Appendix J2

Biodiversity assessment report

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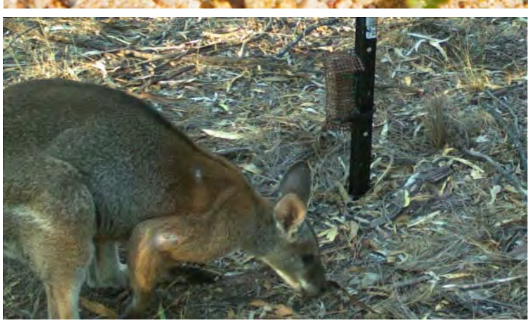
Narrabri Gas Project

Biodiversity Assessment Report

Prepared for
Santos NSW (Eastern) Pty Ltd

November 2016

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Abbreviations

Abbreviation	Description
BAR	Biodiversity Assessment Report
BBS	Brigalow Belt South
BNCCA Act	NSW *Brigalow and Nandewar Community Conservation Area Act 2005*
BOS	Biodiversity Offset Strategy
BSAL	Biophysical strategic agricultural land
BVT	Biometric vegetation type
CCA	Community Conservation Area
CEEC	Critically endangered ecological community
CHM	Canopy height model
CMA	Catchment management authority
DEC	NSW Department of Conservation (now NSW Office of Environment and Heritage)
DECC	NSW Department of Environment and Climate Change (now NSW Office of Environment and Heritage)
DECCW	NSW Department of Climate Change and Water (now NSW Office of Environment and Heritage)
DEWHA	Australian Department of the Environment, Water, Heritage and the Arts (now Department of the Environment)
DMR	NSW Department of Mineral Resources (now NSW Trade and Investment)
DNG	Derived native grassland
EEC	Endangered ecological community
EIS	Environmental Impact Statement
ELA	Eco Logical Australia
EMP	Environmental Management Plan
EOI	Expression of Interest
EPA Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESA	Ecological sensitivity analysis
FBA	Framework for Biodiversity Assessment
GIS	Geographic Information System
IBRA	Interim Biogeographic Regionalisation for Australia
IECA	International Erosion Control Association

Abbreviation	Description
LGA	Local Government Area
LiDAR	Light Detection and Ranging
LPI	Land and Property Information
MNES	Matters of national environmental significance
MPCC	Major Projects Credit Calculator
NPW Act	NSW *National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Service
OEH	NSW Office of Environment and Heritage
PA	Planning Agreement
PAL	Petroleum Assessment Lease
PCT	Plant Community Type
PEL	Petroleum Exploration License
PPL	Petroleum Production Lease
RVC	Regional vegetation community
SAT	Spot assessment technique
SSD	State Significant Development
TSC Act	NSW *Threatened Species Conservation Act 1995*
TWS	Landmark Ecological Services and the Wilderness Society

Executive summary

Eco Logical Australia was engaged by the Proponent to undertake a biodiversity assessment for inclusion in the Environmental Impact Statement for the proposed Narrabri Gas Project (the project). The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales, southwest of Narrabri. This Biodiversity Assessment Report has been prepared in accordance with the NSW Biodiversity Offset Policy for Major Projects and the Framework for Biodiversity Assessment and supports the Environmental Impact Statement for the project.

The project seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approvals process and is therefore not part of this proposed development.

The project design is considered a ‘multiple fragmentation impact development’ under the Framework for Biodiversity Assessment as it is a gas extraction development that requires multiple extraction points and a network of associated development. Due to the progressive nature of the project where exploration and appraisal informs development, the entire development footprint cannot be defined spatially. To account for this, the assessment of the project includes the known and modelled development footprint. Consequently, the development site is synonymous with the development footprint buffer area required by the Framework for Biodiversity Assessment.

An extensive review of existing data and information was undertaken to assist in mapping vegetation and habitat and predicting presence of threatened species and populations in the development site. The existing survey effort was undertaken during all seasons and across multiple years, contributing to a more thorough understanding of temporal and spatial variation of species.

Field surveys from 2010 through to 2014 were undertaken across all seasons to identify and investigate a range of biodiversity values in the development footprint including riparian corridors, Plant Community Types, threatened ecological communities, and threatened flora and fauna species and their habitats. The information obtained from the literature and database reviews and field surveys was used to map the distribution of these environmental values and to then analyse and categorise the ecological sensitivity in the development site.

The landscape features of the development site were assessed to account for the value of the development site within the greater landscape. The native vegetation in the development site currently constitutes 80,398 ha of highly connected, extra large patches of continuous vegetation. The development footprint would fragment the existing patches into smaller patches but would not decrease the overall score for percentage of native vegetation cover. One State Significant Biodiversity Link (Bohena Creek) and seven Regionally Significant Biodiversity Links occur within the development site.

The development site supports 22 Plant Community Types, four of which qualify as endangered ecological communities (with two of these endangered ecological communities being further divided by status under the EPBC Act and TSC Act due to condition). These Plant Community Types are categorised into nine broad fauna habitat types. Each habitat type supports specialised habitat components for a range of threatened species.

Offsets are required for direct and indirect impacts on native vegetation including threatened ecological communities and threatened species and their habitats. A total of 56,113 ecosystem credits are required to meet the outcomes of the Framework for Biodiversity Assessment. Using the OEH credit converter which assumes an average Biobank site will generate 9.3 credits per ha, the equivalent offset area is 6,034 ha. This equates to a 6.1:1 offset ratio against a direct impact of 988.8 hectares or a 4.8:1 offset ratio against a combined direct, indirect and cumulative impact of 1,254.7 ha.

Four threatened fauna species and nine threatened flora species recorded in the development site would be directly and indirectly impacted and are listed as 'species credit' species under the Framework for Biodiversity Assessment. Credits for these species have been calculated. Credits required for flora species range from 42 to 144,326 credits. Credits required for fauna species range from 2,712 to 34,994 credits. *Bertya opponens* requires the largest number of flora credits to be offset, while *Hoplocephalus bitorquatus* (Pale-headed Snake) requires the largest number of fauna credits to be offset.

Three threatened species have been identified as requiring further consideration by the consent authority, namely *Anthochaera phrygia* (Regent Honeyeater), *Anomalopus mackayi* (Five-clawed Work-skink) and *Pomaderris queenslandica* (Scant Pomaderris). The potential impact on these species, the local populations and their habitats have been considered following the requirements of Section 9.2.5.2 of the Framework for Biodiversity Assessment.

Measures to avoid, minimise and mitigate direct and indirect impacts are detailed. Priority has been directed at avoiding impact through utilising existing cleared areas and infrastructure. Where impacts cannot be avoided, a detailed field development protocol and ecological scouting framework have been prepared using an ecological sensitivity analysis to ensure that environmental values are prioritised by importance and risk. This will ensure that impacts are focused in areas of lower environmental value. Additionally, a suite of mitigation measures have been assigned to all direct and potential indirect impacts, further minimising the impacts to environmental values in the development site.

A Biodiversity Offset Strategy is proposed to address all residual impacts of the project. It outlines the process to be taken to secure land-based offset sites and proposes a suite of supplementary measures, complementary measures and contributions to the NSW Biodiversity Offsets Fund for Major Projects.

1 Introduction

Eco Logical Australia (ELA) was engaged by the Proponent to undertake a biodiversity assessment for inclusion in the Environmental Impact Statement (EIS) for the proposed Narrabri Gas Project (the project). The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri.

1.1 Purpose

This Biodiversity Assessment Report (BAR) has been prepared as part of the Environmental Impact Statement for the State Significant Development (SSD) application for the project. Impacts to terrestrial biodiversity under a State Significant Development application must be assessed using the NSW Biodiversity Offset Policy for Major Projects and the Framework for Biodiversity Assessment (FBA) (OEH, 2014b). Impacts to environmental values other than terrestrial biodiversity are not covered in the FBA and hence are not addressed in this report.

Prior to the request for an assessment in accordance with the Framework for Biodiversity Assessment, a comprehensive Ecological Impact Assessment was prepared (Appendix J1 of the EIS) for the Environmental Impact Statement for the project. Extensive detail and comprehensive expert reports are supplied in the Ecological Impact Assessment which is to be submitted concurrently with this BAR. Further detail on all aspects presented in this BAR can be obtained by referring to Appendix J1.

This report responds specifically to the Secretary's Environmental Assessment Requirements (SEARs) (dated 27 September 2016) as they relate to biodiversity assessment as described in **Table 1**.

Table 1: Relevant SEARs addressed in this BAR

SEARs and agency advice	Location in report
An assessment of the likely biodiversity impacts of the development, in accordance with the Framework for Biodiversity Assessment (OEH, 2014b), unless otherwise agreed by the NSW Office of Environment and Heritage (OEH), and having regard to OEH's and DPI's requirements (see Attachments 3A and 3B).	Section 7
A strategy to offset any residual impacts of the development in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014), unless otherwise agreed by OEH.	**Section 8** and **Appendix E**
OEH additional request: Impacts on the species / populations / ecological communities listed in Attachment C will require further consideration and provision of the information specified in s9.2 of the Framework for Biodiversity Assessment. Attachment C species requiring further consideration: *Anomalopus mackayi (*Five-clawed Worm-skink), *Anthochaera phrygia (*Regent Honeyeater), and *Pomaderris queenslandica* (Scant Pomaderris) Attachment C critically endangered entities specifically excluded from requiring further consideration: *Lathamus discolor* (Swift Parrot), *Myriophyllum implicatum,* and White Box Yellow Box Blakely's Red Gum Woodland	Section 7.4 and Appendix D

1.2 Structure of report

The report is structured as follows:

- **Chapter 1 – Introduction**. This chapter introduces the project and the Proponent and describes the development site and data sources.
- **Chapter 2 – Policies and legislation**. This chapter outlines the relevant Commonwealth and State legislation relating to the assessment.
- **Chapter 3 – Landscape features**. This chapter describes and assesses the landscape features relevant to terrestrial ecology in accordance with Stage 1, Section 4 of the FBA.
- **Chapter 4 – Native vegetation**. This chapter describes and assesses the native vegetation in the development site including endangered ecological communities (EECs) and vegetation zones in accordance with Stage 1, Section 5 of the FBA.
- **Chapter 5 – Threatened species and populations**. This chapter describes and assesses the terrestrial threatened species in the development site in accordance with Stage 1, Section 6 of the FBA.
- **Chapter 6 – Measures to avoid and minimise impacts**. This chapter describes and correlates the measures to avoid and minimise impacts to the proposed direct and indirect impacts within the development site in accordance with Stage 2, Section 8 of the FBA.
- **Chapter 7 – Assessment and offsetting requirements for unavoidable impacts**. This chapter identifies and assesses where required the impacts on biodiversity that require further consideration or offsetting in accordance with Stage 2, Sections 9 and 10 of the FBA.
- **Chapter 8 – Biodiversity offset strategy**. This chapter outlines the biodiversity offset strategy proposed for the project.

1.3 Project description

1.3.1 Terminology

Development footprint

Due to the progressive nature of the project where exploration and appraisal informs development, the entire development footprint cannot be defined spatially. For major facilities with a known location (such as Leewood, the Bibblewindi Site and worker accommodation at Westport), the development footprint has been defined. For infrastructure without a known location (such as well pads and gathering systems), modelling using a maximum upper limit of impact within the development site has been undertaken to allow flexibility of infrastructure placement whilst enabling calculations of impacts for this BAR. The development footprint would directly impact about one per cent of the development site.

Development site

The development site covers about 950 square kilometres (95,000 hectares). For this assessment, the development site is synonymous with the development footprint buffer area required for **Section 3**.

Study region

The study region is defined as the area within Petroleum Exploration License (PEL) 238 which includes Petroleum Assessment Lease (PAL) 2 and Petroleum Production Lease (PPL) 3 (**Figure 2**). This area is used to discuss the project within the context of the broader north-east Pilliga Forest.

1.3.2 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (the project) (**Figure 1**; **Figure 2**).

The project seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approvals process and is therefore not part of this proposed development.

The primary objective of the project is to commercialise natural gas to be made available to the NSW gas market and to support the energy security needs of NSW. Production of natural gas under the project would deliver economic, environmental and social benefits to the Narrabri region and the broader NSW community. The key benefits of the project can be summarised as follows:

- The Narrabri Gas Project has the capacity to deliver up to 200 terajoules of gas per day which, at the time of EIS submission, represents approximately 50 per cent of NSW's gas demand. The project would therefore provide an important new energy source for NSW, which would contribute to the State's economy through royalties paid, jobs created and infrastructure investment
- The provision of a reduced greenhouse gas emission fuel source for power generation in NSW as compared to traditional power generation.
- The project would create local and regional job opportunities. The investment is forecast to directly create approximately 1,300 jobs during the construction phase and sustain approximately 200 jobs during the operational phase.
- The establishment of a regional community benefit fund of up to $120 million over the next two decades.

1.3.3 Location

The project would be located in north-western NSW, approximately 20 kilometres south-west of Narrabri, within the Narrabri local government area (LGA) (**Figure 2**).

The development site contains a portion of the region known as 'the Pilliga'; which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW *National Parks and Wildlife Act 1974* (NPW Act). The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of 'forestry, recreation and mineral extraction, with a strategic aim to "provide for exploration, mining, petroleum production and extractive industry" under the *Brigalow and Nandewar Community Conservation Area Act 2005* (BNCCA Act). The parts of the development site on state land are located within this section of the Pilliga.

The semi-arid climate of the region and general unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing. Commercial timber harvesting activities in the Pilliga were preceded by unsuccessful attempts to establish a wool production industry. Resource exploration has been occurring in the area since the 1960s; initially for oil, but more recently for coal and gas.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of drought and wildfire.

The development site avoids the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve and Brigalow Park Nature Reserve. Brigalow State Conservation Area is within the development site but would be protected by a 50 metre surface development exclusion zone.

Agriculture is a major land use within the Narrabri LGA; about half of the LGA is used for agriculture, split between cropping and grazing. Although the majority of the development site would be within State Forests, much of the remaining area is situated on agricultural land that supports dry-land cropping and livestock. No agricultural land in the development site is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and detailed soil analysis has established the absence of BSAL. This has been confirmed by the issue of a BSAL Certificate for the development site by the NSW Government.

1.3.4 Description of project

The project would involve the construction and operation of a range of exploration and production activities and infrastructure including the continued use of some existing infrastructure. The key components of the project are presented in **Table 2**.

Table 2: Key project components

Location	Infrastructure or activity
Major facilities	
Leewood	• a central gas processing facility for the compression, dehydration and treatment of gas • a central water management facility including storage and treatment of produced water and brine • optional power generation for the project • a safety flare • treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities • other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage • continued use of existing facilities such as the brine and produced water ponds • operation of the facility
Bibblewindi	• in-field compression facility • a safety flare • supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower • upgrades and expansion to the staff amenities and car parking • produced water, brine and construction water storage, including recommissioning of two existing ponds • continued use of existing facilities such as the 5ML water balance tank

Location	Infrastructure or activity
	• operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	• widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines
Leewood to Wilga Park underground power line	• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	
Gas exploration, appraisal and production infrastructure	• seismic geophysical survey • installation of up to 850 new wells on a maximum of 425 well pads o new well types would include exploration, appraisal and production wells • installation of water and gas gathering lines and supporting infrastructure • construction of new access tracks where required • water balance tanks • communications towers • conversion of existing exploration and appraisal wells to production
Ancillary	• upgrades to intersections on the Newell Highway • expansion of worker accommodation at Westport • a treated water pipeline and diffuser from Leewood to Bohena Creek • treated water irrigation infrastructure including: o pipeline(s) from Leewood to the irrigation area(s) o treated water storage dam(s) offsite from Leewood • operation of the irrigation scheme

The project is expected to generate approximately 1,300 jobs during the construction phase and sustain around 200 jobs during the operational phase; the latter excluding an ongoing drilling workforce comprising approximately 100 jobs.

Subject to obtaining the required regulatory approvals, and a financial investment decision, construction of the project is expected to commence in early 2018, with first gas scheduled for 2019/2020. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2018 and early/mid-2021. The gas wells would be progressively drilled during the first 20 or so years of the project. For the purpose of impact assessment, a 25 year construction and operational period has been adopted.

1.4 Planning framework

The project is permissible with development consent under the State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007, and is identified as ‘State significant development’ under section 89C(2) of the *Environmental Planning and Assessment Act 1979* (EPA Act) and the State Environmental Planning Policy (State and Regional Development) 2011.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the EPA Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

The project is also a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The project was declared to be a controlled action on 5 December 2014, to be assessed under the bilateral agreement between the Commonwealth and NSW Governments, and triggering the following controlling provisions:

- listed threatened species and ecological communities
- a water resource, in relation to coal seam gas development and large coal mining development
- Commonwealth land.

1.5 General description of the development site

1.5.1 The Pilliga

The Pilliga represents the largest block of remnant vegetation in NSW, west of the Great Dividing Range. The Pilliga is comprised primarily of State Forests managed for timber production, as well as conservation reserves and other landholdings. There are 24 State Forests, four National Parks, two Aboriginal Areas, six State Conservation Areas and two Nature Reserves within the study region.

In recognition of the high ecological and landscape value of the Pilliga, over 240,000 ha of conservation reserve have been gazetted under the NPW Act since the 1960s. The Pilliga Nature Reserve (83,000 ha) was first reserved in 1968. 30 years later, regional assessments of the Brigalow and Nandewar Bioregions (NPWS, 2000a, 2000b) culminated in the NSW Government's decision in 2005 to conserve an additional 160,000 ha of the Pilliga under the BNCCA Act. This area focuses on the central, southern and western extents of the Pilliga. Today, approximately half of the Pilliga is now reserved under the NPW Act, with the other half retained as State Forest for commercial timber production, recreation and mineral extraction.

Of the 240,000 ha of conservation reserve, a total of 146,000 ha, including Pilliga Nature Reserve, four Community Conservation Area (CCA) Zone 1 reserves (National Parks) and two CCA Zone 2 reserves (Aboriginal Areas) are precluded from forestry and mineral/petroleum exploration. Three CCA Zone 3 reserves (State Conservation Areas) totalling 94,000 ha, were created for conservation, recreation and mineral extraction.

1.5.2 Land use

Within the NSW section of the Brigalow Belt South (BBS) Bioregion, the majority of land (approximately 85%) is freehold land. Much of the freehold land is used for agricultural purposes, where cropping (dryland and irrigation farming) and grazing/pastoral activities dominate (NPWS, 2000a, 2000b).

Approximately 5% of the NSW sections of the bioregion are used by the forestry industry. The Pilliga forests managed by the Forestry Corporation of NSW is the largest area of forestry in the NSW sections of the bioregion. There are many small forest and flora reserves in addition to these forests.

Crown lands and conservation reserves form approximately 4% of the bioregion in NSW. Other land uses within the bioregion include mining and apiary industries (NPWS, 2000a). The mining industry is primarily coal, as the region lies mostly within the Gunnedah Basin, which is a major coal-bearing sedimentary basin. Current mining titles are held for coal and some industrial minerals while exploration titles are held for coal, petroleum, gold, base metals, zeolites and clay minerals (OEH, 2011).

Land use in the development site was mapped by ELA for this assessment at a 1:10,000 scale (**Figure 3**) and classified into the following categories; cleared, creek bed, dam, derived native grassland, native vegetation, cropping, improved pasture and previous evidence of pasture improvement. This mapping indicates that native vegetation covers approximately 75% of the development site whilst derived native grassland consists approximately 10% of the development site. Agricultural areas of cropping, improved pasture or areas with evidence of previous pasture improvement together consist approximately 14% of the development site.

1.5.3 Climate

The Brigalow Belt South Bioregion is located within an ecological gradient, or ecotone, between the dry inland or Eyrean zone and the wetter coastal or Bassian zone. Within the south eastern section of the bioregion where the development site is located, the climate is classed as subhumid: there is no dry season and the area experiences hot summers (NPWS, 2000b).

Substantial rainfall can occur at any time of the year but there is a peak in summer and a smaller peak in winter. In summer, high intensity rain or thunderstorms can cause significant erosion. Evaporation rates are high in summer and often exceed precipitation rates, so the net penetration of rainfall is greater in winter than in summer (NPWS, 2000a). Mean annual rainfall in the NSW section of the Brigalow Belt South Bioregion varies from 550 mm in the west (in Gilgandra) to 823 mm on the east of the bioregion (at Murrurundi). On the north-south gradient, mean annual rainfall is 587 mm in Dubbo, 651 mm at Narrabri, and 659 mm on the Queensland border (at Texas).

Temperatures vary with altitude throughout the bioregion and have large daily variation (daily maximum can reach 45 °C in summer and stay above 40 °C for several days, and minimum temperatures can be as low as -9 °C). However, mean monthly temperatures (based on 6 weather stations in NSW) range from a maximum of 33 °C in January to a minimum of 3 °C in July (NPWS, 2000b).

1.6 Data sources

1.6.1 Literature review

Forty-eight previous ecological impact assessments, flora and fauna surveys and research studies conducted in the East Pilliga area were reviewed. The review focussed on surveys that have previously been undertaken within the development site. Additionally, all records of threatened species and communities and their associated habitat and / or distribution were reviewed. The review also included relevant previous surveys located outside of the development site.

Two databases were produced from this literature review to help inform this assessment. The first database contains all reviewed previous survey effort within the development site. It has been tabulated and is spatially enabled. The spatial component consists of a Geographic Information System (GIS) geodatabase which provides both geographic locations for each survey and attribute information for the report name, survey type and site code relating to the written report. This spatial component cross-references to the tabulated component with each previous survey represented by a unique code. The tabulated component presents all reviewed previous survey effort in the development site, stratified by habitat type surveyed, as per the habitat types presented for this assessment (**Section 5.3.1**). The previous survey effort was calculated by the quantum of effort (number of traps / hours) and survey periods (days / nights) for each survey technique when sufficient information was available.

The second database contains a tabulated form of all threatened flora and fauna species recorded in previous surveys. The database is stratified by habitat type, as detailed in each survey report and presents an overview of each habitat type that a particular threatened species has been recorded in.

In addition to previous surveys, a number research papers and reviews conducted in the Pilliga or in similar habitats in the region were reviewed as part of this report. These documents were used to gather species specific information for the Pilliga area, the significance of the Pilliga area for threatened species, and species' responses to disturbances, such as logging and fire. These reports have been referenced where referred to throughout this report.

1.6.2 Database review

A number of key datasets and mapping available to determine biodiversity values and constraints within the development site are listed below:

- BioNet Database (Atlas of NSW Wildlife) (OEH, 2016a)
- EPBC Act Protected Matters Search Tool (DotE, 2013)
- NSW geology mapping (DMR, 2002)
- Watercourse mapping (LPI, 2013)
- Forest Types Mapping (State Forests of NSW, 2007)
- Namoi Catchment Management Authority (CMA) vegetation mapping (ELA, 2013)
- Namoi Catchment Management Authority (CMA) wetland mapping (ELA, 2008)

High resolution aerial photographs and Light Detection and Ranging (LiDAR) data (producing high resolution surface contours, digital terrain models and canopy height models) of the development site were also used to investigate the extent of vegetation cover, landscape features and disturbance patterns in the area. LiDAR data is collected using laser light to densely sample the surface of the earth. The data records distances to the Earth from the aircraft, producing an accurate physical layout of terrain and landscape features.

Databases and maps were searched for state and federally listed threatened species, populations and Threatened Ecological Communities (TECs). Searches were conducted for a 100 km area around the centre point of the development site. It is noted that this large search area included regions of different topography, geology and climate, and included species that will not have suitable habitat in the development site. However, due to the relative paucity of records in the development site (and generally western areas of NSW), this large search area was considered necessary to effectively capture all potential target species.

Figure 1: Site map

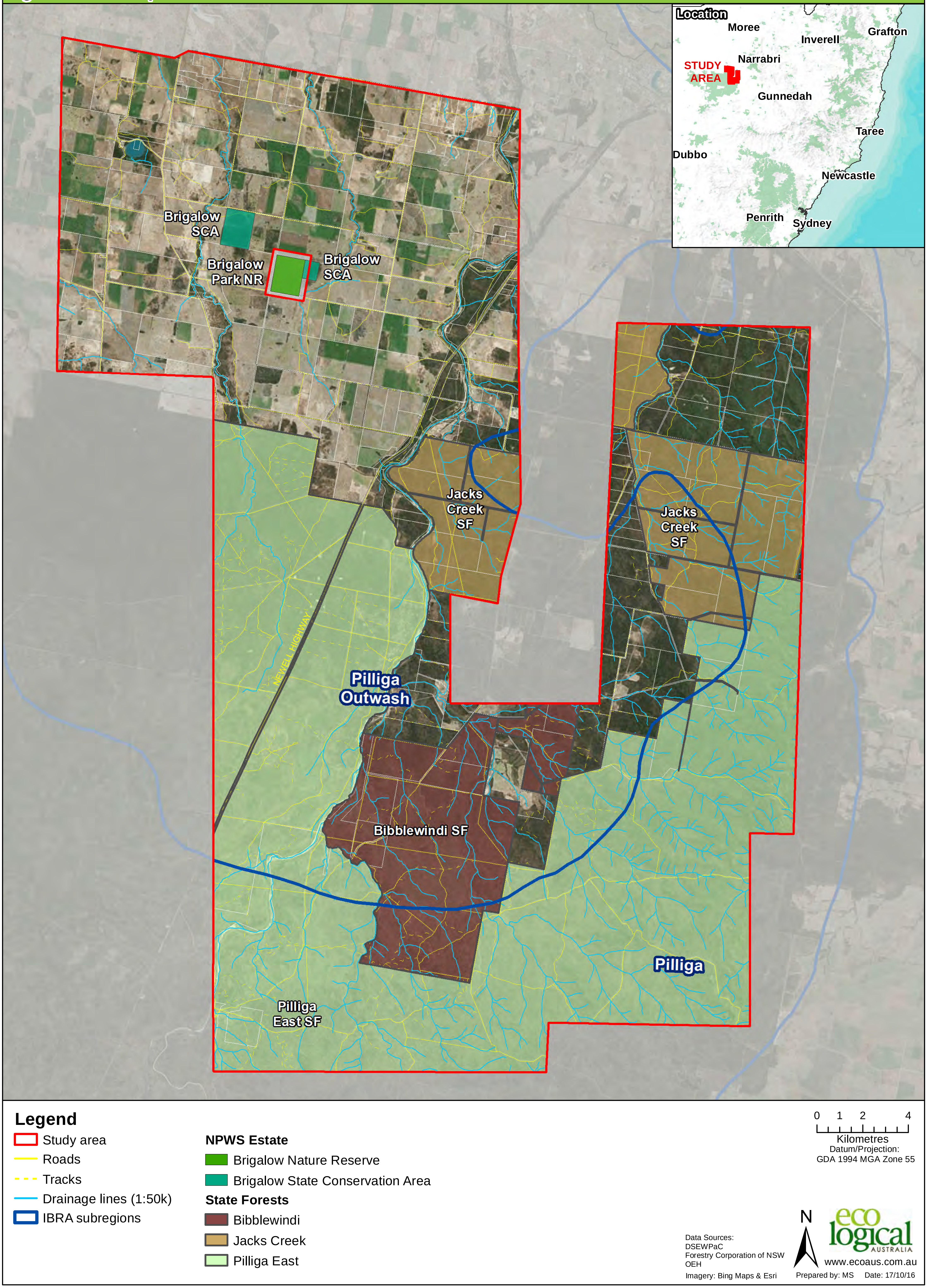


Figure 2: Location map

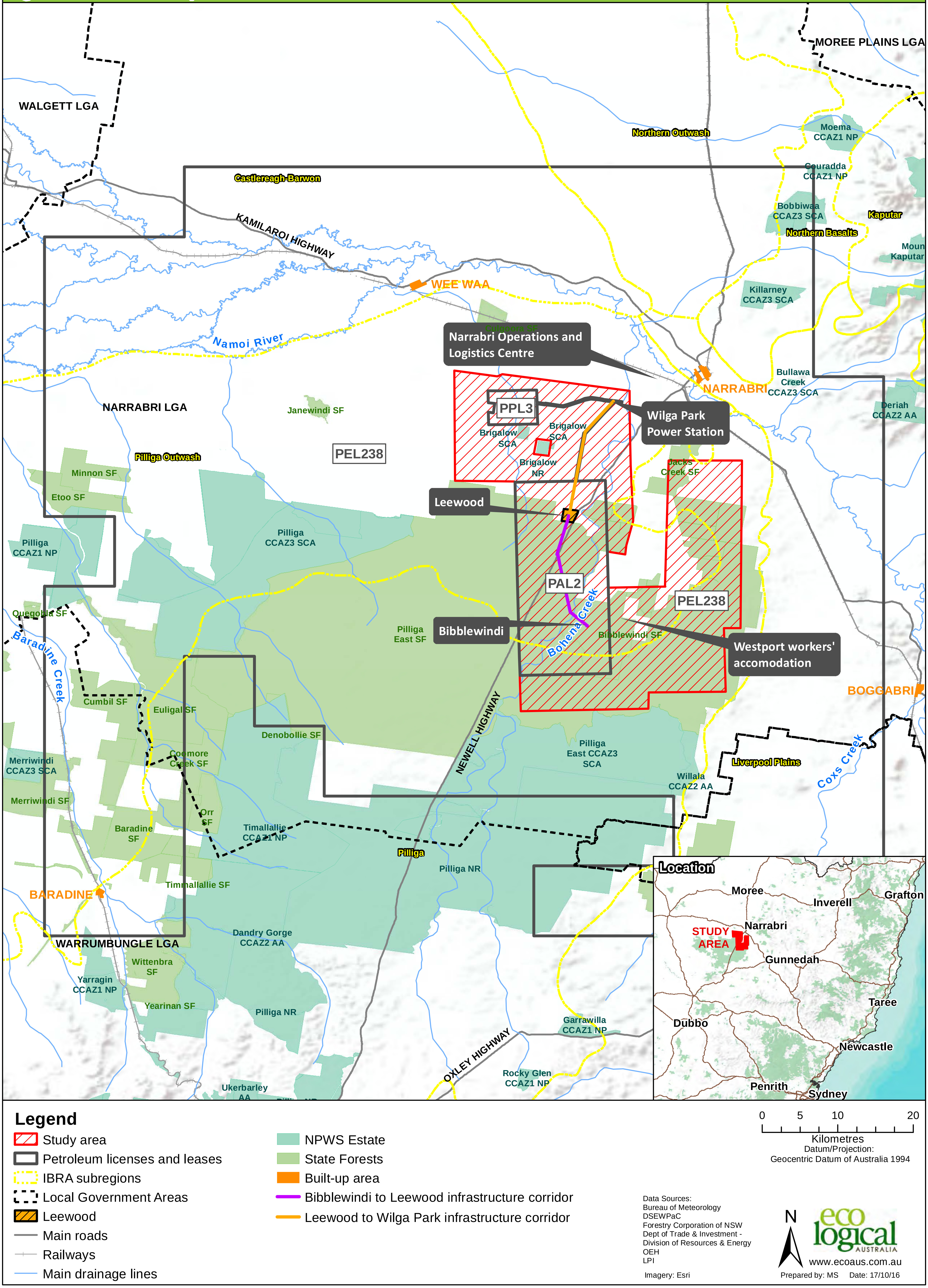
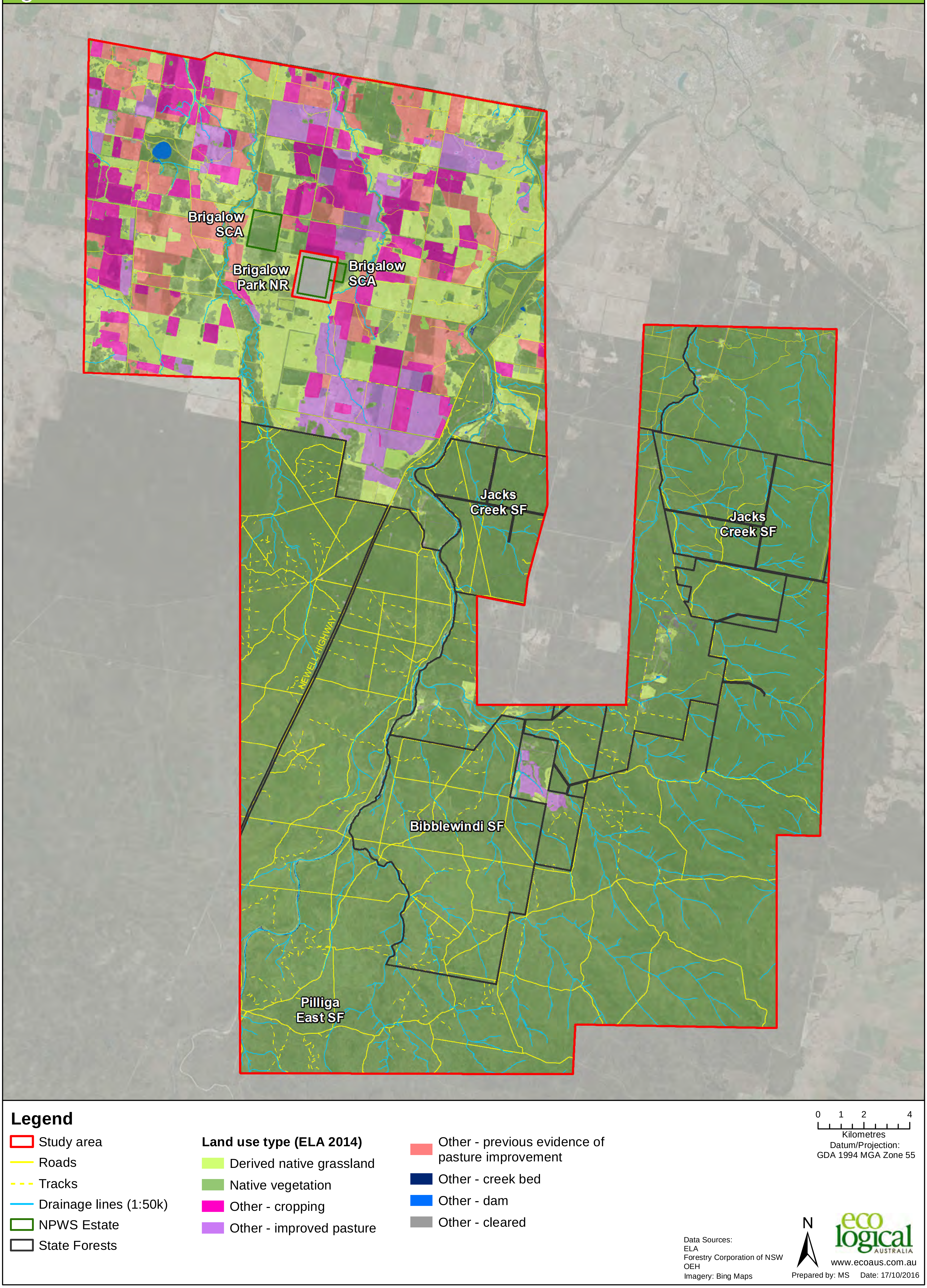


Figure 3: Land use



2 Policies and legislation

2.1 Commonwealth legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Matters of National Environmental Significance (MNES) are protected. The FBA requires proponents to identify and assess the impacts on all nationally listed threatened species and threatened ecological communities that may be on the development site. Other MNES are not considered under the FBA but have been considered as part of the Ecological Impact Assessment (ELA, 2015).

Nationally listed ecological communities are addressed in **Section 4.3.1**. For those nationally listed threatened species that are also listed as 'species credits' and 'ecosystem credits', they have been considered in **Section 5**. Three MNES are considered 'potential' to occur in the development site but have not been included in the offset calculations; *Botaurus poiciloptilus* (Australasian Bittern), *Rostratula australi*s (Australian Painted Snipe), and *Chalinolobus dwyeri* (Large-eared Pied Bat). They were not predicted to occur by the Major Projects Credit Calculator, and have not been recorded in the development site despite targeted surveys across multiple seasons. Further habitat and impact assessments for these species are provided in the Ecological Impact Assessment (ELA, 2015).

2.1.2 Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy

This policy outlines the Australian Government's approach to the use of environmental offsets ('offsets') under the EPBC Act. It replaces the draft policy statement 'Use of environmental offsets under the EPBC Act (2007)'.

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Where appropriate, offsets are considered during the assessment phase of an environmental impact assessment under the EPBC Act. This policy provides transparency around how the suitability of offsets is determined. The suitability of a proposed offset is considered as part of the decision as to whether or not to approve a proposed action under the EPBC Act.

2.1.3 Bilateral Assessment Agreement

Under the *Bilateral agreement made under section 45 of the EPBC Act relating to environmental assessment* (the bilateral agreement; 2015), a proposed action does not require assessment under Part 8 of the EPBC Act, if the action is to be assessed under Part 4 Division 4.1 or Part 5.1 of the EPA Act, provided the assessment:

- Contains an assessment of all impacts the action has on each matter protected under the EPBC Act
- Contains enough information about the controlled action and its relevant impacts to allow the Commonwealth Minister to make an informed decision whether or not to approve the action
- Addresses all matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (EPBC Regs; 2000)

The proposed action will be assessed via an Environmental Impact Statement, which will involve public consultation.

As the *NSW Biodiversity Offset Policy for Major Projects* was developed as a whole-of-government policy and includes Matters of National Environmental Significance, offsets determined under the *NSW Biodiversity Offset Policy for Major Projects* are considered likely to satisfy EPBC offset requirements.

2.2 New South Wales legislation

2.2.1 Environmental Planning and Assessment Act 1979

The EPA Act is the principal planning legislation for NSW. It provides a framework for land use control and assessment, determination and management of development.

The project is being assessed under Division 4.1 of Part 4 of the EPA Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

2.2.2 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act is integrated with the EPA Act. Activities being assessed under the EPA Act require consideration of whether the project is likely to significantly affect threatened species, populations and ecological communities or their habitats listed under the TSC Act. The threatened species and ecological communities relevant to the project are presented in **Section 4.3.1** and **Section 5.**

2.2.3 NSW Biodiversity Offsets Policy for Major Projects

As the project is identified as a State Significant Project, under the NSW Biodiversity Offsets Policy for Major Projects, the SEARs require the Proponent, unless otherwise agreed, to apply the FBA to assess impacts on biodiversity. The FBA must be applied to identify reasonable measures and strategies that can be taken to avoid and minimise impacts to biodiversity. A BAR (this report) will describe the biodiversity values present on the development site and the impact of the Major Project on these values. If required, a Biodiversity Offset Strategy (BOS) will outline how the Proponent intends to offset the impacts of the Major Project. The BAR and BOS then form part of the Environmental Impact Statement.

The SEARs may identify additional assessment requirements for biodiversity impacts not considered by the FBA, which must be documented separately within the Environmental Impact Statement. The project specific environmental assessment requirements that fall under additional assessment requirements are:

a. In the case of a project that adjoins, is in the immediate vicinity or upstream of NPWS estate, the assessment of impacts must address the matters outlined in the *Guidelines for developments adjoining land and water managed by DECCW* (DECCW 2010) and include:

> i. The nature of the impacts, including direct and indirect impacts.
>
> ii. The extent of the direct and indirect impacts.
>
> iii. The duration of the direct and indirect impacts.
>
> iv. The objectives of the reservation of the land.

3 Landscape features

3.1 Landscape features

The project design is considered a 'multiple fragmentation impact development' under the FBA as it requires multiple extraction points and a network of connecting infrastructure. The FBA requires a 550 m buffer from the boundary of the development footprint to assess landscape value. Due to the progressive nature of the project, the exact location of the development footprint has not been defined. As such, the study area defined in the Environmental Impact Statement has been utilised as the buffer distance around the infrastructure and is referred to as the development site (**Figure 1**). For this assessment, the development site is synonymous with the development footprint buffer area.

3.1.1 Interim Biogeographic Regionalisation of Australia (IBRA)

Bioregions

The development site is located within the southern part of the Brigalow Belt South (BBS) Bioregion. This bioregion extends over NSW and Queensland, with the majority occurring in Queensland. In NSW, the bioregion covers an area of 52,409 km², which represents 18.7% of the total bioregion (NPWS, 2000a).

Subregions

The Brigalow Belt South Bioregion is divided into seven subregions in NSW; Northern Outwash, Liverpool Plains, Pilliga Outwash, Liverpool Range, Northern Basalt, Pilliga, and Talbragar Valley. Of these, the development site is situated in the Pilliga and Pilliga Outwash subregions (**Figure 2**). These provinces are characterised by occurring on Mesozoic bedrock containing extensive sandstone hills and coarse sandy soils (Pilliga), and on the plains of deep sandy texture dominated by alluvial and colluvial sediments (Pilliga Outwash) (NPWS, 2000a, 2000b).

3.1.2 Mitchell landscapes

Mitchell Landscapes are a system of ecosystem classification mapped at the 1:250,000 scale, based on a combination of soils, topography and vegetation (DECC, 2008a). Mitchell Landscapes are used in regional conservation planning in NSW and form a component of the BioBanking Assessment Methodology (OEH, 2014a). Four Mitchell Landscape have been mapped in the development site (**Table 3** and **Figure 4**).

Table 3: Mitchell landscapes within the development site

Mitchell landscape	Landscape description (DECC, 2008a)	Location
Barradine - Coghill Channels and Floodplains	Sandy incised channels and distributary streams on Quaternary alluvium in fans of Coghill and Baradine Creeks flowing from the sandstones of the Pilliga forest. General elevation 170 to 210m, local relief 10m. Deep texture-contrast soils with harsh clay subsoils, grey clay with gilgai and uniform deep yellow sands. Sediments and soils become finer down valley merging with the Coghill Alluvial Plains ecosystem. Gallery woodland dominated by river red gum along the channels. Other species including; *Eucalyptus populnea* (Poplar box), *E. pilligaensis* (Pilliga box), *E. blakelyi* (Blakely's Red Gum), *Callitris*	Occurs along the main drainage lines within the development site

Mitchell landscape	Landscape description (DECC, 2008a)	Location
	glaucophylla (White Cypress Pine) and *E. sideroxylon* (Mugga Ironbark) and occasional *E. melanophloia* (Silver-leaved Ironbark).	
Bugaldie Uplands	Stepped stony ridges on Jurassic quartz sandstone with some conglomerate, shale and occasional interbedded basaltic volcanic rocks. General elevation 350 to 490m local relief 50 to 150m, extensive joint controlled stream network. Abundant outcrop on ridge tops with thin discontinuous soils with stony, sandy profiles and low nutrients. Down slope texture-contrast soils are more common typically with harsh clay sub-soils and deep uniform or gradational yellow brown sands on the valley floors. Patches of *E. viridis* (Green Mallee) and *E. dwyeri* (Dwyer's Mallee Gum), clumps of *Acacia concurrens* (Curracabah) and *A. cheelii* (Motherumbah) amongst *E. sideroxylon* and *C. endlicheri* (Black Cypress Pine) with shrubby understorey including *Prostanthera ovalifolia* (Mint Bush), *Stypandra glauca* (Nodding Blue Lily) and *Cheilanthes sieberi* (Rock Fern) on ridges and stony slopes. *E. crebra* (Narrow-leaved Ironbark), *E. macrorhyncha* (Red Stringybark), *C. endlicheri*, *Corymbia trachyphloia* (Brown Bloodwood) and *Angophora floribunda* (Rough-Barked Apple) on the sandy flats. *E. albens* (White Box) and *Ficus rubiginosa* (Port Jackson Fig) on the volcanics	Occurs in the eastern and south-eastern part of the development site
Cubbo Uplands	Pilliga horizontal Jurassic quartz sandstones, limited shales, Tertiary basalt caps and plugs plus the sediments derived from these rocks. Stepped sandstone ridges with low cliff faces and high proportion of rock outcrop. Long gentle outwash slopes intersected by sandy streambeds and prior stream channels. A few patches of heavy clay. General elevation 400 to 550m, local relief 50m. On sandstone, the ridge tops have thin discontinuous soils with stony, sandy profiles and low nutrients. Downslope texture-contrast soils are more common typically with harsh clay subsoils and in the valley floors sediments tend to be sorted into deep sands with yellow earthy profiles, harsh grey clays, or more texture-contrast soils with a greater concentration of soluble salts. The sandstone outcrop areas support various forests and woodlands including; *E. nubila* (Blue-leaved Ironbark), *E. rossii* (Inland Scribbly Gum), *C. endlicheri*, *Atalaya hemiglauca* (Whitewood), and *A. floribunda*. Stony hills in the north of the region carry mallee patches with; *E. melanophloia*, *Corymbia maculata* (Spotted Gum) [sic], and *A. leiocarpa* (Smooth-barked Apple). Gentler sandstone slopes over most of the region carry; *E. crebra* (Narrow-leaved Ironbark), *C. glaucophylla*, *E. macrorhyncha*, patches of *E. viridis* and *Melaleuca uncinata* (Broombush) heath.	Occurs primarily in the central, eastern and south-eastern sections of the development site

Mitchell landscape	Landscape description (DECC, 2008a)	Location
	In western and northern sections on texture-contrast or more uniform harsh clay soils forests of *E. pilligaensis*, *E. microcarpa* (Western Grey Box), *E. populnea*, and *E. conica* (Fuzzy Box) are found with stands of *Allocasuarina luehmannii*, *Alectryon oleifolium* (Rosewood), *Atalaya hemiglauca*, *Geijera parviflora* (Wilga), *Casuarina cristata* (Belah), *Acacia homalophylla* (Yarran), and *Eremophila mitchellii* (Budda).	
Coghill Alluvial Plains	Distal parts of the Quaternary alluvial fans largely derived from Jurassic quartz sandstone on streams draining from the Pilliga Forests. Long gentle slopes broken by sandy abandoned stream channels (sand monkeys), patches of heavy grey clay, and contemporary incised stream channels. General elevation 200 to 280m, local relief 5 to 9m. Deep texture-contrast soils with harsh clay subsoils, grey clay with gilgai. Open forest of *C. glaucophylla*, *E. populnea*, *E. pilligaensis*, *E. blakelyi* and *E. sideroxylon*. *C. trachyphloia* and *Xanthorrhoea* sp. (Grass Trees) on sand monkeys (abandoned stream channels). Patches of *Allocasuarina luehmannii* (Bull Oak) or *A. harpophylla* (Brigalow) on gilgai in heavy clay. *E. chloroclada* (Dirty Gum) and *E. camaldulensis* (River Red Gum) in creek lines.	Occurs primarily in the north and central sections of the development site

3.1.3 Streams and rivers

A total of 717 km of watercourses were mapped in the development site across six Strahler stream orders (**Figure 5**). The lower order streams (i.e. those in the upper catchments) had the greatest length (319 km) while the higher order streams (4 to 6) were an order of magnitude lower (average length 42 km).

Based on the Strahler stream order classification and designation of vegetated riparian zone buffer widths in accordance with the Water Management Act 2000 (WM Act), a total of 5,298 ha of land is included within mapped Riparian Corridors. For more information on the stream mapping, refer to **Section 6.1.7**.

3.1.4 Wetlands

There are no important wetlands within the development site. Dams in the development site have been mapped (**Figure 3**). Impacts to dams would be avoided and hence no local wetlands would be impacted within the development site.

3.1.5 Native vegetation extent

Land use mapping in the development site indicates that native vegetation covers approximately 70,933 ha (75% of the development site) whilst derived native grassland (DNG) consists approximately 9,465 ha (10% of the development site) (**Figure 3**). Further details on methods of mapping are provided in **Section 4.2.3**.

3.1.6 State and regionally significant biodiversity links

State and regionally significant biodiversity links have been assessed in **Table 4**.

Table 4: State and regionally significant biodiversity links

Definition of connecting link	Relevant features of development site
State significant biodiversity link	
An area identified by the assessor as being part of a state significant biodiversity link and in a plan approved by the Chief Executive, OEH	None present.
A riparian buffer 50 m either side of a 6th order stream or higher	Bohena Creek is a 6^{th} order stream. It flows south – north through the development site over approximately 49 km. Using the Strahler stream order classification, and the riparian buffer zones specified in the WM Act, a buffer of 80 m + channel width has been applied to Bohena Creek which is in excess of the 50 m buffer required for this definition.
A riparian buffer 50 m around an important wetland or an estuarine area	There are no important wetlands or estuarine areas in the development site.
Regionally significant biodiversity link	
An area identified by the assessor as being part of a regionally significant biodiversity link and in a plan approved by the Chief Executive, OEH	None present.
A riparian buffer 20 m either side of a 4th or 5th order stream	There are seven creeks which have portions classified as either 4^{th} or 5^{th} order streams, namely Bibblewindi Creek, Cowallah Creek, Jacks Creek, Mount Pleasant Creek, Sandy Creek, Spring Creek and Yellow Spring Creek. These creek portions cover approximately 76 km in the development site and all occur east of Bohena Creek. Using the Strahler stream order classification, and the riparian buffer zones specified in the WM Act, a buffer of 80 m + channel width has been applied to these creeks which is in excess of the 20 m buffer required for this definition.
A riparian buffer 30 m around a regionally significant wetland	There are no regionally significant wetlands in the development site.

3.2 Landscape value score

The FBA requires a calculation of the landscape value score to quantify the value of the development site within the broader landscape. The landscape value score is determined by assessing the amount of native vegetation cover in the development site, how well connected the vegetation in the development site is to surrounding vegetation, and the size of the vegetation patch in which the development site is located. The method used to calculate each of these attributes and then to calculate the overall landscape value score is detailed in Section 4.2 of the FBA. The calculations are then used in the Major Projects Credit Calculator to calculate required offsets for the proposed impact.

3.2.1 Attributes

Percent native vegetation cover

The current and future native vegetation cover was assessed using the Plant Community Type (PCT) mapping (**Figure 8**) and known and modelled impacts (**Table 55**) and is presented below in **Table 5**.

Table 5: Current and future extent of native vegetation within the development site

Area of Development Footprint Buffer (ha)	Current Native Vegetation Extent			Future Native Vegetation Extent			Overall Score for Percent Native Vegetation Cover in the Development Footprint Buffer Area
	Area (ha)	% Cover	Score	Area (ha)	% Cover	Score	
95,077	80,398	84.6	13.8	79,409.2	83.5	13.8	13.8 – 13.8 = **0**

Connectivity value

The project is likely to impact on the riparian buffer of Bohena Creek (a sixth order stream and hence a state significant biodiversity link), which results in a score of **12.5** for this attribute.

Patch size

The patch size classes and scores and presented in **Table 6**.

Table 6: Patch size assessment

Mitchell landscape	Native vegetation cleared in Mitchell landscape (%)	Patch size class	Patch size (score)
Barradine – Coghill Channels and Floodplains	20	Extra large	12.5
Bugaldie Uplands	26	Extra large	12.5
Coghill Alluvial Plains	40	Extra large	12.5
Cubbo Uplands	16	Extra large	12.5
Final patch size score (average of above scores)			**12.5**

Area to patch size

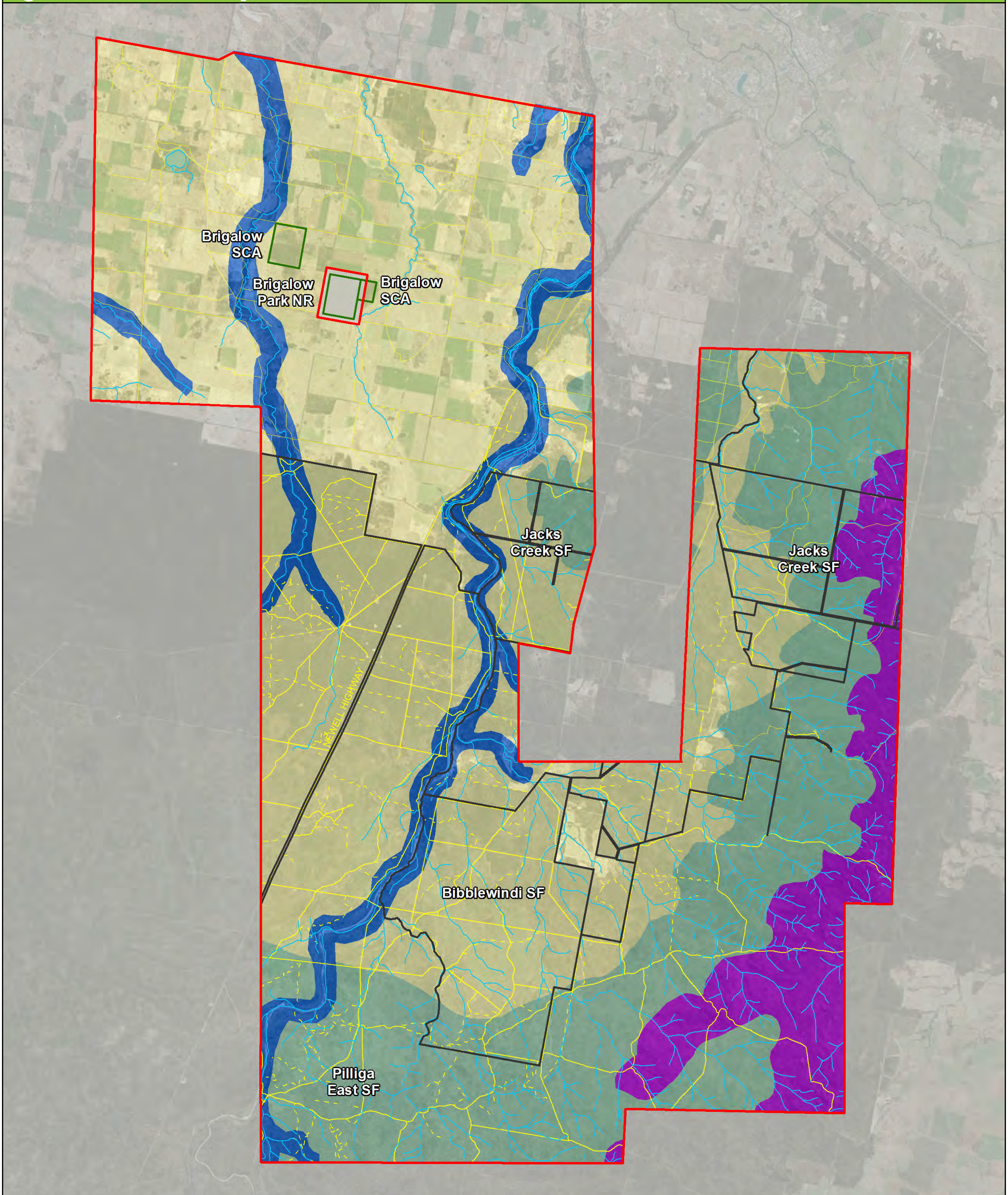
As the entire spatial placement of the development footprint has not been defined, the project includes a combination of known and modelled impacts. Hence, it is not possible to calculate the exact impact to patch sizes. As such, a precautionary approach has been undertaken and the highest possible score of **10** was manually selected.

Note that this represents the worst case as there is an existing network of over 760 km of roads within the forested portion of the development site which already contribute to existing fragmentation. Furthermore, this assessment does not take into consideration design measures proposed to avoid and minimise impacts such as the co-location of linear infrastructure such as gas and water gathering systems and access tracks with existing roads, access tracks and disturbance corridors wherever practicable.

3.2.2 Score

Based on the assessment of landscape attributes above, the Landscape Value Score has been calculated to be **22.5**.

Figure 4: Mitchell landscapes



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Mitchell landscapes (DECC 2008)

- Barradine - Coghill Channels and Floodplains
- Bugaldie Uplands
- Coghill Alluvial plains
- Cubbo Uplands

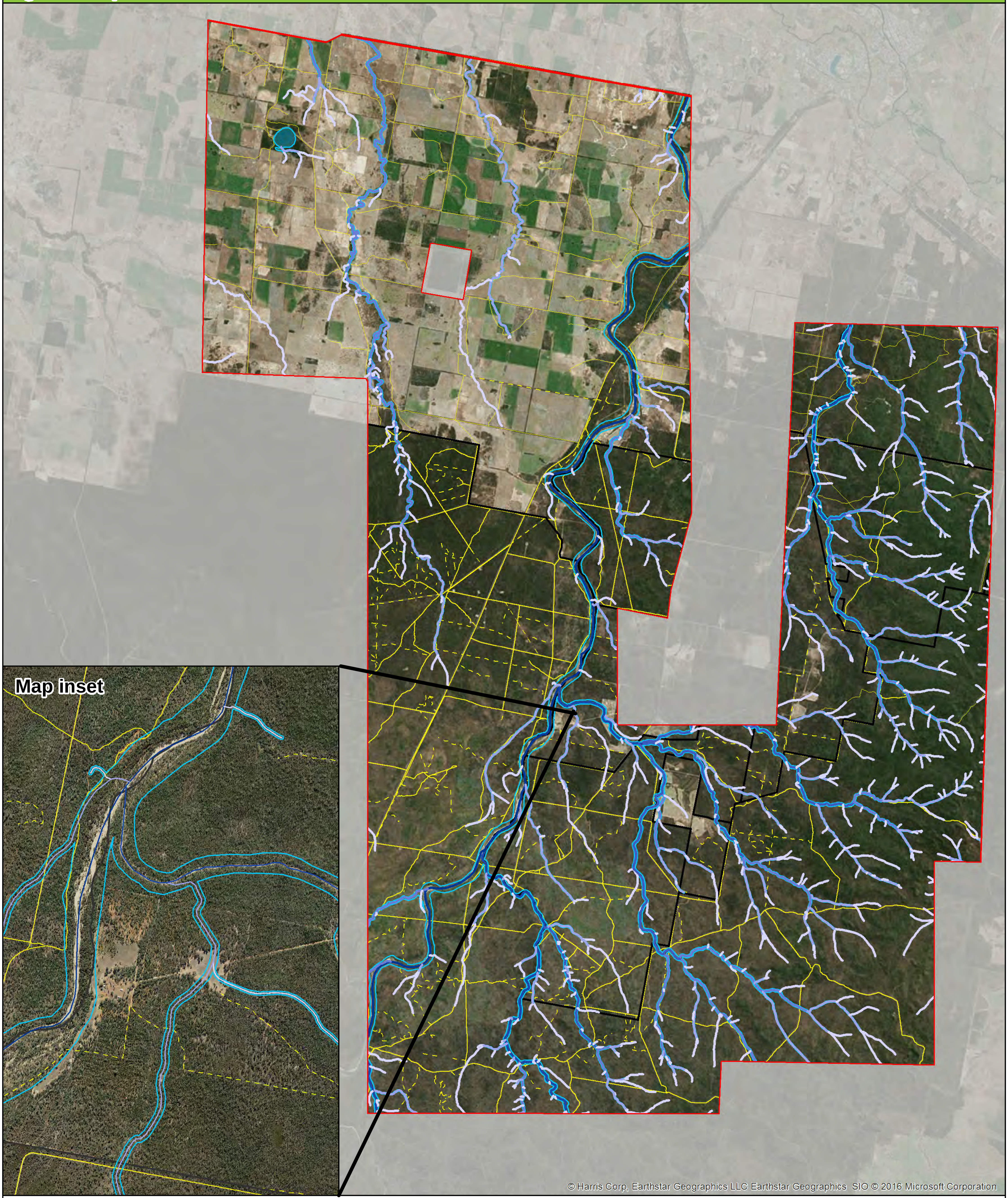
0 1 2 4
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

N

Data Sources:
DECC
Forestry Corporation of NSW
OEH
Imagery: Bing Maps

eco logical AUSTRALIA
www.ecoaus.com.au
Prepared by: MS Date: 17/10/2016

Figure 5: Riparian Corridors



Legend

- Study area
- State Forests
- Roads
- Tracks

Strahler Stream Order

- 1
- 2
- 3
- 4
- 5
- 6
- Riparian corridors (to scale)

0 1,750 3,500 7,000
Metres

Datum/Projection:
GDA 1994 MGA Zone 55

N

www.ecoaus.com.au

Prepared by: MS Date:17/10/16

4 Native vegetation

4.1 Review of existing data

The literature and database review presented in **Sections 1.6.1** and **1.6.2** involved an extensive review of existing data and information to assist in surveying and mapping the vegetation in the development site (**Figure 6**).

Previous flora survey effort reviewed within the development site dates back to 2005 and incorporated a combination of survey methods for site specific impact assessments and general ecology based surveys. These methods included targeted species searches, random meander transects, full floristic plots, rapid assessment plots and road based searches.

Site specific impact assessments conducted by Idyll Spaces Environmental Consultants from 2005 – 2010 incorporated random meander transects and full floristic survey plots. Landmark Ecological Services and the Wilderness Society (TWS) conducted road-based surveys to identify potential endangered ecological communities (EECs) and habitat for threatened species across the development site, followed by intensive ground based searches where necessary in 2011. Further site specific impact assessments were conducted by RPS from 2012 – 2013 at various sites within the development site which included random meander transects and full floristic and rapid assessment plots. Alison Hunt & Associates undertook full floristic plots, rapid assessments and random meander transect in 2010. The results from these surveys, as detailed in their respective reports, were used where applicable to inform this assessment (**Figure 19**).

4.2 Surveys

Flora surveys and vegetation mapping for the development site were conducted between 2010 and 2014, and included an initial desktop approach followed by extensive field validation and data collection (**Table 7** and **Figure 7**). A summary of the flora survey effort across the development site is provided in **Table 8**.

Table 7: Flora survey timing

	2010	2011				2012				2013										2014			
Survey type	November	January	February	April	October	February	March	September	October	March	April	May	June	July	August	September	October	November	December	January	February	March	September
Field reconnaissance	■	■																					
Biometric plots	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	
Targeted threatened flora surveys	■	■	■	■	■			■	■						■	■	■			■	■	■	
Habitat survey			■		■										■	■	■					■	
Rehabilitation monitoring						■				■	■	■	■	■									■
Rapid flora plots											■			■		■		■	■	■	■		

Table 8: ELA field effort for vegetation surveys

Survey Method	Survey Effort	Approximate Field Person Hours
Flora survey (vegetation validation using BioBanking Assessment Methodology) including targeted Box Gum Woodland survey	327 biometric plots	680 hours
Threatened flora survey (two person transects in 2011 and 2012)	523 km at 10 m width (523 ha)	1,300 hours
Threatened flora survey (population distribution and abundance mapping in 2014)	23 transects at 100 m long and 10 m wide (2.3 ha) and 84 point surveys	100 hours
Vegetation and habitat mapping	Over 1,300 rapid vegetation validation plots	216 hours

4.2.1 Stratification

A detailed flora survey implementing the BioBanking Assessment Methodology (OEH, 2014a) was conducted at sampling locations stratified across the entire development site, in lieu of a detailed project design. The spatial distribution of survey effort was not aligned with major facilities as infrastructure locations were not known at the time of the field surveys. Stratification of such a large development site was necessary to ensure that all vegetation types and condition states were systematically sampled. However, some areas in the development site were inaccessible due to restricted access to private land.

Vegetation mapping available at the beginning of the surveys (in 2010) was limited to the regional vegetation community (RVC) mapping of Namoi Catchment Management Authority (CMA) boundary (ELA, 2013) and the Forest Type mapping of State Forests (State Forests of NSW, 2007). As the Namoi CMA RCV mapping layer covered the entire development site and regional vegetation classes are easily attributable to Biometric Vegetation Types – the units required to be reported on in NSW, this mapping was used as the original basis for survey stratification.

It's important to note that the regional vegetation class mapping was utilised for stratification purposes only. Fine scale Plant Community Type mapping was specifically developed for the entire development site as part of this project (**Section 4.5.5**). Plant Community Types, along with Biometric Vegetation Types (BVT) were used to provide detailed descriptions of vegetation types in the development site (**Appendix B**).

4.2.2 Flora field survey

Flora surveys consisted of biometric plot surveys, threatened flora searches, and vegetation type and condition mapping (rapid vegetation validation plots), the latter of which was used to develop a new vegetation map for the development site (**Section 4.2.3**). Details on threatened flora searches are provided in **Section 5.3.3**.

Detailed vegetation surveys were completed by ELA ecologists between 2010 and 2014. Vegetation surveys involved validating the mapped vegetation communities, delineating the boundaries of mapped vegetation and assessing condition. A total of 327 biometric plots following the BioBanking Assessment Methodology (OEH, 2014a) and over 1,300 rapid vegetation validation plots were undertaken in the development site (**Appendix A**).

Rapid vegetation validation plots involved recording dominant species in each structural layer and site characteristics including soil type, soil colour, fire history and fauna habitat features.

Biometric plots involved a nested 0.04 ha (20 m x 20 m) quadrat to record the presence of visible vascular flora species, along with presence-absence (2011) or cover-abundance (2012 onwards) for each species using a modified Braun-Blanquet scale. Vegetation structure and fauna habitat features were determined over a nested 0.1 ha (50 m x 20 m) quadrat; measures included number of hollow-bearing trees and length of fallen dead timber greater than 10 cm diameter. Within the 0.1 ha quadrat, projected foliage cover of each strata level and exotic flora was assessed along a 50 m line transect. The layout of the biometric plots is provided in **Plate 1**.

The physical characteristics (such as aspect, slope and disturbance) at the biometric plots were noted and photos were taken of the quadrat along the 50 m line transect. Species were identified to the lowest taxonomic level possible, following the Flora of NSW (Harden, 1992, 1993, 2002, 2000) and NSW Plantnet (Royal Botanic Gardens and Domain Trust, 2016). Biometric plot locations are shown in **Figure 7**.

Wherever possible, biometric plots were located away from major tracks to reduce bias from edge effects and local disturbances. Biometric plots were located in areas of homogenous vegetation representative of the vegetation community and away from vegetation boundaries. Biometric plots were oriented in the direction which minimised changes in environmental gradients (e.g. biometric plots along riparian areas were oriented upstream/downstream).

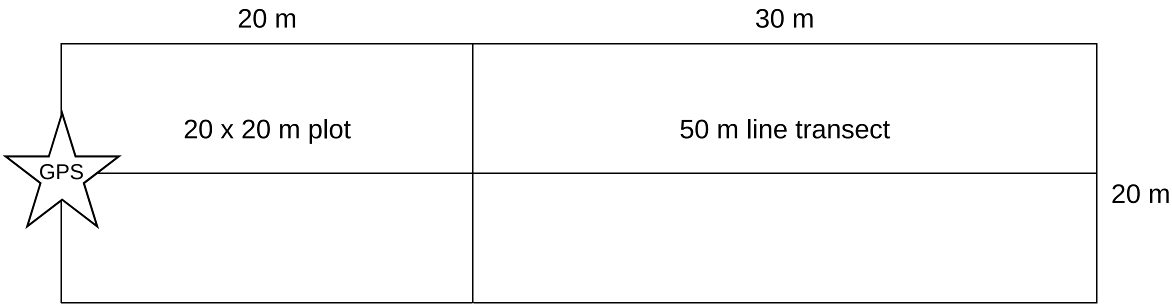


Plate 1: Biometric plot layout

4.2.3 Vegetation mapping

A vegetation mapping project was conducted to map the vegetation communities occurring within the development site to help inform planning/design decisions for the project. Derived native grassland, cropped and pasture improved land, as well as clearings, roads and trails, and dams were also delineated in the mapping process to help inform infrastructure locations to minimise impacts on biodiversity values.

Vegetation mapping was undertaken using a 'heads-up' on screen digitising approach (utilising high quality aerial photography, Light Detection and Ranging datasets including a Canopy Height Model, contours, soil classification and drainage) using a Geographic Information System running the software ArcGIS 10.2. The on screen digitising approach and previous vegetation mapping (State Forests of NSW, 2007) were used to compliment field surveys, including over 1,300 rapid vegetation validation plots and 327 biometric plots to form the basis for vegetation community classification. Vegetation community boundaries (polygons) were digitised at a 1:10,000 scale.

Vegetation communities were attributed in accordance with the Plant Community Types of the NSW Vegetation Classification Assessment (Benson, Richards, Waller, & Allen, 2010) as they provide the best representation of the vegetation in the development site and are at a useful scale for delineating fauna habitat. The project also mapped endangered ecological communities, classified land use and attributed each Plant Community Type to a Biometric Vegetation Type for use in the assessment and quantifications of suitable offsets for the project.

Rapid vegetation validation plots are less comprehensive than biometric plots, however they allow for rapid identification of Plant Community Types and identify boundaries between vegetation communities within the landscape. The data outlined in **Table 9** was recorded at each rapid vegetation validation plot.

