differences ($P > 0.05$) in the structure of the assemblages between sites nested in locations. An ANOSIM test (Global *R*: 0.354) on the pooled data did find significant differences ($P < 0.01$) among locations. The pair-wise comparisons found that the structure of assemblages of macroinvertebrates in the DAM differed significantly from assemblages at locations sampled within the river. Assemblages at locations sampled within river were not significantly different from each other. This was evident in the non-metric multidimensional scaling (nMDS) ordination as samples collected from the DAM tended to group separately from those at locations sampled within NR (Figure 3-16). The nMDS ordination indicated that there was considerable variation in the structure of assemblages between sites at Location 3 on NR (Figure 3-16). The stress value of the ordination (0.14) indicated that it was a potentially useful 2-dimensional picture with no real prospect of a misleading interpretation (Clarke & Warwick 1994).

Table 3-8 Summary of analyses of variance comparing the total number of individuals (abundance) and taxa (richness) of macroinvertebrates sampled in the Project Boundary: ns = not significant (P > 0.05); * = significant (P < 0.05); ** = significant (P < 0.01)

		Abundance		Richness	
Source of variation	**df**	**MS**	**F**	**MS**	**F**
Location	3	19.53	3.01 ns	13.04	2.54 ns
Site(Location)	4	5.16		5.13	1.71 ns
Residual	16	6.81		3.00	
Total	23				
Cochran's Test		ns		ns	
Transformation		Sqrt (X+1)		none	

F-ratios in bold were calculated after post-hoc pooling was done at *P* > 0.25 to create a more powerful test for terms above (Winer 1971), (Underwood 1997).

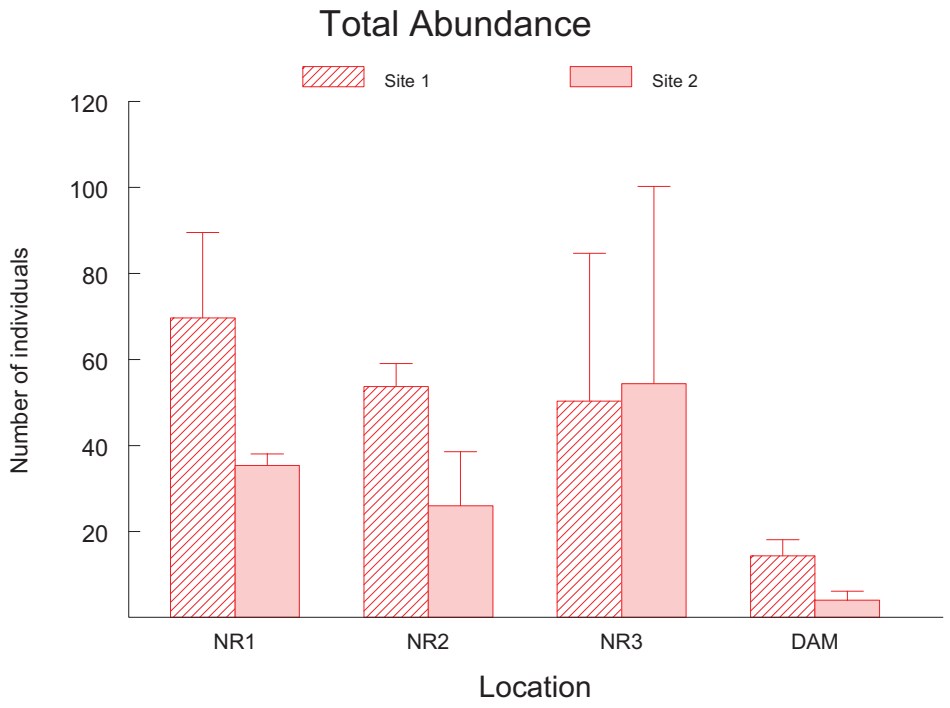


Figure 3-15 Mean (+SE) total abundance of macroinvertebrates at each location (NR1 – Downstream, NR2 – Crossing, NR3 – Upstream)

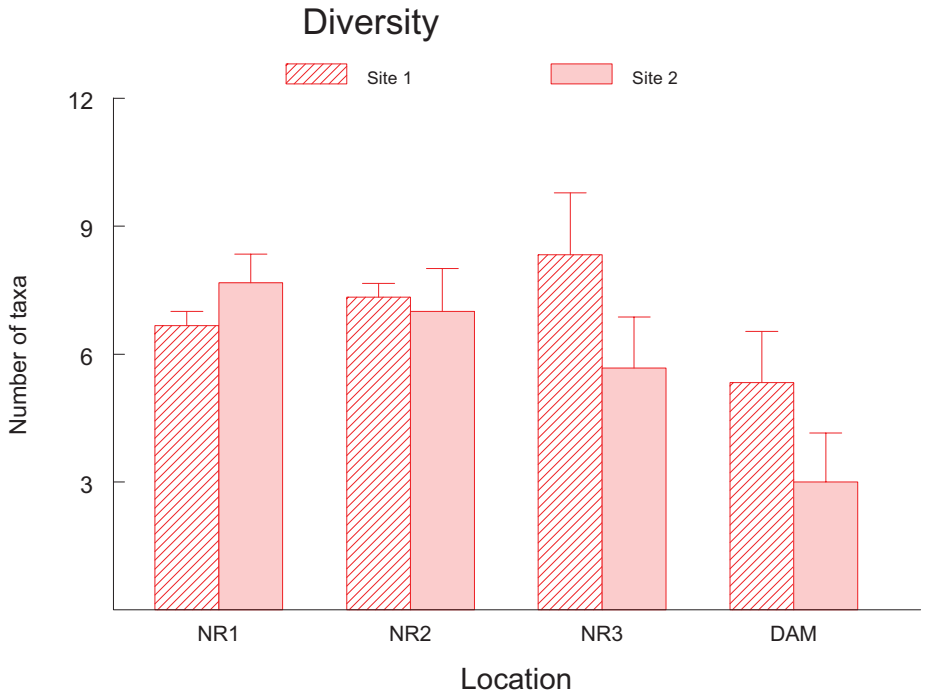


Figure 3-16 **Mean (+SE) diversity of macroinvertebrates at each location (NR1 – Downstream, NR2 – Crossing, NR3 – Upstream)**

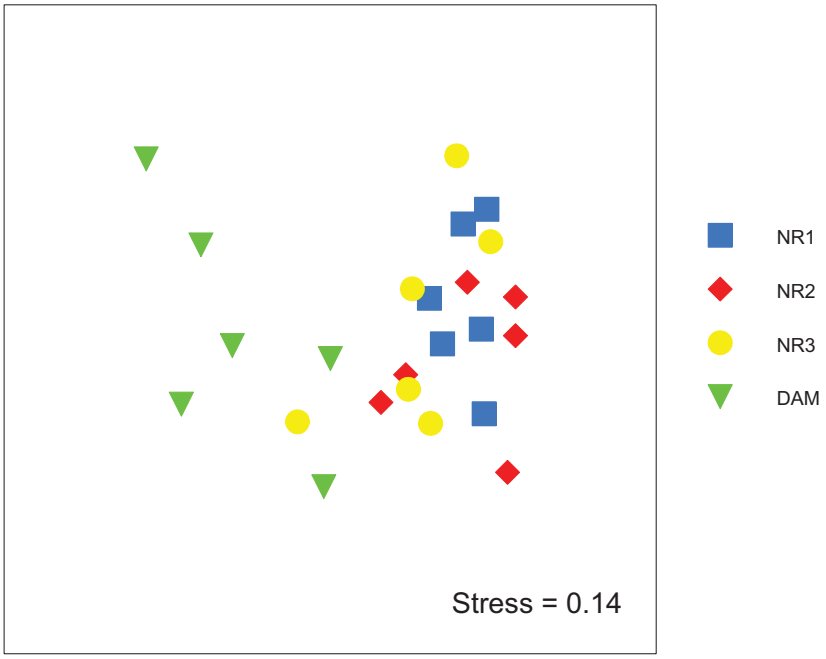


Figure 3-17 **nMDS ordination for macroinvertebrates collected at each location (NR1 – Downstream, NR2 – Crossing, NR3 – Upstream)**

The SIMPER procedure ranked Dytiscidae (aquatic beetles) as the most important species that contributed to the structure of the macroinvertebrate assemblage at Location 1 in NR (Table 3-9). The freshwater shrimp, Atyidae, was ranked as most important at Location 2 on NR (Table 3-9). Corixidae (water boatmen) and Cyclopoida (small crustaceans) were most important at Location 3 on NR and at the DAM, respectively (Table 3-9).

Table 3-9 Macroinvertebrate taxa ranked in order of importance according to the SIMPER procedure for each location

Name	Taxa	NR1	NR2	NR3	DAM
Beetles	Dytiscidae	1	4	4	
Beetles	Hydraenidae		5		
Beetles	Hydrophilidae	3	3	2	
Mayflies	Caenidae			5	
True Flies	Chironomidae				3
Freshwater Shrimps	Atyidae	4	1	3	
True Bugs	Corixidae	2	2	1	
True Bugs	Notonectidae				2
Crustaceans	Cyclopoida				1

The SIGNAL values calculated that all sites were severely polluted (Figure 3-18). The relative large number of pollution tolerant macroinvertebrate taxa suggested that the water quality was generally quite poor (Chessman 2003).

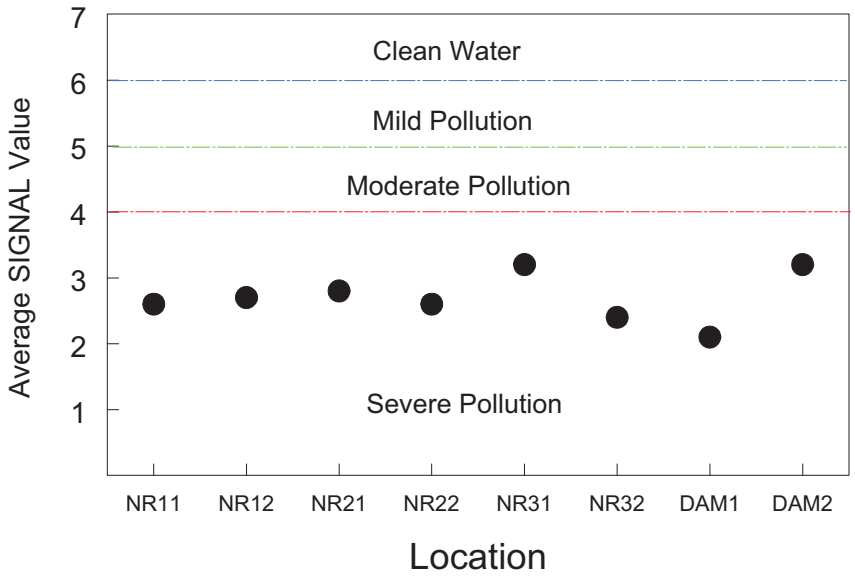


Figure 3-18 Average macroinvertebrate SIGNAL values for each site and location

3.8 Recorded flora and fauna

3.8.1 Terrestrial flora

A total of 427 species of plant was recorded within the Project Boundary of which 365 species (86 %) were native (Appendix A), including 2 threatened flora species, *Pomaderris queenslandica* and *Pultenaea setulosa* and three ROTAP listed species. The most diverse family recorded was the Poaceae (grasses), with 81 species, followed by the Asteraceae and Fabaceae, with 51 and 44 species respectively (Appendix A). In addition to these species, a small number of unidentified planted native and exotic cultivated species were observed within the mine operations buildings and some areas which have been planted for rehabilitation.

Nine species of plant listed under the *Noxious Weeds Act 1993* for the Narrabri local government area were recorded within the Project Boundary (Table 3-10). Blackberry is also listed a Weed of National Significance (Thorp & Lynch 2000).

Table 3-10 Noxious weeds recorded in the Project Boundary

Name	*Noxious Weeds Act 1993* control category[1]
Conium maculatum (Hemlock)	Class 4
Heliotropium amplexicaule (Blue Heliotrope)	Class 4
Opuntia aurantiaca (Tiger Pear)	Class 4
Opuntia stricta (Prickly Pear)	Class 4
Opuntia tomentosa (Velvet Tree Pear)	Class 4
Oxalis corniculata	Class 4
Rubus fruticosus (Blackberry)*	Class 4
Sclerolaena birchii (Galvanised Burr)	Class 4
Xanthium sp.	Class 4

Notes: 1 – *Noxious Weeds Act 1993*: Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Class 5: The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with. * listed as a Weed of National Significance (2006b).

3.8.2 Terrestrial fauna

One hundred and ninety four species of animal were recorded within the Project Boundary during field surveys (Table 3-11), including 21 Threatened species. Seven introduced species were recorded within the Project Boundary (Appendix B).

Table 3-11 Faunal species diversity recorded in Project Boundary

Faunal group	Species diversity (introduced species) (Threatened species)
Birds	129 (1) (15)
Mammals	31 (6) (6)
Reptiles	28 (0) (0)
Amphibians	6 (0) (0)
Total	**194 (7) (21)**

Cumulative species richness

Figure 3-19 depicts cumulative species richness for fauna habitat types, as described in Section 3.3.1 to 3.3.3 and as shown in Figure 3-5. Data was analysed from survey locations (consisting of survey sites S1-S21 and supplementary/targeted survey locations) throughout the Project Boundary. As such, data from the Grassland stratification unit has been omitted as only opportunistic sightings have been recorded for such fauna habitat.

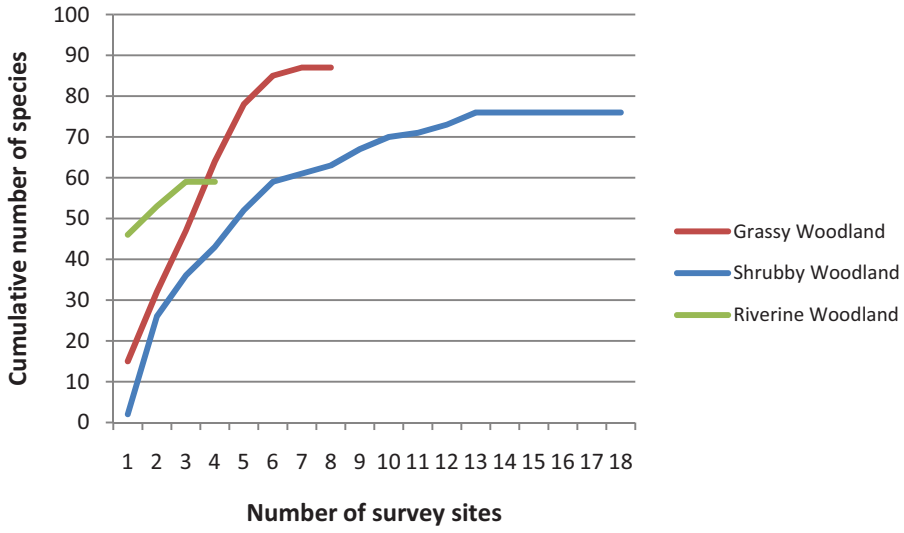


Figure 3-19 Cumulative species richness for fauna habitat types

A total species richness of 194 was recorded within the Project Boundary and included all opportunistic sightings. A cumulative species richness of 124 was recorded for Grassy Woodland on fertile soils habitat, while a cumulative species richness of 104 and 91 were recorded for Shrubby Woodland/Open Forest on skeletal soils and Riverine Woodland respectively.

Birds

Birds were the most diverse group of animals within the Project Boundary with 129 species recorded. The majority of species included open country generalists and species common to Grassy Woodlands, Shrubby Woodlands/Open Forest or Riverine Woodland environments. Species included the Dusky Woodswallow, White-throated Treecreeper, and Fuscous Honeyeater. Fifteen Threatened species of bird, including species with preliminary determinations, were observed within the Project Boundary (Appendix B) and included Brown Treecreeper, Speckled Warbler, Barking Owl, Masked Owl, Black-chinned Honeyeater, Grey-crowned Babbler, Turquoise Parrot, Little Lorikeet, Black-necked Stork, Diamond Firetail, Hooded Robin, Little Eagle, Spotted Harrier, White-browed Woodswallow and Varied Sittella. The Brown Treecreeper and Speckled Warbler were recorded in most fauna habitats, while the Turquoise Parrot and Barking Owl were recorded in Grassy Woodland on fertile soils and Riverine

Woodland. Remnant habitat within the Project Boundary was suitable for woodland species of bird, including Threatened and declining species.

Mammals

Thirty-one species of mammal were recorded within the Project Boundary. The Eastern Grey Kangaroo, House Mouse and microchiropteran bats were the most abundant and widespread mammals with observations in all fauna habitats across the Project area.

Arboreal mammals were generally scarce during field surveys with Brushtail Possum being recorded twice at survey site S16 and once opportunistically. One Sugar Glider was recorded as responding to call playback at survey site S7, whilst several individuals were trapped and relocated from an area in close proximity to current mine operations. Furthermore, the Koala was sighted within the Project Boundary on two separate occasions while scats were recorded from a several locations (Section 3.6). Systematic Koala habitat searches indicate a low population density and low habitat utilisation centred on an area of habitat bounding the northern and western limit of the current mine disturbance (Section 3.6, Figure 2-4 and Figure 3-14). No records of Koala habitat use occurred outside the Project Boundary (i.e. remaining Project Boundary in Leard State Forest).

Microchiropteran bat activity was moderate to high throughout the night and included 16 species; including freetail bats, forest bats and species typical of woodland areas like the White-striped Mastiff Bat (Appendix B). Call sonograms for bat species identified via Anabat detector are attached in Appendix F.

Six Threatened species of mammal – Koala, Yellow-bellied Sheathtail Bat, Eastern Bent-wing Bat, Eastern Cave Bat, Eastern False Pipistrelle and Little Pied Bat – were recorded in the Project Boundary. One other Threatened species, Large-eared Pied Bat, was potentially recorded via Anabat, although this was not confirmed due to a short call sequence.

While the Eastern Cave Bat was recorded at survey site S1, the section of the Project area occurring in Leard State Forest was not considered core habitat for this species, as no roosting habitat (caves) was recorded therein. Habitat resources surrounding a rocky outcrop near survey site S20, where this species was found to be roosting (Figure 4-5), is likely to provide foraging habitat and other resources that support this species.

Six species of introduced mammal – Rabbit, Brown Hare, House Mouse, Black Rat, Fox and Pig – were recorded across the Project Boundary, but primarily in Grassland and Grassy Woodland on fertile soil environments (Appendix B).

Amphibians

Six species of amphibian were recorded during field surveys. Broad-palmed Frog, Long-thumbed Frog and Spotted Grass Frog were recorded from Riverine Woodland at survey site S15, while the Desert Tree Frog and Peron's Tree Frog were also recorded at survey site S18. Green Tree Frog was recorded opportunistically in Grassland and Grassy Woodland (Appendix B).

The Namoi River (S18), together with drainage lines/wetlands (S15), contained moist habitat for amphibians. Habitat for frogs, where present, was generally in moderate condition.

Reptiles

Twenty-eight species of reptile were recorded during field surveys (Appendix B). Burton's Legless Lizard was recorded under timber piles in Shrubby Woodland/Open Forest on skeletal soils at survey site S1, while Thick-tailed Gecko was recorded in Grassy Woodland on fertile soils at survey site S6. Tree Skink was the most abundant reptile recorded within the Project Boundary, with records from all fauna habitat types.

Habitat across the Project Boundary was generally considered poor for reptiles due to the paucity of microhabitat elements (and habitat structure) necessary for these species in fauna habitats such as Grassy Woodlands on fertile soils. While fallen timber, decorticating bark, and leaf litter were recorded within such habitat, microhabitats were generally not abundant and partially imbedded rocks/rock outcrops were absent. The Project Boundary provided moderate habitat for reptile species, particularly concerning acclivities leading to surrounding ridge lines, including survey sites S1 and S2. These locations provided rocky hillside/outcrops and various sized rocks and boulders, which provide refuge and foraging habitat.

3.8.3 Aquatic fauna

A total of 26 individual fish (represented by 3 species) and 304 individual crustaceans (represented by 2 species) were collected from the sites using the Electrofisher and dip nets (Table 3-12). The fish species were Mosquito Fish (Gambusia – 21 individuals), Australian Smelt (*Retropinna semoni* – 3 individuals) and Carp Gudgeon (*Hypseleotris* sp. – 2 individuals). The crustaceans were freshwater shrimps (*Paratya australiensis* – 284 individuals) and prawns (family Palaemonidae – 20 individuals). No fish were recorded in the two sites sampled in the dam.

Table 3-12 Species of fish and crustaceans recorded using the electrofisher at each site in the Namoi River (NR1 – Upstream, NR2 – Crossing, NR3 – Downstream)

Location		**NR1**		**NR2**		**NR3**	
Site		**1**	**2**	**1**	**1**	**2**	**2**
Common Name	**Species**						
Australian Smelt	Retropinna semoni		1			1	1
Mosquito Fish	Gambusia holbrooki	3	4	9	2		3
Carp Gudgeon	Hypseleotris sp.	2					
Freshwater Shrimp	Paratya australiensis	46	53	58	61	64	32
Freshwater Prawn	Palaemonidae spp.	3		16	1		

4. Species, populations and communities of conservation concern

This chapter describes the Threatened biodiversity and other species of conservation concern likely to occur within the Project Boundary based on those found within the study area and the nature of the habitats within the existing environment.

4.1 Matters of national environmental significance

Matters of National Environmental Significance are listed and protected under the EPBC Act. The Act identifies seven Matters of National Environmental Significance:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).

Matters of National Environmental Significance relating to biodiversity are discussed below in relation to the Project based on the results of the EPBC Act Protected Matters Search Tool (Department of the Environment Water Heritage and the Arts 2008), desktop review of databases and literature, and the results of field surveys.

4.1.1 Threatened ecological communities

Threatened ecological communities (Critically Endangered, Endangered and Vulnerable) are listed under the EPBC Act. Four Threatened ecological communities have the potential to occur within the locality of the subject site (Table 4-1).

Table 4-1 Threatened ecological communities with potential to occur within the Project Boundary

Ecological community name	EPBC Act[1]	Recorded within the Project Boundary
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.	CEEC	Yes
Weeping Myall Woodlands.	E	Yes
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions.	E	No
Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld.	CEEC	Yes

1. CEEC = Critically Endangered Ecological Community (EPBC Act).

E = Endangered Ecological Community (EPBC Act).

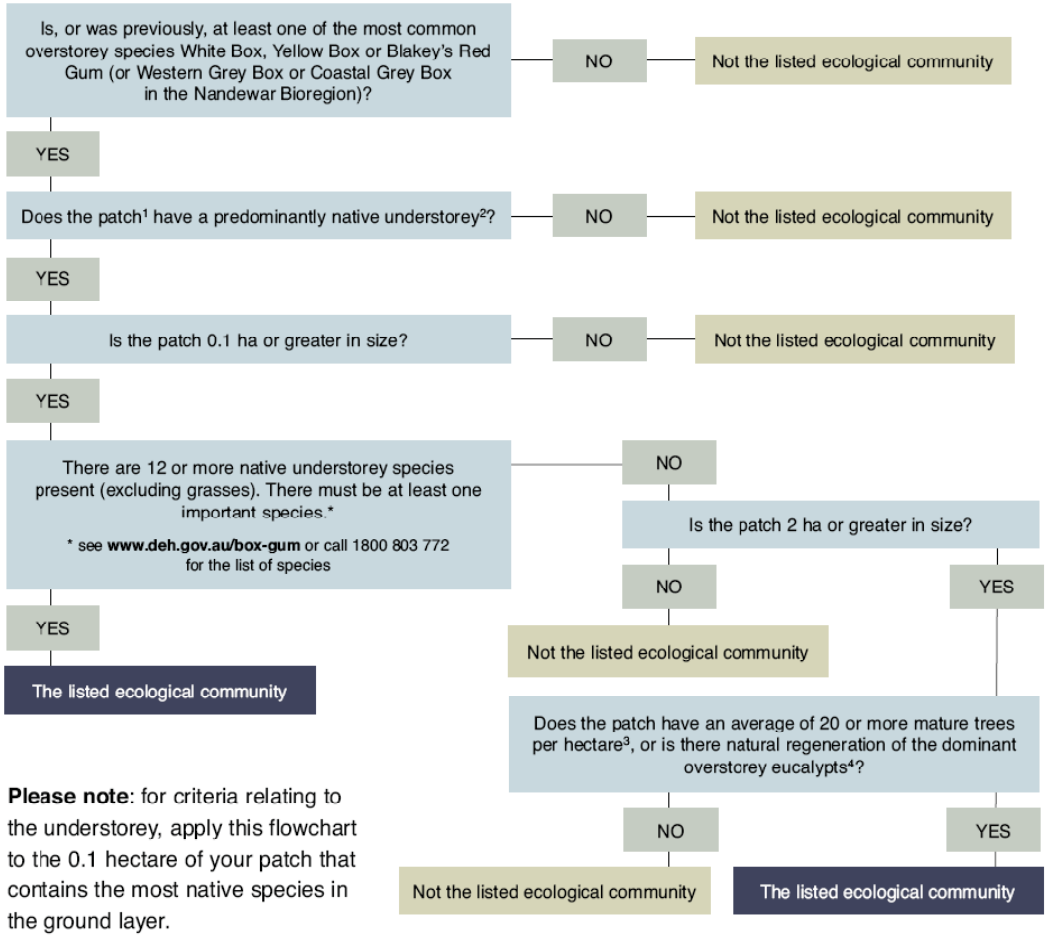
Three Threatened Ecological Communities, Box-Gum Woodlands, Weeping Myall Woodlands and Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld were observed within the Project Boundary. A description of these communities is provided below.

Box-Gum Woodlands

Three vegetation communities identified within the Project Boundary are considered to be commensurate with the characteristics of the Critically Endangered Ecological Community, Box-Gum Woodlands as listed under the EPBC Act:

- Yellow Box – Blakely's Red Gum grassy woodland.
- White Box – White Cypress Pine grassy woodland.
- White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest.

The process for determining that the above communities meet the detailed Box Gum Woodland identification guidelines is provided in Figure 4-1 and is described in more detail below. In addition to the identification guidelines presented below, the advice of the Threatened Species Scientific Committee to the Minister for the Environment and Heritage and final determination for this community were considered in determining the presence of Box-Gum Woodlands (NSW National Parks and Wildlife Service 2002c).



Please note: for criteria relating to the understorey, apply this flowchart to the 0.1 hectare of your patch that contains the most native species in the ground layer.

[1] Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:
- an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
- the area over which the understorey is predominantly native.

Patches must be assessed at a scale of 0.1 ha (1000m^2) or greater.

[2] A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not is if it is difficult to pull out of the soil. Annual species pull out very easily.)

[3] Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.

[4] Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.

Figure 4-1 Identification of Box-Gum Woodland

Shrub layer

The advice to the Minister for the Environment and Heritage in determining the presence of Box-Gum Woodlands (Department of the Environment and Heritage 2006b) specifically identifies that areas of White Box woodlands with greater than 30% cover in the shrub layers are not included within the listed Threatened community.

Given the large areas of both shrubby and grassy White Box dominated vegetation within the Project Boundary, an assessment regarding the shrub layer of those communities potentially meeting the listed Threatened community is discussed below.

The shrub layer within the three vegetation communities considered to be consistent with the listed community was generally patchy. Analysis of the shrub layer cover within the flora survey sample sites and throughout the extent of the community identified an average cover of the shrub layer significantly below the 30% threshold. The average percentage shrub layer was calculated using 42 plots distributed throughout the vegetation communities identified as containing the floristic characteristics of Box-Gum Woodlands. In addition data collected on the shrub layers cover from numerous 50 m transects was also considered.

The shrub layer was dominated by *Acacia* sp and *Cassina* sp., species which are considered to be pioneer or colonising species often associated with disturbance and with short lifecycles of approximately 10-15 years. The prevalence of these species is likely to be directly related to disturbance associated with past logging operations which ceased within Leard State Forest approximately 15-20 years ago rather than naturally occurring shrubby woodlands. It is likely that these small areas of vegetation with increased shrub layer will revert back to a grassy understorey at the end of the pioneer species life cycle (NSW National Parks and Wildlife Service 2002c).

Therefore taking into consideration that the small areas with a shrub layer density over 30% is ***not continuous*** over the entire area of the vegetation community's extent, the dominance of pioneer species within the shrub layer and past disturbance regimes, it is considered that these three vegetation types are likely to be grassy rather than a shrubby woodlands and are commensurate with the Threatened community under the EPBC Act.

Two further vegetation types, White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest and White Box – Melaleuca riverine forest contained a number of characteristic species, including the canopy species *Eucalyptus albens* of the Threatened community. However these two vegetation types contained a ***continuous*** shrub layer of greater than 30% that was dominated by a diverse mix of non – pioneer species and/or were located on steep, skeletal, rocky soils of low fertility. Therefore these vegetation types were excluded from the Threatened community under the EPBC Act.

Patch size

The methodology used to determine patch size for Box-Gum Woodlands used the methodology set out in the *Environment Protection Biodiversity Conservation Act Policy Statement* (Department of the Environment and Heritage 2006b).

Within the Project Boundary, remnant vegetation predominantly occurs as a relatively large continuous remnant within and adjoining to, Leard State Forest. Additional patches are located on the Namoi floodplain and along two minor unnamed drainage lines containing trees, interspersed by areas of modified vegetation (Figure 4-2).

