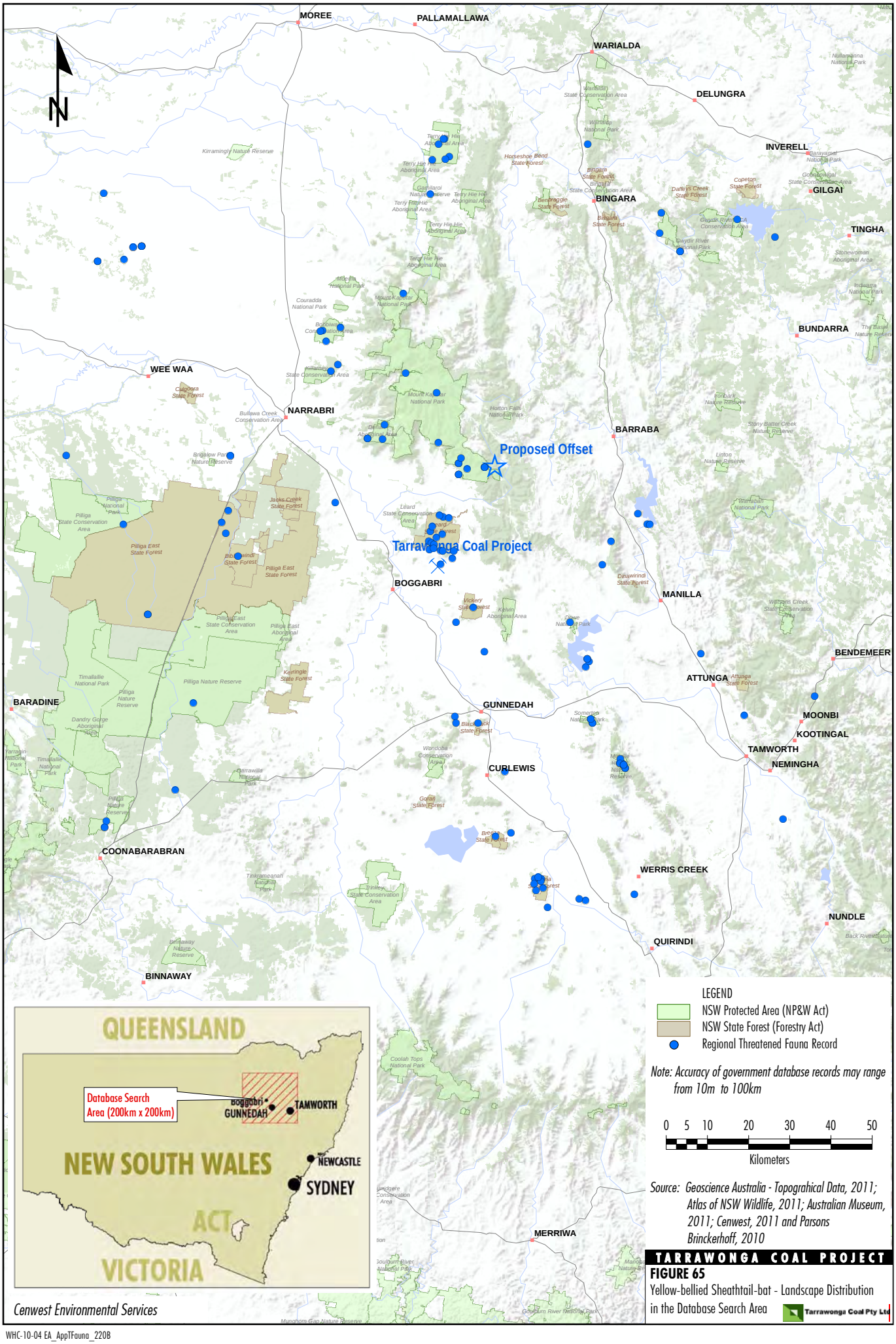


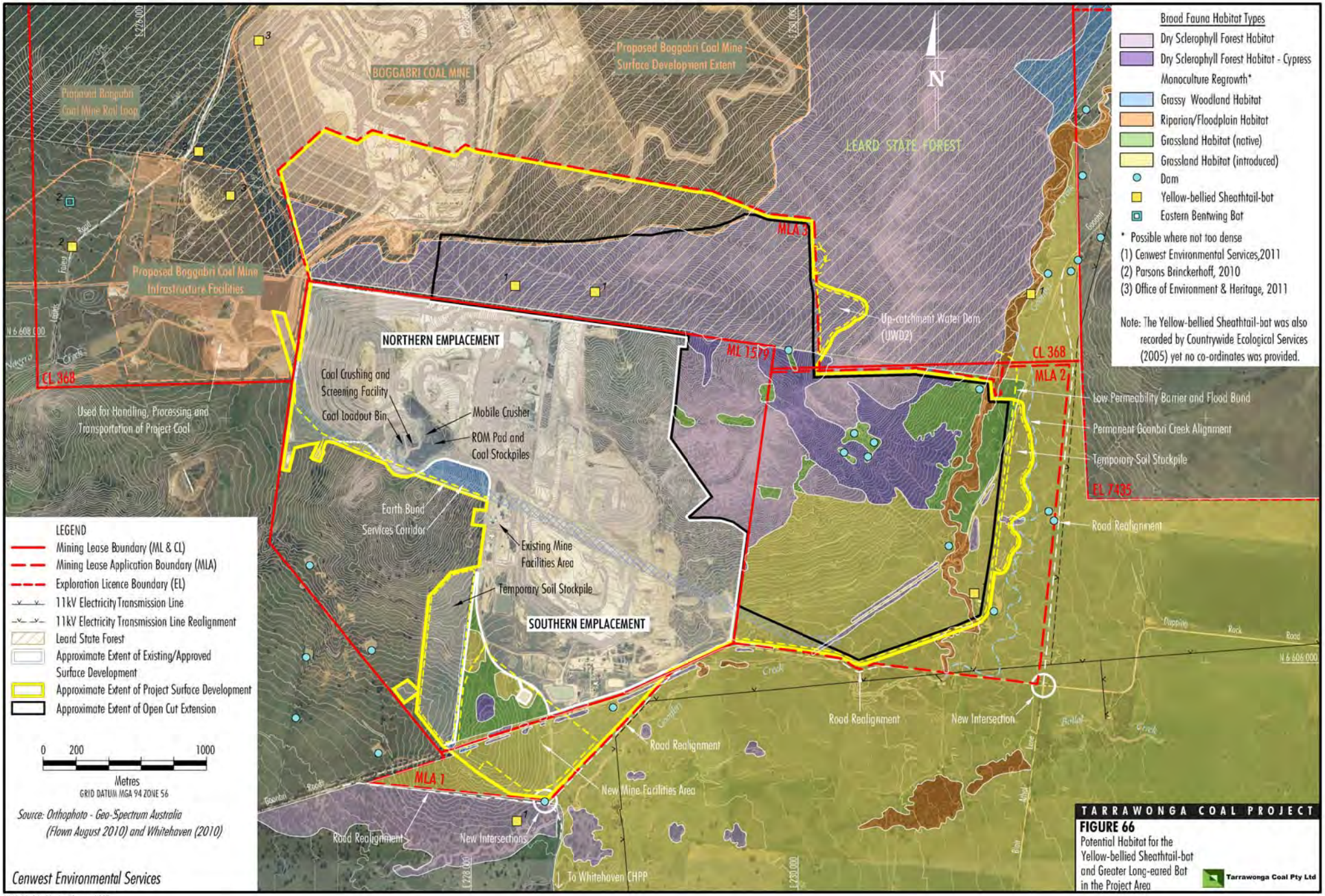