Table 9: Data recorded within rapid vegetation validation plots

Category	Description
Dominant canopy	Dominant canopy species (max. 3 species recorded order in dominance)
Dominant midstorey	Dominant midstorey (max. 3 species recorded in order of dominance)
Dominant ground	Either grass, low shrubs (<1m), shrubs (>1m) or a combination
Structure	Structure according to (Specht & Specht, 2002) – e.g. shrubland, low open woodland, woodland or forest. Prefixed with grassy, low shrubby or mid-shrubby depending on structural elements.
Fire history	Three categories – recent (<3 yrs), not recent (3-10 years) and old (>10 years). This category was determined based on visual assessment of fire damage, age of regrowth and presence of fire-sensitive species.
Soil type	Brief description of soil type – e.g. brown alluvial sand, yellow sand or red sand
Comments	Additional comments pertinent to the location, e.g. presence of old growth trees, threatened species, weeds etc.

The rapid vegetation validation points were used as an initial guide to identifying vegetation community boundaries. Aerial Photograph Interpretation was then used in combination with the Canopy Height Model to identify distinct patterns in the imagery representing potential vegetation community boundaries. Vegetation community boundaries (polygons) were then digitised at a 1:10,000 scale. Supplementary datasets such as contours, drainage layers and soil classification were used to help inform the Aerial Photograph Interpretation to delineate boundaries between vegetation communities.

Forest Types Mapping (State Forests of NSW, 2007) and the Namoi Catchment Management Area Regional Vegetation Class Mapping (ELA, 2013) were used to guide and/or validate the allocation and extent of each Plant Community Type mapped. OEH land use mapping (OEH, 2013) was used to delineate areas of cropping and improved pasture with Aerial Photograph Interpretation undertaken to identify additional areas not mapped by OEH.

Each polygon was assigned a Plant Community Type based on expert opinion on floristic composition, vegetation structure, landscape position and soil type. Vegetation mapping was generally undertaken at a 1:10,000 scale, however areas that were not accessed during vegetation surveys were often inspected carefully at a finer scale. Roads, trails, dams, existing infrastructure and other clearings were also delineated.

Vegetation mapping validation occurred continuously throughout the field surveys with polygon boundaries and Plant Community Types updated where necessary.

4.3 Identification of Plant Community Types

A total of 22 Plant Community Types (totalling 80,398 ha of native vegetation) including one previously undescribed vegetation community were mapped in the development site (**Table 10** and **Figure 8**). The corresponding Biometric Vegetation Types (2008 and 2014) are also included in **Table 10**.

Plant Community Type ID40X (*White Bloodwood – Dirty Gum (Baradine Gum) – Rough Barked Apple – Black Cypress Pine heathy open woodland on deep sand in the Pilliga forests*) does not correspond with the Plant Community Types of the NSW Vegetation Classification Assessment, however this community is most closely related to PCT ID405 (*White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions*). A supplementary description of this community has been developed based on the cover-abundance of species recorded within biometric plots. The Plant Community Type ID379 *Inland Scribbly Gum - White Bloodwood – Red Stringybark – Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the BBS Bioregion* is considered a variation of ID 405 and has been presented that way in the descriptions (**Appendix B**).

Table 10: Summary of Plant Community Types identified in the development site

PCT ID	BVT ID (Oct 2008)	BVT ID (Oct 2014)	Plant Community Type (PCT)	Total area mapped (ha)	Percent cleared (%)
27	NA219	NA219	Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions	209.26	85
35	NA117	NA117	Brigalow – Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	6,695.19	90
55	NA102	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	678.94	85
78	NA193	NA193	River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions	10.49	75
88	NA179	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	5,946.61	80
141	NA121	NA121	Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	1,034.76	30
202	NA141	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions	589.82	90
256	NA143	NA292	Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern BBS Bioeregion	20.33	15
379	NA124	NA294	Inland Scribbly Gum - White Bloodwood – Red Stringybark – Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the BBS Bioregion. (See vegetation description for ID405).	103.56	10
397	NA179	NA324	Poplar Box – White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion	762.80	45

PCT ID	BVT ID (Oct 2008)	BVT ID (Oct 2014)	Plant Community Type (PCT)	Total area mapped (ha)	Percent cleared (%)
398	NA227	NA314	Narrow-leaved Ironbark – White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion	23,975.35	25
399	NA197	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion	1,093.46	10
401	NA197	NA338	Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region	7,580.41	35
402	NA160	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion	358.20	40
404	NA124	NA326	Red Ironbark - White Bloodwood -/+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	9,982.48	10
405	NA124	NA390	White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	6,650.54	15
406	NA124	NA389	White Bloodwood – Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests	3,232.39	5
408	NA124	NA279	Dirty Gum (Baradine Gum) –Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	3,188.25	15
418	NA179	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion	131.59	25
425	NA121	NA363	Spur-wing Wattle heath on sandstone substrates in the Goonoo – Pilliga forests Brigalow Belt South Bioregion	366.69	10
428	NA126	NA267	Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the Brigalow Belt South Bioregion	15.03	50
40X	NA124	NA390	White Bloodwood – Dirty Gum (Baradine Gum) – Rough Barked Apple –Black Cypress Pine heathy open woodland on deep sand in the Pilliga forests	7,772.16	NA
Other			Includes cleared, creek bed, dams and improved pasture	14,678.37	NA
Total				**95,076.68**	**NA**

4.3.1 Threatened ecological communities

Four of the mapped Plant Community Types qualify as endangered ecological communities (with two of these endangered ecological communities being further divided by status under the EPBC Act and TSC Act due to condition). **Table 11** provides a summary of the area of each endangered ecological community in the development site and **Figure 9** shows endangered ecological communities in relation to the development site.

- ID27 Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions. Remnant patches that are > 5 ha in size and have > 5% canopy cover qualify as ‘Weeping Myall Woodlands’ under the EPBC Act and ‘Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions’ under the TSC Act (DotE, 2014c; OEH, 2014c). Areas of ID27 with scattered trees also qualify as the TSC Act listed community. Areas of derived native grassland attributed with ID27 do not qualify as an endangered ecological community.
- ID35 Brigalow – Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion. Remnant patches of ID35 that have not been cleared for over 15 years qualify as 'Brigalow (*Acacia harpophylla* dominant and co-dominant)' under EPBC Act and as ‘Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions’ under the TSC Act. Areas of ID35 that do not meet this requirement may still be considered the TSC Act listed community provided there is regenerating Brigalow present. Areas of derived native grassland attributed with ID35 do not generally qualify as an endangered ecological community.
- ID 202 Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions is listed as ‘Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions’ under TSC Act (OEH, 2016b).
- ID428 Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the Brigalow Belt South Bioregion is listed as ‘Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions’ under the TSC Act (OEH, 2016b).

Table 11: Endangered ecological communities

PCT ID	Endangered ecological community (EEC)	TSC Act area (ha)#	EPBC Act area (ha)
27	Weeping Myall Woodlands (EPBC Act) Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (TSC Act)	36.00	32.52
35	Brigalow (*Acacia harpophylla* dominant and co-dominant) (EPBC Act) Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (TSC Act)	2,467.97	2,447.35
202	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions (TSC Act)	588.4	N/A
428	Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (TSC Act)	15.03	N/A
Total		**3,107.40**	**2,479.87**

TSC Act area includes the EPBC Act area

4.4 Vegetation zones

A total of 32 vegetation zones have been assigned, categorised by Plant Community Types and condition (**Table 12** and **Figure 10**).

Table 12: Summary of vegetation zones within development site

Zone	BVT ID	Biometric vegetation type	Plant Community Type	Land use	Note	Development site (ha)	Site value score
1	NA219	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	27 - Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions	Native Vegetation	EEC	36.00	100
2	NA219	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	27 - Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions	DNG	Not EEC	173.26	36.61
3	NA117	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	35 - Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	Native Vegetation	EEC	2,467.97	75.23
4	NA117	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	35 - Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	DNG	Not EEC	4,228.51	36.61
5	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	55 - Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Native Vegetation		362.51	59.02
6	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	55 - Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	DNG		322.94	36.61
7	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	88 - Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	Native Vegetation		4,456.38	76.04

Zone	BVT ID	Biometric vegetation type	Plant Community Type	Land use	Note	Development site (ha)	Site value score
8	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	88 - Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	DNG		1,526.87	18.75
9	NA121	Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	141 - Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	Native Vegetation		1,035.61	41.84
10	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	202 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South-western Slopes Bioregion	Native Vegetation	EEC	588.93	91.8
11	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	202 - Fuzzy Box Woodland on alluvial brown loam soils mainly in the NSW South-western Slopes Bioregion	DNG	EEC	1.42	30.6
12	NA292	Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern Brigalow Belt South Bioregion	256 - Green Mallee tall mallee woodland rises in the Pilliga - Goonoo regions, southern BBS Bioregion	Native Vegetation		20.33	58.85
13	NA279	Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	408 - Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland of the Pilliga forests and surrounding region	Native Vegetation		3,084.77	71.35
14	NA279	Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	408 - Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland of the Pilliga forests and surrounding region	DNG		103.48	18.75

Zone	BVT ID	Biometric vegetation type	Plant Community Type	Land use	Note	Development site (ha)	Site value score
15	NA314	Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	398 - Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion	Native Vegetation		23,491.95	68.75
16	NA314	Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	398 - Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion	DNG		494.94	18.75
17	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	399 - Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion	Native Vegetation		1,048.04	68.06
18	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	399 - Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion	DNG		47.09	18.75
19	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion	402 - Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion	Native Vegetation		177.69	58.33
20	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and	402 - Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga	DNG		189.71	18.75

Zone	BVT ID	Biometric vegetation type	Plant Community Type	Land use	Note	Development site (ha)	Site value score
		surrounding regions, Brigalow Belt South Bioregion	forests and surrounding regions, BBS Bioregion				
21	NA294	Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion	379 - Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the BBS Bioregion	Native Vegetation		103.56	71.35
22	NA324	Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	397 - Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion	Native Vegetation		326.67	67.88
23	NA324	Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	397 - Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion	DNG		446.26	18.75
24	NA338	Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	401 - Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region	Native Vegetation		5,954.88	82.81
25	NA338	Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	401 - Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region	DNG		1,641.24	18.75
26	NA326	Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	404 - Red Ironbark - White Bloodwood -/+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	Native Vegetation		9,993.90	79.69

Zone	BVT ID	Biometric vegetation type	Plant Community Type	Land use	Note	Development site (ha)	Site value score
27	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	405 - White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	Native Vegetation		6,652.10	71.35
27	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	40X - White Bloodwood – Dirty Gum – Rough Barked Apple heathy open woodland on deep sand in the Pilliga forests	Native Vegetation		7,534.88	71.35
28	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	40X - White Bloodwood – Dirty Gum – Rough Barked Apple heathy open woodland on deep sand in the Pilliga forests	DNG		239.54	18.75
29	NA389	White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests	406 - White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland/open forest mainly in east Pilliga forests	Native Vegetation		3,239.20	65.62
30	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	418 - White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion	Native Vegetation		66.15	73.96
31	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	418 - White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion	DNG		69.57	18.75
32	NA363	Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion	425 - Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion	Native Vegetation		366.69	69.27

Zone	BVT ID	Biometric vegetation type	Plant Community Type	Land use	Note	Development site (ha)	Site value score
No Impact*	NA193	River Red Gum riverine woodlands and forests in the Nandewar and Brigalow Belt South Bioregions (Benson 78)	78 - River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions	Native Vegetation		10.50	~
No impact*	NA267	Carbeen woodland on alluvial soils	428 - Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the Brigalow Belt South Bioregion	Native Vegetation	EEC	15.03	~
Total						**80,518.57**	**~**

* Vegetation community would not be impacted directly, indirectly or cumulatively in the development site. Therefore no offsets are require for the community and it was not entered into the credit calculations.

Figure 6: Survey effort – flora & fauna (additional surveys)

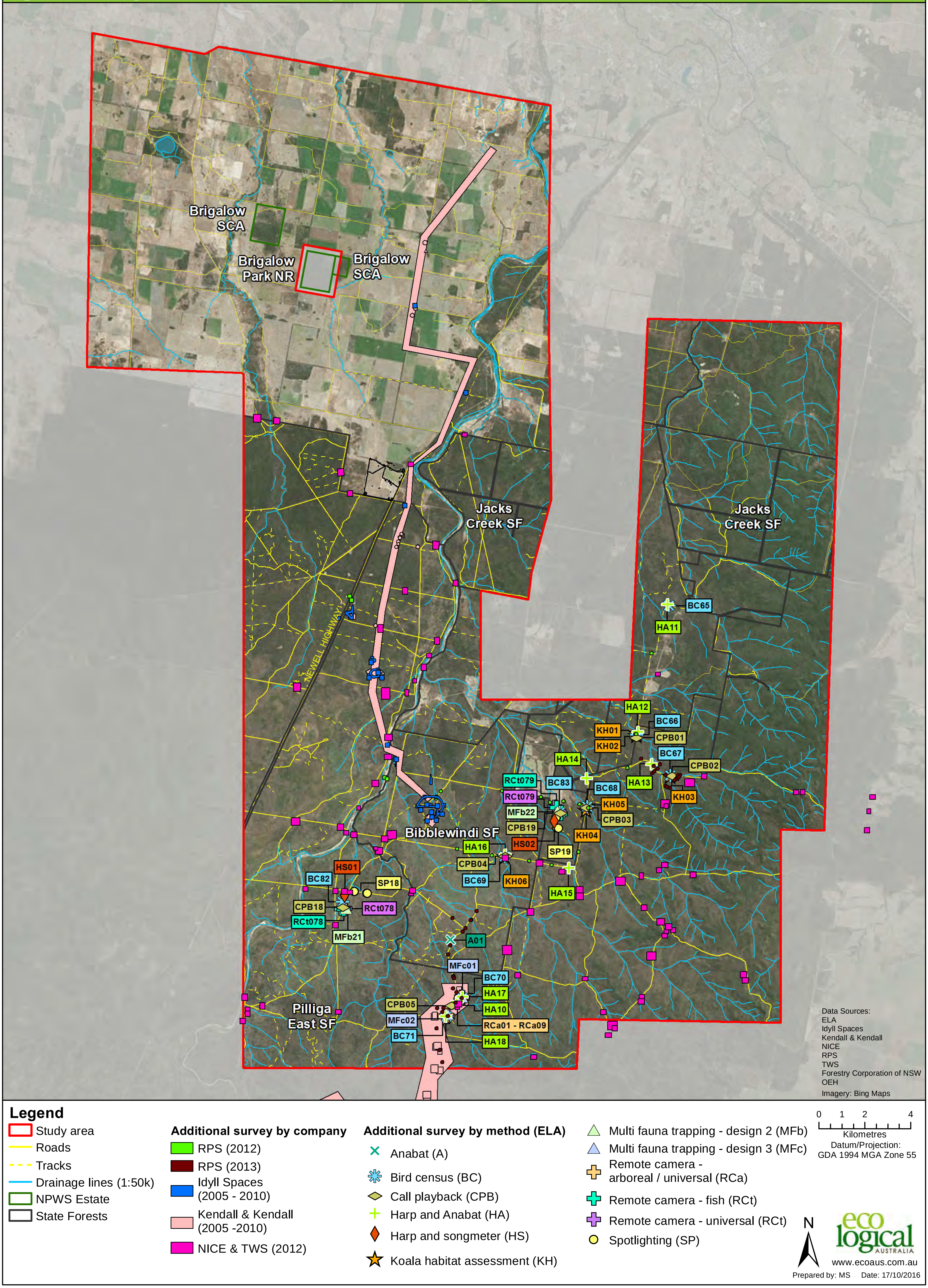


Figure 7: Survey effort – flora

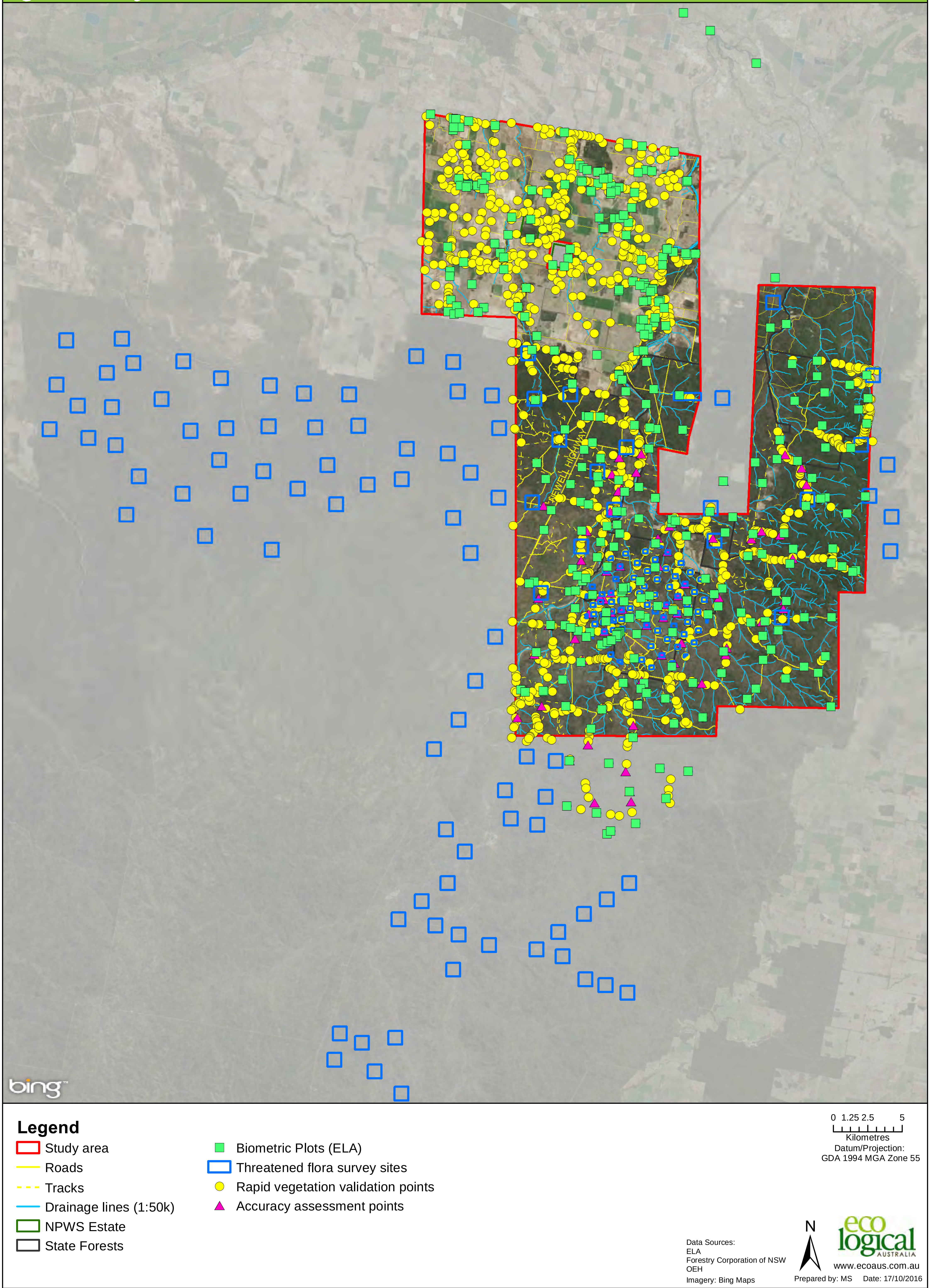
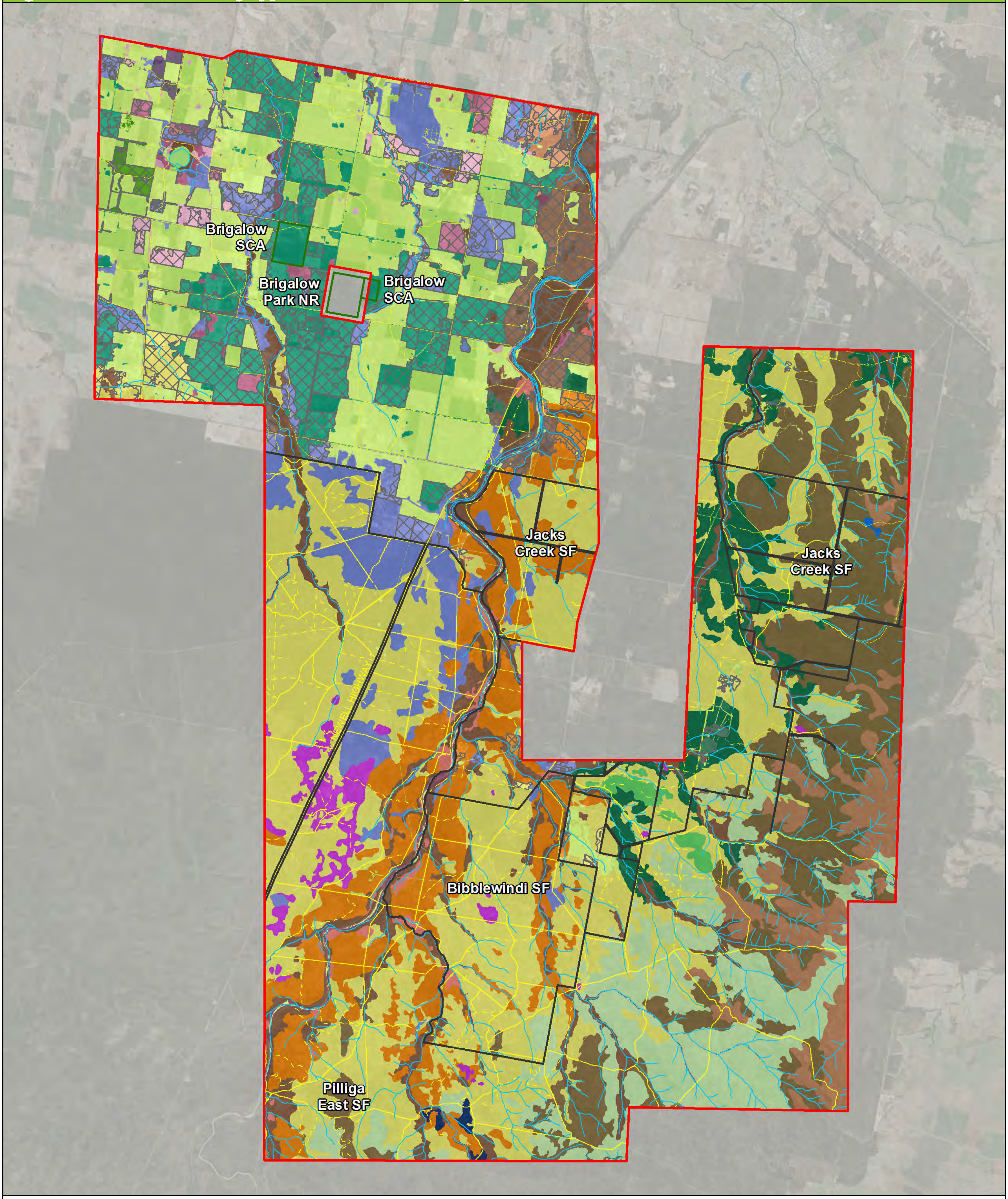


Figure 8: Plant community types within the development site



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Plant community types (ELA 2014)

0 (other), 27, 35, 55, 78, 88, 141, 202, 256, 379, 397, 398, 399, 401, 402, 404, 405, 406, 408, 40X, 418, 425, 428, DNG

0 1 2 4
Kilometres
Datum/Projection: GDA 1994 MGA Zone 55

Data Sources:
ELA
Forestry Corporation of NSW
OEH
Imagery: Bing Maps

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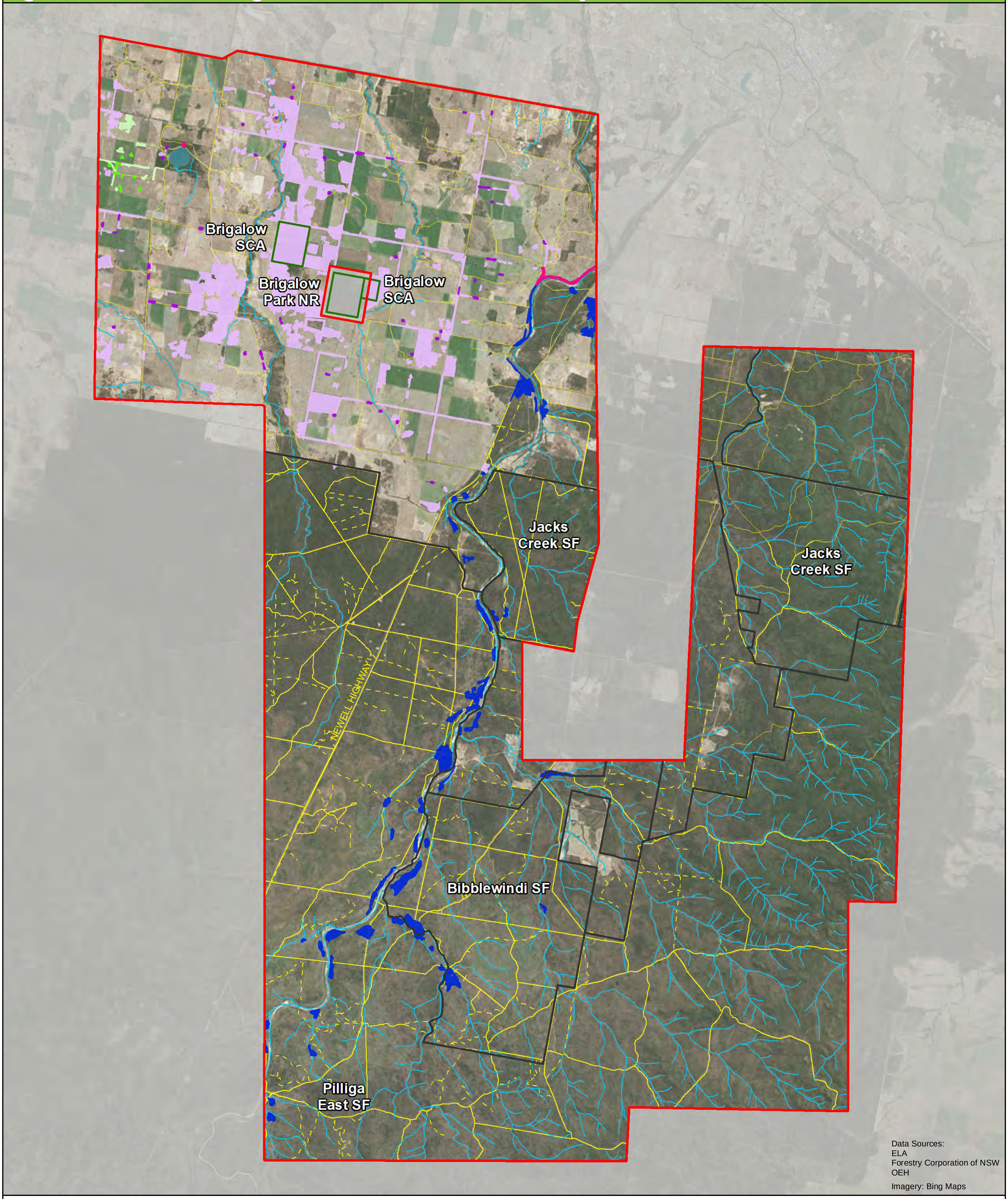
Figure 9: Threatened ecological communities within the development site



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Endangered Ecological Communities (ELA 2014)

- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (TSC Act & EPBC Act)
- Weeping Myall Woodlands (EPBC Act)
- Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (TSC Act & EPBC Act)
- Brigalow (*Acacia* harpophylla dominant and co-dominant) (EPBC Act)
- Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions (TSC Act & EPBC Act)
- Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (TSC Act & EPBC Act)

0 1 2 4
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

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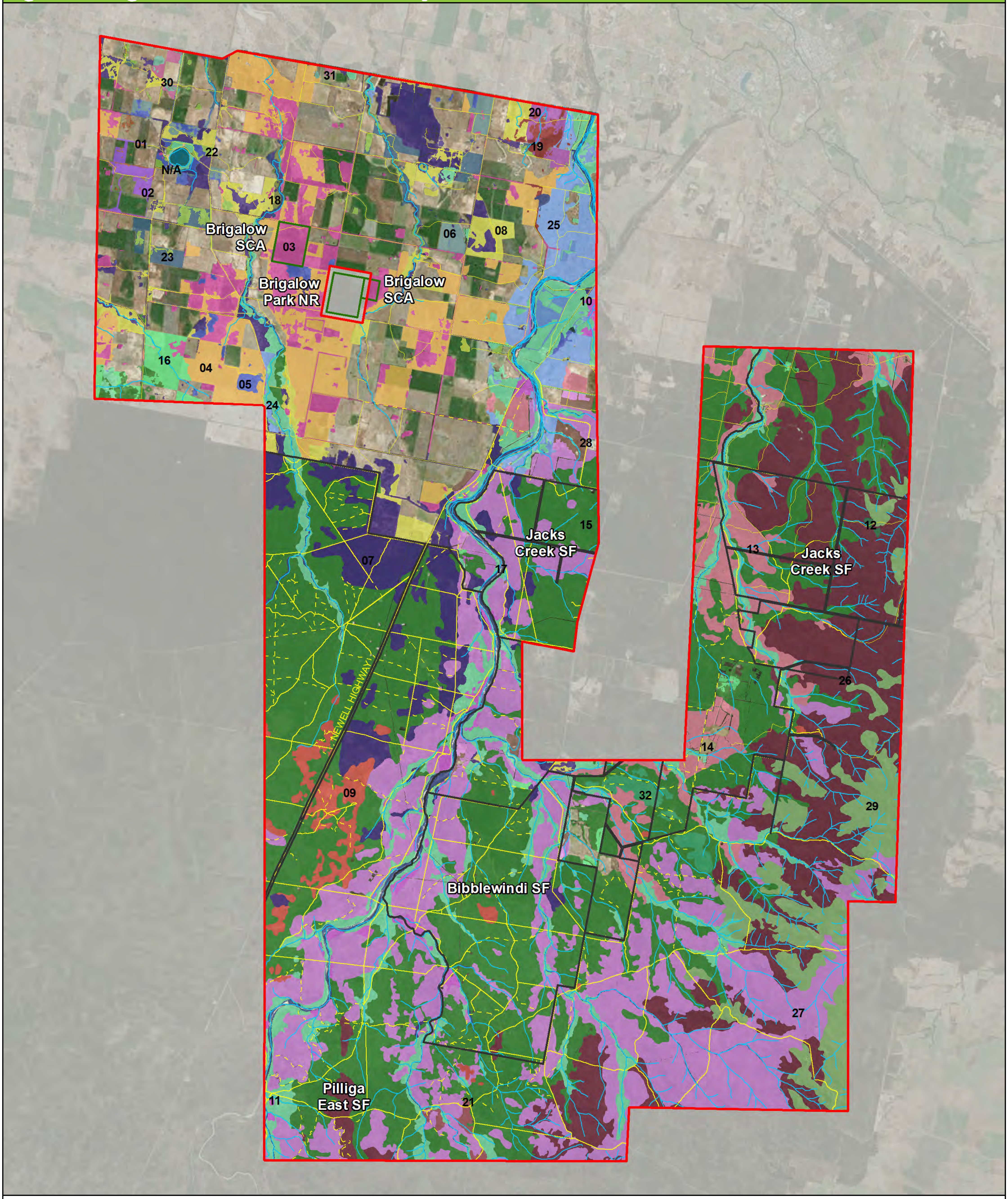
Figure 10: Vegetation zones within the development site



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Vegetation Zones

01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, N/A

0 1 2 4
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

Data Sources:
ELA
Forestry Corporation of NSW
OEH
Imagery: Bing Maps

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5 Threatened species and populations

5.1 Review of existing data

The literature and database review presented in **Sections 1.6.1** and **1.6.2** involved an extensive review of existing data and information to assist in predicting presence of threatened species and populations in the development site (**Figure 6**). The existing survey effort was undertaken during all seasons and across multiple years, contributing to a more thorough understanding of temporal and spatial variation of species.

Habitat associations for those threatened species that were identified as being recorded in the development site were obtained by either reviewing the habitat types or habitat features found to be utilised by each recorded threatened species. This was either through habitat descriptions provided in reports, or correlation with spatial data when the accuracy of the species location was sufficient (**Figure 19** and **Figure 20**). Habitats in which a species were found were recorded as 'known habitat' and habitats that have features that could support a species were recorded as 'predicted habitat'. Threatened species identified as being recorded in the development footprint during the literature review have been included in the overall fauna habitat assessment.

5.2 Ecosystem credit species

The Major Projects Credit Calculator (MPCC) (**Appendix C**) was used to generate a list of ecosystem species predicted at the development site based on the habitat constraint criteria shown in **Table 13**. Two additional ecosystem credit species (Australian Painted Snipe and Large-eared Pied Bat) were added to this list due to the presence of potential habitat in the development site, even though they weren't predicted based on habitat by the MPCC. However, they were not recorded in the development site and could not be added to the credit calculations. A complete list of predicted ecosystem species is shown in **Table 14**. No species were removed from this list for the credit calculations.

Table 13: Ecosystem species constraints within development site

Habitat constraint	Development site
IBRA subregion (s)	Pilliga Outwash and Pilliga#
Associated Plant Community Types	As per Table 10
Condition of Vegetation	Moderate - Good
Patch Size	>1000 ha

Note that the development site extends over two IBRA subregions. Due to the large amount of data for this assessment, the data was split into two to facilitate calculation in the MPCC. Vegetation zones were entered against the Pilliga Outwash subregion.

Table 14: Ecosystem species predicted within development site

Common name	Scientific name	EPBC Act	Threatened species offset multiplier
Australian Bustard	*Ardeotis australis*	Not listed	2.6
Australian Painted Snipe	*Rostratula australis*	Endangered	Not predicted by MPCC
Barking Owl	*Ninox connivens*	Not listed	3
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis* subsp. *gularis*	Not listed	1.3
Brolga	*Grus rubicunda*	Not listed	1.3
Bush Stone-curlew	*Burhinus grallarius*	Not listed	2.6
Corben's Long-eared Bat	*Nyctophilus corbeni*	Vulnerable	2.1
Diamond Firetail	*Stagonopleura guttata*	Not listed	1.3
Gilbert's Whistler	*Pachycephala inornata*	Not listed	1.3
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	Not listed	1.8
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis* subsp. *temporalis*	Not listed	1.3
Hooded Robin (south-eastern form)	*Melanodryas cucullata* subsp. *cucullata*	Not listed	1.7
Large-eared Pied Bat	*Chalinolobus dwyeri*	Vulnerable	Not predicted by MPCC
Little Eagle	*Hieraaetus morphnoides*	Not listed	1.4
Little Lorikeet	*Glossopsitta pusilla*	Not listed	1.8
Little Pied Bat	*Chalinolobus picatus*	Not listed	2.1
Malleefowl	*Leipoa ocellata*	Vulnerable	2.6
Masked Owl	*Tyto novaehollandiae*	Not listed	3
Painted Honeyeater	*Grantiella picta*	Vulnerable	1.3
Pilliga Mouse	*Pseudomys pilligaensis*	Vulnerable	2.6
Speckled Warbler	*Chthonicola sagittata*	Not listed	2.6
Spotted Harrier	*Circus assimilis*	Not listed	1.4
Spotted-tailed Quoll	*Dasyurus maculatus*	Endangered	2.6
Square-tailed Kite	*Lophoictinia isura*	Not listed	1.4
Stripe-faced Dunnart	*Sminthopsis macroura*	Not listed	2.6
Swift Parrot	*Lathamus discolor*	Endangered	1.3
Turquoise Parrot	*Neophema pulchella*	Not listed	1.8
Varied Sittella	*Daphoenositta chrysoptera*	Not listed	1.3
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Not listed	2.2

5.3 Species credit species

5.3.1 Habitat present within development site

The development site supports a range of fauna habitats which have been categorised into nine habitat types for the purpose this assessment (**Table 15**). These habitat types have been mapped at a landscape scale based on fine scale Plant Community Type mapping to predict potential species presence and distribution (**Figure 11**). Each habitat type has a range of habitat features that support threatened fauna species, either for breeding, foraging, roosting or dispersal. The habitat types associated with each threatened species have also been incorporated into an ecological sensitivity analysis (used in the avoidance and minimisation measures presented in **Section 6**) and have been quantified by each species and their corresponding habitat types (i.e. breeding, foraging) for the impact assessment (**Section 7**).

Table 15: Fauna habitat mapped in the development site

Habitat type	PCT ID	Area mapped in development site (ha)	Description
Closed Forest	35, 55	2,827	Closed forests are distributed in the northern portion of the development site and characterised by a dense canopy. The midstorey and ground cover is relatively sparse as a result of the dense canopy. Hollow abundance is low due to the age of the majority of the trees, however some larger hollows and decorticating bark are present. Soil substrate of this habitat type is characterised by a clayey loam soils, which allows surface water to remain for a longer duration than the sandy soils found in the majority of the other habitat types. This ephemeral water pooling creates temporary aquatic habitat, suitable for breeding amphibians and drinking sources for a range of fauna.
Grassland	Many	9,465	The majority of grasslands are located in the north of the development site, as a result of previous clearing of canopy and midstorey structure. There are also small patches of grassland distributed amongst the vegetated areas in the south. Habitat features of grassland include foraging resources (including seeds, pollen and nectar), mosaics of groundcover density (provides tussocks to protect ground fauna from predators) and logs. During rainfall, grasslands in the development site were observed to support ephemeral water bodies.
Grassy Woodland	27, 202, 402, 418	862	Grassy woodland in the development site is predominantly distributed adjacent to riparian habitat along Bohena Creek, with patches also found along Cowallah Creek and Bibblewindi Creek. Other patches of grassy woodland are present in the north of the development site, along roadsides and in paddocks, forming remnant patches in an agricultural landscape. Grassy woodland has a canopy layer of mature eucalypts of up to 30% projected foliage cover. The midstorey is sparse, comprising scattered cypress, shrubs and juvenile eucalypts. The groundcover is dominated by a dense grass layer, with patchy leaf litter, logs and fallen branches and bark. The soil substrate is variable and can consist of loam, sandy loam to light clay soils. The Weeping Myall woodland variation of this habitat type occurs only on cracking clay, black earth or clay loam soils. Fauna habitat features of grassy woodland include foraging resources (seeds, pollen and nectar), mosaics of groundcover density (provides tussocks to protect ground fauna from predators), canopy and midstorey structure suitable for perching and nesting, hollow-bearing trees, decorticating and fallen bark, logs and fallen branches.

Habitat type	PCT ID	Area mapped in development site (ha)	Description
Heath	141, 425	1,041	Heath is distributed within the southern forested portion of the development site. The two major patches are a large patch of Broombush dominated heath, west of Bohena Creek and a large patch of Spur-winged Wattle dominated heath in the centre of the development site, north of Yellow Spring Creek. Additional small patches of heath are scattered throughout the southern half of the development site. Heath lacks a defined canopy layer with occasional canopy species making up less than five percent projected foliage cover. Heath is characterised by a dense heath layer of approximately one to two metres high and over fifty percent projected foliage cover. The heath layer is dominated by one species (either Broombush or Spur-winged Wattle), with a small percentage of other heath species present in patches. The groundcover is very sparse. The soil substrate is loamy sand over sandy clay or shallow sandy soils which is difficult for burrowing species to penetrate and allows surface water to pool. Fauna habitat features of heath includes foraging resources (seeds, pollen and nectar) and mosaics of shrub cover density (provides cover to protect ground fauna from predators).
Heathy Woodland	379, 405, 406, 408, 40X	20,604	Heathy woodland is one of the most abundant habitat types in the development site. The largest continuous patch of heathy woodland is located in the south-eastern corner of the development site. Other large patches are also distributed along creek lines in the southern forested portion of the development site, exterior to riparian habitat. Heathy woodland has a canopy layer of mature eucalypts of approximately 5% – 20% projected foliage cover. The midstorey is often present in two layers, with one layer approximately two to six metres high and a second layer of approximately 0.5 m to one metre high. The second midstorey is the dense heathy layer and can be present up to approximately 80% projected foliage cover. This layer often comprises of a high diversity of heath species. The groundcover is sparse, comprising grasses, leaf litter, logs and fallen branches and bark. The soil substrate is deep sandy soils. Fauna habitat features of grassy woodland include foraging resources (seeds, pollen and nectar), mosaics of heath density (provides clumps of low vegetation to protect ground fauna from predators), canopy and midstorey structure suitable for perching and nesting, hollow-bearing trees, decorticating and fallen bark, logs and fallen branches. The sandy soil provides suitable habitat for burrowing.

Habitat type	PCT ID	Area mapped in development site (ha)	Description
Riparian Woodland	78, 399, 401, 428	7,011	Riparian woodlands are distributed along riparian corridors throughout the development site. The major riparian corridor in the development site is Bohena Creek, which runs south-north through the centre of the development site and supports continuous linear patches of riparian woodland. Additional riparian corridors in the development site dominated by riparian woodland include Bibblewindi Creek, Spring Creek and Cowallah Creek in the south and Jacks Creek and Bundock Creek in the north. Riparian woodland has a canopy layer of mature eucalypts of approximately 5% - 30% projected foliage cover. The midstorey is variable, and in some areas can be a shrubby layer dominated by *Leptospermum* spp. approximately two metres high whereas in other areas it comprises cypress and other shrubs between one metre and three metres high. The groundcover is often dense grasses with abundant logs, fallen branches and bark. Fauna habitat features of riparian woodland also include foraging resources (seeds, pollen and nectar), mosaics of groundcover density (provides tussocks and low shrubs to protect ground fauna from predators), canopy and midstorey structure suitable for perching and nesting, hollow-bearing trees, decorticating and fallen bark, logs and fallen branches.
Shrub Grass Woodland	88, 397, 398	28,225	Shrub grass woodland is one of the most abundant habitat types in the development site. The majority of shrub grass woodland is located on the alluvial plains that run from the northeast to the south west of the development site. Other patches of shrub grass woodland are located on uplands in the south and northwest of the development site. Shrub grass woodland has a canopy layer of mature eucalypts of approximately 5% - 35% projected foliage cover. The midstorey is often dominated by cypress, casuarinas and juvenile eucalypts and ranges from approximately two metres to 10m high. A second midstorey of lower shrubs, approximately one metre to two metres is often present. The groundcover is characterised by dense grasses, with leaf litter, logs and fallen bark and branches also present. The structure of this habitat type is variable with some areas comprising dense midstorey patches and other areas with a fairly sparse midstorey. The soil substrate is variable with areas of sandy loam, clay loam or sandy clay loam. Fauna habitat features of shrub grass woodland include foraging resources (seeds, pollen and nectar), mosaics of groundcover density (provides tussocks and low shrubs to protect ground fauna from predators), canopy and midstorey structure suitable for perching and nesting, hollow-bearing trees, decorticating and fallen bark, logs and fallen branches.

Habitat type	PCT ID	Area mapped in development site (ha)	Description
Shrubby Woodland	256, 404	10,002	Shrubby woodland is most commonly distributed on the uplands in the east of the development site. Smaller patches occur on the uplands in the south of the development site. Shrubby woodland has a canopy layer of mature eucalypts of approximately 5% - 20% projected foliage cover. The midstorey is characterised by a dense shrubby layer of approximately one metre to six metres. The groundcover is often sparse, mainly comprising grasses, leaf litter with logs and fallen bark and branches also present. The soil substrate is loamy sand. Fauna habitat features of shrubby woodland include foraging resources (seeds, pollen and nectar), a complex shrub layer, canopy and midstorey structure suitable for perching and nesting, hollow-bearing trees, decorticating and fallen bark, logs and fallen branches and areas of sandy soils suitable for burrowing.
Water bodies	NA	100	Water bodies in the development site mainly consist of dams which are scattered throughout. Some more permanent water holes were found along creek lines and Yarrie Lake is located in the north of the development site. Rainfall events such as the flooding event observed in 2010 and the infrequent moderate rainfall during the survey period for this assessment created ephemeral ponding of water in depressions in the landscape. However, due to the sandy soils of much of the development site, the ephemeral water sources were not observed to flow for lengthy periods. The clayey loam soils in the north of the development site were observed to retain ephemeral water ponding for a greater period of time following a rainfall event. Water holes that retained water during the drier phases provide a range of habitat features including dense aquatic and fringing vegetation, coarse woody debris and foraging resources adjacent to water in dense shrub and canopy. Yarrie Lake and dams provided some degree of habitat, with occasional fringing vegetation and foraging resources. However, many of the dams have been cleared surrounding the dam and lack aquatic and fringing vegetation. The extended dry periods which are characteristic of the Pilliga make water bodies a valuable habitat resource.

5.3.2 Candidate species

The Major Projects Credit Calculator (**Appendix C**) generated a list of 20 candidate 'species credit' species which required survey. Six additional species credit species; Australasian Bittern, Black-breasted Buzzard, Black-striped Wallaby, *Myriophyllum implicatum,* Regent Honeyeater and *Lepidium monoplocoides*, were added to the list due to potential habitat and records within or adjacent to the development footprint or EPBC listing status (**Table 16**). Desktop and field surveys were conducted for all of these species to identify if the species is present within the development site and hence if further assessment is required. Details of field surveys are provided in the following sections.

Table 16: Likelihood of occurrence of species credit species within development site

Common name	Scientific name	Habitat requirement	EPBC Act	Habitat availability	Likelihood of presence	Assessed in section 7
Australasian Bittern	*Botaurus poiciloptilus*	Tussock and hummock grasslands, preferring the former to the latter. It also occurs in low shrublands and low open grassy woodlands, and is occasionally seen in pastoral and cropping country, golf courses and near dams.	Endangered	Low	Potential (due to use of a range of habitat types)	No
Black-breasted Buzzard	*Hamirostra melanosternon*	Lives in a range of inland habitats including open forests, riverine woodlands, scrubs and heathlands. It is often found along timbered watercourses, which is preferred breeding habitat. It can also hunt over grasslands.	Not listed	Low	Potential (due to use of a range of habitat types)	No
Black-striped Wallaby	*Macropus dorsalis*	Preferred habitat is characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. On the North West Slopes, it is associated with dense vegetation, including brigalow, ooline and semi-evergreen vine thicket.	Not listed	High	Known (recorded in survey)	Yes
Bluegrass	*Dichanthium setosum*	Associated with heavy basaltic black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	Vulnerable	Low	Unlikely (due to lack of associated soils)	No
Commersonia procumbens (syn. *Rulingia procumbens*)	*Commersonia procumbens* (syn. *Rulingia procumbens*)	Grows in sandy sites, often along roadsides. Recorded in *Eucalyptus dealbata* and *E. sideroxylon* communities, *Melaleuca uncinata* scrub, under mallee eucalypts with a *Calytrix tetragona* understorey, and in a recently burnt Ironbark and *Callitris* area. It also occurs in *E. fibrosa*	Vulnerable	High	Known (recorded in survey)	Yes

Common name	Scientific name	Habitat requirement	EPBC Act	Habitat availability	Likelihood of presence	Assessed in section 7
		subsp. *nubila, E. dealbata, E. albens* and *Callitris glaucophylla* woodlands north of Dubbo.				
Coolabah Bertya	*Bertya opponens*	Ranges from stony mallee ridges and cypress pine forest on red soils.	Vulnerable	Moderate	Known (recorded in survey)	Yes
Cyperus conicus	*Cyperus conicus*	Grows in open woodland on sandy soil. In central Australia, it grows near waterholes and on the banks of streams in sandy soils. In Qld the species is usually found on heavy soils. It has been recorded from Callitris forest in the Pilliga area, growing in sandy soil with *Cyperus gracilis*, *C. squarrosus* and *C. fulvus*.	Not listed	Moderate	Unlikely (due to results of extensive surveys)	No
Eastern Pygmy-possum	*Cercartetus nanus*	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight, 2004). In general woodlands and heath are its preferred habitat. Small tree hollows are favoured for nesting during the day, but nests have also been found under bark, in rotten stumps, holes in the ground, old bird nests, Ringtail Possum drays, thickets of vegetation and in the branch forks of tea-trees (Turner & Ward, 1995).	Not listed	Moderate	Known (recorded in survey)	Yes
Five-clawed Worm-skink	*Anomalopus mackayi*	Close to or on the lower slopes of slight rises in grassy White Box woodland on moist black soils, and River Red Gum-Coolibah-Bimble Box woodland on deep cracking loose clay soils. May also occur in grassland areas and open paddocks with scattered trees. Live in permanent deep tunnel-like burrows and deep soil cracks, coming close to the surface under fallen timber and litter, especially partially buried logs.	Vulnerable	Low	Unlikely (due to lack of associated soils and results of extensive survey)	Yes*
Greenhood Orchid	*Pterostylis cobarensis*	Found in Eucalypt woodlands, open mallee or *Callitris* shrublands on low stony ridges and slopes in skeletal sandy-loam soils.	Not listed	High	Known (recorded in survey)	Yes
Grey Falcon	*Falco hypoleucos*	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey .	Not listed	Moderate	Potential (due to use of a	No

Common name	Scientific name	Habitat requirement	EPBC Act	Habitat availability	Likelihood of presence	Assessed in section 7
					range of habitat types)	
Koala	*Phascolarctos cinereus*	Associated with both wet and dry Eucalypt forest and woodland with a canopy cover of approximately 10 –70% (Reed, Lunney, & Walker, 1990), that contains acceptable eucalypt food trees. Primary feed tree in development site: *Eucalyptus camaldulensis*. Secondary food trees in the development site: *E. albens*, *E. blakelyi*, *E. chloroclada*, *E. conica*, *E. dealbata, E. dwyeri*, *E. macrocarpa*, *E. melliodora, E. pilligaensis* and *E. populnea*. Supplementary food tree in development site: *Eucalyptus macrorhyncha*, *Callitris glaucophylla* is common, and is listed as a tree species used for daytime shelter.	Vulnerable	High	Likely (current decline and historical records indicate that development site is not a refuge but may provide habitat in population booms)	No
Myriophyllum implicatum	*Myriophyllum implicatum*	Occurs in moist situations, extending away from fresh water. A recent population was found in NSW in a large open partly inundated gilgai depression on cracking clay soil.	Not listed	Low	Known (recorded in survey)	No^
Narrow Goodenia	*Goodenia macbarronii*#	-	Not listed	-	-	No
Native Milkwort	*Polygala linariifolia*	Occurs in sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of *Eucalyptus caleyi, Eucalyptus dealbata* and *Callitris*, and in yellow podsolic soil on granite in layered open forest.	Not listed	High	Known (recorded in survey)	Yes
Pale-headed Snake	*Hoplocephalus bitorquatus*	Wide range of habitats from rain or wet sclerophyll forest to drier eucalypt forests and favours streamside habitat in drier areas. In the development site the species has been found in redgum communities at Yarrie Lake, remnant roadside and regrowth Brigalow vegetation communities.	Not listed	High	Known (recorded in survey)	Yes

Common name	Scientific name	Habitat requirement	EPBC Act	Habitat availability	Likelihood of presence	Assessed in section 7
Pine Donkey Orchid	*Diuris tricolor*	Grows in sclerophyll forest among grass, often with native Cypress Pine (*Callitris spp.*). 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. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats.	Not listed	High	Known (recorded in survey)	Yes
Prasophyllum sp. Wybong	*Prasophyllum* sp. Wybong	Known to occur in open eucalypt woodland and grassland	Critically Endangered	Low	Unlikely (due to results of extensive surveys)	No
Regent Honeyeater	*Anthochaera phrygia*	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of Casuarina cunninghamiana (River Oak) (S. T. Garnett, 1993). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes. Eucalypts that reliably produce large amounts of nectar occurring in the Pilliga are *E. sideroxylon, E. melliodora* and *E. albens*.	Endangered	High	Potential (due to scattered records and scattered preferred Eucalypts)	Yes*
Rufous Bettong	*Aepyprymnus rufescens*	Mainly inhabits wet sclerophyll forests, often in gullies. When in migratory movement are more likely to occur in dry sclerophyll forests, woodland and more open habitats (DotE, 2014c).	Not listed	Moderate	Potential (due to use of a range of habitat types)	No
Scant Pomaderris	*Pomaderris queenslandica*	Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Not listed	Moderate	Known (recorded in survey)	Yes
Slender Darling Pea	*Swainsona murrayana*	Known from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. 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.	Vulnerable	Low	Unlikely (due to results from extensive surveys)	No

Common name	Scientific name	Habitat requirement	EPBC Act	Habitat availability	Likelihood of presence	Assessed in section 7
Spiny Peppercress	*Lepidium aschersonii*	Found on ridges of gilgai clays dominated by *Acacia harpophylla* (Brigalow), with *Austrodanthonia* and/or *Austrostipa* species in the understorey. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense Brigalow, with sparse grassy understorey and occasional heavy litter.	Vulnerable	Moderate	Known (recorded in survey)	Yes
Squirrel Glider	*Petaurus norfolcensis*	Associated with dry hardwood forest and woodlands (Menkhorst, Weavers, & Alexander, 1988; Quinn, 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al., 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quinn, 1995).	Not listed	High	Known (recorded in survey)	Yes
Tylophora linearis	*Tylophora linearis*	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *E. sideroxylon*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla* and *Allocasuarina luehmannii*.	Endangered	High	Known (recorded in survey)	Yes
Winged Peppercress	*Lepidium monoplocoides*	Known to occur on seasonally moist to waterlogged sites, on heavy fertile soils. In W Pilliga, it was found in White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion vegetation and associated with gilgais.	Endangered	Moderate	Known (recorded in survey)	Yes

Goodenia macbarronii is no longer listed as a threatened species

* Although no individuals were recorded in the development site, the SEARs requirements from OEH listed this species as requiring further consideration.

^ Although this species has been recorded in the development site, the SEARs requirements from OEH listed this species as not requiring further consideration..

5.3.3 Surveys

General and targeted flora and fauna surveys were conducted between 2010 and 2014. General flora survey methods are described in **Section 4.2** with targeted flora survey methods described below. All fauna survey methods are detailed below.

Targeted flora species survey

Targeted surveys for threatened flora considered ‘potential’ or ‘likely’ to occur were undertaken across the development site between spring 2011 to autumn 2014. Additionally, threatened flora were recorded when observed opportunistically during biometric plot surveys. The initial literature and data review identified 14 species with the potential to occur in the development site (**Table 17**).

Targeted flora – 2011 surveys

In October 2011, targeted threatened flora surveys were undertaken within a 6,450 ha area (wholly contained with the development site for this assessment) with the purpose of locating threatened plants within a previously proposed development footprint. A total of 79 sites (10 ha each) and an associated network of gathering systems were traversed over a total length of 447 km and a search area of 446 ha with counts for all threatened flora species observed recorded.

The data obtained from the searches was used to model and estimate the threatened species population sizes in the development site.

Targeted flora – 2012 surveys

In September and October 2012, a broader targeted threatened species survey of the north-east Pilliga (incorporating the development site) was undertaken over a 229,857 ha area. Sites for targeted searches were selected based on the specific habitat requirements for each threatened species. A total of 79 sites were sampled in the 2012 survey. Within each site between one and five strip-quadrats were surveyed (306 in total), with each quadrat being 250 m in length and covering a 10 m width. A total length of 153 km was traversed and a search area of 76.5 ha covered. The surveys were conducted to provide detailed information on population size, distribution and habitat requirements for threatened flora populations within the north-east Pilliga. The data obtained from the searches were used to model and estimate threatened species population sizes in the development site through a stratified survey approach based on areas of suitable habitat.

Targeted flora – 2014 surveys

Detailed population distribution and abundance mapping was undertaken for *Bertya opponens* (Coolabah Bertya) and *Pomaderris queenslandica* (Scant Pomaderris) in the development site in 2014. The number of individuals of *B. opponens* and *P. queenslandica* within the development site was estimated by defining the distribution of the species within the development site and by determining the density of the species across its distribution. The approximate extent of each species within the development site was determined by locating the limits of the population along existing tracks and by surveying suitable habitat around existing records. Supplementary surveys in areas of suitable habitat were also undertaken to identify new populations of each species. Once the approximate limits of the distribution of the species within the development site was determined, traverses of areas between known records were conducted to determine if each species formed a single continuous population within the development site, or if discrete populations of the species were present, separated by large areas where the species was absent.

The approximate density of *B. opponens* within its distribution in the development site was then sampled along 23 strip-quadrats of 10 m x 100 m (total area 1,000 m^2). This involved two ecologist walking the transects (each covering an area of 5 m x 100 m) and counting the number of individuals present. These transects were located at regular intervals from a random starting location and distributed across the species extent within the development site. From these transects a mean density for the species across its distribution was determined and an estimate of the total population size was made.

The approximate density of *P. queenslandica* was determined by surveying suitable habitat around existing records of the species and counting the number of individuals of the species encountered within each population. Where large populations of the species were located, the total number of individuals within the population was determined by counting the number of individuals in smaller sub populations (where accurate counts could be performed) or by measuring the density of individuals within a small representative portion of the population, and multiplying this density across the entire area of the population or subpopulation. The density within representative portions of large populations was measured by counting the number of individuals within a fixed area, along transects through the population, or by measuring distances between plants within a population, or by a combination of these methods.

Populations of these two species were mapped as they occurred in defined locations, compared with other species in the development site which occurred across broad areas and vegetation types and could be reliably modelled.

Table 17: Threatened flora species targeted during field survey

Scientific name	Common name	Status	
		TSC Act	EPBC Act
Bertya opponens	Coolabah Bertya	V	V
Cyperus conicus	-	E1	~
Diuris tricolor	Pine Donkey Orchid / Painted Diuris	V	Delisted
Homopholis belsonii	Belson’s Panic	E1	V
Lepidium aschersonii	Spiny Peppercress	V	V
Lepidium monoplocoides	Winged Peppercress	E1	E
Monotaxis macrophylla	Large-leafed Monotaxis	E1	~
Myriophyllum implicatum	-	CE	~
Philotheca ericifolia	-	Delisted	V
Polygala linariifolia	Native Milkwort	E1	~
Pomaderris queenslandica	Scant Pomaderris	E1	~
Pterostylis cobarensis	A Greenhood Orchid	V	Delisted
Commersonia procumbens	-	V	V
Tylophora linearis	-	V	E

V- vulnerable; E1- endangered under the TSC Act; E- endangered under the EPBC Act and TSC Act; Delisted – no longer listed under relevant legislation (TSC or EPBC Act)

Fauna survey timing

Nine fauna surveys were undertaken by ELA ecologists between 2011 and 2014, specifically for this assessment (**Table 18**). A regional Koala survey was also undertaken specifically for this assessment by both Niche Environment and Heritage and ELA ecologists. Additional surveys undertaken in the development site both by ELA (for other site specific activities) and other scientists have been included in this report and discussed in **Section 5.1**.

Initial reconnaissance of the development site was undertaken by ELA ecologists (30 November and 1 December 2010) followed by detailed fauna surveys (11 – 20 January 2011). Field work was proposed to commence following initial reconnaissance in 2010, however had to be postponed due to heavy rain and widespread flooding in the region.

From this initial survey, a series of targeted fauna surveys were undertaken. These involved a targeted *Anthochaera phrygia* (Regent Honeyeater) survey (21 – 26 October 2012), targeted *Pseudomys pilligaensis* (Pilliga Mouse) and *Dasyurus maculatus* (Spotted-tailed Quoll) surveys (5 – 11 May 2013 & 26 May – 1 June 2013), a targeted winter migratory bird survey (21 – 26 July 2013) and a targeted amphibian and reptile survey (7 – 11 April 2014). Two subsequent detailed fauna surveys were undertaken targeting habitats within the Pilliga (13 – 18 October 2013 and 3 – 8 November 2013) and north of the Pilliga (8 – 18 December 2013 and 12 – 25 January 2014). The regional Koala survey was undertaken between 28 April and 8 May 2014.

Table 18: Fauna survey timing

Survey number	Survey name	2010	2011	2012	2013						2014		
		December	January	October	May	June	July	October	November	December	January	April	May
1	Initial reconnaissance												
2	Detailed fauna survey												
3	Regent Honeyeater targeted survey												
4	Pilliga Mouse targeted survey												
5	Spotted-tailed Quoll targeted survey												
6	Winter migratory bird targeted survey												
7	Fauna survey – forest												
8	Fauna survey – northern												
9	Amphibian and reptile targeted survey												
10	Regional Koala survey												

Fauna survey design

Fauna surveys were designed following survey methods and habitat stratification procedures of the *Draft Threatened Biodiversity Survey and Assessment Guidelines* (DEC, 2004), the *NSW Threatened species survey and assessment guidelines for amphibians* (DECC, 2009), relevant federal government survey guidelines as they became available (DEWHA, 2010a, 2010b, 2010c, DSEWPaC, 2011a, 2011b) and *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC, 2011).

Following the database and literature review, the survey methods were designed to sample both a broad range of taxa, and to specifically target those threatened fauna that were considered 'potential', 'likely' or 'known' to occur in the development site (**Table 19**). Survey effort and details for each of these survey methods is provided below and presented in **Figure 13** to **Figure 18**.

Table 19: Fauna targeted by each survey method

Survey method	Fauna groups targeted	Species targeted
Arboreal trapping and sampling		
Elliott trapping (tree-mounted)	Arboreal mammals	*Petaurus norfolcensis* (Squirrel Glider), *Cercartetus nanus* (Eastern Pygmy Possum)
Hair sampling (tree-mounted) – universal bait	Arboreal mammals	Squirrel Glider, Eastern Pygmy Possum
Terrestrial trapping and sampling		
Cage trapping	Medium terrestrial mammals	*Aepyprymnus rufescens* (Rufous Bettong), Spotted-tailed Quoll
Elliott trapping	Small terrestrial mammals	Pilliga Mouse
Funnel trapping	Reptiles	*Hoplocephalus bitorquatus* (Pale-headed Snake)
Hair sampling – fish bait	Carnivorous terrestrial mammals	Spotted-tailed Quoll
Hair sampling – universal bait	Terrestrial mammals	*Macropus dorsalis* (Black-striped Wallaby), Pilliga Mouse
Pitfall trapping	Mammals, reptiles	Pilliga Mouse, Eastern Pygmy Possum
Sand plot	Mammals, reptiles	-
Diurnal searches		
Diurnal bird census	Birds	Regent Honeyeater, *Lathamus discolor* (Swift Parrot), *Polytelis swainsonii* (Superb Parrot), *Calyptorhynchus lathami* (Glossy Black-cockatoo), *Glossopsitta pusilla* (Little Lorikeet), *Neophema pulchella* (Turquoise Parrot), *Circus assimilis* (Spotted Harrier), *Falco subniger* (Black Falcon) (once listed), *Hieraaetus morphnoides* (Little Eagle), *Lophoictinia isura* (Square-tailed Kite), *Chthonicola sagittata* (Speckled Warbler), *Daphoenositta chrysoptera* (Varied Sittella), *Melanodryas cucullata cucullata* (Hooded Robin (south-eastern form)), *Pomatostomus temporalis temporalis* (Grey-crowned Babbler (eastern subspecies)), *Stagonopleura guttata* (Diamond

Survey method	Fauna groups targeted	Species targeted
		Firetail), *Grantiella picta* (Painted Honeyeater), *Apus pacificus* (Fork-tailed Swift), *Ardea modesta* (Great Egret), *Haliaeetus leucogaster* (White-bellied Sea-eagle), *Hirundapus caudacutus (*White-throated Needletail), *Merops ornatus* (Rainbow Bee-eater), *Myiagra cyanoleuca* (Satin Flycatcher)
Diurnal reptile search	Reptiles	*Anomalopus mackayi* (Five-clawed Worm-skink)
Microbat surveys		
Echolocation recording (Song Meter and Anabat)	Microbats	*Chalinolobus dwyeri* (Large-eared Pied Bat), *Chalinolobus picatus* (Little Pied Bat), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat), *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat), *Vespadelus troughtoni* (Eastern Cave Bat)
Harp trapping	Microbats	*Nyctophilus corbeni* (South-eastern Long-eared Bat), Little Pied Bat
Nocturnal surveys		
Call playback	Nocturnal birds and mammals	*Ninox connivens* (Barking Owl), *Tyto novaehollandiae* (Masked Owl), *Burhinus grallarius* (Bush-stone Curlew), Koala, Squirrel Glider
Nocturnal amphibian search	Amphibians	*Crinia Sloanei* (Sloan's Froglet)
Spotlighting	Nocturnal mammals, birds, reptiles	Pale-headed Snake and species targeted in call playback
Stream search	Nocturnal mammals, birds, reptiles	Pale-headed Snake and species targeted in call playback
Remote recording surveys		
Diurnal call recording (Song Meter)	Birds	Regent Honeyeater
Remote camera – fish / chicken bait	Carnivorous terrestrial mammals	Spotted-tailed Quoll
Remote camera – universal bait	Terrestrial mammals	Black-striped Wallaby
Habitat surveys		
Koala habitat assessment	Koala	Koala
Spot assessment technique (SAT) survey	Koala	Koala

Survey method	Fauna groups targeted	Species targeted
Opportunistic surveys		
Scat collection	Carnivorous predator species, prey species	-
Opportunistic observations	All fauna	-

Arboreal trapping and sampling - Elliott trapping

For the initial survey effort (2011), B type Elliott traps (for medium sized mammals) were secured to a wooden platform that was screwed at approximately 90 degrees to a tree 2 m above the ground. Traps were set in trees (with hollows when possible) proximate to every fourth Elliott trap along the terrestrial Elliott transects. All traps were baited with a mixture of rolled oats, bird seed, peanut butter, honey and vanilla essence; and leaf litter was placed in Elliotts for bedding. A honey and water mixture (approximately 1:5 ratio) was sprayed on the tree trunks supporting the traps to lure arboreal fauna to the trap. Traps were set from four to eight consecutive nights.

For the subsequent survey effort (2013 – 2014), A type Elliott traps (for small sized mammals) and B type Elliott traps were deployed along two parallel lines of six traps alternating between A and B type Elliotts. Traps were mounted to trees in a similar fashion to the initial survey (2011), and covered with a bag (calico, hessian or pillow slip) for added protection from the weather. Quilt batting was placed inside the trap for bedding along with a bait of rolled oats, peanut butter, honey and truffle oil (3:3:1:trace). A honey and water solution (approximately 1:3 ratio) was sprayed above and below each trap to lure arboreal fauna to the trap. Traps were set for four consecutive nights.

All traps were checked daily by two ecologists within the first three hours of sunlight. All fauna caught were identified to species level and released at the point of capture.

Arboreal Elliott trapping survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 20**.

Table 20: Arboreal Elliott survey effort

Habitat	Trap nights per Elliott trap size							
	ELA[1]		ELA[2]		Other[3]		Total	
	A	B	A	B	A	B	A	B
Closed Forest	48	48	-	-	-	24	48	72
Grassy Woodland	72	72	-	-	-	-	72	72
Heathy Woodland	72	112	-	-	-	120	72	232
Riparian Woodland	96	226	-	-	-	40	136	266
Shrub Grass Woodland	120	230	96	96	-	112	216	438
Shrubby Woodland	72	72	-	-	-	-	72	72

[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants including RPS and Kendall & Kendall (excluding survey effort from (Kendall and Kendall Ecological Consultants, 2005, 2006) reports as Elliott trapping effort was not distinguished as arboreal or terrestrial). Note A = A sized Elliott trap for small mammals; B = B sized Elliott trap for medium sized mammals.

Arboreal trapping and sampling – hair sampling

For the initial survey effort (2011) large (70 mm x 110 mm) PVC pipe hair tubes were mounted in trees with nails or packing tape proximate (within 5 m) to the terrestrial hair tube transect, with the exception of one transect which was placed independent of the terrestrial hair tubes, due to the lack of trees in the heath habitat type. Double sided sticky tape was placed inside the entrance to each tube to collect hair samples. A bait mixture of rolled oats, bird seed, peanut butter, honey and vanilla essence was placed in an inaccessible bait chamber to lure arboreal fauna into the tubes. Hair tubes were deployed in the field for eight nights.

For the subsequent survey effort (2013 – 2014), small (50 mm) and large (70 mm x 110 mm) hair tubes were set up in pairs proximate (within 5 m) to the terrestrial hair tube pairs. The hair tubes were mounted using cable ties in trees or in tall shrubs in the absence of trees. Double sided sticky tape was placed inside the entrance to each tube to collect hair samples. A mixture of rolled oats, peanut butter, honey and truffle oil (3:3:1:trace) was placed in an inaccessible bait chamber. Hair tubes were deployed the field for between eight and 21 days.

Hair funnels were mounted in trees proximate (within 5 m radius) to the terrestrial hair funnel stations using screws. A mixture of rolled oats, peanut butter, honey and truffle oil (3:3:1:trace) was placed in an inaccessible bait chamber. The internal surface of the cone was equipped with a 'faunagoo wafer', a removable styrene card coated in a pressure sensitive glue-like substance to collect hair samples. Hair funnels were deployed in the field for six days.

Hair samples collected during all survey effort were identified by Hans Brunner (mammalian hair analysis expert).