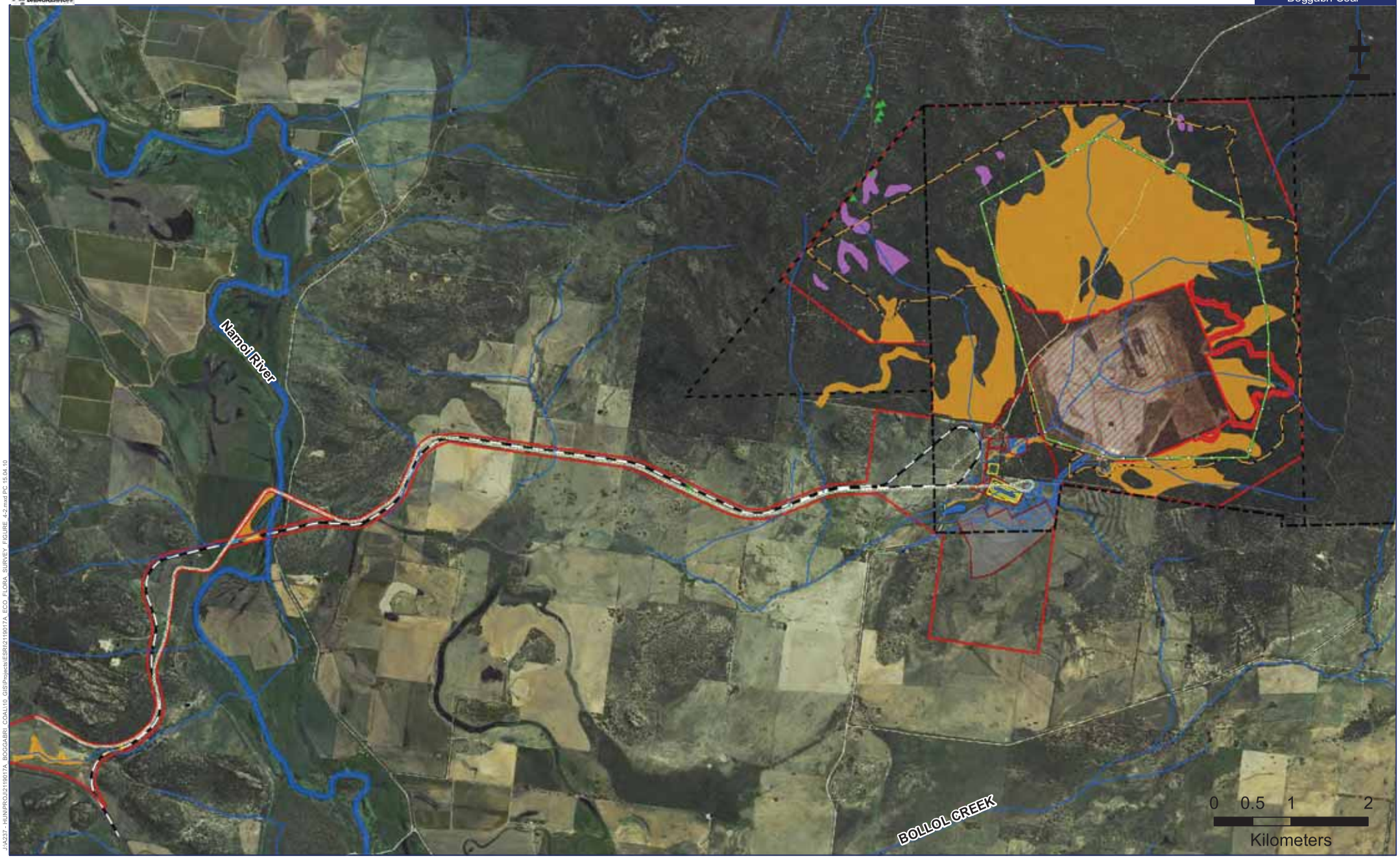
In order to determine which remnants should be combined into which patch, the mapped extent of the vegetation within Project Boundary was buffered by 37.5 m using a GIS system to determine those remnants that were within 75 m of each other.

The buffers were used specifically to identify each of the distinct remnant patches, in accordance with the Figure 4-1 and were not included in the final clearing calculations and impact assessments.

Four distinct remnant patches were identified within the Project Boundary (Figure 4-2):

- Patch 1 – Leard State Forest.
- Patch 2 – Minor drainage line off Goonbri Creek.
- Patch 3 – Naomi floodplain.

Of these three patches, all meet the various criteria to be included as part of the listed community (Table 4-2).



Mining Tenement
Project Boundary
EIS Mine Disturbance (Boggabri Existing)
Existing Haul Road
Existing Infrastructure to 2011
Mine Disturbance to 2011
Proposed Disturbance Limit (Boggabri Extention)
Sediment Dam
Proposed Rail Loop
Proposed New Infrastructure
EIS Infrastructure

Threatened Biodiversity

White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland *(CEEC)*
Weeping Myall Woodland *(EEC)*
Natural grasslands on basalt and fine-textured alluvial plains of northern New New South Wales (NSW) and southern Queensland (CEEC)
Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River
Pultenaea setulosa
Pomaderris queenslandica

Figure 4-2 Distribution of Threatened Ecological Communities and species

Table 4-2 Summary table of EPBC determination of Box-Gum Woodlands for each patch

Step	EPBC Criteria for determining Box-Gum Woodlands	General Comment for all patches within the Project Boundary	Patch Number		
			1 (Leard State forest)	2	3
1	**Is, or was previously, at least one of the most common overstorey species White Box, Yellow Box or Blakely's Red Gum?**	The four vegetation communities that have been included in the definition of White Box, Yellow Box, Blakely's Red Gum Woodland all include White Box, Blakely's Red Gum or Yellow Box as a dominant over storey species.	**Yes (go to 2)**	**Yes (go to 2)**	**Yes (go to 2)**
2	**Does the patch have a predominantly native understorey?**	The EPBC Act Policy Statement (Department of the Environment and Heritage 2006b) indicates that a predominantly native ground layer exists where at least 50% of the perennial vegetation cover in the ground layer is made up of native species. Results have been extrapolated from randomly placed 400 square metre quadrats and transects not necessarily located in the 0.1 hectare of each patch containing the highest quality of native vegetation. In some cases the dominance of native species observed during random transects was used to assume the likelihood of a greater than 50% native perennial groundcover in best 0.1 hectares.	**Yes. Up to 90% in roadside reserve (go to 3)**	**Yes. Up to 90% in roadside reserve (go to 3)**	**Yes. Up to 60% (go to 3)**
3	**Is the patch 0.1 ha or greater in size?**	Because of the definition of a patch (refer above), all patches within the Project Boundary are greater than 0.1 ha in size ((Department of the Environment and Heritage 2006b).	**Yes (go to 4)**	**Yes (go to 4)**	**Yes (go to 4)**
4	**Are there 12 or more native understorey species present (excluding grasses), with at least one important species?**	Throughout the remnant patches the groundcover was the most diverse stratum within this community, typically comprising a variety of native and exotic grasses, sedges and herbs. Approximately 107 characteristic species including 36 important species where observed within the remnants.	**Yes (go to 5)**	**Yes (go to 5)**	**Yes (go to 5)**
5	**Is the patch 2 ha or greater in size?**	All patches within the Project Boundary, as defined under the EPBC Act Policy Statement ((Department of the Environment and Heritage 2006b) (refer above), are larger than 2 ha (Figure 4-2).	**Yes (go to 6)**	**Yes (go to 6)**	**Yes (go to 6)**
6	**Does the patch have an average of 20 or more mature trees per ha, or is there natural regeneration of the dominant overstorey eucalypts?**	All patches within the Project Boundary contain natural regeneration of the dominant overstorey eucalypts.	**Yes** (go to end)	**Yes** (go to end)	**Yes** (go to end)
	Does patch meet the various criteria for classification of the vegetation as the listed community?		**Yes**	**Yes**	**Yes**

Step	EPBC Criteria for determining Box-Gum Woodlands	General Comment for all patches within the Project Boundary	Patch Number		
			1 (Leard State forest)	2	3
END	**Does patch meet final determination of the listed community** ((Department of the Environment and Heritage 2006b). **?**		**Yes**	**Yes**	**Yes**

Weeping Myall Woodlands

The Weeping Myall grassy open woodland vegetation community identified within the Project Boundary corresponds with floristic and geomorphologic characteristics of the Weeping Myall Woodlands listed as Endangered under the EPBC Act.

(Department of the Environment Water Heritage and the Arts 2009) was consulted to assist in the process for identifying the presence of the community. The flowchart from this document is presented in Figure 4-3. In addition to the identification guidelines presented in Figure 4-3, the advice of the Threatened Species Scientific Committee to the Minister for the Environment and Heritage and final determination for this community were considered in determining the presence of Weeping Myall Woodlands within the Project Boundary (Department of Environment Water Heritage and the Arts 2008).

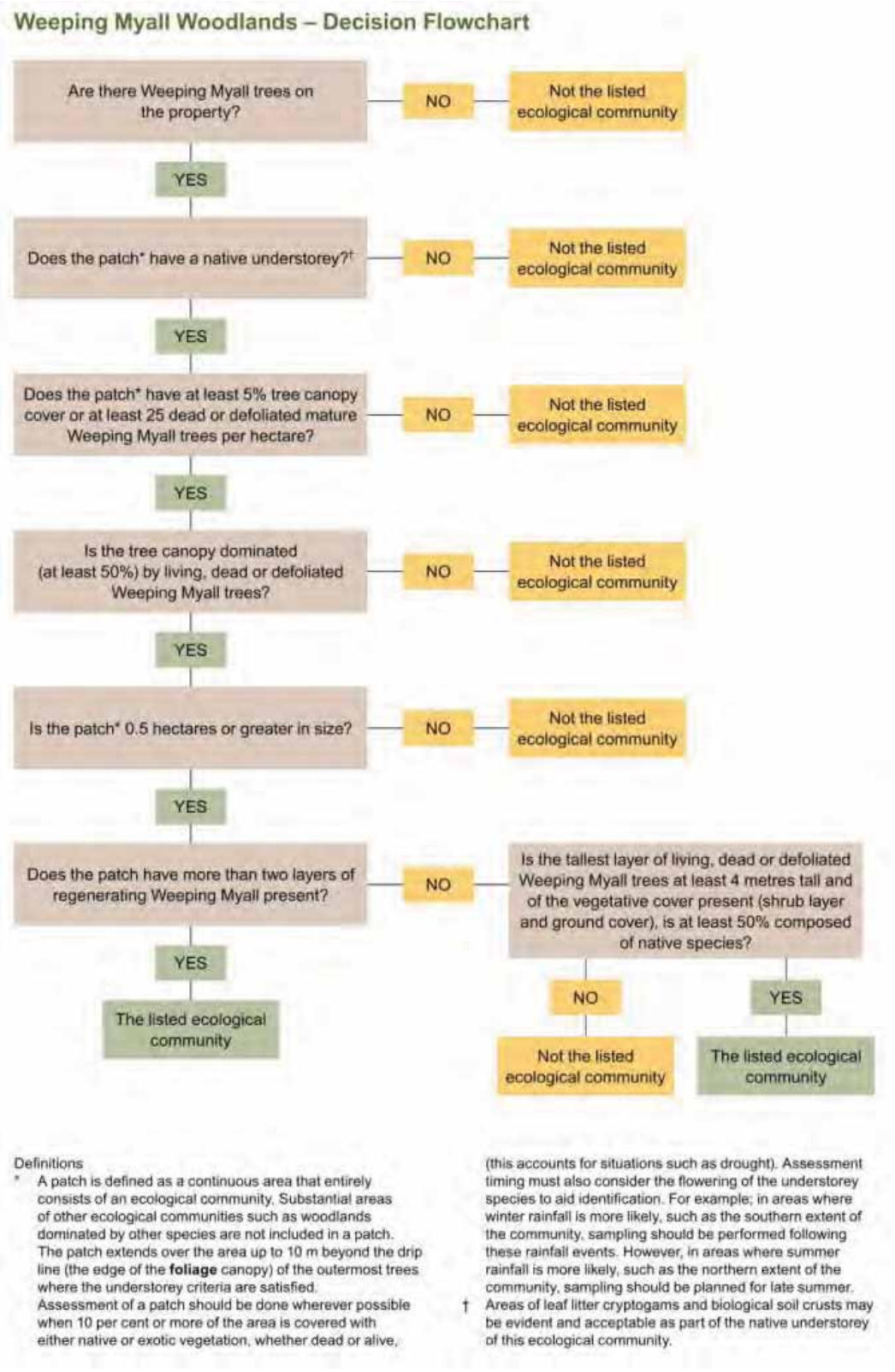


Figure 4-3 Determination of Weeping Myall Woodlands under the EPBC Act

Table 4-3 below summaries the methodology utilised in determining if the Weeping Myall Open Woodland within the Project Boundary meets the criteria of the EPBC listing for this community.

Table 4-3 Summary table of EPBC determination of Weeping Myall Woodland for the Project Boundary

EPBC criteria for determining Weeping Myall Woodlands	General comment for the Project Boundary
The tree canopy is dominated (at least 50% of trees present) by living, dead or defoliated Weeping Myall trees; and	All canopy trees within the patch are living Weeping Myall trees.
Does the patch have a native understorey?	The understorey was dominated by native chenopods, grasses and herbs, approximately 60% Projective foliage cover.
The overstorey must have at least 5% tree canopy cover or at least 25 dead or defoliated mature Weeping Myall trees per hectare; and	The canopy cover within this patch was approximately 10-15%.
The area is at least 0.5 ha in size; and	The area of this patch was greater than 1.5 ha.
The patch has either: ▪ more than two layers of regeneration of Weeping Myall present; or ▪ the tallest layer of living, dead or defoliated Weeping Myall trees is at least 4 m tall and of the vegetative cover present, 50% is comprised of native species.	While no regeneration of Weeping Myall trees were observed, the canopy of Weeping Myall trees was over 4 m and the vegetation cover comprised over 50% native species.
Does patch meet the criteria for classification of the vegetation as the listed community?	Yes

Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld (Plains Grassland)

The Plains Grasslands vegetation community identified within the Project Boundary on the western side of the Namoi floodplain corresponds with many of the floristic and geomorphologic characteristics of the Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland as listed under the EPBC Act. In addition to the listing advice from the Threatened Species Scientific Committee, relevant literature from (Duggin & Allison 1984) and (Bean 1999) were consulted and considered.

The process for identifying the presence of the Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld community needs to consider the diagnostic features outlined in the Threatened Species Scientific Committee listing advice. These are summarised below in Table 4-4.

Table 4-4 Summary table of EPBC diagnostic characteristics of Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld for the Project Boundary

EPBC diagnostic characteristics	General comment for the Project Boundary
Distribution mainly in the Darling Downs of southern Queensland and the Liverpool Plains and Moree Plains of northern NSW. Occurrence is mainly associated with fine textured, often cracking clay soils derived from either basalt or alluvium.	The area is associated within the Liverpool Plains subregion, and associated with cracking fine textured clays soils derived from alluvium and basalt.
Occurrence on landforms that are typically flat to very low slopes (less than 5%/1 degree).	The area of Plains Grassland vegetation is located on a very flat landform with <5% slope.
Tree canopy usually absent to sparse, comprising less than 10% Projective crown cover.	Tree canopy cover is estimated at within the Plains grassland area is <5% Projective crown cover.
The ground layer is typically dominated by perennial native grasses and contains 3 or more of the indicator native species listed below. *Aristida leptopoda* *Astrebla elymoides* *Astrebla lappacea* *Austrodanthonia bipartita* *Austrostipa aristiglumis* *Bothriochloa biloba* *Bothriochloa erianthoides* *Dichanthium sericeum* *Digitaria divaricatissima* *Elymus plurinervis* *Eriochloa crebra* *Eulalia aurea* *Panicum decompositum* *Panicum queenslandicum* *Thellungia advena* *Themeda avenacea* *Themeda triandra (synonym. T. australis)* *Walwhalleya proluta*	Based on the surveys completed in winter, the groundcover of the Plains Grassland vegetation community is dominated in areas by; *Austrostipa aristiglumis, Dichanthium sericeum, Panicum decompositum* and *Bothriochloa sp.*
Does patch meet the criteria for classification of the vegetation as the listed community?	Yes

Note that in a poor season, as in a hot summer or drought, the only visible evidence of natural grassland may be scattered tussocks that are difficult to identify as any particular species. It is therefore, highly desirable to identify and assess the condition of the ecological community during a good season.

In addition to the diagnostic characteristics identified above in Table 4-4, the listed Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland ecological community only comprise those patches that also meet the condition thresholds identified below in Table 4-5.

Sampling for condition criteria should be based upon a quadrat size of 0.1 ha (e.g. 50 m x 20 m) selected in an area with the most apparent native perennial grass species. Unless exceptional circumstances apply, to maximise the assessment of condition, a site must be assessed during a good season, two months after cessation of disturbance (fire, grazing, mowing or slashing) and within two months of effective rain.

Table 4-5 Summary of condition thresholds for the Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland ecological community

EPBC Act condition criteria for determining Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland	Best quality	Good quality	General comment for the Project Boundary
Patch size AND	Minimum patch size at least 0.5 ha AND	Minimum patch size at least 2 ha.	Patch size of Plains Grassland >2 ha.
Grasses	At least 4 native perennial grass species from the indicator species list AND	At least 3 native perennial grass species from the indicator species list AND	Based on the surveys completed to date, the groundcover of the Plains Grassland vegetation community is dominated in areas by 4 native perennial grass species; *Austrostipa aristiglumis, Dichanthium sericeum, Panicum decompositum* and *Bothriochloa sp.*
Tussock cover	At least 200 native perennial grass tussocks AND	At least 200 native perennial grass tussocks AND	It is estimated that at least 200 native perennial grass tussocks are present within the patch.
Woody shrub cover[1]	Total Projected canopy cover of shrubs is less than 30% AND	Total Projected canopy cover of shrubs is less than 50% AND	Total Projected canopy cover of shrubs is less than 30%.
Introduced species	Perennial non-woody introduced weed species are less than 5% of the total Projected crown cover.	Perennial non-woody introduced weed species are less than 30% of the total Projected crown cover.	Perennial non-woody introduced weed species are less than 30% of the total Projected crown cover.
Does patch meet the condition criteria for classification of the vegetation as the listed community?			Yes

Note: [1] Shrubs are typically absent. When present, they are defined as woody plants more than 0.5 m tall that occupy the mid vegetation layer. The upper, tree canopy layer also is typically absent but may comprise scattered trees to less than 10% Projective crown cover.

4.1.2 Threatened species

Threatened plants

A total of nine species of Threatened plant listed under the EPBC Act, have been recorded previously, are predicted to occur, or have habitat within the broader locality (20 km radius) of the subject site Department of Environment, Water, Heritage and the Arts 2008, accessed 20 April 2009). Details of these species are provided in Appendix C.

One Threatened flora species, *Pultenaea setulosa* which is listed as Vulnerable under the EPBC Act was recorded within the Project Boundary (Figure 4-2). This species was wide spread along the drainage lines of the Shrubby open forest on skeletal soils and the Grassy woodlands on fertile soils habitats.

Two species are considered to have a Moderate Likelihood of occurrence based on suitable habitat within the Project Boundary and cryptic seasonal survey requirements: *Diuris tricolor* (Syn *Diuris sheaffiana*) and *Digitaria porrecta.*

Digitaria sp, samples collected during the detailed surveys were sent to the Royal Botanic Gardens, Sydney for confirmation of their identification. However, no samples of *Digitaria porrecta* have been identified. The Department of Environment Heritage Water and the Arts have received a nomination to downgrade the listing of *Digitaria porrecta* from Endangered to Vulnerable.

Diuris tricolor (Syn *Diuris sheaffiana*) *,* is a cryptic flowering orchid that requires targeted survey during its September – October (Bishop 2000) flowering season for detection. No specimens were found despite detailed targeted surveys for this species at the time of a known flowering period. It should be noted here that at the time of writing this report a nomination to de-list this species from the EPBC Act has been proposed.

Threatened animals

Fourteen Threatened faunal species have been recorded, are predicted to occur, or have habitat in a 20 km radius of the Project Boundary as listed under the EPBC Act (Department of the Environment, Water, Heritage and the Arts, accessed 20 April 2009). This comprised one species of amphibian, one species of fish, five species of bird, five species of mammal and two species of reptile. One Threatened species, Pilliga Mouse, while not predicted to occur under EPBC Act Protected Matters Report, has been predicted to occur based on NSW BioBanking (Department of Environment Climate Change 2009a) database search (Table 4-6). Details of these species are provided in Appendix D. No Threatened species listed under the EPBC Act was positively recorded during current surveys, although Large-eared Pied Bat was potentially recorded via Anabat. Furthermore, Greater Long-eared Bat (south-eastern form) was previously recorded in Leard State Forest by NSW National Parks and Wildlife Service.

Table 4-6 Threatened species recorded or predicted to occur within the Project locality based on field surveys and database search results

Group	EPBC Act[1]
Amphibians	1
Fish	1
Birds	5
Mammals	5
Reptiles	2
TOTAL	**14**

Note: 1 – EPBC Act.

It is unlikely, however, that all these species would be affected by the Project (Appendix D). Despite the existence of records in the locality, seven Threatened species are considered to have a low likelihood of occurring within the Project Boundary due to a lack of suitable habitat, including Booroolong Frog, Murray Cod, Malleefowl, Painted Snipe, Brush-tailed Rock Wallaby, Pilliga Mouse and Bell's Turtle. Full details of species requirements and reasons for not considering impacts of the Project further are provided in Appendix D.

Significance assessments required under the EPBC Act have been completed for the remaining seven species (Table 7-1 and Appendix E).

4.1.3 Migratory species

Migratory species are protected under the international agreements to which Australia are a signatory, including JAMBA, CAMBA, RoKAMBA and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered Matters of National Environmental Significance and are protected under the EPBC Act.

Two species of bird, White-throated Needletail and Rainbow Bee-eater, recorded during field surveys are currently recognised under the migratory provisions of the EPBC Act (Appendix B). A further eight species have the potential to occur in the Project locality based on the Department of the Environment, Water, Heritage and the Art's *Protected Matters Search Tool*. This includes, Great Egret, Cattle Egret, Latham's Snipe, Painted Snipe, White-bellied Sea-Eagle, Regent Honeyeater, Fork-tailed Swift and Malleefowl.

Under the EPBC Act, an action is likely to have a significant impact on a Migratory species if it substantially modifies, destroys or isolates an area of important habitat for the species (Department of the Environment and Heritage 2006a). For seven species of Migratory bird considered likely to occur, and for two species recorded during field surveys, the Project area is not considered to comprise important habitat as it does not contain:

- habitat used by a Migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- habitat that is of critical importance to the species at particular life-cycle stages
- habitat used by a Migratory species that is at the limit of the species' range
- habitat within an area where the species is declining (Department of the Environment and Heritage 2006a).

As such, impacts of the Project on Migratory species are not considered further.

One species of Migratory bird, the Regent Honeyeater is, however, listed as Endangered, and as such, the Project area could be considered to contain potential habitat where this species is declining. As the Regent Honeyeater is listed as Migratory and Threatened under the EPBC Act, the assessment of significance is carried out using the Threatened species criteria (Chapter 7 and Appendix E).

4.1.4 World heritage properties

No world heritage properties are within the locality of the Project and none are likely to be directly affected by the Project.

4.1.5 Ramsar wetlands

No Internationally important wetlands (Ramsar sites) are mapped within the locality of the Project Boundary and none are likely to be directly affected.

4.2 State listed species and communities

4.2.1 Threatened ecological communities

Endangered Ecological Communities (EEC's) are listed under Schedule 1, Part 3 of the TSC Act. Nine Endangered ecological communities have the potential to occur within the Brigalow Belt South Bioregion (Table 4-7). In addition to these communities one endangered aquatic community listed under Schedule 4, Part 3 of the FM Act has potential to occur within the Project Boundary (Table 4-7).

Table 4-7 Endangered ecological communities with potential to occur within the Project Boundary

Ecological community name	TSC Act[1]	FM Act[2]	Recorded within the Project Boundary
Artesian Springs Ecological Community	EEC	–	No
White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland)	EEC	–	Yes
Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions	EEC	–	No
Fuzzy Box on alluvials of South West Slopes, Darling Riverine Plains and the Brigalow Belt South	EEC	–	No
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (Inland Grey Box Woodland)	EEC	–	No
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South western Slopes bioregions	EEC	–	Yes
Native Vegetation on Cracking Clay Soils of the Liverpool Plains	EEC	–	Yes
Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South bioregion	EEC	–	No
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	EEC	–	No
Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River	–	EEC	Yes

Notes: 1 EEC = Endangered Ecological Community (*TSC Act*); 2 EEC = Endangered Ecological Community (*FM Act).*

Four Threatened ecological communities listed under the TSC Act occur within the Project Boundary. These are discussed below.

White Box, Yellow Box, Blakely's Red Gum Woodland

White Box, Yellow Box, Blakely's Red Gum Woodland is listed as an Endangered Ecological Community under the TSC Act.

The final determination for this community under the TSC Act is broad, with five main features defining whether a patch is consistent with the community determination:

- Whether the site is within the area defined in the determination.
- Whether the characteristic trees of the site are (or are likely to have been) White Box, Yellow Box or Blakely's Red Gum.
- Whether the site is mainly grassy.
- Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).

- If the site is degraded, whether there is potential for assisted natural regeneration of the overstorey or understorey (NSW National Parks and Wildlife Service 2002a).

Three of the vegetation communities within the Project Boundary are consistent with these first four criteria. These are:

- Yellow Box – Blakely's Red Gum grassy woodland.
- White Box – White Cypress Pine grassy woodland.
- White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest.

Degraded remnants and scattered trees may be included in the definition of the community if sufficient natural soil and seedbank remain, so that under appropriate management, assisted natural regeneration of the overstorey or understorey could occur (NSW National Parks and Wildlife Service 2002c).

To determine the potential for assisted regeneration within each patch, an assessment according to one of the five condition criteria identified by the Box-Gum identification guidelines was completed (Table 4-8). This assessment was based on the results of the sampled plot with the greatest native diversity and cover for each patch.

Table 4-8 Summary table of TSC Act Condition Criteria for determination of White Box, Yellow Box, Blakely's Red Gum Woodlands for each patch

TSC Act condition criteria for determining White Box, Yellow Box, Blakely's Red Gum Woodland	General comment	Patch number		
		1	2	3
Multi-aged overstorey with a grassy, herb-rich understorey (Condition class one).	Remnants in this condition are very scarce and are generally confined to travelling stock reserves, roadside vegetation, cemeteries, some national parks and the occasional private property.	**Yes**	No	No
Partially cleared/thinned stands with a mixture of native and exotic understorey species (Condition class two).	This condition is far more common than the above; however, its long-term future is often insecure due to inadequate regeneration of overstorey species. Often current management (e.g. set-stocking) is inconsistent with tree regeneration.	No	**Yes**	No
Stands where White Box, Yellow Box or Blakely's Red Gum have been killed and other species dominate the canopy (Condition class three).	This condition occurs in woodlands where the characteristic trees occur in conjunction with White Cypress Pine. The understorey is often in reasonable to very good condition.	No	No	No
Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box-Gum Woodland understorey is present (Condition class four).	This condition is likely to be reasonably common in some areas and is likely to be relatively easy to rehabilitate if appropriate management strategies are implemented.	No	No	No
Degraded remnants that have few, if any, native species in the understorey: (Condition class five).	This condition is typical of Box-Gum Woodland where agricultural practices have been more intensive (e.g. pasture improvement over long periods).	No	No	**Yes**
Does patch meet one of the five condition criteria for classification of the vegetation as the listed community? (condition class)		Yes (class one)	Yes (class two)	Yes (class five)

Some of the small remnants of woodland and scattered trees (e.g. Patch three) assessed were in poor condition with little or no native shrub or groundcover species, or were dominated by exotic species (pasture improvement species and weeds). However, all of the patches sampled contained areas with some native groundcover species and potential for regeneration. Patch two has a condition class of two in that it is partially cleared/thinned canopy with a mixture of native and exotic understorey species. Patch three has the lowest condition class (five), but is still considered part of the Endangered Ecological Community.

Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray–Darling Depression, Riverina and NSW South western Slopes bioregions

Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray–Darling Depression, Riverina and NSW South western Slopes bioregions is listed as an Endangered Ecological Community under the TSC Act.

The final determination for this community under the TSC Act encompasses four main features defining whether a patch is consistent with the community determination:

- Whether the site occurs in the eastern parts of alluvial plains of the Murray–Darling River system as defined in the determination.
- Whether one of the dominant tree or the only dominant tree of the site is *Acacia pendula* (Weeping Myall).
- Whether the structure is that of a low to open woodland or low sparse woodland to open shrubland (depending upon site quality and disturbance history).
- Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).

The process for identifying the presence of the Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray–Darling Depression, Riverina and NSW South western Slopes bioregions community needs to consider the diagnostic features outlined in the Final Determination of this community. These are summarised below in Table 4-9.

The Weeping Myall grassy open woodland vegetation identified within the Project Boundary is considered to be consistent with the final determination listing for Myall Woodland as per the diagnostic characteristics as set out in Table 4-9 below.

Table 4-9 Summary table of TSC Act diagnostic characteristics of Myall Woodland for the Project Boundary

TSC Act final determination diagnostic characteristics for Myall Woodland	General comment for the Project Boundary
Distribution that is scattered across the eastern parts of alluvial plains of the Murray–Darling River system. Occurs in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray–Darling Depression, Riverina and NSW South Western Slopes Bioregion.	The area occurs within the Liverpool Plains which occurs within the Brigalow Belt South bioregion. Occurs on dark black clay soil flats or undulating rises on broad alluvial plains or outer floodplains of the Namoi River that rarely flood.
One of the dominant trees is *Acacia pendula* (Weeping Myall) or is the only dominant tree.	All canopy trees within the patch are *Acacia pendula* (Weeping Myall) trees.
The floristic structure is that of a low to open woodland or low sparse woodland to open shrubland.	The floristic structure was that of a open woodland with the canopy up to 10m in height with, approximately 5% Projective foliage cover.

TSC Act final determination diagnostic characteristics for Myall Woodland	General comment for the Project Boundary
Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).	Based on the surveys completed, 20 (24%) of the species listed in the final determination of the Myall Woodland vegetation were recorded within the community. The patch within the study is considered to be a degraded remnant, due to high levels of weed incursions and past agriculture land use.
Does patch meet the criteria for classification of the vegetation as the listed community?	Yes

Native Vegetation on Cracking Clay Soils of the Liverpool Plains

Native Vegetation on Cracking Clay Soils of the Liverpool Plains is listed as an Endangered Ecological Community under the TSC Act.

The final determination for this community under the TSC Act encompasses four main features defining whether a patch is consistent with the community determination:

- Whether the site occurs on cracking clay soils (referred to as Black Soils) of the Liverpool Plains Catchment.
- Whether the floristic structure is that of a grassland (can have sparse occurrences of trees and shrubs).
- Whether the community is generally dominated by one or more of the grasses including *Austrostipa aristiglumis, Dichanthium sericeum* or *Panicum queenslandicum.*
- Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).

The process for identifying the presence of the Natural vegetation on Cracking Clay Soils of the Liverpool Plains community needs to consider the diagnostic features outlined in the Final Determination of this community. These are summarised below in Table 4-10.

The Plains Grassland vegetation community identified within the Project Boundary is considered to be consistent with this final determination listing for this community as per the diagnostic characteristics set out in Table 4-10 below.