Cenwest Environmental Services

TARRAWONGA COAL PROJECT

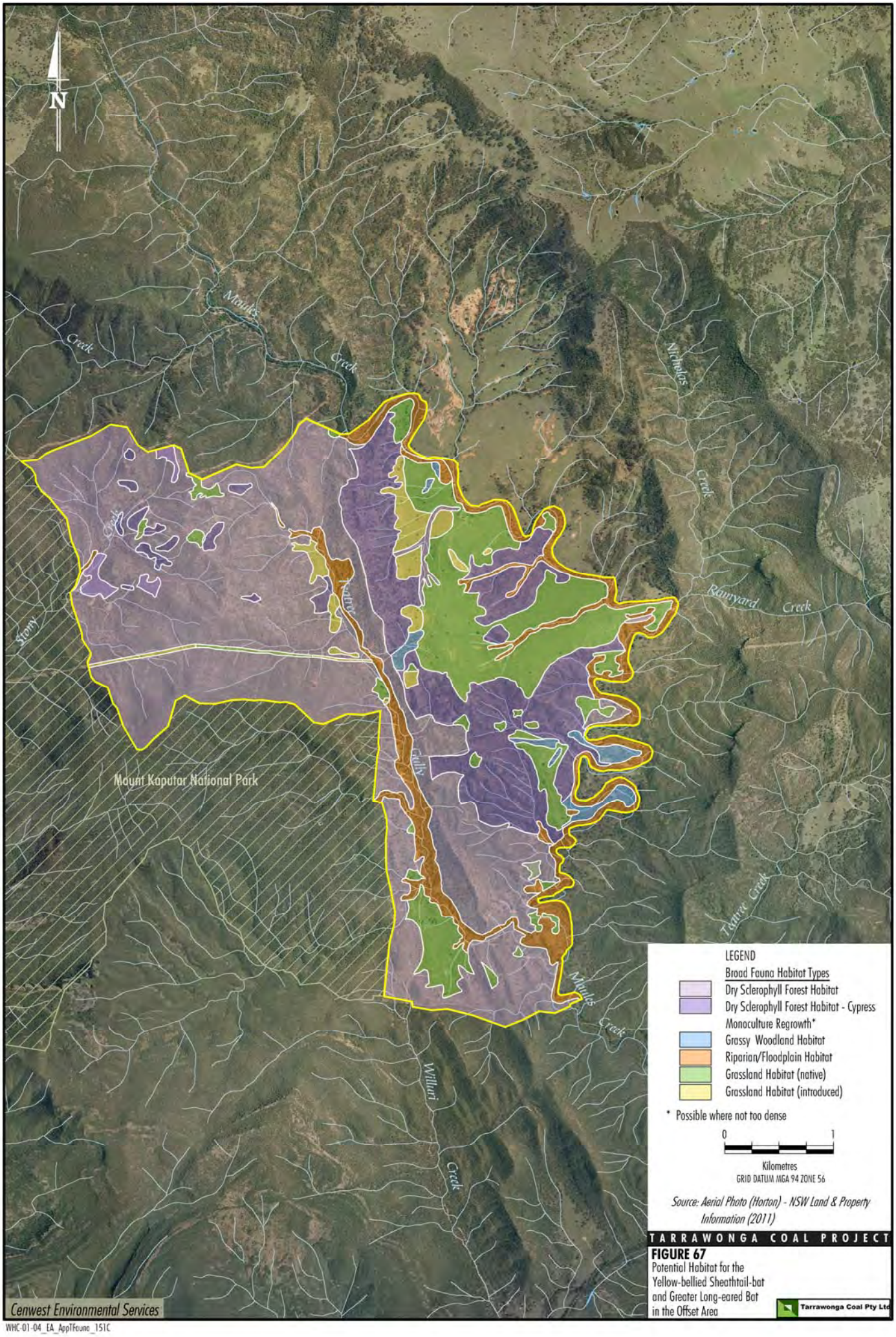
FIGURE 65

Yellow-bellied Sheathtail-bat - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd



WHC-01-04_EA_AppTFauna_130D



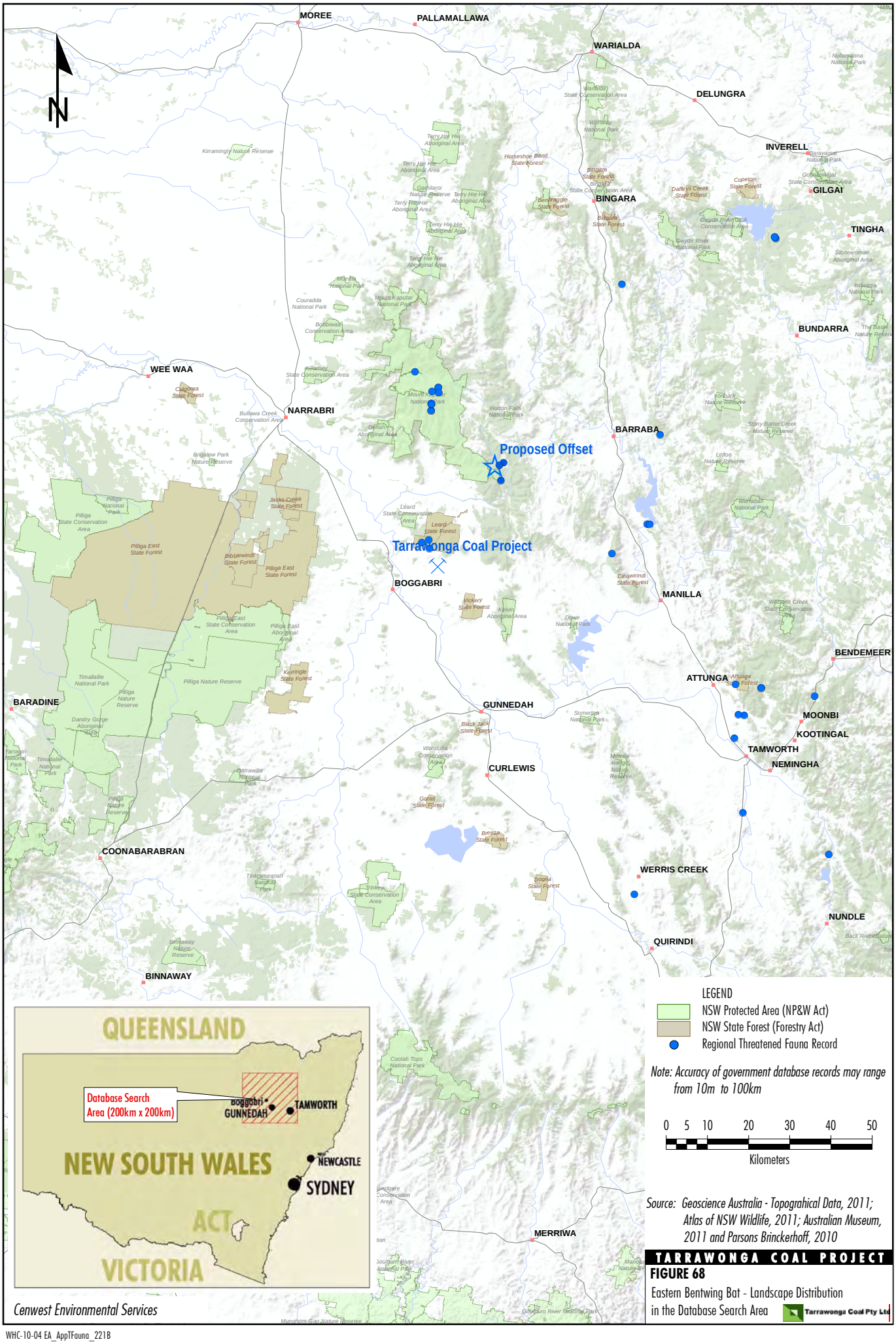
TARRAWONGA COAL PROJECT

FIGURE 67
Potential Habitat for the Yellow-bellied Sheathtail-bat and Greater Long-eared Bat in the Offset Area