Arboreal hair sampling survey effort from this assessment and the literature review is presented in **Table 21**.

Table 21: Arboreal hair tube and hair funnel survey effort

Habitat	Trap nights per trap type					
	ELA[1]		Other[2]		Total	
	HT	HF	HT	HF	HT	HF
Closed Forest	-	60	-	-		60
Grassy Woodland		-	-	-		-
Heathy Woodland	420	60	300	-	720	60
Riparian Woodland	1160	-	-	-	1160	-
Shrub Grass Woodland	320	60	-	80	320	140
Shrubby Woodland	1000	-	-	-	1000	-

[1] ELA surveys for this assessment; [2]Other consultants includes RPS and Kendall & Kendall; HT – Hair funnel; HF – Hair funnel.

Terrestrial trapping and sampling – Elliott trapping

For the initial survey effort (2011) a combination of A and B type Elliott traps were used. Each site consisted of traps set along a transect, with 20 A type Elliotts spaced 10 m – 15 m apart, and five B traps set near every fourth A type Elliott. Traps were baited with a mixture of rolled oats, bird seed, peanut butter, honey, and vanilla essence; and leaf litter was placed in each Elliott trap for bedding. Traps were set from four to eight consecutive nights.

For the subsequent survey effort (2013 – 2014) a combination of A and E type Elliott traps (for small sized mammals) were used. Each site consisted of a grid configuration of six by six traps spaced at approximately 10 m apart, comprising 12 E type Elliotts and 24 A type Elliotts. Traps were baited with a mixture of rolled oats, peanut butter, honey and truffle oil (at a ratio of 3:3:1:trace). Quilt batting was inserted as bedding and traps were covered with a calico or hessian bag. Traps were set from three to five consecutive nights.

All traps were checked daily by two ecologists within the first three hours of sunlight. All fauna caught were identified to species level and released at the point of capture.

Terrestrial Elliott trapping survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 22**.

Table 22: Terrestrial Elliott survey effort

Habitat	Trap nights per Elliott trap size													
	ELA[1]			ELA[2]			Other[3]				Total			
	A	B	E	A	B	E	A	B	E	NS[4]	A	B	E	NS[4]
Closed Forest	240	-	48	-	-	-	100	100	-	-	340	100	48	-
Grassy Woodland	324	-	72	-	-	-	-	-	-	-	324	-	72	-
Heath	208	-	80	-	-	-	150 or 200	-	-	-	358 or 408	-	80	-
Heathy Woodland	1,446	40	406	-	-	-	1,060 or 1260	48	62	700	2,506 or 2,706	88	468	700
Riparian Woodland	1,220	130	128	-	-	-	345	36	40	200	1565	166	168	200
Shrub Grass Woodland	1,020	110	104	288	288	-	521	317	20	300	1829	715	124	300
Shrubby Woodland	466	-	146	-	-	-	750 or 1,000	-	-	-	1,216 or 1,466	-	146	-

[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants including RPS, Kendall & Kendall (excluding survey effort from Kendall and Kendall Ecological Consultants, 2005, 2006 reports as Elliott trapping effort was not distinguished as arboreal or terrestrial), NICE & TWS (two possible values are given where Landmark Ecological Services & The Wilderness Society 2012 report only specified number of traps over 3 or 4 nights); [4]Trap size not specified. Note A = A sized Elliott trap for small mammals; B = B sized Elliott trap for medium sized mammals; E = E sized Elliott trap for small mammals.

Terrestrial trapping and sampling – cage trapping

For the initial survey effort (2011) five wire cage traps (20 cm x 20 cm x 56 cm) were set at each site. Cage traps were placed at every fourth A type Elliott trap on terrestrial Elliott transects, approximately 30 m – 45 m apart. Traps were baited with a mixture of rolled oats, bird seed, peanut butter, honey and canned sardines. Traps were set from four to eight consecutive nights.

For the subsequent survey effort (2013 – 2014) five to six wire cage traps (20 cm x 20 cm x 56 cm) were set at each site. Each trap was draped in hessian or a pillow case and was spaced at approximately 100 m intervals. During the spring survey, all five traps were baited with rolled oats, peanut butter, honey and truffle oil (at a ratio of 3:3:1:trace). During the summer survey, three traps were baited with the same bait used in the spring survey, and three traps were baited with fish bait, made of sardines, flour and tuna oil (at a ratio of 2:2:1). Trap transects were established along roads, with traps located approximately 30 m – 50 m from road edge. Traps were set for four consecutive nights.

All traps were checked daily by two ecologists within the first three hours of sunlight. All fauna caught were identified to species level and released at the point of capture.

Cage trapping survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 23**.

Table 23: Terrestrial cage trapping survey effort

Habitat	Trap nights			
	ELA[1]	ELA[2]	Other[3]	Total
Closed Forest	-	-	24	24
Grassy Woodland	20	-	4	24
Heathy Woodland	84	-	36	120
Riparian Woodland	198	-	28	226
Shrub Grass Woodland	174	-	144	318
Shrubby Woodland	60	-	-	60

[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants (Kendall and Kendall Ecological Consultants, 2005, 2006, 2007, 2009, RPS, 2012b, 2013b).

Terrestrial trapping and sampling – pitfall and funnel trapping

Pitfalls and funnel traps were set along a 30 m x 40 cm dampcourse drift fence transect at each site, comprising two paired funnel traps, two 20 L bucket pitfalls traps and two 150 mm wide x 40 cm deep PVC pipe pitfall traps. A bed of leaf litter was placed in each pitfall. Funnel traps were covered in additional shade cloth. During hot weather events, small 60 ml water baths we also placed in pitfalls. Traps were not baited.

In rocky areas, areas with hard-set clay earths, or sites targeting potential Pale-headed Snake habitat, transects of only funnel traps were set. At these sites, five or six pairs of funnels traps were placed along the 30 m drift fence. Additionally, funnel traps were placed along fallen logs, as the logs performed the same function as a drift fence (i.e. to direct fauna into the traps). Traps were set for three to four consecutive nights.

All traps were checked daily by two ecologists within the first three hours of sunlight. All fauna caught were identified to species level and released at the point of capture. Invertebrates (such as ants or beetles) captured in the pitfall were removed each morning.

Pitfall and funnel trapping survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 24**.

Table 24: Pitfall and funnel trapping survey effort

Habitat	Trap nights per trap method							
	ELA[1]		ELA[2]		Other[3]		Total	
	Pitfall	Funnel	Pitfall	Funnel	Pitfall	Funnel	Pitfall	Funnel
Closed Forest	8	90	-	-	-	-	8	90
Grassy Woodland	40	88	-	-	-	-	40	88
Heath	24		-	-	-	-	24	-
Heathy Woodland	161	144	-	-	133	78	294	222
Riparian Woodland	102	304	-	-	119	54	221	358
Shrub Grass Woodland	72	200	32	32	227	44	331	276
Shrubby Woodland	63	228	-	-	-	-	63	228

[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants including (Kendall and Kendall Ecological Consultants, 2005, 2006, 2007, 2009, RPS, 2013b, 2013c, 2013d) (survey effort by Landmark Ecological Services & The Wilderness Society not included as specific survey details were not provided in report).

Terrestrial trapping and sampling – hair sampling

For the initial survey effort (2011) ten small (50 mm) PVC pipe hair tubes were placed along a transect at each site, and placed approximately 10 m – 15 m apart. Each hair tube was equipped with double-sided sticky tape at the entrance of the tube to collect hair samples. A mixture of rolled oats, bird seed, peanut butter, honey and vanilla essence was placed in an inaccessible bait chamber to lure fauna to the tubes. Hair tubes were deployed in the field for eight nights.

For the subsequent survey effort (2013 – 2014), hair samples were collected using a combination of small (50 mm) and large (70 mm x 110 mm) PVC pipe hair tubes; and hair funnels.

Small and large hair tubes were placed in pairs along a transect of ten stations, approximately 100 m apart. The paired set of hair tubes at each station was placed in proximity to each other (within a 5 m radius); and were positioned to target areas of high fauna movement. U-shaped wire pegs were used to secure the tubes to the ground. Double sided sticky tape was placed inside the entrance to each tube to collect samples. A mixture of rolled oats, peanut butter, honey and truffle oil (at a ratio of 3:3:1:trace) was placed in an inaccessible bait chamber to lure fauna to the tubes. Hair tubes were deployed in the field for between 21 and 22 days.

Hair funnels were placed in pairs along a transect of ten stations, approximately 100 m apart. The paired set of hair funnels at each station was placed approximately 10 m apart from each other. Each station comprised one funnel baited with a mixture of rolled oats, peanut butter, honey and truffle oil (at a ratio of 3:3:1:trace) and a second funnel baited with a mixture of flour, sardines and tuna oil (at a ratio of 2:2:1). All bait was placed in an inaccessible bait chamber to lure fauna to the funnels. The internal surface of the cone was equipped with a 'faunagoo wafer', a removable styrene card coated in a pressure sensitive glue-like substance to collect hair samples. Tent pegs were used to secure funnels to the ground. Hair funnels remained in the field for six days.

Hair samples collected during all survey effort were identified by Hans Brunner.

Terrestrial hair sampling survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 25**.

In addition to this survey effort, four hair funnels were installed over seven nights at a site with a previous unconfirmed record of Rufous Bettong, south-west of the development site. The hair funnels were baited with rolled oats, peanut butter, honey and truffle oil (3:3:1:trace).

Table 25: Terrestrial hair tube & hair funnel survey effort

Habitat	Trap nights per trap type							
	ELA[1]				Other[2]		Total	
	HT-u	HT-f	HF-u	HF-f	HT	HF	HT	HF
Closed Forest	-	-	60	60	-		-	120
Grassy Woodland	-	420	-	-	-	-	420	-
Heath	1,440	-	-	-	-	-	1,440	-
Heathy Woodland	1,680	400	60	60	300	226	2,380	346
Riparian Woodland	1,170	4,450	-	-	90	186	5,710	186
Shrub Grass Woodland	620	-	60	60	90	246	710	366
Shrubby Woodland	624	464	-	-	-	-	1,088	-

[1] ELA surveys for this assessment; [2]Other consultants includes (Kendall and Kendall Ecological Consultants, 2007, 2009, RPS, 2012b, 2013a, 2013b, 2013c); HT – Hair funnel; HF – Hair funnel; u – universal bait; f – fish bait.

Terrestrial trapping and sampling – sand plots

Four sand plots were raked along sandy tracks during the evening and revisited early morning to identify fauna using tracks. The sand plots were approximately three metres long and covered the entire width of the road. All prints and tracks were identified to as low a taxonomic level as possible.

Microbat survey – harp trapping

Microbat species were surveyed using two standard 4.2 m^2 double-bank harp traps coupled with two ultrasonic echolocation recorders (Anabat described below) at each site. Due to the open nature of the mainly woodland habitat types and resultant width of flyways, two harp traps were used together at each site. Harp traps were set prior to dusk for two consecutive nights per survey site and checked each morning before 9.30am. All bats captured were identified to the lowest taxonomic level possible, held in canvas bags during the day prior to and post-identification, for later release at point of capture after dusk.

Harp trapping survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 26**.

Microbat survey – Echolocation recording

At all standard harp trap sites, two Anabat SD2 Bat Detector units (Titley Electronics) were set up for the two survey nights. Where possible an Anabat unit was aligned within the flyway and the second unit placed perpendicular to the site as the Anabat microphone is directional. Each unit was set with a start time delay for 7pm and finish time of 6am.

Song Meter SM2BAT+ (Wildlife Acoustics Inc.) ultrasonic recorders were also used to record microbat calls and are described in more detail in "*Remote recording survey – Echolocation recording*".

Anabat data from the initial survey was processed by Anna Lloyd (independent bat call analysis expert). Anabat data (including Song Meter data) from the subsequent survey was processed by ELA Ecologist, Peter Knock (spring 2013), ELA Fauna Ecologist Alicia Scanlon (summer 2014) and Dr Anna McConville (summer 2014). Peter Knock conducted the majority of microbat field assessments and provided habitat specific knowledge to the data processing team to assist with queries during the call identification process.

Anabat recording survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 26**.

Table 26: Harp trap and Anabat survey effort

Habitat	Trap nights							
	ELA[1]		ELA[2]		Other[3]		Total	
	H	A	H	A	H	A	H	A
Closed Forest	4	12	-	-	2	6	6	18
Grassland	-	-	-	-	-	4	-	4
Grassy Woodland	8	16	-	-	3 or 6	4	11 or 14	20
Heath	-	-	-	-	-	-	-	-
Heathy Woodland	8	12	2	2	13 or 22	32	23 or 32	46
Riparian Woodland	48	52	4	4	13 or 20	36	65 or 72	92
Shrub Grass Woodland	56	64	28	18	34 or 36	45	118 or 120	127
Shrubby Woodland	24	28	-	-	2 or 4	3	26 or 28	31

H – Harp trap; A – Anabat.
[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants including RPS, Kendall & Kendall (excluding Kendall and Kendall Ecological Consultants 2006 and Kendall and Kendall Ecological Consultants 2009 as no specific trap night details were provided in report); and two possible values are given where the Landmark Ecological Services & The Wilderness Society 2012 report only specified number of traps over 3 or 4 nights).

Diurnal survey – bird census

A species time-curve survey technique was applied for this survey method. Each survey was conducted by two ecologists and consisted of an initial 20 minute census, recording all bird calls and observations. After 20 minutes, an extra five minutes was added to the survey for each additional species recorded. This survey technique ensures a maximum number of species is recorded at each site.

Diurnal bird survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 27**.

Table 27: Diurnal bird survey effort

Habitat	Person hours			
	ELA[1]	ELA[2]	Other[3]	Total
Closed Forest	2.67	1.33	0.66	4.66
Grassland	4.83			4.83
Grassy Woodland	28.80	-	-	28.80
Heath	17.60	-	-	17.60
Heathy Woodland	7.50	4.17	4.00	15.67
Riparian Woodland	71.83	3.50	4.00	79.33
Shrub Grass Woodland	15.70	6.83	4.32	26.85
Dam	5.00	-		5.00

[1]ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants includes RPS (not including effort from (RPS, 2012a) as no specific survey details were provided.

Diurnal survey – diurnal call recording

Song Meter SM2+ (Wildlife Acoustics Inc.) sound recorders were also used to record bird calls and are described in more detail in "*Remote recording survey – Echolocation recording*".

Diurnal survey – reptile search

Reptiles were targeted using active diurnal searches in suitable habitat. Diurnal searches involved identifying basking individuals by sight; and searching fallen logs, decorticating and fallen bark, rock outcrops and raking of substrate material to target more cryptic species. Diurnal searches were conducted by two to four ecologists for periods up to an hour.

Diurnal reptile survey effort from this assessment and the literature review is presented in **Table 28**.

Table 28: Diurnal reptile search effort

Habitat	Person hours		
	ELA[1]	Other[2]	Total
Closed Forest	15.23	-	15.23
Heathy Woodland	2.17	-	2.17
Riparian Woodland	16.80	-	16.80
Shrub Grass Woodland	15.20	9.00	24.20
Shrubby Woodland	7.67	-	7.67

[1]ELA surveys for this assessment; [2]Other consultants includes RPS and Kendall & Kendall (not including (Kendall and Kendall Ecological Consultants, 2007; RPS, 2012a) as no specific survey details were provided).

Nocturnal survey – spotlighting

For the initial survey effort (2011), spotlighting transects were conducted in vehicles by two ecologists for approximately one hour per transect, travelling at 10 km/h. The search targeted arboreal fauna, concentrating in the canopy and mid-strata levels of vegetation. A hand held spotlight (12 V 100 watt) was used to detect eye shine of nocturnal fauna.

For the subsequent survey effort (2013 – 2014), spotlighting transects were conducted in vehicles and on foot. Spotlighting in vehicles was carried out opportunistically whilst travelling between sites by two ecologists, travelling at 5 km/h. Spotlighting on foot was carried out by two ecologists along a 1 km transect, searching for approximately 30 minutes. Each site was surveyed twice. A hand held spotlight was used to detect eye shine of nocturnal fauna (EagleTac M3C4 920 lumen; LED Lenser P14 200 lumen; or a 12 V 100W spotlight).

Spotlighting survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 29**. Note this table doesn't include the nocturnal survey effort undertaken for the targeted amphibian and reptile survey presented further below.

Table 29: Spotlighting survey effort

Habitat	Person hours			
	ELA[1]	ELA[2]	Other[3]	Total
Closed Forest		-	3.00	3.00
Heathy Woodland		-	6.00	6.00
Riparian Woodland	16.10	-	-	16.10
Shrub Grass Woodland	8.00	2.67	21.00	31.67
Shrubby Woodland	4.00	-	-	4.00
Multiple habitat types	6.00	-	-	6.00

[1]ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants includes (Kendall and Kendall Ecological Consultants, 2005, 2006, 2007, 2009, RPS, 2013a, 2013b, 2013c) (not including effort from Landmark Ecological Services & The Wilderness Society 2012 as no specific spotlight survey details were provided in the report); Opportunistic spotlighting not included.

Nocturnal survey – stream searches

Two ecologists traversed targeted habitat at night for one hour periods at each site. Ecologists targeted habitat with tree hollows, and carried out searches of upper branches and tree trunks, fallen logs and decorticating and fallen bark. A hand held spotlight was used to detect eye shine of nocturnal fauna (EagleTac M3C4 920 lumen; LED Lenser P14 200 lumen; or a 12 V 100W spotlight).

Nocturnal stream search survey effort is presented in **Table 30**.

Table 30: Nocturnal stream search effort

Habitat	Person hours		
	ELA[1]	Other[2]	Total
Riparian Woodland	16	-	16

[1] ELA surveys for this assessment; [2]Other consultants

Nocturnal survey – call playback

Call playback involved listening for fauna vocalisations, spotlighting and broadcasting using a 15W amplifier. All species identified by vocalisation or by sight were recorded. The structure of a full call playback site is presented in **Table 31**. Up to five species were targeted during the call playback survey, however not all sites targeted all five species.

The number of consecutive nights of call playback varied between species. Koala call playback was undertaken over two consecutive nights. Other species were undertaken over a minimum of four consecutive nights, with the aim of surveying Barking Owl for five consecutive nights and Masked Owl for eight consecutive nights (although this was not always possible). If the target species was recorded, call playback for the recorded species ceased at that site.

Call playback survey effort is presented in **Table 32**. This table has not been classified by habitat type as the call playback technique surveys cover a range of habitat types.

Table 31: Call playback schedule

Item	Task	Time (minutes)	Species	Item	Task	Time (minutes)	Species
1	Listen	5	-	10	Listen	5	-
2	Spotlight	5	-	11	Call	0.5	Bush-stone Curlew
3	Call	5	Barking Owl	12	Listen	4.5	-
4	Listen	5	-	13	Call	0.5	Bush-stone Curlew
5	Call	5	Masked Owl	14	Listen	4.5	-
6	Listen	5	-	15	Call	0.5	Bush-stone Curlew
7	Call	5	Koala (2 nights only)	16	Listen	4.5	-
8	Listen	5	-	17	Spotlight	5	-
9	Call	5	Squirrel Glider	**Total**		**70**	**-**

Table 32: call playback survey effort

Target Species	Person Hours			
	ELA[1]	ELA[2]	Other[3]	Total
Barking Owl	17	9	76	102
Bush Stone Curlew	25	15	44	84
Koala	27	29	64	120
Masked Owl	33	15	80	128
Powerful Owl	-	-	64	64
Squirrel Glider	25	10	60	95
Yellow-bellied Glider	-	-	20	20

[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]Other consultants includes (Kendall and Kendall Ecological Consultants, 2005, 2006, 2007, 2009; RPS, 2012b) (not including effort from Landmark Ecological Services & The Wilderness Society 2012 as no specific survey details were provided)

Remote recording survey – remote camera surveys

Reconyx infrared and white flash motion detector cameras (remote cameras) (models HC500, HC550, HC600, PC800, PC85 and PC900) were installed in areas where there was evidence of animal activity or where there was likely to be animal activity. Tracks, scats and other signs were used to indicate the presence of other fauna which informed remote camera placement. A combination of methods was used to attract fauna to within the sensors of each remote camera. Some remote cameras simply relied on fauna using possible den or high activity sites, while others were lured with a bait station. Bait used in the bait stations was either a combination of rolled oats, peanut butter, honey and truffle oil (3:3:1:trace), chicken pieces or flour, sardines and tuna oil (at a ratio of 2:2:1). Remote cameras were deployed in the field for between one and 21 days with those remote cameras facing a bait station being deployed in the field for at least eight days.

All photographs were reviewed by an ecologist at the end of the survey period and the fauna photographed were identified to species level where possible.

Remote camera survey effort from this assessment, additional ELA assessments and the literature review is presented in **Table 33**.

In addition to this survey effort, four remote cameras were installed at a site with a previous unconfirmed record of Rufous Bettong south-west of the development site. The cameras were installed for seven nights and were facing bait stations with rolled oats, peanut butter, honey and truffle oil (3:3:1:trace).

Table 33: Remote camera survey effort

Habitat	Trap nights by bait type							
	ELA[1]			ELA[2]			Other[3]	Total
	T-u	T-f	T-c	T-u	T-f	A-u		
Closed Forest	39	39	-				-	78
Dam	-	21	-					21
Grassy Woodland	35	16	-				-	51
Heathy Woodland	58	16	-				30	104
Riparian Woodland	234	423	16				12	685
Shrub Grass Woodland	186	88	16	16	16	36	65	423
Shrubby Woodland	112	23	8				-	143

[1] ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3] Other consultants including (Kendall and Kendall Ecological Consultants, 2009; RPS, 2013a, 2013b, 2013c), (effort by Landmark Ecological Services & The Wilderness Society 2012 not included as specific trap night details not provided); T-u – Terrestrial universal bait; T-f – Terrestrial fish bait; T-c – Terrestrial chicken bait; A-u – Arboreal universal bait.

Remote recording survey – diurnal call recording

Song Meter SM2+ (Wildlife Acoustics Inc.) sound recorders were introduced to the project to record bird calls during the subsequent survey (one unit during winter 2013, one unit during spring 2013 and 11 units during summer 2014). All Song Meters were programmed to record at a sample rate of 44,100 Hz for the first four hours of light each morning. Data were recorded in full frequency wav format.

Song Meter data was analysed by ELA ecologist Kurtis Lindsay using SoundID software. All data was processed for detection of Regent Honeyeater calls by using a library of wav format Regent Honeyeater calls from three different locations in NSW; Widden Valley, Wollombi and Glen Alice Capertee Valley.

Song Meter survey effort from this assessment and additional ELA assessments is presented in **Table 34**.

Table 34: Song Meter survey effort

Habitat	Total Recording Nights			
	ELA[1]	ELA[2]	Other[3]	Total
Heathy Woodland	7	-	-	7
Riparian Woodland	51	-	-	51
Shrub Grass Woodland	7	8	-	15
Shrubby Woodland	16	-	-	16

[1]ELA surveys for this assessment; [2]ELA surveys for other site specific assessments; [3]All other consultants excluding ELA.

Remote recording survey – Echolocation recording

Song Meter SM2+ (Wildlife Acoustics Inc.) sound recorders were introduced to the project to record bat calls during the subsequent survey (one unit during spring 2013 and 11 units during summer 2014). They were set up at additional non-harp trap sites. All Song Meters were programmed to record at a sample rate of 192,000 Hz. Settings for the first deployment (spring 2013) was for recording all night. Settings for the second deployment (summer 2014) was for seven nights at four hours of constant recording from 7pm followed by 20 minutes of recording out of each hour for an additional six iterations. Data were recorded in full frequency wav format for later conversion with Song Meter proprietary software *Kaleidoscope* TM to zero-crossing format to be analysed through AnaLook software as for all Anabat data. The Song Meter units differ from the Anabat system by recording in 16 byte full frequency wav format calls and utilising an omnidirectional microphone recording system.

Additionally Echo Meter EM3+ (Wildlife Acoustics Inc.) handheld bat detector / recorders were utilised when releasing captured bats to confirm identification and to record calls for reference purposes. These handheld units were also used for incidental recording during night survey work.

Opportunistic – scat analysis

Predator scats were opportunistically collected in the field. They were analysed by either Hans Brunner or Barbara Triggs (Scat analysis specialist), both for identification of predator and prey species. Prey species were identified by analysing hair, bone or other trace samples in the scat.

Opportunistic – surveys

Opportunistic surveys were undertaken for the duration of the field assessment by all ELA field ecologists. The location, count and important ecological observations (i.e. breeding status, behaviour) of all threatened species observed opportunistically was recorded.

5.3.4 Species that cannot withstand further loss

Species that have been categorised as not able to withstand further loss in the Major Projects Credit Calculator database are listed in **Table 35**.

Table 35: Species that cannot withstand further loss

Common name	Scientific name	Note
Bluegrass	*Dichanthium setosum*	Species not recorded in development site
Cyperus conicus	*Cyperus conicus*	Species not recorded in development site
Five-clawed Worm-skink	*Anomalopus mackayi*	Species listed in SEARs as requiring further consideration.
Greenhood Orchid	*Pterostylis cobarensis*	Species recorded in development site
Myriophyllum implicatum	*Myriophyllum implicatum*	Species listed in SEARs as not requiring further consideration
Native Milkwort	*Polygala linariifolia*	Species recorded in development site
Pine Donkey Orchid	*Diuris tricolor*	Species recorded in development site
Prasophyllum sp. Wybong	*Prasophyllum sp. Wybong*	Species not recorded in development site
Rufous Bettong	*Aepyprymnus rufescens*	Species not recorded in development site

Common name	Scientific name	Note
Commersonia procumbens	*Commersonia procumbens*	Species recorded in development site
Scant Pomaderris	*Pomaderris queenslandica*	Species recorded in development site
Tylophora linearis	*Tylophora linearis*	Species recorded in development site
Winged Peppercress	*Lepidium monoplocoides*	Not stated in database. Species recorded in development site.

5.3.5 Known species abundance and distribution

Flora

The abundance and distribution was calculated for those candidate flora species that were confirmed to be present in the development site. Due to the size of the development site, population estimations and modelling was undertaken using extensive field data with details provided below. Results are provided in **Table 36** and **Table 37**. Prior to surveys for this assessment, the majority of these species were either not known or poorly known in the development site. Detailed surveys and additional population modelling, where appropriate, indicate that some of these species are relatively common in the development site and broader region. Descriptions and habitat for each species are presented in **Table 38** and locations of records in the development site are presented in **Figure 19**.

Flora population estimations

The method used to estimate the number of individuals of each threatened plant species in the development site was determined by assessing whether habitat modelling using Plant Community Types would provide an accurate estimation of population size. Those species with a very patchy or localised distribution that were clearly not consistently associated with occurrences of a particular Plant Community Type/s were not suitable for estimating population numbers based on habitat modelling of Plant Community Types (such as *Bertya opponens* and *Pomaderris queenslandica*).

Population estimations for *Bertya opponens* and *Pomaderris queenslandica* involved:

- Field counts and/or estimates of the number of individuals within mapped population/sub-populations derived from subsamples.
- Supplementary extrapolation to account for sub-populations that are assumed to be present but have not yet been observed. Supplementary extrapolation was based on the total number of observed individuals averaged out across all plant communities where they were known to occur.

Habitat modelling based on Plant Community Types was used for those species with a less restrictive distribution and which occur with greater consistency in specific vegetation types. Modelled population estimates were calculated for *Diuris tricolor*, *Polygala linariifolia*, *Pterostylis cobarensis*, *Commersonia procumbens* and *Tylophora linearis.*

Flora population modelling

Plant density and abundance estimations of threatened plant species were made by combining the 2011 and 2012 targeted survey results and incorporating the data into a population model. An estimate of the area of each vegetation type across the entire development site was required in order to apply the model to habitat present in the development site to estimate of plant abundance with 95% confidence intervals. Vegetation communities mapped at a regional scale (ELA, 2013) were delineated into ten Biometric Vegetation Types. The total area of each Biometric Vegetation Type within the development site was calculated in a Geographic Information System.

A total of 751 threatened flora quadrats were included in the model dataset. Sampling intensity was at about 0.08% which is low but higher levels are considered difficult to achieve over such a large area. The most common vegetation type, *White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion*, was sampled the most frequently, and survey effort was generally related to area of vegetation types.

The number of individual plants from vegetation communities was summarised by summing the counts of each threatened plant species by vegetation type. The proportion of quadrats occupied by a species in each vegetation community for both years combined was calculated by assigning the species as present or absent from a quadrat (using 0 for absent and 1 for present), and then summing the number of quadrats with the species present and presenting as a proportion of total number of quadrats.

Plant densities per quadrat were calculated separately for each species. When sample sizes were low, data were pooled across all vegetation types. Additional distribution models were applied to vegetation types where sample sizes were larger than 10. Finally, plant densities were converted into plants per hectare where plants were present.

The output of the regional modelling data was then applied to the development site to develop rigorous estimates of threatened species populations.

Table 36: Estimated abundance of known threatened flora candidate species

Species	Estimated Mean Abundance	Lower 95% CI	Upper 95% CI
Bertya opponens	956,861	861,791	1,051,932
Diuris tricolor	3,353	1,743	6,444
Lepidium aschersonii	208	N/A	N/A
Lepidium monoplocoides	258	N/A	N/A
Myriophyllum implicatum	1	N/A	N/A
Polygala linariifolia	16,317	8,187	28,095
Pomaderris queenslandica	45,518	44,124	46,913
Pterostylis cobarensis	431,718	338,850	549,833
Commersonia procumbens	240,274	90,799	857,601
Tylophora linearis	33,154	25,739	43,712

Table 37: Estimated area of occupancy / habitat of known threatened flora candidate species

Species	Area of occupancy (ha)	Predicted habitat (ha)
Bertya opponens	456.02	N/A
Diuris tricolor	N/A	70,036.44
Myriophyllum implicatum	10.27	N/A
Polygala linariifolia	N/A	70,036.44
Pomaderris queenslandica	90.11	N/A
Pterostylis cobarensis	N/A	70,036.44
Commersonia procumbens	N/A	70,036.44
Tylophora linearis	N/A	70,036.44

Table 38: Description and habitat of known threatened flora candidate species

Species	Description and habitat
Bertya opponens	*Bertya opponens* is a slender multi- or single-stemmed shrub that grows to four metres (OEH, 2016b). The habitats in which *B. opponens* is found include stony mallee ridges and cypress pine forest on red soils. The species is associated with a shrub layer of *Philotheca ciliata, Phebalium squamulosum* (Scaly Phebalium) and *Acacia* spp. and a sparse grassy groundcover (ELA, 2012).
Diuris tricolor	*Diuris tricolor* is a terrestrial orchid that grows between 20 cm – 40 cm high and has 2 – 6 flowers which are bright yellow to orange, speckled with red to purple and white markings (OEH, 2016b). The species grows amongst grass in sclerophyll forest, often occurring with *Callitris spp.* (Cypress Pine). It is found on both flats and small rises in sandy soils, and has also been recorded from a red earth soil in a Bimble Box community in western NSW (OEH, 2016b). It is most commonly found in Narrow-leaved Ironbark – White Cypress Pine - Buloke tall open forest dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) with shrubby midstorey dominated by *Callitris glaucophylla* (White Cypress Pine) and *Allocasuarina luehmannii* (Bulloak). The associated groundcover is often sparse grasses and occasionally shrubby (ELA, 2012).
Lepidium aschersonii	*Lepidium aschersonii* is an erect perennial herb that grows to 30 cm high, is hairy and has intricate branching (OEH, 2016b). The species grows as a component of the ground flora on grey loamy clays (OEH, 2016b). It is found on ridges of gilgai clays dominated by *Acacia harpophylla* (Brigalow), with *Rytidosperma* and/or *Austrostipa* spp. in the understorey. Vegetation structure varies from open to dense Brigalow, with a sparse grassy understorey and occasional heavy litter.
Lepidium monoplocoides	*Lepidium monoplocoides* is an erect annual herb or perennial forb, 15 cm – 20 cm high, with angular and striped stems roughened with small warts (OEH, 2016b). It is known to occur on seasonally moist to waterlogged sites, on heavy fertile soils (OEH, 2016b). The species is usually associated with open woodland dominated by *A. luehmannii* and/or eucalypts with a tussock grassy understorey. In the Pilliga National Park, this species has been found in Narrow-leaved Ironbark – White Cypress Pine - Buloke tall open forest, and was found to be associated with gilgais (ELA, 2012). In the development site, it was found near roadsides and in run-on areas in Mugga Ironbark - White Cypress Pine - gum tall woodland.

Species	Description and habitat
Myriophyllum implicatum	*Myriophyllum implicatum* is a creeping matted herb, 2 cm – 10 cm high (OEH, 2016b). It was considered possibly extinct in NSW until it was rediscovered in Pilliga National Park by NSW Herbarium botanists in 2008. The population of *Myriophyllum implicatum* in the development site, along with those in the Pilliga National Park and adjoining Pilliga State Conservation Area, and one from near Brewarrina located in 2010 are the only known extant populations in NSW. Within the general Pilliga region *Myriophyllum implicatum* has a highly specialised habitat, occurring in shallow basin wetlands (sensu (Bell, Hunter, & Montgomery, 2012)), though the original 2008 collection was noted as occurring in a tank gilgai wetland.
Polygala linariifolia	*Polygala linariifolia* is an annual or perennial herb, about 20 cm high with a wooy tap root and more-or-less upright branches (OEH, 2016b). During fieldwork it became apparent that rainfall history has a major influence on the detection of the species, with much larger numbers being located following significant rainfall events. Most of the individuals observed were considered to be annual only, with only those individuals in sheltered situations persisting for more than one season. *P. linariifolia* has been observed flowering/fruiting in January, April and October in the Pilliga by ELA. During the 2012 survey, *P. linariifolia* was recorded in White Cypress Pine - Bulloak - Ironbark Woodland and Mugga Ironbark - Pilliga Box - pine- Bulloak shrubby woodland. It was associated with a dense mid-storey of *C. glaucophylla* and/or *A. luehmannii* and a grassy understorey. This is in contrast to previous surveys where *P. linariifolia* has been observed in a range of vegetation types, mostly characterised by a grassy understorey.
Pomaderris queenslandica	*Pomaderris queenslandica* is a medium-sized shrub 2 m – 3 m tall (OEH, 2016b). It is found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks. In the development site, the species is restricted to north eastern section of development site where it occurs in three separate areas. Within these areas the species occurs predominantly as small scattered subpopulations. It was predominantly associated with Narrow-leaved Ironbark – White Cypress Pine – Buloke tall open forest, Red Ironbark – White Bloodwood -/+ Burrows Wattle heathy woodland, White Bloodwood – Motherumbah – Red Ironbark shrubby sandstone hill woodland, and Dirty Gum – Black Cypress Pine – White Bloodwood shrubby woodland.
Pterostylis cobarensis	*Pterostylis cobarensis* is a terrestrial orchid which grows to 40 cm high with transparent flowers with browns and green markings (OEH, 2016b). *P. cobarensis* was recorded in a broad range of vegetation types. It was most often associated with a dense mid-storey of *C. glaucophylla* and/or *A. luehmannii*. The groundcover was characterised by low shrub, grass and herb cover and high leaf litter with sandy soils. It was occasionally recorded within unburnt mosaics that remained within areas that were burnt in a large bushfire in 2006/2007.
Commersonia procumbens	*Commersonia procumbens* is a prostrate shrub with slender training stems to 30 cm long (OEH, 2016b). In the development site, it was mainly found along roadsides although large numbers were also found in areas with dense low shrubs dominated by *Acacia pilligaensis* (Pilliga Wattle) *and Chloanthes parviflora* with evidence of recent fire (within past five years). Many of the locations were observed to be directly downslope of rocky hills on red sand, although this was not a consistent determiner of presence. The location of individuals along roadsides is consistent with previous records (OEH 2014). However, the observations downslope of rocky hills on red sand has not been previously noted.

Species	Description and habitat
Tylophora linearis	*Tylophora linearis* is a slender, almost hairless twiner with purplish flowers and cigar-shaped fruit (OEH, 2016b). Although *T. linearis* occurs in a broad range of vegetation types in the development site, it was most often found in areas heavily burnt by the 2007 wildfire, along track edges and in recently cut road drains. It is often associated with a *Eucalyptus crebra* (Narrow-leaved Ironbark) canopy, shrubby mid-storey dominated by *Callitris glaucophylla* (White Cypress Pine), *Allocasuarina luehmannii* (Bull Oak) and a sparse grassy groundcover. The individuals were often found within *Gahnia aspera* (Rough Saw-sedge), around logs or the base of canopy regrowth. Sites often had evidence of disturbance from forestry, track work or recent fire.

Fauna distribution estimations

The potential distribution of those threatened fauna species that are known or considered likely to occur in the development site was mapped using habitat associations (**Table 39**; **Figure 11**). For Koala, this required associations to the Plant Community Type level due to their specialised demand for certain Eucalypt species (**Figure 12**). Descriptions of each species and the specific habitat requirements are provided in **Table 40**. The locations of all threatened fauna recorded in the surveys are provided in **Figure 20**. Note that available habitat does not correlate with area occupied.

Table 39: Estimated habitat of known and likely threatened fauna candidate species

Scientific name	Common name	Foraging and breeding habitat types#	Dispersal habitat types*#	Foraging/ breeding	Dispersal*	Foraging/ breeding	Dispersal*
				Habitat in development site		Habitat in study region	
Macropus dorsalis	Black-striped Wallaby	All fauna habitat types	-	80,498.28	0	357,190.6	0
Phascolarctos cinereus	Koala	PCT: 78, 88, 202, 379, 397, 399, 401, 405, 406, 408, 40X, 418	PCT: 27, 35, 55, 141,256, 398, 402, 404, 425, 428	32,995.62	80,398.31	100,080.9	331,510.0
Cercartetus nanus	Eastern Pygmy-possum	Heathy woodland, grassy woodland, shrub grass woodland, riparian woodland	-	56,666.19	0	228,597.8	0
Petaurus norfolcensis	Squirrel Glider	Heathy woodland, shrubby woodland, grassy woodland, shrub grass woodland, riparian woodland	-	66,705.00	0	285,998.3	0
Hoplocephalus bitorquatus	Pale-headed Snake	Closed forest, heathy woodland, shrubby woodland, grassy woodland, shrub grass woodland, riparian woodland	-	69,531.87	0	302,437.4	0

* Dispersal habitat different to foraging and breeding habitat for Koala. Note that all Koala foraging and breeding habitat can also be used for Koala dispersal.

Koala habitat could not be calculated by broad habitat types as they are dependent of certain tree species. Hence, habitat modelling used specific Plant Community Types (PCTs).

Table 40: Description and habitat of known and likely threatened fauna candidate species

Species	Description and habitat
Macropus dorsalis Black-striped Wallaby	Black-striped Wallaby is a small to medium-sized wallaby, grey-brown in colour with a narrow black stripe running down the centre of the back (OEH, 2016b). At least 17 Black-striped Wallabies were recorded at 15 sites in the development site during surveys for this assessment. As one record is from a hair sample, it is not possible to determine exactly how many individuals were recorded at that site. The literature review identified records of Black-striped Wallaby in closed forest (Kendall and Kendall Ecological Consultants, 2007), shrub grass woodland (Landmark Ecological Services & The Wilderness Society, 2012) and shrubby woodland (NPWS, 2000a). Results from field surveys indicate that all habitat types in the development site are considered potential or known habitat for the Black-striped Wallaby. The distribution of Black-striped Wallaby is predicted to extend throughout the development site.
Phascolarctos cinereus Koala	Koala is an arboreal marsupial with grey to brown fur above and white below (OEH, 2016b). The development site supports a small area of primary Koala habitat (DECC, 2008b) with *Eucalyptus camaldulensis* (River Red Gum) dominating habitat around Yarrie Lake. Secondary Koala habitat (DECC, 2008b) occurs in riparian woodland, shrub grass woodland and heathy woodland which support secondary food tree species *Eucalyptus populnea, Eucalyptus pilligaensis, Eucalyptus chloroclada, Eucalyptus blakelyi, Eucalyptus conica* and *Eucalyptus dwyeri.* Dense clumps of *Callitris glaucophylla* provide sheltering habitat and all other native vegetation provides dispersal habitat. From a regional Koala study, the habitat in the development site is not considered to provide refuge habitat in times of population contraction (Niche Environment and Heritage, 2014).
Cercartetus nanus Eastern Pygmy-possum	Eastern Pygmy-possum is between 70 mm – 110 mm head through body and has an almost bare, prehensile tail (OEH, 2016b). The species is found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight, 2004). In general woodlands and heath are its preferred habitat (OEH, 2016b). Small tree hollows are favoured for nesting during the day, but nests have also been found under bark, in rotten stumps, holes in the ground, old bird nests, Ringtail Possum drays, thickets of vegetation and in the branch forks of tea-trees (OEH, 2016b; Turner & Ward, 1995).
Petaurus norfolcensis Squirrel Glider	Squirrel Glider is about 20 cm long from head through body with blue-grey to brown-grey fur above, white fur on the bellow and the end third of the tail is black (OEH, 2016b). The Squirrel Glider is associated with eucalypt open forests and woodlands with a Banksia sp. or Acacia sp. shrub layer (van der Ree & Sucking, 2008). The most important habitat features for the species are large trees with abundant hollows, and a good winter supply of nectar (Menkhorst et al., 1988). Prime habitat, on richer soils and gentle terrain, has been largely cleared or degraded. In the eastern Pilliga, the Squirrel Glider has been recorded from grassy woodland, heathy woodland, riparian woodland and shrub-grass woodland habitats. They are also predicted to occur in shrubby woodlands in the development site.
Hoplocephalus bitorquatus Pale-headed Snake	Pale-headed Snake is a largely tree-dwelling snake, up to 90 cm long (OEH, 2016b). Four Pale-headed Snakes were recorded in the development site during surveys for this assessment. All records are from the northern portion of the development site. Two Pale-headed Snake were observed in trees, one in a hollow in shrub grass woodland with a canopy of *Eucalyptus pilligaensis* and *Eucalyptus populnea* and the other in a *Eucalyptus camaldulensis* on the edge of Yarrie Lake. The two other records were of Pale-headed Snake moving on the ground, one in closed forest in the Brigalow Park Nature Reserve and the other in a thin strip of closed forest, adjacent to the road. The literature review obtained one additional record of Pale-headed Snake in the development site

Species	Description and habitat
	(Landmark Ecological Services & The Wilderness Society, 2012). A Pale-headed Snake was trapped in a funnel trap in heathy woodland in the south of the development site. Other records from the literature review that are outside of the development site are from shrub grass woodland with a canopy of either *E. populnea* or *E. crebra* and *E. blakelyi.* These results indicate that Pale-headed Snake habitat in the development site is not dependent on water sources and hence all habitat types in the development site with a canopy layer supporting hollows, loose bark or stags are considered suitable habitat for the Pale-headed Snake.

5.4 Limitations

Surveys for this assessment were undertaken over multiple seasons and years. However, the size of the development site (95,077 ha) precludes the ability to completely identify all species that occur in the development site. For many species already known to occur in the development site, the survey effort undertaken is justified given the assumed presence of these species.

It is likely that some species that utilise the development site were not recorded during field surveys due to the life cycle and behaviour of species, duration or timing of the survey and other environmental factors. In particular, environmental and season factors were observed to play a large role in the number of threatened flora recorded during each year. In dry years, the number of orchids recorded was a small portion of the number recorded in previous, wetter seasons.

The list of species recorded from this study provides an indication of the species present at the time of the surveys. A precautionary approach has been implemented to satisfactorily address the potential presence of threatened species. Those species which had been previously recorded in or near the development site during other surveys were assumed to be present for the purposes of this assessment.

The locations of field surveys were also restricted by site access, either by access to private property, or avoidance of active forestry areas. In particular, it was not possible to complete biometric plots in the Weeping Myall community in the north of the development site due to restricted access to private property

Figure 11: Fauna habitat mapping

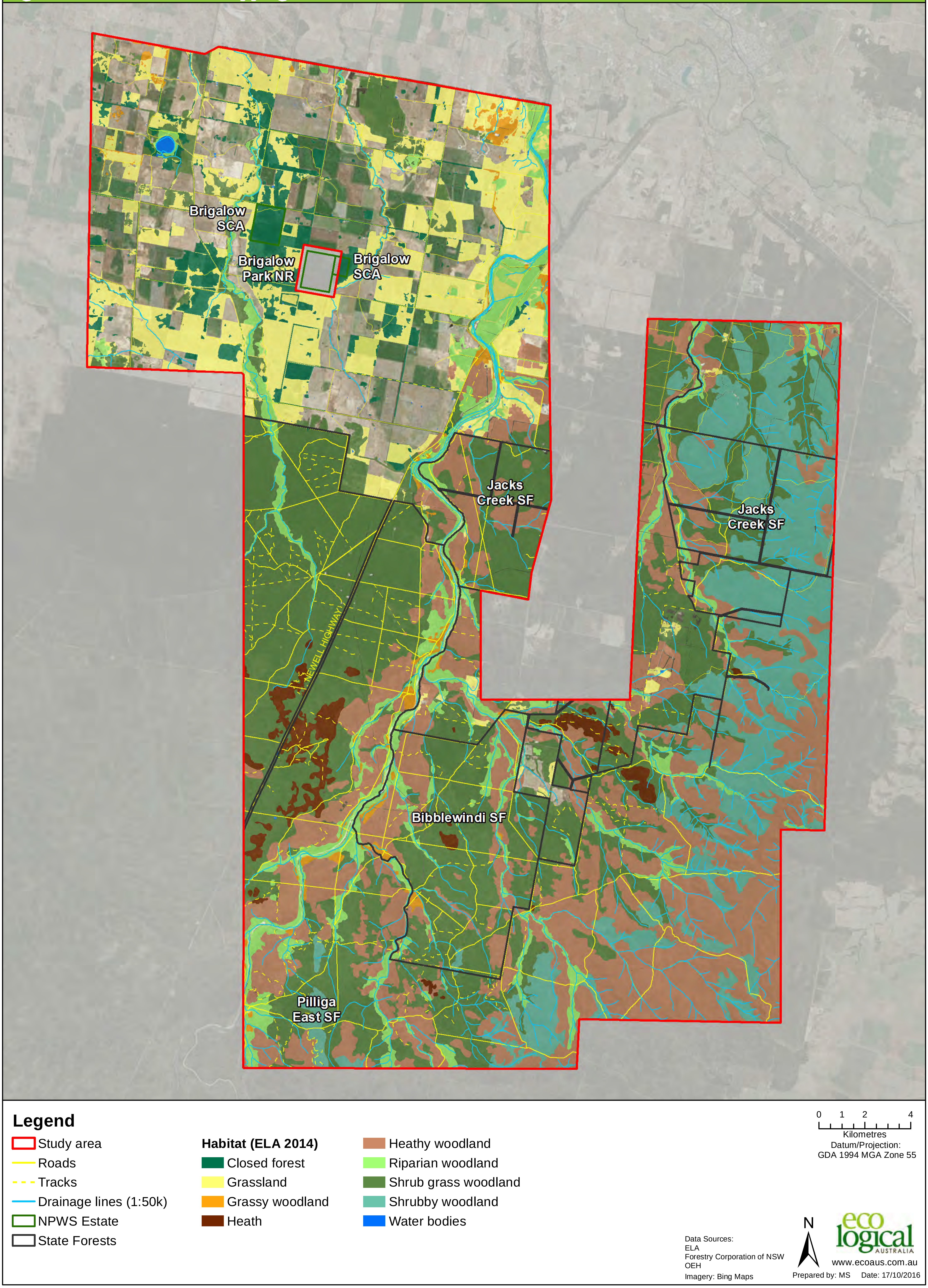


Figure 12: Koala habitat mapping

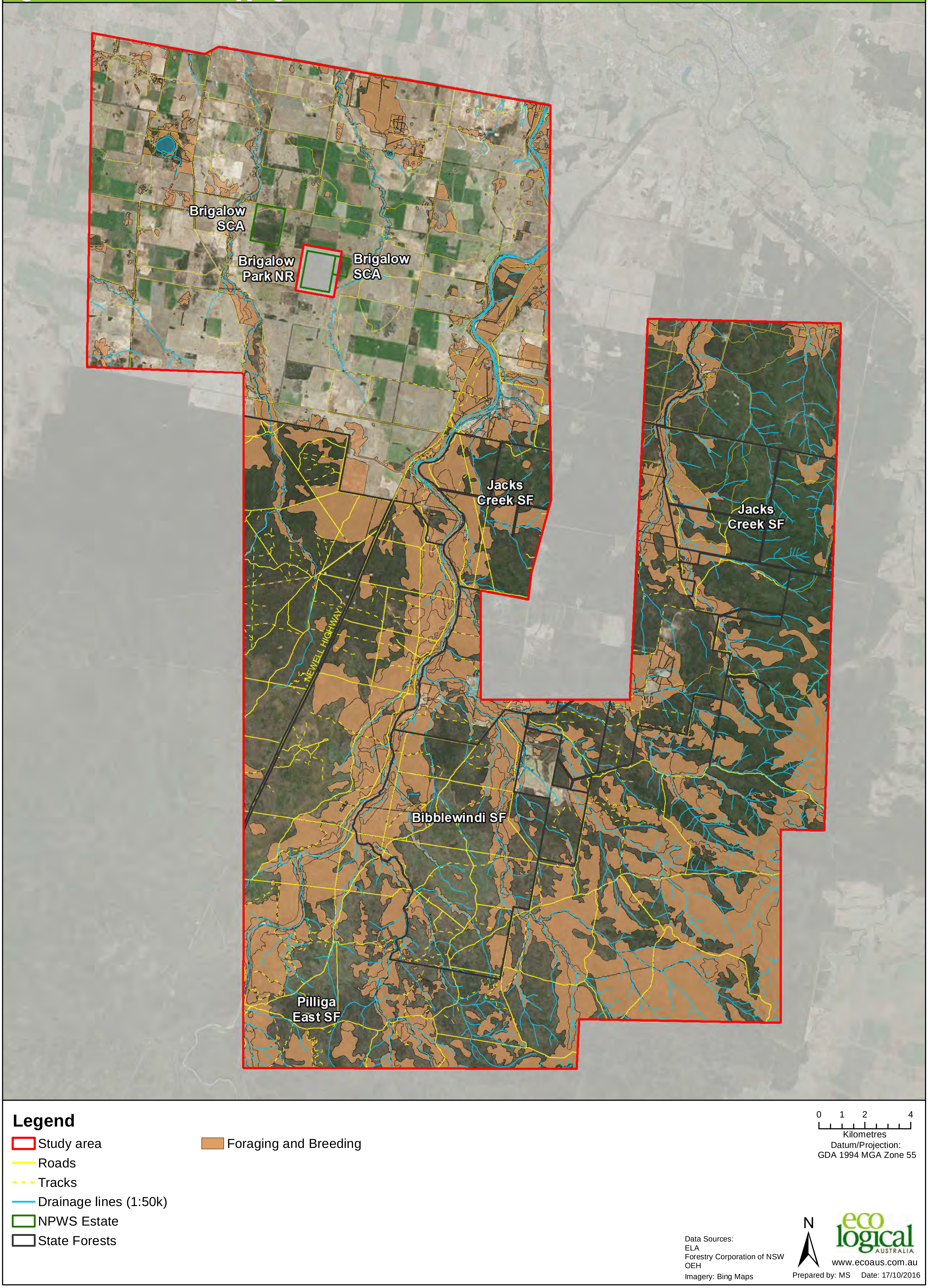


Figure 13: Survey effort – fauna (trapping surveys)

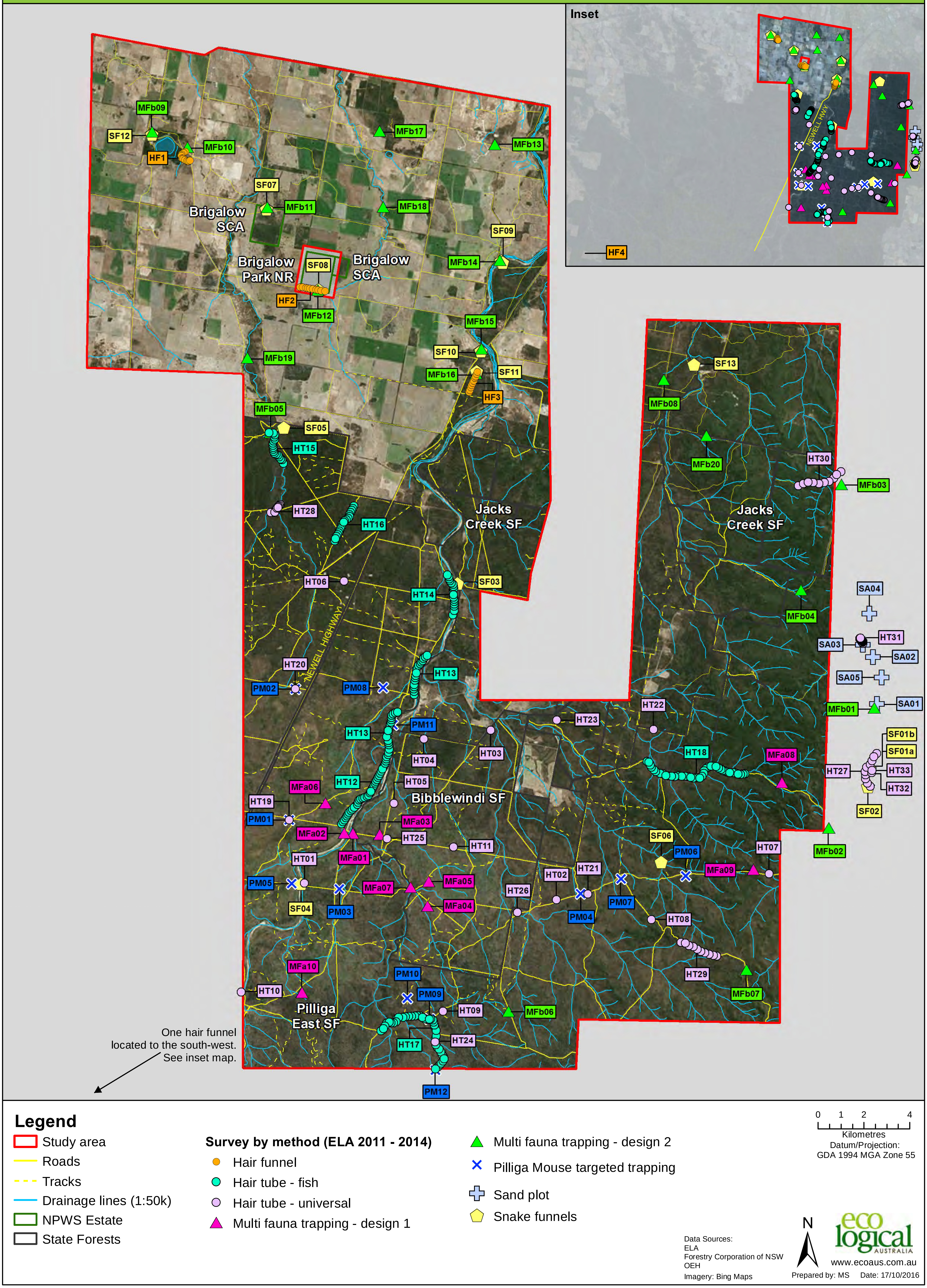


Figure 14: Survey effort – fauna (microbat surveys)

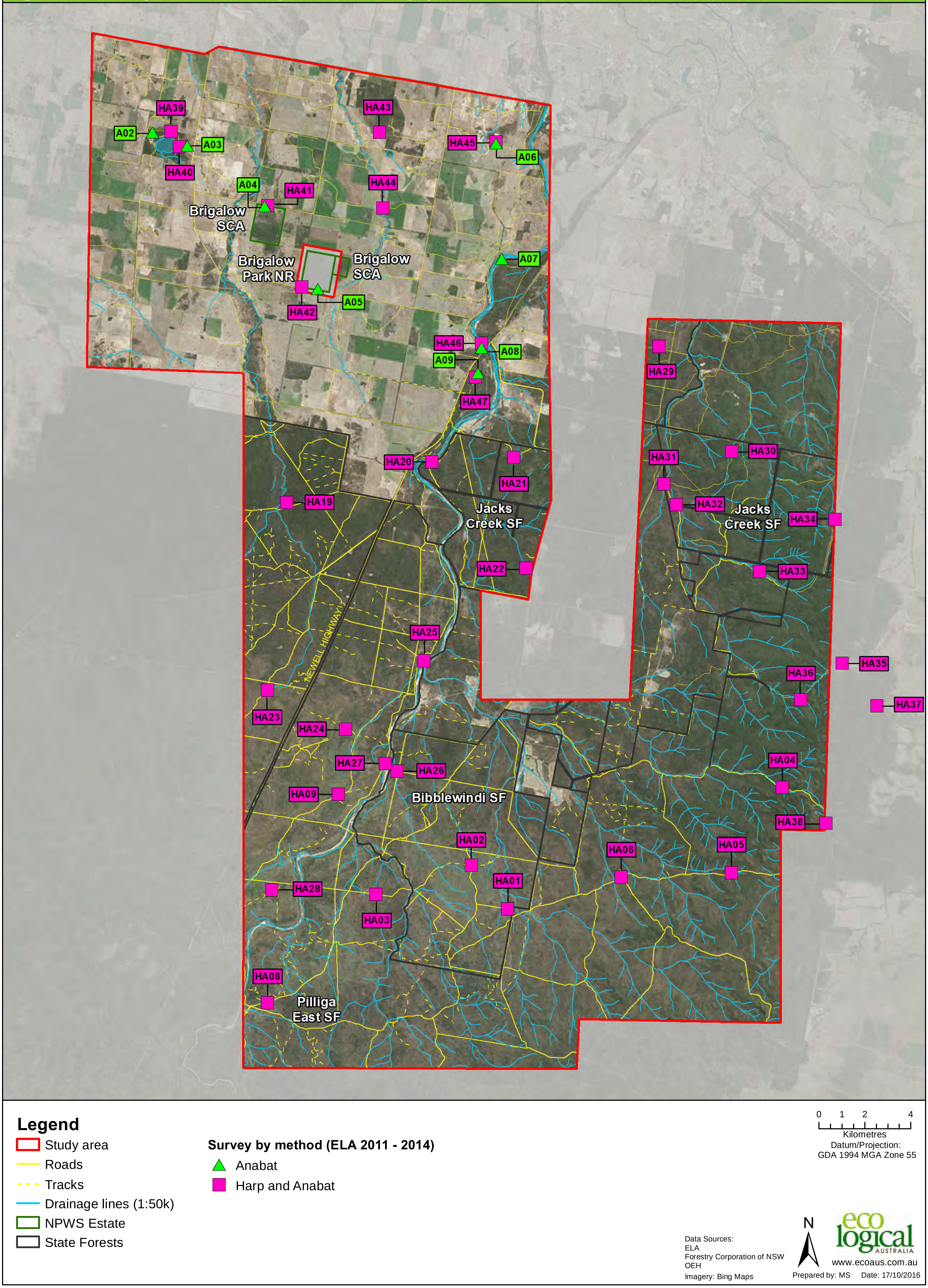


Figure 15: Survey effort – fauna (diurnal surveys)

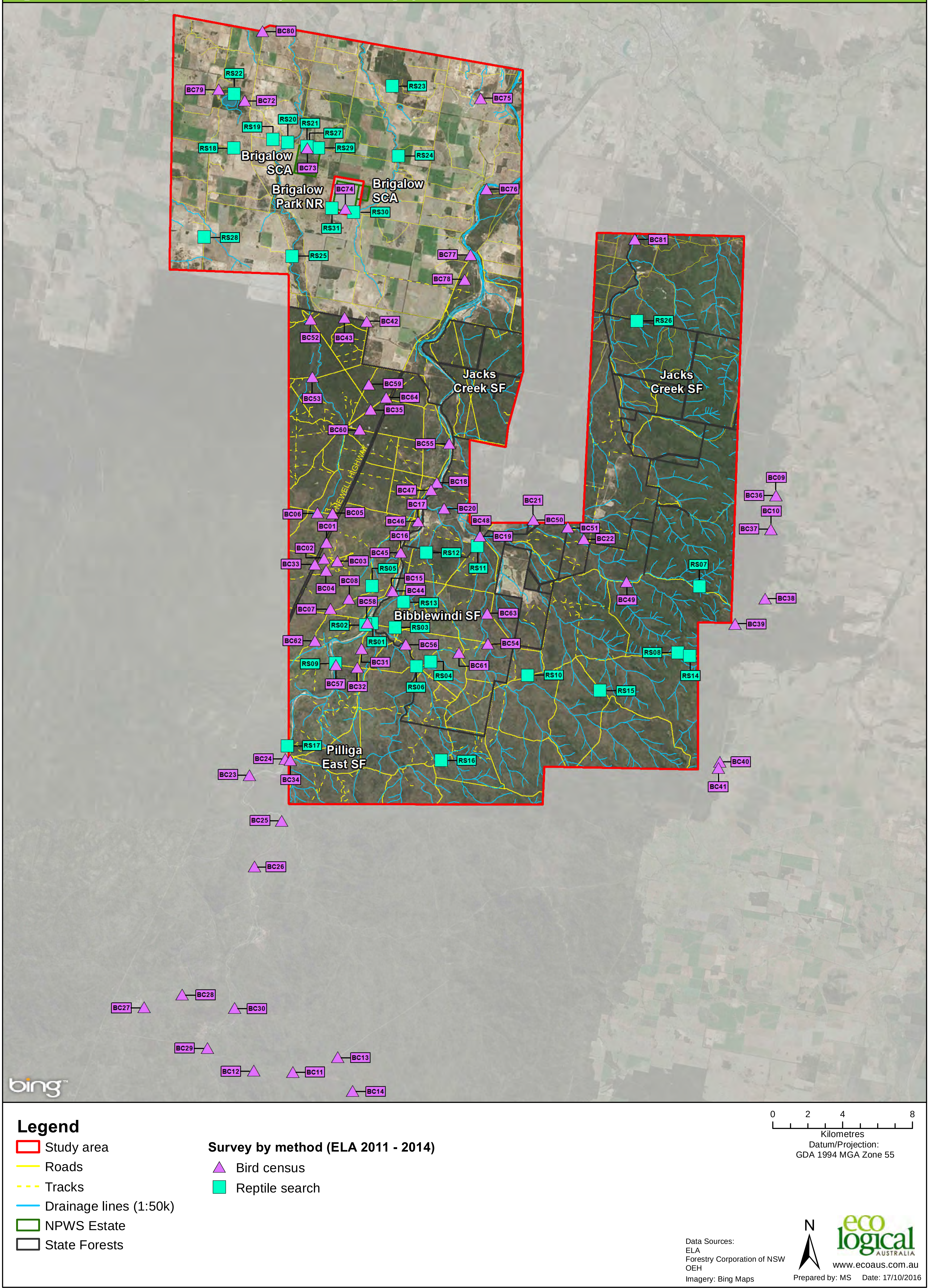


Figure 16: Survey effort – fauna (nocturnal surveys)

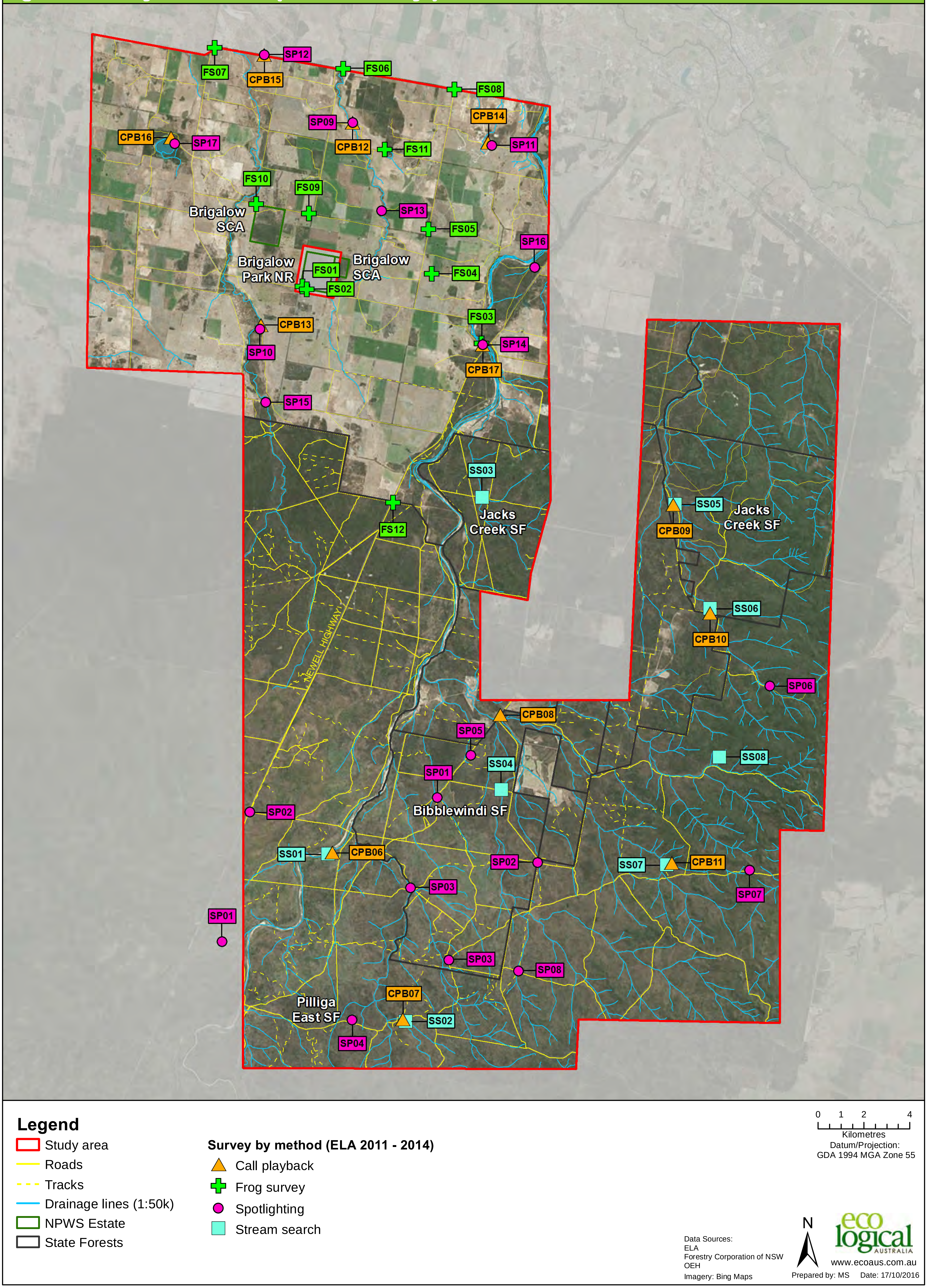
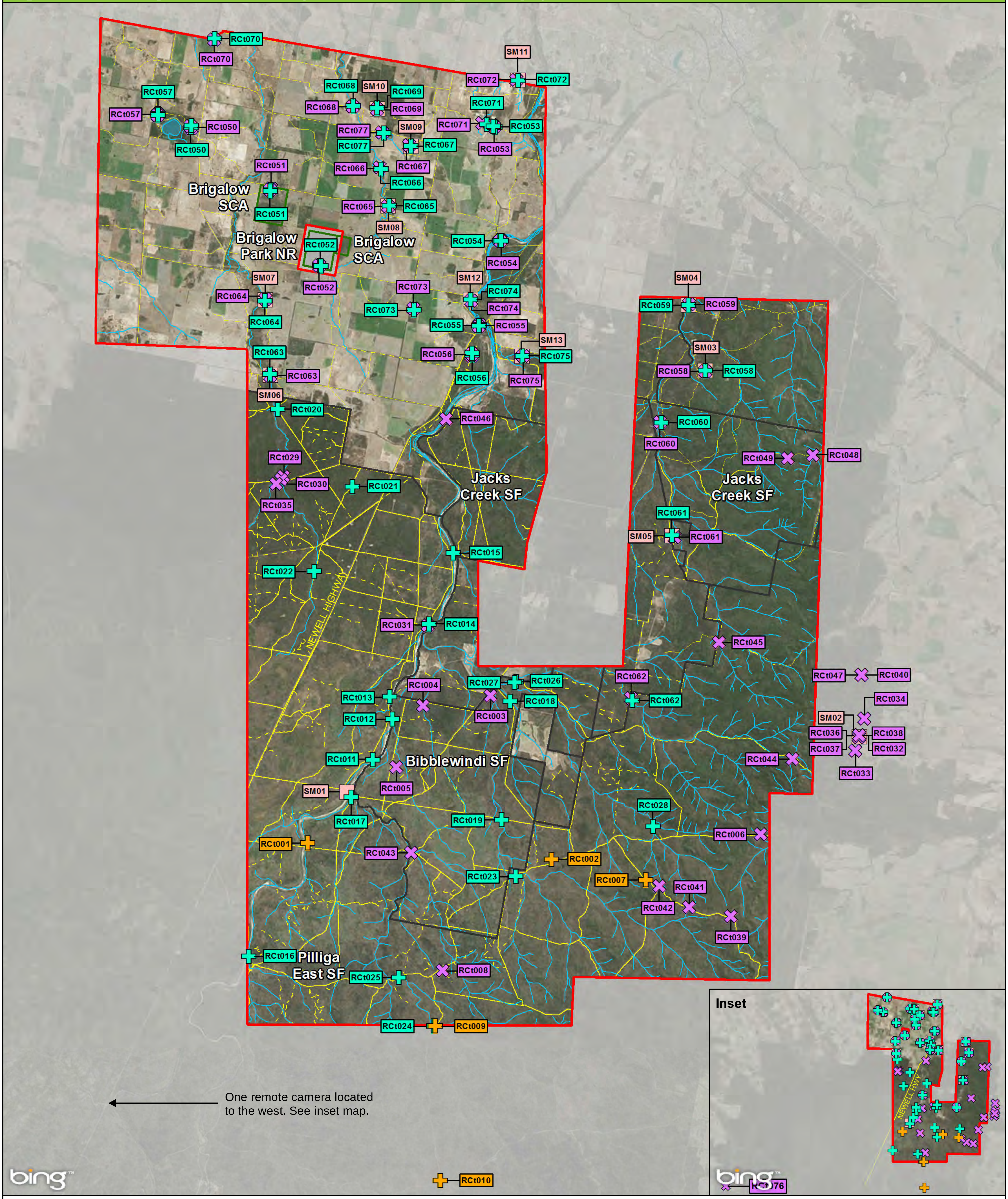