Table 4-10 Summary table of TSC Act diagnostic characteristics of Natural vegetation on Cracking Clay Soils of the Liverpool Plains for the Project Boundary

TSC Act final determination diagnostic characteristics	General comment for the Project Boundary
Distribution mainly occurs on cracking clay soils (vertosols – including soils referred to as Black Earth) and is within the Liverpool Plains Catchment. The Mooki River, Coxs Creek and their tributaries drain this catchment into the Namoi River. This catchment occurs in the Brigalow Bel south and Nandewar Bioregions.	The area is occurs within the Liverpool Plains catchment (specifically on the Namoi Floodplains), and associated with cracking fine textured clays soils derived from alluvium and basalt.
Floristic structure that of a grassland, only spars occurrences of trees or shrubs.	Tree canopy cover is estimated at within the Plains grassland area is <5% Projective crown cover. Therefore identified as grassland.
The ground layer is typically dominated by on or more of the perennial native grasses *Austrostipa aristiglumis, Panicum queenslandicum* or *Dichanthium sericeum.*	Based on the surveys completed in winter, the groundcover of the Plains Grassland vegetation community is dominated in areas by; *Austrostipa aristiglumis, Dichanthium sericeum, Panicum decompositum* and *Bothriochloa sp.*

TSC Act final determination diagnostic characteristics	General comment for the Project Boundary
Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).	Based on the surveys completed in winter, 21 (65%) of the species listed in the final determination of the Plains Grassland vegetation were recorded within the community.
Does patch meet the criteria for classification of the vegetation as the listed community?	Yes

Note that in a poor season, as in a hot summer or drought, the only visible evidence of natural grassland may be scattered tussocks that are difficult to identify as any particular species. It is therefore, highly desirable to identify and assess the condition of the ecological community during a good season.

Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River

The Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (Lowland Catchment of the Darling River) is listed as an Endangered Ecological Community under the FM Act.

The lowland catchment of the Darling River ecological community includes all native fish and aquatic invertebrates within all natural creeks, rivers, streams, and associated lagoons, billabongs, lakes, flow diversions to anabranches, and the floodplains of the Darling River including Menindee Lakes and the Barwon River. Specifically, these areas include the main Barwon–Darling channel from Mungindi (QLD–NSW border) to the confluence with the Murray River, the arid zone intermittent intersections streams (Warrego, Culgoa, and Narran Rivers), Border Rivers (Macintyre, Severn and Dumaresq Rivers), and regulated tributaries of the Gwydir, Namoi, Macquarie, Castlereagh, and Bogan Rivers (NSW Fisheries 2003).

Several Creeks and the Namoi River within the Project Boundary fall within this broad catchment.

4.2.2 Endangered populations

There are no endangered populations within the Project Boundary.

4.2.3 Threatened species

Threatened plants

A total of ten species of threatened plant listed under the TSC Act has been recorded previously, are predicted to occur, or have habitat within 20 km radius of the Project Boundary (DECC 2008, accessed 23 October 2008, and the (Department of the Environment Water Heritage and the Arts 2009), accessed April 2009). Details of these species are provided in Appendix C.

One threatened flora species of *Pomaderris queenslandica* (Scant Pomaderris), which is listed as Endangered on the TSC Act was recorded within the Project Boundary (Figure 4-2). Two species are considered to have a Moderate Likelihood of occurrence based on suitable habitat within the Project Boundary and cryptic seasonal survey requirements: *Diuris tricolor* (*syn Diuris sheaffiana*) and *Digitaria porrecta.*

A number of *Digitaria sp.* specimens collected during the detailed surveys that had the potential to be *Digitaria porrecta* were forwarded to the Royal Botanic Gardens Sydney (RBGS) for identification. However none of the specimens sent to the RBGS, were *Digitaria porrecta*.

Threatened animals

Fifty-seven Threatened faunal species, as listed under the TSC Act or the FM Act (Department of the Environment Water Heritage and the Arts 2009), accessed 20 April 2009, have been recorded, are predicted to occur or have habitat in a 20 km radius of the Project Boundary or

have been predicted to occur based on habitat assessments undertaken during field surveys and database searches carried out at the catchment and sub-catchment level (Namoi Catchment Management Authority, Liverpool Plains (Part B) Sub-Catchment). This total comprised two species of amphibian, four species of fish, one species of aquatic invertebrate, 30 species of bird, 17 species of mammal and three species of reptile. Details of these species are provided in Appendix D.

Table 4-11 Threatened species recorded or predicted to occur within the Project locality based on database search results

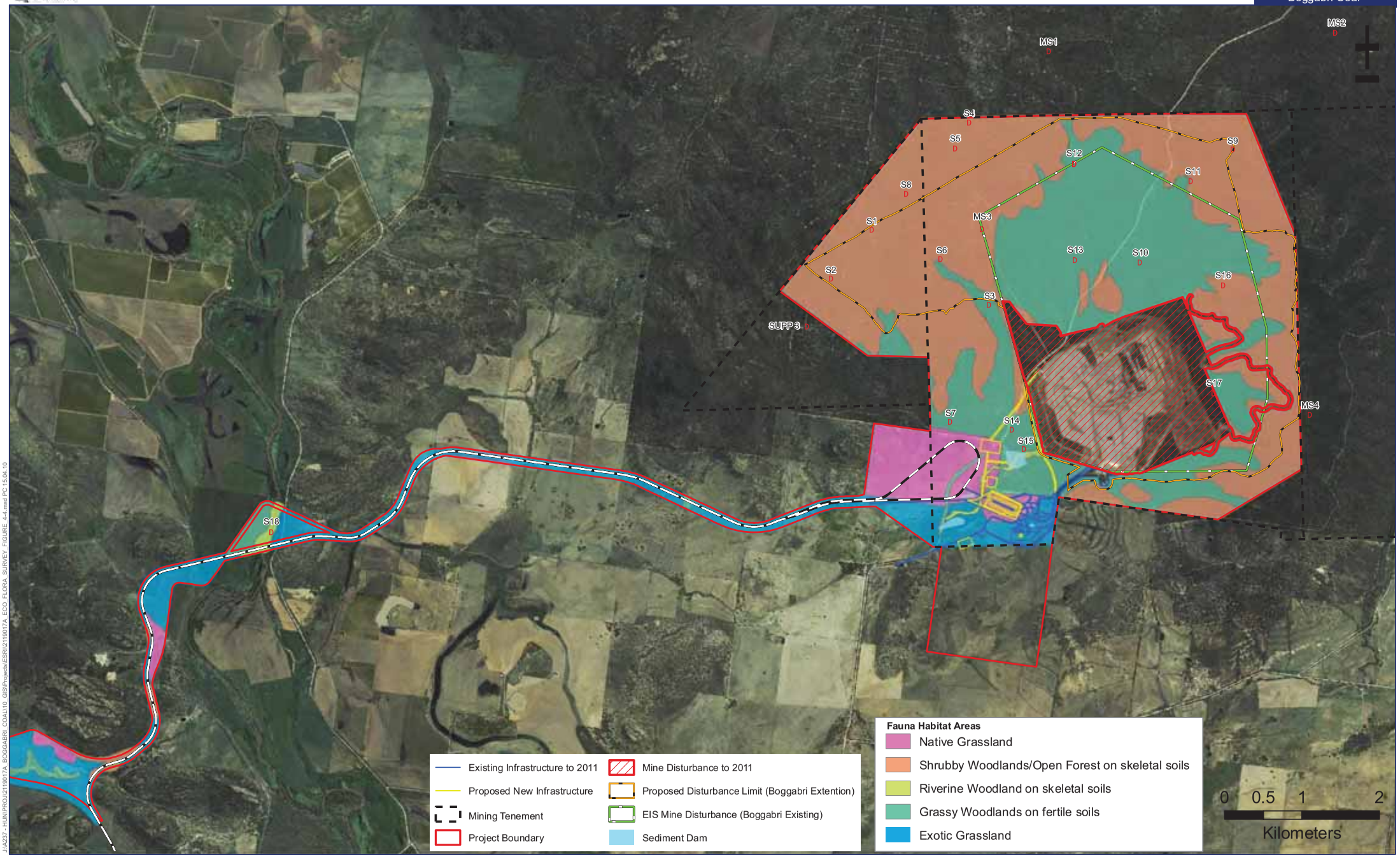
Group	TSC Act[1]
Amphibians	2
Fish	4
Aquatic invertebrates	1
Birds	30
Mammals	17
Reptiles	3
TOTAL	**57**

Notes: 1 – TSC Act.

Twenty-one Threatened species listed under the TSC Act were recorded during field surveys (Figure 4-4, Figure 4-5 and Appendix B). This included Little Eagle, Spotted Harrier, White-browed Woodswallow, Black-necked Stork, Brown Treecreeper, Black-chinned Honeyeater, Varied Sittella, Speckled Warbler, Diamond Firetail, Hooded Robin, Grey-crowned Babbler, Little Lorikeet, Turquoise Parrot, Barking Owl, Masked Owl, Yellow-bellied Sheathtail Bat, Koala, Eastern Bent-wing Bat, Eastern Cave Bat, Eastern False Pipistrelle and Little Pied Bat.

It is not likely, however, that all 57 species would be affected by the Project (Appendix D). Twenty-five Threatened species are considered to have a low likelihood of occurrence based on the availability of habitat. Full details of species requirements and reasons for not considering impacts of the Project further are provided in Appendix D.

Significance assessments required under the *EP&A Act 1979* were completed for the remaining 32 species (Table 7-1 and Appendix E).



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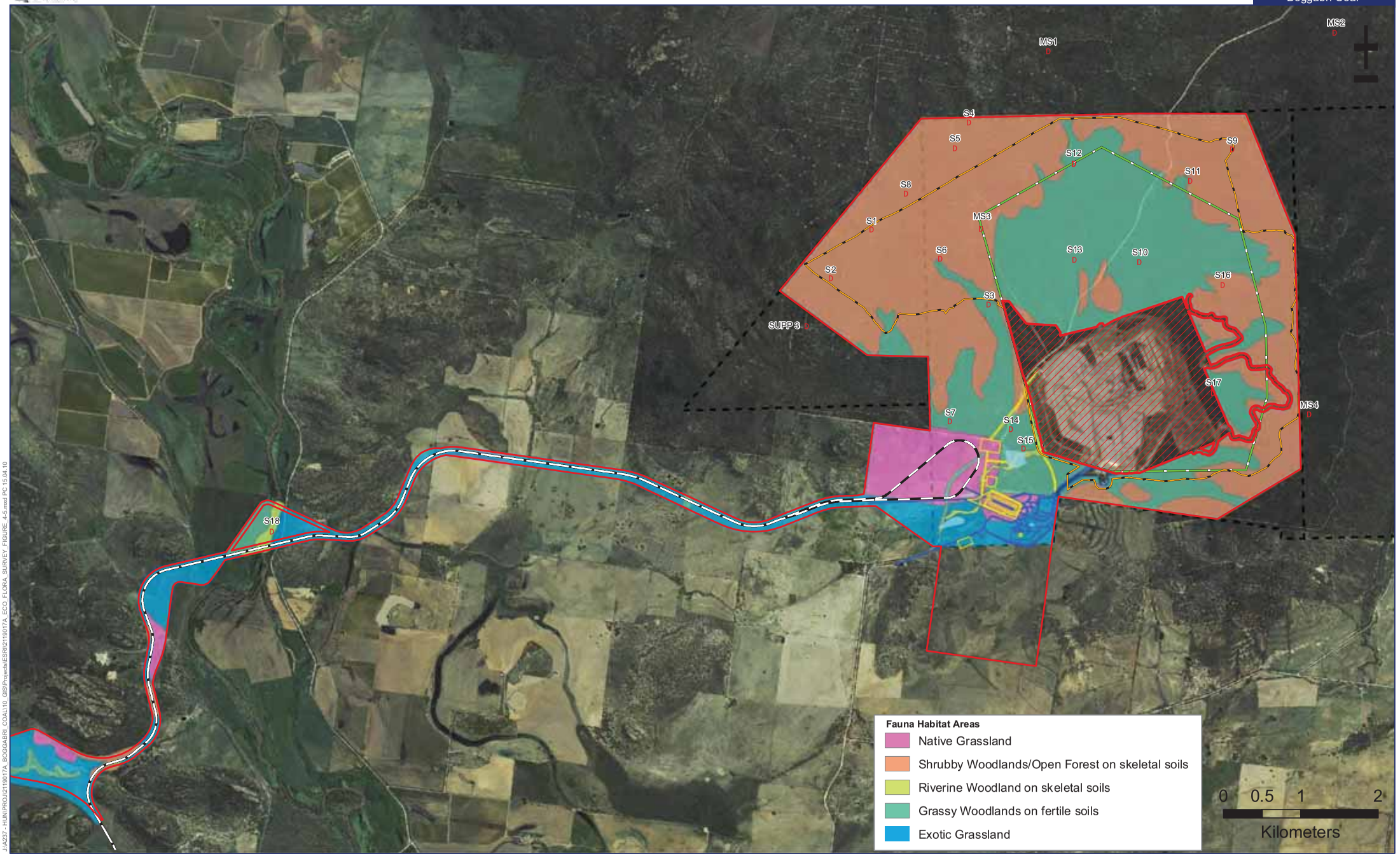
PB Threatened Species Survey (January, March, June and September 2009)

D	Threatened Species Survey Location	Turquoise Parrot	Black-chinned Honeyeater	Hooded Robin
	Speckled Warbler	Brown Treecreeper	Grey-crowned Babbler	Little Eagle
	Varied Sittella	Little Lorikeet	Black-necked Stalk	Spotted Harrier
	Barking Owl	Diamond Firetail	Masked Owl	White-browed Woodswallow

NPWS Threatened Species (DECC, October and November 2001)

Black-chinned Honeyeater	Turquoise Parrot
Speckled Warbler	Brown Treecreeper
Grey-crowned Babbler	Diamond Firetail

Figure 4-4 - Location of Threatened birds



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PB Threatened Species Survey (January and March 2009)

D Threatened Species Survey Location

Eastern Cave Bat

Eastern Bent-wing Bat

Eastern Falsistrellus

Yellow-bellied Sheathtail Bat

Large-eared pied Bat (Potential)

Koala scats recorded

Koala sighting

Eastern Cave Bat Breeding Area

NPWS Threatened Species (DECC, October and November 2001)

Yellow-bellied Sheathtail-bat

Greater Long-eared Bat

Existing Infrastructure to 2011

Proposed New Infrastructure

Mining Tenement

Project Boundary

Mine Disturbance to 2011

Proposed Disturbance Limit (Boggabri Extention)

EIS Mine Disturbance (Boggabri Existing)

Sediment Dam

Figure 4-5 - Location of Threatened mammals

4.3 Regionally significant species

4.3.1 Regionally significant communities

A number of vegetation communities identified within the Project Boundary have been classified as over-cleared vegetation types by the DECC Vegetation Type Database for use in the BioBanking Assessment Methodology and Credit Calculator Operational Manual (Department of Environment Climate Change 2009b) within the Namoi CMA area. An over cleared vegetation type is defined as having been cleared by more than 70% of its pre-European distribution and therefore are considered to be regionally rare.

These communities included:

- River Red Gum riverine woodlands, estimated as 75% cleared.
- Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland estimated as 80% cleared.

4.3.2 Regionally significant plants

Several of the plants which were identified within the Project Boundary were either recorded outside of their previously known range, are listed Rare or Threatened Australian Plant species (ROTAP) or have restricted distribution within their range. These include the following:

- *Eucalyptus nandewarica* (Red Gum Mallee) is a small mallee which only occurs within the Kaputar-Waa Gorge area (Brooker & Kleinig 1999). This species is listed as a ROTAP species with a rating of 3RCa (Briggs & Leigh 1996). This species was tentatively recorded within the Dwyer's Red Gum community. However identification was difficult due to possibly hybridisation with *Eucalyptus dwyeri*. Therefore the identification of this species is not confirmed.
- *Minuria integerrima* (Smooth Minuria) is a small Asteraceae species which has been confirmed by the Royal Botanical Gardens, Sydney to be a range extension. The current known range of *Minuria integerrima* is west from the Moree District, this record within the Leard State Forest is the most north easterly record. Therefore this species is considered regionally significant.
- *Prostanthera cruciflora* is an erect shrub which has been positively identified by the Royal Botanical Gardens, Sydney as occurring within the Leard State Forest. This species is listed as a ROTAP species with a rating of 2RCt (Briggs & Leigh 1996). *Prostanthera cruciflora* was recorded in the Leard State Forest. This species has previously only been recorded from Mount Kaputar National Park and this current record is therefore considered significant.
- *Sauropus ramosissimus* is a slender wiry subshrub to approximately 30 cm height. This species is listed as a ROTAP species with a rating of 3KC- (Briggs & Leigh 1996).

5. Potential impacts of the Project

This chapter describes the potential impacts of the Project on the biological environment, including loss of vegetation and habitats and impacts on Threatened species.

5.1 Loss of vegetation/habitats

The most significant impact of the Project would be loss of native vegetation and associated habitats. The Project would result in the loss of native vegetation within the Project Boundary (as summarised in Table 5-1) including up to 1385 ha of native vegetation. This includes up to 626 ha of Threatened Ecological Communities (Box-Gum Woodland, Weeping Myall Woodlands, Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River and Plains Grassland) listed under the TSC Act, FM Act and the EPBC Act.

Clearing of native vegetation is listed as a Key Threatening Process under the TSC Act and the EPBC Act.

Table 5-1 Potential loss of vegetation and habitat within the Project Boundary

Vegetation communities	Boggabri Project Boundary					Extent within Leard State Forest (James B. Croft and Associates 1983) (ha)
	Area occupied within Project Boundary (ha)	Total Project Disturbance (Boggabri Existing and Boggabri Extension) (ha)	Boggabri Existing (ha)	Boggabri Extension (ha)	Percent removal of Total Disturbance from Project Boundary (ha)	
Yellow Box – Blakely's Red Gum grassy woodland*	17.5	2.0	1.5	0.5	11	268
White Box – White Cypress Pine grassy woodland *	216.2	147.2	135	12.2	68	1262
White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest*	651.4	474.4	405.1	69.3	73	1684
Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland	86.4	10.3	1.5	8.8	12	293
Weeping Myall grassy open woodland*	1.5	0.3	0.3	0	26	N/A
White Box – Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	263.9	175.1	51.1	124	66	NA
Narrow-leaved Ironbark – White Cypress Pine shrubby open forest	955.3	528.8	110.1	418.7	55	4515

Vegetation communities	Boggabri Project Boundary					Extent within Leard State Forest (James B. Croft and Associates 1983) (ha)
	Area occupied within Project Boundary (ha)	Total Project Disturbance (Boggabri Existing and Boggabri Extension) (ha)	Boggabri Existing (ha)	Boggabri Extension (ha)	Percent removal of Total Disturbance from Project Boundary (ha)	
Silver-leaved Ironbark shrubby woodland	21.1	3.7	2.1	1.6	18	114
Narrow-leaved Ironbark – Brown Bloodwood – White Cypress Pine shrubby open forest	20.8	14.8	0	14.8	71	N/A
Dwyer's Red Gum woodland	21.7	0.3	0	0.3	1	N/A
Native Olive dry gully forest	0.8	0	0	0	0	N/A
River Red Gum riparian woodlands and forests and the aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River	9	0.6	0.6	0	6	N/A
White Box – Blakely's Red Gum – Melaleuca riparian forest	0.8	0.6	0.6	0	75	N/A
Derived native grassland	178.4	26.1	26.1	0	14	N/A
Plains grassland*	1	0.4	0.4	0	40	N/A
Exotic grassland	315.4	40.6	40.6	0	13	N/A
Total	**2,761.2**	**1425.2**	**775**	**650.2**	**52**	**8,136**
Threatened Ecological Communities						
CEEC[1]	885.1	623.6	541.6	82	70	3214
CEEC[2]	1	0.4	0.4	0	40	N/A
EEC[3]	1.7	0.3	0.3	0	17	N/A
EEC[4]	9	0.6	0.6	0	0	N/A
Total	**896.8**	**624.9**	**542.9**	**82**	**70**	**3,214**
Fauna habitats						
Fauna Habitats for threatened species (excluding exotic grassland)						
Grassy Woodland on fertile soils	955.5	634.2	543.4	90.8	65	3237
Shrubby Woodlands/Open Forest on skeletal soils	1283.6	722.7	163.3	559.4	56	4629

Vegetation communities	Boggabri Project Boundary					Extent within Leard State Forest (James B. Croft and Associates 1983) (ha)
	Area occupied within Project Boundary (ha)	Total Project Disturbance (Boggabri Existing and Boggabri Extension) (ha)	Boggabri Existing (ha)	Boggabri Extension (ha)	Percent removal of Total Disturbance from Project Boundary (ha)	
Riverine Woodland	27.3	1.2	1.2	0	12	268
Grassland	179.2	26.5	26.5	0	15	0
Total	**2445.8**	**1384.6**	**734.4**	**650.2**	**57**	**8,136**

Notes: * forms part of an Endangered Ecological Community.

1 – Critically Endangered Ecological Community, White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

2 – Critically Endangered Ecological Community, Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland.

3 – Endangered Ecological Community, Weeping Myall Woodlands.

4 – Endangered Ecological Community, Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River FM Act.

5 – Based on (James B. Croft and Associates 1983).

The majority of the clearing is proposed within Leard State Forest, which forms part of an extensive area of remnant native vegetation covering approximately 8,136 ha and includes Leard State Conservation Area. It is expected the Project will effectively reduce this large remnant patch of vegetation by up to 17% (Boggabri Existing 9%, Boggabri Extension 8%).

The remaining areas of vegetation clearing are associated with the proposed upgrade of the approximate 17 km haul route which generally traverses a modified agricultural landscape. However it will also impact on remnant native vegetation along the Namoi River floodplain.

In total the Project will require the removal of up to 1385 ha or 57% of the remnant native vegetation/fauna habitat within the Project Boundary (Boggabri Existing 30%, Boggabri Extension 27%). While significant areas of these communities will remain within the locality and adjoining the Project Boundary, and the amount of clearing is relatively small in relation to their extent in the Brigalow Belt South (Table 5-1), the extent of vegetation removal is still important to the locality.

While the Project would reduce remnant vegetation cover from 94% to 45% within 100 m of the Project, within the local regional locality (10 km) it would only reduce remnant vegetation cover from 51% to 48% (Figure 5-2).

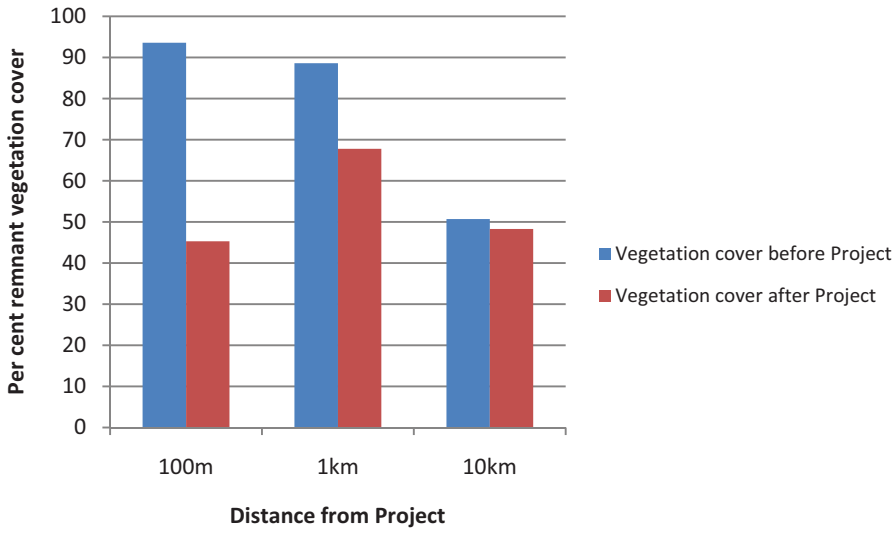

Figure 5-1 Percent remnant vegetation cover before and after the Project

Vegetation cover within the locality would not be reduced below the 10% critical threshold suggested by Bennett and Radford (Bennett & Radford 2004) for woodland birds, and will remain above the 30% level above which (Reid 2000) suggested that most organisms and ecological processes characteristic of that ecosystem persist. However, the Project would result in a considerable reduction in vegetation cover. Based on the threshold limit suggested by Bennett and Radford (2004), the locality would still be capable of maintaining viable populations of woodland birds after construction of the Project.

The Projects impacts on fauna habitats will be greatest on the Shrubby Woodlands/Open Forest on skeletal soils and Grassy Woodland on fertile soils with removal of approximately 722.7 ha and 634.2 ha respectively. The majority of this proposed habitat removal will occur within Leard State Forest with large areas of contiguous similar habitats retained. Some relatively minor clearing will also occur along the proposed haul route to the west of the Project Boundary, however importantly this will include an area of Riverine Woodland along the Namoi river floodplain. The total (cumulative) length of clearing along the haul route is approximately 4 km. This vegetation clearing would be spread over all identified remnant patches of vegetation within the Project Boundary.

5.2 Habitat fragmentation and barrier effects

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with the occurrence of a new habitat type in the area between the fragments. This new dividing habitat type is often artificial and inhospitable to the species remaining within the fragments (Bennett 1990, 1993; Johnson *et al.* 2007). Although the newly created habitat is generally used by some species, those species are usually generalists and are often considered aggressive (e.g. Noisy Miners Grey *et al.* 1998), further decreasing population levels of the species remaining in the fragments. Habitat fragmentation can result in a number of impacts including:

- **Barrier effects** – Barrier effects occur where particular species are either unable, or are unwilling, to move between suitable areas of fragmented habitat. This could result in either a complete halt to movement or a reduced level of movement between fragments. Species most vulnerable to barrier effects include rare species (even a small reduction in movements can reduce genetic continuity within the population, hence reducing the effective population size), smaller ground-dwelling species and species with low mobility. Species least

vulnerable to barrier effects tend to be those that are highly mobile (e.g. birds and bats), although even these species can vary in their response to barriers.

- **Genetic isolation** – Genetic isolation occurs where individuals from a population within one fragment are unable to interbreed with individuals from populations in adjoining fragments. Genetic isolation can lead to inbreeding and genetic drift problems for populations isolated within a fragment.

The Project would affect approximately 1384.6 ha of remnant vegetation within the Project Boundary and as such, would further fragment habitat and increase the isolation of remnant vegetation. However, in that part of the Project Boundary concerning the mining void and Leard State Forest, the Project would not fragment or lead to barriers to wildlife movement given the retention of remaining remnant vegetation, surrounding the Project to the north, east and west. Moreover, the remaining Leard State Forest and Leard State Conservation Area forms part of a larger remnant patch of vegetation of approximately 29,000 ha.

The Project includes a rail spur and loop, which would traverse agricultural land, Namoi River and floodplain. With a rail corridor width of 30 m, the Project would present a barrier within the landscape (in a general east-west direction), particularly within the Namoi River riparian corridor and remnant patches of vegetation within agricultural lands.

The majority of those areas that occurred along the rail corridor alignment have been significantly disturbed by previous agricultural land uses. Given these disturbances, the majority of species likely to be using remnant patches are mobile species, such as birds and bats, particularly as foraging habitat would be within a greater foraging home range.

Barrier effects would increase for some species and in some areas may effectively isolate remaining vegetation on either side of the rail corridor. This would particularly be the case for small and sedentary fauna, such as ground-dwelling mammals, reptiles and amphibians. However, more mobile species, such as birds and bats, would not be as affected by the barrier.

With the Namoi catchment being an important and diverse area of primary production in Australia, it is of no surprise that less than 40% of the catchment's native woodland remains. Therefore, existing remnant vegetation occurring within the Project Boundary, although highly disturbed in parts, is likely to play a key role in a wider corridor network. The Project would increase the level of fragmentation and isolation of some patches of vegetation.

A study of the effects of clearing and habitat fragmentation on Threatened Squirrel Gliders in the Wyong local government area (Smith 2002) classified remnant isolation as follows (Figure 5-2):

- Class 1 – Remnants connected to other remnants by a narrow corridor (up to 250 m wide.
- Class 2 – Remnants separated from other remnants by a cleared gap (e.g. road or clearing) up to 100 m wide, but with a broad area of contact, including native vegetation on both sides of the gaps for a width of at least 250 m.
- Class 3 – As in Class 2 (above), but with a narrow width of contact (less than 250 m wide).
- Class 4 – Remnants separated from other remnants by cleared areas of 100-400 m in rural environments or 100-200 m in urban environments.
- Class 5 – Remnants separated by more than 200 m of urban habitat or 400 m of cleared habitat.

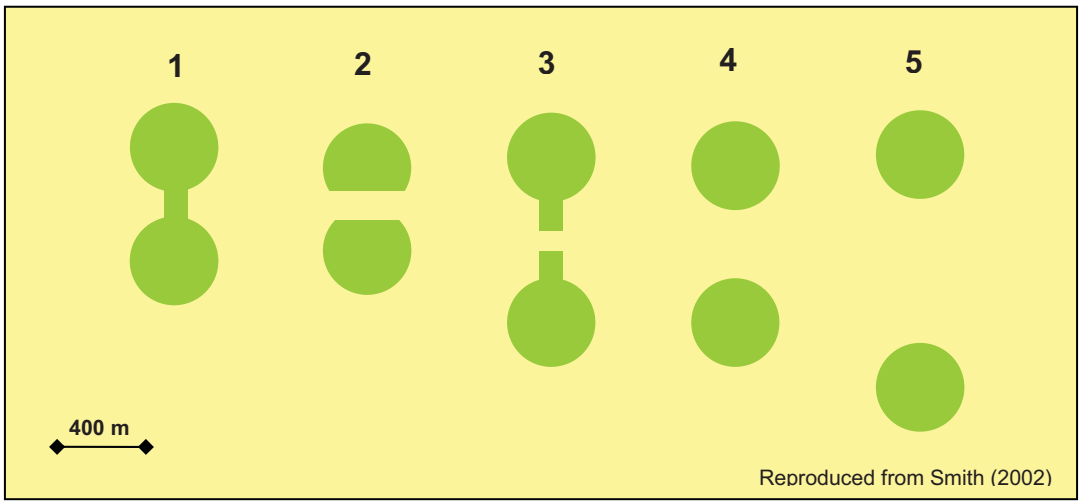

Figure 5-2 Remnant isolation classes

Vegetation occurring along that part of the Project Boundary concerning the proposed rail corridor is already fragmented by land clearing for agricultural purposes and an existing haul road associated with Boggabri Coal. Following the definitions outlined by (Smith 2002), isolation of vegetation communities as a result of this part of the Project would largely fall into Class 2 (Figure 5-2).