Figure 17: Survey effort – fauna (remote recording surveys)



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Survey by method (ELA 2011 - 2014)

- Remote camera - chicken
- Remote camera - fish
- Remote camera - universal
- Song Meter

0 1 2 4
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

Data Sources:
ELA
Forestry Corporation of NSW
OEH
Imagery: Bing Maps

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Prepared by: MS Date: 17/10/2016

Figure 18: Survey effort – fauna (Koala habitat surveys)

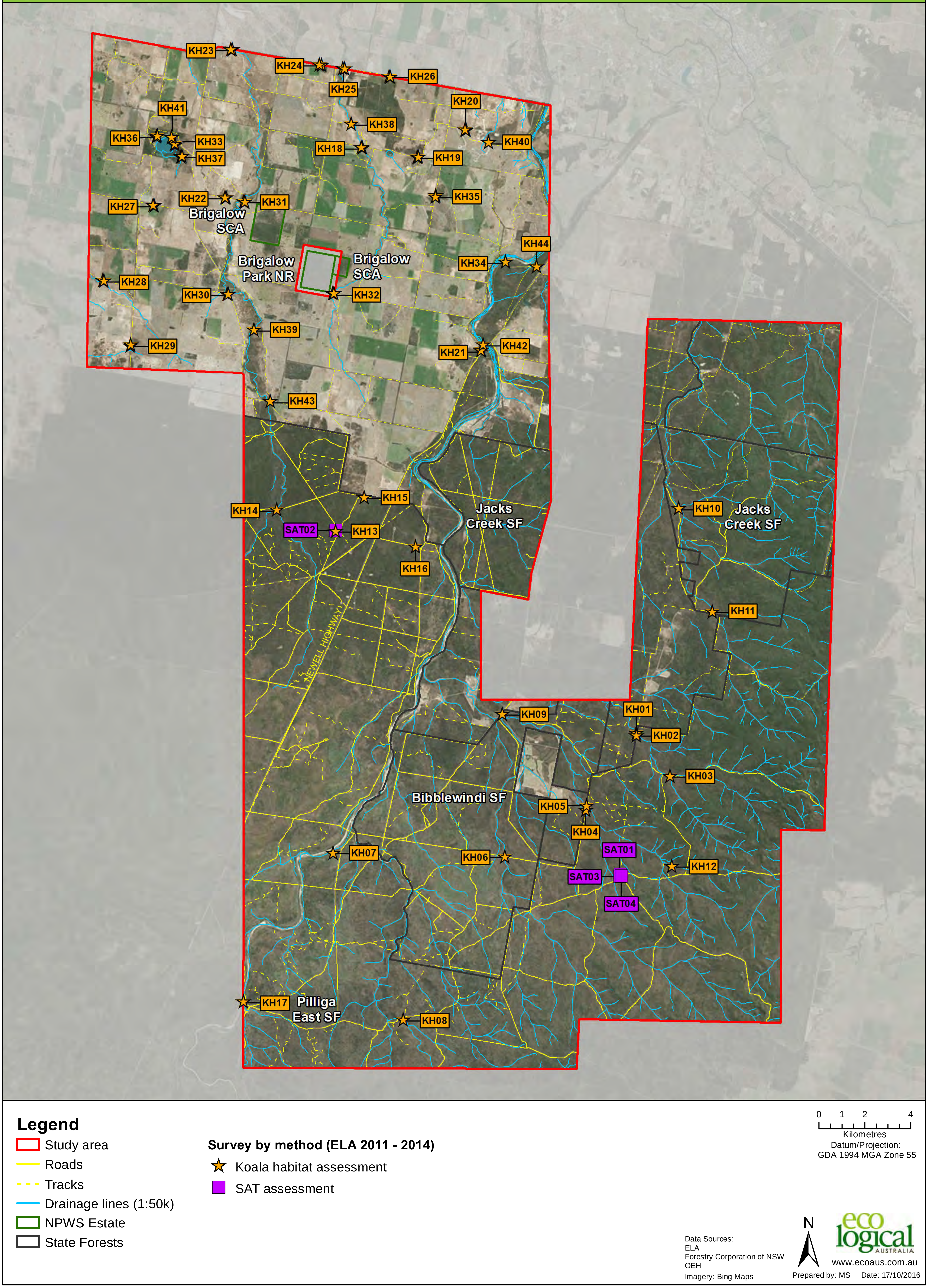
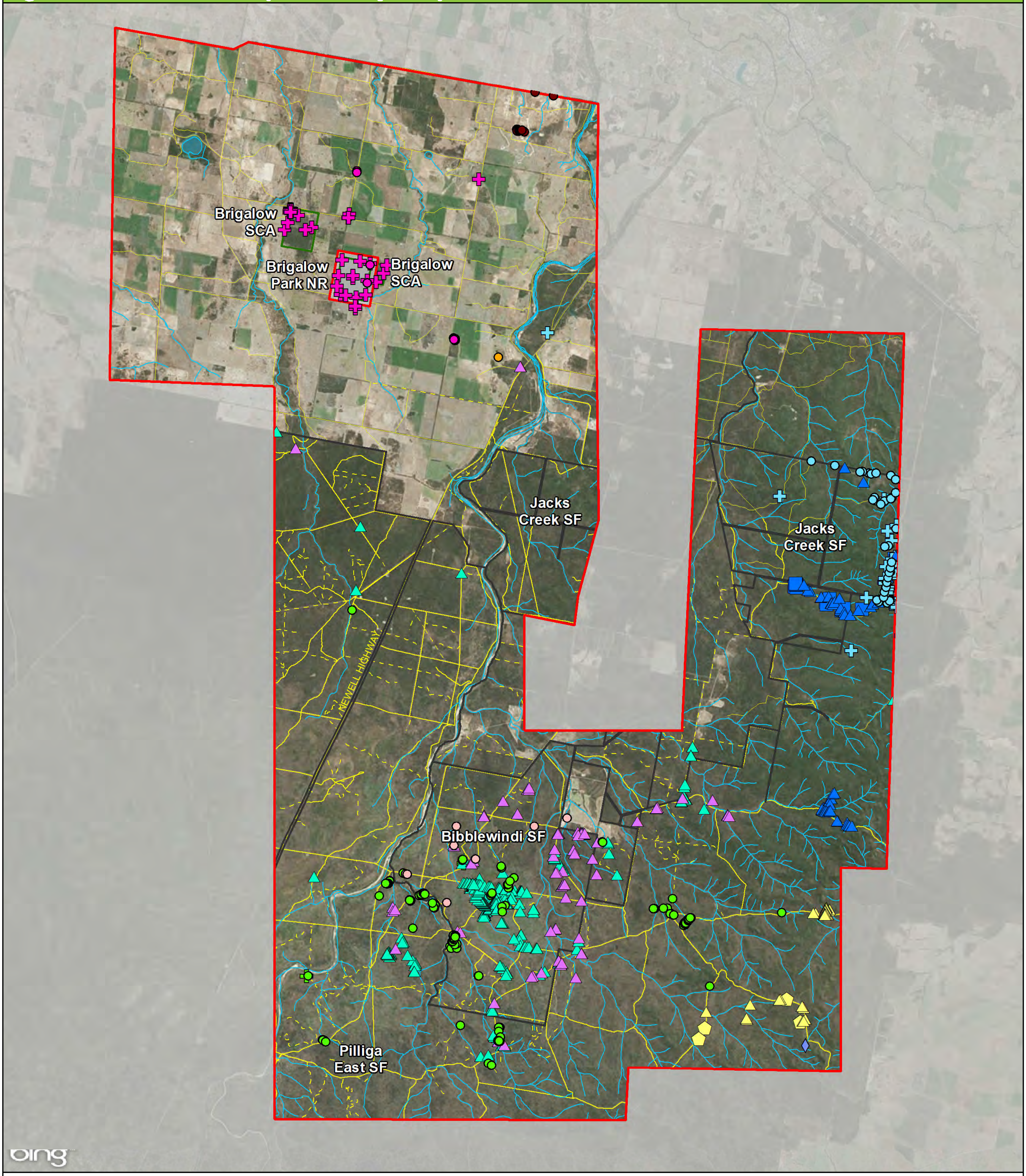


Figure 19: Threatened flora (candidate species)



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Threatened flora records TSC & EPBC Act Listing (ELA)

- *Bertya opponens* (TSC **V**, EPBC **V**)
- *Diuris tricolor* (TSC **V**)
- *Lepidium aschersonii* (TSC **V**, EPBC **V**)
- *Lepidium monoplocoides* (TSC **E**, EPBC **E**)
- *Myriophyllum implicatum* (TSC **CE**)
- *Polygala linariifolia* (TSC **E**)
- *Pomaderris queenslandica* (TSC **E**)
- *Pterostylis cobarensis* (TSC **V**, EPBC **V**)
- *Rulingia procumbens* (TSC **V**, EPBC **V**)
- *Tylophora linearis* (TSC **V**, EPBC **E**)

Threatened flora records TSC & EPBC Act Listing (NICE & TWS 2012)

- *Rulingia procumbens* (TSC **V**, EPBC **V**)

Threatened flora records TSC & EPBC Act Listing (OEH)

- *Bertya opponens* (TSC **V**, EPBC **V**)
- *Lepidium aschersonii* (TSC **V**, EPBC **V**)
- *Philotheca ericifolia* (EPBC **V**)
- *Polygala linariifolia* (TSC **E**)
- *Pomaderris queenslandica* (TSC **E**)

0 1 2 4
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

CE = Critically Endangered
E = Endangered
V = Vulnerable

NSW Office of Environment and Heritage's Atlas of NSW Wildlife, which holds data from a number of custodians. Data obtained 29/04/2014.

Data Sources:
ELA
Forestry Corporation of NSW
NICE & TWS
OEH

Imagery: Bing Maps

N

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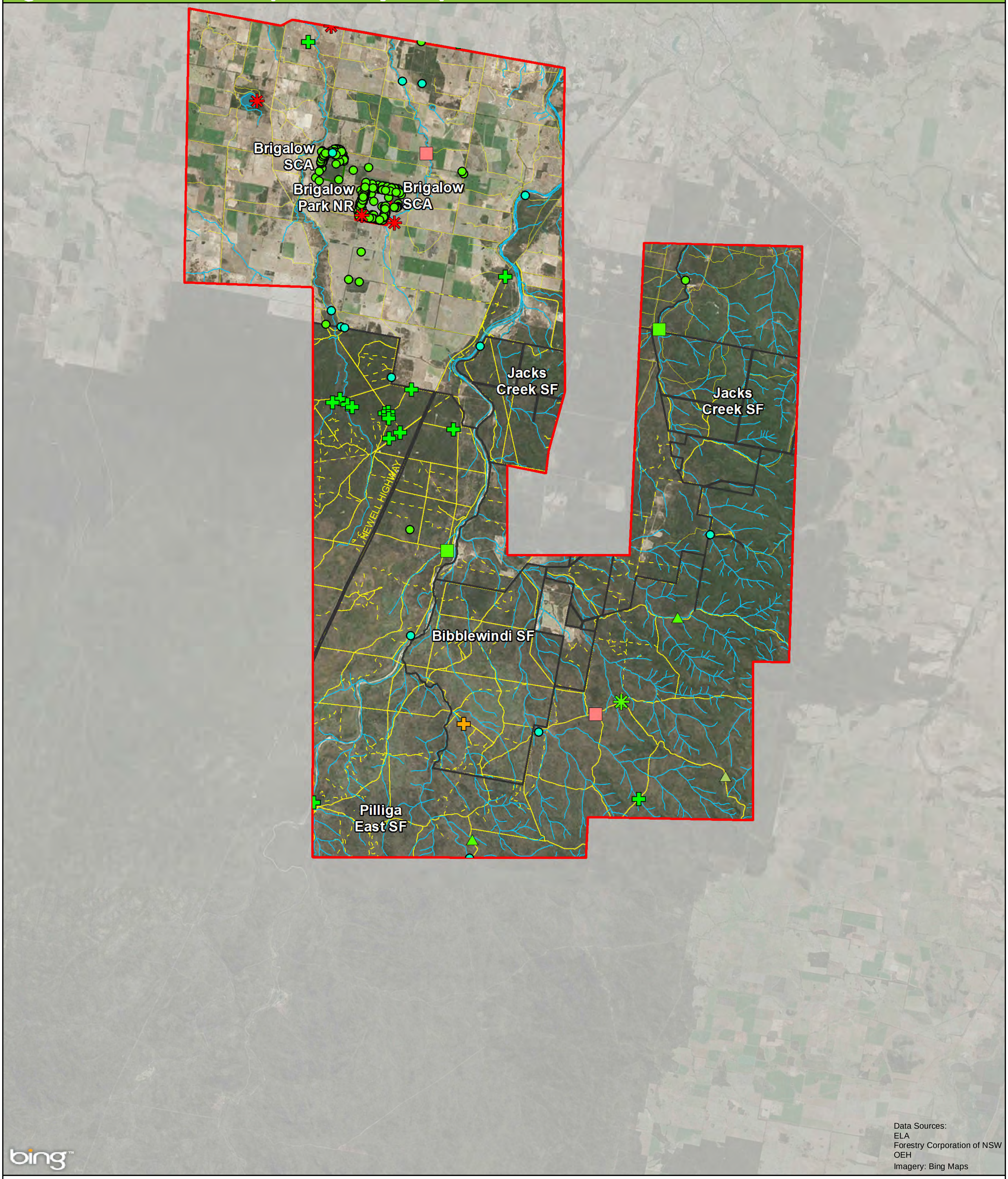
Figure 20: Threatened fauna (candidate species)



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Threatened fauna TSC & EPBC Act Listing (ELA)

- Black-striped Wallaby (TSC **E**)
- Eastern Pygmy-possum (TSC **V**)
- Koala (TSC **V**, EPBC **V**)
- Squirrel Glider (TSC **V**)
- Pale-headed Snake (TSC **V**)

Threatened fauna TSC & EPBC Act Listed (Kendall & Kendall, OEH, RPS and TWS)

- Black-striped Wallaby (TSC **E**)
- Eastern Pygmy-possum (TSC **V**)
- Koala (TSC **V**, EPBC **V**)
- Pale-headed Snake (TSC **V**)
- Squirrel Glider (TSC **V**)

0 2 4 8
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

V = Vulnerable
M = Migratory

N

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6 Measures to avoid and minimise impacts

The design and location of the Project has considered avoiding and minimising direct and indirect impacts on ecological values at the development site through: locating Major facilities (e.g. Leewood) outside the main forested body of the Pilliga; minimising the area required for well pads to 1 ha with linear infrastructure (tracks and the gathering system) being an average of 10 m wide during construction; locating well pads no closer than 750 m to each other; targeting areas of existing disturbance for further development (e.g. Bibblewindi Site); and maximising avoidance of native vegetation in existing fragmented areas outside of the Pilliga.

These broad avoidance and minimisation strategies at the development site scale are further supported by the Field Development Protocol, Ecological Scouting Framework and Pre-clearing and clearing procedures which further avoid and minimise direct and indirect impacts at the site scale. These measures are detailed in the following sections.

6.1 Measures to avoid impacts

6.1.1 Avoidance of direct impacts

A summary of the impact avoidance methods of the project are provided in **Table 41** with descriptions of each method provided in the following sections.

Table 41: Avoidance of direct impacts

<table>
<tr><th>Direct impact to be avoided</th><th>Method to avoid impact</th></tr>
<tr><td>Impacts to endangered ecological communities (EECs) and critically endangered ecological communities (CEECs)</td><td rowspan="4">Ecological sensitivity analysis for the development site (Section 6.1.7) includes the constraints of:
• endangered ecological communities
• threatened fauna habitat, high quality vegetation and large patch sizes which all support threatened species
• watercourses (Bohena Creek mapped with the high constraint stream order classification requirements for a 6TH order stream)
The Ecological sensitivity analysis is used to inform site selection as part of the ecological scouting framework. Implementation of the ecological scouting framework during the planning phase will maximise avoidance of:
• endangered ecological communities
• Plant Community Types (which contain threatened species habitat)
• threatened flora and fauna habitat
• riparian corridors
Implementation of the ecological scouting framework during the planning phase will ensure avoidance of riparian corridors when placing well pads. Only linear infrastructure will intersect these features. The mapping of riparian corridors (Figure 5) will be used in a preliminary constraints desktop assessment to identify corridors and associated buffers using the Strahler classification (Strahler, 1952). A subsequent field survey will confirm the riparian corridor buffers to allow infrastructure micro-siting to be undertaken post fieldwork. The avoidance of riparian corridors and buffers is ranked 1st in the ecological scouting framework.</td></tr>
<tr><td>Impacts to Plant Community Types that contain threatened species habitat</td></tr>
<tr><td>Impacts to areas that contain habitat for Vulnerable, Endangered, or Critically Endangered threatened species or populations in accordance with Step 5 in Section 6.5 of the FBA</td></tr>
<tr><td>Impacts to areas of land that the Minister for Environment has</td></tr>
</table>

<table>
<tr><th>Direct impact to be avoided</th><th>Method to avoid impact</th></tr>
<tr><td>declared as critical habitat in accordance with s47 of the TSC Act</td><td rowspan="3">As well as the impacts to riparian corridors and buffers mentioned above, impacts to Bohena Creek as a state significant biodiversity link will be further avoided as there will be no additional crossings of Bohena Creek by linear infrastructure. All linear infrastructure will follow existing crossings only.

The mapping of communities (Figure 9) will be used in a preliminary constraints desktop assessment to identify areas of endangered ecological communities. Field survey will confirm the community boundaries to allow infrastructure micro-siting to be undertaken post fieldwork. The avoidance of endangered ecological communities is ranked 3rd in the ecological scouting framework after riparian corridors and known Barking Owl trees.

Significant fauna features are included in the ecological scouting framework and are to be avoided with preference on avoiding those features of higher significance. Locations of known Barking Owl nest trees are recorded in an OEH register and will be used in conjunction with data on any additional nest trees found to avoid impacts of known nest trees and a 50 m buffer. The avoidance of these nest trees is ranked 2nd in the ecological scouting framework.

Other fauna features to be avoided by rank in the ecological scouting framework are hollow-bearing trees and logs (ranked 5th), nest trees (ranked 7th), and trees with mistletoe (particularly Amyema spp.) (ranked 8th).

Avoidance of threatened flora species is ranked according to those species with a higher legislative status being afforded more protection. Consideration of the number of individuals of each flora species to be impacted in each status category may be required on a case by case basis (e.g. should 1 endangered individual be retained over 10 vulnerable species). Consideration should be given to the total modelled population (and relatively rarity) of each species within the development site to make an informed decision regarding avoidance.

The ecological scouting framework process is detailed in Appendix E.

There are no critical habitat declarations that are relevant to this assessment.</td></tr>
<tr><td>Impacts to riparian areas of 4th order or higher streams and rivers, important wetlands and estuaries</td></tr>
<tr><td>Impacts to state significant biodiversity links</td></tr>
</table>

6.1.2 Site selection

A summary of considerations during the selection of the development site is shown in **Table 42** with descriptions of each method provided in the following sections.

Table 42: Avoidance and minimisation of direct impacts through site selection

Site selection criteria	Method to avoid impact
Selecting a suitable development site for a Major Project or a route for linear projects, should be informed by knowledge of biodiversity values. An initial desktop assessment of biodiversity values would assist in identifying areas of native vegetation cover, endangered ecological communities (EECs) or critically endangered ecological communities	Major facilities (such as Leewood, the Bibblewindi Site and worker accommodation at Westport) have been sited outside the main body of the Pilliga, or adjacent to existing disturbance to avoid and minimise impacts. Site selection for well pads and linear infrastructure is done through a desktop analysis to ensure impact to biodiversity values are avoided or minimised. Initially, site location will make maximum use of areas within or adjacent to existing disturbance or with lower ecological sensitivity.

Site selection criteria	Method to avoid impact
(CEECs), and potential habitat for threatened species	The ecological scouting framework used in the micro-siting of infrastructure will use data from the ecological sensitivity analysis to prioritise ecological values such as endangered ecological communities, threatened flora, threatened fauna habitat. Furthermore, the clearing limits imposed for each Plant Community Type will insure that direct impacts to each Plant Community Type is controlled and not significant.
Stage 1 of the FBA will provide the preliminary information necessary to inform project planning. Early consideration of biodiversity values is recommended in site selection, or route selection for linear projects, and the planning phase.	The landscape features, native vegetation, and threatened species addressed in Stage 1 of the FBA area discussed in **Section 3** to **Section 5**. These biodiversity values are all incorporated in the site selection process discussed above which will allow route and site selection during the planning phase to be modified to avoid and minimise impacts to biodiversity values.
The site/route selection process should include consideration and analysis of the biodiversity constraints of the proposed development site and consider the suitability of the Major Project based on the types of biodiversity values present on the development site	The biodiversity constraints of the development site have been thoroughly analysed and mapped in the ecological sensitivity analysis. The site selection process will use the data from the ecological sensitivity analysis as part of the ecological scouting framework to identify areas of low sensitivity in which to focus infrastructure placement. The flexibility of well pad and linear infrastructure placement allows for a greater degree of avoidance of biodiversity values in the development site.
When considering and analysing the biodiversity constraints for the purpose of selecting a development site, the following matters should be addressed: (a) whether there are alternative sites within the property on which the proposed development is located where siting the proposed Major Project would avoid and minimise impacts on biodiversity values (b) how the development site can be selected to avoid and minimise impacts on biodiversity values as far as practicable (c) whether an alternative development site to the proposed development site, which would avoid adversely impacting on biodiversity values, might be feasible.	Due to the nature of the development footprint, the site selection will be a reoccurring process that will be applied to each individual well pad, and linear infrastructure component. Each individual site will undergo a process of investigating multiple positions through the micro-siting process to best avoid and minimise impacts on biodiversity values. The ecological scouting framework will ensure that a thorough desktop analysis and subsequent field survey will be undertaken to position the infrastructure in an area with the lowest biodiversity value possible. Additionally, through prioritising infrastructure placement in previously cleared areas, direct impacts will be largely avoided.
For linear projects, the route selection process must include consideration and an analysis of the biodiversity constraints of the various route options. In selecting a preferred option, loss of biodiversity values must be weighed up and justified against social and economic costs and benefits.	The broad scale site location for each well pad is dependent on the resource. However, the specific siting of well pads and linear infrastructure is then modified through the ecological scouting framework. The ecological scouting framework is designed to consider the impacts to biodiversity values of a number of locations, such that the least impacting location can be selected, within the requirements of the project.

6.1.3 Planning

Planning was considered during the selection of the development site. A summary of criteria utilised is shown in **Table 43** with descriptions of each method provided in the following sections.

Table 43: Avoidance and minimisation of direct impacts through planning

<table>
<tr><th>Planning criteria</th><th>Method to avoid impact</th></tr>
<tr><td>Siting of the project – the Major Project should be located in areas where the native vegetation or threatened species habitat is in the poorest condition (i.e. areas that have a lower site value score) or which avoid an endangered ecological community (EEC) or critically endangered ecological community (CEEC)</td><td rowspan="3">Impacts to Plant Community Types and respective threatened species' habitats will be avoided by prioritising infrastructure placement in previously cleared areas.
The ecological sensitivity analysis for the development site has identified areas of low sensitivity in which the infrastructure will be placed as a priority.
Ecological values with high conservation needs (such as endangered ecological values) categorised to a higher sensitivity and hence mapped to maximum avoidance.
The nature of the infrastructure would not form barriers or hostile gaps.</td></tr>
<tr><td>Minimise the amount of clearing or habitat loss – the Major Project (and associated construction infrastructure) should be located in areas that do not have native vegetation, or in areas that require the least amount of vegetation to be cleared (i.e. the development footprint is minimised), and/or in areas where other impacts to biodiversity will be the lowest</td></tr>
<tr><td>Loss of connectivity – some developments can impact on the connectivity and movement of species through areas of adjacent habitat. Minimisation measures may include providing structures that allow movement of species across barriers or hostile gaps</td></tr>
</table>

6.1.4 Design alterations

The design and location of infrastructure for the project will make maximum use of areas within or adjacent to existing disturbance or with lower ecological sensitivity. This strategy will continue to reduce the overall extent of clearing required and will minimise additional fragmentation and additional edge effects within the landscape. This strategy includes:

- Implementation of the Field Development Protocol
- Preparation of an ecological scouting framework which considers biodiversity values such as threatened species, ecological communities and their potential habitats and prioritising them for avoidance. This will ensure that infrastructure is appropriately located for minimal ecological impact.
- The placement of seismic infrastructure in previously cleared areas where practicable to avoid vegetation clearing.
- The placement of the central water and gas processing facilities at the Leewood site, outside of the forest to minimise vegetation clearing.
- Co-location of linear infrastructure such as gas and water gathering systems and access tracks with existing roads, access tracks and disturbance corridors wherever possible. Additionally, when new access tracks are required, the construction of gathering system would be aligned with the access tracks where possible. Further micro-alignment may be undertaken to minimise impacts on known ecological constraints such as threatened species and hollow-bearing trees, if practicable.
- Linear infrastructure, tracks and the gathering system, will be an average of 10 m wide during construction (up to a maximum of 12 m wide).
- Construction of the gas and water gathering systems will use a ‘plough-in’ technique where possible as this reduces the width of the corridor required for construction, minimises disruption to topsoil, and minimises the need for traditional trenching and dewatering of open trenches. This would also reduce the risk to fauna falling into trenches.

6.1.5 Field development protocol

A Field Development Protocol has been prepared to ensure the planning, design and construction phases of the project are undertaken in accordance with mitigations and commitments in the EIS, consent conditions and management plans. In relation to ecological matters, it addresses the avoidance and minimisation of direct and indirect impacts by implementing the steps outlined in **Table 44**.

Table 44: Field development protocol outline

Step	Components	Relevant section of this document
Desktop review	Design development plan following procedures described in Step 1 of the ecological scouting framework. Review cumulative disturbance figures against upper clearing limits.	Detail provided below on ecological scouting framework. Clearing limits presented in **Table 55 Table 56** and **Table 57.**
Micro-siting	Undertake field scouting following procedures described in Step 2 of the ecological scouting framework.	Detail provided below on ecological scouting framework.

Step	Components	Relevant section of this document
Design	Complete detailed design, implementing results from desktop assessment and micro-siting stages following procedures in Step 3 of the ecological scouting framework.	Detail provided below on ecological scouting framework.
Implementation (Management Controls and Auditing)	Implement pre-clearance protocols and relocate fauna out of the construction area	Pre-clearing procedure detailed in **Section 6.2.5**.

6.1.6 Ecological scouting framework

The ecological scouting framework has been incorporated into the Field Development Protocol. It identifies the most suitable areas for proposed infrastructure to be positioned in order to cause the least environmental impact. This process involves:

1. Desktop assessment: a preliminary constraints analysis using spatial layers to highlight areas of ecological sensitivity.
    a. Buffer well pads by 50 m (4 ha area) and linear infrastructure by 5 m (20 m corridor)
    b. Review mapped watercourses and riparian corridors
    c. Review aerial photography
    d. Review Ecological Sensitivity Analysis
    e. Review vegetation mapping
    f. Review Pilliga Mouse habitat model
    g. Review canopy height model (CHM)
    h. Based on (a) to (g) identify and map preliminary constraints
2. In-field micro-siting: a field survey within a buffered area (1a), collecting spatial data for biodiversity values (**Appendix E**) which allows infrastructure micro-siting to be undertaken post-fieldwork.
3. Post-field micro-siting: undertake a post-field micro-siting exercise utilising the ecological scouting framework (**Appendix E**) and a set of design principles (e.g. maximum angles of bends in access tracks, orientation of well sites etc.).

6.1.7 Ecological sensitivity analysis

The potential constraints of the development site from an ecological perspective are complex and involve a number of unique ecological components including riparian corridors, threatened flora, threatened fauna habitat, endangered ecological communities, high quality vegetation, regional vegetation significance, and large patch size. To present these constraints in a meaningful manner, an ecological sensitivity analysis (ESA) was developed for the development site to identify the degree of ecological sensitivity and constraint to development (**Figure 21**).

The primary purpose of the ecological sensitivity analysis is to inform the selection of locations for well sets and associated infrastructure (such as access tracks and gas and water gathering systems) to maximise avoidance on areas of higher ecological sensitivity.

The ecological sensitivity analysis used available spatial data as well as data collected through field investigations and spatial data developed specifically for the project to identify areas of sensitivity. Ecological criteria were identified and assigned ranking and weightings in an internal workshop (attended by ecologists and conservation planners) and based on key indicators of biodiversity values and available information. The sensitivity analysis then combined scores for the data, applied weightings, and modelled sensitivity indices. Five relative sensitivity classes based on identified trends (clustering) in the sensitivity index were modelled:

- **Low** – Areas that include a high degree of disturbance which impact on long term viability. Impacts should be directed to these areas wherever possible.
- **Low - Moderate** – Areas that exhibit effects of disturbance, or habitat values which are of lower sensitivity in the regional context. Impacts on these areas should be minimised at the site scale.
- **Moderate** – Areas that exhibit some effects of disturbance, or habitat values which are of moderate sensitivity in the regional context. Impacts on these areas should be minimised at the site scale.
- **Moderate - High** – Areas that include a range of biodiversity values, including those listed under State or Federal legislation. Maximise avoidance on these areas.
- **High** – Areas which contain a combination of significant biodiversity values, including those listed under State or Federal legislation. Maximise avoidance on these areas.

6.1.8 Watercourse mapping

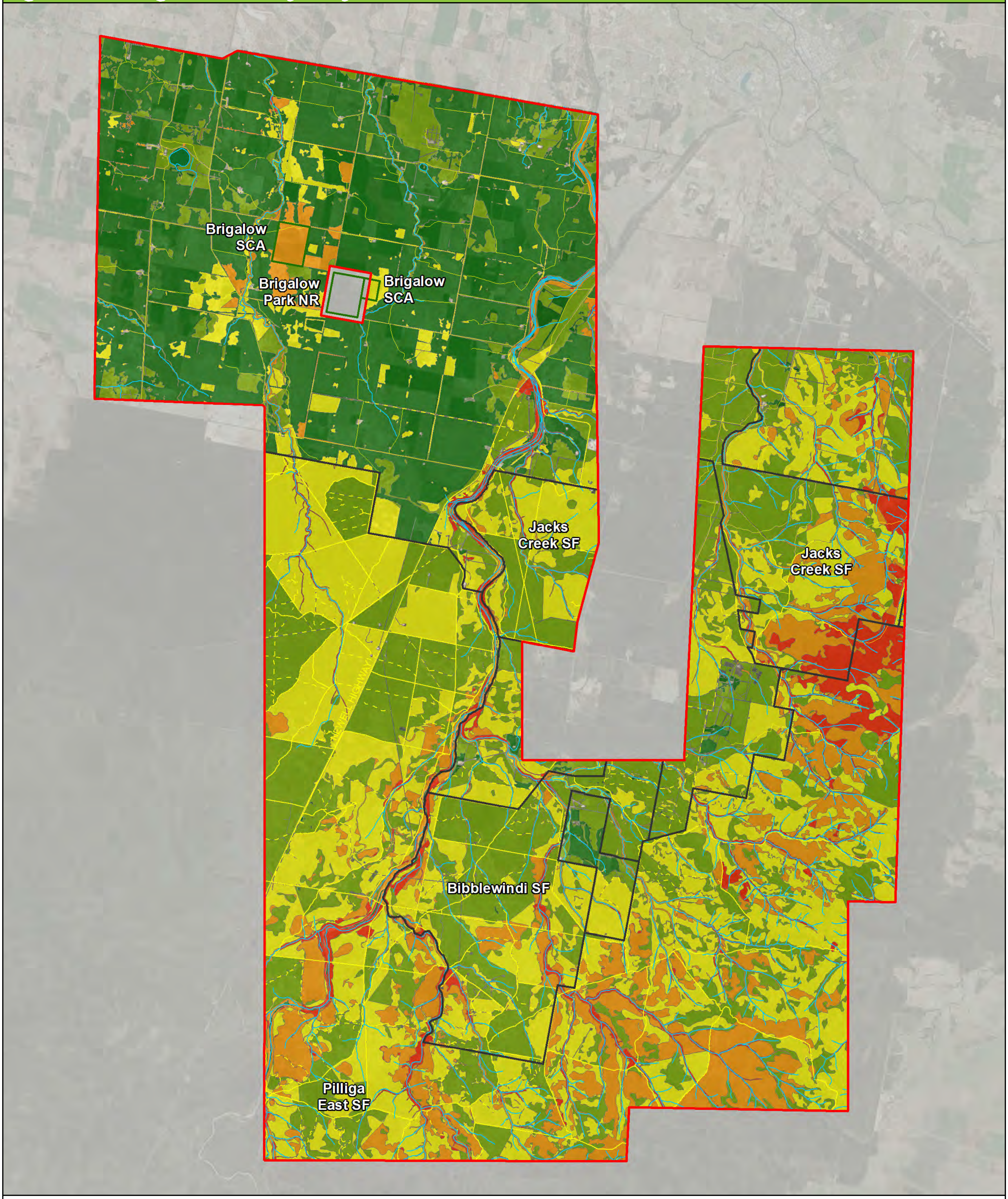
As part of this study, watercourses in the development footprint were refined at a 1:15,000 scale, stream orders classified (Strahler, 1952) and riparian corridors mapped in accordance with recommended widths under the WM Act.

In line with WM Act guidelines, the existing watercourse mapping layer based on the 1:50 000 scale topographic maps was used as the base watercourses dataset. This data was updated at a scale of 1:15 000 by utilising a high-resolution digital elevation model (1 m) and contour data (25 cm) derived from LiDAR.

Strahler stream order classification is an essential component of determining required riparian corridor widths as part of the protection of waterfront land under the WM Act. Stream order was assigned to each watercourse according to the (Strahler, 1952) methodology.

The final watercourse layer classified with Strahler stream order was used to identify the necessary vegetated riparian zone buffer required as part of the WM Act. To account for the need to include channel widths as part of the total riparian corridor width, top of bank was digitized for watercourses with larger channels that could easily be identified at a scale of 1:15 000 (including all 5th and 6th order watercourses). For all other watercourses, an average channel width was applied based on their stream order.

Figure 21: Ecological sensitivity analysis



Legend

- Study area
- Roads
- Tracks
- Drainage lines (1:50k)
- NPWS Estate
- State Forests

Ecological sensitivity analysis (ELA 2014)

- Low
- Low - Moderate
- Moderate
- Moderate - High
- High

0 1 2 4
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 55

Data Sources:
ELA
Forestry Corporation of NSW
OEH
Imagery: Bing Maps

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Prepared by: MS Date: 17/10/2016

6.2 Measures to minimise impacts

The following section provides mitigation measures recommended for the project. These measures are recommended following the implementation of the avoidance and minimisation measures provided in **Section 6.1**. All measures and management required will be detailed as part of the Environmental Management Framework. Relevant management plans will be prepared prior to construction works commencing and would integrate ecological management procedures with construction and operation phases during implementation of the Field Development Protocol.

The successful application of the proposed mitigation measures requires personnel working on the construction or operation of the project to be aware of the mitigation measures and the reasons why they are required. An ecological induction will be prepared and undertaken by relevant staff and contractors prior to commencement of work. The ecological induction will include contemporary biodiversity issues and site environmental procedures specific to the project. The induction will incorporate stop work procedures and details on key contacts for an environmental emergency or environmental notification.

6.2.1 Measures to minimise impacts during construction phase

A summary of mitigation measures to minimise impacts during the construction phase is presented in **Table 45**.

Table 45: Minimisation of impacts during the construction phase

Matter considered to minimise impacts	Method to minimise impact
Method of clearing – using a method of clearing during the construction phase that avoids damage to retained native vegetation and reduces soil disturbance. For example, removal of native vegetation by chain-saw, rather than heavy machinery, is preferable in situations where partial clearing is proposed	The clearing procedure (**Section 6.2.5**) is designed to ensure clearing disturbance is contained within the development footprint. Furthermore, partial rehabilitation (**Section 7.2**) will reduce erosion and soil transportation.
Clearing operations – minimising direct harm to native fauna during actual construction operations through onsite measures such as undertaking pre-clearing surveys, daily fauna surveys and the presence of a trained ecologist during clearing events	The pre-clearing and clearing procedure (**Section 6.2.5**) is designed to minimise direct harm to fauna. The pre-clearing procedure would identify key fauna habitat features (such as nests, hollow-bearing trees, and hollow logs) that would be removed using the slow drop technique. General mitigation measure D4: Open trenches should be inspected once daily by a suitably qualified fauna handler. Data should be collected on the species, number of individuals captured and capture locations. All clearing of key fauna habitat features will be done under the supervision of a suitably trained ecologist.
Timing of construction – identifying reasonable measures that minimise the impacts on biodiversity. For example, timing construction activities for when migratory species are absent from the site, or when particular species known to or likely to use the habitat on the site are not breeding or	General mitigation measure D5: Vegetation clearing would be managed to minimise clearing during sensitive breeding periods for fauna. A hierarchical timing for clearing from most to least

Matter considered to minimise impacts	Method to minimise impact
nesting, can minimise the impacts of construction activities on biodiversity	preferred is: March to June; February and July/August; and September to January.
Other measures that minimise inadvertent impacts of the Major Project on the biodiversity values – measures such as installing temporary fencing to protect significant environmental features such as riparian zones, promoting the hygiene of construction vehicles to minimise spread of weeds or pathogens, appropriately training and inducting project staff and contractors so that they can implement all measures that minimise inadvertent adverse impacts of the Major Project on biodiversity values.	A suite of general mitigation measures targeted for direct and indirect impacts is provided in **Section 6.2.4**

6.2.2 Measures to minimise impacts during the operational phase

A summary of mitigation measures to minimise impacts during the construction phase is presented in **Table 46**.

Table 46: Minimisation of impacts during the operational phase

Operational phase impact	Method to avoid impact
Seasonal impacts – whether there are likely to be any impacts that occur during specific seasons. Minimisation measures may include amending operational times to minimise impacts on biodiversity during periods when seasonal events such as breeding or species migration occur	General mitigation measure D5: Vegetation clearing would be managed to minimise clearing during sensitive breeding periods for fauna. A hierarchical timing for clearing from most to least preferred is: March to June; February and July/August; and September to January.
Artificial habitats – using 'artificial habitats' for fauna where they may be effective in minimising impacts on such fauna. These include nest boxes, glider-crossings or habitat bridges.	General mitigation measure D2: The removal of large hollows ($\geq$300 mm) will be compensated for by at least a 1:1 replacement.

6.2.3 Minimising indirect impacts during construction

A summary of mitigation measures to minimise impacts during the construction phase is presented in **Table 47**.

Table 47: Minimisation of indirect impacts

Indirect impact	Method to avoid indirect impact
Sedimentation and run-off – sediment barriers or sedimentation ponds to minimise impacts of the Major Project on biodiversity values on land that is adjoining the development site, and waterways downstream of the development site	General mitigation measures I–d3 to I–d9
Noise, dust or light spill – adopting onsite measures that can minimise the impacts on biodiversity values from noise, dust or light spill during the construction phase. For	General mitigation measures I-s2, I-s6, I-d1, and I-d2

Indirect impact	Method to avoid indirect impact
example, only undertake construction during daylight hours to avoid impacts from light spill where this may be detrimental to species habitat on adjoining lands	
Inadvertent impacts on adjacent habitat or vegetation – considering measures such as retaining vegetation on the development site as a buffer to protect significant environmental features (e.g. riparian zones, likely or known threatened species habitat)	Riparian corridors, a stream plus a buffer, have been mapped for the development site. Only linear infrastructure will intersect with riparian corridors. Indirect impacts have been assessed within a buffer around all infrastructure to ensure that offset calculations consider the buffer of indirect impacts surrounding the development footprint.
Feral pest, weed and/or pathogen encroachment into vegetation on land adjoining the development site – one example is using protocols for hygiene that minimise the likelihood of construction vehicles spreading weeds or pathogens from the development site into native vegetation on land adjoining the development site	General mitigation measures I-s7 to I-s10
Impacts that are infrequent, cumulative or difficult to measure – where there are likely to be indirect impacts on biodiversity that are infrequent, cumulative or difficult to measure over time, consideration should be given to how an operational monitoring program can be used to assess the timing and/or extent of these impacts. A proposal for an operational monitoring program should be set out in the BAR. Development of a monitoring program may involve determining the base-line information that will be necessary to measure the impact over time. It should also consider how the results of the monitoring program could be used to inform ongoing operations in order to reduce the extent of indirect impacts	The proposed monitoring program (**Section 6.2.6**) would monitor the direct and indirect impacts of the project and compare results against benchmarks to ensure that management measures are sufficient.
Impacts during the operational phase – measures to avoid or minimise the indirect impacts on threatened species and threatened species habitat on land adjoining the development site, migratory species or flight pathways as a result of the operation of the development. Such measures may include those adopted to avoid and minimise: (i) trampling of threatened flora species (ii) rubbish dumping (iii) noise (iv) light spill (v) weed encroachment (vi) nutrient run-off (vii) increased risk of fire, and (viii) pest animals.	General mitigation measures for Indirect site impacts, downstream or downwind impacts, and facilitated impacts are provided in **Section 6.2.4**

6.2.4 General mitigation measures

General mitigation measures have been provided for each identified risk and the timing in which the mitigation measure should be applied (**Table 48**).

Table 48: Mitigation measures by impact

Impact	No.	Mitigation measure	Timing
General ecology management			
General ecology management	G1.	A Biodiversity Management Plan would be developed and would include: • Significant Species Management Plan • Management measures to minimise impacts to flora and fauna.	Pre-construction
Direct impacts			
Vegetation removal, habitat removal, removal of threatened flora individuals	D1.	Vegetation would be cleared in accordance with the clearing procedure provided in **Section 6.2.5** to minimise impacts to fauna during vegetation removal.	Pre-construction, and construction
	D2.	The removal of large hollows (≥300 mm) will be compensated for by at least a 1:1 replacement.	Construction
	D3.	Protocols would be developed and implemented to record vegetation clearance and threatened flora removal and ensure it is within the approved overall limits.	Construction
	D4.	Open trenches should be inspected once daily by a suitably qualified fauna handler. Data should be collected on the species, number of individuals captured and capture locations.	Construction
	D5.	Vegetation clearing would be managed to minimise clearing during sensitive breeding periods for fauna. A hierarchical timing for clearing from most to least preferred is: March to June; February and July/August; and September to January.	Construction
	D6.	Rehabilitation of impacted areas would occur as soon as practicable in accordance with the Rehabilitation Strategy	Construction Decommissioning
Indirect site impacts			
Fragmentation		Infrastructure will be co-located with existing roads wherever practicable. Well pads located no closer than 750 m to each other. Mitigation measures D1 – D6.	See D1 – D6

Impact	No.	Mitigation measure	Timing
Noise	I - s 1.	Noise mitigation design and engineering measures as specified in Appendix M of the Environmental Impact Statement.	Design, construction and operation
Traffic	I - s 2.	The speed limit of 60 km/h within State Forests will be enforced. This speed limit will be reduced to 40 km/h in construction areas (i.e. lease areas and service corridors constructed for the activity). Otherwise the posted speed limit will apply.	Construction, operation and rehabilitation
	I - s 3.	Driving during high fauna activity periods (that is, from dusk through to dawn) would be minimised.	Construction, operation and rehabilitation
Fencing	I - s 4.	'Fauna friendly' exclusion fencing (without barbed wire) would be installed around well sites during operation unless determined under a land access agreement.	Construction
Light	I - s 5.	Lighting would be focused on work sites during construction and on project infrastructure during operation to minimise light spill into adjoining areas.	Construction and operation
Weed invasion	I - s 6.	Prior to earthworks, weeds listed as Noxious under the NW Act that are present on the site would be removed or treated with herbicide to prevent or reduce their spread.	Construction
	I - s 7.	Weeds would be controlled in accordance with a Pest Plant and Animal Management Plan that would be developed for the project.	Construction, operation and rehabilitation
Increased feral fauna	I - s 8.	Feral animals would be controlled in accordance with a Pest Plant and Animal Management Plan that would be developed for the project.	Construction, operation and rehabilitation
	I - s 9.	No domestic pets (including cats or dogs) will be allowed within the development site.	Construction, operation and rehabilitation
Fire	I - s 10.	Smoking should be restricted in the development site to decrease risk of a fire.	Construction, operation and rehabilitation
	I - s 11.	A bushfire hazard and risk assessment will be developed and implemented.	Construction, operation and rehabilitation
Indirect downstream or downwind impacts			
Sedimentation, erosion and dust	I - d 1.	Dust suppression within the roads and well sites should be undertaken to reduce the impacts of dust.	Construction, operation and rehabilitation

Impact	No.	Mitigation measure	Timing
	I - d 2.	Dust suppression using water trucks should be correlated with vehicle and construction activity. Once construction is complete, water trucks should not be used to control dust at well pads.	Construction, operation and rehabilitation
	I - d 3.	Implement the sediment and erosion control management plan. This plan should include the following measures: a. Specifics about activities that intersect with the riparian corridor or a waterway	Construction, operation and rehabilitation
	I - d 4.	b. Excess topsoil and subsoil generated during site preparation activities will be stockpiled onsite and used as backfill following completion of drilling.	Construction, operation and rehabilitation
	I - d 5.	c. Excavated surface and subsurface soils will be stockpiled separately to avoid profile inversion.	Construction and operation
	I - d 6.	d. Stockpiled subsoils should be covered to avoid compaction and water erosion.	Construction and operation
	I - d 7.	e. Stockpiles will be managed according to best management practices such as the measures outlined in Managing Urban Stormwater: Soils and Construction (Landcom, 2004) ('the Blue Book').	Construction and operation
	I - d 8.	f. Erosion and sediment controls will be implemented where necessary during construction activities, in accordance with best management practices (such as the Blue Book or International Erosion Control Association (IECA) Guidelines). These controls will be maintained until disturbed areas of the site are stabilised.	Construction, operation and rehabilitation
	I - d 9.	g. Given the very high potential dispersibility of subsoils at the sites, exposed subsoils should be protected either with vegetation (high ground cover), appropriate matting or preferred surface protection measures during both.	Construction, operation and rehabilitation
Hydrological change	I - d 10.	Addressed in infrastructure placement and design (**Section 6.2**).	Design

Impact	No.	Mitigation measure	Timing
	I - d 11.	A water management plan will be developed and implemented, to address issues associated with hydrological changes and water quality impacts for both surface and groundwater.	Construction and operation
Accidental spills and leaks	I - d 12.	All liquids (fuel, oil, cleaning agents, drilling liquids etc.) will be stored appropriately and disposed of at suitably licensed facilities.	Construction, operation and rehabilitation
	I - d 13.	Spill management procedures will be implemented as required.	Construction, operation and rehabilitation
	I - d 14.	A chemical management procedure will be developed to control and manage chemical use on site. This would ensure that no chemicals would enter aquatic environments through runoff or direct application.	Construction and operation
Indirect facilitated impacts			
Hunting	I - h 1.	Observations of illegal hunting or collecting of flora or fauna materials should be recorded and appropriate personnel should be notified.	Construction, operation and rehabilitation

6.2.5 Pre-clearing and clearing procedure

A pre-clearing and clearing procedure has been developed to minimise potential impacts or risk to fauna during vegetation removal. The purpose of the procedure is to identify fauna occurrence in the proposed clearing area, encourage fauna to relocate outside of the proposed subject site prior to habitat clearing and move fauna during clearing.

Clearing operations are supervised by an appropriately qualified ecologist following the steps listed below and described in more detail in **Appendix F**. During clearing, the number of hollow-bearing trees and threatened flora removed will be recorded so that clearing limits are not surpassed. The clearing procedure contains the following key steps.

1. Planning and walk-through
2. Slash shrub and ground layer (under scrubbing)
3. Tap hollow-bearing trees
4. Remove hollow-bearing trees

Positive communication is maintained throughout the clearing process.

6.2.6 Monitoring

A monitoring program will be developed post-approval as part of a Biodiversity Management Plan for the project. The Biodiversity Management Plan will include a Significant Species Management Plan and management measures to minimise impacts to flora and fauna.

The monitoring program will specify a rigorous methodology to scientifically monitor the direct and indirect impacts of the project. This will include ensuring that the proposed mitigation measures are adequately addressing the impacts and will work to implement additional measures as required to ensure that impacts are avoided and mitigated to the highest degree possible throughout the 25 year construction and operational life of the project. The monitoring program will include quantitative key performance targets to ensure that progress is being compared to measurable benchmark conditions.

Monitoring will also occur at offset properties as required to ensure that the management of the offset properties is adequate for the aims of the associated Offset Management Plan. The monitoring required will depend on the management tasks required but may include rehabilitation monitoring or revegetation monitoring.

Previous monitoring programs (e.g. by Forestry Corporation of NSW) would be reviewed to align efforts where possible with existing data sources.

7 Assessment and offsetting requirement for unavoidable impacts

7.1 Introduction

The project will involve impacts to native vegetation, fauna habitat and threatened flora species throughout the entire extent of the development site. The impacts have been presented below with an assessment of those species that require further consideration or offsetting.

7.1 Direct impacts

Direct impacts are those impacts that directly affect habitat and individuals (DECC, 2007). Direct impacts considered for this assessment are vegetation removal, habitat removal and removal of threatened flora individuals. The direct impacts of the project by infrastructure element are outlined in **Table 49** with detail on specific direct impacts provided in **Section 7.1.1** to **Section 7.1.4**.

It is important to note that the calculation of direct impacts is based on the upper disturbance limit for each Plant Community Type and is inherently conservative. The upper disturbance limits allow for flexibility of infrastructure placement within the development site (depending on the viability of the resource, proximity to existing infrastructure, landholder feedback and constraints) and it is unlikely that total upper disturbance limit will be reached.

Table 49: Direct impacts by infrastructure element

Location	Leewood	Bibblewindi	Bibblewindi to Leewood infrastructure corridor	Leewood to Wilga Park underground power line	The gas field	Ancillary	Total
Clearing required (ha)	0	16	26.7	0	920.6	25.5	988.8

7.1.1 Vegetation

For major facilities (except the Leewood to Wilga Park underground power line), the amount of each Plant Community Type directly impacted was calculated in a Geographic Information System. The rationale to not include the Leewood to Wilga Park underground power line was due to all disturbances being within the existing gas pipeline easement which is a previously assessed cleared corridor.

Due to the progressive nature of the project where exploration and appraisal informs development, the exact footprint for vegetation removal is not known at this stage. To address this uncertainty for gas field infrastructure, the potential impact to each Plant Community Type was modelled and an upper disturbance limit determined.

A vegetation impact model was developed to assess the potential impacts or disturbance of well pads and associated linear infrastructure (roads, access tracks and gathering line easements) from the project on native vegetation. The model utilised the vegetation map for the development site and a probabilistic approach to predict the number of hectares of each Plant Community Type to be removed. To facilitate integration of the probabilistic assessment with the vegetation mapping, the model impact area was divided into standard 1 km^2 blocks, into which well and linear infrastructure (of differing densities) potentially could be placed. Each block was furthered divided into four hundred 0.25 ha squares for the analysis to replicate the potential size of infrastructure that would be constructed in the field. The 0.25 ha squares allowed for statistical assessment and to develop a system that can be used to assess the potential impacts of a multitude of development scenarios. The model grid sizes were selected based on the size of petroleum infrastructure and to allow for assessment of the impact of percent vegetation coverage/habitat within each 0.25 ha cell and the 1 km^2 development area on the magnitude of disturbance.

For the model to assess the maximum probable disturbance associated with various development scenarios, an algorithm was applied to the standard grid system described above. The implementation of the algorithm for maximum probable disturbance utilised the following methodology with the infrastructure considered fixed and the distribution of vegetation and habitat considered an independent variable:

1. Develop the infrastructure footprint by designating the fraction of each 0.25 ha block that potentially could contain infrastructure for a series of standard development scenarios (well densities and associated linear infrastructure).

2. Assess the impact of different densities of vegetation on the probability of disturbance by randomly selecting the appropriate number of 0.25 ha squares (i.e. for 30% of vegetation coverage, select 30 out of the 100 squares) for each discrete ‘percentage’ of vegetation communities and habitat.

3. For the squares with vegetation communities overlaid by infrastructure, sum the area of infrastructure footprints – this is the total vegetation communities or habitat impacted area.

4. Repeat steps 2 and 3 thousands of times and record the impacted area for each ‘realization’.

5. Process the recorded values from the realizations to determine the median, 25th and 75th percentile values.

Modelling was conducted for 21 separate scenarios utilising the methodology described above, the 21 scenarios consisted of seven separate development scenarios run over three well pad avoidance area assessments: avoiding riparian corridors only; avoiding riparian corridors and high ecological sensitivity areas; and avoiding riparian corridors, high and moderate-high ecological sensitivity areas. The development scenarios differed by the spatial location of infrastructure around the development site. The modelling assessed the impact of 425 well sets and associated linear infrastructure and an additional 5 water balance tanks to account for the potential worse case impact of the project.

The amount of clearing for each Plant Community Type under each scenario was modelled to determine an upper disturbance limit against each Plant Community Type. A qualitative assessment was then undertaken to review the modelled outputs and determine the final upper disturbance limit for each Plant Community Type through the consideration a range of factors including: conservation status; percent remaining in NSW; potential offset availability; sensitivity classification; and extent. The qualitative assessment considered where concentrated development may result in higher impacts to specific Plant Community Types and ensures that the upper disturbance limits account for the most likely development scenarios.

The upper disturbance limits selected were most often the maximum value generated out of all of the scenarios. Where the upper limit deviated from this value was when a decision was made to have no impact to a vegetation community (based on small size or location), or where a particular scenario was having an adverse effect on the maximum value generated (i.e. highly unlikely to occur). Specific instances where this occurred are outlined in **Table 50**.

Table 50: Deviations from the modelled upper disturbance limit

Plant Comm. ID	Plant Community Type	Maximum modelled disturbance (ha)	Upper disturbance limit (ha)	Rationale
78	River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions	0.03	0	The restricted distribution of this community and low overall area allows for complete avoidance of this community.
404	Red Ironbark - White Bloodwood - /+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	100.04	84.3	Second highest modelled disturbance scenario selected. The upper disturbance limit selected accounts for the most likely development scenarios.
405	White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	125.33	105.88	Upper disturbance limit selected is for the scenario with the maximum modelled disturbance, but driven by a higher level of avoidance.
428	Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the Brigalow Belt South Bioregion	0.08	0	The restricted distribution of this community and low overall area allows for complete avoidance of this community.

7.1.2 Fauna habitat

The development site provides habitat for a range of threatened fauna species. The direct vegetation removal would result in the removal of known or potential fauna foraging, breeding, roosting, sheltering and dispersal habitat. The upper limits of direct vegetation removal have been converted to upper limits for direct impact to fauna habitat, categorised into foraging, breeding and other.

7.1.3 Threatened flora

Flora population estimations and population modelling were utilised in combination with the upper disturbance limits for each Plant Community Type to determine total number of threatened flora individuals that would be impacted. For *Bertya opponens* and *Pomaderris queenslandica* (population estimations), the maximum value generated out of all of the scenarios modelled above was selected. For threatened flora species that were modelled, the direct impact to each species was calculated in proportion to the area of each Plant Community Type impacted.

7.1.4 Threatened fauna

There is a risk of death to threatened fauna during the removal of habitat. Fauna death can occur from impact during tree felling, stress or loss of breeding sites during the critical growth phase for juveniles. This risk cannot be quantified but has been incorporated into the avoidance, minimisation and mitigation measures.

7.2 Indirect impacts

Indirect impacts are those impacts that do not directly affect habitat and individuals but that have the potential to interfere through indirect action. Indirect impacts considered for this assessment are site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna, fire), downstream or downwind impacts (sedimentation, erosion, dust, hydrological change, accidental spills and leaks) and facilitated impacts (hunting).

Indirect impacts have been quantified to provide values for the area of vegetation and habitat that would have potential to be indirectly impacted. Operational indirect impacts have been assessed with a duration of 35 years (25 years during the construction and operational period and an additional 10 years for rehabilitation to become established). In order to quantify the amount of indirect impact that would be required to be offset, the level of indirect impact was correlated with an equivalent area of direct impact. As such, a proportionate amount of vegetation removal can be calculated to correspond with the direct impact calculations presented above.

To undertake this calculation, all site, downstream and facilitated impacts were compared and quantified where possible, firstly without mitigation measures, and then with proposed mitigation measures. A buffer surrounding infrastructure was calculated that would contain all indirect impacts, pre-mitigation. Within the indirect impact buffer, the level of impact is not linear as it will be generally greater closer to the impact source and as such the vegetation within the buffer is not considered to be 100% affected. To account for these factors, a formula was applied to the buffered area to account for the reduction in habitat quality within the indirect impact buffer. This formula was applied to two scenarios; without and with mitigation measures in place. Details of the calculations are presented in **Table 51** and **Table 52** below.

The indirect impact values were then applied to each Plant Community Type, based on the ratio of direct impacts to each Plant Community Type. This allowed for a value of indirect impact to each Plant Community Type which could then be subsequently applied to fauna habitat types and threatened flora individuals.

Table 51: Indirect impact buffer rationale

Infrastructure	Indirect impact buffer	Proportion of indirect impact buffer affected (without mitigation) (25%)	Proportion of indirect impact buffer affected (with mitigation) (10%)
Well pads	50 m	12.5 m	5 m
Gathering system / access tracks	10 m	2.5 m	1 m
Bibblewindi to Leewood infrastructure corridor	10 m	2.5 m	1 m
The Bibblewindi site	50 m	12.5 m	5 m
Workers accommodation at Westport	50 m	12.5 m	5 m
The Leewood property	As the majority of the indirect impacts would be contained within the Leewood boundary, the indirect impacts have only been calculated where the modelled 45 dB(A) noise boundary crosses the Leewood boundary.		

Infrastructure	Indirect impact buffer	Proportion of indirect impact buffer affected (without mitigation) (25%)	Proportion of indirect impact buffer affected (with mitigation) (10%)
Seismic lines	Seismic lines are to be largely undertaken in previously cleared areas (e.g. roadsides) or in pasture/grassland. Seismic survey generally only require slashing of shrub and mid-storey layers and will minimise removal of canopy species. Due to nature of works (maximum width 3 m, slashing, short duration), no indirect impacts have been calculated.		
Leewood to Wilga Park power line	The underground power line would be installed within the existing gas pipeline easement. As no disturbance would occur outside of the easement, no indirect impacts have been calculated.		

Table 52: Indirect impact calculations

Infrastructure	Direct impact	Direct and indirect impact	Indirect impact
Well pads and balance tanks	1 ha x 430 = 430 ha	110 m x 110 m x 430 = 520.3 ha	90.3 ha
Gathering system / access tracks	10 m x 430 km = 430 ha	(10m + (1m x 2)) x 430 km = 516 ha	86 ha
Bibblewindi to Leewood infrastructure corridor	20 m width x 15.8 km length = 31.6 ha (construction footprint) Note that the actual vegetation disturbance is 26.7 ha due to previously cleared areas in corridor.	22 m width x 15.8 km length = 34.76 ha	3.16 ha
The Bibblewindi site	283 m x 565 m (approx.) = 16 ha	293 m x 575 m = 16.85 ha	0.85 ha
Workers accommodation at Westport	100 m x 300 m = 3 ha	110 m x 310 m = 1.41 ha	3.41 ha
The Leewood property	N/A	0.36 ha	0.36 ha
Total indirect impact			181.1 ha

Indirect impacts have been calculated to equate to the removal of an additional 181.11 ha of vegetation in the development site as outlined in **Table 53**. When combined with direct impacts, this equates to a total impact of 1,169.91 ha of vegetation and removal of approximately 1.46% of native vegetation in the development site.

Table 53: Indirect impacts by infrastructure element

Location	Leewood	Bibblewindi	Bibblewindi to Leewood infrastructure corridor	Leewood to Wilga Park underground power line	The gas field	Ancillary	Total
Clearing required (ha)	0.36	.88	3.16	0	176.3	0.41	181.11

7.1 Cumulative impacts

Cumulative impacts of existing and proposed exploration and production appraisal activities associated with the Energy NSW petroleum exploration and appraisal program operated by the Proponent in the study region have been assessed under the TSC Act (ELA, 2013) and the EPBC Act (ELA, 2013). Further impact assessments have added to these reports to record subsequent impacts (ELA, 2014, 2014). The total cumulative impact from existing and proposed operations has been included in this assessment.

As the Pilliga is a unique biological, geological and geographic unit, most existing and proposed impacts in the study region by other companies or industries were not considered in the cumulative impact, except for Narrabri Coal Mine which adjoins the eastern edge of the Pilliga. Biodiversity values impacted by other activities in the study region are not equivalent to the values in the development site. Hence there is unlikely to be cumulative impacts from other activities on the biodiversity values that would be impacted in the development site.

The direct and indirect impacts of Narrabri Coal Mine were considered in the cumulative impact assessment for those biodiversity values that are present in the development site (ELA, 2014). The Narrabri Coal Mine has directly and indirectly impacted on the Biometric Vegetation Type *Red Ironbark – Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion* and the threatened flora species *Bertya opponens*. Both of these biodiversity values have been included in the cumulative impact assessment for this project, however they have not been included in the cumulative offset calculations as they do not directly relate to the project.

The direct and indirect impacts calculated for the project were added to the current cumulative impact values. As the direct and indirect impacts for the project are categorised by Plant Community Type, they were reassigned to the equivalent biometric vegetation type in order to assess the impact in the study region (as biometric vegetation types were the base unit used at the regional scale).

The Namoi regional vegetation mapping used in the cumulative impact assessment has been recently updated (ELA, 2013) and was used to inform the cumulative impact assessments. Due to minor changes in the regional mapping unit areas, the existing impact values used for this assessment are slightly different to those published in previous cumulative impact reports (ELA, 2013, 2014).

The cumulative impact presented is a ‘worst case’ scenario as it uses the upper disturbance limits against each Plant Community Type as a base for direct impacts of the project which, as previously stated, are conservative.

7.2 Rehabilitation

Rehabilitation is proposed in two stages; partial rehabilitation following construction activities and final rehabilitation following operation completion. Partial rehabilitation of well pads will involve reducing the well lease area width through progressive rehabilitation following construction activities, whilst enabling ongoing access and maintenance. Just over half of each cleared one hectare well pad would be partially rehabilitated at this stage, following an assessment of the operational performance of the well. This assessment would typically be undertaken less than 6 months after installation, but may take 12 months or more depending on well performance. Well pads that contain other infrastructure such as water balance tanks or telecommunication towers will not be partially rehabilitated at this stage and will remain at approximately 1 ha in area.

A network of underground gas and water gathering systems will connect the well pads to the gas and water processing facility. This will be undertaken wherever practicable using the ’ploughing’ method. Ploughing is the preferred option for the installation of underground gathering systems, as equipment is able to ‘plough in’ the underground pipes which requires minimises topsoil disturbance and allows for immediate natural regeneration.

Underground gas and water gathering systems that require a trench to be dug before pipelines are installed require subsoil and topsoil to be excavated and stored during construction. The trench will be backfilled as the pipes are installed and the area will be partially rehabilitated.

Approximately 50% of the right of way would be rehabilitated following construction, the remaining area will be an access track.

Natural regeneration of shrubs, grasses and herbs will be encouraged through the spreading of woody material and management of weeds. Partial rehabilitation directly over pipelines would comprise shrubs and grasses only, with overstorey trees that germinate being selectively removed to prevent damage to pipes and related infrastructure.

7.3 Impact thresholds

A summary of the impact thresholds identified in the FBA is provided in **Table 54**.

Table 54: Impact thresholds for landscape features, native vegetation, and threatened species and populations

Impact	Present within the development site
Impacts that require further consideration by consent authority	C: Impacts to critically endangered species: Regent Honeyeater. C: Impacts to Five-clawed Worm-skink and Scant Pomaderris as specified by the SEARs.
Impacts for which the assessor is required to determine an offset	B: Impacts to endangered ecological communities (PCT ID 27, 35 and 202). B/C: Impacts to Plant Community Types in the development site (all Plant Community Types would be impacted except PCT ID 78 and 428) as they are associated with threatened species habitat and have a site value score ≥ 17. C: Impacts on habitat associated with those species listed in **Table 14** as ecosystem species. C: Impacts on known threatened species listed in **Table 16** as credit species.
Impacts for which the assessor is not required to determine an offset	C: Impacts to non-threatened species.

Impact	Present within the development site
Impacts that do not require further assessment by the assessor	A/B: Areas of land without native vegetation (**Figure 3**).

7.4 Further consideration

The impacts on Regent Honeyeater, Five-clawed Work-skink and Scant Pomaderris were considered further, with details provided in **Appendix D**.

7.5 Impacts requiring offsetting

Quantification of the impacts of the project integrated direct, indirect and cumulative impacts of the project. Additionally, partial rehabilitation was assessed to quantify the contribution that undertaking immediate rehabilitation post construction makes to reduce the overall offset liability.

Due to the complex nature of the project, it is not possible to completely assess the offset liability within the Major Projects Credit Calculator, however the intent of the Framework of Biodiversity Assessment has been maintained with the approach taken. The full impact (direct, indirect and cumulative) and offset liability of the project has been calculated using data entered into the Major Projects Credit Calculator with supplementary calculations undertaken using data generated by the Major Projects Credit Calculator.

100 hectares were entered against each Plant Community Type Impacted and 100 hectares were entered against each Plant Community Type to be rehabilitated. 100 hectares was entered so that detailed analysis of the contribution of direct impacts, indirect impacts, cumulative impacts and rehabilitation on offset requirements could be determined outside of the Major Projects Credit Calculator. 100 hectares was used as it is a large enough number to reduce the subsequent impacts of rounding (compared to if 1 hectare was used).

Due the requirement for up to four management zones per Plant Community Type (i.e. native vegetation, native vegetation rehabilitation, derived native vegetation, and derived native vegetation rehabilitation) and for ease of analysis, the assessment was split across two identical versions of the assessment in the Major Projects Credit Calculator.

For flora, 100 individuals were entered, while for fauna 100 hectares were entered. Similarly to vegetation zones, ‘100’ was entered as the base unit so that detailed analysis of the contribution of direct impacts, indirect impacts, cumulative impacts and rehabilitation on offset requirements could be determined outside of the Major Projects Credit Calculator. 100 hectares was used as it is a large enough number to reduce the subsequent impacts of rounding (compared to if 1 hectare was used).

7.5.1 Native vegetation

The results of the ecosystem credit assessment are summarised in **Table 55** which indicate that a total of 56,113 ecosystem credits are required to meet the outcomes of the Framework for Biodiversity Assessment. Using the OEH credit converter which assumes an average Biobank site will generate 9.3 credits per ha, the equivalent offset area is 6,034 ha. This equates to a 6:1:1 offset ratio against a direct impact of 988.8 hectares or a 4.8:1 offset ratio against a combined direct, indirect and cumulative impact of 1,254.7 ha.