5.3 Edge effects

Edge effects are zones of changed environmental conditions (i.e. altered light levels, wind speed and/or temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators. Edge effects have mainly been recorded adjacent to roads and at distances greater than 1,000 m from the road surface (Forman et al. 2000). However, Bali (2005), in a comparison of edge effects in a variety of different habitat types, estimated that average edge effects generally occur up to 50 m away from the road edge.

The majority of vegetation occurring along the proposed rail corridor occurs within relatively small, fragmented patches, many of which are subject to past and present disturbance regimes (e.g. grazing and existing coal haulage road), and hence, already consist of edge-affected habitats. However, that part of the Project Boundary encompassing Leard State Forest occurs within a large relatively undisturbed remnant patch with limited disturbances associated with edge effects. Observations within the current edges of Leard State forest and the existing Boggabri Coal Mine indicate only a limited increase in the disturbances present. These were typically associated with minor changes in vegetation structure associated with an increased density in native pioneer shrub species in zones of edges. Using the estimate of 50 m proposed by Bali (Bali 2005) it is likely that new edge effects would be introduced in the larger remnants of vegetation, such as remaining Leard State Forest and vegetation occurring along the proposed rail corridor, particularly near survey sites S20 and S21. The changes to habitat resulting from the introduction of edge effects into the previously ‘core’ areas of these remnants is likely to be approximately 110 ha.

A change in the microhabitat conditions in remnant vegetation patches as a result of vegetation clearing and earthworks increases the likelihood of the germination and establishment of exotic

plants (weeds). The germination and establishment of weeds is most likely to occur in areas affected by vegetation clearing, in areas of exposed soil/fill (such as topsoil stockpiles, soil cuttings, fill batters and scree slopes) and along edge-affected areas of remnant vegetation, particularly vegetation bordering the mining void and remnants adjoining the proposed rail corridor. However, field surveys within remnant patches occurring along the proposed rail corridor identified significant disturbances associated with edge effects from grazing and adjoining agricultural land practices. It is considered that any marginal increase in these edge effects caused by the Project is unlikely to be significant.

5.4 Potential environmental impact of noise and light on wildlife and domestic animals

5.4.1 Noise/vibrations (acoustic ecology)

Many animals detect and depend on sound to communicate, navigate, evade danger and find food, but human-made noise can alter the behaviour of animals or interfere with their normal functioning e.g.(Bowles 1997). In some cases it can harm their health, reproduction, survivorship, habitat use, distribution, abundance, or genetic composition (Forman et al. 2000).

However, variation in ambient noise, such as from wind or other animals, is part of the natural environment (Eve 1991) and many animals display behavioural adaptations to this variation. For example, certain species of frogs avoid vocalising during loud calling by cicadas (Paez *et al.* 1993) or other frogs (Matsui *et al.* 1993), and some species will time their calls during brief periods of silence (Schwartz & Henderson 1991).

Studies on the impacts of noise on animals relate primarily to domestic animals and have generally been completed outside of Australia. Studies relating to stress in livestock from noise pollution have indicated that increased noise levels can trigger behavioural changes and physiological responses such as:

- increased heart rate and altering of metabolism (Busnel & Fletcher 1978)
- altering of hormone balance (Busnel & Fletcher 1978)
- head raising, body shifting, trotting short distances, panic and escape behaviour (Busnel & Fletcher 1978)
- a decrease in food intake, habitat avoidance and abandonment, and reproductive losses (Larkin 2005)
- retreating from favourable habitat near noise sources (Larkin 2005)
- a reduction in foraging efficiency (Stockwell et al. 1991)
- inhibition of milk production by mother cows during calving season (Harrington & Veitch 1991)
- cow and calf separation (Harrington & Veitch 1991)
- injuries to newborn calves (if the mother bolts) and stillbirths (Harrington & Veitch 1991).

Van der Toorn et al (1996) studied the effects of human-made noise levels on wildlife and domestic livestock in America and were able to establish minimum sound exposure levels that induced specific behavioural and physiological effects in different species. The study concluded that the minimum threshold of response for disturbance from noise levels was approximately 77 dB and this initiated behavioural or physiological responses from animals ranging from the ‘startle effect’, changes in hormones (93-120 dB in pigs), accelerated hatchling rates (80 dB) and even hearing loss in some birds (95-100 dB) (Table 5-2). Many studies report levels in the vicinity of 100 dB as associated with an observable effect.

Table 5-2 Summary of noise levels associated with effects on animals

Animal category	Species	Noise level and type (if known) associated with effect	Effect
Domestic Mammals	Dairy Cow	105 dB	Reduction in milk production
		97 dB	Changes in blood composition
		110 dB, 1 kHz	Changes in blood composition
	Sheep	108-120 dB	Increased heart rate, respiration
		90 dB 'white noise'	Decreased thyroid activity
		100 dB	Increase in number of lambs per ewe
Wild Birds	Quail	80 dB	Accelerated hatching rate
	Canary	95-100 dB	Hearing loss
	Tern	Sonic boom, frequent	Reduced reproduction
	Raptors	Sonic booms	Alarm

Adapted from van der Toorn *et al* (1996).

While the construction and operational phases of the Project (along with its ancillary activities) may cause temporary disturbance to animals, the impacts from noise emissions are likely to be localised close to the mining void (up to 100 m) and are not likely to have a significant, long-term, impact on either wildlife populations or domesticated animals. Furthermore, it is likely most animal species will habituate to the periodic noise disturbance e.g. (Larkin 2005);(Forman *et al.* 2000). This is supported by the last four years of ecological monitoring of the existing open cut mine operation impacts on the biodiversity within Leard State Forest (PB 2005-2009), which has not seen any significant changes attributed to the mine operations from the sampling of invertebrates, micro bats, birds.

The ability of the local native fauna species to habituate to the existing mine operations periodic noise disturbance was evident during the field surveys as evidence of Koalas and small arboreal mammals (Sugar Gliders) were recorded within 100 m of the existing mining void. Additionally, there were no discernable changes observed in the density or diversity of woodland birds recorded with increased distance from the void. In fact, a number of species, including the Plum-headed Finch and Hooded Robin were only recorded from areas in close vicinity along the existing voids disturbance boundary.

5.4.1 Ecological light pollution

While research into the role natural light plays in regulating species interactions has been relatively well studied, little has been documented about the effects of artificial lighting on native wildlife and domestic livestock.

Longcore and Rich (Longcore & Rich 2004; Salmon *et al.* 1995) have proposed 'Ecological Light Pollution' as the descriptive term for light pollution, which includes direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in lighting (including lights from a passing car or train), that can have potentially adverse effects on wildlife.

Studies relating to the effect of ecological light pollution on fauna have indicated light pollution from a variety of sources can trigger behavioural and physiological responses such as:

- An extension of diurnal or crepuscular foraging behaviour into the night-time environment (sometimes referred to as the 'night light niche' where reptiles, microbats and some diurnal birds will forage for insects under artificial lights (Schwartz & Henderson 1991).

- A disruption of seasonal day length cues which trigger critical behaviours (Longcore & Rich 2004).
- Disorientation (Salmon et al. 1995).
- Temporary blindness (sometimes lasting hours).
- A disruption to predator-prey relationships (Longcore & Rich 2004).
- Altering of communication patterns (Bender et al 1996).

In regards to this particular Project, two impacts, predator-prey interactions and effects of 'Sky glow' are considered potentially relevant and are briefly disused below.

Predator–prey interactions are particularly vulnerable to influence by lighting. In general, additional light benefits the predator, except when the prey are found in groups where individuals warn each other of predators, such as flocks of birds, mobs of kangaroo and schools of fish (Longcore & Rich 2004). With the large number of predator pest species (foxes and cats) recorded within the Lead State Forest areas surrounding the mining void, this may result in an increased predation of small mammals or a shift in small mammal foraging patterns to areas of dense cover. However, it is also likely that these interactions would result in increased predation on the widely recorded pest species, house mouse and rabbit, possibly by the large forest owls inhabiting the Project Boundary which are known to utilise breaks in the natural forest and open areas for predation.

The effects of artificial lights can even occur when organisms are not exposed directly. Illumination from urban areas that reflect off clouds can produce unnaturally bright conditions at night; commonly known as 'sky glow'. Three general types of impacts are considered to be the main effects off artificial light on wildlife: direct mortality, interference with reproduction, and altered predation (Longcore & Rich 2007).

While the construction and operational phases of the proposed Project (along with its ancillary activities) have the potential to affect the surrounding environment, the impacts from ecological light pollution are likely to be localised close to the immediate disturbance boundary of the mining void. This currently consists of large movable lights shone directly into the mining void, with only limited glare into the surrounding natural vegetation. It is also likely most species of animal will habituate to the periodic disturbance. As a result, light pollution from the proposed ongoing operation of the open cut mine is unlikely to have a significant or long-term impact on any species of animal.

5.5 Vehicle strike and direct mortality

Fauna injury or death could occur as a result of the Project's construction phase, when vegetation and habitats are being cleared. They also have the potential to occur during the operation of the mine as a result of collision with vehicles entering and leaving the void through the Leard State Forest and along the rail loop and haul route.

While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile, or those that are nocturnal and restricted to tree hollows, may have difficulty moving over relatively large distances. Threatened species that may be affected by vegetation clearing include microchiropteran bats, woodland birds, Koalas and potentially Squirrel Gliders.

While the Project would result in a linear corridor in the form of a rail loop and haul route traversing a relatively modified landscape, this would result in an area of road for animals to cross and negotiate, which would increase the extent of vehicle strikes. Threatened fauna that may be affected by vehicle strikes include the Koala (Department of Environment and Climate Change

2008a), potentially the Squirrel Glider (Claridge & van der Ree 2004) and woodland species of bird such as the Grey-crowned Babbler (Davidson & Robinson 1992; Robinson *et al.* 2001).

It is likely that the Project will have the greatest impacts on these species across the Namoi River floodplain and the southern entry to Leard State Forest, where the alignment traverses between existing remnant roadside vegetation and large remnants associated with the Leard State Forest.

5.6 Weeds

Forty-nine species of weed were observed within the Project Boundary. Amongst these were seven species of noxious weed listed under the *Noxious Weed Act 1993* (Table 3-10). One of these species, *Rubus fruticosus* (Blackberry) is listed as a Weed of National Significance (Thorp & Lynch 2000).

The distribution of these exotic weed infestations across the Project Boundary can generally be split into the following broad distributional areas:

- Riparian areas which are associated with the Riverine Woodland communities.
- Disturbed Grassland areas which are associated within the exotic, derived and natural grassland communities.

The Riparian areas vegetation community which contained dense infestations of weeds was the River Red Gum riverine woodland. This community occurred along the banks of the Namoi River. There was no shrublayer, the groundcover on the creek banks was dominated by *Hordeum leporinum, Vulpia myuros, Lythrum hyssopifolia, Lolium perenne, Conium maculatum, Vicia sativa subsp. nigra, Xanthium occidentale, Phalaris aquatica* and *Bromus molliformis.*

Disturbed Grassland areas were located along the proposed rail corridor and within the south west of the Project Boundary. The exotic grassland community contains high levels of exotic pasture weed invasion, with the derived native grasslands containing a moderate level of weed incursions. Finally, the plains grassland had a low level of weed incursions. The most abundant exotic species within these areas were *Galenia pubescens, Paspalum dilatatum, Chloris gayana, Lolium perenne, Cynodon dactylon, Trifolium repens, Silybum marianum Senecio madagascariensis, Pennisetum clandestinum, Cirsium vulgare, Sida rhombifolia* and *Brassica sp.*

The remaining areas of natural vegetation communities contain a low level of weed incursions. The only weeds that are present are located along the unformed roads which cross through the vegetation communities. The noxious weeds of *Opuntia stricta* (Prickly Pear) and *Opuntia aurantiaca* (Tiger Pear) were present in minor occurrences throughout the Grassy Woodlands and Shrubby Forests and Woodlands vegetation assemblages.

The disturbances of land during the construction phase of the Project have the potential to disperse weeds into areas of remnant vegetation where weed species do not currently occur. The most likely causes of weed dispersal associated with the Project would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery. This may, in turn, reduce the habitat quality of the sites for Threatened species, such as woodland species of bird (Robinson *et al.* 2001).

The proposed rail corridor has considerable weed growth already; therefore, the overall extent of habitat modification is not likely to increase significantly. However, within the Leard State Forest the weed incursions are minor, and the Project may facilitate the spread of weeds into the northern portion of the Leard State Forest. This is considered to be minor and weed control methods in accordance with Narrabri Shire Council guidelines will be undertaken to control the spread of weeds during the mining operations.

5.7 Feral animals

Seven species of feral animal were observed in the Project Boundary including Common Starling, Fox, Brown Hare, Rabbit, Black Rat, Common House Mouse and Pig.

The Common House Mouse was the most abundant feral species recorded within the Project Boundary, being associated with all fauna habitat types, while the Black Rat was recorded once within Riverine Woodland fauna habitat. The Brown Hare and Rabbit were observed opportunistically and via scat searches, with species occurring in most habitat assemblages, but predominately in Grassland and Grassy Woodland on fertile soils fauna habitats.

The Project has the potential to extend the range of some feral animals into habitat where they may not currently exert pressure on native species. The Common House Mouse was already widespread throughout the Project area and is essentially in competition with small terrestrial marsupials such as the Yellow-footed Antechinus. Species such as Common Starling (only observed in cleared environments), could extend their range and potentially pressure native species either directly (aggression) or indirectly (competition for resources). While the Fox was recorded within the Project Boundary via scat searches, this species was only observed in Grassland fauna habitat along the proposed rail corridor. The Project has the potential to further increase the foxes range within Leard State Forest, although its presence may already be substantial.

5.8 Changed hydrology

Waterway crossings could modify the natural hydrology of creeks within the Project Boundary, which could ultimately affect the aquatic assemblages that use these areas (Fairfull & Witheridge 2003). Impacts from waterway crossings may include:

- Excessive flow velocities, which could erode creek banks and lead to changes in water quality, as well as acting as a barrier to any fish movements in the creek.
- Modified water depths of the creek, which could act as a barrier to fish movement and cause loss of interconnectivity between pools.
- Increased water turbulence, which could lead to the avoidance of the area by various aquatic organisms.

Waterways to be crossed by the Project include the Namoi River.

5.9 Aquatic disturbance and impacts on fish passage

The Project would require the construction of a rail bridge over the Namoi River. Indirect impacts would be associated with this crossing.

Barriers to fish passage from the installation of waterway crossings (including bridges and culverts) can occur temporarily (i.e. during construction) and/or over the long term if inappropriate structures are used. Several species of fish have the potential to occur within the Project Boundary that potentially need to move between habitats for a variety of reasons, including the search for food and shelter, dispersal into available habitat and reproduction. In addition to potential impacts from alteration of natural hydrology at waterway crossings (Section 5.7), other impacts, such as decreased light levels and debris blockage, have the potential to affect fish passage (Fairfull & Witheridge 2003).

The Namoi River currently has disrupted fish passage due to waterway crossings. These crossings include the historic ‘Iron Bridge’ on the Manila Road and the existing coal haulage route bridge associated with Boggabri Coal. During construction, run-off from disturbed surfaces could

potentially affect water quality in the Namoi River due to sedimentation. In addition, there is the potential for accidental spillage/leakage of road construction materials, fuels, lubricants and hydraulic oils from construction equipment. Boggabri Coal will manage its construction activities to minimise environmental impacts to the Namoi River.

Fish and mobile invertebrate assemblages of the water bodies sampled during this study were fairly typical of freshwater habitats within the region and the fish assemblage consisted of introduced species. Therefore, it is unlikely that any unique fish assemblages would be significantly affected by the proposed waterway crossings themselves. Given that suitable habitat exists upstream and downstream of the Project, no long-term impacts from the proposed waterway crossings would be expected for fish and mobile invertebrate assemblages within the area.

5.10 Potential impacts on groundwater dependent ecosystems

Groundwater dependant ecosystems are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation 2002b). When considering groundwater dependant ecosystems, groundwater is generally defined as the saturated zone of the regolith (the layer of loose rock resting on bedrock, constituting the surface of most land) and its associated capillary fringe, however it excludes soil water held under tension in soil pore spaces (the unsaturated zone or vadose zone) (Eamus et al. 2006).

Groundwater dependant ecosystems include a diverse range of ecosystems as shown in Figure 5-3. These ecosystems range from those entirely dependent on groundwater to those that may use groundwater while not having a dependency on it for survival (i.e. ecosystems or organisms that use groundwater opportunistic or as a supplementary source of water) (Hatton & Evans 1998). Eamus *et al*. (2006) considers the following broad classes of these ecosystems:

- Aquifer and cave ecosystems, where stygofauna (groundwater-inhabiting organisms) may reside within the groundwater resource. The hyporheic zones (see ecosystem 5 in Figure 5-3) of rivers and floodplains are also included in this category because these ecotones often support stygobites (obligate groundwater inhabitants).
- All ecosystems dependent on the surface expression of groundwater. This category includes base-flow rivers and streams, wetlands (see ecosystems 2 and 3 in Figure 5-3), some floodplains and mound springs and estuarine seagrass beds. While it is acknowledged that plant roots are generally below ground, this class of groundwater dependant ecosystems requires a surface expression of groundwater, which may, in many cases, then soak below the soil surface and thereby become available to plant roots.

  All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the saturated zone of the water table) when roots penetrate this zone. This class includes terrestrial ecosystems such as River Red Gum (*Eucalyptus camaldulensis*) forests on the Murray–Darling basin (see ecosystems 1 and 4 in (Figure 5-3). No surface expression of groundwater is required in this class of groundwater dependant ecosystems.

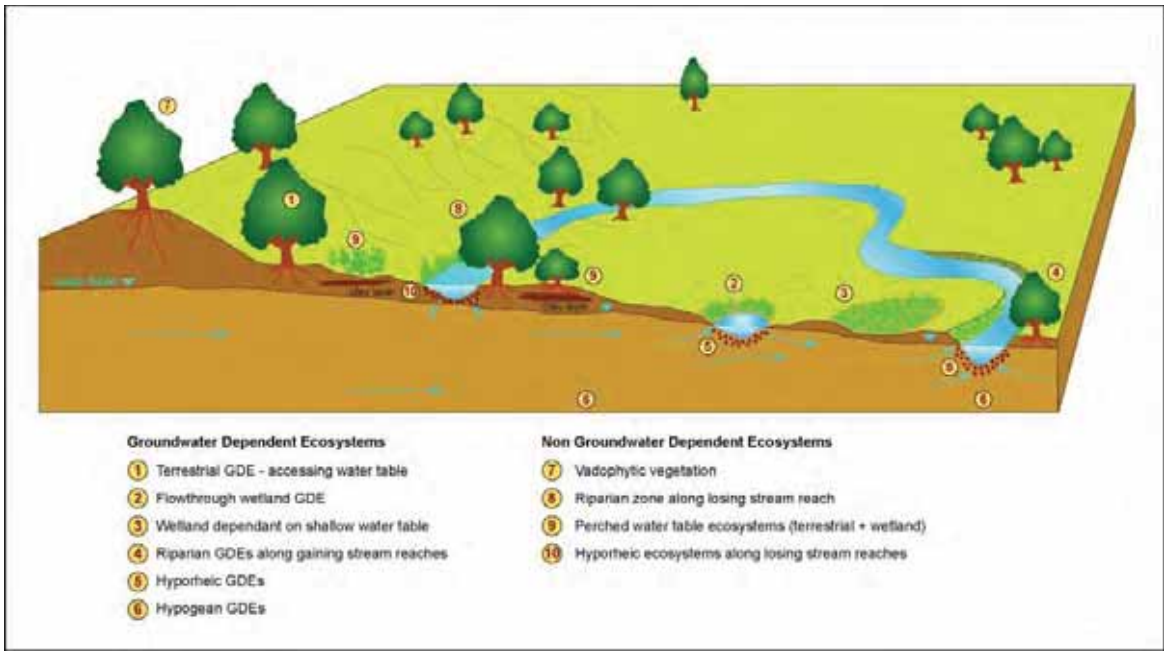

Figure 5-3 Conceptual biophysical model of groundwater dependent ecosystems

Groundwater dependent ecosystems possess a range of values, including being important and sometimes rare ecosystems in themselves, as well as providing important ecosystem services such as water purification (Department of Land and Water Conservation 2002b). Groundwater is also an increasingly important resource for human uses in Australia (there was a 90% increase in groundwater extraction between 1985 and 1997 (National Land and Water Resources Audit 2001). Nationally groundwater is extracted for uses including irrigation (48%), urban and industrial use (33%) and stock watering and rural use (19%) (Department of Land and Water Conservation 2002b; Eamus *et al.* 2006; Murray *et al.* 2003; PPK Environment & Infrastructure 1999; Sinclair Knight Mertz 2001).

The potential for groundwater extraction to exceed recharge has resulted in awareness of the effects of groundwater availability or regimes that may result in adverse impacts to groundwater dependent ecosystems (Department of the Environment and Heritage 2001), and thereby threaten the values they provide.

Whether or not ecosystems show some level of groundwater dependence will depend, in part, on their location in the landscape relative to the level of groundwater. Within the Project Boundary, the groundwater aquifer within the alluvium along Nagero Creek is approximately 9 m below the surface (bgl), but it is much deeper (greater than 30 to 80 m bgl) in the sandstone and volcanics (Parsons Brinckerhoff 2009a).

The Project will access coal from seams within the Maules Creek Formation, which are generally the most transmissive units within the Formation – particularly the Merriown Seam. Interburden and overburden sediments are generally very low permeability. The Maules Creek Formation aquifers are confined to semi-confined, bounded below by fresh volcanic bedrock and above by low permeability sandstones and conglomerates. Within the Project Boundary, the Maules Creek Formation (including the coal seams) is recharged in topographically higher areas. Groundwater flows towards the lower topographic areas of the Nagero and Bollol Creek valley. To the west of the Project Boundary, a bedrock high (Boggabri Volcanics) separates the Maules Creek Formation from the most extensive aquifer in the region; Namoi alluvium aquifer. Groundwater in the alluvium aquifer is generally good quality, and produces high yields.

Dependence (or interaction) of the vegetation communities identified within the Project Boundary, on groundwater was determined by aligning them with the groundwater dependant ecosystem types identified by (Murray *et al.* 2003) and Eamus *et al* (2006).

The majority of vegetation communities were excluded from groundwater dependency given their location in the landscape. These terrestrial vegetation communities were found to occur on slopes and ridges associated with well drained soils characterised by shallow skeletal conglomerate on the steeper upper slopes and drainage lines and deep basaltic derived fertile soils on the lower slopes, disconnected from localised groundwater systems.

The numerous minor ephemeral tributaries within the Project Boundary, including Najero Creek, were considered to be 'losing streams' which are fed by overland flow of surface water during, and for short periods after, an intensive rain event. The Yellow Box – Blakely's Red Gum grassy woodland vegetation that occurs adjacent to these ephemeral streams is therefore not considered to be reliant upon groundwater fed streams.

The remnant vegetation communities, Pilliga Box – Popular Box – White Cypress Pine Grassy Open Woodland and Plains Grassland are restricted to the lower lying plain areas within the Project Boundary. These communities are considered to be associated with shallow perched water tables over impermeable clay lenses rather than groundwater fed by subsurface aquifers. Shallow groundwater monitoring sites within the Pilliga Box – Popular Box – White Cypress Pine Grassy Open Woodland community have identified that the subsurface aquifers are located approximately 30 m below the surface and it is unlikely there is any significant connection between these aquifers and the perched water tables within the Project Boundary (Parsons Brinckerhoff 2009a).

Derived Native Grassland and Exotic Grassland vegetation types are disturbed communities dominated by shallow rooted grass and herb species. These vegetation communities are considered to be predominately terrestrial with small areas situated upon a perched water table and thus are not groundwater dependent ecosystems.

Table 5-3 Vegetation community dependency on groundwater

Ecosystem type[1]	Hydrological ecosystem[2]	Vegetation communities[3]	Known groundwater dependency[4]
Terrestrial ecosystems	7 – Vadophytic vegetation	White Box – Narrow-leaved Ironbark – White Cypress Pine shrubby open forest	No apparent dependency on groundwater
	7– Vadophytic vegetation	White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest	No apparent dependency on groundwater
	7 – Vadophytic vegetation	Silver-leaved Ironbark heathy woodland	No apparent dependency on groundwater
	7 – Vadophytic vegetation	Narrow-leaved Ironbark – pine – Brown Bloodwood shrub/grass open forest	No apparent dependency on groundwater
	7 – Vadophytic vegetation	Dwyer's Red Gum woodland	No apparent dependency on groundwater
	7 – Vadophytic vegetation	Native Olive Dry Gully Forest	No apparent dependency on groundwater
	8 – Riparian zone along losing stream reach	Yellow Box – Blakely's Red Gum grassy woodland	No apparent dependency on groundwater
	7 – Vadophytic vegetation	White Box – White Cypress Pine grassy woodland	No apparent dependency on groundwater

Ecosystem type[1]	Hydrological ecosystem[2]	Vegetation communities[3]	Known groundwater dependency[4]
	7 – Vadophytic vegetation	White Box – Narrow-leaved Ironbark – White Cypress Pine grassy open forest	No apparent dependency on groundwater
	9 – Perched water table ecosystems	Pilliga Box – Poplar Box – White Cypress Pine grassy open woodland	Proportional dependence on groundwater
	9 – Perched water table ecosystems	Plains Grassland	Proportional dependence on groundwater
	7 – Vadophytic vegetation	Derived Native Grassland	No apparent dependency on groundwater
	7 – Vadophytic vegetation	Exotic grassland	No apparent dependency on groundwater
River base flow	4 – Riparian zone along gaining stream	River Red Gum very tall open forest	Proportional dependence on groundwater

Notes: 1 – Ecosystem Types as per Eamus et al (2006)(Murray *et al.* 2003); 2 – Hydrological ecosystem classification Figure 1-1); 3 – Vegetation Communities as per Parsons Brinckerhoff 2009a) , 4 – Known groundwater dependency as per (Hatton & Evans 1998).

Given the broad regional distribution of the vegetation communities found within the Project Boundary and the varied topography that they occur over, it is unlikely that they will be dependent on the groundwater resources. No groundwater aquifer or cave systems, wetlands or other potential groundwater dependant ecosystems were identified within the Project Boundary from the field surveys and desktop assessment. The exception was the River Red Gum open forest and other riparian vegetation that may show a proportional dependence on the groundwater. This community is believed to be directly associated with the Namoi River which is considered to be a major 'gaining' stream with the local hydrological cycle. The Projects impacts on this community and the Namoi River is restricted to a linear crossing by the haulage route and considered to be relatively minor.

The Pilliga box – Poplar Box – White Cypress Pine grassy open woodland and Plains Grassland communities are considered to be primarily associated with the perched water tables not likely to be dependent on groundwater and are thus not included within the GDE classification of (Eamus et al. 2006). It is considered unlikely that the Project will require extracting water from these perched water tables and therefore the impact on these communities is likely to be negligible.

The Project would require the excavation and shaping of the upper soil profile and minor alterations to the existing surface water, drainage, however is unlikely to require groundwater extraction or significant impacts on the existing subsurface aquifers and their associated groundwater dependent ecosystems.

5.11 CO_2 and climate change

Current scientific evidence indicates that modification of the environment by humans may result in climate change, including the production of carbon emissions into the atmosphere, which changes climate at a faster rate than has previously occurred naturally (CSIRO 2001). Human-induced climate change can impact on the habitats of a range of species, including Threatened species (Department of Environment and Heritage 2005).

Atmospheric climate controls how the spatial distribution of most species, populations and communities is determined and has been a major driving force for evolution, resulting in biodiversity. Human-induced climate change by the emission of greenhouse gases (including carbon dioxide) is known to impact on threatened species of flora and fauna. It is also recognised

as a Key Threatening Process under the EPBC Act, listed as loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases.

The response of organisms to future climate change (however caused) is likely to differ from that in the past because it would occur in a highly modified landscape in which the distribution of natural communities is highly modified. This may limit the ability of organisms to survive climate change through dispersal (Department of Environment and Heritage 2005). Species at risk include those with long generations, poor mobility, narrow ranges, specific host relationships and isolated and specialised species (Busby & Pearman 1988). Pest and some native species may, however, be advantaged by climate change. Fire regimes may also change and affect species composition and the structure of ecological communities (NSW Scientific Committee 2000).

Modelling of the distribution of species under realistic climate change scenarios suggests that many species (including threatened species) would be adversely affected unless populations are able to move across the landscape (Hughes & Westoby 1994). Changes in essential microhabitat conditions in areas that are fragmented from suitable habitats and/or are at the limit of a species' distribution could result in localised extinctions, affecting the recovery of threatened species. Conservation reserves, including national parks and nature reserves that contain significant refuges for threatened species, have not been designed specifically to accommodate climate change, and the present biodiversity values of the protected area system may not all survive under different climatic conditions (NSW Scientific Committee 2000).

5.12 Cumulative impacts

The potential biodiversity impacts of the Project have been considered as a consequence of the construction and operation of the Project within the existing environment. The incremental effect of multiple sources of impact (past, present and future) are referred to as cumulative impacts (Contant & Wiggins 1991; Council on Environmental Quality 1978) and provide an opportunity to consider the Project within a strategic context. This is necessary so that impacts associated with the Project and other activities within the region are examined collectively.

Extensive agricultural tenures have led to vast amounts of vegetation clearing in the locality and at the catchment scale (Namoi CMA), with more than 60 % of native vegetation being cleared (NSW National Parks and Wildlife Service 2003). Furthermore, Leard State Forest has been selectively logged over a period of more than 50 years, although remnant vegetation/habitat occurring in Leard State Forest was still considered of good quality.

The primary developments within the Projects locality are agricultural, the previously assessed Boggabri Coal Mine and other neighbouring mining operations to the east and south of the Project. The biodiversity impacts of the Project considered in this report are therefore likely to be more significant as a result of past clearing for agricultural activities and the existing Mine. These cumulative impacts would exacerbate the biodiversity impacts associated with the Project.

Potential developments in the nearby area that may interact with the Project include:

- future mining developments in the region
- the coal transport corridors for the Project
- significant agricultural developments.

All such developments are likely to contribute to a greater extent of vegetation clearing in the region and a further fragmentation of habitat.

Since preparing this assessment, information has become available on a number of significant other coal mining projects proposed in the immediate vicinity of Boggabri Project.

To specifically address the potential cumulative biodiversity impacts resulting from these projects a Simultaneous Worst Cast Cumulative Impact Scenario (SWCCIS) for the local biodiversity within and surrounding the Boggabri Project has been prepared and is presented in Appendix J.

6. Project design features and mitigation measures

A general principle of environmental management is to, (in order of preference):

- avoid environmental impacts
- minimise impacts
- mitigate the impacts
- where impacts cannot be avoided or minimised, compensate for the residual impacts using other mitigation measures such as offsets.

These principles have been followed, where possible, for the Project.

6.1 Avoiding environmental impacts

Avoiding environmental impacts has been considered where possible throughout the Project planning and design phases. There will also be ongoing opportunities to further avoid impacts at a local scale through the detailed design process.

The capacity of major components of the Project, such as the mine plan and schedule to minimise environmental impacts while achieving the objectives of the Project (coal extraction) is limited. However, much of the design and layout of the infrastructure upgrades, such as the coal transport infrastructure, Site and water infrastructure have been positioned adjacent existing infrastructure to avoid or limit impacts to remnant vegetation and regrowth and the associated flora and fauna habitats. Further avoidance should be an aim during detailed design.

Significant modification to the current MOP and design of the Project has led to improved Biodiversity outcomes (Table 6-1).

Table 6-1 Modification avoiding impacts

Modification	Area (hectares) avoided	Habitat type
Removal of the western drainage contour from the remnant Box Gum Woodland within Leard State Forest	6	CEEC, Box Gum Woodland
Relocation of proposed mine site infrastructure to existing areas of disturbance	25	Derived grassland and Grassy Woodlands
Utilisation of existing haulage route for the majority of the proposed rail corridor	24	Derived grassland, Riverine Woodland and Grassy Woodlands

6.2 Mitigation measures

The impacts and mitigation associated with the Project are discussed below in general terms. As part of the detailed design, and prior to the start of construction of the Project, it is recommended that detailed mitigation measures be developed and presented in a biodiversity management plan relating to the construction and operation of the mine. The plan should include, where appropriate, procedures for:

- staff and contractor inductions to address the location of sensitive biodiversity and their role and responsibilities in the protection and/or minimisation of impacts to all native biodiversity
- pre-clearing surveys and fauna salvage/translocation where practical

- vegetation clearing protocols
- rehabilitation and restitution of adjoining habitat where possible
- weed control
- pest management
- rehabilitation protocols
- a flora and fauna monitoring program for the Project to better understand and manage impacts and rehabilitation actions to flora and fauna.

The plan should include clear objectives and actions for the Project including, where appropriate:

- minimising human interferences to flora and fauna
- minimising vegetation clearing/disturbance
- minimising impact to threatened species and communities
- minimising impacts to aquatic habitats and species
- ongoing monitoring of impacts on flora and fauna.

The mitigation measures described in this section are based on the likely impacts of the Project and follow the principle of avoid, minimise and mitigate. Mitigation measures are discussed in broad terms below and specific mitigation measures are presented in Section 6.4.5.

6.2.1 Vegetation and habitat loss

Disturbance to areas of native vegetation and habitat will be unavoidable during the construction and operational phases of the Project. However, in order to minimise clearing impacts and further disturbance, the limits of clearing should be clearly identified during the construction process. The limits of clearing should be marked clearly on plans and on the ground. Areas beyond the identified clearing areas should not be disturbed. Ancillary facilities such as stockpile sites, site compounds and construction sites should not be located beyond the limits of clearing. During the detailed design stage, opportunities to further minimise vegetation disturbance should be considered.

Where clearing of vegetation and fauna habitats will take place, clearing protocols should be put in place, including preparing an inventory of trees and hollows to be removed, checking hollow-bearing trees for the presence of bird nests and arboreal mammals, such as possums, gliders and bats, prior to felling. Animals found to be occupying trees should be safely removed before clearing and relocated into nearby woodlands. Nest boxes or salvaged tree hollows should be provided in nearby woodland and be proportional to the number of hollows removed during felling. Ideally information on fauna habitat and the tree hollows would be surveyed prior to tree removal to ascertain the number likely to be removed and other data including, tree species, tree hollow size, height, position and aspect.

A rehabilitation plan should be developed so that it integrates and complements the habitat values of the Project Boundary. The landscape plan should:

- use locally occurring native shrubs, trees and groundcover plants
- include logs, dead trees and stumps in strategic locations to enhance fauna habitat
- incorporate existing natural vegetation where possible
- provide vegetative links to existing bushland remnants in the Project Boundary
- include measures to manage weeds through a weed management plan.

6.2.2 Fragmentation, terrestrial barrier effects and road mortality

While the Projects mining void is likely to provide a significant barrier it will not result in the fragmentation of a major wildlife corridor as remnant vegetation will still remain surrounding the areas of disturbance. The greatest barrier effects are likely to result from the clearing of remnant vegetation for the rail spur and loop across the Namoi Floodplain. As discussed above, consideration should be given in the design process to minimising vegetation clearing in these areas. This would maintain the overall width of the existing habitat corridor and maintain connectivity for a range of birds and mammals using this habitat as a movement corridor in a north-south direction.

The Project would include drainage structures, including box culverts and a bridge within the potential local wildlife corridor associated with the Namoi Floodplain and other minor creek lines dissecting the rail spur. Generally, fauna underpasses work well for ground dwelling species. Monitoring of underpasses on the Pacific Highway has indicated that 20 native mammal species used the fauna underpasses (Australian Museum Business Services 2001a, 2001b, 2001c, 2001d). Species that were found to use the underpasses include a range of terrestrial mammals like dasyurids, macropods, rodents, bandicoots and bats, as well as reptiles and amphibians. Given that the drainage structures in the Project are likely to be dry for some of the year, they may potentially act as fauna underpasses for a range of ground-dwelling animals including amphibians, reptiles and mammals.

I & I NSW (Fisheries) guidelines (Fairfull & Witheridge 2003) would be used when designing the Namoi River crossing for the Project, so as to maintain the flow of all water bodies within the Project Boundary. This would mitigate any impacts due to the potential loss of aquatic habitat, excessive water flows, modified water depths and increased turbulence.

6.2.3 Aquatic disturbance and barrier effects

Little aquatic disturbance within the Project Boundary is expected once construction of the Namoi River crossings is completed, provided that the crossing is designed according to NSW Fisheries guidelines (Fairfull & Witheridge 2003) and damage to any aquatic habitat and riparian vegetation during construction is minimised. Areas of the Namoi River riparian vegetation likely to be damaged or removed during construction should be replanted on completion of the works. In addition, appropriate erosion and sediment control measures should be put in place around all proposed waterway crossings prior to construction to ensure minimal change in water quality of the waterways due to run-off.

Best practice erosion and sediment controls should be implemented in accordance with Volume 2D of Managing Urban Stormwater: soils and construction (Department of Environment and Climate Change 2008d).

6.2.4 Monitoring

Regular monitoring of the effectiveness of the mitigation measures proposed in this assessment should be undertaken over the course of the Project. This would include the recording of any issues associated with the mitigation measures and any actions taken to resolve them. These monitoring activities could form part of the existing Flora and Fauna biodiversity monitoring program used by Boggabri Coal Mine.

6.2.5 Detailed mitigation measures

Detailed mitigation measures for the Project are shown in Table 6-2. These are presented for both the construction and operational phases of the Project. Mitigation measures should be

incorporated into a mine operational plan and existing measures that have produced favourable outcomes incorporated where possible. This biodiversity management plan should be an important document for the environmental field supervisor or ecologist in enacting the 'avoid and mitigate' principles during the construction phase. The biodiversity management plan should include detailed information such as protocols for vegetation clearing, feral animal and pest control, rehabilitation objectives, monitoring activities and further detailed design measures (Table 6-2).

Table 6-2 Detailed mitigation measures

Impact	Mitigation
Construction	
Vegetation and habitat loss	▪ Limit disturbance of vegetation to the minimum necessary for each stage of the clearing. ▪ Implement a two stage clearing protocol for all hollow-bearing tree clearing. ▪ Mark all hollow-bearing trees to be felled and catalogue their species and approximate dimensions so that hollows or nest boxes can be affixed to similar standing trees. ▪ Attach salvaged sections of hollows or nest boxes to trees in a way that allows for tree expansion and does not poison the tree. Hollows or nest boxes should be attached to trees with consideration of aspect, height and location appropriate for the target fauna species. The location of each relocated hollow or nest box should be recorded using GIS equipment during installation. ▪ Collect native seed prior to clearing, for use in the revegetation of disturbed areas. ▪ Landscaping should include: ‣ Planting of a range of native shrubs, trees and groundcover plants. ‣ Incorporation of existing natural vegetation where possible. ‣ Linking of bushland remnants. ‣ Maintenance of plantings through a landscaping plan. ▪ Mark the limits of clearing and install fencing around the construction footprint area prior to construction activities commencing to avoid unnecessary vegetation and habitat removal. ▪ Restrict equipment and stockpiling of resources to designated areas in cleared land to minimise the overall impact of the construction. ▪ Place transportable habitat features such as large logs and boulders, in adjacent retained areas where possible to allow their continuation as potential fauna refuge sites. ▪ Progressively revegetate disturbed areas. ▪ Locate sediment ponds in existing cleared areas where possible to minimise the loss of habitat.
Weeds	▪ A weed management plan should be developed to manage weeds during the construction phase. ▪ Undertake ongoing management and monitoring of weed invasion through the weed management plan.
Habitat fragmentation and barrier effects	▪ Maintain where possible linkages and or crossing zones between isolated vegetation remnant patches within Leard State Forest. ▪ Maintain fish passage at all times during the bridge construction over the Namoi River.

Impact	Mitigation
Changed hydrology	▪ Design and construct Namoi River crossings in accordance with the I & I NSW *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull & Witheridge 2003). ▪ Prepare a progressive erosion and sediment control plan following best practice. Design temporary scour protection and energy dissipation measures to protect receiving environment from erosion. ▪ Revegetate riparian zones affected by the Project with native species.
Success of mitigation	▪ Undertake monitoring in line with current monitoring programs.
Cumulative loss of habitat	▪ Offset any residual biodiversity impacts.
Operation	
Weeds	▪ Undertake ongoing management and monitoring of weed invasion within the Project Boundary during the life of the Projects operation.
Ecological Monitoring	▪ A flora and fauna monitoring program for the Project should be developed and implemented aimed at achieving a better understanding of impacts and rehabilitation actions to flora and fauna throughout the Project Boundary. ▪ The monitoring plan should consider and develop the existing monitoring plan in place as part of the MOP for existing operations. ▪ Monitoring should also include exotic weeds and feral animals. The plan should be adaptive and identify trigger points and responses for ongoing impacts to flora and fauna. ▪ The monitoring should include consideration of the observed microbat roost site in close proximity to the haul route.
Rehabilitation	Areas not required for mining purposes or activities should be revegetated following a revegetation/rehabilitation plan. This plan should include: ▪ Planting of a range of locally occurring native shrubs, trees and groundcover plants, in keeping with the former vegetation types present. Choice of species should be in consultation with the relevant regulators NSW and should include Acacia, Eucalyptus species to compensate for any impacts to habitat of the koalas and hollow dependent species. ▪ Incorporating existing natural vegetation where possible. ▪ Linking vegetation remnants. ▪ Focusing on riparian vegetation to protect waterways. ▪ Excluding stock from areas rehabilitated for nature conservation objectives.
Vehicle strike and direct mortality	▪ Locate revegetation works to increase fauna habitat linkages. ▪ Design drainage structures to incorporate fauna movement. ▪ Reduce the median width to the minimum necessary for safe operation of the road in fauna crossing zones.
Changed water quality	▪ Plant macrophytes along the stream banks of the Namoi River to filter flow and enhance bank stability. ▪ All water discharge into streams should be guided by the ANZECC Water Quality Guidelines (2000).

6.2.6 Summary of mitigation measures

A summary of the mitigation measures proposed against the various potential impacts is presented in Table 6-3.

The summary indicates that although the mitigation measures are generally adequate for the impacts that are likely to occur, they are not sufficient with respect to the clearing of native vegetation. Although some vegetation may be retained within the Project Boundary to reduce the extent of vegetation clearing, extensive vegetation clearing would still remain (including clearing of the Threatened ecological communities).

Table 6-3 Assessment matrix of mitigation measures

Mitigation measure	Vegetation clearing and habitat loss	Fragmentation and terrestrial barrier effects	Changed hydrology	Aquatic disturbance and barriers to fish passage
Retaining vegetation	✓	✓		
Delineating extent of vegetation clearing on ground	✓			
Putting in place vegetation clearing protocols including inspection of hollows	✓			
Revegetation (including habitats)	✓	✓		
Weed management	✓			
Including fish friendly waterway crossings			✓	✓
Prepare an erosion and sediment control plan			✓	✓
Flora and Fauna Management Subplan	✓	✓	✓	✓
Adequate mitigation?	No	Yes	Yes	Yes

6.3 Biodiversity offsets

Following consideration of the proposed mitigation measures (Table 6-3), it is concluded that impacts relating to the clearing of native vegetation and fauna habitats would not be sufficiently mitigated. Where there is residual loss or degradation of native vegetation after route selection, mine planning and implementation of mitigation measures, compensation in the form of biodiversity offsets developed in accordance with State and Commonwealth policies may be employed.

In a regional context the Projects impacts on the Project Boundary has already been considered and offsets provided and set aside under the BNC Agreement (Section 1.3.2).

Boggabri Coal has developed a Biodiversity Offset Strategy to further mitigate and offset the ecological impacts arising from the Project. The Biodiversity Offset Strategy considers the objectives of SEWPAC's National Recovery Plan for *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Box-Gum Grassy Woodland) (2010) and is presented in full in Appendix I to this report.

7. Assessment of significance of impacts

This chapter summarises the assessment of significance of the potential impacts following the requirements of the EP&A Act 1979 (draft *Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act 1979*) and the EPBC Act.

Projects assessed under Part 3A of the EP&A Act 1979 do not require assessments of significance under Section 5A of the Act (the Seven Part Test). Instead the assessment is based against heads of consideration detailed in the draft *Guidelines for Threatened Species Assessment*, indicating the significance of the impacts relative to the conservation importance of the habitat, individuals and populations likely to be affected.

Impacts are considered more significant if:

- Areas of high conservation value are affected.
- Individual animals and/or plants and/or subpopulations that are likely to be affected by a Project play an important role in maintaining the long-term viability of the species, population or ecological community.
- Habitat features are likely to be affected by a Project play an important role in maintaining the long-term viability of the species, population or ecological community.
- The impacts are likely to be long-term in duration.
- Impacts are likely to be permanent and irreversible.

Threatened biodiversity listed under the EPBC Act was assessed following the *Principal Significant Impact Guidelines*. A referral under the EPBC Act has been completed for the Project.

Assessments were completed for Threatened biodiversity that were recorded or likely to occur within the Project Boundary, as listed in Table 7-1, including four Threatened ecological communities, four species of plant and 33 species of animal. Details of the assessments are presented in Appendix E.

Table 7-1 Summary of significance assessments completed

Threatened biodiversity	Recorded in Project Boundary	TSC Act[1]	FM Act[2]	EPBC Act[3]	Likely significant impact
Endangered Ecological Communities					
Box-Gum Woodland	Yes	E		CE	Yes
Weeping Myall Woodland	Yes	E		E*	No
Plains grassland	Yes	E		CE	No
Lowland Catchment of the Darling River			E		No
Threatened plants					
Digitaria porrecta	No	E		E	No
Diuris tricolor	No			V	No
Pomaderris queenslandica	Yes	E			No
Pultenaea setulosa	Yes			V	No
Threatened animals					
Sloane's Froglet	No	V			No

Threatened biodiversity	Recorded in Project Boundary	TSC Act[1]	FM Act[2]	EPBC Act[3]	Likely significant impact
Threatened woodland birds assessed as a group (Brown Treecreeper, Hooded Robin, Black-chinned Honeyeater, Painted Honeyeater, Pied Honeyeater, Grey-crowned Babbler, Speckled Warbler, Diamond Firetail and Varied Sittella[†])	Yes	V			Yes
White-browed Wood swallow	Yes	V[†]			No
Spotted Harrier	Yes	V			No
Little Lorikeet	Yes	V			No
Little Eagle	Yes	V			No
Swift Parrot	No	E		E	No
Square-tailed Kite	No	V			No
Turquoise Parrot	Yes	V			No
Barking Owl	Yes	V			No
Masked Owl	Yes	V			No
Superb Parrot	No	V		V	No
Regent Honeyeater	No	E[5]		EM	Yes
Black-necked Stork	Yes	V			No
Threatened hollow-dependent microchiropteran bats assessed as a group (Eastern False Pipistrelle, Greater long-eared Bat and Yellow-bellied Sheath-tail Bat)	Yes	V		V[4]	Yes
Threatened cave-dependent microchiropteran bats assessed as a group (Eastern Cave Bat, Eastern Bent-wing Bat, Large-eared Pied Bat and Little Pied Bat				V[4]	No
Spotted-tailed Quoll	No	V		E	No
Squirrel Glider	No	V			No
Koala	Yes	V			No
Border Thick-tailed Gecko	No	V		V	No

Notes: 1 – TSC Act, V = Vulnerable, E = Endangered. 2 – FM Act, E = Endangered. 3 – EPBC Act, CE = Critically Endangered, V = Vulnerable, E = Endangered, M = Migratory. 4 – Greater Long-eared Bat and Large-eared Pied Bat only. 5 Regent Honeyeater preliminary listing Critically Endangered TSC Act,

[†] Preliminary listing.

These assessments suggest that the Project is likely to have a significant and long-lasting impact on the Box Gum Woodland as listed under the TSC Act and the equivalent community listed under the EPBC Act within the locality. This community has been heavily cleared in the local and regional area. The Project will result in the fragmentation and loss of a large remnant of this community, which exhibits a relatively high species richness and undisturbed condition in relation to other remnants within the local and regional area.

The Leard State Forest has been intensively logged for its valuable timber resource on a regular basis up until the late 1970s early 1980s. These activities have reduced the quality and diversity of habitats with the Forest and in the absence of the Project, these activities would continue as productive timber develops. Despite this the Project is considered likely to have a significant impact on threatened woodland birds and hollow-dependent microchiropteran bats within the locality and potentially the Regent Honeyeater. While large areas of contiguous known habitat for

these species will be retained with the remaining areas of Leard State Forest and Leard State Conservation Area, the shear extent of habitat (both known and potential) proposed for removal is highly likely to result in the reduction of local population sizes for these species.

With appropriate mitigation measures, the Project is not likely to have a significant impact on other Threatened biodiversity (Appendix E). With the implementation of suitable mitigation measures as outlined in this report, it is also unlikely that non-Threatened biodiversity would be placed at risk of local extinction.

Under the draft *Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act 1979*, the objective of the biodiversity assessment process is to provide information to enable decision-makers to ensure that developments deliver the environmental outcomes outlined and discussed in Sections 7.1.1 to 7.1.6.

7.1.1 Improve or Maintain biodiversity values

The term 'improve or maintain' is defined in the draft *Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act* 1979 as 'no net impact on threatened species or native vegetation'. Given that the Project would result in clearing of native vegetation, including (Critically) Endangered Ecological Communities and habitat for Threatened species, it would be necessary to develop offset strategies to fulfil this outcome.

Boggabri Coal has developed a Boggabri Coal Biodiversity Offsets Strategy in conjunction with relevant stakeholders, and approval authorities. The document includes the methodology used to determine how the ecological values lost as a result of the Project will be offset and provides a framework for the development and implementation of a biodiversity offsets package. Biodiversity offsets for the current Project, including both their calculation and implementation, should be guided by this document.

7.1.2 Conserve biological diversity and promote ecologically sustainable development

The BNC Agreement (Section 1.3.2) provides for the conservation of 350,000 ha of woodlands in the Brigalow and Nandewar bioregions. The agreement provides a regional approach to the protection of important conservation values with the aim of long-term sustainability of the region's important timber, gas, minerals and apiary industries. As part of this agreement the Leard State Forest was identified as an area set aside for the purposes of forestry, recreation and mineral extraction. Therefore whilst the Project will result in a reduction of native vegetation, as part of the BNC Agreement this has been assessed in terms of conservation within a regional context which allows for improved conservation outcomes while providing for the exploitation of the States natural resources.

The Project maintains vegetation in key areas of the locality (where practicable) and gives consideration to connectivity of existing native vegetation. Recommendations have also been provided in Section 6.3 and Appendix I to mitigate potential effects on biodiversity. In particular the implementation of the Boggabri Coal Biodiversity Offsets Strategy will provide for the immediate conservation of large areas of habitats for the locally occurring Threatened species.

7.1.3 Protect areas of high conservation value (including areas of critical habitat)

There is no critical habitat as defined under the TSC Act within the Project locality. However, the vegetation within the Project Boundary does have high conservation value, given its listing as Endangered under the TSC Act and Critically Endangered under the EPBC Act. Boggabri Coal

has developed an offset strategy in conjunction with the relevant regulatory authorities to address the ecological impacts of the Project on conservation values (Section 6.3 and Appendix I).

Furthermore, the habitat to be removed has been considered under the BNC Agreement (Section 1.3.2) which has set aside large areas of native woodlands for conservation in the Brigalow and Nandewar region.

Mitigation measures, as discussed/presented in Section 6.3 have been included to further minimise impacts on Threatened species.

7.1.4 Protect the long-term viability of local populations of a species, population or ecological community

Mitigation measures have been recommended in this assessment (Section 6.3) to minimise impacts to local biodiversity. As a result, the long-term viability of most biodiversity would be protected. The implementation of the Boggabri Coal Biodiversity Offsets Strategy will provide for the immediate conservation of large areas of habitats for the locally occurring Threatened species. Furthermore, this strategy will result in the medium to long term improvement in Threatened species habitats of the locality through the restoration of a large regional wildlife corridor linking the isolated remnant of the Leard State Conservation Area and State Forest with the Namoi River floodplain to the west and Nandewar range to the east. No Threatened species would become extinct as a result of the Project with large areas of contiguous known habitats for all of the effected Threatened species being retained within the locality and region.

7.1.5 Protect aspects of the environment that are matters of National Environmental Significance

In the absence of the recommended management strategies and the Boggabri Coal Biodiversity Offsets Strategy the Project would have a significant and long-lasting impact on the Box-Gum Woodland community. Box-Gum Woodland is listed as Critically Endangered under the EPBC Act and the Project was determined by SEWPAC to be a controlled action.

8. Conclusions

The Project is largely located within Leard State Forest, which comprises a very large remnant patch of vegetation surrounded by a landscape that has been significantly affected by past land uses. The Leard State Forest has been intensively logged for its valuable timber resources on a regular basis up until the late 1970s/early 1980s. These activities have affected the quality and diversity of habitats for locally occurring Threatened species and it is likely that in the absence of the Project, these activities would continue throughout the Forest as productive timber develops.

Despite the impacts of past forestry operations within the Leard State Forest and in the absence of any amelioration works or offset areas, the Project would have a substantial impact on the ecology of the local area. It would remove nearly 1,385 ha of native vegetation, much of which is listed as Threatened under NSW and/or Commonwealth legislation. This vegetation also provides habitat for a range of Threatened species.

Twenty-one Threatened species of animal, as listed under the TSC Act and/or the EPBC Act, were recorded within the Project Boundary, with a further 12 species considered likely to occur. A total of two Threatened species of plant, as listed under the TSC Act and/ or EPBC Act, were recorded in the Project Boundary, and a further two species were predicted likely to occur.

In addition to Threatened species, the Project would impact four Threatened ecological communities within the Project Boundary, including:

- Approximately 623.6 ha of Box-Gum Woodland as listed under the EPBC Act and TSC Act.
- Approximately 0.3 ha Weeping Myall Woodlands as listed under the EPBC Act and TSC Act.
- Approximately 0.4 ha of Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Qld as listed under the EPBC Act and TSC Act.
- Approximately 0.6 ha of Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River as listed under the FM Act.

The Project would impact habitats for locally occurring Threatened biodiversity in the short term, this however, is only considered to be a temporary disturbance. The Project would incorporate an extensive rehabilitation program as part of the mine closure procedures. This rehabilitation plan includes restoration of the Leard State Forest to the existing forest where practical. The restoration of Leard State Forest would be a staged process and has been designed with the intention of providing a self sustaining native forestry operation as well as maintaining pre-mine biodiversity values.

Assessment under the EPBC Act is only required for impacts resulting from “Boggabri Extension”, as approval under the Environment Protection (Impact of Proposals) Act 1974 currently exists for all impacts associated with “Boggabri Existing”. In particular, the current assessment of the Project under the EPBC Act relates to the Project’s impacts on 82 ha of White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland, habitat for the locally occurring Threatened Eastern Long-eared Bat and potential impacts on important habitat for the Migratory and Critically Endangered Regent Honeyeater. Given the scale of the Project’s potential impacts on the local Threatened species and the Critically Endangered Ecological Community, White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland, the Project triggered an assessment by SEWPAC and Boggabri extension was deemed to be a controlled action under the EPBC Act.

Significance assessments also indicate that given the extent of habitat removal, the Project is likely to have a significant impact on a local scale on Box-Gum Woodland, Threatened woodland birds and hollow-dependent microchiropteran bats as listed under the TSC Act.

A detailed rehabilitation management plan has been developed that specifically provides for the staged rehabilitation of all mine disturbed areas. The key objectives of this plan are to restore, where possible, the pre-mining biodiversity within a safe and stable landform including 1019 ha of the Threatened Box-Gum Woodland and supplementary habitat features. Although the post mine rehabilitation and mitigation measures have, and would, reduce the extent of impacts on this Threatened biodiversity, they are not likely to totally ameliorate the significance.

Boggabri Coal has developed a Boggabri Coal Biodiversity Offsets Strategy to further mitigate and offset the impacts arising from the Project. The offset strategy identifies large patches of remnant vegetation in the locality of the Project Boundary. Field assessments confirm that these vegetation remnants contain high quality habitat and would create a valuable corridor for Threatened species in the region. Importantly, these areas would provide upfront mitigation of the Project's impacts on locally occurring biodiversity. A critical component of the Boggabri Coal Biodiversity Offsets Strategy would be the restoration and establishment of a Regional East-West Wildlife Corridor linking the Leard State Forest with the Namoi River and large vegetation remnants to the west and the Nandewar range to the east. The inclusion of these lands as potential biodiversity offsets would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented.

This assessment has found that there are large areas of contiguous known habitats for all of the affected Threatened species within the locality of the Project Boundary. Despite this it is recognised that the Project will significantly impact the habitat for these Threatened species within the locality. The mitigation measures and extent of the proposed Boggabri Coal Biodiversity Offsets Strategy to be implemented over the life of the Project is, however, likely to sufficiently ameliorate these impacts to the extent that no Threatened species are likely to become extinct within the locality as a result of the Project.

9. References

ANZECC 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Australian Government 2004, *Australian code of practice for the care and use of animals for scientific purposes 7th Edition 2004*, endorsed by the NHMRC, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian Research Council (ARC) and the Australian Vice-Chancellor's Committee (AV-CC). Canberra.

Bali, R 2005, *Discussion Paper - Compensating for Edge Effects*, Ecosense Consulting for the NSW Roads and Traffic Authority, Sydney.

Bean, JM 1999, '*Bothriochloa biloba* (Poaceae) in natural grasslands on slopes of the Liverpool Plains, New South Wales', *Cunninghamia*.

Bennett, AF 1990, *Habitat corridors: Their role in wildlife management and conservation*, Arthur Rylah Institute for Environmental Research, Melbourne.

Bennett, AF & Radford, JQ 2004, 'Landscape-level requirements for conservation of woodland birds: are there critical thresholds in habitat cover?' in R Smithers (ed.), *Landscape Ecology of Trees and Forests*, proceedings of the Woodland Trust and the International Association of Landscape Ecology, Gloucester UK.

Benson, JS, Allen, C.B., Togher, C.& Lemmon, J., & 2006, 'New South Wales Vegetation Classification and Assessment: Part 1 Plant Communities of the NSW Western Plains. ' *Cunninghamia*, vol. 9(3) pp. 383-450.

Biolink ecological consultants 2009, *The utility of regularized, grid-based SAT (RGB-SAT) sampling for the purposes of identifying areas being utilized by koalas (Phascolarctos cinereus) in the South-east Forests of NSW – a Pilot Study.*

Bishop, T 2000, *Field guide to the orchids of New South Wales and Victoria*, Second edn, University of New South Wales Press Ltd. Pty., Sydney.

Bowles, AE 1997, 'Responses of wildlife to noise', in RL Knight & KJ Gutzwiller (eds), *Wildlife and Recreationists: Coexistence through Management and Research*, Island Press, Washington DC.

Briggs, JD & Leigh, JH 1996, *Rare or Threatened Australian Plants*, CSIRO, Canberra.

Brooker, MIH & Kleinig, DA 1999, *Field guide to Eucalypts, Volume 1: South-eastern Australia*, Blooming Books, Hawthorn, Australia.

Burbidge, AA, Williams, MR & Abbott, I 1997, 'Mammals of Australian Islands: factors influencing species richness. ' *Journal of Biogeography*, vol. 24, no. 6, pp. 703-15.

Busby, JR & Pearman, GI 1988, *Potential impacts of climate change on Australia's flora and fauna* CSIRO.

Busnel, RG & Fletcher, J 1978, *Effects of Noise on Wildlife*, Academic Press, New York.

Chessman, B 2001, *Signal 2 A Scoring System for macroinvertebrates ('water-bugs) in Australian Rivers, User manual Version,* , 2nd November 2001.

Chessman, B 2003, 'New sensitivity grades for Australian river macroinvertebrates', *Marine and Freshwater Research*, vol. 54, no. 2, pp. 95-103.

Claridge, AW & van der Ree, R 2004, 'Recovering endangered populations in fragmented landscapes: the squirrel glider *Petaurus norfolcensis* on the south-west slopes of New South Wales', in D Lunney (ed.), *Conservation of Australia's Forest Fauna (second edition)*, Royal Zoological Society of New South Wales, Mosman, pp. 678 - 87.

Clarke, KR & Warwick, RM 1994, *Changes in Marine Communities: An Approach to Statistical Analysis and Interpretation.*, Plymouth Marine Laboratory, Plymouth.

Contant, CK & Wiggins, LL 1991, 'Defining and analyzing cumulative environmental impacts', *Environmental Impact Assessment Review*, vol. 11, pp. 297-309.

Council on Environmental Quality 1978, *CEQ - Regulations for Implementing National Environmental Policy Act (NEPA) - Sec. 1508.7 Cumulative impact*, Council on Environmental Quality (United States of America), Washington DC.