Calculating future management

The future management was considered in the calculations to incorporate the proposed partial rehabilitation. Two management zones were defined: development (complete clearing); and partial rehabilitation (partial clearing). For development areas, the default '0' was applied to site value scores (indicating complete clearing). For partial rehabilitation, site value scores were manually adjusted from the current maximum value to the following values:

- Native species richness = '1'
- Native overstorey cover = '1'
- Native midstorey cover = '1'
- Native ground cover (grasses) = '1'
- Native ground cover (shrubs) = '1'
- Native ground cover (other) = '1'
- Exotic plant cover = same as original plot data
- Number of trees with hollows = '0'
- Proportion of over-storey species occurring as regeneration = '1'
- Total length of fallen logs = same as original plot data

The rationale for the modification to site value scores for partial rehabilitation management scores is as follows:

- Native species richness is unlikely to change as a result of the project due to the effective management of topsoil and the soil seedbank (and actually is likely to increase), however a precautionary approach has been taken and a reduction in site value from a maximum of '3' to '1' has been taken.
- Native plant cover will be reduced initially following clearing, but will regenerate rapidly over time. As such, a reduction in native plant cover from a maximum of '3' to '1' has been taken.
- Exotic plant cover is unlikely to increase as a result of the project due to the commitment to prepare and implement a pest plant and animal management plan.
- The number of trees with hollows will be reduced to '0' in development areas as a result of the project. The installation of nest boxes is not currently a supported method for the replacement of hollows in the FBA.
- The proportion of over-storey species occurring as regeneration is unlikely to change as a result of the project due to the effective management of topsoil and the soil seedbank.
- Total length of fallen logs is unlikely to change as a result of the project and is more likely to increase due to the respreading of felled timber.

The proposed rehabilitation methodology for the project differs significantly from traditional mine site rehabilitation in that the subsoil structure, water infiltration and nutrient cycling are largely unaffected during construction.

A comprehensive rehabilitation strategy has been developed (Appendix V of the EIS). The primary objective of rehabilitation in the development site is to manage topsoil to conserve the soil seed bank, nutrients and to encourage the establishment of vegetation. This will be achieved through slashing and mulching of vegetation (rather than clear-felling), minimising impacts on topsoil and the soil seedbank during construction and facilitating natural regeneration through rapid rehabilitation following construction.

The rehabilitation strategy for the project utilises the inherent capacity of the native vegetation of the Pilliga to regenerate. Progressive rehabilitation has been undertaken in the development site for a selection of well pads and linear infrastructure as part of existing exploration and appraisal activities. Monitoring of this rehabilitation has been undertaken since 2012 and has shown that on average, rehabilitation sites approximate 74% of the site value of reference sites within relatively short timeframes (<5 years).

The methodology specified above for determining the site value of partial rehabilitation management zones results in approximately 68% of the credits required for development areas (complete clearing). This is consistent with the demonstrated ability of rehabilitation sites to approximate reference sites within relatively short periods as outlined above.

Table 55: Major projects assessment (Version 4.1) – ecosystem credits required

Vegetation zone	Vegetation code	Biometric vegetation type	Ancillary	Direct impacts		Indirect impacts		Cumulative impacts		Rehabilitation		Total		Offset required
				Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)
1	NA219	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Native Vegetation	0.04	3.35	0.00	0.00	0.00	0.00	0.06	3.74	0.10	7.09	0.76
2	NA219	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	DNG	0.19	6.88	0.00	0.00	0.00	0.00	0.31	8.01	0.50	14.89	1.60
3	NA117	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	Native Vegetation	7.30	475.74	3.90	76.25	5.10	332.37	12.00	532.92	28.30	1,417.28	152.40
4	NA117	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	DNG	13.95	505.13	0.00	0.00	0.00	0.00	23.25	600.55	37.20	1,105.68	118.89
5	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Native Vegetation	1.48	78.47	0.80	12.72	0.00	0.00	2.43	80.70	4.71	171.89	18.48
6	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	DNG	0.64	23.17	0.00	0.00	0.00	0.00	1.06	27.38	1.70	50.55	5.44
7	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	Native Vegetation	18.85	1,239.95	8.19	161.62	2.90	190.76	21.95	980.95	51.89	2,573.28	276.70
8	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	DNG	3.30	75.27	0.00	0.00	0.00	0.00	5.50	80.36	8.80	155.63	16.73
9	NA121	Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	Native Vegetation	7.38	265.31	4.00	43.14	0.00	0.00	12.13	270.38	23.51	578.83	62.24
10	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	Native Vegetation	2.35	182.36	1.23	28.63	0.90	69.84	3.55	201.75	8.03	482.58	51.89
11	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	DNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	NA292	Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern Brigalow Belt South Bioregion	Native Vegetation	0.11	5.17	0.10	1.41	0.00	0.00	0.19	6.34	0.40	12.92	1.39
13	NA279	Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	Native Vegetation	12.60	784.48	6.80	127.01	0.70	43.58	20.70	865.67	40.80	1,820.74	195.78
14	NA279	Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	DNG	0.15	3.42	0.00	0.00	0.00	0.00	0.25	3.65	0.40	7.07	0.76
15	NA314	Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	Native Vegetation	135.26	8,157.53	63.35	1,146.19	59.70	3,600.51	188.14	7,501.14	446.45	20,405.37	2,194.13
16	NA314	Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	DNG	1.46	33.30	0.00	0.00	0.00	0.00	2.44	35.65	3.90	68.95	7.41
17	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	Native Vegetation	1.60	95.68	0.66	11.84	3.10	185.38	1.80	73.66	7.16	366.56	39.41
18	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	DNG	0.08	1.82	0.00	0.00	0.00	0.00	0.13	1.90	0.21	3.72	0.40

Vegetation zone	Vegetation code	Biometric vegetation type	Ancillary	Direct impacts		Indirect impacts		Cumulative impacts		Rehabilitation		Total		Offset required
				Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)
19	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion	Native Vegetation	0.60	31.50	0.30	4.73	0.00	0.00	1.00	32.05	1.90	68.28	7.34
20	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion	DNG	0.60	13.69	0.00	0.00	0.00	0.00	1.00	14.61	1.60	28.30	3.04
21	NA294	Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion	Native Vegetation	1.03	64.13	0.50	9.34	0.70	43.58	1.68	71.35	3.91	188.40	20.26
22	NA324	Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	Native Vegetation	0.38	22.67	0.20	3.58	2.90	173.01	0.63	24.30	4.11	223.56	24.04
23	NA324	Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	DNG	0.49	11.18	0.00	0.00	0.00	0.00	0.81	11.83	1.30	23.01	2.47
24	NA338	Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	Native Vegetation	19.10	1,353.43	9.22	196.00	3.10	219.67	27.30	1,376.19	58.72	3,145.28	338.20
25	NA338	Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	DNG	6.79	154.88	0.00	0.00	0.00	0.00	11.31	165.24	18.10	320.12	34.42
26	NA326	Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	Native Vegetation	32.76	2,244.72	17.60	361.79	3.60	246.67	53.84	2,588.09	107.80	5,441.26	585.08
27	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	Native Vegetation	103.54	6,446.40	48.46	905.14	1.40	87.16	143.56	6,096.99	296.96	13,535.69	1,455.45
28	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	DNG	0.71	16.20	0.00	0.00	0.00	0.00	1.19	17.39	1.90	33.58	3.61
29	NA389	White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests	Native Vegetation	26.10	1,512.76	14.00	243.43	0.70	40.57	42.90	1,609.61	83.70	3,406.37	366.28
30	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	Native Vegetation	0.08	5.14	0.10	1.93	0.00	0.00	0.13	5.81	0.31	12.87	1.38
31	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	DNG	0.11	2.51	0.00	0.00	0.00	0.00	0.19	2.78	0.30	5.29	0.57
32	NA363	Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion	Native Vegetation	3.18	193.03	1.70	30.96	0.00	0.00	5.23	213.96	10.11	437.94	47.09
				402.21	**24,009.25**	**181.11**	**3,365.70**	**84.80**	**5,233.11**	**586.66**	**23,504.92**	**1,254.78**	**56,112.98**	**6,033.65**

7.5.2 Species and populations

Four threatened fauna species and nine threatened flora species recorded in the development site are listed as ‘species credit’ species under the Framework for Biodiversity Assessment (**Table 56** and **Table 57**). Credits required for flora species range from 42 to 144,326 credits. Credits required for fauna species range from 2,712 to 34,994 credits. *Bertya opponens* requires the largest number of flora credits to be offset, while *Hoplocephalus bitorquatus* (Pale-headed Snake) requires the largest number of fauna credits to be offset.

Table 56: Major projects assessment (Version 4.1) – flora species credits required

Species	Threatened species offset multiplier	Direct and indirect impact (# Individuals)	Cumulative impact (# Individuals)	Credits	Credits / plant
Bertya opponens	1.4	10,309		144,326	14.00
Diuris tricolor	1.3	52		676	13.00
Lepidium aschersonii	1.4	3		42	14.00
Lepidium monoplocoides	1.5	4		60	15.00
Polygala linariifolia	1.5	252		3,780	15.00
Pomaderris queenslandica	1.5	467		7,005	15.00
Pterostylis cobarensis	1.3	7,364	706	95,732	13.00
Commersonia procumbens	1.5	3,716		55,740	15.00
Tylophora linearis#	7.7	479	81	36,883	77.00

#The status and offset multiplier for *Tylophora linearis* is currently under review by OEH. Should the offset multiplier be reduced, then the resulting offset liability will also be reduced.

Table 57: Major projects assessment (Version 4.1) – fauna species credits required

Species	Common name	Threatened species offset multiplier	Direct impact (ha)	Indirect impact (ha)	Cumulative impact (ha)	Credits	Credits/ ha
Macropus dorsalis	Black-striped Wallaby	2.6	988.80	181.11	84.80	32,622	26.00
Cercartetus nanus	Eastern Pygmy-possum	2	774.80	153.01	76.80	20,092	20.00
Hoplocephalus bitorquatus	Pale-headed Snake	3.3	885.00	175.41	84.80	37,792	33.00
Petaurus norfolcensis	Squirrel Glider	2.2	861.80	170.71	84.80	24,581	22.00

8 Biodiversity offset strategy

This section provides a brief summary of the Biodiversity Offset Strategy including objectives, quantification of offset liability and the approach which will be undertaken to address the residual impacts of the project. The Biodiversity Offset Strategy will be included in **Appendix G**.

The Biodiversity Offset Strategy has been prepared to ensure that the residual impacts of the project (following implementation of avoidance, minimisation and mitigation measures) are adequately compensated for and that long-term conservation outcomes are achieved in recognition of the *NSW Offsetting Principles* (OEH, 2014d) and the *NSW Biodiversity Offset Policy for Major Projects* (OEH, 2014c). As the *NSW Biodiversity Offset Policy for Major Projects* was developed as a whole-of-government policy and includes Matters of National Environmental Significance, offsets determined under the *NSW Biodiversity Offset Policy for Major Projects* are considered likely to satisfy EPBC Act offset requirements.

This objective will be accomplished by ensuring:

- Vegetation, habitat and threatened species at offset sites have equal or greater conservation status to areas impacted by the project.
- Offsets are greater than the loss of areas impacted by the project.
- Land-based offset sites, supplementary measures and contributions to the Biodiversity Offset Fund are appropriately funded, secured and managed.
- That Aboriginal people have opportunities to increase cultural knowledge of their country and opportunities to access and manage its natural and cultural values.

The Biodiversity Offset Strategy is a framework document which considers threatened and migratory species, populations and ecological communities listed under the TSC Act and the EPBC Act and will be supported by a detailed Biodiversity Offset Management Plan detailing how the offset strategy and offset package will be implemented.

The Biodiversity Offset Strategy follows a four-step approach:

1. Quantification of the impacts of the project for informed by the Framework for Biodiversity Assessment (FBA) to guide the development of the offset strategy including direct, indirect and cumulative impacts as well as the contribution that undertaking immediate rehabilitation post construction makes to reducing the overall offset liability.
2. Undertaking ‘reasonable steps’ to locate like-for-like offset, including:
    a. Checking the biobanking public register and having an expression of interest (EOI) for credits wanted for at least six months.
    b. Liaising with the OEH Northern Plains Region office and Narrabri Council to obtain a list of potential sites that meet the requirements for offsetting.
    c. Considering properties for sale in the area.
    d. providing evidence of why offset sites are not feasible.
3. Development and contribution of funds for supplementary measures such as feral animal control, threatened species research and monitoring measures to be implemented through Planning Agreements (PAs).
4. For the remaining offset liability to be held for eventual transfer into the Biodiversity Offset Fund (once established).

8.1 Offset requirements to achieve long-term conservation outcomes

The Framework for Biodiversity Assessment (Major Projects Credit Calculator Version 4.1) was used to inform the 'quantum' of biodiversity offsets required for the project. Four key elements were considered:

- **Direct impacts** – 988.8 ha (split between direct impacts and areas subject to immediate rehabilitation) - vegetation/habitat/species clearance
- **Indirect impacts** – 181.1 ha - fragmentation, noise, light, weeds, feral animals etc.
- **Cumulative impacts** – 84.8 ha - existing impacts in the development site from infrastructure that will be utilised by the project
- **Immediate rehabilitation** – 586.6 ha - partial rehabilitation of linear and non-linear infrastructure areas immediately following construction

Quantification of impacts and offset liability for both ecosystem and species credit species was undertaken as outlined in **Section 7.5**.

8.2 Biodiversity Offset Package

The biodiversity offset package for the project will contain a combination of

- **Like-for-like offsets** secured via an appropriate conservation mechanism (including purchase and retirement of biodiversity credits (where available), protection under Biobanking Agreements, or reservation under the NSW *National Parks and Wildlife Act 1974*).
- **Supplementary measures** developed and funded through Planning Agreements (PAs) under the NSW *Environmental Planning and Assessment Act 1979* (EPA Act).
- **Compensatory measures** such as Koala research.
- **NSW Biodiversity Offsets Fund for Major Projects** will be used for remaining offset liability (when established).

The availability and suitability of potential offset sites in the region will be investigated post submission of the Environmental Impact Statement. This process will seek to meet the majority of the like-for-like offset liability of the project as far as practicable

A range of supplementary measures have been considered as part of the Biodiversity Offset Package including a nil-tenure feral animal control strategy, weed control and prescribed burning. The Proponent has committed to the development of a nil-tenure feral animal control strategy which will be approximately equivalent to one third of the total offset liability of the project. The feral animal control strategy will initially focus on the development site (including a 5 – 10 km buffer) and will be implemented over a 20 year period.

The Biodiversity Offset Package will also include compensatory measures, including a *Phascolarctos cinereus* (Koala) research proposal which aims to determine the precise location and sizes of remnant Koala populations in the broader Pilliga region to inform conservation efforts for the important population of this species.

Once land-based offsets and supplementary measures have been finalised, the remaining offset liability for the project will be converted into a dollar figure and held for eventual transfer into the Biodiversity Offset Fund (once established). The precise mechanism for holding the financial offset liability until the establishment of the Biodiversity Offset Fund is yet to be determined, but may include preparation of a Planning Agreement or bond.

8.3 Indigenous cultural heritage values and activities

Consideration of Aboriginal cultural heritage values is a key component of the Biodiversity Offset Strategy. Cultural heritage values will be identified and integrated into biodiversity offsets in three ways:

- Aboriginal cultural heritage values such as important sites, places of traditional or recent significance and culturally important plants and animals will be identified as part of the selection of suitable land-based biodiversity offsets.
- Community access to biodiversity offset areas will be facilitated where practicable.
- Community management of offset lands will be encouraged.

8.4 Statement of commitments

In line with the contents of the Biodiversity Offset Strategy, The Proponent will:

- Commit to delivering biodiversity offsets which meets the offset quantum determined by the Framework for Biodiversity Assessment, including the development of an offset package which includes a combination of:
  - Like-for-like offsets secured via an appropriate conservation mechanism.
  - Supplementary measures developed and funded through Planning Agreements.
  - Compensatory measures including Koala research.
  - NSW Biodiversity Offsets Fund for Major Projects will be used for remaining offset liability (when established).
- Identify cultural heritage values as part of the biodiversity offset package, including:
  - Incorporation of Aboriginal cultural heritage values in land-based offset sites.
  - Community access to biodiversity offsets.
  - Community management of land-based offsets.
- Prepare a Biodiversity Offset Management Plan that clearly outlines the responsible parties for the implementation of the plan, the works required to improve biodiversity values (including but not restricted to fire management, weed and feral animal control, erosion and sediment control, restrictions on access, revegetation), performance criteria and a reporting and monitoring program in accordance with the Biobanking Assessment Methodology.
- Prepare a nil-tenure feral animal control strategy which will be approximately equivalent to one third of the total offset liability of the project which will address feral animal control at a landscape scale.
- Undertake reporting for land-based offsets owned and managed by the Proponent in accordance with the Biobanking Assessment Methodology.
- Undertake a periodic review of the Biodiversity Offset Management Plan every 5 years in accordance with the Biobanking Assessment Methodology.

Prior to the issue of construction certificate, the Proponent will acquire and retire the full quantum of required ecosystem and species credits, make financial contributions to the Biodiversity Offset Fund (when available), or make financial contributions to supplementary measures to the equivalent value of credits as outlined in **Table 55, Table 56** and **Table 57**. A detailed biodiversity offset strategy will be provided in a separate document which would identify and describe the offset site(s), ecosystem and species credits created at the offset site(s), rehabilitation objectives at the offset site(s), supplementary measures and a summary of biodiversity offset measures and how these match to credit requirements created by the development site (**Appendix G**).

8.5 Assumptions and limitations

- Biometric Vegetation Types for the Namoi CMA were updated in October 2014. Vegetation stratification, habitat stratification, population modelling and cumulative impacts are reported on for Biometric Vegetation Types October 2008 (ELA, 2015), while offset calculations have been undertaken using Biometric Vegetation Types October 2014 in accordance with the NSW Biodiversity Offset Policy for Major Projects.
- Due to access restrictions, no plot data was available for *NA219 Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion* and benchmark plot data was used as a surrogate.
- There was insufficient plot data for some derived native grassland (DNG) zones and all plots in derived native grassland (n=15) were pooled and entered against each derived native grassland zone.
- No plots were surveyed in *NA294 Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow*. This vegetation type was included in a broader Biometric Vegetation Types (October 2008) which was subsequently split in the update to Namoi CMA vegetation types (October 2014). To account for this, vegetation plot data from NA279, NA326, NA390 and NA389 (previously pooled types) were pooled and entered against this vegetation zone.
- The development site is intersected equally by the Pilliga A and Pilliga Outwash Catchment Management Authority (CMA) subregions. Vegetation zones were entered against the Pilliga Outwash CMA subregion.

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Appendix A Plot and transect data

	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	
Plot Name	**Number of native plant species**	**Native over-storey cover (%)**	**Native mid-storey cover (%)**	**Native ground cover (hits/50 points) – Grasses**	**Native ground cover (hits/50 points) – shrubs**	**Native ground cover (hits/50 points) – other**	**Exotic plant cover**	**Number of trees with hollows**	**Total length fallen logs >10cm width (m)**	**Over-storey regeneration**	**Easting**	**Northing**	**Zone**
Plot 01	42	8	1.7	10	66	4	0	1	15	1	757213	6602274	55
Plot 02	43	8.5	5	36	46	24	0	0	0	1	756036	6611220	55
Plot 03	49	21.5	0	32	6	44	0	2	12	1	753210	6604399	55
Plot 04	39	21.5	0.5	44	12	36	0	0	25	1	752437	6606209	55
Plot 05	30	3.5	15.5	4	28	3	0	0	23	1	752423	6605572	55
Plot 06	28	1.5	37.5	34	76	12	0	0	11	1	754132	6605800	55
Plot 07	56	24	1.5	48	8	28	0	1	89	1	752028	6611333	55
Plot 08	28	0	0	60	2	30	8	0	0	1	753593	6613520	55
Plot 09	17	8	24	6	58	6	0	0	0	1	748440	6613631	55
Plot 10	36	6	8.5	12	40	2	0	3	34	1	750654	6612127	55
Plot 11	27	0.5	34.5	64	72	0	0	0	9	1	747207	6608463	55
Plot 12	33	12.5	2.5	42	0	4	0	2	81	1	752005	6620415	55
Plot 13	32	9.5	9.5	38	0	20	0	2	88	1	750974	6620477	55
Plot 14	31	0	13.5	48	14	14	0	2	30	1	750842	6618018	55
Plot 15	28	1.5	10.6	34	18	14	0	0	41	1	747404	6617056	55
Plot 16	34	13	2.3	54	24	10	0	3	73	1	751889	6615627	55
Plot 17	37	6	5.5	34	0	38	0	0	124	1	749449	6619496	55
Plot 18	27	2.4	16.3	32	30	6	0	0	30	1	748070	6615909	55
Plot 19	31	5.7	37.5	54	74	8	0	0	29	1	750601	6614234	55
Plot 20	28	0.5	0.5	44	0	6	52	5	37	1	753803	6614983	55
Plot 21	25	9.7	11.5	20	2	40	0	0	19	1	755999	6609475	55
Plot 22	44	10	3.2	52	6	36	0	0	117	1	756000	6614540	55

	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	
Plot Name	**Number of native plant species**	**Native over-storey cover (%)**	**Native mid-storey cover (%)**	**Native ground cover (hits/50 points) – Grasses**	**Native ground cover (hits/50 points) – shrubs**	**Native ground cover (hits/50 points) – other**	**Exotic plant cover**	**Number of trees with hollows**	**Total length fallen logs >10cm width (m)**	**Over-storey regeneration**	**Easting**	**Northing**	**Zone**
Plot 23	36	7	5.7	34	4	24	0	0	12	1	760943	6615735	55
Plot 24	46	15	0.9	36	8	44	0	1	60	1	759972	6613530	55
Plot 25	33	3.2	14.2	4	24	12	0	3	18	1	761630	6613133	55
Plot 26	44	2.5	5.7	30	8	20	0	0	29	1	758318	6607102	55
Plot 27	31	37	0	6	84	36	0	1	4	1	761074	6612008	55
Plot 28	30	0	0	52	8	26	10	0	0	1	758274	6611772	55
Plot 29	33	9.2	0.6	26	42	30	0	3	37	1	760579	6606654	55
Plot 30	38	4	2.7	6	40	8	0	1	64	1	760856	6607959	55
Plot 31	32	17.5	0	30	2	36	0	2	52	1	757297	6606382	55
Plot 32	36	9	16	6	56	16	0	2	18	1	766028	6610835	55
Plot 33	42	4.2	5.1	14	18	44	0	4	35	1	765789	6609751	55
Plot 34	38	13.2	3.8	22	10	20	0	3	15	1	763769	6610448	55
Plot 35	46	5.7	18	30	34	10	0	0	37	1	762736	6610300	55
Plot 36	43	6.8	3.3	56	16	10	0	4	42	1	763095	6611892	55
Plot 37	27	4.5	27.5	24	72	2	0	0	0	1	747939	6612195	55
Plot 38	44	17.3	5.4	70	14	20	0	5	88	1	768373	6614570	55
Plot 39	19	4.3	17.5	12	58	14	0	2	43	1	768017	6614472	55
Plot 40	40	5.9	2	26	24	26	0	2	15	1	767393	6615982	55
Plot 41	39	6	4.6	60	4	34	0	2	24	1	766327	6617228	55
Plot 42	43	3.7	5.1	2	18	16	0	3	28	1	751458	6607471	55
Plot 43	23	6.1	1	6	2	12	0	2	34	1	753013	6610979	55
Plot 44	36	6	1.9	2.3	12	24	0	0	62	1	754920	6608471	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 45	28	3.3	2.3	6	70	4	0	3	18	1	757255	6604785	55
Plot 46	14	0.2	6.7	10	66	2	0	3	6	1	754648	6604646	55
Plot 47	28	3.5	43.5	42	38	8	0	0	28	1	755574	6607428	55
Plot 48	9	0	48.5	10	74	4	0	0	0	1	754976	6607247	55
Plot 49	35	7.1	24	46	30	14	0	1	42	1	755288	6605820	55
Plot 50	48	24	15.3	30	2	28	0	5	39	1	754404	6597147	55
Plot 51	40	12	12.5	10	28	22	0	3	24	1	765043	6618753	55
Plot 52	52	13.5	14	54	2	24	0	2	61.5	1	750010	6609373	55
Plot 53	40	29	0	38	0	34	38	2	55	1	750701	6608480	55
Plot 54	38	9	4.5	6	23	4	0	1	35	1	749762	6607748	55
Plot 55	47	27	1.5	44	2	26	0	4	87.5	1	750182	6606523	55
Plot 56	54	21.5	6.5	8	24	34	0	3	41	1	750409	6604874	55
Plot 57	26	22.9	1.7	34	0	10	20	3	40	1	748399	6605296	55
Plot 58	30	21.7	13.4	0	4	6	0	3	87	1	749454	6605281	55
Plot 59	33	7.4	8.8	22	10	2	0	4	61.5	1	750613	6602606	55
Plot 60	40	28.7	7.3	20	8	0	0	1	52.5	1	749279	6601317	55
Plot 61	44	3.1	10	18	4	16	0	0	38	1	746241	6600587	55
Plot 62	41	2.9	8.6	2	38	12	0	1	4	1	749512	6599420	55
Plot 63	53	27.5	5	24	10	14	0	4	60	1	752144	6599164	55
Plot 64	54	15.1	6.1	20	4	16	0	2	37	1	749581	6592142	55
Plot 65	44	16.9	5.9	4	8	10	0	0	14	1	751728	6591663	55
Plot 66	36	0	4.9	2	62	34	0	0	6.5	1	752510	6590113	55

	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	
Plot Name	**Number of native plant species**	**Native over-storey cover (%)**	**Native mid-storey cover (%)**	**Native ground cover (hits/50 points) – Grasses**	**Native ground cover (hits/50 points) – shrubs**	**Native ground cover (hits/50 points) – other**	**Exotic plant cover**	**Number of trees with hollows**	**Total length fallen logs >10cm width (m)**	**Over-storey regeneration**	**Easting**	**Northing**	**Zone**
Plot 67	52	16.5	5.7	6	6	4	0	2	75	1	749778	6595450	55
Plot 68	48	18.3	8.8	12	10	6	0	1	87.5	1	752634	6595265	55
Plot 69	41	11.6	16.1	16	12	20	0	2	45	1	751341	6597767	55
Plot 70	39	21	5.7	0	34	16	0	0	50	1	752762	6590347	55
Plot 71	41	0.5	15.7	2	52	6	0	0	13.5	1	754589	6590886	55
Plot 72	42	26.3	4.6	26	12	12	0	1	30	1	754127	6593192	55
Plot 73	49	4.8	13	28	32	28	0	0	38.5	1	756350	6594892	55
Plot 74	42	18.5	5.7	18	30	16	0	1	49	1	758381	6594676	55
Plot 75	46	18.8	2.3	18	20	12	0	4	22.5	1	756777	6592696	55
Plot 76	47	24.7	12	16	20	26	0	2	20.5	1	757365	6598137	55
Plot 77	39	17	6	26	4	26	0	1	103	1	756749	6599969	55
Plot 78	33	23.7	6.6	14	6	28	0	2	3.5	1	758744	6601101	55
Plot 79	44	2.5	18.1	6	18	36	0	1	10.5	1	760806	6601800	55
Plot 80	43	4.3	29.7	36	18	34	0	1	106.5	1	755191	6601077	55
Plot 81	61	15.5	20	18	12	14	0	1	84	1	768811	6605860	55
Plot 82	26	18.2	17.1	40	6	36	0	1	80	1	764774	6607716	55
Plot 83	24	22	31	16	2	42	0	0	93.5	1	764410	6603566	55
Plot 84	47	22.5	17.5	50	6	30	0	2	56.5	1	763976	6605557	55
Plot 85	47	28.3	1.9	26	0	36	0	0	38.5	1	763844	6602771	55
Plot 86	41	15.7	12	24	18	24	0	2	64.5	1	763803	6604515	55
Plot 87	40	7.7	16.2	64	4	32	0	2	61	1	766830	6605850	55
Plot 88	30	16.2	12	8	10	20	0	0	28	1	765508	6607049	55

	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	
Plot Name	Number of native plant species	Native over-storey cover (%)	Native mid-storey cover (%)	Native ground cover (hits/50 points) – Grasses	Native ground cover (hits/50 points) – shrubs	Native ground cover (hits/50 points) – other	Exotic plant cover	Number of trees with hollows	Total length fallen logs >10cm width (m)	Over-storey regeneration	Easting	Northing	Zone
Plot 89	48	16	14.1	28	2	22	0	2	19	1	760975	6603370	55
Plot 90	47	23.3	10.8	70	0	40	0	6	64.5	1	753347	6615816	55
Plot 91	33	3	29.2	22	2	10	0	5	21.5	1	749858	6615528	55
Plot 92	34	26.5	6.1	22	4	40	0	1	44	1	746566	6600438	55
Plot 93	28	25.7	12.5	2	44	16	0	0	0	1	753687	6601100	55
Plot 94	39	11.3	0.9	10	66	6	0	0	16	1	754721	6599549	55
Plot 95	39	4	6.8	34	8	12	0	1	36	1	754955	6600659	55
Plot 96	46	0	12.2	14	46	18	0	0	35	1	754464	6602890	55
Plot 97	36	17	14.4	30	4	22	0	2	61	1	762951	6605481	55
Plot 98	40	2	11.5	6	24	4	0	2	13	1	762225	6606196	55
Plot 99	29	14.2	12.5	0	2	2	0	3	47	1	759832	6606067	55
Plot 100	41	18	7.4	20	4	18	0	0	42	1	756189	6606662	55
Plot 101	35	17	6	38	30	2	0	2	31	1	746847	6608328	55
Plot 102	41	24.5	0.7	46	2	2	0	1	30	1	751808	6616095	55
Plot 103	41	25	2.7	24	2	2	0	1	83	1	752021	6617404	55
Plot 104	30	9.5	13.4	8	2	4	0	2	105	1	751453	6618551	55
Plot 105	24	0	31.6	10	28	0	0	0	33	1	747917	6600468	55
Plot 106	40	13	2	62	0	18	0	1	16	1	757172	6612700	55
Plot 107	46	25.5	2.5	38	12	32	0	6	20	1	750204	6607800	55
Plot 108	20	0	0	6	4	2	0	0	10	1	753745	6607013	55
Plot 109	33	0	1	14	4	4	8	4	42	1	752525	6609523	55
Plot 110	32	0	3	14	24	0	0	0	14	0	751784	6610230	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 111	35	0	5.6	38	12	4	0	0	6	1	751151	6614047	55
Plot 112	32	0	2.2	32	30	2	0	0	27	1	750698	6616773	55
Plot 113	31	1	11.5	42	46	2	0	0	58	0.5	751197	6620439	55
Plot 114	45	0	0.2	4	0	4	0	0	79	0.3	753847	6608062	55
Plot 115	23	0	0	2	0	8	0	0	54	1	753698	6607856	55
Plot 116	41	12.4	25.8	32	8	28	0	0	52	1	753564	6607700	55
Plot 117	50	16.6	8	40	8	26	0	0	47	1	753646	6607874	55
Plot 118	45	24.5	1.7	46	22	20	0	1	48	1	753653	6608018	55
Plot 119	39	5	8.5	10	0	52	4	0	8	0	757375	6639643	55
Plot 120	27	17.5	15	40	8	0	0	3	106	1	744637	6641573	55
Plot 121	39	17.7	1	42	6	10	0	2	40	1	743726	6637869	55
Plot 122	29	13	3.5	14	0	10	0	0	12	1	742174	6637287	55
Plot 123	20	28	0	0	15	0	0	1	84	1	741752	6637707	55
Plot 124	11	33	0	14	0	0	0	0	120	1	743090	6637197	55
Plot 125	31	21	26	28	24	14	0	0	148	1	742297	6640165	55
Plot 126	28	22.5	0	0	6	6	0	0	10	1	749810	6632607	55
Plot 127	15	24	2	0	16	0	0	0	225	1	749684	6631909	55
Plot 128	16	26	2	2	12	0	0	0	95	1	748553	6631432	55
Plot 129	15	33.5	1.5	4	14	0	0	0	165	1	746928	6633358	55
Plot 130	27	21	6.5	20	44	6	0	0	40	1	746954	6634770	55
Plot 131	26	8.5	2	36	8	4	0	1	5	1	755312	6638324	55
Plot 132	19	9	5	46	10	12	0	1	47	1	755756	6638261	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 133	25	10	3	50	0	14	40	1	21	1	756361	6628871	55
Plot 134	33	13	15	40	0	4	54	0	54	1	756808	6632510	55
Plot 135	28	7	17.5	78	0	14	0	1	33	1	758311	6635164	55
Plot 136	35	9	10.5	2	32	4	0	1	1	1	765533	6627155	55
Plot 137	32	9	7	38	10	8	0	1	61.5	1	764360	6626895	55
Plot 138	18	12	21.5	38	10	2	0	1	60	1	767746	6624491	55
Plot 139	19	16	15.5	2	2	0	0	1	7	1	771355	6619929	55
Plot 140	37	22	8	42	28	14	0	1	44	1	770207	6618158	55
Plot 141	32	12.8	1.8	8	16	18	0	1	14	1	766130	6621569	55
Plot 142	30	14.6	19.5	8	36	4	0	2	20	1	771243	6614626	55
Plot 143	26	12.9	5.1	20	50	24	0	2	36	1	766950	6613951	55
Plot 144	22	9.3	17.1	4	40	2	0	2	12	1	765354	6611968	55
Plot 145	40	9	21	6	50	4	0	1	7	1	770567	6609271	55
Plot 146	31	15	7.3	14	20	2	0	0	22.5	1	770333	6609163	55
Plot 147	30	30.5	2.8	10	16	8	0	0	0	1	769575	6609559	55
Plot 148	32	12.8	4.1	46	28	12	0	0	31.5	1	768784	6609809	55
Plot 149	25	11.1	12.5	0	30	4	0	1	0	1	762683	6599941	55
Plot 150	37	14.9	8.1	0	42	20	0	0	3.5	1	763302	6600678	55
Plot 151	30	17	10	52	12	10	0	1	42.5	1	768768	6599372	55
Plot 152	33	7.5	20	8	22	20	0	0	0	1	767830	6601838	55
Plot 153	42	18.3	7.8	2	24	14	0	3	1.5	1	766799	6602275	55
Plot 154	18	14.5	16	26	14	4	0	0	24.5	1	764422	6603508	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 155	31	8.8	5	8	0	14	0	3	50	1	754514	6619808	55
Plot 156	23	21.8	3.5	24	0	0	0	1	45.5	1	753200	6613552	55
Plot 157	20	10.6	6.6	8	0	26	4	4	38	1	752508	6612455	55
Plot 158	19	9.7	1	0	0	14	4	3	14.5	1	747385	6603332	55
Plot 159	16	3.6	1	52	0	26	14	1	18.5	1	753391	6623516	55
Plot 160	34	13.5	7.1	8	12	10	62	1	39	1	767744	6623362	55
Plot 161	25	7.1	17	34	18	4	0	0	33.5	1	768321	6622194	55
Plot 162	31	31.5	3	70	2	6	0	0	0	1	770134	6622733	55
Plot 163	27	5	14	12	22	8	0	0	9	1	751265	6604779	55
Plot 164	28	2.5	1.3	0	26	0	0	0	7	1	751003	6604436	55
Plot 165	29	0	19	12	10	0	0	0	52	1	759651	6608668	55
Plot 166	31	24.5	5.5	8	4	0	0	1	21	1	760291	6607526	55
Plot 167	22	2	11.9	0	0	0	0	0	68	1	754903	6606046	55
Plot 168	34	32	14	28	14	28	0	2	49	0	753452	6604825	55
Plot 169	30	30	7.5	36	2	8	0	3	16	1	753388	6604788	55
Plot 170	27	22	2.5	14	0	10	0	3	62	1	753321	6604701	55
Plot 171	27	36	3	10	2	2	0	1	75	1	753253	6604624	55
Plot 172	24	15.5	3.2	18	10	20	0	1	47	1	753193	6604554	55
Plot 173	30	13.5	3.5	0	28	12	0	1	24	1	752118	6603889	55
Plot 174	30	2.5	14	0	12	0	0	0	42	1	752521	6604060	55
Plot 175	22	2	2.5	50	0	8	0	1	55	1	752830	6604199	55
Plot 176	28	7	1	6	12	14	0	0	6	1	744360	6632985	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 177	28	26	0	28	8	0	0	0	125	1	744745	6632319	55
Plot 178	18	21	15	2	54	2	0	1	115	1	745012	6631131	55
Plot 179	18	20	0	16	0	26	4	2	10	1	745011	6631994	55
Plot 180	29	35	17.5	18	16	30	0	0	33	1	742079	6631665	55
Plot 181	29	0	0	48	16	28	6	0	0	0	755058	6640060	55
Plot 182	41	25	19.5	24	14	6	0	0	14	1	754762	6638153	55
Plot 183	42	27.5	25	0	8	2	0	0	165	1	754490	6636699	55
Plot 184	31	14	10.5	34	6	22	0	2	45	1	754284	6635604	55
Plot 185	21	19.5	25	10	30	10	0	2	41	1	749441	6637284	55
Plot 186	11	20	25	2	0	0	86	0	42	1	749774	6639090	55
Plot 187	27	28	20.5	58	0	0	0	1	52	1	753377	6637069	55
Plot 188	40	27	15	30	6	16	0	2	50	1	752783	6637176	55
Plot 189	45	0	0	56	2	8	0	0	0		751843	6637360	55
Plot 190	32	14	29	30	6	0	14	0	71	1	750580	6637582	55
Plot 191	24	23	22.5	8	0	2	24	0	36	1	749391	6641083	55
Plot 192	32	23	41	48	0	6	0	0	56	1	741360	6642079	55
Plot 193	31	29	18	46	16	8	0	1	31	1	739684	6642387	55
Plot 194	11	5	0.3	20	0	0	78	1	0	1	741530	6642051	55
Plot 195	9	46	3	74	0	0	0	1	32	1	742468	6641874	55
Plot 196	25	43	15.5	22	2	6	0	0	11.5	1	753989	6640265	55
Plot 197	23	14.5	26	54	6	4	0	3	50.5	1	754059	6634508	55
Plot 198	30	0	0	28	4	18	28	0	0	1	753889	6633593	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 199	34	0	0	76	0	4	4	0	0	0	754998	6631812	55
Plot 200	36	23	21	24	0	16	0	2	51	1	757321	6632386	55
Plot 201	28	25	31	48	4	4	0	0	15.5	1	755186	6630129	55
Plot 202	35	18	41	0	36	14	0	2	34	1	754386	6630273	55
Plot 203	14	20	17	12	2	0	0	0	21	1	752025	6638219	55
Plot 204	23	18	8	20	2	0	0	1	8	1	751806	6638212	55
Plot 205	22	18	24.5	4	0	0	0	0	33	1	750523	6638688	55
Plot 206	22	0	0	42	0	6	0	0	0	0	750787	6638457	55
Plot 207	32	0	0	44	0	0	0	0	0	0	751044	6638337	55
Plot 208	23	20	6.5	6	2	10	0	1	77	1	753148	6636836	55
Plot 209	14	47.5	0	0	0	0	32	0	5	0	752778	6636589	55
Plot 210	23	0	0	44	0	12	0	0	0	0	752789	6636738	55
Plot 211	25	7	0	40	0	0	0	0	0	1	751376	6636741	55
Plot 212	16	9.5	0	2	0	24	0	4	33	1	751345	6636800	55
Plot 213	17	0	0	44	0	26	0	0	0	0	750682	6637480	55
Plot 214	17	12.5	15.5	6	0	2	0	1	23	1	752591	6637754	55
Plot 215	17	17.5	15	0	0	0	0	2	29	1	752260	6637699	55
Plot 216	23	0	0	54	0	10	0	0	0	0	753018	6634844	55
Plot 217	15	20	0	10	0	12	0	7	59	1	751946	6634884	55
Plot 218	14	21	0	0	0	50	0	1	12	1	752180	6634070	55
Plot 219	27	27	7	18	0	10	0	4	33	1	752287	6634089	55
Plot 220	16	24	0	0	0	10	0	0	1	1	753424	6634846	55

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	Zone
	Number of native plant species	Native over-storey cover (%)	Native mid-storey cover (%)	Native ground cover (hits/50 points) – Grasses	Native ground cover (hits/50 points) – shrubs	Native ground cover (hits/50 points) – other	Exotic plant cover	Number of trees with hollows	Total length fallen logs >10cm width (m)	Over-storey regeneration	Easting	Northing	
Plot 221	27	2	3	16	12	12	0	1	6	1	753721	6635079	55
Plot 222	15	5.5	0	10	0	4	0	0	3	1	758257	6637462	55
Plot 223	26	9	19	6	0	0	0	1	7	1	755289	6629917	55
Plot 224	8	17	0	0	0	2	18	0	5	1	755256	6629796	55
Plot 225	22	20	4	0	0	2	0	2	14	1	754905	6629984	55
Plot 226	23	17	0	0	0	0	0	0	42	1	753355	6629548	55
Plot 227	20	0	0	12	0	20	0	0	0	0	753373	6629644	55
Plot 228	16	0	0	0	4	26	0	0	0	0	755396	6628861	55
Plot 229	19	13	0	0	0	0	0	2	21	1	755130	6628816	55
Plot 230	30	9.5	0	28	0	22	0	0	28	1	755845	6629730	55
Plot 231	9	0	0.5	0	0	0	56	0	0	0	755806	6629670	55
Plot 232	17	18	7	16	0	8	0	1	11	1	758340	6637534	55
Plot 233	23	1	1	36	2	20	0	0	0	0	751773	6624914	55
Plot 234	31	13	4.9	8	36	10	0	1	74.5	1	754812	6615318	55
Plot 235	36	16	25.3	32	0	4	0	0	88.5	1	757993	6619481	55
Plot 236	23	7.4	4.9	10	0	0	0	0	19	1	754826	6613036	55
Plot 237	15	0	0	48	0	2	6	0	0	1	753226	6612577	55
Plot 238	25	5.5	21.5	6	4	4	0	1	51	1	753411	6611924	55
Plot 239	19	15.2	1.7	4	0	10	0	0	3.5	1	757241	6612976	55
Plot 240	30	8.7	9.7	46	6	14	0	0	52.5	1	763258	6617119	55
Plot 241	34	9.2	22.2	4	0	12	0	1	41.5	1	763785	6615609	55
Plot 242	41	12	36	0	8	0	0	0	26.5	1	769936	6613393	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 243	34	9.7	1	42	6	32	4	2	27.5	1	753870	6622276	55
Plot 244	30	17.4	14	26	4	0	0	0	99	1	749969	6622814	55
Plot 245	24	9	17.5	50	6	0	0	1	5.5	1	748689	6625229	55
Plot 246	30	8.1	11	18	0	48	0	3	43	1	747071	6625287	55
Plot 247	27	16	6.3	12	8	36	0	3	29	1	747285	6621639	55
Plot 248	26	21	10.2	14	2	12	0	0	6	1	755554	6618101	55
Plot 249	26	15.7	16	8	18	6	0	2	64	1	757765	6621963	55
Plot 250	28	2	18.5	6	18	18	0	0	8.5	1	756082	6619531	55
Plot 251	17	17.5	0.5	22	0	46	0	0	39.5	1	755595	6619635	55
Plot 252	37	7.5	32.5	56	0	4	0	0	20.5	1	756754	6627033	55
Plot 253	34	18	13.5	20	0	6	0	2	36	1	755522	6626346	55
Plot 254	21	18.5	18.5	32	22	0	0	2	61	1	754742	6625174	55
Plot 255	35	18	13.7	44	4	0	0	0	50	1	755365	6624421	55
Plot 256	26	14.7	8.7	2	22	8	0	2	153.5	1	755903	6622412	55
Plot 257	35	4.6	8.5	34	0	34	0	0	11	1	757460	6612847	55
Plot 258	25	10.5	0	12	0	30	12	1	25	1	750987	6608695	55
Plot 259	44	2.2	20.5	52	70	12	0	0	86	1	764714	6630510	55
Plot 260	28	0	3.5	64	36	2	0	0	145	1	750358	6608877	55
Plot 261	32	0	4	52	8	0	0	0	73	1	747878	6600510	55
Plot 262	33	6.5	2.5	2	3.6	4	0	0	3	1	749861	6605103	55
Plot 263	28	0	4.3	36	18	2	0	0	68	1	758391	6606256	55
Plot 264	18	26.5	0	90	0	2	46	3	21	1	760009	6648464	55

Plot Name	NPS Number of native plant species	NOS Native over-storey cover (%)	NMS Native mid-storey cover (%)	NGCG Native ground cover (hits/50 points) – Grasses	NGCS Native ground cover (hits/50 points) – shrubs	NGCO Native ground cover (hits/50 points) – other	EPC Exotic plant cover	NTH Number of trees with hollows	FL Total length fallen logs >10cm width (m)	OR Over-storey regeneration	Longitude Easting	Latitude Northing	Zone
Plot 265	23	41.5	0	46	0	0	95	5	8	0	758049	6649757	55
Plot 266	24	17.5	0	32	0	0	98.2	2	3	1	763334	6646087	55
Plot 267	34	0	0	38	2	12	0	1	5	0	755162	6625242	55
Plot 268	24	3	0	90	0	14	18	4	8	0	753368	6623477	55
Plot 269	31	0.5	4	26	10	14	0	0	0	0	755340	6621352	55
Plot 270	31	26.5	0	18	0	16	46	6	55	1	753617	6623105	55
Plot 271	17	16.5	4.2	14	0	38	0	0	48	1	745589	6634917	55
Plot 272	19	15.5	2.5	2	0	50	0	1	8	1	745309	6633627	55
Plot 273	20	7.3	6.6	4	4	0	0	4	12	1	755921	6627272	55
Plot 274	24	1.5	4.3	4	34	2	0	0	23	1	756003	6627612	55
Plot 275	26	27.8	4.3	46	0	14	0	2	13	1	758919	6632254	55
Plot 276	4	29	2.5	4	0	0	0	0	14.5	0.66	741174	6628919	55
Plot 277	8	11.1	4.5	6	0	0	0	0	22	1	741599	6628441	55
Plot 278	4	18.2	0	0	2	0	0	0	0	1	742680	6630046	55
Plot 279	14	10.6	3.5	2	0	0	0	1	19.5	1	740954	6628064	55
Plot 280	12	10.4	8.3	6	0	0	0	0	26	1	741392	6627862	55
Plot 281	6	22.6	1.4	0	0	0	0	0	19	1	743560	6628349	55
Plot 282	6	7.1	0	0	0	0	0	0	25	0.66	743146	6628029	55
Plot 283	7	8.5	0.6	0	0	0	0	1	3	0	741796	6627945	55
Plot 284	24	18.9	7.7	46	2	10	0	0	16.5	1	741102	6631005	55
Plot 285	24	5.9	4.2	22	0	0	0	2	68	0.66	754965	6627443	55
Plot 286	21	11.5	7.3	4	0	6	0	1	42	1	755457	6626820	55

	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	
Plot Name	Number of native plant species	Native over-storey cover (%)	Native mid-storey cover (%)	Native ground cover (hits/50 points) – Grasses	Native ground cover (hits/50 points) – shrubs	Native ground cover (hits/50 points) – other	Exotic plant cover	Number of trees with hollows	Total length fallen logs >10cm width (m)	Over-storey regeneration	Easting	Northing	Zone
Plot 287	15	26	0	56	0	0	0	0	11	1	755671	6629517	55
Plot 288	24	7.3	2.5	42	0	2	0	2	42	1	756262	6628759	55
Plot 289	27	7.5	10.1	26	0	14	0	1	67	0.5	756549	6632020	55
Plot 290	10	8.1	0	10	0	0	0	0	38	1	746639	6629790	55
Plot 291	19	13	5.3	10	0	20	0	2	64	1	746021	6628403	55
Plot 292	15	8.7	1	28	0	0	0	0	25	0.66	746544	6627676	55
Plot 293	19	8.3	0.7	36	6	62	0	0	84	0.5	747400	6626290	55
Plot 294	7	0	0	36	0	0	0	0	0	0	748123	6636648	55
Plot 295	11	0.5	6.7	0	0	0	0	0	0	0.5	747055	6636851	55
Plot 296	13	0	0	46	0	0	24	0	0	0	754931	6626904	55
Plot 297	12	0	0	62	0	2	16	0	8	1	755149	6627474	55
Plot 298	12	0	5	40	0	20	2	0	14	0	741079	6630622	55
Plot 299	15	0	0	42	0	6	6	0	5	0	740930	6632767	55
Plot 300	29	13	11	36	26	0	0	0	47	1	771373	6623455	55
Plot 301	13	2.5	15.5	26	2	2	0	2	6	1	771446	6621767	55
Plot 302	23	3.5	13.5	20	0	32	0	0	43	1	765931	6624276	55
Plot 303	26	17	12.5	2	0	16	0	0	22	1	768116	6619785	55
Plot 304	22	7.5	10	22	0	8	0	1	24	1	768373	6618179	55
Plot 305	29	16.5	10.7	16	14	10	0	0	35	1	759445	6598601	55
Plot 306	29	10	4.5	0	0	8	0	0	0	1	765462	6601400	55
Plot 307	45	8	20.5	0	18	4	0	0	9	1	768350	6603034	55
Plot 308	41	10.1	1.3	4	30	12	0	0	9	1	764945	6604903	55

	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	FL	OR	Longitude	Latitude	
Plot Name	**Number of native plant species**	**Native over-storey cover (%)**	**Native mid-storey cover (%)**	**Native ground cover (hits/50 points) – Grasses**	**Native ground cover (hits/50 points) – shrubs**	**Native ground cover (hits/50 points) – other**	**Exotic plant cover**	**Number of trees with hollows**	**Total length fallen logs >10cm width (m)**	**Over-storey regeneration**	**Easting**	**Northing**	**Zone**
Plot 309	37	12.5	13.5	34	8	12	0	1	65	1	768887	6610847	55
Plot 310	21	9.5	23.5	24	2	0	0	0	23	1	770765	6620945	55
Plot 311	20	10	10.5	2	8	2	0	2	30	1	741851	6637194	55
Plot 312	24	12.5	0	18	0	4	0	3	94	0.66	742416	6637219	55
Plot 313	7	6.5	0	0	0	0	0	0	7	0	742309	6637105	55
Plot 314	17	12	7.5	28	0	6	0	0	65	0	756648	6628324	55
Plot 315	24	6.5	1.5	34	2	2	0	0	5	0	743441	6637368	55
Plot 316	26	4	13	32	2	8	0	3	10	0	743599	6636960	55
Plot 317	28	9.5	8	40	0	4	0	0	74	0	758218	6632287	55
Plot 318	11	2.5	10.5	2	2	0	76	2	44	0	756881	6632603	55
Plot 319	16	4.5	7	42	0	0	0	0	97	0	756520	6631455	55
Plot 320	13	9	5.5	32	2	2	0	0	52	1	755219	6626406	55
Plot 321	9	15	0.5	4	10	78	0	0	100	1	749393	6631350	55
Plot 322	7	4	18	4	0	0	0	0	45	1	741793	6641442	55
Plot 323	11	0	0	54	0	0	0	0	0	0	741325	6641228	55
Plot 324	18	5.5	3	34	0	0	0	2	0	0.5	741388	6641442	55
Plot 325	46	5.5	12	20	4	8	0	0	67	0.5	764824	6617337	55
Plot 326	33	6	7.5	0	4	4	0	1	109	1	755378	6600368	55
Plot 327	29	13.2	2.7	10	31	6	0	0	48	1	754747	6599519	55

Appendix B Plant Community Type profiles

27 Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions

BVT Equivalent ID & Name:	NA219: Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions
Vegetation formation (CMA):	Semi-arid Woodlands (Grassy subformation) [Namoi CMA]
Vegetation class:	Riverine Plain Woodlands
Conservation status:	Endangered EPBC Act/ TSC Act

Photo by John Benson (Benson et al., 2010)

Characteristic Trees	*Acacia pendula, Casuarina cristata, Capparis mitchellii*, *Eucalyptus populnea* subsp. *bimbil*
Shrubs/ Vines/ Epiphytes	Shrubs/Vines/Epiphytes not surveyed
Groundcovers	Groundcover not surveyed
Threatened Flora Species	Not surveyed
Exotic Flora Species	Not surveyed
Vegetation Structure	Open Woodland
% remaining in NSW	14% ±
No. sites sampled	0, all vegetation located on private property not able to be accessed

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
No data available												

35: Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

BVT Equivalent ID & Name:	NA117: Brigalow - Belah woodland on alluvial often gilgaied clay soil mainly in the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Semi-arid Woodlands (Grassy subformation) [Namoi CMA]
Vegetation class:	Brigalow Clay Plain Woodlands
Conservation status:	Endangered EPBC Act/ TSC Act

Characteristic Trees	*Acacia harpophylla* (Brigalow), *Casuarina cristata* (Belah)
Shrubs/ Vines/ Epiphytes	*Rhagodia spinescens* (Spiny Saltbush), *Geijera parviflora* (Wilga), *Maireana microphylla* (Eastern Cottonbush), *Eremophila deserti* (Turkey-bush)
Groundcovers	*Enteropogon acicularis* (Curly Windmill Grass), *Brunoniella australis* (Blue Trumpet), *Sclerolaena tetracuspis* (Brigalow Burr), *Portulaca oleracea* (Pigweed), *Sporobolus caroli* (Fairy Grass)
Threatened Flora Species	*Lepidium aschersonii* (Vulnerable EPBC Act/ TSC Act)
Exotic Flora Species	*Opuntia stricta* (Prickly Pear), *Portulaca pilosa, Cynodon dactylon* (Couch), *Carthamus lanatus* (Saffron Thistle)
Vegetation Structure	Woodland / Open Forest
% remaining in NSW	10% ± 50%
No. sites sampled	25

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
21.52 ±10.15	15.32 ±10.74	6.27 ±9.66	17.68 ±20.18	9.40 ±10.5	10.1 ±19.6	1.8 ±6.2	44.2 ±27.9	19.2 ±22.5	0.6 ±1.5	0.2 ±0.6	54.1 ±63.0	0.8 ±0.4

55: Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions

BVT Equivalent ID & Name:	NA102: Belah woodland on alluvial plains in central-north NSW
Vegetation formation (CMA):	Semi-arid Woodlands (Grassy subformation) [Namoi CMA]
Vegetation class:	Brigalow Clay Plain Woodlands
Conservation status:	Not listed

Characteristic Trees	*Casuarina cristata* (Belah), *Eucalyptus pilligaensis* (Narrow-leaved Grey Box)
Shrubs/ Vines/ Epiphytes	*Geijera parviflora* (Wilga), *Eremophila deserti* (Turkey-bush), *Maireana microphylla* (Eastern Cottonbush), *Exocarpos aphyllus (*Leafless Ballart), *Rhagodia spinescens* (Spiny Saltbush), *Pittosporum angustifolium* (Berrigan)
Groundcovers	*Enteropogon acicularis* (Curly Windmill Grass), *Portulaca oleracea* (Pigweed), *Paspalidium sp., Brunoniella australis* (Blue Trumpet), *Carex inversa* (Knob Sedge)
Threatened Flora Species	-
Exotic Flora Species	*Opuntia stricta* (Prickly Pear), *Oxalis sp., Lepidium africanum* (Common Peppercress)
Vegetation Structure	Woodland/ Open Forest
% remaining in NSW	17% ± 50%
No. sites sampled	8

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
19.63 ±8.52	21.95 ±19.69	5.44 ±7.75	19.75 ±21.07	5.25 ±7.17	9.5 ±12.55	4.75 ±11.21	46 ±34.99	15.75 ±16.88	2.75 ±7.01	0.25 ±0.71	28.06 ±39.41	0.58 ±0.50

78: River Red Gum riparian tall woodland / open forest wetland in the Nandewar and Brigalow Belt South Bioregions

BVT Equivalent ID & Name:	NA193: River Red Gum riverine woodlands and forests in the Nandewar and Brigalow Belt South Bioregions
Vegetation formation (CMA):	Forested Wetlands [Namoi CMA]
Vegetation class:	Inland Riverine Forests
Conservation status:	Not listed

Characteristic Trees	*Eucalyptus camaldulensis* (River Red Gum)
Shrubs/ Vines/ Epiphytes	-
Groundcovers	*Paspalidium sp., Paspalidium gracile* (Slender Panic), *Dichanthium sericeum*, (Silky Blue-grass), *Alternanthera denticulata* (Common Joyweed), *Oxalis perennans* (Oxalis)
Threatened Flora Species	-
Exotic Flora Species	*Cynodon dactylon (*Couch), *Conyza bonariensis* (Flaxleaf Fleabane), *Bidens subalternans* (Greater Beggar's Ticks), *Xanthium occidentale* (Noogoora Burr), *Bidens pilosa* (Farmer's Friend)
Vegetation Structure	Tall Woodland/ Tall Open Forest
% remaining in NSW	40% ± 50%
No. sites sampled	6

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
20.83 ±7.63	19.58 ±12.63	0.58 ±1.43	33.33 ±31.92	0 ± 0	2.67 ±3.93	39.87 ±47.43	37.33 ±38.96	6.67 ±13.49	0 ± 0	2.17 ±1.94	24.17 ±34.75	0.61 ±0.49

88: Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion

BVT Equivalent ID & Name:	NA179: Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrub/grass subformation) [Namoi CMA]
Vegetation class:	Pilliga Outwash Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	*Callitris glaucophylla* (White Cypress-pine), *Eucalyptus pilligaensis* (Narrow-leaved Grey Box), *Allocasuarina luehmannii* (Bulloak)
Shrubs/ Vines/ Epiphytes	*Geijera parviflora* (Wilga), *Acacia deanei subsp. Deanei* (Green Wattle)
Groundcovers	*Enteropogon acicularis* (Curly Windmill Grass), *Eragrostis lacunaria* (Purple Lovegrass), *Fimbristylis dichotoma*, *Aristida sp.*, *Aristida caput-medusae* (Many-headed Wiregrass), *Brunoniella australis* (Blue Trumpet*), Lomandra multiflora* (Many-flowered Mat-rush), *Paspalidium sp., Carex inversa* (Knob Sedge)
Threatened Flora Species	*Lepidium monoplocoides* (Endangered TSC / EPBC Act), *Pterostylis cobarensis* (Vulnerable TSC / EPBC Act), *Tylophora linearis* (Vulnerable TSC Act/ Endangered EPBC Act)
Exotic Flora Species	*Opuntia stricta* (Prickly Pear), *Gomphrena celosioides* (Gomphrena Weed), *Lycium ferocissimum* (African Boxthorn)
Vegetation Structure	Woodland/ Open Woodland
% remaining in NSW	62% ± 80%
No. sites sampled	36

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
25.67 ±9.52	12.61 ±8.96	9.25 ±10.17	29.39 ±18.90	8.67 ±17.18	9.33 ±10.63	0.22 ±1.05	41.38 ±19.06	18.62 ±17.40	0.48 ±1.38	1.28 ±1.45	32.69 ±33.26	0.77 ±0.41

141: Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion

BVT Equivalent ID & Name:	NA121: Broombush shrubland of the sand plains of the Pilliga region, subtropical sub-humid climate zone
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrub/grass subformation) [Namoi CMA]
Vegetation class:	Pilliga Outwash Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	*Eucalyptus crebra* (Narrow-leaved Ironbark)
Shrubs/ Vines/ Epiphytes	*Acacia caroleae, Melaleuca erubescens, Melaleuca uncinata* (Broom Honeymyrtle), *Platysace lanceolata* (Lance-leaf Platysace), *Mirbelia pungens, Calytrix tetragona* (Fringe-myrtle), *Cassytha pubescens* (Devil's Twine), *Hibbertia covenyana, Lissanthe strigosa* (Peach Heath), *Westringia cheelii*
Groundcovers	*Aristida sp.* (Wiregrass), *Dianella revoluta* (Blue Flax-lily), *Hypericum gramineum* (Small St Johns-wort), *Cheilanthes sieberi subsp. Sieberi* (Rock Fern), *Cyperus gracilis* (Slender Sedge), *Digitaria breviglumis, Drosera sp.* (Sundew*),* *Goodenia paniculata, Poranthera microphylla* (Small Poranthera)
Threatened Flora Species	*Tylophora linearis* (Vulnerable TSC Act/ Endangered EPBC Act)
Exotic Flora Species	-
Vegetation Structure	Tall Shrubland
% remaining in NSW	89% ± 30%
No. sites sampled	4

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
20.25 ±8.10	9.55 ±11.25	28.13 ±15.02	10.5 ±9.57	62 ±13.95	7 ±6.22	0 ± 0				0 ± 0	0 ± 0	1 ± 0

202: Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion

BVT Equivalent ID & Name:	NA141: Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion
Vegetation formation (CMA):	Grassy Woodlands [Namoi CMA]
Vegetation class:	Western Slopes Grassy Woodlands
Conservation status:	Endangered TSC Act

Characteristic Trees	*Eucalyptus conica* (Fuzzy Box), *Callitris glaucophylla* (White Cypress-pine), *Eucalyptus chloroclada* (Dirty Gum)
Shrubs/ Vines/ Epiphytes	*Acacia deanei subsp. deanei* (Green Wattle), *Hibbertia obtusifolia* (Guinea-flower), *Melichrus urceolatus* (Urn Heath)
Groundcovers	*Cymbopogon refractus* (Barbed Wire Grass), *Aristida caput-medusae* (Many-headed Wiregrass), *Aristida sp.* (Wiregrass) , *Cheilanthes sieberi subsp. Sieberi* (Rock Fern), *Austrostipa verticillata* (Slender Bamboo Grass), *Austrostipa scabra subsp. Scabra* (Rough Speargrass), *Ajuga australis*(Native Bugle), *Dianella revoluta* (Blue Flax-lily)
Threatened Flora Species	*Polygala linariifolia* (Endangered TSC Act), *Pterostylis cobarensis* (Vulnerable TSC / EPBC Act)
Exotic Flora Species	*Opuntia aurantiaca* (Tiger Pear), *Bidens subalternans* (Greater Beggar's Ticks), *Conyza bonariensis* (Flaxleaf Fleabane)
Vegetation Structure	Woodland/ Open Forest
% remaining in NSW	25% ± 60%
No. sites sampled	16

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
20.25 ±8.10	9.55 ±11.25	28.13 ±15.02	10.5 ±9.57	62 ±13.95	7 ±6.22	0 ± 0				0 ± 0	0 ± 0	1 ± 0

256: Green Mallee tall mallee woodland rises in the Pilliga - Goonoo regions, southern BBS Bioregion

BVT Equivalent ID & Name:	NA143: Green Mallee scrub on sandstone rises in the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrub/grass subformation) [Namoi CMA]
Vegetation class:	North-west Slopes Dry Sclerophyll Woodlands
Conservation status:	Not listed

Characteristic Trees	*Eucalyptus viridis* (Green Mallee)
Shrubs/ Vines/ Epiphytes	*Solanum ferocissimum* (Spiny Potato-bush*), Dodonaea viscosa subsp. cuneata* (Wedge-leaf Hopbush), *Psydrax oleifolia* (Wild Lemon), *Solanum jucundum*
Groundcovers	*Aristida caput-medusae(*Many-headed Wiregrass), *Austrostipa scabra subsp. scabra (*Rough Speargrass), *Paspalidium gracile* (Slender Panic), *Cheilanthes sieberi subsp. sieberi* (Rock Fern), *Digitaria sp., Panicum sp.*
Threatened Flora Species	-
Exotic Flora Species	-
Vegetation Structure	Low Woodland/ Low Open Forest
% remaining in NSW	77% ± 50%
No. sites sampled	1

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
31	31.5	3	70	2	6	0	26	0	0	0	0	1

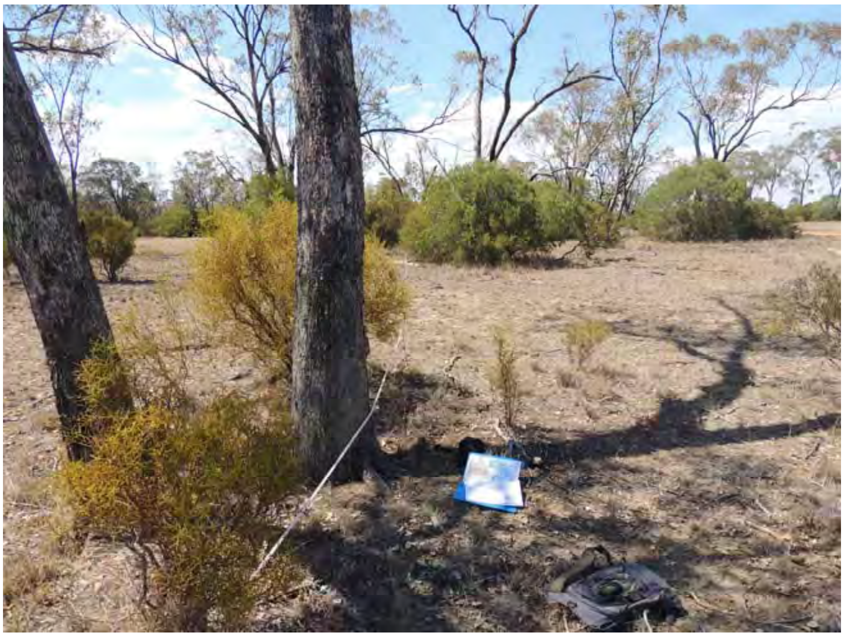
397: Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion

BVT Equivalent ID & Name: NA179: Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone

Vegetation formation (CMA): Dry Sclerophyll Forests (Shrub/grass subformation [Namoi CMA]

Vegetation class: Pilliga Outwash Dry Sclerophyll Forests

Conservation status: Not listed



Characteristic Trees *Eucalyptus populnea subsp. bimbil* (Poplar Box), *Callitris glaucophylla* (White Cypress-pine), *Allocasuarina luehmannii* (Bulloak)

Shrubs/ Vines/ Epiphytes *Geijera parviflora* (Wilga), *Maireana microphylla* (Eastern Cottonbush), *Eremophila deserti* (Turkey-bush)

Groundcovers *Bothriochloa decipiens* (Redleg Grass), *Eragrostis elongata* (Clustered Lovegrass), *Eragrostis leptostachya* (Paddock Lovegrass), *Carex inversa* (Knob Sedge), *Glycine sp., Aristida sp.*, *Juncus aridicola* (Tussock Rush), *Eragrostis lacunaria* (Purple Lovegrass), *Austrostipa scabra subsp. scabra* (Rough Speargrass), *Fimbristylis dichotoma*

Threatened Flora Species -

Exotic Flora Species *Portulaca pilosa, Gomphrena celosioides* (Gomphrena Weed), *Cynodon dactylon* (Couch).

Vegetation Structure Woodland

% remaining in NSW 80% ± 20%

No. sites sampled 11

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
22.27 ± 8.92	14.79 ± 9.46	4.68 ± 8.78	23.82 ±21.06	0.55 ± 1.81	8.18 ±14.65	1.64 ± 5.43	36.91 ±19.85	29.45 ±15.95	0.36 ± 1.21	1.36 ± 2.25	18.18 ±19.90	0.82 ± 0.40

398: Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion

BVT Equivalent ID & Name:	NA227: White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrub/grass subformation [Namoi CMA]
Vegetation class:	Pilliga Outwash Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	*Allocasuarina luehmannii* (Bulloak), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Callitris glaucophylla* (White Cypress-pine)
Shrubs/ Vines/ Epiphytes	*Acacia spectabilis, Cassinia arcuata* (Sifton Bush), *Lissanthe strigosa* (Peach Heath)
Groundcovers	*Fimbristylis dichotoma, Cheilanthes sieberi subsp. sieberi* (Rock Fern), *Lomandra multiflora* (Many-flowered Mat-rush), *Gahnia aspera* (Rough-leaved Saw-sedge), *Dianella revoluta* (Blue Flax-lily), *Eragrostis brownii* (Brown's Lovegrass), *Eragrostis lacunaria* (Purple Lovegrass), *Digitaria breviglumis Goodenia rotundifolia*, *Aristida sp*., *Digitaria diffusa*
Threatened Flora Species	*Diuris tricolor* (Vulnerable TSC Act), *Polygala linariifolia* (Endangered TSC Act), *Pomaderris queenslandica* (Endangered TSC Act), *Pterostylis cobarensis* (Vulnerable TSC / EPBC Act), *Tylophora linearis* (Endangered TSC / EPBC Act)
Exotic Flora Species	*Conyza bonariensis* (Flaxleaf Fleabane), *Sonchus oleraceus* (Common Sow-thistle), *Conyza sp., Solanum sp.*
Vegetation Structure	Tall Woodland
% remaining in NSW	73% ± 30%
No. sites sampled	57

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
31.9 ±10.09	8.61 ±7.86	10.68 ±10.05	25.17 ±16.98	14.55 ±19.24	10.8 ±11.10	0.17 ±1.29	52.14 ±28.88	10.31 ±11.85	0.55 ±1.99	0.47 ±0.81	45.2 ±31.19	0.97 ±0.12

399: Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion

BVT Equivalent ID & Name:	NA197: Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion
Vegetation formation (CMA):	Grassy Woodlands [Namoi CMA]
Vegetation class:	New England Grassy Woodlands
Conservation status:	Not listed

Characteristic Trees	*Eucalyptus blakelyi* (Blakely's Red Gum), *Callitris glaucophylla* (White Cypress-pine)
Shrubs/ Vines/ Epiphytes	*Acacia deanei subsp. deanei* (Green Wattle), *Leptospermum polygalifolium subsp. transmontanum* (Tantoon)
Groundcovers	*Lomandra longifolia* (Spiny-headed Mat-rush), *Imperata cylindrica* (Blady Grass), *Arundinella nepalensis* (Reedgrass), *Chrysocephalum apiculatum* (Common Everlasting), *Juncus sp., Austrostipa verticillata* (Slender Bamboo Grass), *Cymbopogon refractus* (Barbed Wire Grass)
Threatened Flora Species	*Pterostylis cobarensis* (Vulnerable TSC / EPBC Act)
Exotic Flora Species	*Cynodon dactylon* (Couch) , *Opuntia stricta* (Prickly Pear), *Bidens subalternans* (Greater Beggar's Ticks)
Vegetation Structure	Woodland
% remaining in NSW	90% ± 50%
No. sites sampled	20

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
23.75 ±7.00	10.14 ±8.78	2.91 ±3.57	24.9 ±23.20	1.7 ±4.01	20 ±12.31	12.3 ±19.50	32.42 ±23.46	19.79 ±17.76	0 ± 0	2.05 ±1.82	26.65 ±18.45	0.75 ±0.44

401: Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region

BVT Equivalent ID & Name:	NA197: Rough-barked Apple riparian forb/grass open forest of the Nandewar Bioregion
Vegetation formation (CMA):	Grassy Woodlands [Namoi CMA]
Vegetation class:	New England Grassy Woodlands
Conservation status:	Not listed

Characteristic Trees	*Callitris glaucophylla* (White Cypress-pine), *Eucalyptus chloroclada* (Dirty Gum), *Angophora floribunda* (Rough-barked Apple)
Shrubs/ Vines/ Epiphytes	*Acacia deanei subsp. deanei* (Green Wattle), *Melichrus urceolatus* (Urn Heath), *Hibbertia obtusifolia* (Guinea-flower), *Cassinia arcuata* (Sifton Bush)
Groundcovers	*Aristida caput-medusae* (Many-headed Wiregrass), *Cheilanthes sieberi subsp. sieberi* (Rock Fern), *Lomandra multiflora* (Many-flowered Mat-rush), *Microlaena stipoides* (Meadow Rice-grass), *Cymbopogon refractus* (Barbed Wire Grass), *Eragrostis brownii* (Brown's Lovegrass), Dianella *revoluta* (Blue Flax-lily)
Threatened Flora Species	*Diuris tricolor* (Vulnerable TSC Act), *Myriophyllum implicatum* (Critically Endangered TSC Act), *Polygala linariifolia* (Endangered TSC Act), *Pterostylis cobarensis* (Vulnerable TSC / EPBC Act)
Exotic Flora Species	*Conyza sp., Sonchus oleraceus* (Common Sow-thistle), *Bidens subalternans* (Greater Beggar's Ticks), *Hypochaeris radicata* (Catsear)
Vegetation Structure	Woodland/ Open Forest
% remaining in NSW	67% ± 50%
No. sites sampled	35

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
33.46 ±11.79	16.03 ± 8.81	8.44 ± 9.45	26.97 ±18.73	7.2 ±12.87	17.66 ±14.31	3.37 ± 8.88	45.06 ±22.26	15.41 ± 21.7	0 ± 0	1.89 ± 1.43	37.6 ±23.41	0.94 ± 0.24

402: Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion

BVT Equivalent ID & Name:	NA160: Mugga Ironbark - Pilliga Box - pine- Bulloak shrubby woodland on Jurassic Sandstone of outwash plains
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrubby subformation) [Namoi CMA]
Vegetation class:	Western Slopes Dry Sclerophyll Forests
Conservation status:	Not listed

Photo by John Benson (Benson et al., 2010)

Characteristic Trees	*Eucalyptus sideroxylon* (Mugga), *Allocasuarina luehmannii* (Bulloak), *Eucalyptus pilligaensis* (Narrow-leaved Grey Box)
Shrubs/ Vines/ Epiphytes	*Myoporum montanum* (Waterbush), *Enchylaena tomentosa* (Ruby Saltbush)
Groundcovers	*Carex inversa* (Knob Sedge), *Juncus sp., Marsilea sp.* (Nardoo), *Cyperus sp., Commelina cyanea* (Blue Spiderwort), *Eragrostis lacunaria* (Purple Lovegrass)
Threatened Flora Species	*Lepidium monoplocoides* (Endangered TSC / EPBC Act)
Exotic Flora Species	*Gomphrena celosioides* (Gomphrena Weed), *Opuntia stricta* (Prickly Pear)
Vegetation Structure	Tall Open Woodland
% remaining in NSW	60% ± 50%
No. sites sampled	2

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
29 ±14.14	7 ±2.83	6.75 ±2.47	28 ±25.46	5 ±7.07	32 ±28.28	2 ±2.83	35 ±4.24	6 ±8.49	1 ±1.41	0.5 ±0.71	27.5 ±27.58	0.5 ±0.71

404: Red Ironbark - White Bloodwood -/+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests

BVT Equivalent ID & Name:	NA124: Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrubby subformation) [Namoi CMA]
Vegetation class:	Western Slopes Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	*Eucalyptus fibrosa* (Broad-leaved Red Ironbark), *Corymbia trachyphloia* (Brown Bloodwood), *Callitris glaucophylla* (White Cypress-pine)
Shrubs/ Vines/ Epiphytes	*Cassinia arcuata* (Sifton Bush), *Acacia burrowii* (Burrow's Wattle), *Melichrus urceolatus* (Urn Heath), *Melichrus erubescens*, *Homoranthus flavescens*
Groundcovers	*Cheilanthes sieberi subsp. sieberi* (Rock Fern), *Gahnia aspera* (Rough-leaved Saw-sedge), *Dianella revoluta* (Blue Flax-lily), *Lomandra multiflora* (Many-flowered Mat-rush), *Pomax umbellata* (Pomax), *Aristida sp.*, *Aristida caput-medusae* (Many-headed Wiregrass), *Thyridolepis mitchelliana* (Mulga Grass), *Goodenia rotundifolia*, *Lomandra filiformis subsp. filiformis* (Wattle Mat-rush), *Microlaena stipoides* (Meadow Rice-grass), *Panicum effusum* (Hairy Panic)
Threatened Flora Species	*Bertya opponens* (Vulnerable TSC / EPBC Act), *Polygala linariifolia* (Endangered TSC Act), *Pomaderris queenslandica* (Endangered TSC Act), *Commersonia procumbens* (Vulnerable TSC / EPBC Act), *Tylophora linearis* (Vulnerable TSC Act/ Endangered EPBC Act)
Exotic Flora Species	*Sonchus oleraceus* (Common Sow-thistle), *Conyza sp., Solanum sp.*
Vegetation Structure	Woodland/ Tall Woodland
% remaining in NSW	91% ± 40%
No. sites sampled	34

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
33.97 ±10.06	12.78 ±7.21	12.09 ±7.13	20.47 ±17.67	19 ±17.29	14.06 ±11.49	1.82 ±10.63	47.1 ±21.49	3.7 ±3.20	0 ± 0	1.09 ±1.22	32.93 ±21.62	1 ± 0

405: White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions

BVT Equivalent ID & Name:	NA124: Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrubby subformation) [Namoi CMA]
Vegetation class:	Western Slopes Dry Sclerophyll Forests
Conservation status:	Not listed
Variations	A variation of this community was mapped in the development site (379) which has a canopy dominated by Eucalyptus rossii (Inland Scribbly Gum).

Characteristic Trees	*Corymbia trachyphloia* (White Bloodwood)
Shrubs/ Vines/ Epiphytes	*Melichrus urceolatus* (Urn Heath), *Calytrix tetragona* (Fringe-myrtle), *Brachyloma daphnoides* (Daphne Heath), *Grevillea floribunda* (Rusty Spider-flower), *Allocasuarina diminuta subsp. diminuta*, *Hibbertia obtusifolia* (Guinea-flower), *Persoonia sericea, Boronia glabra, Acacia gladiiformis*, *Cassinia arcuata* (Sifton Bush), *Cassytha pubescens* (Devil's Twine), *Homoranthus flavescens*
Groundcovers	*Pomax umbellata* (Pomax), *Schoenus ericetorum* (Heath Bog-rush), *Lomandra multiflora* (Many-flowered Mat-rush), *Lomandra filiformis subsp. filiformis* (Wattle Mat-rush)
Threatened Flora Species	*Polygala linariifolia* (Endangered TSC Act), *Commersonia procumbens* (Vulnerable TSC / EPBC Act)
Exotic Flora Species	*Conyza sp.*
Vegetation Structure	Woodland
% remaining in NSW	86% ± 30%
No. sites sampled	17

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
39.59 ±8.28	11.08 ±6.03	10.03 ±6.91	7.41 ±9.37	28.59 ±19.59	14.35 ±10.98	0 ± 0	54.86 ±10.19	8.57 ±15.31	0 ± 0	1.12 ±1.11	21.24 ±23.72	1 ± 0

406: White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland/open forest mainly in east Pilliga forests

BVT Equivalent ID & Name: NA124: Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion

Vegetation formation (CMA): Dry Sclerophyll Forests (Shrubby subformation) [Namoi CMA]

Vegetation class: Western Slopes Dry Sclerophyll Forests

Conservation status: Not listed

Characteristic Trees *Eucalyptus fibrosa* (Broad-leaved Red Ironbark), *Corymbia trachyphloia* (White Bloodwood), *Acacia cheelii (*Motherumbah)

Shrubs/ Vines/ Epiphytes *Philotheca ciliata, Dodonaea falcata, Cassinia arcuata* (Sifton Bush), *Grevillea floribunda* (Rusty Spider-flower), *Melichrus erubescens, Calytrix tetragona* (Fringe-myrtle)

Groundcovers *Pomax umbellata* (Pomax), *Thyridolepis mitchelliana* (Mulga Grass), *Lomandra multiflora* (Many-flowered Mat-rush), *Gahnia aspera* (Rough-leaved Saw-sedge)

Threatened Flora Species *Bertya opponens* (Vulnerable TSC / EPBC Act), *Pomaderris queenslandica* (Endangered TSC Act), *Commersonia procumbens* (Vulnerable TSC / EPBC Act).

Exotic Flora Species -

Vegetation Structure Woodland/ Tall Woodland

% remaining in NSW 94% ± 50%

No. sites sampled 8

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
26.63 ±8.58	15.14 ±5.63	15.11 ±7.21	25.75 ±14.36	10.5 ±6.82	17.5 ±15.63	0 ± 0	49 ±12.38	3 ±3.83	0 ± 0	0.75 ±0.89	45.19 ±30.94	1 ± 0

408: Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland of the Pilliga forests and surrounding region

BVT Equivalent ID & Name:	NA124: Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrubby subformation) [Namoi CMA]
Vegetation class:	Western Slopes Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	*Eucalyptus chloroclada* (Dirty Gum), *Callitris glaucophylla* (White Cypress-pine), *Callitris endlicheri* (Black Cypress-pine)
Shrubs/ Vines/ Epiphytes	*Bossiaea rhombifolia subsp. concolor, Calytrix tetragona* (Fringe-myrtle), *Grevillea floribunda* (Rusty Spider-flower), *Persoonia sericea*, *Allocasuarina diminuta subsp. diminuta, Melichrus erubescens*
Groundcovers	*Cheilanthes sieberi subsp. sieberi* (Rock Fern), *Brachyloma daphnoides* (Daphne Heath), *Dianella revoluta* (Blue Flax-lily), *Lomandra multiflora* (Many-flowered Mat-rush), *Chrysocephalum apiculatum* (Common Everlasting).
Threatened Flora Species	*Pomaderris queenslandica* (Endangered TSC Act), *Pterostylis cobarensis* (Vulnerable TSC / EPBC Act)
Exotic Flora Species	*Solanum sp., Cynodon dactylon* (Couch), *Hypochaeris radicata* (Catsear)
Vegetation Structure	Woodland/ Open Woodland
% remaining in NSW	86% ± 50%
No. sites sampled	9

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
28.22 ±10.23	6.34 ±4.13	5.57 ±4.06	15.56 ±19.41	18 ±16.73	7.78 ±9.61	1.78 ±5.33	56.33 ±25.78	7 ±6.78	3.67 ±8.04	1.56 ±1.33	28.56 ±24.20	0.96 ±0.11

418: White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion

BVT Equivalent ID & Name:	NA179: Pilliga Box - Poplar Box- White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrub/grass subformation) [Namoi CMA]
Vegetation class:	Pilliga Outwash Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	*Callitris glaucophylla* (White Cypress-pine), *Eucalyptus melanophloia* (Silver-leaved Ironbark)
Shrubs/ Vines/ Epiphytes	*Geijera parviflora* (Wilga), *Myoporum montanum* (Waterbush), *Rhagodia spinescens* (Spiny Saltbush)
Groundcovers	*Cheilanthes distans* (Bristly Cloak-fern), *Walwhalleya subxerophila* (Gilgai Grass), *Einadia sp., Austrostipa verticillata* (Slender Bamboo Grass), *Austrostipa scabra subsp. scabra* (Rough Speargrass), *Juncus aridicola* (Tussock Rush)
Threatened Flora Species	-
Exotic Flora Species	*Opuntia stricta* (Prickly Pear), *Bidens subalternans* (Greater Beggar's Ticks), *Lepidium bonariense* (Cut-leaf Peppercress)
Vegetation Structure	Woodland/ Open Forest
% remaining in NSW	75% ± 80%
No. sites sampled	7

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
16 ±10.69	17 ±15.83	16.19 ±15.71	32.86 ±26.90	3.43 ±9.07	2.86 ±5.40	23.43 ±40.08	31.71 ±31.44	5.43 ±12.69	0 ± 0	0.29 ±0.49	46.14 ±49.91	0.86 ±0.38

425: Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion

BVT Equivalent ID & Name:	NA121: Broombush shrubland of the sand plains of the Pilliga region, subtropical sub-humid climate zone
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrub/grass subformation) [Namoi CMA]
Vegetation class:	Pilliga Outwash Dry Sclerophyll Forests
Conservation status:	Not listed

Characteristic Trees	-
Shrubs/ Vines/ Epiphytes	*Acacia triptera* (Spurwing Wattle), *Allocasuarina diminuta subsp. diminuta, Calytrix tetragona* (Fringe-myrtle), *Cassinia arcuata* (Sifton Bush), *Homoranthus flavescens, Melaleuca erubescens*, *Melaleuca uncinata* (Broom Honeymyrtle)
Groundcovers	*Aristida sp.*, *Cyperus gracilis* (Slender Sedge), *Digitaria breviglumis, Gahnia aspera* (Rough-leaved Saw-sedge), *Gonocarpus teucrioides* (Raspwort), *Hypericum gramineum* (Small St Johns-wort)
Threatened Flora Species	-
Exotic Flora Species	-
Vegetation Structure	Heathland/ Open Heathland
% remaining in NSW	90% ± 40%
No. sites sampled	2

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
38.5 ±10.61	21.35 ±22.13	9 ±12.73	18 ±16.97	59 ±35.36	23 ±18.38	0 ± 0				0.5 ± 0.71	20.5 ±23.33	1 ± 0

428: Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the Brigalow Belt South Bioregion

BVT Equivalent ID & Name:	NA126: Carbeen woodland on alluvial soils
Vegetation formation (CMA):	Semi-arid Woodlands (Shrubby subformation) [Namoi CMA]
Vegetation class:	North-west Alluvial Sand Woodlands
Conservation status:	Endangered (TSC Act)

Characteristic Trees	*Callitris glaucophylla* (White Cypress-pine), *Corymbia tessellaris* (Carbeen), *Eucalyptus chloroclada* (Dirty Gum)
Shrubs/ Vines/ Epiphytes	*Geijera parviflora* (Wilga)
Groundcovers	*Austrostipa verticillata* (Slender Bamboo Grass), *Aristida caput-medusae* (Many-headed Wiregrass), *Austrostipa setacea (*Corkscrew Grass), *Microlaena stipoides* (Meadow Rice-grass)
Threatened Flora Species	-
Exotic Flora Species	*Eragrostis curvula* (African Lovegrass), *Bidens subalternans* (Greater Beggar's Ticks), *Opuntia aurantiaca* (Tiger Pear)
Vegetation Structure	Woodland/ Open Woodland
% remaining in NSW	50% ± 60%
No. sites sampled	2

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
22 ±15.56	7.75 ±7.42	12.75 ±3.18	21 ±26.87	1 ±1.41	2 ±2.83	65 ±15.56	13 ±9.90	0 ± 0	0 ± 0	1 ±1.41	49 ±7.07	0.5 ±0.71

40X: White Bloodwood – Dirty Gum – Rough Barked Apple – Black Cypress Pine heathy open woodland on deep sand in the Pilliga forests

BVT Equivalent ID & Name:	NA124: Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion
Vegetation formation (CMA):	Dry Sclerophyll Forests (Shrubby subformation) [Namoi CMA]
Vegetation class:	Western Slopes Dry Sclerophyll Forests
Conservation status:	N/A

Characteristic Trees	*Callitris endlicheri* (Black Cypress-pine), *Eucalyptus chloroclada* (Dirty Gum)
Shrubs/ Vines/ Epiphytes	*Grevillea floribunda* (Rusty Spider-flower), *Calytrix tetragona* (Fringe-myrtle), *Brachyloma daphnoides* (Daphne Heath), *Melichrus urceolatus* (Urn Heath), *Acacia gladiiformis*, *Hibbertia obtusifolia* (Guinea-flower), *Dodonaea peduncularis* (Stalked Hopbush)
Groundcovers	*Lomandra multiflora* (Many-flowered Mat-rush), *Schoenus ericetorum* (Heath Bog-rush), *Aristida sp.*, *Dianella revoluta* (Blue Flax-lily), *Gahnia aspera* (Rough-leaved Saw-sedge)
Threatened Flora Species	*Diuris tricolor* (Vulnerable TSC Act), *Polygala linariifolia* (Endangered TSC Act), *Pterostylis cobarensis* (Vulnerable TSC / EPBC Act), *Tylophora linearis* (Vulnerable TSC Act/ Endangered EPBC Act)
Exotic Flora Species	*Hypochaeris radicata* (Catsear), *Cenchrus incertus* (Spiny Burrgrass), *Oxalis sp.*
Vegetation Structure	Woodland/ Open Woodland
% remaining in NSW	N/A
No. sites sampled	24

Biometric Data:

No. native species	Over-storey cover (%)	Mid-storey cover (%)	Ground cover (grasses)	Ground cover (shrubs)	Ground cover (other)	Exotic plant cover	Litter (%)	Bare/ rock (%)	Cryptogams (%)	No. trees with hollows	Length fallen logs (m)	Over-storey regeneration
31.13 ±8.58	7.5 ±7.17	7.2 ±6.27	16.83 ±20.58	18.78 ±15.73	9.79 ±9.63	0.75 ±2.11	42 ±29.50	14.27 ±13.65	1.33 ±3.18	1.04 ±1.16	41.42 ±40.38	0.96 ±0.20

Appendix C Major projects credit calculator report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 17/10/2016 Time: 2:37:22PM Calculator version: v4.0

Major Project details

Proposal ID:	0027/2015/2046MP
Proposal name:	Santos NGP v2015
Proposal address:	Newell Highway Narrabri NSW 2390
Proponent name:	Santos NSW (Eastern) Pty Ltd
Proponent address:	Level 22, Gateway Building 1 Macquarie Place Sydney NSW 2390
Proponent phone:	+61 2 9276 1100
Assessor name:	Martin Sullivan
Assessor address:	PO Box 1056 Newcastle NSW 2300
Assessor phone:	02 4910 3405
Assessor accreditation:	0027

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	200.00	8,272.50
Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	200.00	10,608.25
Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	200.00	5,474.00
Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	200.00	10,058.00
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	200.00	13,093.25
Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern Brigalow Belt South Bioregion	200.00	7,685.00
Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion	200.00	10,123.00
Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion	200.00	8,105.00
Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	200.00	9,668.00
Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	200.00	10,697.00
Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	200.00	9,473.00
Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	200.00	9,721.00
Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	200.00	11,309.00
Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	200.00	11,777.00
Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion	200.00	9,811.00
Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	200.00	14,255.00

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests	200.00	9,199.00
White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	200.00	10,123.00
White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	200.00	10,541.00
Total	3,800.00	189,993

Credit profiles

1. Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion, (NA141)

Number of ecosystem credits created	13,093
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion, (NA141) Grey Box - Blakely's Red Gum - Yellow Box grassy open forest of the Nandewar Bioregion and New England Tableland Bioregion, (NA144)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion, (NA121)

Number of ecosystem credits created	5,474
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	**Offset options - IBRA sub-regions**
Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion, (NA121) Dirty Gum - Buloke - White Cypress Pine - ironbark shrubby woodland on deep sandy soils in the Liverpool Plains region of the Brigalow Belt South Bioregion, (NA135) Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179) Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion, (NA189) White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion, (NA227) Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion, (NA324) Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions, Brigalow Belt South Bioregion, (NA265)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179)

Number of ecosystem credits created	10,697
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179) Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions, Brigalow Belt South Bioregion, (NA265)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion, (NA324)

Number of ecosystem credits created	9,473
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion, (NA324) Dirty Gum - Buloke - White Cypress Pine - ironbark shrubby woodland on deep sandy soils in the Liverpool Plains region of the Brigalow Belt South Bioregion, (NA135) Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179) Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion, (NA189) White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion, (NA227) Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions, Brigalow Belt South Bioregion, (NA265)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion, (NA409)

Number of ecosystem credits created	10,541
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion, (NA409) Narrow-leaved Ironbark grassy woodland of the Brigalow Belt South bioregion, (NA164) Silvertop Stringybark - Orange Gum shrubby open forest of the central parts of the Nandewar Bioregion, (NA206) White Box - Red Stringybark shrubby woodlands on basalt slopes of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA222) White Box - White Cypress Pine shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA225) White Cypress Pine - White Box - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA232) Semi-mesic woodland on basalt hills of the dry subtropical climate zone, north western slopes of NSW, (NA242) Rough-barked Apple - Yellow Box grass/shrub footslope open forest, Brigalow Belt South Bioregion, (NA343) Warrumbungle mountains Nandewar Box - Yellow Box shrub grass open forest, Brigalow Belt South Bioregion, (NA385) Nortons Box - stringybark - cough bush shrub - grass woodland on volcanic crests of the Warrumbungle Range, Brigalow Belt South Bioregion, (NA320) Warrumbungle trachyte hillcrest Tumbledown Red Gum - Black Cypress Pine - White Bloodwood shrubby woodland, (NA382) Tumbledown Red Gum trachyte rock flat sedgeland - shrubland of the Warrumbungle Range region, (NA377) Motherumbah - White Bloodwood - cypress pine very tall shrubland / woodland of the Coonabarabran region, Brigalow Belt South Bioregion, (NA300) White Box shrubby woodland of the western Liverpool Range, Warrumbungle Range and south-west Pilliga forests, Brigalow Belt South Bioregion, (NA402) Narrow-leaved Ironbark - White Cypress pine woodland on slopes and flats in the Coonabarabran - Pilliga Scrub regions, (NA317) White Box - Black Cypress Pine shrubby hill woodland in the east Pilliga - Mendooran - Gulgong regions, mainly Brigalow Belt South Bioregion, (NA392) Silver-leaved Ironbark - White Cypress Pine - box dry shrub grass woodland of the Pilliga Scrub - Warialda region, Brigalow Belt South Bioregion, (NA348) White Cypress Pine - Poplar Box - Silver-leaved Ironbark viney shrub woodland of the Brigalow Belt South Bioregion, (NA407) White Box - White Cypress Pine shrub grass hills woodland in the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA397) Black Cypress Pine - White Box - Tumbledown Gum shrubby open forest / woodland mainly in the Mt Kaputar region, Nandewar Bioregion, (NA250) Mugga Ironbark - stringybark shrubby open forest of the far southern Nandewar Bioregion and New England Tableland Bioregion, (NA305) Rough-barked Apple - White Box - Rusty Fig shrubby open forest in the Kaputar area of Brigalow Belt South and Nandewar Bioregions, (NA341)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Cypress Pine - Orange Gum - Acacia granite outcrop shrubland in the Moonbi area of the Nandewar Bioregion and New England Tableland Bioregion, (NA406) Tumbledown Red Gum - White Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar Bioregion and western New England Tableland Bioregion, (NA376) White Box - Silvertop Stringybark +/- White Cypress Pine grass shrub open forest of the southern Nandewar Bioregion and New England Tableland Bioregion, (NA393) White Cypress Pine - Silver-leaved Ironbark - Caley's Ironbark open forest of the central Nandewar Bioregion and western New England Tableland Bioregion, (NA408) Stringybark - spinifex woodland associated serpentinite outcrops in the Nandewar Bioregion, (NA365) White Box - White Cypress Pine - Rough-barked Apple shrubby open forest in the Kaputar area of Brigalow Belt South Bioregion and Nandewar Bioregion, (NA394) White Box - White Cypress Pine shrubby hills open forest mainly in the Nandewar Bioregion, (NA398) White Box shrubby open forest on hills mainly in the Nandewar Bioregion, (NA401) Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion, (NA349) White Box - cypress pine - Silver-leaved Ironbark shrub grass open forest / woodland of the northern Brigalow Belt South Bioregion and Nandewar Bioregion, (NA396) Silver-leaved Ironbark - White Box - White Cypress Pine viney scrub woodland in the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA347)	

6. Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294)

Number of ecosystem credits created	10,123
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326) White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion, (NA330)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of

the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion, (NA281) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316) Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range, (NA245)	

7. Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314)

Number of ecosystem credits created	9,668
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390) White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387) Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279) White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246) Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329) Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259) Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298) White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388) Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328) Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340) Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313) White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391) Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311) Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283) White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

8. Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255)

Number of ecosystem credits created	9,721
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326) White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion, (NA330)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of

the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion, (NA281) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316) Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range, (NA245)	

9. Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338)

Number of ecosystem credits created	11,777
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411) Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329) Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259) Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298) Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328) Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Bioregion, (NA340) Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313) White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391) Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311) Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283) White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

10. Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307)

Number of ecosystem credits created	8,105
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411) Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329) Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259) Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298) Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328) Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340) Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313) White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391) Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311) Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283) White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

11. Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326)

Number of ecosystem credits created	11,309
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion, (NA330)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of

the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion, (NA281) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316) Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range, (NA245)	

12. White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)

Number of ecosystem credits created	10,123
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404)

Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

13. White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

Number of ecosystem credits created	9,199
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion, (NA330)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of

the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion, (NA281) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316) Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range, (NA245)	

14. Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Number of ecosystem credits created	10,058
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

sandy soil in the Pilliga forests, (NA326)

White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404)

Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

15. Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Number of ecosystem credits created	9,811
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion, (NA330)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of

the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion, (NA281) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316) Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range, (NA245)	

16. Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions, (NA102)

Number of ecosystem credits created	8,273
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions, (NA102)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

17. Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion, (NA117)

Number of ecosystem credits created	10,608
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion, (NA117)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

18. Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion, (NA219)

Number of ecosystem credits created	14,255
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion, (NA219)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

19. Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern Brigalow Belt South Bioregion, (NA292)

Number of ecosystem credits created	7,685
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern Brigalow Belt South Bioregion, (NA292) Cypress pine - Tumbledown Red Gum low open woodland to grassland on rocky benches, mainly in the Nandewar Bioregion, (NA410) Mock Olive - Tumbledown Red Gum - Red Ash - Wilga siliceous rocky hill low woodland / shrubland in the Gunnedah - Tambar Springs region, Brigalow Belt South Bioregion, (NA297)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Coolabah Bertya	Bertya opponens	100.00	1,400
Pine Donkey Orchid	Diuris tricolor	100.00	1,300
Native Milkwort	Polygala linariifolia	100.00	1,500
Scant Pomaderris	Pomaderris queenslandica	100.00	1,500
Greenhood Orchid	Pterostylis cobarensis	100.00	1,300
Commersonia procumbens	Commersonia procumbens	100.00	1,500
Tylophora linearis	Tylophora linearis	100.00	7,700
Black-striped Wallaby	Macropus dorsalis	100.00	2,600
Eastern Pygmy-possum	Cercartetus nanus	100.00	2,000
Pale-headed Snake	Hoplocephalus bitorquatus	100.00	3,300
Squirrel Glider	Petaurus norfolcensis	100.00	2,200
Spiny Peppercress	Lepidium aschersonii	100.00	1,400

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 17/10/2016 Time: 2:42:19PM Calculator version: v4.0

Major Project details

Proposal ID:	0027/2015/2046MP
Proposal name:	Santos NGP v2015
Proposal address:	Newell Highway Narrabri NSW 2390
Proponent name:	Santos NSW (Eastern) Pty Ltd
Proponent address:	Level 22, Gateway Building 1 Macquarie Place Sydney NSW 2390
Proponent phone:	+61 2 9276 1100
Assessor name:	Martin Sullivan
Assessor address:	PO Box 1056 Newcastle NSW 2300
Assessor phone:	02 4910 3405
Assessor accreditation:	0027

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	200.00	5,854.00
Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	200.00	5,854.00
Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	200.00	3,392.00
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	200.00	4,952.00
Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion	200.00	3,392.00
Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	200.00	3,392.00
Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	200.00	3,392.00
Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	200.00	3,392.00
Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	200.00	3,392.00
Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	200.00	3,392.00
Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	200.00	5,853.50
White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	200.00	3,392.00
White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	200.00	3,392.00
Total	2,600.00	53,042

Credit profiles

1. Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion, (NA141)

Number of ecosystem credits created	4,952
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion, (NA141) Grey Box - Blakely's Red Gum - Yellow Box grassy open forest of the Nandewar Bioregion and New England Tableland Bioregion, (NA144)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179) Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions, Brigalow Belt South Bioregion, (NA265)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion, (NA324)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion, (NA324) Dirty Gum - Buloke - White Cypress Pine - ironbark shrubby woodland on deep sandy soils in the Liverpool Plains region of the Brigalow Belt South Bioregion, (NA135) Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion, (NA179) Red Ironbark - Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion, (NA189) White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion, (NA227) Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions, Brigalow Belt South Bioregion, (NA265)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion, (NA409)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion, (NA409) Narrow-leaved Ironbark grassy woodland of the Brigalow Belt South bioregion, (NA164) Silvertop Stringybark - Orange Gum shrubby open forest of the central parts of the Nandewar Bioregion, (NA206) White Box - Red Stringybark shrubby woodlands on basalt slopes of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA222) White Box - White Cypress Pine shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA225) White Cypress Pine - White Box - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA232) Semi-mesic woodland on basalt hills of the dry subtropical climate zone, north western slopes of NSW, (NA242) Rough-barked Apple - Yellow Box grass/shrub footslope open forest, Brigalow Belt South Bioregion, (NA343) Warrumbungle mountains Nandewar Box - Yellow Box shrub grass open forest, Brigalow Belt South Bioregion, (NA385) Nortons Box - stringybark - cough bush shrub - grass woodland on volcanic crests of the Warrumbungle Range, Brigalow Belt South Bioregion, (NA320) Warrumbungle trachyte hillcrest Tumbledown Red Gum - Black Cypress Pine - White Bloodwood shrubby woodland, (NA382) Tumbledown Red Gum trachyte rock flat sedgeland - shrubland of the Warrumbungle Range region, (NA377) Motherumbah - White Bloodwood - cypress pine very tall shrubland / woodland of the Coonabarabran region, Brigalow Belt South Bioregion, (NA300) White Box shrubby woodland of the western Liverpool Range, Warrumbungle Range and south-west Pilliga forests, Brigalow Belt South Bioregion, (NA402) Narrow-leaved Ironbark - White Cypress pine woodland on slopes and flats in the Coonabarabran - Pilliga Scrub regions, (NA317) White Box - Black Cypress Pine shrubby hill woodland in the east Pilliga - Mendooran - Gulgong regions, mainly Brigalow Belt South Bioregion, (NA392) Silver-leaved Ironbark - White Cypress Pine - box dry shrub grass woodland of the Pilliga Scrub - Warialda region, Brigalow Belt South Bioregion, (NA348) White Cypress Pine - Poplar Box - Silver-leaved Ironbark viney shrub woodland of the Brigalow Belt South Bioregion, (NA407) White Box - White Cypress Pine shrub grass hills woodland in the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA397) Black Cypress Pine - White Box - Tumbledown Gum shrubby open forest / woodland mainly in the Mt Kaputar region, Nandewar Bioregion, (NA250) Mugga Ironbark - stringybark shrubby open forest of the far southern Nandewar Bioregion and New England Tableland Bioregion, (NA305) Rough-barked Apple - White Box - Rusty Fig shrubby open forest in the Kaputar area of Brigalow Belt South and Nandewar Bioregions, (NA341)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Cypress Pine - Orange Gum - Acacia granite outcrop shrubland in the Moonbi area of the Nandewar Bioregion and New England Tableland Bioregion, (NA406) Tumbledown Red Gum - White Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar Bioregion and western New England Tableland Bioregion, (NA376) White Box - Silvertop Stringybark +/- White Cypress Pine grass shrub open forest of the southern Nandewar Bioregion and New England Tableland Bioregion, (NA393) White Cypress Pine - Silver-leaved Ironbark - Caley's Ironbark open forest of the central Nandewar Bioregion and western New England Tableland Bioregion, (NA408) Stringybark - spinifex woodland associated serpentinite outcrops in the Nandewar Bioregion, (NA365) White Box - White Cypress Pine - Rough-barked Apple shrubby open forest in the Kaputar area of Brigalow Belt South Bioregion and Nandewar Bioregion, (NA394) White Box - White Cypress Pine shrubby hills open forest mainly in the Nandewar Bioregion, (NA398) White Box shrubby open forest on hills mainly in the Nandewar Bioregion, (NA401) Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion, (NA349) White Box - cypress pine - Silver-leaved Ironbark shrub grass open forest / woodland of the northern Brigalow Belt South Bioregion and Nandewar Bioregion, (NA396) Silver-leaved Ironbark - White Box - White Cypress Pine viney scrub woodland in the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA347)	

5. Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390) White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387) Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279) White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404)

Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310)

Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373)

Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)

6. Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326) White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, Brigalow Belt South Bioregion, (NA330)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of

the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion, (NA281) Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316) Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range, (NA245)	

7. Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411) Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329) Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259) Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298) Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328) Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Bioregion, (NA340) Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313) White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391) Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311) Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283) White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

8. Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411) Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329) Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259) Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298) Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328) Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340) Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313) White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391) Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311) Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283) White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

9. White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests, (NA326)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404)

Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

10. Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279)

Number of ecosystem credits created	3,392
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions

Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region, (NA279) Black Cypress Pine - Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion, (NA106) Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion, (NA109) Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion, (NA116) Brown Bloodwood - cypress - ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion, (NA124) Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion, (NA143) Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion, (NA160) Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion, (NA165) White Box - White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA224) White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion, (NA228) White Cypress Pine - Silver-leaved Ironbark - Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion, (NA229) White Cypress Pine - Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion, (NA231) Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion, (NA294) Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region, (NA374) White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, Brigalow Belt South Bioregion, (NA405) Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion, (NA314) Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion, (NA255) Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region, (NA338) Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion, (NA307) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (NA306) Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

sandy soil in the Pilliga forests, (NA326)

White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions, (NA390)

White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests, (NA389)

White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests, (NA387)

Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, Brigalow Belt South Bioregion, (NA280)

White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, Brigalow Belt South Bioregion, (NA411)

Fringe Myrtle shrubland of the Pilliga Scrub, (NA287)

Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, Brigalow Belt South Bioregion, (NA246)

Red Stringybark - Rough-barked Apple +/- Nortons Box open forest on hillslopes in the Warrumbungle NP - Coolah regions, (NA329)

Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, Brigalow Belt South Bioregion, (NA259)

Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion, (NA363)

Motherumbah - Dwyer's Red Gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA298)

White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, Brigalow Belt South Bioregion, (NA388)

Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW Brigalow Belt South Bioregion, (NA328)

Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, Brigalow Belt South Bioregion, (NA340)

Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA313)

White Bloodwood - Red Ironbark - Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, Brigalow Belt South Bioregion, (NA391)

Narrow-leaved Ironbark - Black Cypress Pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, Brigalow Belt South Bioregion, (NA311)

Dwyer's Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, Brigalow Belt South Bioregion, (NA283)

White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, Brigalow Belt South Bioregion, (NA404)

Narrow-leaved Ironbark - Black Cypress Pine - Motherumbah woodland in the Kaputar area in the Nandewar Bioregion, (NA310) Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion, (NA312) Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion, (NA299) Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion, (NA373) Narrow-leaved Ironbark - cypress pine - White Box shrubby open forestin the Brigalow Belt South Bioregion and Nandewar Bioregion, (NA316)	

11. Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions, (NA102)

Number of ecosystem credits created	5,854
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	**Offset options - IBRA sub-regions**
Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions, (NA102)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

12. Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion, (NA117)

Number of ecosystem credits created	5,854
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion, (NA117)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

13. Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion, (NA219)

Number of ecosystem credits created	5,854
IBRA sub-region	Pilliga Outwash - Namoi

Offset options - Plant Community types	Offset options - IBRA sub-regions
Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion, (NA219)	Pilliga Outwash - Namoi and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Appendix D Impacts on biodiversity that require further consideration

The following assessments follow the requirements of Section 9.2.5.2 of the FBA for the impacts on threatened species that require further consideration as outlined in **Table 54**.

***Anthochaera phrygia* (Regent Honeyeater)**

(a) the size of the local population directly and indirectly impacted by the development.

Due to the lack of records of Regent Honeyeater in the development site, the impact to this species has been calculated based on potential habitat (see section (b)). A description of the potential for a population to use the development site is presented below.

All individuals of the Regent Honeyeater are considered to comprise a single population (DotE, 2016a), with some exchange between regularly used areas (Garnett et al. as cited in DotE, 2016b). There are no records of Regent Honeyeater in the development site on the BioNet Database (OEH, 2016a). Furthermore, the species was not recorded during targeted surveys or general fauna surveys for this project (for methods see **Section 5.3.3**). Regent Honeyeaters have been recorded sporadically in the Pilliga (in 1991, 1992, 1997 and 2003; OEH 2014a). These previous sightings of Regent Honeyeaters in the Pilliga Forest have been largely associated with drainage lines (OEH, 2016a). Their distribution in the Pilliga may fluctuate based on episodic eucalypt flowering, including *E. albens* beyond the Pilliga. Minor and sporadic breeding occurs in Warrumbungle National Park, Pilliga Nature Reserve and Mudgee-Wollar region (S. Garnett, Szabo, & Dutson, 2011; OEH, 2016b).

The Regent Honeyeater has an extremely patchy distribution across the inland slopes of south-east Australia between north-eastern Victoria and south-eastern Queensland (OEH, 2016b). Birds are also found in drier coastal woodlands and forests in some years. In NSW, most records are from the Great Dividing Range, mainly on the North-West Plains, North-West and South-West Slopes, Northern Tablelands, Central Tablelands and Southern Tablelands regions; as well as the Central Coast and Hunter Valley regions.

(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to:

(i) an estimate of the change in habitat available to the local population as a result of the proposed development

Within the development site, approximately 57,579 ha of potential habitat has been mapped which provides 57,579 ha of foraging habitat and 0 ha of breeding habitat. Within the study region, approximately 246,370 ha of habitat has been mapped which provides 246,370 ha of foraging habitat. An upper limit of 796.80 ha of potential foraging habitat would be directly impacted which equates to 1.38% of foraging habitat directly impacted in the development site. Indirect impacts have the potential to modify additional habitat. The reduction in habitat quality would be comparable to additional loss of up to 157.48 ha of habitat which would combine to impact a total of 1.66% of foraging habitat in the development site.

(ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and

The habitat in the development site that would be modified and destroyed is not occupied by the Regent Honeyeater and is considered 'potential' habitat for the species. As a result, no habitat used by a local population would be impacted.

(iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.

The phases of the life cycle considered relevant for Regent Honeyeater in the development site are development and aging. None of the known breeding sites for Regent Honeyeater are in the development site and hence the reproduction and growth phases of their lifecycle are not affected by activities in the development site. Additionally, genetic diversity and evolutionary development are dependent on breeding and hence would not be impacted by the modification of potential habitat in the development site. Death is not considered a stage of the lifecycle which needs to be assessed.

Development and aging requires adequate habitat and conditions for foraging, communication and roosting. The habitat in the development site is not considered necessary for the maintenance of development and aging by the species as the habitat is not known to be occupied and is considered potential habitat that could be used sporadically.

It is relevant to consider that the Warrumbungles, Pilliga Nature Reserve and adjoining habitat to the south of the development site has been mapped as 'other breeding areas' that support the key breeding area of Bundarra-Barraba in the National Recovery Plan (DotE, 2016a). A coarse-scale map provided in the National Recovery Plan was digitised and overlayed with the development site boundary. The 'other breeding area' mapped in the Pilliga overlays with approximately 2,755 ha (2.90%) of the development site in the south-eastern corner. The vegetation communities mapped in this area are predominantly PCT IDs 404, 405 and 406 which are shrubby and heathy woodlands. They are not associated with drainage lines and don't support local preferred flowering Eucalypt species. At a site-scale, this habitat is not considered preferred breeding habitat for Regent Honeyeater.

(c) the likely impact on the ecology of the local population. At a minimum, address the following:

(i) for fauna:

– breeding, foraging, roosting, and dispersal or movement pathways

There are no known breeding sites for Regent Honeyeater in the development site and hence the project would not impact on breeding (see section (b) for detail on breeding habitat in the Pilliga). The direct loss of up to 796.80 ha and additional indirect loss of up to 157.48 ha of potential foraging habitat which constitutes 1.66% of potential foraging habitat in the development site would not restrict foraging or roosting potential in the development site. Infrastructure that would be installed would not inhibit movement and hence the development site would continue to support any foraging, roosting or movement of Regent Honeyeaters in the Pilliga.

(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development

Additional fragmentation of foraging habitat would occur as a result of the project. It is likely that additional patches of habitat would be formed. Due to the scale of the proposed infrastructure, the additional patches are not considered ‘isolated’ as the Regent Honeyeater would have the mobility to move between patches. The majority of linear fragmentation would be an average width of 10 m and rehabilitated directly after impact to 5 m. The widest linear corridor proposed would be up to 30 m wide. These linear clearing widths would not prevent movement by this species. Major infrastructure at Bibblewindi and drillers camps would be placed to minimise isolating habitat patches and would be surrounded by habitat such that movement by this species would be possible around the infrastructure.

(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species’ range

As the Regent Honeyeater moves to access seasonally available resources, the local population is not a static, geographically bound population. They are known to undertake large-scale nomadic movements in the order of hundreds of kilometres. The patchy sightings of the species in the Pilliga indicates that their use of the area fluctuates with eucalypt flowering. As such, the development site could provide sporadic habitat for a population when more favourable resources are not available.

The sub-population that regularly uses the Bundarra-Barraba region is considered to use the Pilliga, the Warrumbungles, and Inverell-Ashford-Emmaville as subsidiary areas (DotE, 2016a). As a subsidiary area, the Pilliga Forests provides potential sporadic breeding and foraging habitat for the species, and supports the more stable breeding region.

(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population

A suite of indirect impacts have been considered for this species and the reduction in habitat condition from these indirect impacts has been related to the comparable direct loss of habitat. The indirect impacts constitute a comparable loss of 157.48 ha. As this combines with the direct removal to impact up to 1.66% of potential foraging habitat in the development site, it is not considered that this scale of loss would decrease the viability of a local population.

Indirect impacts of the project are categorised into three categories; site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna and fire), downstream or downwind impacts (sediment, erosion and dust, hydrological change, and accidental spills and leaks), and facilitated impacts (hunting). Specific avoidance, minimisation and mitigation measures have been proposed to address each indirect impact identified (**Section 6**).

(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

The recovery of the Regent Honeyeater in the IBRA subregion requires improving extent and quality of regent honeyeater habitat, increasing understanding of size, structure, trajectory and viability of the wild population, and maintaining and increasing community awareness (DotE, 2016a). The surveys for this project, coupled with the monitoring within the development site and future offset areas would assist in improving understanding of Regent Honeyeater distribution and habitat use within the study region. Furthermore, all vegetation communities that provide potential foraging habitat for this species that would be directly or indirectly impacted in the development site would be offset, allowing for the maintenance and improvement of potential foraging habitat in the study region. The improvement of potential foraging habitat would be assisted by supplementary offset measures such as feral animal control, weed control, and fire management.

Anomalopus mackayi (Five-clawed Worm-skink)

(a) the size of the local population directly and indirectly impacted by the development.

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site. Details on the population in the Namoi floodplains are provided below.

The Five-clawed Worm-skink is difficult to detect and the size and extent of populations are largely unknown. There are no records of the species in the development footprint. A record from approximately 6 km north-east of the development site was recorded on 13 January 2015 (OEH, 2016a). The record is of a dead specimen along Gun Club Road, Narrabri. The location was supplied to OEH by a public member as a residential address and hence the exact location of the species is unknown. A further record which is approximately 5 km north of the development site was recorded in 1976. A targeted survey for the species along the Namoi River floodplains in 2009/10 recorded two individuals north-west of the development site (North West Ecological Services, 2010).

The preferred habitat of this species is in native vegetation communities with alluvial cracking clay soils which are not present in the development site. The clay soils in the north of the development site (particularly associated with PTCs 27, 35 and 55) do not form deep cracking preferred by this species.

(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to:

(i) an estimate of the change in habitat available to the local population as a result of the proposed development

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site.

The Five-clawed Work-skink is known to occur on the floodplains of the Namoi river, and it's likely distribution within the Namoi River catchment extends to just north of the development site (North West Ecological Services, 2010). The preferred habitat of deep cracking clay is not present in the development site and hence would not be directly or indirectly impacted in the development site.

(ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site.

As stated above, there is a low availability of habitat and no records of the Five-clawed Worm-skink in the development site. As such, available habitat used by a local population would not be impacted in the development site.

(iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.

As stated above, there is a low availability of habitat and no records of the Five-clawed Worm-skink in the development site. The habitat in the development site is not considered required by the species for maintenance of life cycle processes.

(c) the likely impact on the ecology of the local population. At a minimum, address the following:

(i) for fauna:

– breeding, foraging, roosting, and dispersal or movement pathways

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site.

As stated above, there is a low availability of habitat and no records of the Five-clawed Worm-skink in the development site. The development site is unlikely to support breeding, foraging or movement pathways for this species.

(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site. Additionally, the local population of the Namoi floodplains is entirely north of the development site and would not be fragmented or isolated by the proposed development.

(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site. Therefore, a relationship between a local population and other populations is not relevant to the development site.

(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population

A local population of Five-clawed Worm-skink is not considered likely to occur in the development site. A suite of indirect impacts have been considered for native fauna generally in the development site. Indirect impacts of the project are categorised into three categories; site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna and fire), downstream or downwind impacts (sediment, erosion and dust, hydrological change, and accidental spills and leaks), and facilitated impacts (hunting). Specific avoidance, minimisation and mitigation measures have been proposed to address each indirect impact identified (**Section 6**).

(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

As the species is considered unlikely to be present, and the habitat potential is low in the development site, an offset for this species was not required for direct and indirect impacts of the proposed development.

Pomaderris queenslandica (Scant Pomaderris)

(a) the size of the local population directly and indirectly impacted by the development.

Pomaderris queenslandica is restricted to the north-eastern section of the development site where it occurs in three separate areas. Within these areas, the species occurs predominantly as small scattered subpopulations. A targeted survey and subsequent modelling of the development site (based on habitat mapping calculations and supplementary extrapolation for sub-populations that are assumed to be present) estimated a total population size of 45,518 individuals.

The direct and indirect impacts are modelled to impact up to 467 individuals which constitutes an impact of 1.03% of the population in the development site.

(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to:

(i) an estimate of the change in habitat available to the local population as a result of the proposed development

The area of occupancy of the population in the development site was calculated to cover 90.11 ha. The direct and indirect impact of the area of occupancy would be up to 1.44 ha. This impact constitutes 1.60% of the area of occupancy of the species in the development site.

(ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and

The change in area of occupancy above represents the loss, modification and destruction of habitat by the proposed development. Additional fragmentation of habitat would occur as a result of the project. It is likely that additional patches of habitat would be formed. Due to the scale of the proposed infrastructure, the additional patches are not considered 'isolated' as dispersal by *Pomaderris queenslandica* during the reproduction phase would still be possible between patches. The majority of linear fragmentation would be an average width of 10 m and rehabilitated directly after impact to 5 m.

(iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.

The area of occupancy would support the full life cycle for *Pomaderris queenslandica* (pollination, seed set, seed dispersal, and germination). Additionally, it is likely that the patches identified are sub-populations which would allow for genetic diversity to be maintained among sub-populations. As such, the proposed development would remove and modify up to 1.44 ha of habitat that supports the life cycle of *Pomaderris queenslandica*. Within the development site, there would be over 98% of occupied habitat that would not be directly or indirectly impacted. Hence, all processes of the life cycle would be able to be maintained in the development site.

(c) the likely impact on the ecology of the local population. At a minimum, address the following:

(ii) for flora, address how the proposal is likely to affect the ecology and biology of any residual plant population that will remain post development including where information is available:

– pollination cycle, seedbanks, recruitment, and, interactions with other species (e.g. pollinators, host species, mycorrhizal associations)

After the direct and indirect impacts, the residual population would be approximately 99% of the existing population and cover over 98% of the occupied habitat in the development site. Within this remaining area, the species would not be directly or indirectly impacted and would be able to maintain the pollination cycle and seasonal setting of seedbanks which would support continued recruitment of germinants. Continued monitoring of populations in the development site would ensure the ecology remains stable in the residual population.

(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development

Additional fragmentation of habitat would occur as a result of the project. It is likely that additional patches of habitat would be formed. Due to the scale of the proposed infrastructure, the additional patches are not considered 'isolated' as dispersal by *Pomaderris queenslandica* during the reproduction phase would still be possible between patches. The majority of linear fragmentation would be an average width of 10 m and rehabilitated directly after impact to 5 m.

(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range

Most NSW populations of *Pomaderris queenslandica* occur towards the Queensland border, north and northwest of Armidale, in near-coastal areas between Newcastle and Coffs Harbour, north and south of Dubbo, and between Muswellbrook and Gulgong (OEH, 2016a). The species also occurs in Queensland, however it is not listed as threatened in that state. The populations in the development site and others occurring approximately 20 km to the northeast towards Mt Kaputar and near Boggabri form a loose cluster separated from the nearest population by a significant distance of over 100 km. This cluster is important as it covers a considerable size and maintains quality habitat.

(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population

A suite of indirect impacts have been considered for this species and the reduction in habitat condition from these indirect impacts has been related to the comparable direct loss individuals and area of occupancy. The indirect impacts combine with the direct impacts to constitute a loss of 467 individuals (1.03% of the population size) over 1.44 ha of area occupied. With over 98% of the area of occupied not impacted, it is not considered that this scale of loss would decrease the viability of a local population.

Indirect impacts of the project are categorised into three categories; site impacts (fragmentation, noise, traffic, fencing, light, weed invasion, increased feral fauna and fire), downstream or downwind impacts (sediment, erosion and dust, hydrological change, and accidental spills and leaks), and facilitated impacts (hunting). Specific avoidance, minimisation and mitigation measures have been proposed to address each indirect impact identified (**Section 6**).

(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

The recovery of *Pomaderris queenslandica* in the IBRA subregion would be assisted by offsetting individuals and habitat, as well as monitoring of existing population in the development site. *Pomaderris queenslandica* is a 'species credit' that was included in the offset calculations for the project. The calculations indicated that 7,005 credits would be required (at 15 credits per plant) to offset the impacts in the development site.

Appendix E Ecological scouting framework

This appendix presents an ecological scouting framework designed to minimise impacts on a range of biodiversity values as part of the field scouting process.

Key biodiversity values within the development site include:

- Riparian corridors
- Threatened species and endangered ecological communities
- Hollow-bearing trees
- Significant fauna habitat features

The ecological scouting framework considers the significance of each value against legislative requirements, other policy/approval requirements and potential offsetting requirements. Key legislation and policy/approval requirements include:

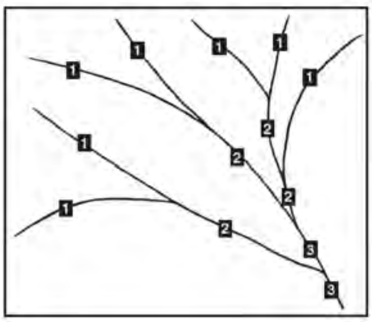
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- NSW *Environmental Planning and Assessment Act 1979* (EPA Act)
- NSW *Threatened Species Conservation Act 1995* (TSC Act)
- NSW *Fisheries Management Act 1994* (FM Act)
- NSW *Water Management Act 2000* (WM Act)
- State Environmental Planning Policy 44 (Koala Habitat)
- Guidelines for riparian corridors on waterfront land (DPI, 2012).

Due to the disperse nature of natural gas infrastructure, not all impacts can be avoided across the full range of biodiversity values present. For each of the key biodiversity values, a thorough consideration has been made against the policy framework to prioritise impact minimisation process both within and between values (**Table 58**).

Ecological Field Scouting Procedure

1. Desktop assessment (preliminary constraints analysis)
    a. Buffer well pads by 50 m (4 ha area) and linear infrastructure by 5 m (20 m corridor)
    b. Review mapped watercourses and riparian corridors
    c. Review aerial photography
    d. Review Ecological Sensitivity Analysis
    e. Review vegetation mapping
    f. Review Pilliga Mouse habitat model
    g. Review canopy height model (CHM)
    h. Based on (a) to (g) identify and map preliminary constraints
2. Undertake field survey within buffered area (1a) collecting GPS data for biodiversity values (**Table 58**) which allows infrastructure micro-siting to be undertaken post-fieldwork.
3. Undertake a post-field micro-siting exercise utilising the ecological scouting framework (**Table 59**) and a set of design principles (e.g. maximum angles of bends in access tracks, orientation of well sites etc.).

Table 58: Review of and categorisation of biodiversity values

<table>
<tr><th>Ecological value</th><th>Detail</th></tr>
<tr><td>Riparian corridors
</td><td>As part of the project, watercourses have been mapped at a 1:15,000 scale (including banks mapped (5th and 6th order) or modelled (1st to 4th order)), categorised by stream order, and the appropriate riparian corridor widths applied.
<table>
<tr><th>Watercourse Strahler stream order</th><th>Riparian zone (each side of watercourse)</th><th>Total riparian corridor width</th></tr>
<tr><td>1st order stream</td><td>10 m</td><td>20 m + channel width</td></tr>
<tr><td>2nd order stream</td><td>20 m</td><td>40 m + channel width</td></tr>
<tr><td>3rd order stream</td><td>30 m</td><td>60 m + channel width</td></tr>
<tr><td>4th order or greater stream</td><td>40 m</td><td>80 m + channel width</td></tr>
</table></td></tr>
<tr><td>Threatened flora species and ecological communities</td><td>Threatened flora species and ecological communities are to be ranked based on their relative legislative status with those values having higher legislative status being afforded more protection.

Due their mobile nature, threatened fauna species are considered in the hollow-bearing tree and specific fauna habitat section.
<table>
<tr><th>Ranking (highest to lowest)</th><th>Status</th></tr>
<tr><td>1</td><td>EPBC Act Critically Endangered</td></tr>
<tr><td>2</td><td>TSC Act Critically Endangered</td></tr>
<tr><td>3</td><td>EPBC Act Endangered</td></tr>
<tr><td>4</td><td>TSC Act Endangered</td></tr>
<tr><td>5</td><td>EPBC Act Vulnerable</td></tr>
<tr><td>6</td><td>TSC Act Vulnerable</td></tr>
</table></td></tr>
<tr><td>Hollow-bearing trees and logs</td><td>Hollow-bearing trees and logs provide habitat for a range of hollow-dependant fauna including mammals, birds and reptiles. Ecological studies have shown that hollows are likely to be a limiting factor in the distribution and populations of native fauna species.

Previous studies have located hollow-bearing trees used as nest sites for Barking Owl in the development site. Nest sites are</td></tr>
</table>

<table>
<tr><th>Ecological value</th><th colspan="2">Detail</th></tr>
<tr><td rowspan="5"></td><td colspan="2">reused by breeding pairs and are important habitat features for Barking Owl. It is important to maintain suitable habitat surrounding the nest tree such that it can remain viable.
Due to past logging activities and frequent high-intensity bushfire there is a relative paucity of large hollows (>300 mm) in the development site.
Hollow-bearing trees are to be classified based on their relative size class</td></tr>
<tr><td>Ranking (highest to lowest</td><td>Size Class</td></tr>
<tr><td>1</td><td>> 300 mm</td></tr>
<tr><td>2</td><td>≥200 mm < 300 mm</td></tr>
<tr><td>3</td><td><200 mm</td></tr>
<tr><td rowspan="5">Significant fauna habitat features</td><td colspan="2">The development site contains a range of fauna habitat values such as Pilliga Mouse habitat, stick nests and food sources (e.g. mistletoe).</td></tr>
<tr><td>Value</td><td>Recommendation</td></tr>
<tr><td>Pilliga Mouse Habitat</td><td>Maximise avoidance</td></tr>
<tr><td>Nests (e.g. old stick nests that are reused by threatened birds of prey).</td><td>Maximise avoidance</td></tr>
<tr><td>Mistletoe (in particular Amyema spp.)</td><td>Avoid where possible</td></tr>
</table>

Table 59: Ecological scouting framework

Ranking (priority highest to lowest)	Description	Action
1	Riparian Corridors	**Avoid impacts** of well pads on designated riparian corridors and mapped wetland habitat (dams) **Avoid impacts** of linear infrastructure on mapped wetland habitat (dams) Maximise avoidance of designated riparian corridors No additional crossings of Bohena Creek (linear infrastructure to follow existing crossings only).
2	Known Barking Owl nest trees	**Avoid impacts** of well pads and linear infrastructure on known Barking Owl nest trees and vegetation within a 50 m buffer of the known nest tree. OEH holds a register of known Barking Owl nest trees. This register should be sought before commencing infrastructure design.
3	Endangered ecological communities	**Maximise avoidance** of well pads and linear infrastructure on endangered ecological communities
4	Threatened flora species	**Maximise avoidance** for well pads and linear infrastructure. Impacts to threatened flora species and ecological communities should be assessed according to the ranking outlined in **Table 58** with those values having higher legislative status being afforded more protection. Consideration of the number of individuals of each flora species to be impacted in each status category may be required on a case by case basis (e.g. should 1 endangered individual be retained over 10 vulnerable species). Consideration should be given to the total modelled population (and relatively rarity) of each species within the study to make an informed decision regarding avoidance.
5	Hollow bearing trees and logs	**Maximise avoidance** for well pads and linear infrastructure. Impacts to hollow-bearing trees should be assessed according to the ranking outlined in **Table 58** with those values having higher ecological significance being afforded more protection.
6	Pilliga Mouse habitat	**Maximise avoidance** of well pads and linear infrastructure on Pilliga Mouse habitat
7	Nest trees	**Maximise avoidance** for well pads and linear infrastructure.

Ranking (priority highest to lowest)	Description	Action
8	Trees with mistletoe (particularly *Amyema* spp.)	Trees with mistletoe should be avoided where possible as they support Painted Honeyeater and other threatened fauna foraging habitat. Seek to minimise impacts on trees supporting mistletoe for well pads and linear infrastructure.

Appendix F Pre-clearing and clearing procedure

Step 1: Planning and walk-through

1. All appropriate licences with respect to working with native fauna are to be obtained prior to clearing.
    a. Ecologists working with fauna require a current scientific licence issued by the NSW Office of Environment and Heritage and ethics approval issued by the Animal Welfare Unit of the NSW Department of Primary Industries.
    b. Project Approval is required.
2. The nearest veterinary clinic should be notified of the clearing works prior to clearing commencing and their phone number on hand if fauna are injured or distressed.
    a. Veterinary clinic:
        a. Practice: Western Namoi Veterinary Clinic
        b. Principal Vet: Dr Michael Reed
        c. Contact: 02 6792 2577
        d. Address: 24 Francis Street, Narrabri.
    a. WIRES: 13 000 WIRES or 13 000 94737
    b. WIRES (central northern branch): 1300 131 554
3. Discuss clearing procedure, equipment / machinery required, schedule. All staff and contractors involved in the clearing will undertake the ecological induction prior to commencing work.

Step 2: Slash shrub and ground layer

Clearing of shrub and groundcover vegetation (under-scrubbing) around the hollow-bearing trees can commence once habitat features have been surveyed and marked to encourage dispersal of fauna from the active features. Under-scrubbing should be undertaken at least one day prior to removal of hollow-bearing trees to allow fauna time to self-relocate from the disturbance footprint.

Step 3: Tap hollow-bearing trees

1. Hollow-bearing trees are to be agitated (nudged by heavy machinery or with a chainsaw) the day prior to felling and left over night.
2. Active roosts, dens or dormitories are to be re-inspected following agitation to confirm absence of fauna prior to clearing.

Step 4: Remove hollow-bearing trees

1. A suitably qualified fauna ecologist with training/experience in fauna capture and rescue is to be present during the felling process.
2. Pre-felling procedures for all trees to be felled will include a visual inspection for fauna immediately prior to tree removal and care should be taken to allow all fauna to vacate a given tree prior to felling. Each tree is to be nudged and shaken immediately prior to felling to encourage fauna such as birds to vacate the tree. Felling cannot commence until the supervising ecologist has signalled that it is safe to do so.
3. The “slow drop” technique is to be attempted when removing all hollow-bearing trees. This technique aims to lower hollow-bearing trees to the ground whilst minimising disturbance

to hollows. This involves nudging and shaking the tree, followed by lowering of the tree to the ground. Practical execution of this method may involve the use of the bull dozer blade or mulcher bar to push the tree mid-trunk to initiate felling, followed by lowering the blade / bar to the base of the tree trunk. It is essential to ensure that suitable exclusion zones are implemented during these activities and personnel are not exposed to increased risk by implementing these procedures. Job Hazard Analyses (JHAs) and stepback are to be completed prior to completing felling activities.

4. Once on the ground, hollows are to be inspected for resident fauna (fibre optic camera technology is useful for deeper and angled hollows). If injured or juvenile fauna are present they must be cared for. Injured fauna should be taken to the veterinary clinic (details above). Juvenile fauna should be taken to WIRES if it is not possible to relocate them to a suitable location. The ability for the parents to continue to care for the juvenile fauna should be considered at this stage. Fauna captured and not requiring treatment are to be relocated into the same habitat near the point of rescue at dusk or left inside the hollow. Trees are to be left on the ground overnight giving fauna trapped in the trees an opportunity to escape. Hollows with fauna left inside should be re-checked the following day to ensure the fauna have self-relocated during the evening.
5. All data on species and number of hollow dependent fauna are to be recorded.
6. Some of the hollow-bearing trees or other significant fauna habitat features should be relocated to adjoining vegetation or moved into areas of rehabilitation where feasible.
7. Note that if fauna are observed to be in the tree that cannot self-relocate (e.g. chicks that haven't yet fledged) it may be necessary to contact an appropriately trained ecologist and/or wildlife carer to be present to encourage the removal and provide care for the animal/s. While translocation of fauna is not ideal, the OEH Policy for the translocation of threatened fauna in NSW are to be followed in these circumstances.

Communication

Positive communication between the ecologist supervising the clearing and the machinery operator is paramount to clearing being undertaken in a safe and efficient manner. Communication will operate by the following procedure:

1. Daily discussion prior to work commencing, outlining the areas of operation for the day.
2. A 2-way radio will be used for communication which will be set on a dedicated channel.
3. The ecologist will outline the clearing procedure to be followed. This will include outlining the following communication points during the clearing process:
    a. Confirm location ecologist should stand to observe felling. The minimum safe distance when felling will be determined by the height of the tree plus an extra 10 m for observer safety (expected to be 30 m). If the mulcher drum is operational, the safe distance will be a minimum of 100 m.
    b. 'Ok to tap' to nudge the tree.
    c. 'Ok to start' to start felling the tree.
    d. 'Ok to access' for ecologist to inspect hollows in felled tree (once felling has been completed and machinery has been switched off).
    e. 'Stop work' to stop clearing due to fauna observed or a safety concern.

Appendix G Biodiversity offset strategy

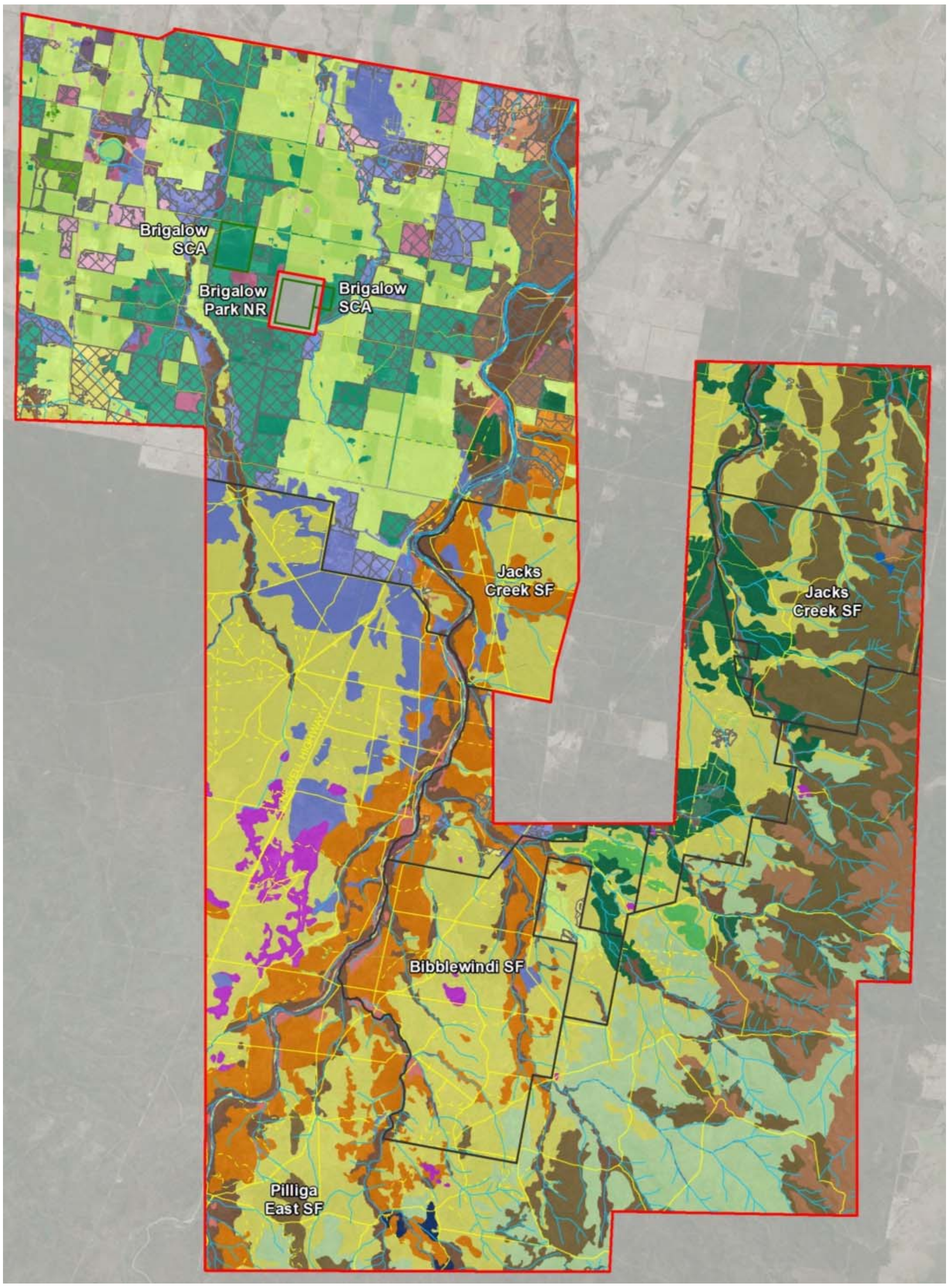
This Appendix will be updated following confirmation of Biodiversity offset strategy.