Cropper, SC 1993, *Management of Endangered Plants*, CSIRO Australia, Melbourne.

CSIRO 2001, *Climate change projections for Australia*, CSIRO and Australian Greenhouse Office, Canberra.

Cummins, S, Roberts, D., Church, A., Ling, J. 1997, 'Invertebrate associations in macrophyte assemblages within the Hawkesbury-Nepean River, NSW. Science and Technology in the Management of the Hawkesbury-Nepean Catchment, ' *Geographical Society NSW,*, vol. 14, pp. 36-40.

David Robertson 2009, *Discussion of local threatened species.*

Davidson, I & Robinson, D 1992, *Grey-crowned Babbler Action Statement No 34* Department of Sustainability and Environment, Victoria.

Davidson, I, Scammell, A, O'Shannassy, P, Mullins, M & Learmoth, S 2005, 'Travelling stock reserves: refuges for stock and biodiversity', *Ecological Management & Restoration*, vol. 6, no. 1, pp. 5-15.

Debus, SJS 1995, 'Surveys of large forest owls in Northern New South Wales: methodology, calling behaviour and owls responses', *Corella*, vol. 19, no. 2, pp. 38-50.

Department of Environment and Climate Change 2007, *Threatened species assessment guidelines. The assessment of significance*, Department of Environment and Climate Change, Hurstville.

Department of Environment and Climate Change 2008a, *Approved Recovery Plan for the Koala.*

Department of Environment and Climate Change 2008b, *Atlas of NSW Wildlife*, Department of Environment and Climate Change.

Department of Environment and Climate Change 2008c, *Atlas of NSW Wildlife*, Department of Environment and Climate Change, Sydney.

Department of Environment and Climate Change 2008d, *Managing Urban Stormwater: soils and construction, Vol 2D: main road construction*, Department of Environment and Climate Change NSW, South Sydney.

Department of Environment and Climate Change 2008e, *Recovery Plan for the Koala (Phascolarctos cinereus) (Approved)*, Department of Environment and Climate Change, Sydney.

Department of Environment and Climate Change 2009a, *Atlas of NSW Wildlife*, Department of Environment and Climate Change.

Department of Environment and Climate Change 2009b, *Bionet*, Department of Environment and Conservation.

Department of Environment and Climate Change 2009c, *Threatened species, populations and communities database* Department of Environment and Climate Change, <http://www.threatenedspecies.environment.nsw.gov.au/>.

Department of Environment and Conservation 2004, *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)*, Department of Environment and Conservation, Hurstville.

Department of Environment and Conservation 2005, *Draft guidelines for Threatened species assessment under Part 3A*, Department of Environment and Conservation, Hurstville.

Department of Environment and Heritage 2005, *Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases- key threatening process listing*, Department of Environment and Heritage, Canberra.

Department of Environment Climate Change 2009a, *BioBanking Assessment Methodology and Credit Calculator Operational Manual*.

Department of Environment Climate Change 2009b, *Vegetation Type Database*.

Department of Environment Water Heritage and the Arts 2008, *Weeping Myall Woodlands: Advice to the Minister for Environment, Water, Heritage and the Arts from the Threatened Species Scientific Committee (TSSC) on Amendments to the List of Ecological Communities under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, Canberra.

Department of Land and Water Conservation 2002a, *Native Vegetation Map Report Series No. 3, Boggabri 8936, 1:100,000 mapsheet, Edition 1*, Department of Land and Water Conservation NSW, Native Vegetation Mapping Team, Inverell, December 2002.

Department of Land and Water Conservation 2002b, *The NSW State Groundwater Dependent Ecosystem Policy*, Department of Land and Water Conservation, Sydney.

Department of the Environment and Heritage 2001, *Australia: State of the Environment 2001*, CSIRO Publishing, Melbourne.

Department of the Environment and Heritage 2006a, *EPBC Act Policy Statement 1.1 Significant Impact Guidelines*, Department of the Environment and Heritage, Canberra.

Department of the Environment and Heritage 2006b, *EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum grassy woodlands and derived native grasslands* Department of the Environment and Heritage.

Department of the Environment Water Heritage and the Arts 2008, *Protected Matters Search Tool*, Department of the Environment, Water, Heritage and the Arts, <http://www.deh.gov.au/erin/ert/epbc/index.html >.

Department of the Environment Water Heritage and the Arts 2009, *Protected Matters Search Tool*, Department of the Environment, Water, Heritage and the Arts, <http://www.deh.gov.au/erin/ert/epbc/index.html >.

DGRs 2009, *NSW Director-General Environmental Assessment requirements for the Tarcutta Bypass*.

Drayton, B & Primack, RB 1996, 'Plant species lost in an isolated conservation area in metropolitan Boston from 1894 to 1993. ' *Conservation Biology* vol. 10, no. 1, pp. 30-9.

Duggin, JA & Allison, PN 1984, *The natural grasslands of the Liverpool Plains, NSW*, Department of Environment and Planning.

Eamus, D, Froend, R, Loomes, R, Hose, G & Murray, B 2006, 'A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation', *Australian Journal of Botany*, vol. 24, pp. 97–114.

Ellis, M 1998, *Draft Guidelines for Fauna Surveys in the Western Zone of New South Wales*, Dubbo.

Ellis, WA, Hale, PT & Carrick, BF 2000, 'Breeding dynamics of koalas in open woodlands', *Australian Journal of Zoology*, vol. 48, no. 1, pp. 317-33.

Eve, R 1991, 'The sound environment of a tropical forest bird community - order or chaos', *Revue D Ecologie La Terre Et La Vie*, vol. 46, pp. 191-220.

Fairfull, S & Witheridge, G 2003, *Why do fish need to cross the road? Fish passage requirements for waterway crossings*, NSW Fisheries, Cronulla.

Forman, RTT, Sperling, D, Bissonette, JA, Clevenger, AP, Cutshall, CD, Dale, VH, Fahrig, L, France, R, Goldman, CR, Heanue, K, Jones, JA, Swamson, FJ, Turrentine, T & Winter, TC 2000, *Road Ecology. Science and Solutions.*, Island Press, Washington.

Gibbons, P, Ayers, D, Seddon, J, Doyle, S & Briggs, S 2008, *BioMetric 2.0. A terrestrial biodiversity assessment tool for the NSW Native Vegetation Assessment Tool* NSW Department of Environment and Climate Change, Canberra.

Gibbons, P & Boak, M 2000, *The importance of paddock trees for regional conservation in agricultural landscapes.* , NSW National Parks and Wildlife Service.

Grey, MJ, Clarke, MF & Loyn, RH 1998, 'Influence of the Noisy Miner *Manorina melanocephala* on avian diversity on avian diversity and abundance in Grey Box woodland', *Pacific Conservation Biology*, no. 4, pp. 55-69.

Harrington, F & Veitch, A 1991, 'Short-term Impacts of Low Level Jet Fighter Training on Caribou in Labrador', *Artic*, vol. 44, no. 4, pp. 318-27.

Harris, JH & Gehrke, PC 1997, *Fish and Rivers in Stress: The NSW Rivers Survey*, NSW Fisheries, Cronulla NSW, Australia.

Hatton, T & Evans, R 1998, *Dependence of ecosystems on groundwater and its significance to Australia*, Land and Water Resources Research and Development Corporation, Canberra.

Hughes, W & Westoby, M 1994, 'Climate change and conservation policies in Australia: coping with change that is far away and not yet certain', *Pacific Conservation Biology* no. 1, pp. 308-18.

James B. Croft and Associates 1983, *Report on the botany, wildlife and ecology of the Leard State Forest. Draft Environmental Impact Statement for Amax-BHP Joint Venture Boggabri Coal Project, Appendix 1.*

Kavanagh, RP & Debus, SJS 1994, 'The Powerful Owl *Ninox strenua* in New South Wales', *Australian Birds* vol. 28, supplement 21-38.

Keith, DS, C., 2006, *Spatial data layers for extant native vegetation in New South Wales*.

Larkin, RP 2005, *Effect of Military Noise on Wildlife*, viewed 11/12/2009 2009, <http://www.aerohabitat.org/link/2005/09-06-2005%20-%20Larkin,%20Effect%20military%20noise%20and%20wildlife%20(0.4MB).pdf>.

Lindenmayer, DB & Burgman, M 2005, *Practical conservation biology*, CSIRO Publishing, Collingwood, Victoria.

Longcore, T & Rich, C 2004, 'Ecological Light Pollution', *Frontiers in Ecology and the Environment*, vol. 2, no. 4, pp. 191-8.

Longcore, T & Rich, C 2007, 'Lights Out! For Nature', in C Marin & J Jafari (eds), *StarLight A common Heritage*, Starlight Initiative, Spain, pp. 165-71.

Matsui, M, Wu, GF & Yong, HS 1993, 'Acoustic characteristics of 3 species of the genus *Amolops (amphibia anura, ranidae)*', *Zoological Science*, vol. 10, pp. 691-5.

McIntyre, S, McIvor, JG & MacLeod, ND 2000, 'Principles for sustainable grazing in eucalypt woodlands: Landscape-scale indicators and the search for thresholds.' in P Hale, A Petrie, D Maloney & P Sattler (eds), *Management for Sustainable Ecosystems* Centre for Conservation Biology, University of Queensland, Brisbane.

Morgan, JW 1998, 'Patterns of invasion of an urban remnant of a species-rich grassland in southeastern Australia by non-native plant species. ' *Journal of Vegetation Science*, vol. 9, no. 2, pp. 181-90.

Murray, BR, Zeppel, MJB, Hose, GC & Eamus, D 2003, 'Groundwater-dependent ecosystems in Australia: It's more than just water for rivers', *Ecological restoration and management*, vol. 4, no. 2, pp. 110-3.

National Land and Water Resources Audit 2001, *Australian water resources assessment 2001. National Land and Water Resources Audit. Land and Water Australia*, Commonwealth of Australia, Canberra.

NSW Department of Environment and Climate Change 2008, *BioMetric - Version 2*, NSW Department of Environment and Climate Change, Hurstville.

NSW Department of Environment, CCaW 2009, *Threatened Species survey and assessment guidelines: field survey and methods for fauna- Amphibians*

NSW Fisheries 2003, *Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River, Fishnote FSC 01/10*, NSW Fisheries, Sydney.

NSW National Parks & Wildlife Service 2002, *Pilliga Nature Reserve, Plan of Management*, NSW National Parks and Wildlife Service, Sydney.

NSW National Parks and Wildlife Service 2001, *Hygiene protocol for the control of disease in frogs. Information Circular Number 6*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002a, *Identification guidelines for endangered ecological communities: White box - Yellow box - Blakely's red gum (box gum) woodland*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002b, *Landscapes (Mitchell) of NSW*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002c, *White Box Yellow Box Blakely's Red Gum (Box-Gum) woodland: fact-sheet for NSW*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003, *The Bioregions of New South Wales: their biodiversity, conservation and history*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2006, *Mount Kaputar National Park, Plan of Management*, Department of Environment and Conservation (NSW), Sydney, NSW.

NSW Scientific Committee 2000, *Human-caused climate change - key threatening process declaration*, Department of Environment and Conservation, Hurstville.

NSW Scientific Committee 2007, *Final Determination to list the endangered population of Diuris tricolor* NSW National Parks and Wildlife Service, Hurstville.

Paez, VP, Bock, BC & Rand, AS 1993, 'Inhibition of evoked calling of *Dendrobates pumilio* due to acoustic interference from cicada calling', *Biotropica*, vol. 25, pp. 242-5.

Parkes, D, Newell, G & Cheal, D 2003, 'Assessing the quality of native vegetation: The 'habitat hectares' approach', *Ecological Management and Restoration*, vol. 4 (supplementary), pp. S29-38.

Parsons Brinckerhoff 2005a, *Boggabri Coal project - flora and fauna Construction Environmental Management Plan*, Parsons Brinckerhoff, Singleton.

Parsons Brinckerhoff 2005b, *Flora and Fauna Summary of the Boggabri Coal Project*, Parsons Brinckerhoff, Sydney.

Parsons Brinckerhoff 2008, *Boggabri Coal Biodiversity Monitoring February 2006- May 2008*.

Parsons Brinckerhoff 2009a, *Aquifer interference licensing requirements supporting documentation.*

Parsons Brinckerhoff 2009b, *Preliminary vegetation mapping and survey report for Boggabri Coal lease*.

Pennay, M 2001, *Results of Fauna survey work undertaken by the NSW National Parkes and Wildlife Service within Leard State Forest*, Summary report edn, WRA Biodiversity Survey Coordinator NSW National Parks and Wildlife Service Sydney.

Pennay, M 2002, *Vertebrate fauna survey, analysis and modelling projects, NSW Western Regional Assessments: Bringalow Belt South Bioregion (Stage 2)*, New South Wales Government.

Pennay, M, Law, B & Reinhold, L 2004, *Bat calls of NSW. Region based guide to the echolocation calls of microchiropteran bats*, New South Wales Department of Environment and Conservation,
State Forests of New South Wales, Sydney.

Planning NSW 2004, *Joint Vegetation Mapping Project. NSW Western Regional Assessments, Brigalow Belt South Bioregion. Report to* Planning NSW, Dubbo.

Pusey, BJ, Arthington, A. H. 1996, 'Importance of the riparian zone to the conservation and management of freshwater fish: a review.' *Mar. Freshwater Res.*, vol. 54, pp. 1-16.

Radford, JQ & Bennett, A 2007, 'The relative importance of landscape properties for woodland birds in agricultural environments', *Journal of Applied Ecology*, vol. 44, no. 737-747.

Reid, JRW 2000, *Threatened and Declining Birds in the New South Wales Sheep-Wheat Belt: II Landscape Relationships - Modelling Bird Atlas Data Against Vegetation Cover*, Report prepared for the New South Wales National Parks and Wildlife Service, Hurstville.

Renjifo, LM 1999, 'Composition changes in a sub-Andean avifauna after long-term forest fragmentation'. *Conservation Biology*, vol. 13, no. 5, pp. 1124-39.

Resource and Conservation Assessment Council 2000, *Preliminary overview of the Brigalow Belt South Bioregion (Stage 1)*, Sydney.

Robinson, D, Davidson, I & Tzaros, C 2001, *Biology and conservation of the Grey-crowned Babbler in Victoria*, Department of Natural Resources and Environment, East Melbourne.

Royal Botanic Gardens 2005, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney.

Royal Botanic Gardens 2008, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, <http://plantnet.rbgsyd.nsw.gov.au/>.

Royal Botanic Gardens 2009, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, <http://plantnet.rbgsyd.nsw.gov.au/>.

Salmon, M, Tolbert, MG, Painter, DP, Goff, M & Reiners, R 1995, 'Behaviours of Logger-head sea turtles on an urban beach II Hatchling Orientation', *Journal of Herpetology*, vol. 29, no. 4, pp. 568-76.

Saunders, DA, Hobbs, RJ & Margules, CR 1991, 'Biological Consequences of Ecosystem Fragmentation: A Review', *Conservation Biology*, vol. 5, no. 1, pp. 18-32.

Schwartz, A & Henderson, RW 1991, *Amphibians and Reptiles of the West Indies: descriptions, distributions and natural history*, University of Florida Press, Gainesville, Florida.

Smith, A 2002, *Squirrel Glider (Petaurus norfolcensis) Conservation Management Plan: Wyong Shire*, Report prepared by Austeco Environmental Consultants for Wyong Shire Council, Armidale.

Stewart, D 1998, *Australian Frog Calls: Subtropical East*, Nature Sound.

Stockwell, CA, Bateman, BJ & Berger, J 1991, 'Conflict in National Parks: A Case Study of Helicopters and Bighorn sheep time budges as the Grand Canyon', *Biological Conservation*, vol. 56, no. 3, pp. 317-28.

Thackway, R & Cresswell, ID 1995, *An Interim Biogeographic Regionalisation of Australia*, Australian Nature Conservation Agency, Canberra.

Thoms, MC 1999, *The condition of the Namoi River System. A report to: NSW Department of Land and Water Conservation.* , CRC for Freshwater Ecology, University of Canberra.

Thorp, J & Lynch, R 2000, *The Determination of Weeds of National Significance*, National Weeds Strategy Executive Committee, Launceston.

Todd, J 2003, *Guidelines for applying the Habitat Hectares approach*, Department of Natural Resources and Environment, Melbourne.

Underwood, AJ 1981, 'Techniques of analysis of variance in experimental marine biology and ecology.' *Oceanography and Marine Biology Annual Review 1*, vol. 19, pp. 513-605.

Underwood, AJ 1997, *Experiments in Ecology. Their Logical Design and Interpretation Using Analysis of Variance*, Cambridge University Press, Cambridge.

van der Toorn, JD, Hendriks, H & van den Dool, TC 1996, 'Measuring TGV source strength with SYNTACAN', *Journal of Sound and Vibration*, vol. 193, no. 1, pp. 113-21.

Wilson, A & Lindenmayer, DB 1995, *Wildlife Corridors and the Conservation of Biodiversity: A Review*, National Corridors of Green Program, Green Australia Ltd., Canberra.

Winer, BJ 1971, *Statistical Principles in Experimental Design.* , McGraw Hill, New York.

Zanette, L, Doyle, P & Tremont, SM 2000, 'Food shortage in small fragments: Evidence from an area-sensitive passerine', *Ecology*, vol. 81, pp. 1654-66.

Appendix A

Species of plant recorded

Appendix A: Species of plant recorded within the study area

Family Name	Scientific Name	Common Name	Native	TSC Act	EPBC Act
Acanthaceae					
	Brunoniella australis	Blue Trumpet	Y		
	Pseuderanthemum variabile	Pastel Flower	Y		
	Rostellularia adscendens ssp. adscendens var. adscendens		Y		
Adiantaceae					
	Adiantum formosum	Giant Maidenhair	Y	P13	
	Cheilanthes austrotenuifolia	Rock Fern	Y		
	Cheilanthes distans	Bristly Cloak Fern	Y		
	Cheilanthes sieberi	Mulga Fern	Y		
Agavaceae					
	Agave americana	Century Plant	N		
Aizoaceae					
	Galenia pubescens	Galenia	N		
Amaranthaceae					
	Alternanthera nana	Hairy Joyweed	Y		
	Alternanthera pungens	Khaki Weed	N		
	Amaranthus viridis	Green Amaranth	N		
Anthericaceae					
	Arthropodium milleflorum	Vanilla Lily	Y		
	Caesia parviflora	Pale Grass-lily	Y		
	Dichopogon strictus	Chocolate Lily	Y		
	Laxmannia gracilis		Y		
Apiaceae					
	Actinotus helianthi	Flannel Flower	Y	P13	
	Conium maculatum	Hemlock	N		
	Daucus glochidiatus	Native Carrot	Y		
	Hydrocotyle geranifolia		Y		
Apocynaceae					
	Alstonia constricta	Quinine Bush	Y		
	Parsonsia eucalyptophylla	Gargaloo	Y		
Asclepiadaceae					
	Marsdenia australis	Doubah	Y		
	Marsdenia viridiflora ssp. viridiflora	Native Pear	Y		
	Rhyncharrhena linearis		Y		
Aspleniaceae					
	Pleurosorus rutifolius		Y		
Asteraceae					
	Ammobium alatum		Y		
	Arctotheca calendula	Capeweed	N		
	Bidens pilosa	Cobbler's Pegs	N		
	Brachyscome ciliaris	Variable Daisy	Y		
	Brachyscome multifida	Cut-leaved Daisy	Y		
	Calotis cuneata	Mountain Burr-Daisy	Y		
	Calotis cuneifolia	Purple Burr-Daisy	Y		
	Calotis erinacea	Tangled Burr-daisy	Y		
	Calotis hispidula	Bogan Flea	Y		
	Calotis lappulacea	Yellow Burr-daisy	Y		

	Carthamus lanatus	Saffron Thistle	N
	Cassinia aculeata	Dolly Bush	Y
	Cassinia laevis	Cough Bush	Y
	Cassinia quinquefaria		Y
	Chondrilla juncea	Skeleton Weed	N
	Chrysocephalum apiculatum	Common Everlasting	Y
	Chrysocephalum semipapposum	Clustered Everlasting	Y
	Cirsium vulgare	Spear Thistle	N
	Conyza albida	Tall Fleabane	N
	Conyza bonariensis	Flaxleaf Fleabane	N
	Euchiton sphaericus		Y
	Glossogyne tenuifolia	Native Cobbler's Peg	Y
	Gnaphalium sphaericum		Y
	Hypochaeris glabra	Smooth Catsear	N
	Leptorhynchos panaetioides	Woolly Buttons	Y
	Leptorhynchos tetrachaetus	Beauty Buttons	Y
	Minuria integerrima		Y
	Minuria leptophylla		Y
	Olearia elliptica	Sticky Daisy Bush	Y
	Olearia nernstii		Y
	Olearia ramulosa	Twiggy Daisy-bush	Y
	Pseudognaphalium luteoalbum	Jersey Cudweed	Y
	Schkuhria pinnata		N
	Senecio madagascariensis	Fireweed	N
	Senecio quadridentatus	Cotton Fireweed	Y
	Senecio sp.		Y
	Sigesbeckia australiensis		Y
	Silybum marianum	Variegated Thistle	N
	Solenogyne bellioides		Y
	Sonchus oleraceus	Common Sowthistle	N
	Vernonia cinerea		Y
	Vittadinia cervicularis		Y
	Vittadinia cuneata	Fuzzweed	Y
	Vittadinia dissecta		Y
	Vittadinia muelleri		Y
	Vittadinia pterochaeta	Rough Fuzzweed	Y
	Vittadinia sulcata		Y
	Xanthium spinosum	Bathurst Burr	N
	Xanthium strumarium		Y
	Xerochrysum bracteatum	Golden Everlasting	Y
	Xerochrysum palustre	Swamp Everlasting	Y
	Xerochrysum viscosum	Sticky Everlasting	Y
Bignoniaceae			
	Pandorea pandorana	Wonga Wonga Vine	Y
Boraginaceae			
	Ehretia membranifolia	Peach Bush	Y
	Heliotropium amplexicaule	Blue Heliotrope	N
Brassicaceae			
	Brassica napus		N
	Brassica rapa		N
	Brassica sp.		N
	Capsella bursa-pastoris	Shepherd's Purse	N
	Lepidium africanum		N

	Lepidium papillosum	Warty Peppercess	Y
	Lepidium sagittulatum		Y
Cactaceae			
	Opuntia aurantiaca	Tiger Pear	N
	Opuntia stricta	Prickly Pear	N
	Opuntia tomentosa	Velvet Tree Pear	N
Campanulaceae			
	Wahlenbergia communis	Tufted Bluebell	Y
	Wahlenbergia gracilis	Sprawling or Australian Bluebell	Y
	Wahlenbergia planiflora ssp. longipila		Y
	Wahlenbergia sp.	Bluebell	Y
	Wahlenbergia stricta	Tall Bluebell	Y
Capparaceae			
	Capparis mitchellii	Native Orange	Y
Caryophyllaceae			
	Polycarpaea corymbosa		Y
	Polycarpon tetraphyllum	Four-leaved Allseed	N
Casuarinaceae			
	Allocasuarina gymnanthera		Y
	Allocasuarina luehmannii	Bulloak	Y
	Allocasuarina stricta		Y
	Casuarina cristata ssp. cristata		Y
Celastraceae			
	Maytenus cunninghamii	Yellow-berry Bush	Y
Chenopodiaceae			
	Atriplex muelleri		Y
	Einadia hastata	Berry Saltbush	Y
	Einadia nutans	Climbing Saltbush	Y
	Einadia nutans ssp. linifolia		Y
	Einadia polygonoides		Y
	Einadia trigonos	Fishweed	Y
	Enchylaena tomentosa	Ruby Saltbush	Y
	Maireana microphylla		Y
	Maireana pentagona	Hairy Bluebush	Y
	Maireana sp.		Y
	Salsola kali		Y
	Sclerolaena birchii	Galvinized Burr	Y
	Sclerolaena muricata	Black Rolypoly	Y
Chloanthaceae			
	Spartothamnella juncea		Y
Clusiaceae			
	Hypericum gramineum	Small St John's Wort	Y
Convolvulaceae			
	Convolvulus erubescens		Y
	Dichondra repens	Kidney Weed	Y
	Dichondra sp.A		Y
	Evolvulus alsinoides		Y
Cupressaceae			
	Callitris endlicheri	Black Cypress Pine	Y
	Callitris glaucophylla	White Cypress Pine	Y
Cyperaceae			
	Carex appressa	Tussock Sedge	Y
	Carex inversa	Knob Sedge	Y

	Carex sp.		Y	
	Cyperus fulvus		Y	
	Cyperus gracilis		Y	
	Eleocharis sp.		Y	
	Fimbristylis dichotoma		Y	
	Isolepis hookeriana		Y	
	Lepidosperma laterale		Y	
Dilleniaceae				
	Hibbertia obtusifolia		Y	
Epacridaceae				
	Melichrus urceolatus	Urn Heath	Y	
Euphorbiaceae				
	Beyeria viscosa		Y	
	Breynia oblongifolia	Coffee Bush	Y	
	Chamaesyce drummondii	Caustic Weed	Y	
	Euphorbia drummondii		Y	
	Euphorbia eremophila	Desert Spurge	Y	
	Phyllanthus gunnii		Y	
	Phyllanthus virgatus		Y	
	Poranthera microphylla		Y	
	Sauropus ramosissimus		Y	
Fabaceae (Caesalpinioideae)				
	Cassia barclayana		Y	
	Cassia eremophila var. eremophila		Y	
	Senna aciphylla		Y	
	Senna artemisioides		Y	
Fabaceae (Faboideae)				
	Daviesia nova-anglica		Y	
	Daviesia pubigera		Y	
	Desmodium brachypodum	Large Tick-trefoil	Y	
	Desmodium varians	Slender Tick-trefoil	Y	
	Dillwynia sieberi		Y	
	Glycine canescens	Silky Glycine	Y	
	Glycine clandestina		Y	
	Glycine tabacina		Y	
	Hardenbergia violacea	False Sarsaparilla	Y	
	Hovea lanceolata		Y	
	Indigofera adesmiifolia		Y	
	Indigofera australis		Y	
	Medicago polymorpha	Burr Medic	N	
	Medicago sativa	Lucerne	Y	
	Pultenaea cuneata		Y	
	Pultenaea retusa		Y	
	Pultenaea setulosa		Y	V
	Swainsona galegifolia	Smooth Darling Pea	Y	
	Swainsona swainsonioides		Y	
	Templetonia stenophylla	Leafy Templetonia	Y	
	Trifolium arvense	Haresfoot Clover	N	
	Trifolium repens	White Clover	N	
	Vicia sativa ssp .nigra	Narrow-leaved Vetch	N	
	Zornia dyctiocarpa		Y	
Fabaceae (Mimosoideae)				
	Acacia aneura	Mulga	Y	

	Acacia cheelii	Motherumbah	Y
	Acacia dealbata ssp. dealbata	Silver Wattle	Y
	Acacia deanei ssp. deanei	Deane's Wattle	Y
	Acacia decora	Western Golden Wattle	Y
	Acacia doratoxylon	Currawang	Y
	Acacia excelsa	Ironwood	Y
	Acacia gladiiformis	Sword-leaved Wattle	Y
	Acacia hakeoides	Hakea Wattle	Y
	Acacia harpophylla	Brigalow	Y
	Acacia homalophylla	Yarran	Y
	Acacia leiocalyx		Y
	Acacia oswaldii	Miljee	Y
	Acacia pendula	Boree	Y
	Acacia spectabilis	Mudgee Wattle	Y
	Acacia triptera	Spurwing Wattle	Y
	Neptunia gracilis	Sensitive Plant	Y
	Vachellia farnesiana	Mimosa Bush	Y
Geraniaceae			
	Geranium molle		N
	Geranium solanderi	Native Geranium	Y
Goodeniaceae			
	Goodenia bellidifolia		Y
	Goodenia fascicularis		Y
	Goodenia glabra		Y
	Goodenia hederacea		Y
	Goodenia rotundifolia		Y
	Goodenia sp.		Y
	Scaevola spinescens		Y
Haloragaceae			
	Gonocarpus elatus		Y
	Gonocarpus teucrioides		Y
Juncaceae			
	Juncus continuus		Y
	Juncus sp.		Y
	Juncus usitatus		Y
Juncaginaceae			
	Triglochin procera		Y
Lamiaceae			
	Ajuga australis	Austral Bugle	Y
	Marrubium vulgare	Horehound	N
	Mentha satureioides	Native Pennyroyal	Y
	Prostanthera cruciflora		Y
	Prostanthera rhombea		Y
	Salvia plebeia		Y
	Salvia verbenaca	Wild Sage	N
	Scutellaria humilis	Dwarf Skullcap	Y
	Stachys arvensis	Stagger Weed	N
	Teucrium racemosum	Grey Germander	Y
	Westringia rigida	Stiff Westringia	Y
Lauraceae			
	Cassytha pubescens		Y
Linaceae			
	Linum marginale	Native Flax	Y

Lobeliaceae			
	Isotoma axillaris	Showy Isotome	Y
Lomandraceae			
	Lomandra bracteata		Y
	Lomandra confertifolia		Y
	Lomandra filiformis		Y
	Lomandra glauca	Pale Mat-rush	Y
	Lomandra longifolia	Spiny-headed Mat-rush	Y
	Lomandra multiflora		Y
Loranthaceae			
	Amyema cambagei		Y
	Amyema lucasii		Y
	Amyema miquelii		Y
	Amyema miraculosum		Y
	Amyema quandang var. bancroftii		Y
	Amyema quandang var. quandang		Y
	Lysiana subfalcata		Y
Lythraceae			
	Lythrum hyssopifolia	Hyssop Loosestrife	Y
Malvaceae			
	Abutilon leucopetalum		Y
	Abutilon oxycarpum	Flannel Weed	Y
	Hibiscus sturtii var. sturtii		Y
	Hibiscus trionum	Bladder Ketmia	Y
	Malva parviflora	Small-flowered Mallow	N
	Malvastrum americanum	Spiked Malvastrum	N
	Sida corrugata	Vaiable Sida	Y
	Sida cunninghamii		Y
	Sida filiformis		Y
	Sida rhombifolia	Paddy's Lucerne	N
	Sida subspicata		Y
Marsileaceae			
	Marsilea drummondii	Common Nardoo	Y
Meliaceae			
	Melia azedarach	White Cedar	Y
Moraceae			
	Ficus rubiginosa	"Port Jackson Fig, Rusty Fig"	Y
Myoporaceae			
	Eremophila debilis	Amulla	Y
	Eremophila longifolia	Emubush	Y
	Eremophila mitchellii	Budda	Y
	Myoporum deserti		Y
	Myoporum montanum	Western Boobialla	Y
Myrtaceae			
	Angophora floribunda	Rough-barked Apple	Y
	Corymbia trachyphloia	White Bloodwood	Y
	Eucalyptus albens	White Box	Y
	Eucalyptus blakelyi	Blakely's Red Gum	Y
	Eucalyptus camaldulensis	River Red Gum	Y
	Eucalyptus chloroclada	Dirty Gum	Y
	Eucalyptus crebra	Narrow-leaved Ironbark	Y
	Eucalyptus dealbata	Tumbledown Red Gum	Y
	Eucalyptus dwyeri	Dwyer's Red Gum	Y