Narrabri Gas Project

Working Draft: Biodiversity Offset Strategy

Prepared for
Santos NSW (Eastern) Pty Ltd

October 2015



ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Santos.

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Abbreviations

Abbreviation	Description
BBAM	Biobanking Assessment Methodology
BOS	Biodiversity Offset Strategy
BVT	Biometric Vegetation Type
CCA	Community Conservation Area
CHMP	Cultural Heritage Management Plan
CMA	Catchment Management Authority
CQCHM	Central Queensland Cultural Heritage Management
DNG	Derived Native Grassland
DoTE	Commonwealth Department of Environment
DPE	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
ELA	Eco Logical Australia Pty Ltd
EPA Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
IBRA	Interim Biogeographic Regionalisation for Australia
LALC	Local Aboriginal Land Council
MNES	Matters of National Environmental Significance
NPW Act	NSW *National Parks and Wildlife Act 1974*
NPWS	NSW National Parks and Wildlife Service
NSW	New South Wales
NT	Native Title
OEH	NSW Office of Environment and Heritage
PA	Planning Agreement
PCT	Plant Community Type
RVC	Regional Vegetation Class
SEARs	Secretary's Environmental Assessment Requirements
TBD	To be determined
TSC Act	NSW *Threatened Species Conservation Act 1995*

1 Introduction

Eco Logical Australia (ELA) was commissioned by the Proponent to prepare a Biodiversity Offset Strategy for the Narrabri Gas Project (the project). The Biodiversity Offset Strategy forms part of the Environmental Impact Statement (EIS) being prepared to support the Proponents' application for development consent for the project (GHD, 2015).

The Biodiversity Offset Strategy provides a comprehensive strategy for residual impacts of the project following implementation of avoidance, minimisation and mitigation strategies which are detailed in the Ecological Impact Assessment (ELA, 2015) which supports the Environmental Impact Statement. The Biodiversity Offset Strategy is a framework document which will be supported by a detailed Biodiversity Offset Management Plan detailing how the offset strategy and offset package will be implemented. The study area for the project is shown in **Figure 1**.

1.1 Secretary's environmental assessment requirements

The Secretary's Environmental Assessment Requirements (SEARs) for the project identify the following key issues relating to biodiversity offsets:

- *An assessment of the likely biodiversity impacts of the development, having regard to the principles and strategies in the draft NSW Biodiversity Offsets Policy for Major Projects, and the OEH's and NSW Trade and Investments' requirements, and using a suitable methodology for credit calculation (for instance,* [Biobanking assessment methodology] *BBAM or* [Framework for Biodiversity Assessment] *FBA).*
- *A comprehensive offset strategy for the project, using a suitable methodology for calculating the credits of any offsets*

This report details how these requirements will be fulfilled.

1.2 Objectives

The key objectives of the Biodiversity Offset Strategy are to:

- Provide a comprehensive strategy to ensure that the residual impacts of the project are adequately compensated for and that long-term conservation outcomes are achieved, by ensuring:
    - Vegetation, habitat and threatened species at offset sites have equal or greater conservation status to areas impacted by the project.
    - Offsets are greater than the loss of areas impacted by the project.
    - Land-based offset sites, supplementary measures and contributions to the Biodiversity Offset Fund are appropriately funded, secured and managed.
- Ensure that Aboriginal people have opportunities to increase cultural knowledge of their country and opportunities to access and manage its natural and cultural values.

1.3 Report structure

The report is structured as follows:

1. **Introduction** - introduces the report, objectives and report structure
2. **Biodiversity Offset Strategy** – outlines how non-avoidable impacts to native vegetation and threatened species and their habitat will be quantified and the approach that will be taken achieved long-term conservation outcomes.
3. **Biodiversity Offset Package** – details a package of measures that compensate for non-avoidable impacts to native vegetation and threatened species and their habitat.
4. **Statement of commitments** – outlines the Proponents' commitment to the identification, securing and conservation of biodiversity and cultural heritage values as part of the project.

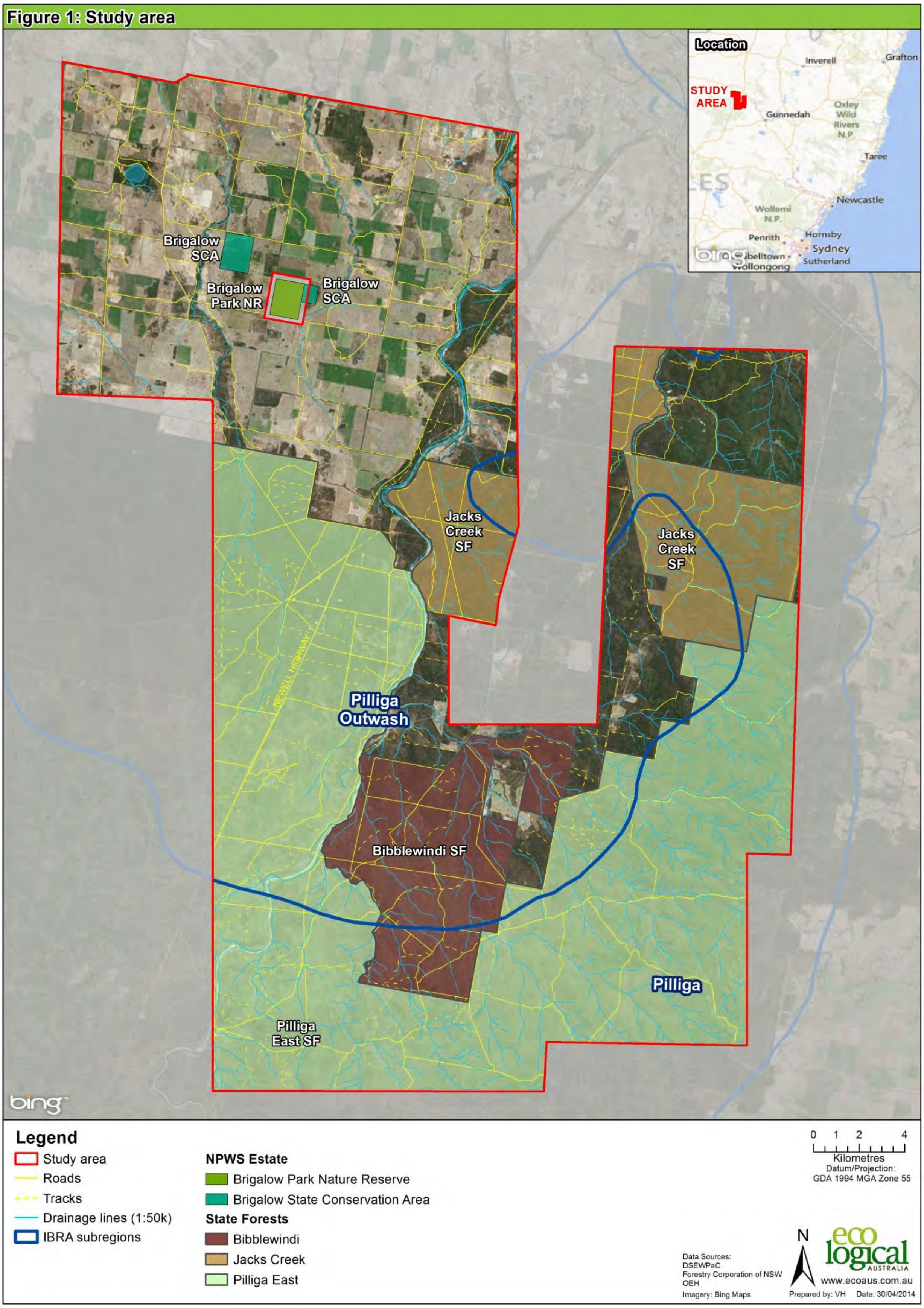

Figure 1: Study area

2 Biodiversity Offset Strategy

This Biodiversity Offset Strategy has been prepared to ensure that the residual impacts of the project are adequately compensated for and that long-term conservation outcomes are achieved in recognition of the *NSW Offsetting Principles* (OEH, 2014b) and the *NSW Biodiversity Offset Policy for Major Projects* (OEH, 2014a). This Biodiversity Offset Strategy considers threatened and migratory species, populations and ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPBC Act Offset Policy requires 'offset measures to be considered for residual impacts that cannot be mitigated to ensure the protection of Matters of National Environmental Significance (MNES) in perpetuity'. This Biodiversity Offset Strategy has been prepared to generally be consistent with the EPBC Act Offset guide (DSEWPaC, 2012). As the *NSW Biodiversity Offset Policy for Major Projects* was developed as a whole-of-government policy and includes Matters of National Environmental Significance, offsets determined under the *NSW Biodiversity Offset Policy for Major Projects* are considered likely to satisfy EPBC offset requirements.

The Biodiversity Offset Strategy provides a quantification of the impacts of the project informed by the Framework for Biodiversity Assessment to guide the development of the offset strategy and is based on direct impacts of 988.8 ha (of which 586.6 ha will be rehabilitated following construction), an indirect impact of 181.1 ha and cumulative impacts of 84.8 ha (ELA, 2015).

Methods undertaken to quantify the potential impacts of the project are outlined in Section 4 of the Ecological Impact Assessment of the project (ELA, 2015) and are not repeated here. Similarly, measures taken to avoid, minimise and mitigate the impacts of the project are outlined in Section 7 and Section 8 of the Ecological Impact Assessment (ELA, 2015).

A Biodiversity Offset Package (**Section 3**) has been prepared to provide a framework for accounting for offset liability through land-based offset properties, supplementary measures, research and contribution to the Biodiversity Offset Fund (once established).

2.1 Offset principles

The following principles for providing offsets against the impacts of the project have been used to guide the development of the Biodiversity Offset Strategy:

NSW Biodiversity Offset Policy for Major Projects

1. Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.
2. Offset requirements should be based on a reliable and transparent assessment of losses and gains.
3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.
4. Offsets must be additional to other legal requirements.
5. Offsets must be enduring, enforceable and auditable.
6. Supplementary measures can be used in lieu of offsets.

Commonwealth

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action.
2. Be built around direct offsets but may include other compensatory measures.
3. Be in proportion to the level of statutory protection that applies to the protected matter.
4. Be of a size and scale proportionate to the residual impacts on the protected matter.
5. Effectively account for and manage the risks of the offset not succeeding.
6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action.
7. Be efficient, effective, timely, transparent, scientifically robust and reasonable.
8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

In assessing the suitability of an offset, government decision-making will be:

1. Informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty.
2. Conducted in a consistent and transparent manner.

The Commonwealth policy identifies two kinds of biodiversity offset, 'direct offsets' including such measures as long-term protection of existing habitat (land-based offsets and supplementary measures) and 'compensatory measures' (indirect offsets) for such measures as implementing recovery plan actions or contributions to relevant research.

As previously noted, offsets determined under the NSW Biodiversity Offset Policy for Major Projects are considered likely to satisfy EPBC offset requirements.

2.2 Offset approach

The Biodiversity Offset Strategy follows a four-step approach:

1. Quantification of the impacts of the project informed by the Framework for Biodiversity Assessment (FBA) to guide the development of the offset strategy including direct, indirect and cumulative impacts as well as the contribution that undertaking immediate rehabilitation post construction makes to reducing the overall offset liability.
2. Undertaking 'reasonable steps' to locate like-for-like offset, including:
    a. Checking the biobanking public register and having an expression of interest (EOI) for credits wanted for at least six months.
    b. Liaising with the OEH Northern Plains Region office and Narrabri Council to obtain a list of potential sites that meet the requirements for offsetting.
    c. Considering properties for sale in the area.
    d. providing evidence of why offset sites are not feasible.
3. Development and contribution of funds for supplementary measures such as feral animal control, threatened species research and monitoring measures to be implemented through Planning Agreements (PAs).
4. For the remaining offset liability to be held for eventual transfer into the Biodiversity Offset Fund (once established).

2.3 Offset requirements to achieve long-term conservation outcomes

The project will result in the removal of up to 988.ha of remnant native vegetation and fauna habitat including 0.1 ha of Weeping Myall Woodlands (TSC & EPBC Act Endangered), 19.3 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) (TSC & EPBC Act Endangered) and 5.9 ha of Fuzzy Box Woodland (TSC Endangered), habitat for at least 26 threatened fauna species, six migratory birds and ten threatened plant species.

A Major Project assessment was undertaken by an accredited Biobank Assessor using the Framework for Biodiversity Assessment (Major Projects Credit Calculator Version 4.1) inform the 'quantum' of biodiversity offsets required for the project. Four key elements were considered:

- **Direct impacts** – 988.8 ha (split between direct impacts and areas subject to immediate rehabilitation) - vegetation/habitat/species clearance
- **Indirect impacts** – 181.1 ha - fragmentation, noise, light, weeds, feral animals etc.
- **Cumulative impacts** – 84.8 ha - existing impacts in the study area from infrastructure that will be utilised by the project
- **Immediate rehabilitation** – 586.6 ha - partial rehabilitation of linear and non-linear infrastructure areas immediately following construction

Specific detail on how these figures were determined are contained within the Ecological Impact Assessment (ELA, 2015), with further detail provided in **Section 2.3.1** and **Section 2.3.2**.

2.3.1 Assessment using the Major Projects Credit Calculator

The process for undertaking an assessment using the Framework for Biodiversity Assessment and the Major Projects Credit Calculator involves eight steps:

- Step 1 - Compile data
- Step 2 - Landscape value assessment
- Step 3 - Enter vegetation zones
- Step 4 – Geographic / habitat features
- Step 5 – Site survey
- Step 6 – Site values and management scores
- Step 7 – Threatened species survey results
- Step 8 – Credits

These steps and the process followed to assess the offset requirements of the project using the Major Projects Credit Calculator are detailed below.

Step 1 – Compile data

Comprehensive baseline data and mapping products collected and developed over four years including 1:10,000 scale Plant Community Type (PCT) vegetation and fauna habitat mapping, threatened flora survey and modelling and 327 full floristic biometric plots (ELA, 2015).

A total of 22 Plant Community Types have been mapped within the study area, however only 19 of these are likely to be directly, indirectly or cumulatively impacted on by the project. In addition 13 derived native grassland (DNG) forms are considered likely to be directly, indirectly or cumulatively impacted. Plant Community Types and their associated Biometric Vegetation Types (BVTs) were compiled for the assessment.

Biometric data from 327 full floristic biometric plots (including quantitative data for native species richness, vegetative cover in each structural layer, weed abundance, regeneration occurring, and fauna habitat features such as length of logs and presence of hollows) were compiled for the assessment.

Threatened flora and fauna species identified within the study area which are also classified as 'species credit' species under the Framework for Biodiversity Assessment were also compiled. This list includes nine threatened flora species and four threatened fauna species.

Step 2 – Linear/multiple fragmentation impacts module

An assessment of the potential impacts of the project at the landscape scale was undertaken using the linear/multiple fragmentation impacts module of the Major Projects Credit Calculator. This module requires the assessment of four key attributes including percent cover of native vegetation, connectivity, patch size and change in perimeter to area ratio. These attributes were assessed as follows:

1. Native vegetation cover before and after development
    - Based on detailed vegetation mapping undertaken for the project, the total native vegetation cover before development in the study area was 84.6%. As the project will only result in the removal of 1.29% of native vegetation within the study area, the total vegetation cover after development is 83.3% which results in a score of 13.8 for this attribute.
2. Assess connectivity value
    - The project is likely to impact on the riparian buffer of a sixth order stream or greater (state significant biodiversity link), which results in a score of 12.5 for this attribute.
3. Assess patch size by Mitchell Landscape
    - The study area contains extra-large patch size classes for at least one of the Mitchell Landscapes that have been mapped in the study area, which results in a score of 12.5 for this attribute.
4. Assessing the change in area to perimeter ratio
    - As the project includes a combination of known and modelled impacts, it is not possible to assess the change in area to perimeter ratio as a result of the project. As such, a precautionary approach has been undertaken and the highest possible score of 10 was manually selected.
    - Note that this represents the worst case as there is an existing network of over 760 km of roads within the forested portion of the study area which already contribute to existing fragmentation. Furthermore, this assessment does not take into consideration design measures proposed to avoid and minimise impacts such as the co-location of linear infrastructure such as gas and water gathering systems and access tracks with existing roads, access tracks and disturbance corridors wherever possible.

The intent of the linear/multiple fragmentation impacts module is to more accurately assess the potential impacts of a project (such as a coal seam gas development) at a landscape scale. This has been achieved through the reapportioning of landscape value weightings from 'site based developments' and the additional requirement to assess change in area to perimeter ratio for linear/multiple fragmentation impacts developments. The purpose of assessing change in area to perimeter ratio is to account for additional indirect impacts of a development such as fragmentation and edge effects at the landscape scale.

It is important to note that the Framework for Biodiversity Assessment does not differentiate between the width of fragments (e.g. a 1 m wide linear clearing is treated the same as a 100 m wide linear clearing). Under the BioBanking assessment methodology (DECC, 2008a), patches of woody habitat are considered to be linked if they are separated by less than 100 m (or less than 30 m for grassy ecosystems), provided the habitat is in moderate to good condition, the patch size is greater than 1 ha and the separation is not a dual carriageway or wider highway. The effect that the width and size of fragments has will depend on the particular ecological values being considered (e.g. flora, fauna or ecological communities).

The Ecological Impact Assessment (ELA, 2015) considered the impact of fragmentation on each threatened species and ecological community considered potentially or known to occur in the study area. Assessing the ability of each flora species and ecological community to continue their life cycles and of each fauna species to move through the habitat with the additional fragmentation required understanding of the dispersal potential of each species and the magnitude of the clearing in comparison to this dispersal potential.

The Ecological Impact Assessment (ELA, 2015) has demonstrated that the impacts of the project (including fragmentation and edge effects) are unlikely to significantly impact threatened species or ecological communities. This is primarily due to the small proportion of habitat being removed relative to that retained in the study area; the removal of habitat not being at a scale likely to result in the isolation or fragmentation of populations; that the project is unlikely to result in invasive species or diseases becoming established; and that progressive rehabilitation of disturbed areas will be implemented as part of the project. Therefore, the potential impacts that the project may have at the landscape scale are not considered to be significant. Nevertheless, the linear/multiple fragmentation impacts module has been utilised as required in the Framework for Biodiversity Assessment.

Step 3 - Enter vegetation zones

Based on the data compiled in Step 1, a total of 32 vegetation zones were entered into the Major Projects Credit Calculator. 100 hectares were entered against each Plant Community Type Impacted and 100 hectares were entered against each Plant Community Type to be rehabilitated. 100 hectares was entered so that detailed analysis of the contribution of direct impacts, indirect impacts, cumulative impacts and rehabilitation on offset requirements could be determined outside of the Major Projects Credit Calculator. 100 hectares was used as it is a large enough number to reduce the subsequent impacts of rounding (compared to if 1 hectare was used).

Due the requirement for up to four management zones per Plant Community type (i.e. native vegetation, native vegetation rehabilitation, derived native vegetation, and derived native vegetation rehabilitation) and for ease of analysis, the assessment was split across two identical versions of the assessment in the Major Projects Credit Calculator.

Due to the complex nature of the project, it is not possible to completely assess the offset liability within the Major Projects Credit Calculator, however the intent of the Framework of Biodiversity Assessment has been maintained with this approach.

Step 4 - Geographic / habitat features

Based on the information entered in Steps 1-3, the Major Projects Credit Calculator requires the assessor to answer a series of geographic/habitat feature questions. These questions and their response are detailed below:

- Land within 40 m of watercourses, containing hollow-bearing trees, loose bark and/or fallen timber – YES.
- Land containing within 100 m of riparian woodland on inland rivers containing mature living eucalypts or isolated paddock trees overhanging water or dry watercourses – YES.
- Land containing soil cracks or fallen timber and litter on ridges of gilgai clays – YES.

- Land north of Gunnedah in Liverpool Plains (Part B) CMA subregion – NO
- Seasonally wet/boggy sites (including table drains) – YES.
- Wetlands and wet run on areas – YES.
- Land containing cliffs or rocky areas – YES.

Step 5 – Site survey

Based on the information entered in Steps 1-4, the Major Projects Credit Calculator identifies a range of 'species credit' species that require survey. A total of 20 species were identified as requiring survey by the Major Projects Credit Calculator as outlined in **Table 1**. Surveys for these species and a range of other threatened and migratory species were undertaken in the appropriate season and over multiple years.

Table 1: Species requiring survey and survey time matrix

Common name	Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bluegrass	*Dichanthium setosum*	Yes	Yes	Yes	Yes	Yes							Yes
Coolabah Bertya	*Bertya opponens*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cyperus conicus	*Cyperus conicus*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eastern Pygmy-possum	*Cercartetus nanus*	Yes	Yes	Yes	Yes					Yes	Yes	Yes	Yes
Five-clawed Worm-skink	*Anomalopus mackayi*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Greenhood Orchid	*Pterostylis cobarensis*									Yes	Yes	Yes	
Grey Falcon	*Falco hypoleucos*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Koala	*Phascolarctos cinereus*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Narrow Goodenia	*Goodenia macbarronii*#	Yes	Yes							Yes	Yes	Yes	Yes
Native Milkwort	*Polygala linariifolia*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pale-headed Snake	*Hoplocephalus bitorquatus*	Yes	Yes	Yes	Yes						Yes	Yes	Yes
Pine Donkey Orchid	*Diuris tricolor*									Yes	Yes		
Prasophyllum sp. Wybong	*Prasophyllum sp. Wybong*										Yes		

Common name	Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rufous Bettong	*Aepyprymnus rufescens*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rulingia procumbens	*Rulingia procumbens*	Yes	Yes	Yes	Yes	Yes			Yes	Yes	Yes	Yes	Yes
Scant Pomaderris	*Pomaderris queenslandica*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Slender Darling Pea	*Swainsona murrayana*	Yes	Yes							Yes	Yes	Yes	Yes
Spiny Peppercress	*Lepidium aschersonii*	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Yes
Squirrel Glider	*Petaurus norfolcensis*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tylophora linearis	*Tylophora linearis*	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Yes

Goodenia macbarronii is no longer listed as a threatened species

Step 6 - Site values and management scores

This step requires the assessor to enter biometric plot data for each vegetation zone and assign Endangered Ecological Communities where appropriate. This step also requires the assessor to assign management zones to each vegetation zone. Two management zones were defined: development (complete clearing); and partial rehabilitation (partial clearing). For development areas, the default '0' was applied to site value scores (indicating complete clearing). For partial rehabilitation, site value scores were manually adjusted from the current maximum value to the following values:

- Native species richness = '1'
- Native overstorey cover = '1'
- Native midstorey cover = '1'
- Native ground cover (grasses) = '1'
- Native ground cover (shrubs) = '1'
- Native ground cover (other) = '1'
- Exotic plant cover = same as original plot data
- Number of trees with hollows = '0'
- Proportion of over-storey species occurring as regeneration = '1'
- Total length of fallen logs = same as original plot data

The rationale for the modification to site value scores for partial rehabilitation management scores is as follows:

- Native species richness is unlikely to change as a result of the project due to the effective management of topsoil and the soil seedbank (and actually is likely to increase), however a precautionary approach has been taken and a reduction in site value from a maximum of '3' to '1' has been taken.
- Native plant cover will be reduced initially following clearing, but will regenerate rapidly over time. As such, a reduction in native plant cover from a maximum of '3' to '1' has been taken.

- Exotic plant cover is unlikely to increase as a result of the project due to the commitment to prepare and implement a pest plant and animal management plan.
- The number of trees with hollows will be reduced to ‘0’ in development areas as a result of the project. The installation of nest boxes is not currently a supported method for the replacement of hollows in the Framework for Biodiversity Assessment.
- The proportion of over-storey species occurring as regeneration is unlikely to change as a result of the project due to the effective management of topsoil and the soil seedbank.
- Total length of fallen logs is unlikely to change as a result of the project and is more likely to increase due to the respreading of felled timber.

The proposed rehabilitation methodology for the project differs significantly from traditional mine site rehabilitation in that the subsoil structure, water infiltration and nutrient cycling are largely unaffected during construction.

A comprehensive rehabilitation strategy has been prepared as part of the EIS (Appendix V of the EIS). The primary objective of rehabilitation in the study area is to manage topsoil to conserve the soil seed bank, nutrients and to encourage the establishment of vegetation. This will be achieved through slashing and mulching of vegetation (rather than clear-felling), minimising impacts on topsoil and the soil seedbank during construction and facilitating natural regeneration through rapid rehabilitation following construction.

The rehabilitation strategy for the project utilises the inherent capacity of the native vegetation of the Pilliga to regenerate. Progressive rehabilitation has been undertaken in the study area for a selection of well pads and linear infrastructure as part of existing exploration and appraisal activities. Monitoring of this rehabilitation has been undertaken since 2012 and has shown that on average, rehabilitation sites approximate 74% of the site value of reference sites within relatively short timeframes (<5 years).

The methodology specified above for determining the site value of partial rehabilitation management zones results in approximately 68% of the credits required for development areas (complete clearing). This is consistent with the demonstrated ability of rehabilitation sites to approximate reference sites within relatively short periods as outlined above.

Step 7 - Threatened species survey results

This step requires the assessor to enter all ‘species credit’ species likely to be impacted by the development. This includes 9 threatened flora and 4 threatened fauna species. Only those species detected during detailed field surveys in the study area were included (**Table 2**).

Table 2: 'Species credit' species assessed

Name	Scientific name *
Black-striped Wallaby	*Macropus dorsalis*
Coolabah Bertya	*Bertya opponens*
Eastern Pygmy-possum	*Cercartetus nanus*
Greenhood Orchid	*Pterostylis cobarensis*
Native Milkwort	*Polygala linariifolia*
Pale-headed Snake	*Hoplocephalus bitorquatus*
Pine Donkey Orchid	*Diuris tricolor*

Name	Scientific name *
Rulingia procumbens	*Rulingia procumbens*
Scant Pomaderris	*Pomaderris queenslandica*
Spiny Peppercress	*Lepidium aschersonii*
Winged Peppercress	*Lepidium monoplocoides*
Squirrel Glider	*Petaurus norfolcensis*
Tylophora linearis	*Tylophora linearis*

For flora, 100 individuals were entered, while for fauna 100 hectares were entered. Similarly to vegetation zones, '100' was entered as the base unit so that detailed analysis of the contribution of direct impacts, indirect impacts, cumulative impacts and rehabilitation on offset requirements could be determined outside of the Major Projects Credit Calculator. 100 hectares was used as it is a large enough number to reduce the subsequent impacts of rounding (compared to if 1 hectare was used).

Step 8 – Credits required

This step allows the assessor to generate the 'credits required' for the development. This data was subsequently exported to Microsoft Excel and the credit requirements per hectare for each Plant Community Type and management zone could be ascertained. Credits required were then analysed separately for direct impacts, indirect impacts, cumulative impacts and rehabilitation resulting in the overall ecosystem credits required for each Plant Community Type and 'species credit' species'. This process is detailed in the following sections.

2.3.2 Ecosystem credits

Quantification of impacts and offset liability for both ecosystem and species credit species was undertaken as outlined in the following sections

Direct impact quantification

The direct impacts of the project require 58,813 ecosystem credits to be offset. This requirement is reduced to 24,009 ecosystem credits when areas subject to immediate rehabilitation are separated as outlined in the rehabilitation section below.

Indirect and cumulative impact quantification

The Credit Calculator is used to assess 'direct' impacts to biodiversity (i.e. vegetation clearance). Section 8.4 of the Framework for Biodiversity Assessment requires the Biobank Assessor to demonstrate minimisation of indirect impacts on biodiversity values using reasonable onsite measures, however it does not specifically require the assessor to quantify indirect impacts. For this assessment, the areas of both indirect and cumulative impacts were assessed in the same way as direct impacts.

Indirect impacts have only been assessed as functioning over a 30 year period while the project is in operation. This allows for the operation of particular wells for approximately 20 years (operating life), initial progressive rehabilitation of approximately 50% of the disturbed area associated with the well and linear infrastructure and final rehabilitation following plugging and abandoning of each well. An additional 10 years has been included to allow sufficient time for the rehabilitation to become established. After the 30 year period, indirect site impacts (such as fragmentation, noise, traffic etc.) will cease to operate. In order to quantify the contribution that the duration of indirect impacts plays on the offset liability, indirect impacts were multiplied by 0.3 to determine the final number of credits required (based on the proportion of 30 out of 100 years as a surrogate for in-perpetuity as defined by the OEH credit additionality position paper).

Indirect impacts require an additional 3,366 ecosystem credits to be offset.

For cumulative impacts, only those impacts relating to existing exploration and appraisal infrastructure which are likely to be utilised as part of the project (totalling approximately 84.8 ha) were included in the assessment. This was calculated as approximately 50% of the cumulative impact to date (excluding derived native grassland). Cumulative impacts require an additional 5,233 ecosystem credits to be offset.

The calculations of indirect and cumulative impacts are considered to be additional measures (i.e. they are not required to be directly assessed), but have been included to account for and in recognition of the full impacts of the project.

Immediate rehabilitation quantification

The construction and rehabilitation methodology proposed as part of the project differs from traditional mine site rehabilitation in that it utilises the inherent capacity of the native vegetation in the study area to regenerate naturally as discussed in **Section 2.3.1**.

Due to this unique method of rehabilitation, direct impacts (988.8 ha) were split between those areas which will be rehabilitated immediately following construction (586.7 ha) and areas with no immediate rehabilitation (402.2 ha).

Up to 55% of each well pad (0.55 ha) and up to 50% of the width of linear infrastructure (gas and water gathering systems and access tracks) will be rehabilitated immediately following construction. Those areas subject to immediate rehabilitation following construction require 23,505 ecosystem credits, which reduces the overall offset requirement for directly impacted areas by 19.2%.

Summary of ecosystem credit requirements

The results of this ecosystem credit assessment are summarised in **Table 3** which indicate that a total of 53,009 ecosystem credits are required to meet the outcomes of the Framework for Biodiversity Assessment. Using the OEH credit converter which assumes an average Biobank site will generate 9.3 credits per ha, the equivalent offset area is 6,034 ha. This equates to a 6.1:1 offset ratio against a direct impact of 988.8 hectares or a 4.8:1 offset ratio against a combined direct, indirect and cumulative impact of 1,254.7 ha.

The assessment indicates that the offsets can be secured in a range of similar plant community types, across a number of IBRA subregions and in accordance with the Framework for Biodiversity Assessment, meet the ‘like-for-like’ offset principle (Principle 3). Additionally, the variation criteria in the Framework for Biodiversity Assessment allows plant community types in the same vegetation ‘formation’ to be used as offsets as well as species in the same ‘order’ (fauna) or family (flora) provided they have undergone similar levels of clearing or threat.

Table 3: Major Projects Assessment (Version 4.1) – Ecosystem Credits Required

VegZone	Veg code	Biometric Vegetation Type	Ancillary	Direct Impacts		Indirect Impacts		Cumulative Impacts		Rehabilitation		Total		Offset required
				Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)
1	NA219	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Native Vegetation	0.04	3.35	0.00	0.00	0.00	0.00	0.06	3.74	0.10	7.09	0.76
2	NA219	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	DNG	0.19	6.88	0.00	0.00	0.00	0.00	0.31	8.01	0.50	14.89	1.60
3	NA117	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	Native Vegetation	7.30	475.74	3.90	76.25	5.10	332.37	12.00	532.92	28.30	1,417.28	152.40
4	NA117	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	DNG	13.95	505.13	0.00	0.00	0.00	0.00	23.25	600.55	37.20	1,105.68	118.89
5	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Native Vegetation	1.48	78.47	0.80	12.72	0.00	0.00	2.43	80.70	4.71	171.89	18.48
6	NA102	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	DNG	0.64	23.17	0.00	0.00	0.00	0.00	1.06	27.38	1.70	50.55	5.44
7	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	Native Vegetation	18.85	1,239.95	8.19	161.62	2.90	190.76	21.95	980.95	51.89	2,573.28	276.70
8	NA179	Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	DNG	3.30	75.27	0.00	0.00	0.00	0.00	5.50	80.36	8.80	155.63	16.73
9	NA121	Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	Native Vegetation	7.38	265.31	4.00	43.14	0.00	0.00	12.13	270.38	23.51	578.83	62.24
10	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	Native Vegetation	2.35	182.36	1.23	28.63	0.90	69.84	3.55	201.75	8.03	482.58	51.89
11	NA141	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	DNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	NA292	Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern Brigalow Belt South Bioregion	Native Vegetation	0.11	5.17	0.10	1.41	0.00	0.00	0.19	6.34	0.40	12.92	1.39
13	NA279	Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	Native Vegetation	12.60	784.48	6.80	127.01	0.70	43.58	20.70	865.67	40.80	1,820.74	195.78
14	NA279	Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	DNG	0.15	3.42	0.00	0.00	0.00	0.00	0.25	3.65	0.40	7.07	0.76
15	NA314	Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	Native Vegetation	135.26	8,157.53	63.35	1,146.19	59.70	3,600.51	188.14	7,501.14	446.45	20,405.37	2,194.13
16	NA314	Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	DNG	1.46	33.30	0.00	0.00	0.00	0.00	2.44	35.65	3.90	68.95	7.41
17	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	Native Vegetation	1.60	95.68	0.66	11.84	3.10	185.38	1.80	73.66	7.16	366.56	39.41
18	NA255	Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion	DNG	0.08	1.82	0.00	0.00	0.00	0.00	0.13	1.90	0.21	3.72	0.40
19	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South	Native Vegetation	0.60	31.50	0.30	4.73	0.00	0.00	1.00	32.05	1.90	68.28	7.34

VegZone	Veg code	Biometric Vegetation Type	Ancillary	Direct Impacts		Indirect Impacts		Cumulative Impacts		Rehabilitation		Total		Offset required
				Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)	# Credits	Area (ha)
		Bioregion												
20	NA307	Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, Brigalow Belt South Bioregion	DNG	0.60	13.69	0.00	0.00	0.00	0.00	1.00	14.61	1.60	28.30	3.04
21	NA294	Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow Belt South Bioregion	Native Vegetation	1.03	64.13	0.50	9.34	0.70	43.58	1.68	71.35	3.91	188.40	20.26
22	NA324	Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	Native Vegetation	0.38	22.67	0.20	3.58	2.90	173.01	0.63	24.30	4.11	223.56	24.04
23	NA324	Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, Brigalow Belt South Bioregion	DNG	0.49	11.18	0.00	0.00	0.00	0.00	0.81	11.83	1.30	23.01	2.47
24	NA338	Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	Native Vegetation	19.10	1,353.43	9.22	196.00	3.10	219.67	27.30	1,376.19	58.72	3,145.28	338.20
25	NA338	Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	DNG	6.79	154.88	0.00	0.00	0.00	0.00	11.31	165.24	18.10	320.12	34.42
26	NA326	Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	Native Vegetation	32.76	2,244.72	17.60	361.79	3.60	246.67	53.84	2,588.09	107.80	5,441.26	585.08
27	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	Native Vegetation	103.54	6,446.40	48.46	905.14	1.40	87.16	143.56	6,096.99	296.96	13,535.69	1,455.45
28	NA390	White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	DNG	0.71	16.20	0.00	0.00	0.00	0.00	1.19	17.39	1.90	33.58	3.61
29	NA389	White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests	Native Vegetation	26.10	1,512.76	14.00	243.43	0.70	40.57	42.90	1,609.61	83.70	3,406.37	366.28
30	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	Native Vegetation	0.08	5.14	0.10	1.93	0.00	0.00	0.13	5.81	0.31	12.87	1.38
31	NA409	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	DNG	0.11	2.51	0.00	0.00	0.00	0.00	0.19	2.78	0.30	5.29	0.57
32	NA363	Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, Brigalow Belt South Bioregion	Native Vegetation	3.18	193.03	1.70	30.96	0.00	0.00	5.23	213.96	10.11	437.94	47.09
				402.21	**24,009.25**	**181.11**	**3,365.70**	**84.80**	**5,233.11**	**586.66**	**23,504.92**	**1,254.78**	**56,112.98**	**6,033.65**

2.3.3 Species credits

Four threatened fauna species and nine threatened flora species recorded in the study area are listed as 'species credit' species under the Framework for Biodiversity Assessment (**Table 4** and **Table 5**). Credits required for flora species range from 42 to 144,326 credits. Credits required for fauna species range from 2,712 to 34,994 credits. *Bertya opponens* requires the largest number of flora credits to be offset, while *Hoplocephalus bitorquatus* (Pale-headed Snake) requires the largest number of fauna credits to be offset.

Table 4: Major Projects Assessment (Version 4.1) – Flora Species Credits Required

Species	TS offset multiplier	Direct and indirect impacts impact (# individuals)	Cumulative impact (# individuals)	Credits	Credits/ plant
Bertya opponens	1.4	10,309		144,326	14.00
Diuris tricolor	1.3	52		676	13.00
Lepidium aschersonii	1.4	3		42	14.00
Lepidium monoplocoides	1.5	4		60	15.00
Polygala linariifolia	1.5	252		3,780	15.00
Pomaderris queenslandica	1.5	467		7,005	15.00
Pterostylis cobarensis	1.3	7,364	706	95,732	13.00
Rulingia procumbens	1.5	3,716		55,740	15.00
Tylophora linearis#	7.7	479	81	36,883	77.00

#The status and offset multiplier for *Tylophora linearis* is currently under review by OEH. Should the offset multiplier be reduced, then the resulting offset liability will also be reduced.

Table 5: Major Projects Assessment (Version 4.1 – Fauna Species Credits Required

Species	Common name	Tg value	Direct impact (ha)	Indirect impact (ha)	Cumulative impact (ha)	Credits	Credits/ ha
Macropus dorsalis	Black-striped Wallaby	2.6	988.80	181.11	84.80	32,622	26.00
Cercartetus nanus	Eastern Pygmy-possum	2	774.80	153.01	76.80	20,092	20.00
Hoplocephalus bitorquatus	Pale-headed Snake	3.3	885.00	175.41	84.80	37,792	33.00
Petaurus norfolcensis	Squirrel Glider	2.2	861.80	170.71	84.80	24,581	22.00

2.3.4 Hollow-bearing trees

The removal of large hollows (>300 mm) will be compensated for by at least a 1:1 replacement. Specific detail regarding offset ratios, locations for hollow re-instatement and an implementation strategy will be developed as part of the Biodiversity Offset Package for the project.

2.3.5 Assumptions and limitations

- Biometric Vegetation Types for the Namoi CMA were updated in October 2014. Vegetation stratification, habitat stratification, population modelling and cumulative impacts are reported on for Biometric Vegetation Types October 2008 (ELA, 2015), while offset calculations have been undertaken using Biometric Vegetation Types October 2014 in accordance with the NSW Biodiversity Offset Policy for Major Projects.
- Due to access restrictions, no plot data was available for *NA219 Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion* and benchmark plot data was used as a surrogate.
- There was insufficient plot data for some derived native grassland (DNG) zones and all plots in derived native grassland (n=15) were pooled and entered against each derived native grassland zone.
- No plots were surveyed in *NA294 Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the Brigalow*. This vegetation type was included in a broader Biometric Vegetation Types (October 2008) which was subsequently split in the update to Namoi CMA vegetation types (October 2014). To account for this, vegetation plot data from NA279, NA326, NA390 and NA389 (previously pooled types) were pooled and entered against this vegetation zone.
- The study area is intersected equally by the Pilliga A and Pilliga Outwash Catchment Management Authority (CMA) subregions. Vegetation zones were entered against the Pilliga Outwash CMA subregion.

2.4 EPBC offset requirements

The Commonwealth Department of the Environment (DoE) EPBC Act ‘offset assessment guide’ (DSEWPaC, 2012) applies to new referrals and variations to approval conditions from 2 October 2012 and projects currently under assessment. Offsets are only relevant to EPBC Act approvals declared as a ‘controlled action’ and where there is likely to be a residual ‘significant’ impact (DSEWPaC, 2012).

The project was referred to the Commonwealth Department of the Environment on 3 November 2014 (2014/7376). The project was determined a ‘controlled action’ on 1 December 2014 due to potential impacts on listed threatened species and communities, a water resource, in relation to coal seam gas development and large coal mining development and commonwealth land. Assessment of the project has been delegated to the State under the assessment bilateral agreement with the NSW Government.

As the NSW Biodiversity Offset Policy for Major Projects was developed with full consideration of MNES, offsets determined under the *NSW Biodiversity Offset Policy for Major Projects* are considered to satisfy EPBC offset requirements.

The DoE offset policy states that impacts should first be avoided and mitigated as offsets do not reduce the impacts of a proposed action. Offsets will not be considered until all reasonable avoidance and mitigation measures are considered. Measures taken to avoid, minimise and mitigate the impacts of the project are outlined in Section 7 and Section 8 of the Ecological Impact Assessment of the project (ELA, 2015).

Direct offsets are to meet a minimum 90 percent of the measureable environmental gain for the impacted protected matter. A conservation gain may be achieved by:

- improving existing habitat for the protected matter
- creating new habitat for the protected matter
- reducing threats to the protected matter
- increasing the values of a heritage place
- averting the loss of a protected matter or its habitat that is under threat.

The delivery of offsets that establish positive social or economic co-benefits are encouraged such as increasing landscape connectivity, offsets that employ local indigenous rangers to undertake management actions or pay rural landholders to protect and manage land for conservation purposes.

The DotE policy states that offset packages should be developed in consultation with the Department and that if the Department is satisfied that the offset activities are suitable, the Department will consider the magnitude and composition of the preliminary offset package. The Department will take a range of considerations at both the impact and proposed offset site(s) into account, including:

Matters to be considered at the impact site:

1. Presence and conservation status of protected matters likely to be impacted by the proposed action.
2. Specific attributes of the protected matter being impacted at a site, for example: the type of threatened species or ecological community habitat, the quality of habitat, population attributes such as recruitment or mortality, landscape attributes such as habitat connectivity, or heritage values.
3. Scale and nature of the impacts of the proposed action – including direct and indirect impacts.
4. Duration of the impact (not of the action).

Matters to be considered at the offset site:

1. Extent to which the proposed offset actions correlate to, and adequately compensate for, the impacts on the attributes for the protected matter.
2. Conservation gain to be achieved by the offset. This may be through positive management activities that improve the viability of the protected matter or averting the future loss, degradation or damage of the protected matter.
3. Current land tenure of the offset and the proposed method of securing and managing the offset for the life of the impact.
4. Time it will take to achieve the proposed conservation gain.
5. Level of certainty that the proposed offset will be successful. In the case of uncertainty, such as using a previously untested conservation technique, a greater variety and/or quantity of offsets may be required to minimise risk.
6. Suitability of the location of the offset site. In most cases this will be as close to the impact site as possible. However, if it can be shown that a greater conservation benefit for the impacted protected matter can be achieved by providing an offset further away, then this will be considered.

It is noted that under the EPBC Act Environmental Offsets Policy consideration of offsets is only required for MNES where there remains a residual significant impact after avoidance and mitigation measures.

When considering the magnitude and duration of direct, indirect and cumulative impacts; partial rehabilitation proposed and demonstrated rehabilitation success; and proposed mitigation measures such the Ecological Scouting Framework and the nil-tenure feral animal control strategy, there is unlikely to be a significant adverse impact on Matters of National Environmental Significance as a result of the project. Nevertheless, Matters of National Environmental Significance have been assessed and offsets have been determined under the *NSW Biodiversity Offset Policy for Major Projects*) .

2.5 Cultural Heritage

Consideration of Aboriginal cultural heritage values is a key component of the Biodiversity Offset Strategy. Cultural heritage will be identified and integrated into biodiversity offsets in three ways:

- Aboriginal cultural heritage values such as important sites, places of traditional or recent significance and culturally important plants and animals will be identified as part of the selection of suitable land-based biodiversity offsets.
- Community access to biodiversity offset areas will be facilitated where practicable.
- Community management of offset lands will be encouraged.

2.5.1 Cultural heritage offsets

Aboriginal cultural heritage values will be identified within suitable lands intended for biodiversity offsets. Considerations for Aboriginal cultural heritage values for inclusion in Biodiversity Offsets will include:

- Existing important sites such as burials, stone arrangements and earthen circles, carved or scarred trees, rock shelters, grinding grooves, quarries, mounds, hearths and ovens, stone artefact concentrations and shell middens.
- Places of traditional and anthropological significance.
- Places of recent historic and anthropological significance.
- Culturally important plants (refer **Appendix A** (CQCHM, 2014)) and animals.

These values will be considered in assessing the relative merits of one potential offset site over another.

2.5.2 Community access to cultural heritage offsets

Community access to land-based biodiversity offset areas will be facilitated where practicable. Access will be negotiated under the following principles. Aboriginal people should be able to:

- Access, use and enjoy, move about and hold meetings on the offset area.
- Camp, erect shelters and other structures on the offset area in limited designated areas.
- Hunt, fish and use the natural resources of the offset area (including water, food, medicinal plants, timber, tubers, charcoal, wax, stone, ochre and resin as well as materials for fabricating tools, hunting implements, making artwork and musical instruments) provided the activities are undertaken in an ecologically sustainable manner and not contradict the objectives of biodiversity conservation.
- Conducting ancillary cultural activities such as burning programs to ensure the continued viability of the area for cultural purposes, provided the activities are undertaken in an ecologically sustainable manner and not contradict the objectives of biodiversity conservation.
- Conduct and participate in cultural and spiritual activities, ceremonies and rituals.
- Maintain and protect places of importance under traditional laws, customs and practices in the offset area.

2.5.3 Community management of offset lands

The Proponent will enter into agreements with appropriately qualified Aboriginal people to manage certain lands acquired as land-based biodiversity offsets and will identify land management funding that can be used for training opportunities to acquire the necessary skills where required. Community management of land will ensure that proposed management regimes will not impair other Aboriginal cultural heritage values.

3 Biodiversity offset package

The Biodiversity Offset Package for the project will deliver environmental, cultural and socio/economic benefits through:

- Land-based offsets which will seek to increase landscape connectivity and conservation of ecological values unique to the Pilliga.
- Incorporation of some areas of land into the offset package because of their Aboriginal cultural heritage values, or that the land is owned by the Aboriginal community, as well as their biodiversity values.
- Providing ongoing access to this land for traditional cultural activities and practices.
- Actively involve Aboriginal people in the management of some offset land and implementation of supplementary measures.

The Biodiversity Offset Package for the project will contain a combination of

- **Like-for-like offsets** secured via an appropriate conservation mechanism (including purchase and retirement of biodiversity credits (where available), protection under Biobanking Agreements, or reservation under the NSW *National Parks and Wildlife Act 1974*).
- **Supplementary measures** developed and funded through Planning Agreements (PAs) under the NSW *Environmental Planning and Assessment Act 1979* (EPA Act).
- **Compensatory measures** such as Koala research.
- **NSW Biodiversity Offsets Fund for Major Projects** will be used for remaining offset liability (when established).

3.1 Land based offset sites

The availability and suitability of potential offset sites in the region will be investigated post submission of the Environmental Impact Statement. This process will seek to meet the majority of the like-for-like offset liability of the project as far as practicable. This process will include:

1. Checking the biobanking public register and having an expression of interest (EOI) for credits wanted for at least six months.
2. Liaising with an OEH office and Narrabri Council to obtain a list of potential sites that meet the requirements for offsetting.
3. Considering properties for sale in the area.

This process will included identifying lands with appropriate conservation values in proximity to the project, identifying where these lands have potential to provide like-for-like vegetation and threatened species habitat (including large hollow-bearing trees), identifying Aboriginal cultural heritage values, and where cost effective management can be implemented to improve the overall conservation value of the land.

Wherever possible, investigation of potential offsets will be directed to areas adjacent to existing conservation areas to improve the overall extent and connectivity of conserved land in the region.

Should potential offsets be considered not feasible, suitable evidence will be provided (e.g. unwillingness of landowner to sell or establish a Biobank site, or sale price significantly above market rates).

3.2 Supplementary measures

Supplementary measures are measures other than protecting and managing land which result in improvements to biodiversity values. They may include improving existing habitat or reducing threats to individual threatened or migratory species, populations and ecological communities.

Due to the existing threats to biodiversity values in the Pilliga (such as well-established feral animal populations, weed invasion, inappropriate fire regimes and unmanaged vegetation community regrowth), an exclusively land-based offset is likely to be less effective for threatened species conservation than supplementary measures using species-specific recovery actions over large areas.

The supplementary measures identified in this Biodiversity Offset Strategy have been nominated as they are cost-effective and will maximise biodiversity outcomes. Wherever possible, the supplementary measures are accompanied by scientific evidence that the measures are likely to lead to long-term benefits to biodiversity and are in accordance with best practice techniques.

Supplementary measures will be implemented through Planning Agreements which will ensure long-term security of financial contributions and ensure that suitable arrangements are in place for monitoring and reporting on the progress of each measure.

Detailed management plans, cost estimates and preparation of Planning Agreements will be prepared post-approval to the satisfaction of the State and Federal Government agencies.

3.2.1 Species threat analysis

In recognition of the high ecological and landscape value of the Pilliga Forest, over 240,000 ha of conservation reserve have been gazetted under the NSW *National Parks and Wildlife Act 1974* (NPW Act) since the 1960s. The Pilliga Nature Reserve (83,000 ha) was first reserved in 1968. 30 years later, regional assessments of the Brigalow and Nandewar Bioregions (NPWS, 2000) culminated in the NSW Government’s decision in 2005 to conserve an additional 160,000 ha of Community Conservation Area (CCA) in the Pilliga Forest under the NSW *Brigalow and Nandewar Community Conservation Area Act 2005* (BNCCA Act). This area focuses on the central, southern and western extents of the Pilliga. Today, approximately half of the Pilliga is now reserved under the NPW Act, with the other half mostly State Forest.

To help inform which recovery actions would be most beneficial, a species threat analysis was undertaken. From this analysis, high priority recovery actions were identified where they are known to have achievable conservation benefits. The analysis highlighted which actions offer the most cost effective means of achieving the greatest benefit for threatened species recovery.

For every threatened flora and fauna species known or considered likely or to have the potential to occur in the study area, the threatened species profile (OEH, 2015), species profiles and threats database (DotE, 2014) and national or state management plans were reviewed to determine the listed threats to each species and the recommended recovery actions or strategies. Only those threats which could feasibly be mitigated through on-ground management strategies were included.

The threats and management strategies identified fell under common themes, most of which corresponded with key threatening processes listed under either the TSC Act or the EPBC Act. For most threats there was a clear corresponding management strategy (e.g. the threat of inappropriate fire regimes can be managed by fire management). The number of threatened species affected by each threat and benefited by the corresponding management action was tabulated (treating flora and fauna separately) in order to elucidate the actions that benefited the greatest number of species (**Appendix B**).

The threatening processes found to impact on the highest number of threatened species in the study area are presented in **Table 6** for fauna and **Table 7** for flora, along with the corresponding management action to address each threat. Also included are the listed key threatening processes under TSC Act and EPBC Act which correspond to each identified threat.

Note that the two threats 'grazing pressure' and 'feral herbivores' were combined, since the pressure of feral herbivores leads to increased grazing pressure. This category was again broken down into specific herbivore species to determine where management efforts should be directed. Similarly, the threat of 'feral predators' was initially considered as one threat, and then later broken down to examine the impact of individual predator species.

Table 6: Threatening processes – fauna

Number of species impacted	% of total species	Management action	Equivalent Key Threatening Processes: TSC Act	Equivalent Key Threatening Processes: EPBC Act
Grazing/ habitat disturbance by herbivores				
Specific threat: Stock / unspecified (42); pigs (6); rabbits (9); goats (7); horses (1) **Overall# (43)**	75.4%	Feral herbivore control	Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) Competition and habitat degradation by feral goats (*Capra hircus*)	Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs Competition and land degradation by rabbits Competition and land degradation by unmanaged goats
Inappropriate fire regimes				
36	63.2%	Fire management	High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	
Feral predators				
Specific threat: Foxes (27); cats (25); wild dogs (11); rats/mice (3); unspecified (3) **Overall* (31)**	54.4%	Feral predator control	Predation by the European red fox (*Vulpes vulpes*) Predation by the feral cat (*Felis catus*) Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	Predation by European red fox Predation by feral cats
Weed invasion				
19	35.1%	Weed management	Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata*	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants,

Number of species impacted	% of total species	Management action	Equivalent Key Threatening Processes: TSC Act	Equivalent Key Threatening Processes: EPBC Act
			Invasion, establishment and spread of *Lantana camara* Invasion of native plant communities by exotic perennial grasses Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	including aquatic plants.

#Note that these categories are not mutually exclusive and thus the total of all species threatened by feral animals does not equal the sum of those affected by each type of feral animal.

Table 7: Threatening processes – flora

Number of species impacted	% of total species	Management action	Equivalent Key Threatening Processes: TSC Act	Equivalent Key Threatening Processes: EPBC Act
Weed invasion				
12	75%	Weed control	Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* Invasion, establishment and spread of *Lantana camara* Invasion of native plant communities by exotic perennial grasses Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
Grazing/ habitat disturbance by herbivores				
Specific threat: Stock/ unspecified (10); pigs (5); rabbits (7); goats (5) **Overall# (12)**	62.5%	Feral herbivore control	Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) Competition and habitat degradation by feral goats (*Capra hircus*)	Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs Competition and land degradation by rabbits Competition and land degradation by unmanaged goats

Number of species impacted	% of total species	Management action	Equivalent Key Threatening Processes: TSC Act	Equivalent Key Threatening Processes: EPBC Act
Inappropriate fire regimes				
8	50	Fire management	High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	

[#]Note that these categories are not mutually exclusive and thus the total of all species threatened by feral animcals does not equal the sum of those affected by each type of feral.

Feral animal control

Feral animal control was identified as the highest (grazing/habitat disturbance) and third highest (feral predators) threat to threatened fauna species. Feral animal control (grazing/habitat disturbance) was the second highest threat to threatened flora species. Control of feral animals is an action that is highly beneficial to a large number of threatened flora and fauna species in the Pilliga.

Recent survey work targeting *Dasyurus maculatus maculatus* (Spotted-tailed Quoll) in the north-east Pilliga Forest identified the following feral animals via remote camera - *Vulpes vulpes* (European Red Fox), *Felis catus* (Cat), *Sus scrofa* (Pig), *Canis lupus familiaris* (Dog) and *Bos* sp. (Cattle), with feral animals accounting for 36% of all images captured (ELA, 2015). This work has identified a range of feral animals including both herbivores that are likely to be adversely affecting habitat quality and carnivores which are likely to be directly contributing to the decline of threatened species through predation.

Weed control

Weed invasion was identified as a threat to 12 of 16 (75%) threatened flora species and 19 of 57 (33.33%) threatened fauna species. Weed invasion is identified as the threat affecting the greatest number of threatened flora and appropriate management is an action that would be beneficial to a large number of threatened species in the Pilliga.

Surveys in the study area identified 116 weed species which comprises 14% of the flora diversity recorded (ELA, 2015). This list was refined to focus on those species which are of most concern to the study area, due to their abundance, distribution or listed impact on threatened flora or fauna (**Table 8**).

Table 8: Weed species of most concern

Weed group	Species of concern in the study area	Threatened fauna affected (DotE, 2014; OEH, 2015)	Threatened flora affected (DotE, 2014; OEH, 2015)	Location of weeds in study area	Priority areas (OEH, 2011)	
					Reserves	Specific sites
Pasture grasses	*Eragrostis curvula* (African Lovegrass), *Hyparrhenia hirta* (Coolatai Grass), *Panicum maximum* (Green Panic),	Bush Stone-curlew, Speckled Warbler, Hooded Robin, Turquoise Parrot, Barking Owl, Scarlet Robin, Grey-crowned Babbler, Diamond Firetail	*Polygala linariifolia, Lepidium monoplocoides, Myriophyllum implicatum, Lepidium aschersonii*	Widespread *E. curvula* abundance observed to be increasing along edge of X-line Road	-	-
Berry-bearing shrubs	*Lycium ferocissimum* (African Boxthorn)	Scarlet robin, Diamond Firetail	*Lepidium aschersonii, Lepidium monoplocoides*	Records from the field survey are restricted to the north-western portion of the study area, outside of the Pilliga forests.	Pilliga West State Conservation Area, Pilliga West National Park	Brumby Rd, Gilgais
Noogoora Burr	*Xanthium occidentale*	-	-	Records from the field survey are in the north-western portion of the study area, outside of the Pilliga forests and along Bohena Creek in the Pilliga forests.	Pilliga National Park, Yarragin National Park, Timallallie National Park	South Yarragin, Wittenbra Springs, Bugaldie Creek

Weed group	Species of concern in the study area	Threatened fauna affected (DotE, 2014; OEH, 2015)	Threatened flora affected (DotE, 2014; OEH, 2015)	Location of weeds in study area	Priority areas (OEH, 2011)	
					Reserves	Specific sites
Opuntia spp.	*Opuntia stricta* (Prickly Pear), *Opuntia aurantiaca* (Tiger Pear)	Koala	-	Both species are widespread in the study area.	Pilliga National Park, Pilliga State Conservation Area, Pilliga East State Conservation Area, Timallallie National Park, Pilliga Nature Reserve, Willala Aboriginal Area, Yarragin National Park, Timallallie National Park, Pilliga West State Conservation Area, Pilliga West National Park, Merriwindi State Conservation Area	Talluba Creek, No. 1 break, Delwood Road, Scratch Road, Brumby Road, Willala Knobs, South Yarragin, The Duke, Tinegie Creek, Pilliga to Coonamble Road, Bugaldie Creek
Pasture herbs	*Phyla canescens* (Lippia)	-	*Myriophyllum implicatum*	Only recorded at one location, however this location is within 1 km of the *M. implicatum* record.	-	-

Fire management

Inappropriate fire regimes were identified as the second-highest threat to threatened fauna species in the study region, and the third-highest threat to threatened flora species. Therefore, fire management is one of the management actions which would have the greatest benefit to threatened species.

For the majority of flora and fauna species threatened by inappropriate fire regimes, it is high-frequency fire regimes that are detrimental. High frequency fire can lead to direct mortality, food deprivation, an increase in predation levels on native fauna, a reduction in the availability of critical habitat features such as hollow-bearing trees or an inability to attain a critical lifecycle before the next fire event (Gill & Bradstock, 1992; Gill, 1975; Whelan, 2002). For some species, the suppression of fire is also a threat to their survival (e.g. *Rulingia procumbens, Bertya opponens, Tylophora linearis)*.

3.2.2 Management costs

The estimated state-wide expenditure on weed and feral animal control by the National Parks and Wildlife Service in 2006-2007 was $18 million (DECC, 2006). This included $4.5 million for feral animal control programs, $2.8 million for weed control programs and $10.7 million for operational costs (e.g. labour and other costs) to implement the programs. Assuming this funding was distributed evenly across the 14 NPWS regions then approximately $1.3 million would be allocated to the Northern Plains Region (in which the Pilliga is located). The Pilliga agglomeration of reserves (including Warrumbungle National Park) accounts for 34% of the total NPWS estate in the Northern Plains Region, so again assuming funding is allocated proportionally within individual regions, then $440,000 per annum would be allocated to weed and feral animal control in the Pilliga. As funding is unlikely to be allocated evenly across or within regions, an estimate of $440,000 per annum for weed and feral animal control in the Pilliga is likely to be overly conservative.

The following sections provide detail on the estimated costs to undertake individual actions such as feral animal control, weed control and prescribed burning as identified in the species threat analysis.

Feral animal control

An integrated feral animal control program would provide substantial cost savings compared with a series of single eradications (Griffiths, 2011). An integrated feral control program would also minimise the potential for unintended consequences of the control of particular feral animal species. For example, targeting foxes and/or wild dogs without also implementing control of feral cats has the potential to lead to an increase in cat numbers, as they are released from predation by the larger feral predators (Algar & Smith, 1998). There may also be a need to implement control of feral grazing animals (e.g. rabbits) if foxes or other feral predators are to be targeted, in order to avoid an increase in the populations which previously would have been suppressed through predation. Equally, controlling feral grazing animals without also controlling feral predators could lead to prey switching by feral predators to native animals (Cupples, Crowther, Story, & Letnic, 2011).

<u>Feral Fox control</u>

Costs of various fox baiting programs throughout Australia were reviewed. Baiting using 1080 is considered to be the only cost-effective broadscale control option for foxes (DEC, 2011). Other methods of fox control, such as trapping, shooting, and baiting with other poisons, are labour intensive and not practical on a large scale, and therefore have not been considered. Costs for aerial and ground baiting vary from $0.37 to $1.73/ha. A minimum of two baits per square km is necessary for a fox to detect one bait within three days, but up to five baits per square km is highly recommended to allow for non-target uptake by birds and reptiles (Arid Recovery, 2011). Five fox baits per square kilometre are used by Western Australia's highly effective Western Shield Program (DPAW, 2014). For most areas of

Australia, 5-10 baits per square km is considered to be the optimum density for reduction of fox populations (Saunders & Mcleod, 2007).

Quarterly baiting has been found to be necessary to prevent reinvasion of baited areas by foxes in arid South Australia with annual baiting being found to be insufficient (Moseby & Hill, 2011). Fox baiting is also conducted four times a year in the Western Shield Program (DPAW, 2014).

Some research has also been carried out as to the efficacy of different delivery methods of bait. For example, at Yathong Nature Reserve in western New South Wales intensive ground baiting of foxes was found to be ineffective in mitigating the threat of predation by foxes on reintroduced *Leipoa ocellata* (Malleefowl) and *Bettongia penicillata* (Brush-tailed Bettongs), but broad-scale aerial baiting three times a year substantially enhanced malleefowl survival (Wheeler & Priddel, 2009).

Aerial baiting is more cost effective for large areas than ground baiting (Fairbridge & Fisher, 2001; Saunders & Mcleod, 2007), due to the lower labour costs and time involved.

Table 9: Costs for fox baiting programs in various areas of Australia (adjusted to 2014 prices)

Method	Location	Cost per ha ($)	Details of program	Reference
Aerial baiting	Western Shield program WA (3.5 million ha/ year)	0.37	Four times per year, over 3.5 million ha with 800,000 baits (5 per km^2 per session) Includes $200,000 operating expenses equivalent to ~$0.06/ha (advertising, training, materials and education) Covers fuel and provision of a bombardier.	(Saunders & Mcleod, 2007)
Ground baiting	Central NSW (2,000 ha)	0.60-1.20	Four times per year (one-off treatment costs $0.15-$0.30/ha). 3 baits/km^2 which are checked every 3-5 days and replaced if taken. Cost varies depending on whether baits are checked and replaced 1-5 times. Includes labour costs, baits, vehicle use.	(Saunders & Mcleod, 2007)
	NSW	1.73	Four times a year. Cost is $0.94 for once a year	(Saunders & Mcleod, 2007)
	Central Victoria (44,000 ha)	1.02	One-off baiting, 10.5 baits/km^2	(Saunders & Mcleod, 2007)
	Hattah-Kulkyne NP Victoria (28000 ha)	0.89	Continuous baiting throughout year, checked every 3-4 weeks (>0.6 baits/km^2).	(Robley, Wright, Gormley, & Evans, 2008)
	Coopracamba NP Victoria (38800 ha)	0.60	Continuous baiting throughout year, checked every 3-4 weeks (<0.2 baits/km^2).	
	Grampians NP	1.10	Pulse of 6-8 weeks baiting,	

Method	Location	Cost per ha ($)	Details of program	Reference
	Victoria (72520 ha)		checked daily, then repeated after several weeks break (0.2-0.6 baits/km^2)	
	Wilsons Promontory NP Victoria (36000 ha)	0.75	Pulse of 6-8 weeks, checked daily, then repeated after several weeks break (0.2-0.6 baits/km^2).	
	Little Desert NP Victoria (47600 ha)	0.22[1]	October/November to March/April with bait stations checked and baits replaced every three to four weeks (<0.2 baits/km^2).	
	Little Desert NP Victoria (45500 ha)	0.29[2]	October/November to March/April with bait stations checked and baits replaced every three to four weeks (<0.2 baits/km^2).	

Feral cat control

Baiting is widely considered to be the most effective method for controlling feral cats on mainland Australia (Algar, Angus, & Williams, 2007; Algar & Burrows, 2004; DEWHA, 2008; Environment Australia, 1999; Short, Turner, & Risbey, 1997). The feral cat bait Eradicat® developed for the Western Shield program in WA has proven to be highly effective in reducing feral cat numbers, especially in semi-arid and arid areas. The effectiveness of other control techniques, including trapping, shooting and fencing is limited by a significant input cost when implemented over large areas (DPAW, 2013).

The theoretical cost of cat baiting could be calculated by adding the cost of the number of baits required per hectare to the cost of a fox baiting program (particularly because fox baiting should not be implemented without also controlling cats due to the potential impacts of mesopredator release on cat populations.

The cost of Eradicat® baits is currently $0.3 per bait at today's level of production (Algar & Burrows, 2004). At a minimum, 25 baits per square kilometre (0.25/ha) are required for a cat to detect one bait within three days (Arid Recovery, 2011). The Western Shield program in WA uses 50 feral cat baits per square kilometre (0.5/ha), and baiting is conducted once a year. Using these figures, cat baiting could be integrated into a fox baiting program for an added cost of approximately $0.15/ha.

Feral pig control

The costs of various feral pig control methods were reviewed. The cost per hectare was not available for several of the control method reviewed and in these cases, the cost per hectare was estimated based on potential pig density per hectare. Costs for aerial and ground baiting vary from $0.2 to $2.47/ha while costs for trapping are higher (up to $15/ha) due to increased labour. Costs for aerial shooting range from $0.2 to $7.43/ha. Ground shooting is not generally considered a cost-effective control method due to being labour-intensive (DEC, 2011), however it may be useful as a follow-up method.

Table 10: Comparative costs of feral pig control methods in different habitats

Control method	Habitat/area	Cost per pig ($)	Cost per ha ($)	Source
Ground Baiting	Slopes and plains	43.01-117.70	0.65-1.77[1]	(Turvey, 1978)
	Wetland	13.19	1.94	(Choquenot, McIlroy, & Korn, 1996)
	Dryland	6.31	0.194	(Choquenot et al., 1996)
	Dryland	6.50	0.58	(Korn, 1986)
	Agricultural land (eastern NSW)[2]	55	1.07	(Saunders, Kay, & Parker, 1990)
	Arid rangelands (western NSW)	1.67	0.15	(Bryant, Hone, & Robards, 1984)
Aerial baiting	Dry tropical savannah (Qld)	37.19	2.47[2]	(Mitchell & Kanowski, 2003)
Trapping	Slopes, plains, scrub (NSW)	56-106	–	(Turvey, 1978)
Trapping	Dry tropical savannah (Qld)	62.90	14.82[3]	(Mitchell & Kanowski, 2003)
	Alpine forest (Kosciusko NP)	136	1.50[4]	(Saunders, Kay, & Nicol, 1993)
Aerial Shooting	Woodland (Western NSW)	112.21	2.09	(Hone, 1983)
	Wetland (Macquarie Marshes NSW)	20.92	7.43	(Bryant et al., 1984)
	Wetland	9.70-30.08	0.49-0.69	(Korn, 1986)
	Dryland	5.65–30.08	0.19-0.29	(Korn, 1986)
	Wetland/ dryland	22.86	1.82	(Saunders & Bryant, 1988)
	Wetland/ woodland	11.22	0.56	(Hone, 1990)
	Rangeland	76	0.30	(Lapidge, Derrick, & Conroy, 2003)
	Dry tropical savannah (Qld)	25.90	1.73[5]	(Mitchell & Kanowski, 2003)

[1] Calculated from the upper figure in the range of 0.2-1.5 pigs/km^2 for semi-arid rangelands in NSW

[2] Warfarin used

[3] Calculated from a pre-baiting pig density estimate of 6.7 pigs/km

[4] Calculated from a pre-trapping pig density estimate of 10.9 pigs/km

[5] Calculated from an average pig density estimate of 1.1 pigs/km^2 for Kosciusko NP

[6] Calculated from a pre-shooting pig density estimate of 6.7pigs/km

Feral goat control

The costs of various feral goat control methods were reviewed. The cost per hectare was not available for several of the control method reviewed and in these cases, the cost per hectare was estimated based on potential goat density per hectare. Costs for aerial shooting range between $0.1 to $3.74/ha, mustering ranges between $0.58 and $1.29/ha and trapping ranges between $0.42 and $6.32/ha.

Ground shooting is not generally considered a cost-effective control method due to being labour-intensive (DEC, 2011), however it may be useful as a follow-up method.

Table 11: Comparative costs of feral goat control methods in different habitats (adjusted to 2014 prices)

Control Method	Habitat/ area	Cost per goat ($)	Cost per ha ($)	Reference
Aerial shooting	Western Australia	-	0.09	(Parkes, Henzell, & Pickles, 1996)
	Gammon Ranges SA	-	0.17	(Naismith, 1992)
	Arkaroola (Flinders Ranges SA)	-	3.74	(Henzell, 1981)
	Coolah Tops NP NSW	18.63-41.04	0.67-1.48[1]	(Fleming et al., 2002)
Mustering	Coolah Tops NP NSW	27.39-28.35	0.99-1.02[1]	(Fleming et al., 2002)
	South-western Qld	2.41-5.37 (average 2.92)	0.58-1.29[2]	(Thompson, Riethmuller, Kelly, Boyd-Law, & Miller, 1999)
Trapping at waterpoints	South-western Qld	1.74-5.85 (average 3.15)	0.42-1.40[2]	(Thompson et al., 1999)
	Western CMA NSW	-	6.32[3]	(Grant, 2012)
Ground shooting	Rangelands	774	17.03[4]	(Edwards, Clancy, Lee, & McDonnell, 1994)
	Kennedy Range NP WA	14-54	0.22-0.86[5]	(DEC, 2011)
	Cape Range NP WA	113-149	1.81-2.38[5]	(DEC, 2011)

<u>Feral rabbit control</u>

The costs of various rabbit control methods were reviewed. Trapping is not considered an effective rabbit control technique (Williams, Parer, Coman, Burley, & Braysher, 1995) whilst shooting is time consuming and labour intensive, and is therefore not suitable for broadscale control (DEC, 2011). Fumigation is generally thought unsuitable for large areas as it is high cost and labour-intensive but could be useful in smaller target areas where rabbits are a particular problem, or where a particular threatened species is present.

Costs per hectare for rabbit control vary from $5 to $32/ha for warren ripping and fumigation and $9.55 to $12.74/ha for poisoning. A cost/benefit analysis for rabbit control methods (Williams et al., 1995) shows that some combinations of treatments achieve a high level of control for little more cost than some single treatments, and at much lower cost per benefit obtained. A combination of poisoning, ripping and fumigation achieved an effectiveness of 99% and the lowest cost/benefit of treatment or combination of treatments, followed by ripping and fumigation (96% effectiveness), poisoning and ripping (91%), ripping alone (80%), poisoning and fumigation (21%) and poisoning alone (12%).

A conservative estimate of costs of rabbit control could be calculated from the total of the upper range figure for all three treatments per hectare per year, although in reality rabbit management becomes progressively cheaper as repeated maintenance treatments achieve higher levels of control (Williams et al., 1995).

Table 12: Rabbit control options (adjusted to 2014 prices)

Control Method	Cost per ha ($)	Notes	Frequency treatment required	Reference
Warren ripping	5-25			(DAFF, 2006)
	4.78-31.85	Cost given is for large-scale contracts. The higher figure applies to rocky hills with a high density of warrens.	Depends on soil type- on sandy soils 62% of warrens may be reopened within 6 months vs. 12% in 10 years on heavy soils	(Williams et al., 1995)
Warren fumigation	15.92-31.85	Cost given is for large-scale contracts. Cost varies depending on the density of warrens and the nature of the terrain and vegetation.		(Williams et al., 1995)
Poisoning (Pindone or 1080)	9.55-12.74	Cost given is for large-scale contracts and includes all materials and labour. The cost of poisoning is relatively insensitive to variations in density of rabbits and warrens	1-6 years	(Williams et al., 1995)

Weed control

The cost of broad scale weed control will depend on a number of variables: types of weeds present, type of treatment required (e.g. herbicide application vs. mechanical control), frequency of treatment required, area of infestation, density of infestation and climate and terrain of the area to be treated. As such, it is very difficult to provide even an estimate of the cost of weed control per hectare.

There is little data available pertaining to the amount per hectare spent on weed control by government agencies. Those figures which are available show a vast range in costs; for example, yearly weed control costs are given as $47/ha for the 7,969 ha Canberra Nature Park, compared with $1/ha for the 102,862 ha Namadgi National Park (Taylor, 2002). Much of this variability would relate to reserve size (and the resulting differences in edge to area ratio), condition, location, and the amount of funding allocated to weed control in the management budget, and thus not necessarily a useful basis for calculating the potential costs of weed control across the Pilliga.

Even focussing on the priority weed species identified in **Table 8**, the cost of treatment per hectare shows extreme variability. For example, the cost of controlling Opuntioid cacti species by spraying with herbicides can range from a few hundred dollars to $8,000 or more per hectare (Lloyd & Reeves, 2014). **Table 13** shows the costs of control per hectare that were able to be obtained for weed species of concern to threatened flora and fauna. Should weed control be identified as a priority supplementary measure, then a detailed weed management plan will be prepared to address the priority weed species across the Pilliga.

Table 13: Approximate costs per hectare for the control of weeds of concern to threatened species occurring in study area

Weed Species	Control method	Cost per ha	Details and location	Reference
African boxthorn	Spraying with herbicides and mechanical excavation of plants	$130-140	3 year trial of control in remnant vegetation in Murry CMA	(Institute for Land Water and Society, 2007)
Blackberry		$100-249 chemical costs + >$500 labour costs Total $600 - >$749	Conservation and natural environments NSW	(DPI, 2014)
Coolatai grass	Spraying with glyphosate/ flupropanate	>$360	Pasture, North West Slopes NSW	(McCormick, L., Lodge, & McGullicke, 2002)
	Flupropanate	<$100 chemical cost + $100-249 labour costs Total ~ $200-349	Roadsides North and Central Coast NSW	(DPI, 2014)
	Spot spraying with glyphosate or flupropanate	$180- 220	Kwiambal National Park northern NSW	(McCormick et al., 2002)
Lippia		<$100 chemical costs $100-249 labour costs	Unimproved grazing areas NSW	(DPI, 2014)
	Spraying with DP-600	$45 chemical cost only	Grazing land, south-east QLD	(Leigh, C. and Walton, 2004)
Opuntia spp.	Spot spraying/ digging out	<$100 chemical cost + $100-249 labour costs Total ~$349	NSW	(DPI, 2014)

Weed Species	Control method	Cost per ha	Details and location	Reference
	Spraying	$750-1000	Leander QLD	(Lloyd & Reeves, 2014)
	Spraying (triclopyr, picloram or Access)	Few hundred dollars to >$8000	Western Australia	(Lloyd & Reeves, 2014)

Prescribed burning

The costs of implementing a prescribed burning regime are extremely variable, as shown in **Table 14**. In most cases the range in costs is largely explained by differences in the size of the areas treated in the burning program. The smaller the area, the greater the cost on a per hectare basis (Scherl, 2005).

The most relevant figures obtained are those for burning specifically for flora and fauna management by Victoria's Department of Sustainability and Environment (Environment and Natural Resources Committee, 2008). The cost of these programs is given as $30-$300/ha. However, to provide a more conservative estimate of the potential costs of implementing a prescribed burning regime, it may be necessary to use the highest figure found in the literature: in this case $1,778/ha for asset protection burning by South Australia's Department of Environment, Water and Natural Resources (Gibson & Pannell, 2014). Should prescribed burning be identified as a priority supplementary measure, then a detailed prescribed burning management plan will be prepared.

Table 14: Costs of prescribed burning in Australia

Location	Purpose of burning	Cost per ha ($)	Notes on figure given	Reference
Southwest WA	Pre-suppression prescribed burning	$80	Presumed cost of burning, based on data from WA. 100,000 ha jarrah forest (5% burned per year)	(Florec et al., 2013)
Victoria	Ecological burning for specific flora and fauna management	$30 - $300		(Environment and Natural Resources Committee, 2008)
Mt Lofty region SA	Prescribed burning for asset protection (not for ecological improvement)	$1,778	Figure includes $416/ha administering the prescribed burning program, $235 on monitoring and post burn weed management and $1127 on the implementation of the burn.	(Gibson & Pannell, 2014)
Tasmania	Forestry Tasmania fuel reduction burning	$60 - $300 (average $115)		(Deloitte Access Economics, 2014)
Australian forested landscapes	Prescribed burning for fuel management	$7 - $1,000	Lower figure is for broader forest treatment areas generally greater than 500 ha; upper figure for regions near large urban areas	(Scherl, 2005)

Location	Purpose of burning	Cost per ha ($)	Notes on figure given	Reference
			Figures include staff and resourcing costs.	

3.2.3 Nil-tenure feral animal control strategy

The Proponent has committed to the development of a nil-tenure feral animal control strategy which will be approximately equivalent to one third of the total offset liability of the project. The feral animal control strategy will initially focus on the study area (including a 5 – 10 km buffer) and will be implemented over a 20 year period. The strategy will focus efforts heavily in the first couple of years followed by maintenance control for the remaining period.

Consultation with NSW Forestry Corporation, the NSW National Parks and Wildlife Service and private landholders will be held during the preparation of the strategy to identify ways to integrate the feral animal control strategy with other strategies across the Pilliga region.

The nil-tenure feral animal control strategy will address feral animal control at a landscape scale. Given the connectivity of habitat in the study area and Pilliga, it is considered most beneficial to approach feral animal control at this scale.

The strategy will be designed to target feral fauna identified as high risk to the survival of native flora and fauna in the Pilliga. Control measures used will be specific for the target fauna species, with a range of control techniques to be applied. The poisoning of non-target species will be addressed through the design of the control techniques. The strategy will include monitoring to detect changes to targeted feral fauna abundance from control measures applied at the landscape scale. Monitoring will also aim to detect poisoning of non-target species to ensure the program is not having adverse effects on native wildlife.

3.2.4 Compensatory measures

Compensatory measures are other measures (such as funding for research of educational programs) that do not directly offset the impacts on threatened or migratory species, populations or ecological communities, but are anticipated to lead to biodiversity benefits. The proposed compensatory measures directly relate to the conservation of *Phascolarctos cinereus* (Koala) in the Pilliga and will be capped at 10% of the total offset package in accordance with the NSW Biodiversity Offset Policy for Major Projects.

Koala research proposal

In recent years there has been a dramatic decline in Koala numbers inhabiting the Pilliga. Recent studies (ELA, 2015; Niche Environment and Heritage, 2014) failed to locate Koalas within the study area, however isolated remnant populations have been detected in the western Pilliga (Niche Environment and Heritage, 2014). Given the decline in the Pilliga Koala population, a research proposal from Dr Stephen Phillips (an internationally acknowledged authority on Koalas) has been prepared which aims to provide the best value for money in determining the precise location and sizes of remnant Koala populations in the broader Pilliga region to inform conservation efforts for the important population of this species. The detailed Koala research proposal is included in **Appendix C** with a brief summary provided below.

This method proposed includes establishing a 500 m survey grid across the entire 500,000 ha of Pilliga with the intent to establish a permanently fixed grid that can be surveyed at varying scales, initially at 8 km sampling intersections in order to provide an unbiased occupancy estimate. At this scale of sampling approximately 120 primary field sites would be involved.

Working off the same grid but at a finer resolution of sampling (i.e. 250 m - 500 m intervals) in areas where remnant populations have been detected or are otherwise known to occur, a Koala meta-population model would be prepared that delineates the precise areas being utilized by resident populations with a view to enabling a focusing of management/recovery effort on such issues as weed control, fire suppression and other threatening processes. The models will be accompanied by robust Koala density estimates with the actual number of animals comprising the relic population cell precisely identified with 95% confidence.

In order to demonstrate the outcome and potential of this approach, at least two localities where Koalas were detected during the 2013 –2014 survey program (Niche Environment and Heritage, 2014) will be specifically targeted. Other localities may also be considered. All grid points once sampled have utility for longer-term monitoring biodiversity and koala population monitoring purposes.

Additional funding would be sought to capture additional population cells following completion of this project and/or government/community/industry staff could be trained in the technique with a view to developing a program of ongoing assessment and monitoring.

3.3 Indigenous cultural heritage values and activities

As identified in **Section 2.5**, consideration of Aboriginal cultural heritage values is a key component of the Biodiversity Offset Strategy and Biodiversity Offset Package. Cultural heritage values will be identified and integrated into biodiversity offsets in three ways:

- Aboriginal cultural heritage values such as important sites, places of traditional or recent significance and culturally important plants and animals will be identified as part of the selection of suitable land-based biodiversity offsets.
- Community access to biodiversity offset areas will be facilitated where practicable.
- Community management of offset lands will be encouraged.

3.4 Biodiversity offset fund or bond

Once land-based offsets and supplementary measures have been finalised, the remaining offset liability for the project will be converted into a dollar figure and held for eventual transfer into the Biodiversity Offset Fund (once established).

The precise mechanism for holding the financial offset liability until the establishment of the Biodiversity Offset Fund is yet to be determined, but may include preparation of a Planning Agreement or bond.

The Biodiversity Offset Fund will then be used by the fund program manager (NSW Government or others) to meet the remaining liability of the project to ensure the ‘like for like’ conservation of biodiversity values impacted in the study area.

4 Statement of commitments

This Biodiversity Offset Strategy is the Proponents' commitment to adequately offset the residual impacts of the project following implementation of avoidance, minimisation and mitigation strategies. The Biodiversity Offset Strategy ensures that long-term conservation outcomes are achieved in recognition of the *NSW Offsetting Principles* and the *NSW Biodiversity Offset Policy for Major Projects*.

In line with the contents of this Biodiversity Offset Strategy, the Proponent will:

- Commit to delivering biodiversity offsets which meets the offset quantum determined by the Framework for Biodiversity Assessment, including the development of an offset package which includes a combination of:
    - Like-for-like offsets secured via an appropriate conservation mechanism.
    - Supplementary measures developed and funded through Planning Agreements.
    - Compensatory measures including Koala research.
    - NSW Biodiversity Offsets Fund for Major Projects will be used for remaining offset liability (when established).
- Identify cultural heritage values as part of the Biodiversity Offset Package, including:
    - Incorporation of Aboriginal cultural heritage values in land-based offset sites.
    - Community access to biodiversity offsets.
    - Community management of land-based offsets.
- Prepare a Biodiversity Offset Management Plan that clearly outlines the responsible parties for the implementation of the plan, the works required to improve biodiversity values (including but not restricted to fire management, weed and feral animal control, erosion and sediment control, restrictions on access, revegetation), performance criteria and a reporting and monitoring program in accordance with the Biobanking Assessment Methodology.
- Prepare a nil-tenure feral animal control strategy which will be approximately equivalent to one third of the total offset liability of the project which will address feral animal control at a landscape scale.
- Undertake reporting for land-based offsets owned and managed by the Proponent in accordance with the Biobanking Assessment Methodology.
- Undertake a periodic review of the Biodiversity Offset Management Plan every 5 years in accordance with the Biobanking Assessment Methodology.

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Appendix A Culturally important food plants

Scientific Name	Common Name/s	Use
Acacia farnesiana	Prickly moses, prickly mimosa, north-west curara, sponge wattle, cassy, sheep's briar, thorny acacia, thorny feather-wattle	The pods from the mimosa bush were once sucked and the seeds eaten raw as though they were green beans. The thorns were used to pick out splinters.
Ajuga australis	Austral bungle	This plant was used to bathe sores and boils. Fresh leaves were bruised and soaked in hot water to create the infusion. Leaves were also placed in shoes to remove bad odours
Allocasuarina diminuta	Drooping sheoak	Leaves and young cones were chewed raw to quench thirst. Ngarrindjeri people of the lower Murray River made shields, clubs and boomerangs from the hard wood. As a main source of food for Glossy Black Cockatoos, areas where these plants are common were used to hunt birds. Archaeologists found a boomerang 10,000 years old made from sheoak wood in Wyrie Swamp, South Australia.
Alphitonia excelsa	Shampoo tree, soap tree, red ash	The leaves from the red ash are used very similarly to soap and having much of the same effect. The young leaf tips were chewed for an upset stomach and a decoction of bark and wood was used as a liniment for muscular pains or gargled to relive toothache. Commonly used as a fish poison, crushed leaves and berries were placed in water, the plant contains saponin, which removes oxygen from the water, causing the fish to flounder to the surface. The water is then undrinkable, usually done towards the end of the dry season or in an emergency.
Alstonia constricta	Quinine tree, quinine, bitter-bark, fever-bark, peruvian bark	Latex from the quinine bush was used to cure infectious sores, though rather harsh on the skin and considered poisonous. Also said to assist in the case of diabetes and blindness
Amyema miquelii	Drooping mistletoe, stalked mistletoe, snotty gobbles, boxed mistletoe	Edible fruit, Mrs Jean Hamilton grew up at Cuttabri and around Pilliga and she remembers collecting snottygobbles from different trees. Mr Dan Trindall and Mrs Delma Brennan during the oral histories told how they used to get snottygobbles off the vines on horseback, it made it easy to reach the fruit off the horses. Delma described snottygobbles as a thing that was full of

Scientific Name	Common Name/s	Use
		moisture
Astrebla pectinata	Barley mitchell grass, cow mitchell	The seeds were gathered, ground and made into damper. Aboriginal seed grinding dishes are a reminder of the important usage of grasses
Astroloma humifusum	Cranberry heath, Fiery hogs, native cranberry	The sweet edible berries from the native cranberry were eaten. During the oral histories Mervyn Cain and Maureen Sulter told how as children they would collect fiery hogs at Burra Bee Dee
Banksia marginata	Silver banksia, warrock, dwarf honeysuckle	The flower-cones are soaked in wooden or bark containers with water, the liquid turns sweet from the nectar then is ready for drinking or the nectar may be sucked directly from the flower. Victorian Aborigines used the dried flowers from the Banksia as strainers for drinking water.
Brachychiton populneus	Black Kurrajong, common kurrajong	The pods contain edible seeds, which are collected and in most cases roasted. Mr Brad Sulter while on a bush tucker survey conducted in Coonabarabran spoke of a drink made from the crushed seeds that is quite like coffee. During the oral histories Mrs Delma Brennan from Narrabri talked about how when she was a kid they used to collect and eat the seeds. She was taught never to eat them green but only when the pod had cracked. Delma also made little birds out of the pods as toys sitting around the camp with the other children. Roots once were tapped for water in times of drought, the young roots are eaten as well as the gum produced on the tree. Mrs Maureen Sulter from Coonabarabran told how dilly bags were made from the inner bark. Fish and bird nets and net bags were also made from the fibrous bark.
Calandrinia eremaea	Parakeelya	The leaves were an important food source to Aborigines and were eaten as greens or as a thirst quencher. The seeds are also useful as they could be grounded up into a past eaten raw or cooked

Scientific Name	Common Name/s	Use
Callitris glaucophylla	Murray pine, white pine, cypress pine, native pine	The fresh needle leaves are used as a ‘washing’ medicine for the treatment of sores and scabies; the leaves are ground quite finely with a stone and boiled in water. It can also be rubbed on the chest to relive coughing, rather like Vicks Vaporub. When used as a smoking medicine, a hole is dug and filled with leafy branches, which smoke profusely when lit. The sick person stands over the hole in the smoke and the sickness comes out with the sweat, leaving them feeling strong. The resin from *Callitris* species was used as a type of glue for fastening barbs to reed spears and axe-heads to handles, fish spears were also made from the long branches.
Capparis lasiantha	Nipan, slip-jack, maypan, honeysuckle, napan, nepine	For coughs honey is used from the flowers. For the relief of swellings, snake bites, insect bites and stings, the whole plant including the roots is mixed up with water then applied to the affected area. The unripe fruit were picked and placed in sand to ripen away from ants. During the oral histories Mrs Jean Hamilton spoke of plants kids used to eat growing up in Cuttabri and around Pilliga and napans were one of the plants that Jean had mentioned. Mrs Thelma Leonard from Minnom Mission at Pilliga described the napans as being egg shaped but only tiny, they start out green then turn yellow like a banana when ready to be picked
Capparis mitchellii	Bimbi, bumbil, native pomegranate, native orange, bumble tree, mondo, karn-doo-thal, small native pomegranate	The fruit is filled with a brightly coloured orange pulp, which is eaten raw and the taste is very sweet. The seeds inside the pulp can be ingested and are best to be swallowed without chewing. This fruit is still a favourite bush tucker today providing moderate energy, water, and carbohydrates. It is a good source of vitamin C and thiamine. Mrs Jean Hamilton spoke of growing up at Cuttabri and around the Pilliga and she remembers going out and collecting the bumble fruit. Mrs Thelma Leonard also spoke of the old bumble tree she was taught about as a child on Minnon Mission at Pilliga. Mrs Mavis Dennison grew up at Old Toomelah and she described the bumble like an apple or orange and very tasty.
Cassytha glabella	Slender dodder-laurel, tangled dodder-laurel, dodder, devil’s twine	The small fruits are edible but resinous. The flesh surrounding the central stone is said to taste very aromatic and tangy.

Scientific Name	Common Name/s	Use
Centipeda cunninghamii	Scent weed, old mans weed, common sneeze weed	Webb (1948) notes that this species has been used to alleviate cases of sandy blight (inflammation of the eyes) in humans. Boiling the plant in water creates a black liquid this substance can be either drunk for tuberculosis or used as a lotion for skin infections
Chenopodium cristatum	Crested crumbweed, crested goose floot	Poultice of leaf and stem were applied for septic inflammation and breast abscess
Citrullus colocynthis	Colocynth, paddymelon	Although this plant species is poisonous in some regions the juice from the melon is heated and once warm, rubbed onto skin infections such as ringworm and scabies
Dodonaea viscosa	Giant hopbush, watchupga, switch-sorrel, sticky hopbush, akeake, apiri, hopbush	Cochrane *et al.* (1968) recorded that Aborigines used the wood of larger plants for making clubs. For toothaches and cuts, the boiled roots or juice of roots was applied. Hopbush was burnt to smoke newborn babies. On the coast the chewed leaf and juice was used for stonefish and stingray stings. The juice was placed directly on the sting and bound up for 4-5 days.
Enchylaena tomentosa	Creeping saltbush, Barrier saltbush, plum puddings, berry cottonbush, ruby saltbush	The juicy sweet tasting berries from the salt bush were eaten they contained a small black seed, which was also eaten. The young leaves, which are quite fleshy, were boiled and eaten like vegetables. Soaking the fruits in water made a drink. The fruit was also used as a red dye
Eucalyptus camaldulensis	Red river gum, flooded gum, forest gum, yarrah, biall, creek gum, blue gum, Murray red gum, river gum	River red gums offer a powerful antiseptic. The dark inner bark is boiled until the red gum comes out, when cool it is used as a rubbing medicine for sores such as scabies. For children with diarrhoea the heartwood is boiled in water, then drunk. The seeds are edible and can be ground to make damper. Also used for the treatment of burns. The bark from the river red gum was commonly used to make canoes. On some old ‘canoe trees’ the scares are still present to this day

Scientific Name	Common Name/s	Use
Eucalyptus populnea	Popular box, round-leaf box, bimble box, red box, bimble, white box, egolla, nankeen gum, round-leaved box, shiny-leaf box, popular-leaved box	The roots were tapped for water
Exocarpos cupressiformis	Wild cherry, cherry ballart, native cherry.	The sap was applied from the native cherry as a cure for snakebites and the wood was used for making spears, spearthrowers and bull-roarers (a ceremonial instrument). Edible juicy fruits are also produced on the tree. In Gamilaraay country, trees in this family are used for smoking for protection
Flindersia maculosa	Spotted tree, spotted dog, leopard tree	This tree produces a good quality gum used for sticking things together. During the summer large masses of clear amber-coloured residue come from the stem & branches, it has a pleasant taste and forms a very common bushman's remedy for diarrhoea
Geijera parviflora	Australian willow, dogbush, sheep bush, gingerah, wilga	For relief of pain an infusion of leaves has been used internally as well as externally. Wilga leaves are used for toothaches, chewed leaves are placed into the cavities. This method alleviates the pain. When used for ceremonial purposes leaves are baked, powdered and smoked in sequence with other narcotic plants this mixture induces drowsiness and drunkenness. Wilga makes an excellent windbreak and provides good shelter
Grevillea striata	Western beefwood, beef oak, beef silky oak, silvery honeysuckle	The sap is scrapped from the damaged beefwood tree then grated into powder and sprinkled on sores, burns and cuts. It is said to dry them out and cause them to heal rapidly. Mixing the grated sap with charcoal from the beefwood and stuffing it into wounds is used to stop bleeding and promote healing. The beefwood provides a dark-reddish resinous exudate from the trunk and from the roots, this is used as cementing material. The root extract requires complex preparation involving baking, pounding and firing before it is ready for use. The seeds are edible. The timber is close grain and highly durable, this made it suitable for many purposes.

Scientific Name	Common Name/s	Use
Hakea leucoptera	Silver needlewood, needle hakea, pin bush, water tree, needlewood	The roots contain a drinkable watery sap, used as a substitute for pure water. The roots can be cut into lengths and stood on end to allow the liquid to drain out. The ends of the roots were also plugged with clay, and carried around while hunting or food gathering. The roots may also be blown at one end to expel the water. The summer flowers are white with eatable nectar
Indigofera australis	Austral indigo, native indigo	The leaves are crushed then added to water to kill or stun fish (Murray Cod) and eels. It usually takes a few days to effect the fish. The seed pod contains a chemical capable of producing hallucinations called hallucinogen
Lomandra longifolia	Spiny headed matrush	From the strap-shaped leaves women made baskets, nets and net-bags. After splitting each rush the women would then tie them into bundles to be soaked allowing the fibres to become suitable for weaving. Some usages for the baskets were fish and eel traps. The flowers are edible – tasty and starchy. Fruit are also edible – tough, ground into meal first

Scientific Name	Common Name/s	Use
Macrozamia heteromera	Commentary applies to this and following Macrozamia species found in the Southern Brigalow Belt	Traditionally, the cycad plant is used for its seeds as a food source. However, the cycad seed contains cycasin which is an acutely toxic substance. Two to three seeds are sufficient to cause vomiting, diarrhoea and abdominal cramps (Beck et al). The part of the seed used is the softer kernel which lays inside a hard outer shell. Usage of the cycad is one of the more interesting of known Aboriginal plants, because of its toxicity and the skill required in selecting and preparing the seeds. Information of Aboriginal usage of cycad seeds comes from Northern Australia where it still forms a significant part of the diet among the Donydji people of northeast Arnhem Land. Three different methods of preparing the seeds for use are as follow. In northern Australia, the most common technique used is to gather dead fallen seeds from under the cycad plant. The fallen seeds are gathered after prolonged periods during which the seeds have often been subjected to fires and fungus, decreasing the levels of toxicity. The gathered seeds (called munbuwa) are still vigorously inspected and sorted using an acquired skill with smell and touch to determine the least toxic seeds for food preparation. The other technique involves leeching of the fresh nuts collected from the tree. These seeds will be highly toxic. Preparing the seeds for safe usage involves cracking the outer shell of the seed open to expose the softer kernel, which is then crushed and leeched in running water for a week. After this it is ground into a paste, wrapped in paperbark and roasted in ashes for one hour. This method enables the cycad plant to be used during seasons when less dead seeds are available. A less known method involves rolling the removed kernels in hot sand mixed with charcoal, and then placed in a bag with charcoal. The contents of the bag are dried in the sun for several days, then leeched in water. After 4-7 days the kernels are made into a long cake and roasted in a fire. Fragments of used macrozamia have been discovered in archaeological deposits in the Warrumbungles (Kawambrai Cave). How the seeds were prepared is unknown. However, one theory is that whole cones were gathered from the plants and cached in caves to dry the seeds prior to use.
Marsilea drummondii	Nardoo, Southern cross	Aboriginal women gathered Nardoo spores-cases once the water had dried up. The spore-cases were broken up on grindstones, and the spores were separated then ground between stones, removing the black husks the remaining yellow powder was mixed in with water to produce damper or porridge. Usually made when food was scarce or in hard times such as

Scientific Name	Common Name/s	Use
		drought.
Mentha satureioides	Creeping mint, squeejit, and penneroi, native pennyroyal	Pennyroyal was placed on floors and in beds, it was very efficient in keeping insects, bugs and fleas away. In the south districts of NSW, pennyroyal was used by female's as a tea or decoction for irregular periods, with most satisfactory results
Myoporum montanum	Water bush, western boobialla, bush boobialla, boomeralla, native daphne, native myrtle	The plant is left in hot or boiling water for several minutes, the liquid is then used to scrub the head to treat general ailments. Leaves boiled for external use
Opuntia stricta	Common pest-pear, pest-pear, erect prickly pear, gayndah pear, common prickly pear, spiny prickly pear	Although an introduced species and considered a pest Aboriginal people interviewed in the oral history project as part of the cultural heritage assessment for the Brigalow Belt Bioregion often talked about prickly pear as a delicious refreshing fruit. Use of this fruit is especially common among Aboriginal drovers. A high cultural value among Aboriginal people
Owenia acidula	Native peach, gruie, sour plum, native nectarine, mooley apple, rancooran, warrongan, colane, moalie apple, gruie-colane, kangaroo apple, gooya	A wood decoction was used to bathe sore eyes. Emu apple apparently was used to treat malaria although there is no mention to which part of the tree was used. The fruit was also eaten.
Persoonia spp. (*curvifolia, sericea* and *cuspidifera*)	Geebung	The Geebung is a famous heathland plant. The word geebung is a traditional name thought to originate from New South Wales. Geebung fruit was an important food source. Mrs Maureen Sulter and her brother Mervyn Cain spoke of collecting Geebung berries at Burra Bee Dee Mission in Coonabarabran.

Scientific Name	Common Name/s	Use
Phragmites australis	Phragmites, cane grass	Underground shoots from the common reed are eaten. People from the lower Murray River made rectangular rafts by layering and bounding the long stems together; they were used for collecting mussels on inland lakes. The bamboo-like stems made excellent light spears, when the stem was cut into short lengths it was used to stick through the septum of the nose as an ornament or it could be threaded onto fibre or animal fur and worn around the neck for both women and men. Baskets and bags were made from the leaves
Pimelea linifolia	Ganny's bonnet, queen-of-the-bush, flax-leaf rice-flower, white riceflower, native candy-tuft, buttons, slender rice flower	String was made from riceflower bark and was known as 'Bushman's Bootlace'. The bark was first striped off the shrub, dried, then placed in a stream for about a week then dried once more. Next, the bark was softened by chewing or beating with sticks and stones then rolled on the thigh and spun to a fine strong thread. The string could be used for numerous purposes such as net making
Pittosporum phylliraeoides	Western pittosporum, berrigan, locketbush, native willow, poison-berry tree, inland pittosporum, cheesewood, meeimeei, cumby cumby, cattle bush, weeping pittosporum, wild apricot, narrow-leaved pittosporum, dessine	During autumn a gum is collected from the branches and eaten, the gum contains high amounts of carbohydrates, but does not offer much in the way of taste. The seeds are pound into flour for food usage or ground to form an oily paste, which is then rubbed on sore areas of the body. An infusion of leaf, fruit and wood was prepared, the brew is taken internally or applied externally for a variety of illnesses including internal pains, sprained limbs and skin irritations such as eczema. In some parts of New South Wales the leaves are warmed than placed on a mothers breast to induce the first flow of milk following childbirth.
Portulaca oleracea	Munyeroo, Purslane, pigweed	Common pigweed was eaten by Aboriginals, early Australian explorers and settlers, both raw and as a cooked vegetable. It contains high amounts of protein, water, dietary fibre and trace elements. Pigweed actually contains 18.5 per cent protein compared with 11.5 per cent for wholemeal bread and only 6.9 per cent for brown rice. Although pigweed was quite a god source of minerals European settlers believed it to cure scurvy, resent tests by the department of Defence Support showed only traces of vitamin C. After collecting the seeds in a coolamon

Scientific Name	Common Name/s	Use
		they were ground in between stones, adding water the mixture was ready to be baked in hot ashes to produce damper or cakes, similar tasting to linseed. Seeds could be stored for long periods of time making them a stable and reliable source of food especially in times of drought. In some cases the whole plant, stem and leaves were ground with stones to create a thick green edible paste. The mush was eaten immediately. This food source could also be rolled into balls dried and then recreated latter by soaking in water
Santalum acuminatum	Sweet quandong, native quandong, desert quandong, quandong	Quandongs were a useful source of food. Due to the high content of water contained in the fruit quandongs were often gathered during droughts. Dehydrated fruit may also have been pounded in to a paste. The kernel was extracted when it could be heard knocking from inside the stone. It may be eaten raw or pounded so the oil can be removed and used as a cosmetic to smooth the skin of face or body. Aborigines were able to distinguish trees that may have 'good' kernels and which may be toxic. The stones were made up into necklaces and ornaments. Aboriginal people interviewed in the oral history project as part of the cultural heritage assessment for the Brigalow Belt South Bioregion often talked about quandongs. Quandongs have high cultural value among Aboriginal people
Sarcostemma australe	Caustic bush, milk bush, tableland caustic bush, caustic plant, ley bush, snake plant, milk vine, pencil caustic, snake vine	A rubbing medicine. *Kiji kiji* is used on scabies and irritating sores by breaking the stem and dabbing the white sap on to the affected area. It is best to use the sap after rain because the flow is much stronger. The whole vine as well as the sap were also warmed and rubbed on women's breasts to induce lactation
Sonchus oleraceus	Sowthistle, annual sowthistle, thalaak, common sowthistle	This species is eaten raw in western Victoria to ease pain and induce sleep. Leaves roots and stems of the common milk thistle were eaten. European settlers cooked the shoots as a vegetable. Villagers in Asia and Africa also eat this species. E. Stephens, a settler near Adelaide, even witnessed a thistle feast: "the Aborigines" saw about a quarter of an acre of luxuriant sow thistle on our land. Some of them asked if they might have them. I obtained the requisite permission, and told them that they could take the lot. In a moment they had climbed the fence, and this little plot was one mass of seething men, women and children. Ten minutes later the ground was bare of thistles, and the tribe passed on gratefully devouring the juicy

Scientific Name	Common Name/s	Use
		weed.”
Styphelia triflora	Five corners	The edible berry found growing on this species is quite favoured among Aboriginal people within the Brigalow Belt South. Mrs Maureen Sulter (Coonabarabran) as a child remembers collecting five corners in little tins or jars at Burra Bee Dee. Dan Trindall (Narrabri) mentioned his uncle Barry Williams who worked in the Pilliga scrub as a dingo trapper teaching him about the five corners and many other bush fruits. Five corners is a plant food commonly known to the Toomelah/Boggabilla community.
Themeda spp. (*australis* and *avenacea*)	Kangaroo grass	The seeds are ground and baked. A closely related species, Themeda avenacea know as Native oatgrass is similar but larger & has larger needs. The seeds of this species may also have been used. It grows in depressions & floodways and good soils in drier regions of the Brigalow Belt South Bioregion and the north west slopes & plains of NSW
Thysanotus tuberosus	Fringed violet, violet lily, 1bulb, and 2bulb (depending on amount of bulbs produced), goomei or goomyeye.	Under the ground the roots swell into small sugary tubers that are dug up with digging sticks, the roots and base of the stem can both be eaten. A hard shell surrounds the roots, which splits open when the tuber is cooked in hot ashes
Typha orientalis	Broad-leaved cumbungi, cat’s-tail, reed-mace, wonga, miranda	The rhizomes were collected by Aborigines and ground to make a type of flour from which cakes were produced, the glutinous rhizome also provided starch, sugar, and a considerable amount of fibre seasonally to the people of Victoria and New South Wales. The strap-like leaves have been used in the production of mats and baskets. In the Marshlands of south western Australia and the Murray Darling system of New South Wales the very new white to green shoots of these rushes are gathered during spring and early summer and either eaten raw or cooked. The fluffy seed heads were once collected along the Murray River and sold as stuffing for pillows. According to the Explorer Thomas Mitchell, bulrushes were the principle food of Aborigines of the Lachlan River. He observed the Aborigines gathering large bundles and carrying them in net bags on their heads. String was made from bulrushes by steaming the stems in an earth oven. After steaming, the stems they were chewed removing starch and the

Scientific Name	Common Name/s	Use
		remaining fibre was used to make the string.
Urtica incisa	Tall nettle, scrub nettle, stinging nettle	It is known in some areas that stinging nettle was used for rheumatism, the affected area is beaten with a bunch of leaves to cause a nettle rash. Another usage was for sprains, an infusion of leaves was created to bathe the sprain in, and boiled leaves were also used as a poultice
Xanthorrhoea australis	Grass trees	Grass trees were once a multiple source of food. Flowers contain a considerable amount of nectar and were soaked in water to make a sweet drink. The soft basal parts of the leaves, as well as the stem were eaten. Nutty tasting starch was gouged from the top of the trunk. The tall straight stems of the flower spikes, which were up to 3 m long, made excellent light spear shafts. They were attached to the lower end of spears to extend their length and, therefore, range. The section of the spear closest to the tip was of harder wood that could withstand impact. To haft the spears, the gum from the grass tree was used. The gum when slightly heated would form a liquid and then reharden when cooled, fibrous material such as wood shavings were added during the process. This method helped to shape the resin making it easier to attach stone flakes to spears, to make handles for numerous stone implements, and to fasten stone axe-heads to wooden handles. At Bunbury in southwest Australia, soaking the flower heads or cones of grass trees made a drink called mangaitj. The mixture was allowed to ferment for several days in water in a bark trough. It was reported to make people excited and voluble. The tree age can be determined by the height of the trunk, early photos show trees twice the height of a human. It is quite rare to find specimens of such height today. Grass trees are now a protected species. To make a fire, the dry stalk from the flowering part of the grass tree (Xanthorrhoea australis) was used serving as a base in which a stem of Austral Mulberry (Hedycarya angustifolia) was spun or drilled rapidly, both of these species are found within the boundaries of the Brigalow Belt South.

Appendix B Threats and management actions

Table 15 to **Table 18** outline the potential threats and respective recovery actions which apply to each threatened species either known or with the potential to occur in the study area

The following key applies to each table:

Likelihood of occurrence:
P = Potential
K = Known

Threats and recovery actions:
1 = threat or recovery directly stated in reference source
2 = threat or recovery action implied by the recommendation by listing of threat or detailing a management strategy (e.g. feral cats listed as a threat but “control feral cats” not explicitly listed as a management strategy)

Table 15: Threats to threatened fauna species known or with the potential to occur in the study area

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Predation/competition by feral animals						Loss of hollow- bearing trees	Inappropriate fire regimes	Forest structural changes	Weed invasion	Grazing pressure (general)	Feral herbivores					Competition from noisy miners	Removal of fallen timber/dead trees	Competition from feral bees	Info sources
					Feral predators	Foxes	Cats	Wild dogs	Rats/Mice	Unspecified						Unspecified	Pigs	Rabbits	Goats	Horses				
Aepyprymnus rufescens	Rufous Bettong	V	~	P	1	1	1	1				2	1	2	1			1				1		(OEH, 2015); (Kavanagh & Stanton, 2005)
Anseranas semipalmata	Magpie Goose	V	Mar	P	1	1				1		1		1	1									(OEH, 2015); (DotE, 2014)
Anthochaera phrygia	Regent Honeyeater	CE	E, M	P	1	2	1					1	1		1			1			1	1		(ACT Government, 1999b), (OEH, 2015), (DECCW, 1999)
Apus pacificus	Fork-tailed Swift	-	M, Mar	K	1		1																	(DotE, 2014)
Ardea alba	Great Egret, White Egret	~	M, Mar	K								1		1										(DotE, 2014)
Ardea ibis	Cattle Egret	~	M, Mar	K	1		1																	(DotE, 2014)
Ardeotis australis	Australian Bustard	E1	~	P	1	1	1					2			1		1		1					(OEH, 2015)
Botaurus poiciloptilus	Australasian Bittern	E1	E	P	1	1	1	1				1			1	1								(OEH, 2015); (DotE, 2014)
Burhinus grallarius	Bush Stone-curlew	E1	~	P	1	1	1	1				1		1	1		1					1		(OEH, 2015); (DEC, 2006b)
Calidris acuminata	Sharp-tailed Sandpiper		M, Mar	P										1										
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	~	K							1	1			1	1								(OEH, 2015)
Cercartetus nanus	Eastern Pygmy-possum	V	~	K	1	1	1	1				1			1			1				1		(OEH, 2015)
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	P	1	1						1			1				1					(OEH, 2015); (DotE, 2014)
Chalinolobus picatus	Little Pied Bat	V	~	K	1		1																	(OEH, 2015)
Chthonicola	Speckled Warbler	V	~	K	1	1	1	1	1			1		1	1			1				1		(OEH, 2015)

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Predation/competition by feral animals						Loss of hollow- bearing trees	Inappropriate fire regimes	Forest structural changes	Weed invasion	Grazing pressure (general)	Feral herbivores					Competition from noisy miners	Removal of fallen timber/dead trees	Competition from feral bees	Info sources
					Feral predators	Foxes	Cats	Wild dogs	Rats/Mice	Unspecified						Unspecified	Pigs	Rabbits	Goats	Horses				
sagittata																								
Circus assimilis	Spotted Harrier	V	~	K											1									(Attwood et al., 2009)
Daphoenositta chrysoptera	Varied Sittella	V	~	K										2							1	1		(OEH, 2015)
Dasyurus maculatus	Spotted-tailed Quoll	V	E	P	1	1	1	1				1		1	1							1		(DECCW, 2010); (OEH, 2015); (TSSC, 2004)
Ephippiorhynchus asiaticus	Black-necked Stork	E1	~	K										2	2									(OEH, 2015)
Falco hypoleucos	Grey Falcon	E1	~	P											1									(OEH, 2015)
Falco subniger	Black Falcon	V	~	K											1									(NSW Scientific Committee, 2013)
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	~	M, Mar	P	1	1							1		1									(DotE, 2014)
Glossopsitta pusilla	Little Lorikeet	V	~	K							1	2												(OEH, 2015)
Grantiella picta	Painted Honeyeater	V	~	K											1			1						(DSE, 2003a); (OEH, 2015)
Grus rubicunda	Brolga	V	~	P	1	1						1			1									(DSE, 2003b)
Haliaeetus leucogaster	White-bellied Sea-Eagle	~	M, Mar	K																				
Hamirostra melanosternon	Black-breasted Buzzard	V	~	P											1									(OEH, 2015)
Hieraaetus morphnoides	Little Eagle	V	~	K											1							2		(OEH, 2015)
Hirundapus caudacutus	White-throated Needletail	-	M, Mar	K																				
Hoplocephalus bitorquatus	Pale-headed Snake	V	~	K								1			2							1		(OEH, 2015)

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Predation/competition by feral animals						Loss of hollow- bearing trees	Inappropriate fire regimes	Forest structural changes	Weed invasion	Grazing pressure (general)	Feral herbivores					Competition from noisy miners	Removal of fallen timber/dead trees	Competition from feral bees	Info sources
					Feral predators	Foxes	Cats	Wild dogs	Rats/Mice	Unspecified						Unspecified	Pigs	Rabbits	Goats	Horses				
Lathamus discolor	Swift Parrot	E1	E, Mar	P	1		1				1	1			1						1			(DotE, 2014);
Lophoictinia isura	Square-tailed Kite	V	~	K								1			1									(OEH, 2015)
Macropus dorsalis	Black-striped Wallaby	E1	~	K	1	1	1					1		1	1			1	1					(OEH, 2015)
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	~	K	1	1	1	1				1		1	1						1	1		(ACT Government, 1999a); (NSW Scientific Committee, 2008a); (OEH, 2015)
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	~	K											1						1			(OEH, 2015)
Merops ornatus	Rainbow Bee-eater	~	M, Mar	K	1	1		1																(DotE, 2014)
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	~	K	1	1	1					1		1										(OEH, 2015)
Myiagra cyanoleuca	Satin Flycatcher	~	M, Mar	K																				
Neophema pulchella	Turquoise Parrot	V	~	K	1	1	1				1			1	1		2		2					(OEH, 2015)
Ninox connivens	Barking Owl	V	~	K	1	1	1				1	1	1	1	1							1		(OEH, 2015); (NPWS, 2003)
Nyctophilus corbeni (syn. Nyctophilus timoriensis (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat	V	V	K						1	1	1			1			1						(DotE, 2014)
Oxyura australis	Blue-billed Duck	V	~	P	1	2						1			1									(OEH, 2015)
Pachycephala	Gilbert's Whistler	V	~	P								1			1									(OEH, 2015)

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Predation/competition by feral animals						Loss of hollow- bearing trees	Inappropriate fire regimes	Forest structural changes	Weed invasion	Grazing pressure (general)	Feral herbivores					Competition from noisy miners	Removal of fallen timber/dead trees	Competition from feral bees	Info sources
					Feral predators	Foxes	Cats	Wild dogs	Rats/Mice	Unspecified						Unspecified	Pigs	Rabbits	Goats	Horses				
inornata																								
Petaurus norfolcensis	Squirrel Glider	V	~	K	1	1	1	1			1	1	2	1	1	1				2				(DSE, 2004); (NSW Scientific Committee, 2008b); (OEH, 2015); (Woinarski, Burbidge, & Harrison, 2014)
Petroica boodang	Scarlet Robin	V	~	P			1		1			2	1	1	1							1		(OEH, 2015)
Phascolarctos cinereus	Koala	V	V	K				1				1		1	1									(DECC, 2008); (OEH, 2015); (Woinarski et al., 2014)
Polytelis swainsonii	Superb Parrot	V	V	P	1	1	1				1	1			1								1	(ACT Government, 1999c); (OEH, 2015); (Baker-Gabb, 2011)
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	~	K	1	1	1							1	1						1	1		(DSE, 2001); (OEH, 2015)
Pseudomys pilligaensis	Pilliga Mouse	V	V	K	1	1	1		1			1					1							(DotE, 2014); (OEH, 2015)
Rostratula australis (syn. Rostratula benghalensis australis)	Australian Painted Snipe	E1	E, Mar	P	1	1	1	1				1		1	1									(DotE, 2014); (OEH, 2015)
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	~	K							1													(OEH, 2015)
Scoteanax rueppellii	Greater Broad-nosed Bat	V	~	K							1	1												(OEH, 2015); (Woinarski et al., 2014)
Sminthopsis macroura	Stripe-faced Dunnart	V	~	P	1	1	1					1			1		2	2	2			1		(OEH, 2015)
Stagonopleura guttata	Diamond Firetail	V	~	K								1		1	1			1				1		(OEH, 2015)

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Predation/competition by feral animals						Loss of hollow- bearing trees	Inappropriate fire regimes	Forest structural changes	Weed invasion	Grazing pressure (general)	Feral herbivores					Competition from noisy miners	Removal of fallen timber/dead trees	Competition from feral bees	Info sources
					Feral predators	Foxes	Cats	Wild dogs	Rats/Mice	Unspecified						Unspecified	Pigs	Rabbits	Goats	Horses				
Stictonetta naevosa	Freckled Duck	V	~	P						2		2			1		2		2					(OEH, 2015)
Tyto novaehollandiae	Masked Owl	V	~	K	1	1					1	1	1		1							1		(DEC, 2006b);(DSE, 2003c); (OEH, 2015)
Vespadelus troughtoni	Eastern Cave Bat	V	~	K	1	1	1					1			1				2					(OEH, 2015)
TOTAL COUNT:					**31**	**27**	**25**	**11**	**3**	**3**	**11**	**36**	**7**	**20**	**42**	**3**	**6**	**9**	**7**	**1**	**6**	**16**	**1**	

Table 16: Management actions that benefit threatened fauna species known or with the potential to occur in the study area

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurrence	Feral predator control					Nest box supplementation	Fire management	Ecological thinning	Weed control	Grazing management/ stock exclusion	Fenced refugia	Feral herbivore control					Removal of feral bees	Captive breeding	Retention/placement woody debris	Info sources
					Foxes	Cats	Wild dogs	Rats/Mice	Unspecified							Unspecified	Pigs	Rabbits	Goats	Horses				
Aepyprymnus rufescens	Rufous Bettong	V	~	P	1	1	2				1		1	1		1							1	(OEH, 2015)
Anseranas semipalmata	Magpie Goose	V	Mar	P	2				1		1		1	1										(OEH, 2015)
Anthochaera phrygia	Regent Honeyeater	CE	E, M	P	1	1					1			1			1					1	2	(OEH, 2015); (QLD EPA, 2008)
Apus pacificus	Fork-tailed Swift	-	M, Mar	K		2																		
Ardea alba	Great Egret, White Egret	~	M, Mar	K							2		2											
Ardea ibis	Cattle Egret	~	M, Mar	K		2																		
Ardeotis australis	Australian Bustard	E1	~	P	1	1					1			1	1		1		1					(OEH, 2015)
Botaurus poiciloptilus	Australasian Bittern	E1	E	P	1	1	2				1			1	1	2								(OEH, 2015)
Burhinus grallarius	Bush Stone-curlew	E1	~	P	1	1	1				2		1	1	1							1	1	(OEH, 2015); (DEC, 2006a)
Calidris acuminata	Sharp-tailed Sandpiper		M, Mar	P									2											(DotE, 2014)
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	~	K						1	1			1										(OEH, 2015)
Cercartetus nanus	Eastern Pygmy-possum	V	~	K	1	1	1				1			1									1	(OEH, 2015)
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	P	1						1			1					1					(OEH, 2015)
Chalinolobus picatus	Little Pied Bat	V	~	K		1																		(OEH, 2015)
Chthonicola sagittata	Speckled Warbler	V	~	K	1	1					2		2	1	1			2					1	(OEH, 2015)
Circus assimilis	Spotted Harrier	V	~	K										1										(OEH, 2015)
Daphoenositta chrysoptera	Varied Sittella	V	~	K									1	1									1	(OEH, 2015)
Dasyurus maculatus	Spotted-tailed Quoll	V	E	P	1	1	2				1		2	2										(ACT Government, 2005), (OEH, 2015)

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurrence	Feral predator control					Nest box supplementation	Fire management	Ecological thinning	Weed control	Grazing management/ stock exclusion	Fenced refugia	Feral herbivore control					Removal of feral bees	Captive breeding	Retention/placement woody debris	Info sources
					Foxes	Cats	Wild dogs	Rats/Mice	Unspecified							Unspecified	Pigs	Rabbits	Goats	Horses				
Ephippiorhynchus asiaticus	Black-necked Stork	E1	~	K									1	1										(OEH, 2015)
Falco hypoleucos	Grey Falcon	E1	~	P										1										(OEH, 2015)
Falco subniger	Black Falcon	V	~	K										2										
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	~	M, Mar	P	2							2		2										
Glossopsitta pusilla	Little Lorikeet	V	~	K							1													(OEH, 2015)
Grantiella picta	Painted Honeyeater	V	~	K										1				2						(OEH, 2015)
Grus rubicunda	Brolga	V	~	P	1						2			1										(DSE, 2003b); (OEH, 2015)
Haliaeetus leucogaster	White-bellied Sea-Eagle	~	M, Mar	K																				
Hamirostra melanosternon	Black-breasted Buzzard	V	~	P										1									1	(OEH, 2015)
Hieraaetus morphnoides	Little Eagle	V	~	K																				
Hirundapus caudacutus	White-throated Needletail	-	M, Mar	K																				
Hoplocephalus bitorquatus	Pale-headed Snake	V	~	K							1			1									2	
Lathamus discolor	Swift Parrot	E1	E, Mar	P		2					2			1										(DotE, 2014); (Swift Parrot Recovery Team, 2011)
Lophoictinia isura	Square-tailed Kite	V	~	K							1			2										
Macropus dorsalis	Black-striped Wallaby	E1	~	K	1	1					1		1	1				1	1					
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	~	K	2	2	2				2		2	1									1	(OEH, 2015)
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	~	K										2										(OEH, 2015)
Merops ornatus	Rainbow Bee-eater	~	M, Mar	K	2		2																	(DotE, 2014)

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurrence	Feral predator control					Nest box supplementation	Fire management	Ecological thinning	Weed control	Grazing management/ stock exclusion	Fenced refugia	Feral herbivore control					Removal of feral bees	Captive breeding	Retention/placement woody debris	Info sources
					Foxes	Cats	Wild dogs	Rats/Mice	Unspecified							Unspecified	Pigs	Rabbits	Goats	Horses				
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	~	K	1	1					1		1											(OEH, 2015)
Myiagra cyanoleuca	Satin Flycatcher	~	M, Mar	K																				
Neophema pulchella	Turquoise Parrot	V	~	K	1	1							1	1			1		1					(OEH, 2015)
Ninox connivens	Barking Owl	V	~	K	2	2					1	2	2	1									1	(OEH, 2015)
Nyctophilus corbeni (syn. Nyctophilus timoriensis (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat	V	V	K					1		1			2				2						(DotE, 2014)
Oxyura australis	Blue-billed Duck	V	~	P	1						1			1										(OEH, 2015)
Pachycephala inornata	Gilbert's Whistler	V	~	P							1			1										(OEH, 2015)
Petaurus norfolcensis	Squirrel Glider	V	~	K	2	2	2				1	1	2	1						1				(OEH, 2015); (Woinarski et al., 2014)
Petroica boodang	Scarlet Robin	V	~	P		1		1			1	2	2	1									1	(OEH, 2015)
Phascolarctos cinereus	Koala	V	V	K			1				1		2	2										(DECC, 2008); (OEH, 2015); (Woinarski et al., 2014)
Polytelis swainsonii	Superb Parrot	V	V	P	2	2					1			1							1			(DotE, 2014); (OEH, 2015)
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	~	K	2	1							2	1									1	(DSE, 2001); (OEH, 2015)
Pseudomys pilligaensis	Pilliga Mouse	V	V	K	1	1		1			1						2							(DotE, 2014); (OEH, 2015)
Rostratula australis (syn. Rostratula benghalensis australis)	Australian Painted Snipe	E1	E, Mar	P	1	1	1				1		2	1										(DotE, 2014); (OEH, 2015)
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	~	K																				
Scoteanax rueppellii	Greater Broad-nosed Bat	V	~	K							2													(OEH, 2015)
Sminthopsis macroura	Stripe-faced Dunnart	V	~	P	1	1					1			1	1		1	1	1				1	(OEH, 2015)
Stagonopleura guttata	Diamond Firetail	V	~	K							2		1	1				2					1	(OEH, 2015)

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurrence	Feral predator control					Nest box supplementation	Fire management	Ecological thinning	Weed control	Grazing management/ stock exclusion	Fenced refugia	Feral herbivore control					Removal of feral bees	Captive breeding	Retention/placement woody debris	Info sources
					Foxes	Cats	Wild dogs	Rats/Mice	Unspecified							Unspecified	Pigs	Rabbits	Goats	Horses				
Stictonetta naevosa	Freckled Duck	V	~	P					1		1			1			1		1					(OEH, 2015)
Tyto novaehollandiae	Masked Owl	V	~	K	2						2	2		2									2	
Vespadelus troughtoni	Eastern Cave Bat	V	~	K	1	1					1			2					1					(OEH, 2015)
TOTAL COUNT:					**27**	**25**	**10**	**2**	**3**	**1**	**36**	**5**	**20**	**42**	**5**	**2**	**6**	**6**	**7**	**1**	**1**	**2**	**15**	

Table 17: Threats to threatened flora species known or with the potential to occur in the study area

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Inappropriate fire regimes	Forest structural changes	Weed invasion	Grazing pressure (general)	Feral herbivores				Info sources
									Pigs	Rabbits	Goats	Horses	
Bertya opponens	Coolabah Bertya	V	V	K	1		1				1		(DotE, 2014); (OEH, 2015)
Cyperus conicus	A sedge	E1	~	P				1		1			(OEH, 2015)
Desmodium campylocaulon	Creeping Tick-Trefoil	E1	~	P				1					(OEH, 2015)
Dichanthium setosum	Bluegrass	V	V	P	1		1	1		2			(DotE, 2014); (OEH, 2015)
Digitaria porrecta	Finger Panic Grass	E1		P	1		1	1					(OEH, 2015)
Diuris tricolor	Painted Diuris	V	~	K			1			1	1		(OEH, 2015)
Homopholis belsonii	Belson's Panic	E1	V	P		1	1	1					(DotE, 2014); (OEH, 2015)
Lepidium aschersonii	Spiny Peppercress	V	V	K			1	1	1	1			(DotE, 2014); (OEH, 2015)
Lepidium monoplocoides	Winged Peppercress	E1	E	K			1	1	1	1			(DotE, 2014); (OEH, 2015)
Monotaxis macrophylla	Large-leafed Monotaxis	E1	~	P	1								(OEH, 2015)
Myriophyllum implicatum		CE	~	K			1		1				(OEH, 2015)
Polygala linariifolia	Native Milkwort	E1	~	K	1		1	1		1	1		(OEH, 2015)
Pomaderris queenslandica	Scant Pomaderris	E1	~	K	1		1						(OEH, 2015)
Pterostylis cobarensis	Greenhood Orchid	V	~	K			1	1	1	1	1		(OEH, 2015)
Rulingia procumbens		V	V	K	1	1							(OEH, 2015)
Tylophora linearis	-	V	E	K	1		1	1	1		1		(NSW Scientific Committee, 2008c); (OEH, 2015); (TSC, 2008)
TOTAL COUNT:					**8**	**2**	**12**	**10**	**5**	**7**	**5**	**0**	

Table 18: Management actions that benefit threatened flora species known or with the potential to occur in the study area

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Fire management	Ecological thinning	Weed control	Grazing management/ stock exclusion	Fenced refugia	Feral herbivore control				Info sources
										Pigs	Rabbits	Goats	Horses	
Bertya opponens	Coolabah Bertya	V	V	K	1		1					1		(DotE, 2014); (OEH, 2015)
Cyperus conicus	A sedge	E1	~	P				2			2			(OEH, 2015)
Desmodium campylocaulon	Creeping Tick-Trefoil	E1	~	P				1	1					(OEH, 2015)
Dichanthium setosum	Bluegrass	V	V	P	1		1	1			1			(DotE, 2014); (OEH, 2015)
Digitaria porrecta	Finger Panic Grass	E1		P	1		2	1						(OEH, 2015)
Diuris tricolor	Painted Diuris	V	~	K			2				2	2		(OEH, 2015)
Homopholis belsonii	Belson's Panic	E1	V	P			1	1						(DotE, 2014); (OEH, 2015)
Lepidium aschersonii	Spiny Peppercress	V	V	K			1	1		1	1			(Carter, 2010); (DotE, 2014); (OEH, 2015)
Lepidium monoplocoides	Winged Peppercress	E1	E	K			1	1		2	1			(DotE, 2014); (Mavromihalis, 2010); (OEH, 2015)
Monotaxis macrophylla	Large-leafed Monotaxis	E1	~	P	1									(OEH, 2015)
Myriophyllum implicatum		CE	~	K			1			1				(OEH, 2015)
Polygala linariifolia	Native Milkwort	E1	~	K	1		1	1			1	1		(OEH, 2015)
Pomaderris queenslandica	Scant Pomaderris	E1	~	K	1		1							(OEH, 2015)
Pterostylis cobarensis	Greenhood Orchid	V	~	K			1	1	1	2	2	2		(OEH, 2015)
Rulingia procumbens		V	V	K	1	1								(OEH, 2015)
Tylophora linearis	-	V	E	K	1		1	1		2		2		(NSW Scientific Committee, 2008c); (OEH, 2015); (TSC, 2008)

Scientific name	Common name	TSC Act Status	EPBC Act Status	Likelihood of occurrence	Fire management	Ecological thinning	Weed control	Grazing management/ stock exclusion	Fenced refugia	Feral herbivore control				Info sources
										Pigs	Rabbits	Goats	Horses	
TOTAL COUNT					**8**	**1**	**12**	**10**	**2**	**5**	**7**	**5**	**0**	

Appendix C Koala Research Proposal

CONSERVING KOALAS ACROSS THE PILLIGA SCRUB

RESEARCH PROPOSAL

Principal Investigator: Dr. Stephen Phillips
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Background

In recent years there has been a dramatic decline in koala numbers inhabiting the Pilliga Scrub in central western NSW. Recently available data arising from intensive field surveys by several independent researchers over 2013 – 2014 collectively implies a reduction of as much as 95% in the habitat occupancy rate over the last three koala generations (i.e. 18 – 20 years), a finding that arguably qualifies the remaining population(s) as Critically Endangered by International, National and State-focused conservation criteria. The reasons for the dramatic decline remain to be determined but likely include the effects of drought compounded by the cumulative impacts of high intensity/frequency wildfire, aspects of both being arguably exacerbated by anthropogenic climate change. The distribution of remaining koala population cells, aside from generally (but not always) being associated with proximity to water, remains difficult to model and/or predict with certainty.

Whatever the reasons for the decline of koalas across the Pilliga Scrub, there is considerable interest in halting the decline and assisting recovery by way of directing management effort into areas supporting the remaining population cells. However, in order to focus management effort efficiently and expeditiously, there is an over-riding need to know exactly where the remaining populations are located, along with knowledge about how many koalas comprise the population.

Regularised Grid-based Spot Assessment Technique (RGb-SAT) sampling is being regularly applied throughout eastern Australia in areas where koalas are considered to occur, the technique repeatedly demonstrating a capacity to provide robust data and information about koala population size, distribution and habitat use both at the macro-landscape and local population scale. The RG-bSAT approach offers a number of advantages over more conventional survey techniques by adopting a completely unbiased yet systematic approach to survey design while also being able to operate at varying scales depending on what the specific research objective is. By example, simple occupancy data (i.e. presence of koalas within a predetermined *Extent of Occurrence*) can be simply obtained by using a coarse sampling regime of regularly spaced field sites located at say 2 – 4 km intervals or alternatively, finer-scale output that delineates the precise boundaries of resident meta-population cells (i.e. areas occupied by and/or supporting resident koala populations) can be obtained by modelling koala activity data obtained at 500 m and 350 m sampling intervals in areas known to be occupied by the species (Figure 1).

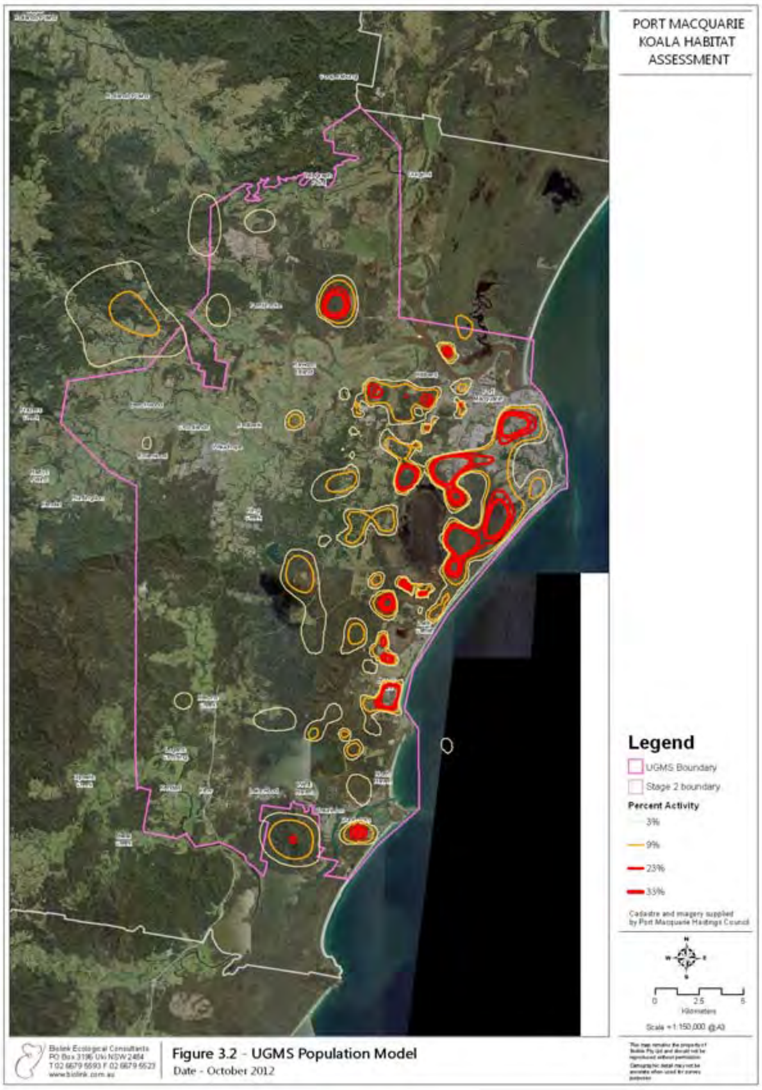

Figure 1. Koala meta-population model for a 74,000 ha coastal portion of the Port Macquarie Hastings Local Government area on the mid-north coast of NSW. The model was based on interpolation of koala activity data collected using the RG-bSAT approach with sampling intervals of 250 m – 1000 m. Across the LGA, habitat occupancy by resident populations based on sampling at 4000 m intervals was estimated at ~24% of available habitat.

Research Proposal

This proposal envisages establishing a 500 m survey grid across the entire ~ 600,000 ha of Pilliga Scrub, the intent to establish a permanently fixed grid that can be surveyed at varying scales, initially at 8 km sampling intersections in order to provide an unbiased occupancy estimate. At this scale of sampling approximately 120 primary field sites would be involved.

Working off the same grid but at a finer resolution of sampling (i.e. 250 m - 500 m intervals) in areas where relic populations have been detected or are otherwise known to occur, we would prepare koala meta-population models that delineate the precise areas being utilized by resident populations with a view to enabling a focusing of management/recovery effort on such issues as weed control, fire suppression and other threatening processes. The models will be accompanied by robust koala density estimates with the actual number of animals comprising the relic population cell precisely identified with 95% confidence.

In order to demonstrate the outcome and potential of this latter approach this proposal envisages focusing on at least two localities where koalas were detected during the 2013 –2014 survey program. Other localities may also be considered. All grid points once sampled have utility for longer-term monitoring biodiversity and koala population monitoring purposes.

Additional funding would be sought to capture additional population cells following completion of this project and/or government/community/industry staff could be trained in the technique with a view to developing a program of ongoing assessment and monitoring.

Project Costs

Working on the basis of discounted professional rates, estimated project costs for the project are in the vicinity of A$65 – A$70K (Excl GST) as follows:

Task 1: Provision of Pilliga-wide unbiased occupancy estimate

(Field crew: n = 2)

Travel: 2,700kms at A$0.75 km^{-1}…………………………………….	2,025
Accommodation (allowance): 22 person days @ A$125.00 day^{-1}…….	2,750
Salaries & on-costs: 22 person days at A$500.00 day^{-1}……………..	11,000
Data analysis, mapping & reporting: 5 days @ A$500 day^{-1}………..	2,500
Total project cost (exc GST)…………………………………………	**18,275**

Note: some funds (approx A$10K) are already available to assist completion of this task (i.e. unbiased occupancy estimate); this proposal is thus only seeking funds to the extent of A$8,275.

Task 2: Koala meta-population models x 2

(Field crew: n = 3)

For each of the two koala meta-population models envisaged by this component of the project we estimate costs on the vicinity of A$25K (exc GST) in both instances, these being the funds required to transport, accommodate and remunerate a field survey team of three people for a minimum of 10 – 12 days, a breakdown of which is as follows:

Travel: 2,700 kms at A$0.75 km^{-1}……………:………………………..	2,025
Accommodation (allowance): 32 person days @ A$125.00 day^{-1}….	4,000
Salaries and on-costs: 32 person days @ A$500 day^{-1}……..	16,000
Data analysis, GIS modeling and reporting: 7 days at $A500.00 day^{-1}…	3,500
Total project cost for each model ……………………………………...	**25,525**

Project Management

Projects would be managed as consultancies, the results expected to be in a format suitable for use by agencies and/or industry in terms of directing management responses, while also being suitable for publication in a peer-reviewed scientific journal.

About the Principal Investigator

Dr. Stephen Phillips is an internationally acknowledged authority on koalas and has over 40 years of demonstrable experience in management of the species. In 1998 and while employed as Principal Biologist with the Australian Koala Foundation his work on processes of habitat assessment and koala population management was recognised by the Smithsonian Institute. In addition to presentations at seminars and conferences he has written book chapters on koalas and had papers on their ecology published in national and international peer-reviewed, scientific journals; he is a former member (independent scientist) of the NSW Koala Recovery Team and more recently a member of the Federal Government's Expert Working Group on koala distribution and abundance. His primary research and consultancy interests focus on the development of landscape-scale habitat and population assessment techniques that can serve to increase the certainty of sustainable development and planning outcomes for koalas and other threatened species.

Further details including a *Curriculum Vitae*, supporting publications and list of koala themed consultancy projects completed over the last 10 years can be provided if required.

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bsi. AS/NZS 4801:2001 Occupational Health and Safety Management

bsi. ISO 9001 Quality Management

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