	Eucalyptus fibrosa ssp. nubila		Y	
	Eucalyptus melanophloia	Silver-leaved Ironbark	Y	
	Eucalyptus melliodora	Yellow Box	Y	
	Eucalyptus microcarpa	Western Grey Box	Y	
	Eucalyptus nandewarica		Y	
	Eucalyptus pilligaensis	Narrow-leaved Grey Box	Y	
	Eucalyptus populnea	Bimble Box	Y	
	Melaleuca bracteata		Y	
Nyctaginaceae				
	Boerhavia dominii	Tarvine	Y	
Olacaceae				
	Olax stricta		Y	
Oleaceae				
	Jasminum lineare	Desert Jasmine	Y	
	Notelaea linearis		Y	
	Notelaea microcarpa var. microcarpa		Y	
Orchidaceae				
	Cymbidium canaliculatum	Tiger Orchid	Y	P13
	Pterostylis boormanii		Y	
	Pterostylis hamata		Y	
	Pterostylis mutica	Midget Greenhood	Y	
	Pterostylis revoluta		Y	
Oxalidaceae				
	Oxalis corniculata	Creeping Oxalis	N	
	Oxalis perennans		Y	
	Oxalis radicosa		Y	
Phormiaceae				
	Dianella longifolia		Y	
	Dianella revoluta		Y	
Pittosporaceae				
	Bursaria spinosa	Native Blackthorn	Y	
	Pittosporum angustifolium		Y	
Plantaginaceae				
	Plantago cunninghamii		Y	
	Plantago debilis		Y	
Poaceae				
	Aristida jerichoensis var. jerichoensis		Y	
	Aristida leptopoda	White Speargrass	Y	
	Aristida personata (Syn Aristida ramosa var. speciosa)	Purple Wiregrass	Y	
	Aristida ramosa		Y	
	Aristida sp.		Y	
	Aristida vagans	Threeawn Speargrass	Y	
	Austrodanthonia auriculata	Lobed Wallaby Grass	Y	
	Austrodanthonia bipartita	Wallaby Grass	Y	
	Austrodanthonia caespitosa	Ringed Wallaby Grass	Y	
	Austrodanthonia monticola		Y	
	Austrodanthonia racemosa		Y	
	Austrodanthonia setacea		Y	
	Austrodanthonia sp.		Y	
	Austrostipa aristiglumis	Plains Grass	Y	
	Austrostipa bigeniculata		Y	
	Austrostipa ramosissima	Stout Bamboo Grass	Y	

Austrostipa scabra	Speargrass	Y
Austrostipa setacea	Corkscrew Grass	Y
Austrostipa verticillata		Y
Avena fatua	Wild Oats	N
Bothriochloa decipiens	Red Grass	Y
Bothriochloa macra	Red Grass	Y
Brachiaria miliiformis		Y
Chloris divaricata		Y
Chloris gayana	Rhodes Grass	N
Chloris truncata	Windmill Grass	Y
Chloris ventricosa	Tall Chloris	Y
Cymbopogon refractus	Barbed Wire Grass	Y
Cynodon dactylon	Common Couch	Y
Dichanthium sericeum	Queensland Bluegrass	Y
Dichelachne micrantha	Shorthair Plumegrass	Y
Digitaria brownii	Cotton Panic Grass	Y
Digitaria diffusa		Y
Digitaria divaricatissima	Umbrella Grass	Y
Digitaria sp.		Y
Echinopogon sp.		Y
Eleusine indica	Crowsfoot Grass	N
Elymus scaber var. scaber	Common Wheatgrass	Y
Elymus scabrus		Y
Enneapogon gracilis	Slender Nineawn	Y
Enneapogon intermedius		Y
Enneapogon nigricans	Niggerheads	Y
Enteropogon acicularis		Y
Entolasia sp.		Y
Eragrostis brownii	Brown's Lovegrass	Y
Eragrostis cilianensis	Stinkgrass	N
Eragrostis lacunaria	Purple Lovegrass	Y
Eragrostis laniflora	Woollybutt	Y
Eragrostis leptostachya	Paddock Lovegrass	Y
Eragrostis megalosperma		Y
Eragrostis molybdea		Y
Eragrostis sp.		Y
Eragrostis tenellula	Delicate Lovegrass	Y
Eriochloa pseudoacrotricha	Early Spring Grass	Y
Eriochloa sp.		Y
Hordeum leporinum	Barley Grass	N
Joycea pallida	Silvertop Wallaby Grass	Y
Lolium perenne	Perennial Ryegrass	N
Microlaena stipoides		Y
Notodanthonia longifolia	Long-leaved Wallaby Grass	Y
Oplimensus aemulus var. aemulus		Y
Panicum decompositum	Native Millet	Y
Panicum effusum	Poison or Hairy Panic	Y
Panicum simile	Two-colour Panic	Y
Paspalidium caespitosum	Brigalow Grass	Y
Paspalidium constrictum	Knottybutt Grass	Y
Paspalidium gracile	Slender Panic	Y
Paspalum dilatatum	Paspalum	N
Paspalum urvillei	Vasey Grass	N

	Pennisetum clandestinum	Kikuyu Grass	N	
	Phalaris aquatica	Phalaris	N	
	Phragmites australis	Common Reed	Y	
	Poa sieberiana		Y	
	Setaria sp.		Y	
	Sporobolus caroli	Fairy Grass	Y	
	Sporobolus creber	Slender Rat's Tail Grass	Y	
	Sporobolus sp.		Y	
	Themeda australis	Kangaroo Grass	Y	
	Tragus australianus	Small Burrgrass	Y	
	Urochloa advena		N	
	Vulpia bromoides	Squirrel Tail Fesque	N	
	Vulpia myuros	Rat's Tail Fescue	N	
Polygonaceae				
	Persicaria decipiens	Slender Knotweed	Y	
	Polygonum aviculare	Wireweed	N	
	Polygonum plebeium	Small Knotweed	Y	
	Rumex brownii	Swamp Dock	Y	
	Rumex crispus	Curled Dock	N	
Portulacaceae				
	Portulaca oleracea	Pigweed	Y	
Primulaceae				
	Anagallis arvensis	Scarlet/Blue Pimpernel	N	
Rhamnaceae				
	Alphitonia excelsa	Red Ash	Y	
	Pomaderris andromedifolia		Y	
	Pomaderris queenslandica	Scant Pomaderris	Y	E1
Rosaceae				
	Rubus ulmifolius	Blackberry	N	
Rubiaceae				
	Asperula conferta	Common Woodruff	Y	
	Canthium odoratum	Shiny-leaved Canthium	Y	
	Galium gaudichaudii	Rough Bedstraw	Y	
	Galium migrans		Y	
	Opercularia hispida	Hairy Stinkweed	Y	
	Pomax umbellata		Y	
Rutaceae				
	Geijera parviflora	Wilga	Y	
Santalaceae				
	Exocarpos cupressiformis	Native Cherry	Y	
	Santalum lanceolatum	Northern Sandalwood	Y	
Sapindaceae				
	Alectryon diversifolius		Y	
	Alectryon oleifolius	"Western Rosewood, Bonaree"	Y	
	Atalaya hemiglauca	Whitewood	Y	
	Dodonaea boroniifolia		Y	
	Dodonaea heteromorpha		Y	
	Dodonaea sinuolata ssp. sinuolata		Y	
	Dodonaea tenuifolia		Y	
	Dodonaea truncatiales		Y	
	Dodonaea viscosa		Y	
	Dodonaea viscosa ssp. angustifolia		Y	
	Dodonaea viscosa ssp. cuneata		Y	

	Heterodendrum oleifolium		Y
Scrophulariaceae			
	Veronica plebeia	Trailing Speedwell	Y
Solanaceae			
	Solanum ellipticum	Velvet Potato Bush	Y
	Solanum ferocissimum	Spiny Potato-bush	Y
	Solanum linearifolium	Mountain Kangaroo Apple	Y
	Solanum nigrum	Black-berry Nightshade	N
	Solanum opacum	Green-berry Nightshade	Y
	Solanum parvifolium		Y
	Solanum stelligerum	Devil's Needles	Y
	Solanum tetrathecum		Y
Stackhousiaceae			
	Stackhousia viminea	Slender Stackhousia	Y
Sterculiaceae			
	Brachychiton populneus	Kurrajong	Y
	Gilesia biniflora	Western Tarvine	Y
Thymelaeaceae			
	Pimelea curviflora		Y
	Pimelea microcephala		Y
	Pimelea neo-anglica	Poison Pimelea	Y
	Pimelea stricta		Y
Urticaceae			
	Urtica incisa	Stinging Nettle	Y
Verbenaceae			
	Oncinocalyx betchei		Y
	Verbena bonariensis	Purpletop	N
	Verbena gaudichaudii		Y
	Verbena officinalis	Common Verbena	N
Xanthorrhoeaceae			
	Xanthorrhoea glauca		Y
Zygophyllaceae			
	Tribulus terrestris	Catshead	N

Appendix B

Species of animal recorded

Family Name	Common Name	Latin Name	TSC Act[1]	EPBC Act[2]	Opportunistic[3]	Grassy Woodland[3]	Shrubby Open Forest[3]	Riverine Woodland[3]	Grassland[3]
Amphibians									
Hylidae	Broad-palmed Frog	*Litoria latopalmata*			T		T	T	T
Hylidae	Desert Tree Frog	*Litoria rubella*						T	
Hylidae	Green Tree Frog	*Litoria caerulea*			T	T			T
Hylidae	Peron's Tree Frog	*Litoria peronii*						T	
Myobatrachidae	Long-thumbed Frog	*Limnodynastes fletcheri*			T		T		T
Myobatrachidae	Spotted Grass Frog	*Limnodynastes tasmaniensis*			T			W	T
Reptiles									
Agamidae		*Lophognathus burnsi*					T		
Agamidae	Bearded Dragon	*Pogona barbata*			T		T		
Agamidae	Nobbi	*Amphibolurus nobbi*			T	T	T	T	
Chelidae	Eastern Long-necked Tortoise	*Chelodina longicollis*			O				
Elapidae	Eastern Tiger Snake	*Notechis scutatus*			T		T		
Elapidae	Red-bellied Black Snake	*Pseudechis porphyriacus*			O			O	O
Elapidae	Western Brown Snake	*Pseudonaja nuchalis*							O
Elapidae	Yellow-faced Whip Snake	*Demansia psammophis*				T	T		
Gekkonidae		*Gehyra dubia*			T	T	T		
Gekkonidae	Bynoe's Gecko	*Heteronotia binoei*			T	T	T		
Gekkonidae	Robust Velvet Gecko	*Oedura robusta*			T	T			
Gekkonidae	Soft-tailed Gecko	*Diplodactylus williamsi*				T			
Gekkonidae	Stone Gecko	*Diplodactylus vittatus*				T	T		
Gekkonidae	Thick-tailed Gecko	*Underwoodisaurus milii*				T			
Gekkonidae	Tree Dtella	*Gehyra variegata*				T	T		
Pygopodidae		*Delma plebeia*				K	T		
Pygopodidae	Burton's Legless Lizard	*Lialis burtonis*					T		

Pygopodidae	Unidentified Delma	*Delma spp.*					O		
Scincidae		*Egernia modesta*			O				
Scincidae	Bougainville's Skink	*Lerista bougainvillii*				T	T		
Scincidae	Boulenger's Skink	*Morethia boulengeri*				T	T		
Scincidae	Copper-tailed Skink	*Ctenotus taeniolatus*					O		
Scincidae	Eastern Blue-tongued Lizard	*Tiliqua scincoides*			T				
Scincidae	Grass Skink	*Lampropholis delicata*			O				
Scincidae	Striped Skink	*Ctenotus robustus*				T		T	
Scincidae	Tree Skink	*Egernia striolata*			O	T	T		
Scincidae	Wall Lizard	*Cryptoblepharus virgatus*			T				
Varanidae	Lace Monitor	*Varanus varius*			O	O	T		
Native Birds									
Accipitridae	Black-shouldered Kite	*Elanus axillaris*							O
Accipitridae	Brown Goshawk	*Accipiter fasciatus*			O	O	O		
Accipitridae	Little Eagle	*Hieraaetus morphnoides*	V		O	O		O	
Accipitridae	Spotted Harrier	*Circus assimilis*	V		O				O
Accipitridae	Wedge-tailed Eagle	*Aquila audax*			O	O	O		
Accipitridae	Whistling Kite	*Haliastur sphenurus*			O	O		O	
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*			W		W		
Alcedinidae	Azure Kingfisher	*Alcedo azurea*			O			O	
Anatidae	Australian Wood Duck	*Chenonetta jubata*			O			O	O
Anatidae	Grey Teal	*Anas gracilis*			O			O	O
Apodidae	White-throated Needletail	*Hirundapus caudacutus*		M	O		O		O
Ardeidae	White-faced Heron	*Egretta novaehollandiae*			O			O	O
Ardeidae	White-necked Heron	*Ardea pacifica*			O			O	O
Artamidae	Australian Magpie	*Gymnorhina tibicen*			O	O		O	O
Artamidae	Dusky Woodswallow	*Artamus cyanopterus*			O	O	O	O	O

Artamidae	Grey Butcherbird	*Cracticus torquatus*				W			
Artamidae	Pied Butcherbird	*Cracticus nigrogularis*			O	O	O	O	O
Artamidae	Pied Currawong	*Strepera graculina*			O	O	O		
Artamidae	White-browed Woodswallow †	*Artamus superciliosus*	V†		O	O	O		
Cacatuidae	Cockatiel	*Nymphicus hollandicus*				O		O	
Cacatuidae	Galah	*Cacatua roseicapilla*			O	O	O	O	O
Cacatuidae	Little Corella	*Cacatua sanguinea*			O			O	
Cacatuidae	Sulphur-crested Cockatoo	*Cacatua galerita*			O	O		O	O
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			O	O	O		
Campephagidae	White-bellied Cuckoo-shrike	*Coracina papuensis*			O		O		
Charadriidae	Black-fronted Dotterel	*Elseyornis melanops*			O			O	
Ciconiidae	Black-necked Stork	*Ephippiorhynchus asiaticus*	E1		O			O	O
Climacteridae	Brown Treecreeper	*Climacteris picumnus*	V		O	O	O		
Climacteridae	White-throated Treecreeper	*Cormobates leucophaeus*			O	O	O		
Columbidae	Bar-shouldered Dove	*Geopelia humeralis*				O	O		
Columbidae	Common Bronzewing	*Phaps chalcoptera*			O	O	O	O	
Columbidae	Crested Pigeon	*Ocyphaps lophotes*			O			O	O
Columbidae	Peaceful Dove	*Geopelia striata*			W	O	O	W	
Coraciidae	Dollarbird	*Eurystomus orientalis*			O	O	O		
Corcoracidae	Apostlebird	*Struthidea cinerea*			O	O		O	O
Corcoracidae	White-winged Chough	*Corcorax melanorhamphos*			O	O	O	O	
Corvidae	Australian Raven	*Corvus coronoides*			O	O		O	O
Corvidae	Little Raven	*Corvus mellori*						W	W
Cuculidae	Black-eared Cuckoo	*Chrysococcyx osculans*					O		
Cuculidae	Fan-tailed Cuckoo	*Cacomantis flabelliformis*			O	O	O		
Cuculidae	Pallid Cuckoo	*Cuculus pallidus*			W	W	W		

Dicaeidae	Mistletoebird	*Dicaeum hirundinaceum*				O		O	
Dicruridae	Grey Fantail	*Rhipidura fuliginosa*			O	O	O	O	
Dicruridae	Leaden Flycatcher	*Myiagra rubecula*				O			
Dicruridae	Magpie-lark	*Grallina cyanoleuca*					O	O	
Dicruridae	Restless Flycatcher	*Myiagra inquieta*				O			
Dicruridae	Satin Flycatcher	*Myiagra cyanoleuca*		M				O	
Dicruridae	Willie Wagtail	*Rhipidura leucophrys*			O	O	O	O	O
Falconidae	Australian Hobby	*Falco longipennis*				O			
Falconidae	Brown Falcon	*Falco berigora*				O			
Falconidae	Nankeen Kestrel	*Falco cenchroides*				O			O
Falconidae	Peregrine Falcon	*Falco peregrinus*					O	O	
Halcyonidae	Laughing Kookaburra	*Dacelo novaeguineae*			O	O		O	O
Halcyonidae	Sacred Kingfisher	*Todiramphus sanctus*				O			
Hirundinidae	Fairy Martin	*Hirundo ariel*						O	
Hirundinidae	Tree Martin	*Hirundo nigricans*						O	
Hirundinidae	Welcome Swallow	*Hirundo neoxena*				O		O	O
Maluridae	Superb Fairy-wren	*Malurus cyaneus*			O	O		O	
Maluridae	Variegated Fairy-wren	*Malurus lamberti*			O	O	O	O	
Meliphagidae	Black-chinned Honeyeater	*Melithreptus gularis gularis*	V				O		
Meliphagidae	Brown-headed Honeyeater	*Melithreptus brevirostris*				O	O		
Meliphagidae	Fuscous Honeyeater	*Lichenostomus fuscus*			O	O	O	O	
Meliphagidae	Grey-fronted Honeyeater	*Lichenostomus plumulus*				O			
Meliphagidae	Little Friarbird	*Philemon citreogularis*				O			
Meliphagidae	Noisy Friarbird	*Philemon corniculatus*			O	O	O	O	
Meliphagidae	Noisy Miner	*Manorina melanocephala*			O		O	O	
Meliphagidae	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*			O	O	O	O	
Meliphagidae	Striped Honeyeater	*Plectorhyncha lanceolata*				O	O		

Meliphagidae	White-eared Honeyeater	*Lichenostomus leucotis*				O	O		
Meliphagidae	White-naped Honeyeater	*Melithreptus lunatus*				O			
Meliphagidae	White-plumed Honeyeater	*Lichenostomus penicillatus*			O	O	O	O	
Meliphagidae	Yellow-faced Honeyeater	*Lichenostomus chrysops*			O	O	O		
Meliphagidae	Yellow-throated Miner	*Manorina flavigula*						O	
Meropidae	Rainbow Bee-eater	*Merops ornatus*		M		O	O		
Motacillidae	Richard's Pipit	*Anthus novaeseelandiae*							O
Neosittidae	Varied Sittella	*Daphoenositta chrysoptera*	V				O		
Oriolidae	Olive-backed Oriole	*Oriolus sagittatus*				O		O	
Pachycephalidae	Crested Shrike-tit	*Falcunculus frontatus*				O	O		
Pachycephalidae	Golden Whistler	*Pachycephala pectoralis*				O	O		
Pachycephalidae	Grey Shrike-thrush	*Colluricincla harmonica*			O	O	O	O	
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*			O	O	O	O	
Pardalotidae	Brown Thornbill	*Acanthiza pusilla*			O	O	O	O	
Pardalotidae	Buff-rumped Thornbill	*Acanthiza reguloides*			O	O	O	O	
Pardalotidae	Chestnut-rumped Thornbill	*Acanthiza uropygialis*					O		
Pardalotidae	Inland Thornbill	*Acanthiza apicalis*				O	O		
Pardalotidae	Southern Whiteface	*Aphelocephala leucopsis*			O				
Pardalotidae	Speckled Warbler	*Pyrrholaemus sagittatus*	V		O	O	O	O	
Pardalotidae	Spotted Pardalote	*Pardalotus punctatus*			W	O		O	
Pardalotidae	Striated Pardalote	*Pardalotus striatus*			W	O	O	O	
Pardalotidae	Weebill	*Smicrornis brevirostris*				O			
Pardalotidae	Western Gerygone	*Gerygone fusca*			O				
Pardalotidae	White-browed Scrubwren	*Sericornis frontalis*					O		
Pardalotidae	White-throated Gerygone	*Gerygone olivacea*				O		O	

Pardalotidae	Yellow Thornbill	*Acanthiza nana*							O
Pardalotidae	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			O	O			O
Passeridae	Diamond Firetail	*Stagonopleura guttata*	V		O	O			O
Passeridae	Double-barred Finch	*Taeniopygia bichenovii*			O	O	O		
Passeridae	Plum-headed Finch	*Neochmia modesta*			O				
Passeridae	Red-browed Finch	*Neochmia temporalis*				O			
Petroicidae	Eastern Yellow Robin	*Eopsaltria australis*			O	O	O	O	
Petroicidae	Hooded Robin	*Melanodryas cucullata*	V			O			
Petroicidae	Jacky Winter	*Microeca fascinans*			O	O	O		
Petroicidae	Red-capped Robin	*Petroica goodenovii*				O	O		
Phasianidae	Brown Quail	*Coturnix ypsilophora*			O				
Phasianidae	Stubble Quail	*Coturnix pectoralis*				O		O	
Podargidae	Tawny Frogmouth	*Podargus strigoides*				O	O		
Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*						O	
Pomatostomidae	Grey-crowned Babbler	*Pomatostomus temporalis*	V			O	O		
Pomatostomidae	White-browed Babbler	*Pomatostomus superciliosus*			O	O	O		
Psittacidae	Australian King-Parrot	*Alisterus scapularis*				O	O	O	
Psittacidae	Australian Ringneck	*Barnardius zonarius*				O	O	O	O
Psittacidae	Blue Bonnet	*Northiella haematogaster*							O
Psittacidae	Eastern Rosella	*Platycercus eximius*				O		O	O
Psittacidae	Little Lorikeet	*Glossopsitta pusilla*	V		O	O	O	O	
Psittacidae	Musk Lorikeet	*Glossopsitta concinna*						O	
Psittacidae	Red-rumped Parrot	*Psephotus haematonotus*				O		O	O
Psittacidae	Red-winged Parrot	*Aprosmictus erythropterus*				O	O		
Psittacidae	Turquoise Parrot	*Neophema pulchella*	V			O	O		
Strigidae	Barking Owl	*Ninox connivens*	V			O		O	

Strigidae	Southern Boobook	*Ninox novaeseelandiae*				O	O		
Threskiornithidae	Royal Spoonbill	*Platalea regia*						O	O
Threskiornithidae	Straw-necked Ibis	*Threskiornis spinicollis*						O	O
Threskiornithidae	Yellow-billed Spoonbill	*Platalea flavipes*						O	O
Turnicidae	Painted Button-quail	*Turnix varia*				O	O		
Turnicidae	Red-chested Button-quail	*Turnix pyrrhothorax*				O			
Tytonidae	Barn Owl	*Tyto alba*			O		O	O	
Tytonidae	Masked Owl	*Tyto novaehollandiae*	V					O	
Zosteropidae	Silvereye	*Zosterops lateralis*							
Introduced Birds									
Sturnidae	Common Starling	*Sturnus vulgaris*	U					O	
Native Mammals									
Dasyuridae	Common Dunnart	*Sminthopsis murina*				O			
Dasyuridae	Yellow-footed Antechinus	*Antechinus flavipes*				T	T	T	
Emballonuridae	Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V		W	W	W	W	
Macropodidae	Common Wallaroo/Euro	*Macropus robustus*			O	O	O		
Macropodidae	Eastern Grey Kangaroo	*Macropus giganteus*			O	O	O	O	
Macropodidae	Swamp Wallaby	*Wallabia bicolor*			O	O	O	O	
Molossidae	Inland Freetail Bat	*Mormopterus sp 3 (little penis)*						T	
Molossidae	Southern freetail Bat	*Mormopterus sp 4. (big penis)*						T	
Molossidae	White-striped freetail bat	*Austronomus australis*			W	W	W	W	
Petauridae	Sugar Glider	*Petaurus breviceps*			W/ T	T			
Phalangeridae	Common Brushtail Possum	*Trichosurus vulpecula*			O	T	T		
Phascolarctidae	Koala	*Phascolarctos cinereus*	V		K	O			
Tachyglossidae	Short-beaked Echidna	*Tachyglossus aculeatus*			O				O

Vespertilionidae	Chocolate Wattled Bat	*Chalinolobus morio*				T	T	T	
Vespertilionidae	Eastern Bent-wing Bat	*Miniopterus schreibersii*	V		W				
Vespertilionidae	Eastern Cave Bat	*Vespadelus troughtoni*	V				T	T	
Vespertilionidae	Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V		W				
Vespertilionidae	Gould's Long-eared Bat	*Nyctophilus gouldi*				T	T	T	
Vespertilionidae	Gould's Wattled Bat	*Chalinolobus gouldii*				T	T	T	
Vespertilionidae	Inland Broad-nosed Bat	*Scotorepens balstoni*				T	T	T	
Vespertilionidae	Lesser Long-eared Bat	*Nyctophilus geoffroyi*				T	T	T	
Vespertilionidae	Little Broad-nosed Bat	*Scotorepens greyii*				T	T	T	
Vespertilionidae	Little Forest Bat	*Vespadelus vulturnus*				T	T	T	
Vespertilionidae	Little Pied Bat	*Chalinolobus picatus*	V						
Vespertilionidae	Southern Forest Bat	*Vespadelus regulus*					T		
Introduced Mammals									
Canidae	Fox	*Vulpes vulpes*	U		O	O	O	O	O
Leporidae	Brown Hare	*Lepus capensis*	U		O	O	O		O
Leporidae	Rabbit	*Oryctolagus cuniculus*	U		O	O	O		O
Muridae	Black Rat	*Rattus rattus*	U					T	
Muridae	House Mouse	*Mus musculus*	U			T	T	T	
Suidae	Pig (feral)	*Sus scrofa*	U			O	O		

Note:

1: U = Unprotected, V = Vulnerable, E = Endangered, † = Preliminary listing (*Threatened Species Conservation Act 1995*).

2: V = Vulnerable, E = Endangered, M = Migratory (*Environment Protection and Biodiversity Conservation Act 1999*).

3: O = Observed, W = Heard Call (includes Anabat detection), T= Trapped/ Handheld, K= Dead

Appendix C

Threatened species of plant in the locality

Scientific Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat[4]	Flowering Time	Notes	Likelihood of Occurrence[5]	Significance Assessment Required
Cadellia pentastylis	Ooline	V	V	3Ra	Occurs west from near Tenterfield and north from Terry Hie Hie (Royal Botanic Gardens 2005). Grows mainly in vine thickets or dry rainforest, and more rarely occurs in woodlands. It is a relict rainforest species and tends to favour upper and mid slope positions, often with a northerly aspect. It commonly occurs on sandy-loam to clay soils of low to medium fertility. It can occur in pure stands or in a mixed community on the slopes of residual sandstone ranges and scarps (Department Environment and Conservation 2005).	chiefly Spring.		**Low**. There is marginal preferred habitat for this species available within the study area.	**No**
Cyperus conicus	-	E	-	-	Occurs rarely in the Pilliga area of NSW and is also found in Victoria, Qld, the NT and WA. It grows in open woodland on sandy soil. In central Australia, the species grows near waterholes and on the banks of streams in sandy soils. In Qld the species usually found on heavy soils. Recorded from Callitris forest in the Pilliga area, growing in sandy soil with *Cyperus gracilis, C. squarrosus* and *C. fulvus*. Often associated with other sedge species including *C. victoriensis*, *C. difformis*, *C. iria, C. compressus, C. nervulosus, C. dactylotes, Fimbristylis* and *Eleocharis* species. *Cyperus conicus* has been recorded as very rare and occasional, to common and abundant in populations. Interstate habitats include floodplains, creek beds and banks, swamps, run-on areas and various watercourses, near or in dams and bores, and in vegetation communities such as Melaleuca swamps, open Box woodland and sedgelands. Soils are usually sandy or silty and damp to wet (Department of Environment and Conservation 2005a).			**Low.** There is low to moderate habitat for this species within the riparian habitats and dam areas in the study area. This species was not recorded on site despite careful checking with other *Cyperus* sp.	**No**
Digitaria porrecta[7]	Finger Panic Grass	E1	E	3E	In NSW it occurs in north western slopes and north western plains subdivisions (Royal Botanic Gardens 2004) where it grows in native grassland, woodlands or open forest with a grassy	Summer		**High**. Potentially recorded within study area.	**Yes**

Scientific Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat[4]	Flowering Time	Notes	Likelihood of Occurrence[5]	Significance Assessment Required
					understorey, on richer soils. It is often found along roadsides and travelling stock routes where there is light grazing and occasional fire.			There is marginal preferred habitat for this species available within the study area.	
Diuris tricolor (Syn Diuris sheaffiana) [6]	Donkey Orchid	V	V	3K	Grows in sclerophyll forest among grass, often with Callitris (Royal Botanic Gardens 2005), or in grassy Callitris woodland It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Soils include gritty orange-brown loam on granite, shallow red loamy sand on stony porphyry, skeletal lateritic soil and alluvial grey silty loam. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats(Department of Environment and Conservation 2005b). Within the Upper Hunter it is known to occur in *Eucalyptus albens/Eucalyptus crebra/Eucalyptus blakelyi/Corymbia maculata* woodland complexes and grasslands (Parsons Brinckerhoff 2004).	Sept-Nov	Endangered population in the Muswellbrook Local Government Area.	**Moderate**. There is preferred habitat for this species available within the study area. However this species was not recorded despite targeted surveys during the flowering period.	**Yes**
Homopholis belsonii			V	3R	Occurs north from the Warialda district. It grows in dry woodland on poor soils such as Belah woodlands. (Royal Botanic Gardens 2005); (Department of Environment and Conservation 2006)			**Low**. There is no preferred habitat for this species available within the study area.	**No**
Philotheca ericifolia		V	V	3R	Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies, in the upper Hunter Valley and Pilliga to Peak Hill district (Royal Botanic Gardens 2004). It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include *Melaleuca uncinata*, *Eucalyptus crebra, E. rossii, E. punctata, Corymbia trachyphloia, Acacia triptera, A. burrowii, Beyeria viscosa, Philotheca australis, Leucopogon muticus* and *Calytrix*	Spring. Fruits Nov-Dec		**Low**. There is low to moderate potential habitat for this species available within the study area. However targeted searches failed to locate any of these species.	**No**

Scientific Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat[4]	Flowering Time	Notes	Likelihood of Occurrence[5]	Significance Assessment Required
					tetragona. Noted as being a moisture-loving plant, with plants common on the sides of a particular spur of the Hervey Ranges where soakage from the high background provides sufficient moisture for the plants (Department of Environment and Conservation 2005b).			The closest record for this species is within the Pilliga to the west of the study area.	
Pomaderris queenslandica	Scant Pomaderris	E1			Widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolatai, and also from several locations on the NSW north coast (Department of Environment and Conservation 2005b). It grows in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks (Department of Environment and Conservation 2005b).	Spring-Summer		**High** This species was recorded within the study area. This species was recorded in the Narrow-leaved Ironbark – White Cypress Pine shrubby open forest. This species was only recorded in the Leard State Forest in the offset areas. It was not recorded within the proposed mining areas.	**Yes**

Scientific Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat[4]	Flowering Time	Notes	Likelihood of Occurrence[5]	Significance Assessment Required
Pterostylis cobarensis	Cobar Rustyhood	V	V	3V	Grows among rocks on low hills and on slopes above streams; chiefly from Nyngan to Bourke district (Royal Botanic Gardens 2005). Western plains of NSW, chiefly in Nyngan - Cobar - Bourke region; favours stony ridges, often growing under *Eucalyptus morrisii* (Grey Mallee) (Bishop 2000). Habitats are eucalypt woodlands, open mallee or Callitris shrublands on low stony ridges and slopes in skeletal sandy-loam soils. It has been recorded from ridge tops as well as steep exposed slopes and sheltered east slopes. Soils include shallow red clay-loam, skeletal red loam on metaquartzite, shallow sandy-loam on conglomerate and sandstone, and skeletal gritty organic loam on microgranite. Associated species include *Eucalyptus morrisii, E. viridis, E. intertexta, E. vicina, Callitris glaucophylla, Geijera parviflora, Casuarina cristata, Acacia doratoxylon, Senna* sp. and *Eremophila* sp.	Sept-Nov		**Low**. There is low to moderate habitat for this species available within the study area. Targeted searches were undertaken during the flowering period for this species. Other *Pterostylis* sp. species were recorded and careful checking for this species was undertaken.	**No**
Pultenaea pedunculata	Matted Bush Pea	E1			Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. If grows on a variety of soils in dry sclerophyll forest and disturbed sites (Harden 2000; NSW National Parks and Wildlife Service 2002; NSW Scientific Committee 1999). It is largely confined to loamy soils in dry gullies in populations in the Windellama area (Department of Environment and Climate Change 2008).			**Low**. There is no preferred habitat for this species available within the study area.	**No**

Scientific Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat[4]	Flowering Time	Notes	Likelihood of Occurrence[5]	Significance Assessment Required
Pultenaea setulosa		-	V	3K	Occurs in central coast, central and northern tablelands and western slopes bioregions west to Gilgandra district. It grows in dry sclerophyll forest (Royal Botanic Gardens 2005).	Spring		**High:** This species was recorded within the project boundary.	**Yes**
Swainsona murrayana	Slender Darling Pea	V	V	3Vi	Often grows with Maireana species on heavy soils, especially in depression (Royal Botanic Gardens 2005). Found throughout NSW, it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. It grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated. The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (Department of Environment and Conservation 2005b).	flower in spring to early summer and then die back	Plants produce winter-spring growth, flower in spring to early summer and then die back after flowering. They re-shoot readily and often carpet the landscape after good cool-season rains. *Swainsona* species contain a poisoning principle, swainsonine, which affects the nervous system and is toxic to stock.	**Low**. There is low to moderate potential habitat for this species available within the study area. However this species was not recorded despite targeted searches within the study area. Furthermore, the closest records are 50km to the west at Narrabri and 60km to the south.	**No**
Thesium australe	Austral Toadflax	V	V	3Vi	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be *Themeda australis* and *Poa* spp. (Department of Environment and Climate Change 2008; Harden 1992).	spring-summer	On the tablelands it occurs with *Eucalyptus pauciflora, E. dalrympleana* or *E. viminalis* (DLWC, 2001).	**Low**. There is low to moderate habitat for this species available within the study area. This species was not recorded despite surveys undertaken during the	**No**

Scientific Name	Common Name	TSC Act[1]	EPBC Act[2]	ROTAP[3]	Habitat[4]	Flowering Time	Notes	Likelihood of Occurrence[5]	Significance Assessment Required
								flowering period for this species.	

Notes:

1: TSC Act - *Threatened Species and Conservation Act 1995*. CE = Critically Endangered, E1 = Endangered V = Vulnerable E2= Endangered Population, P = Protected (NPWS Act)

2. EPBC Act - *Environmental Protection and Biodiversity Conservation Act 1999*. CE = Critically Endangered, E = Endangered V = Vulnerable

3. ROTAP (Rare or Threatened Australian Plants (Briggs & Leigh 1996) is a conservation rating for Australian plants. Codes are:

1	Species only known from one collection
2	Species with a geographic range of less than 100 km in Australia
3	Species with a geographic range of more than 100 km in Australia
X	Species presumed extinct; no new collections for at least 50 years
E	Endangered species at risk of disappearing from the wild state if present land use and other causal factors continue to operate
V	Vulnerable species at risk of long-term disappearance through continued depletion.
R	Rare, but not currently considered to be endangered.
K	Poorly known species that are suspected to be threatened
C	Known to be represented within a conserved area
a	At least 1,000 plants are known to occur within a conservation reserve(s).
i	Less than 1,000 plants are known to occur within a conservation reserve(s).

4. Based on database searches and field surveys

5. Likelihood of Occurrence – species subject to the likelihood of occurrence assessments were those identified during the desktop and field-based investigations and / or the professional opinion of contributors to this assessment

6. *Diuris tricolor* currently undergoing a status review to de-list this species under the *Environmental Protection and Biodiversity Act 1999*

7. *Digitaria porrecta* is currently undergoing a status review to downgrade listing from endangered to vulnerable under the *Environmental Protection and Biodiversity Act 1999*

Bishop, T 2000, *Field guide to the orchids of New South Wales and Victoria*, Second edn, University of New South Wales Press Pty. Ltd., Sydney.

Briggs, JD & Leigh, JH 1996, *Rare or Threatened Australian Plants*, CSIRO, Canberra.

Department Environment and Conservation 2005, *Ooline Cadellia pentastylis Species profile*, viewed 18 November 2009 <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10118>.

Department of Environment and Climate Change 2008, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2008, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Department of Environment and Conservation 2005a, *Threatened Species Information Profile: Cyperus conicus*, viewed 15 December 2009 <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10198>.

Department of Environment and Conservation 2005b, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2006, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Department of Environment and Conservation 2006, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Harden, G 1992, *Flora of New South Wales Volume 3*, University of New South Wales Press Ltd., Kensington.

Harden, G 2000, *Flora of New South Wales Volume 1 (Revised Edition)*, University of New South Wales Press Ltd., Kensington.

NSW National Parks and Wildlife Service 2002, *Pultenaea pedunculata threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1999, *Final determination to list Pultenaea pedunculata as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

Parsons Brinckerhoff 2004, *Woodland Ridge Estate Diuris tricolor Significance Assessment*, Parsons Brinckerhoff, Rhodes.

Royal Botanic Gardens 2004, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Royal Botanic Gardens 2005, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Appendix D

Threatened species of animal in the locality

Scientific Name	Common Name	TSC/ FM Act[1]	EPBC Act[2]	Recorded in Locality[3]	Preferred Habitat[4]	Likelihood of Occurrence[5]	Significance Assessment Required
Amphibians							
Crinia sloanei	Sloane's Toadlet	V		No	Sloane's Froglet is a small (25mm), cryptic ground-dwelling frog which is found in woodland, grassland and open or disturbed areas, usually associated with inundated areas (Robinson 1998). In appearance this species superficially resembles other frogs of the genus Crinia, but it can be readily identified by its call and specific physical characteristics. It can usually only be found after rain events when it calls from grasses within and fringing temporarily inundated areas (Cogger 2000). Sloane's Froglet has been recorded from widely scattered sites in the floodplains of the Murray-Darling Basin, with the majority of records in the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions in New South Wales. Since 1958 Sloane's Froglet has been recorded only 45 times in NSW. The low number of sites, low number of recorded individuals per site, and the low proportion of records of this species in regional surveys all indicate that a moderately low number of mature individuals exist. The apparent loss from previous recorded sites and decline of recording rates indicates at least a moderate reduction in population size of the species. Threats to survival of the species include infection from Chytrid fungus, habitat clearing, overgrazing and changes in flooding regimes, predation and climate change (Department of Environment and Climate Change 2008)	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*

Litoria booroolongensis	Booroolong Frog	E1	E	No	Confined to mountain streams of the Great Dividing Range (Cogger 2000). Usually found on or under boulders and debris in and beside the rocky beds of mountain streams; breeds in summer (Anstis 2002).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Fish							
Ambassis agassizii	Olive Perchlet	E2		No	Inhabits rivers, creeks, ponds and swamps in both eastern (coastal) and western (Murray-Darling) drainage lines. This species is usually found in slow flowing or still water, often in proximity to overhanging vegetation, snags and boulders during the day. At night they disperse to feed on micro-crustaceans and insects (NSW Department of Primary Industries 2009).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Bidyanus bidyanus	Silver Perch	V		Yes. Two records	Schools in large numbers sometimes seen near the surface. In summer, often congregates below rapids and weirs. Prefers warmer sluggish waters with debris cover. Once very common throughout the warmer waters of the Murray-Darling, silver perch river numbers have dropped alarmingly in recent years.	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Maccullochella peelii peelii	Murray Cod		V		The Murray Cod occurs in lower reaches of the Murray-Darling Basin, where the water temperature is warm. The diverse range of habitats frequented by the Murray Cod includes slow moving rivers, murky billabongs and clear, rocky rivers (Department of the Environment and Water Resources, 2007).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Mogurnda adspersa	Purple Spotted Gudgeon	E1		No	A Murray-Darling fish, now reduced to a patchy distribution in Northern New South Wales and Southern Queensland. Slow flowing waters among weed where suitable hard objects are available for spawning. Primarily a bottom dweller, rarely swims continuously. Longer distances accomplished by a series of jerky darts. Migrate from deeper water and spend winter in sheltered situations. An ambush predator, lying motionless on bottom until suitable prey approaches.	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Tandanus tandanus	Eel-tailed Catfish	E2		No	Occupies a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons. It inhabits flowing streams but preferes slow and still waters and can be found in clear or turbid water over substrates including mud, gravel and rock (NSW Department of Primary Industries 2009).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Aquatic Invertebrates							
Notopala sublineata	River Snail	E		No	River snails are endemic to the Murray-Darling Basin and were once common and widely distributed. Although now virtually extinct throughout its natural range, they are restricted to a few populations near Mildura. River Snails were found along river banks attached to logs and rocks or crawling in the mud (NSW Department of Primary Industries 2007).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Native Birds							
Anseranas semipalmata	Magpie Goose	V		No	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry season this species migrates hundreds of kilometres to perennial swamps (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002a).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Apus pacificus	Fork-tailed Swift		M		Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks (Higgins 1999).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. Please see Section 4.1.3.
Ardea alba	Great Egret		M		Great Egrets occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in groups. In Australia, the breeding season of the Great Egret is normally October to December in the south and March to May in the north. This species breeds in colonies, and often in association with cormorants, ibises and other egrets. (Australian Museum 2003).	**Moderate**. Suitable habitats are available for this species.	**No**. Please see Section 4.1.3.
Ardea ibis	Cattle Egret		M		Subsepecies A. i. coromanda is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan 2005).	**Moderate**. Suitable habitats are available for this species.	**No**. Please see Section 4.1.3.

Ardeotis australis	Australian Bustard	E1		No	The ground-dwelling bird mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams. Breeds on bare ground on low sandy ridges or stony rises in ecotones between grassland and protective shrubland cover; roosts on ground among shrubs and long grasses or under trees. Forages on insects, young birds, lizards, mice, leaves, seeds and fruit. Dispersive, with irregular widespread movements over long distances; movements are thought to be in response to habitat and climatic conditions (Marchant & Higgins 1993).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Artamus superciliosus	White-browed Woodswallow	V[†]			The White-browed Woodswallow occurs in eastern, northern and central Australia. In NSW it typically breeds in open forests and woodlands from the inland slopes to the far western plains but during dry years its distribution extends east to open habitats of the tablelands and coast (NSW Scientific Committee 2009).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Burhinus grallarius	Bush Stone-curlew	E1		No	Require sparsely grassed, lightly timbered, open forest of woodland. In southern Australia they often occur where there is a well structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots (NSW National Parks and Wildlife Service 1999a, 2003b).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Calyptorhynchus lathami	Glossy Black-Cockatoo	V		No	Occurs in eucalypt woodland and forest with Casuarina/ Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 1999b).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Certhionyx variegatus	Pied Honeyeater	V		Yes. One record	Inhabits wattle shrub (primarily Mulga, *Acacia aneura*), mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (Eremophila spp.); also from mistletoes and various other shrubs (e.g. Brachysema spp. and Grevillea spp.); also eats saltbush fruit, berries, seed, flowers and insects. Highly nomadic, following the erratic flowering of shrubs; can be locally common at times. Constructs a relatively large cup-shaped nest, constructed of grasses and fine twigs, in the fork of a shrub or tree (Higgins and Marchant 2001).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Circus assimilis	Spotted Harrier	V			The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast and ranges. Individuals disperse widely in NSW and occur in grassy open woodland including acacia and mallee remnants, inland riparian woodland and grassland. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (NSW Scientifc Committee 2010).	**High**. This species was recorded during field surveys	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*

Climacteris picumnus	Brown Treecreeper	V		Yes. Forty-three records	Occurs in eucalypt woodland and adjoining vegetation. Feeds on ants, beetles and larvae on trees and from fallen timber and leaf litter. Usually nests in hollows (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Daphoenositta chrysoptera	Varied Sittella	V			The Varied Sittella is sedentary and inhabits most of mainland Australia with a nearly continuous distribution in NSW from the coast to the far west. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches and twigs in the tree canopy (NSW Scientific Committee 2010).	**High**. This species was recorded during field surveys	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Ephippiorhynchus asiaticus	Black-necked Stork	E1		Yes. Two records	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Falco hypoleucos	Grey Falcon	V		No	Generally centred on inland drainage systems where the average rainfall is less than 500 millimetres. It is found in timbered lowland plains that are crossed by tree-lined water courses. Nests in the old nests of other birds, particularly raptors (Garnett & Crowley 2000).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Gallinago hardwickii	Latham's Snipe		M		Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett & Crowley 2000).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. Please see Section 4.1.3.
Glossopsitta pusilla	Little Lorikeet	V			Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins 1999).	**High**. This species was recorded during field surveys	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Grantiella picta	Painted Honeyeater	V		No	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus Amyema, though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks (Garnett & Crowley 2000).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Grus rubicunda	Brolga	V		No	Occurs in well vegetated shallow freshwater wetlands, small isolated swamps in eucalypt forests, floodplains, grasslands, paddocks, ploughed fields, irrigated pastures, stubbles, crops, desert claypans, bore drains, tidal areas, mangroves, beach wastes. Roosts in shallow, bare swamps and nests on small islands in wetland or standing in shallow water, eggs are occasionally laid on bare ground (Pizzey & Knight 2007).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Haliaeetus leucogaster	White-bellied Sea-Eagle		M		Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. Please see Section 4.1.3.
Hamirostra melanosternon	Black-breasted Buzzard	V		No	Distributed throughout most of inland Australia and prefers arid scubland, and open woodlands. Feeds on small mammals and birds (Garnett & Crowley 2000).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Hieraaetus morphnoides	Little Eagle	V			The Little Eagle is distributed throughout the Australian mainland except in the most densely forested parts of the Dividing Range. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch. It feeds on birds, reptiles and mammals (NSW Scientific Commitee 2010).	**High**. This species was recorded during field surveys	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Hirundapus caudacutus	White-throated Needletail		M		Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 2007).	**High**. This species was recorded during field surveys.	**No**. Please see Section 4.1.3.

Lathamus discolor	Swift Parrot	E1	E	No	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants. Sites used vary from year to year. (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*
Leipoa ocellata	Malleefowl	E1	VM	No	Ground-dwelling bird found in mallee woodland and other dry scrub in the semi-arid zone of inland Australia. Restricted to semi-arid rangelands and small habitat remnants in the dryland cropping zone of the southwest and centre of NSW. Prefers well drained, light sandy or loamy soils. Habitat usually contains dense but discontinuous canopy which provides abundant leaf litter and dense, varied shrub and herb layers containing food plants, particularly acacia, cassia, bassiaea, beyeria and some open ground for ease of movement (NSW National Parks and Wildlife Service 1999d).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Lophoictinia isura	Square-tailed Kite	V		No	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes (Garnett & Crowley 2000).	**High**. This species has previously been recorded in Leard State Forest.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979*.
Melanodryas cucullata	Hooded Robin	V		Yes. Three records	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia (Garnett & Crowley 2000; Traill & Duncan 2000).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Melithreptus gularis gularis	Black-chinned Honeyeater	V		Yes. One record	Found in dry eucalypt woodland particularly those containing ironbark and box. Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Merops ornatus	Rainbow Bee-eater		M		Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins 1999).	**High**. This species was recorded during field surveys.	**No**. Please see Section 4.1.3.

Myiagra cyanoleuca	Satin Flycatcher		M		Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 2007).	**High**. This species was recorded during field surveys.	**No**. Please see Section 4.1.3.
Neophema pulchella	Turquoise Parrot	V		Yes. Forty-seven records	Occurs in the foothills of the great dividing range in eucalypt woodlands and forests with a grassy or sparsely shrubby understorey. Nests in hollows in trees, stumps or even fence posts. It feeds on seeds of both native and introduced grass and herb species (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Ninox connivens	Barking Owl	V		Yes. Two records	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Polytelis swainsonii	Superb Parrot	V	V	No	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the inland slopes, Superb Parrots both forage and feed within box woodland, mostly nesting in dead trees (Garnett & Crowley 2000).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*

Pomatostomus temporalis	Grey-crowned Babbler	V		Yes. Seven records	Found throughout western slopes and plains, southern and central tablelands and occurring in Northern Rivers area, mid-north coast and the Hunter Valley of NSW. Lives in open forest and woodland, acacia shrubland and adjoining farmland. Large stick dome nest with spout-like entrance (Pizzey & Knight 2007).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Pyrrholaemus sagittatus	Speckled Warbler	V		Yes. Twenty-eight records	Occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and insects and builds domed nests on the ground (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Rostratula benghalensis	Painted Snipe	E1	VM	No	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as *Eucalyptus camaldulensis* (River Red Gum), *E. populnea* (Poplar Box) or shrubs such as *Muehlenbeckia florulenta* (Lignum) or *Sarcocornia quinqueflora* (Samphire). Feeds at the water's edge and on mudlflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Stagonopleura guttata	Diamond Firetail	V		Yes. Six records	Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Feed on seeds, mostly of grasses (Garnett & Crowley 2000).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Stictonetta naevosa	Freckled Duck	V		No	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (*Muehlenbeckia cunninghamii*) within which they build their nests (Garnett & Crowley 2000).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Tyto novaehollandiae	Masked Owl	V		Yes. Three records	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett & Crowley 2000).	**High**. This species has previously been recorded in Leard State Forest.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*

Xanthomyza phrygia	Regent Honeyeater	E1	EM	No	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box) , *E. melliodora* (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett & Crowley 2000).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*
Native Mammals							
Aepyprymnus rufescens	Rufous Bettong	V		No	Distribution: From Cooktown in north Queensland, to north-east NSW, where it occurs east of the Dividing Range. In Queensland, it still occurs on both sides of the Great Divide. Macrohabitat: Found in a variety of forest types from wet sclerophyll to dry open woodland, where grass tussocks or fallen timber are present. Also known to occupy a mosaic of open forest and grasslands. Microhabitat: It appears to prefer a more open forest structure, with an sparse shrub layer and a diverse ground cover. Builds nests in grass tussocks and under logs. Strongly associated with dry sclerophyll forest particularly those dominated by Spotted Gum (NSW National Parks and Wildlife Service 1999g).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Cercartetus nanus	Eastern Pygmy-possum	V		No	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds nests and shredded bark in the fork of trees (Turner & Ward 1995).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Yes. Five records	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects (Churchill 2008).	**Moderate**. Suitable foraging habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*
Chalinolobus picatus	Little Pied Bat	V		Yes. One record	The species roosts in trees, caves, and abandoned mines and houses. Roost sites in caves are usually warm and dry but they can tolerate roost temperatures of more than 40 degrees celsius. The Little Pied Bat has been recorded in dry open forest, open woodland, Mulga woodlands, chenopod shrublands, Callitris forest and mallee (Churchill 2008).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*

Dasyurus maculatus	Spotted-tailed Quoll	V	E	Yes. One record	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999g). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999e, 1999g).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		No	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high (Churchill 2008).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Macropus dorsalis	Black-striped Wallaby	E1		No	The preferred habitats for the species is forested country with a dense shrub layer including rainforest margins; brigalow scrub, particularly in a phase of regrowth; open forest with a thick acacia or other shrub understorey; and lantana thickets (Strahan 1995).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Micronomus norfolkensis	East Coast Freetail-bat	V		Yes. One record	Thought to live in sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge (Churchill 2008).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Miniopterus schreibersii	Eastern Bent-wing Bat	V		No	Usually found in well timbered valleys where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Nyctophilus timoriensis	Greater Long-eared Bat (South-eastern form)	V	V	Yes. Twenty-two records	Roosts in tree hollows and under loose bark in arid and semi-arid Australia (Strahan 1995) and forages in the understorey of woodlands and open savanna and swamps (Churchill 1998).	**High**. This species has previously been recorded in Leard State Forest.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*

Petaurus norfolcensis	Squirrel Glider	V		No	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999f).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Petrogale penicillata	Brush-tailed Rock-wallaby	E1	V	Yes. One record	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003a).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Phascolarctos cinereus	Koala	V		Yes. Twenty records	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum *Eucalyptus tereticornis*, Grey Gum *E. punctata*, Monkey Gum *E. cypellocarpa* and Ribbon Gum *E. viminalis*. In coastal areas, Tallowwood *E. microcorys* and Swamp Mahogany *E. robusta* are important food species, while in inland areas White Box *E. albens*, Bimble Box *E. populnea* and River Red Gum *E. camaldulensis* are favoured (NSW National Parks and Wildlife Service 1999c, 2003c).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*

Pseudomys pilligaensis	Pilliga Mouse	V	V	No	Restricted to unique habitat known as Pilliga scrub, which occurs on deep, low nutrient sand in the Pilliga region of NSW (south of Narrabri). Specifically, Pilliga mouse has been found in areas dominated by broombush, or with *Acacia burrowii* shrub layer and *Corymbia trachyphloia* overstory. Both of these habitats had relatively high species richness with moist groundcover and medium to high shrub cover. An additional habitat for the Pilliga Mouse is recently burnt moist gullies with high cover of low grasses and sedges, yet low cover of shrubs (Department of Environment and Climate Change 2007).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V		Yes. Fourteen records	Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts in tree hollows. Thought to be a migratory species(Churchill 2008).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Sminthopsis macroura	Stripe-faced Dunnart	V		No	The species are found in many habitats in the arid and semi-arid parts of Australia; they occur in low shrublands of saltbush and bluebush, in tussock grasslands on clay, sandy or stony soils, among sparse shrublands and on low, shrubby, rocky ridges. Dense populations occur in tussock grasslands. The species shelters in cracks in the soil or under rocks and logs, probably in nests (Strahan 1995).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Vespadelus troughtoni	Eastern Cave Bat	V		No	A cave-dwelling species found in eastern Australia from Cape York to NSW. They inhabit tropical mixed woodland and wet sclerophyll forests on the coast and the dividing range, but extend into drier forests on the western slopes (Churchill 2008).	**High**. This species was recorded during field surveys.	**Yes**. Known habitat exists within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979.*
Reptiles							
Elseya belli	Bell's Turtle	V	V	No	Found in upper reaches of rivers overlying granite, on the western slopes of the Northern NSW Tablelands, specifically in the Namoi, Gwydir and MacDonald Rivers and major tributaries. Often occurs in shallow or deep pools or in narrow (30 - 40 m wide) river stretches along grazing land (Department of Environment and Climate Change 2007).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.
Hoplocephalus bitorquatus	Pale-headed Snake	V		No	A partly arboreal, nocturnal species found in a range of habitats from rainforest and wet sclerophyll forest to the drier eucalypt forests of the western slopes. Feeds largely on frogs and lizards (Cogger 2000).	**Low**. There is no preferred habitat available for this species in the study area.	**No**. No preferred habitat is available within the study area. Therefore, this species is unlikely to be affected by the Proposal.

Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	V	V	Yes. One record	Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. It is found on rocky hills with dry open eucalypt forest or woodland. It favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter (Department of Environment and Conservation 2005; NSW National Parks and Wildlife Service 2002b; Royal Botanic Gardens 2005).	**Moderate**. Suitable habitats are available for this species.	**Yes**. Potential habitat was identified within the study area. Therefore, this species has been assessed under the *Environmental Planning and Assessment Act 1979* and *Environment Protection and Biodiversity Act 1999.*

Note:

1: V = Vulnerable, E1 = Endangered, E2 = Endangered Population, † = preliminary listed species (*Threatened Species Conservation Act 1995 or Fisheries Management Act 1994*).

2: V = Vulnerable, E = Endangered, M = Migratory (*Environment Protection and Biodiversity Conservation Act 1999*).

3: Previously recorded refers to records of Threatened species that were identified within the locality (20 kilometres) from the Atlas of NSW Wildlife (Department of Environment and Climate Change 2007)

4: Based on database searches and field surveys.

5: Likelihood of occurrence (refer Section 2.8).

References

Anstis, M 2002, *Tadpoles of South-eastern Australia: a Guide with Keys*, vol. 1, 1 vols., New Holland Publishers, Sydney.

Australian Museum 2003, *Great Egret factsheet*, Australian Museum,

Churchill, S 2008, *Australian Bats*, 2nd edn, Allen & Unwin, Sydney.

Cogger, HG 2000, *Reptiles and Amphibians of Australia*, Reed Books, Sydney.

Department of Environment and Climate Change 2007, *Atlas of NSW Wildlife*, Department of Environment and Conservation,

Department of Environment and Climate Change 2008, *Threatened Species Profile: Sloane's Froglet, Crinia sloanei*, Department of Environment and Climate Change, viewed 16th June 2008 <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=20088>.

Department of Environment and Conservation 2005, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2006, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>.

Garnett, ST & Crowley, GM 2000, *The Action Plan for Australian Birds*, Environment Australia, Canberra.

Higgins, PJ (ed.) 1999, *Handbook of Australian, New Zealand and Antarctic Birds Volume 4: Parrots to Dollarbirds*, Volume 4: Parrots to Dollarbird, Oxford University Press, Melbourne.

Marchant, S & Higgins, PJ (eds) 1993, *Handbook of Australian, New Zealand and Antarctic Birds Volume 2: Raptors to Lapwings*, vol. 2, Volume 2: Raptors to Lapwings, Oxford University Press, Melbourne.

McKilligan, N 2005, *Herons, egrets and bitterns: their biology and conservation in Australia*, CSIRO Publishing, Collingwood, Victoria.

NSW Department of Primary Industries 2007, *Recovery plan for the endangered river snail (Notopala sublineata)*, NSW Department of Primary Industries, <http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0020/184241/Recovery-plan-for-the-endangered-river-snail-Notopala-sublineata---June-2007.pdf>.

NSW National Parks and Wildlife Service 1999a, *Bush Stone-curlew threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999b, *Glossy Black-cockatoo threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999c, *Koala threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999d, *Malleefowl Threatened Species Information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999e, *Spotted-tailed Quoll threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999f, *Squirrel Glider threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999g, *Terms of licence under the Threatened Species Conservation Act 1995. Appendix B of the Integrated Forestry Operations Approval for the Upper North East Region.*,

NSW National Parks and Wildlife Service 2002a, *Threatened Species of the Upper North Coast of New South Wales - Fauna*, NSW National Parks and Wildlife Service, Northern Directorate, Coffs Harbour.

NSW National Parks and Wildlife Service 2002b, *Threatened species of the upper north coast of New South Wales - Flora*, NSW National Parks and Wildlife Service, Northern Directorate, Coffs Harbour.

NSW National Parks and Wildlife Service 2003a, *Brush-tailed Rock Wallaby Warrumbungles endangered population threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003b, *Draft Recovery Plan for the Bush Stone-curlew Burhinus grallarius*, National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003c, *Draft Recovery Plan for the Koala*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2010, *Spotted Harrier (Circus assimilis) Vulnerable species listing*, Department of Environment, Climate Change and Water, Hurstville, NSW.

NSW Scientific Committee 2010, *Little Eagle (Hieraaetus morphnoides) Vulnerable species listing*, Department of Environment, Climate Change and Water, Hurstville, NSW.

NSW Scientific Committee 2009, *White-browed Woodswallow (Artamus superciliosus) - proposed vulnerable species listing*, Department of Environment, Climate Change and Water, Hurstville, NSW.

NSW Scientific Committee 2010, *Varied Sittella (Daphoenositta chrysoptera) Vulnerable species listing*, Department of Environment, Climate Change and Water, Hurstville, NSW.

Pizzey, G & Knight, F 2007, *Field Guide to the Birds of Australia*, Harper and Collins, Sydney.

Robinson, M 1998, *A field guide to frogs of Australia*, Second edition edn, Reed New Holland, Sydney.

Royal Botanic Gardens 2005, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Strahan, R 1995, *The Mammals of Australia*, Reed New Holland, Sydney.

Swift Parrot Recovery Team 2001, *Swift Parrot Recovery Plan*, Department of Primary Industries, Water and Environment, Hobart.

Traill, BJ & Duncan, S 2000, *Status of birds in the New South Wales temperate woodlands region*, Consultancy report to the NSW National Parks and Wildlife Service by the Australian Woodlands Conservancy, Chiltern, Victoria.

Turner, V & Ward, SJ 1995, 'Eastern Pygmy-possum', in R Strahan (ed.), *The Mammals of Australia*, Reed New Holland, Sydney, pp. 217-8.