Cenwest Environmental Services

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_AppTFauna_151C



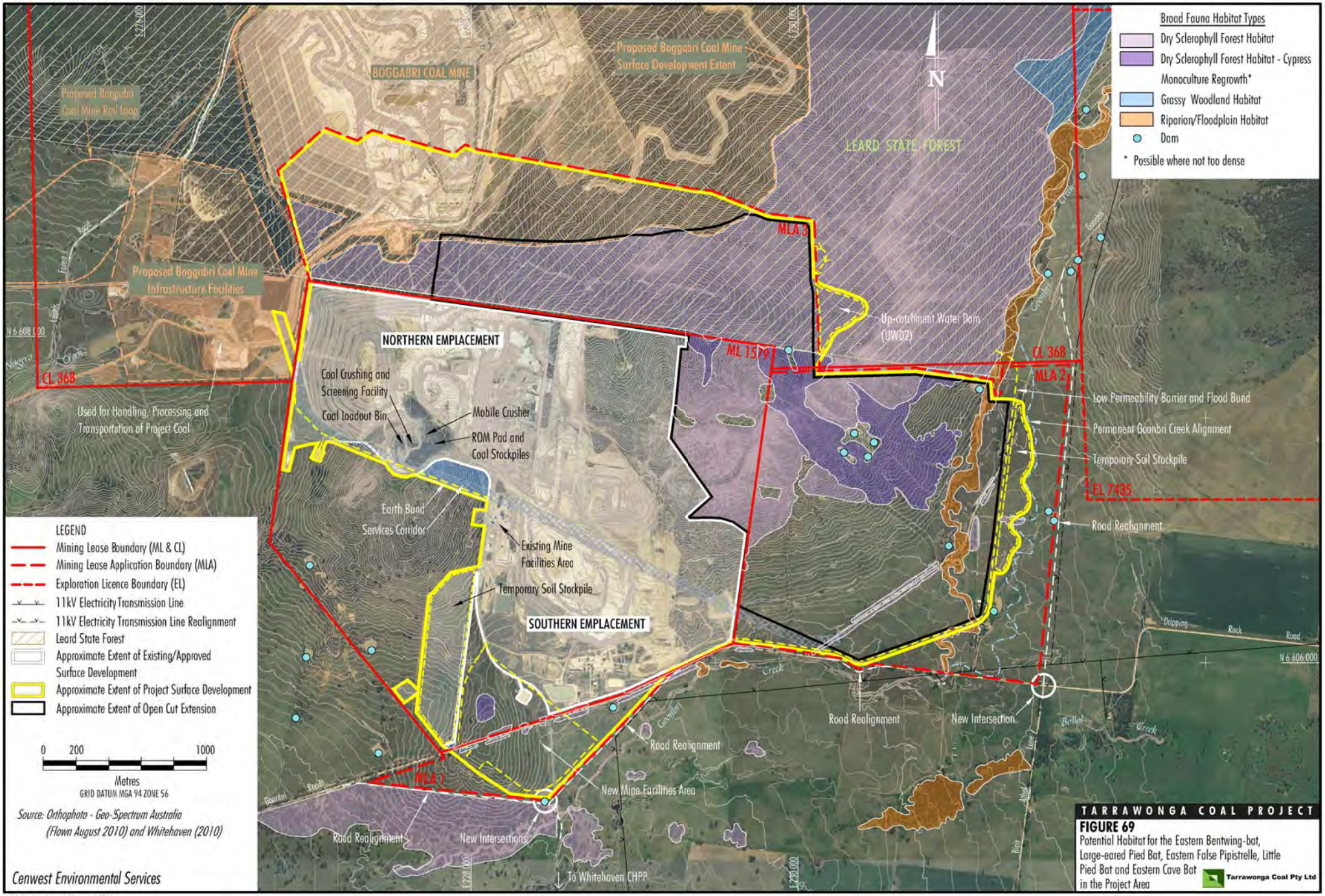
Cenwest Environmental Services

TARRAWONGA COAL PROJECT

FIGURE 68

Eastern Bentwing Bat - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd



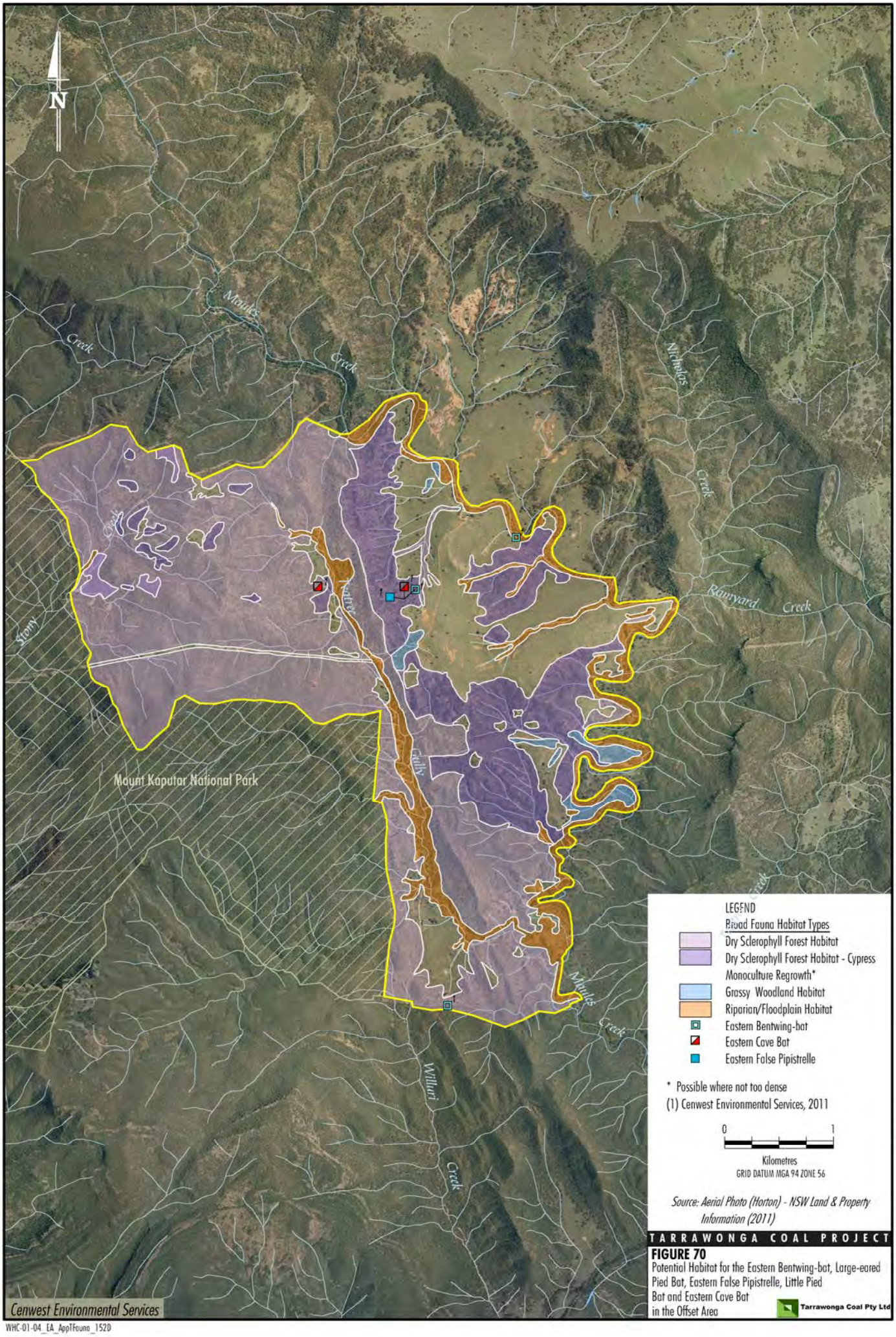
TARRAWONGA COAL PROJECT

FIGURE 69

Potential Habitat for the Eastern Bentwing-bat, Large-eared Pied Bat, Eastern False Pipistrelle, Little Pied Bat and Eastern Cave Bat in the Project Area

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_AppTFauna_133E



TARRAWONGA COAL PROJECT

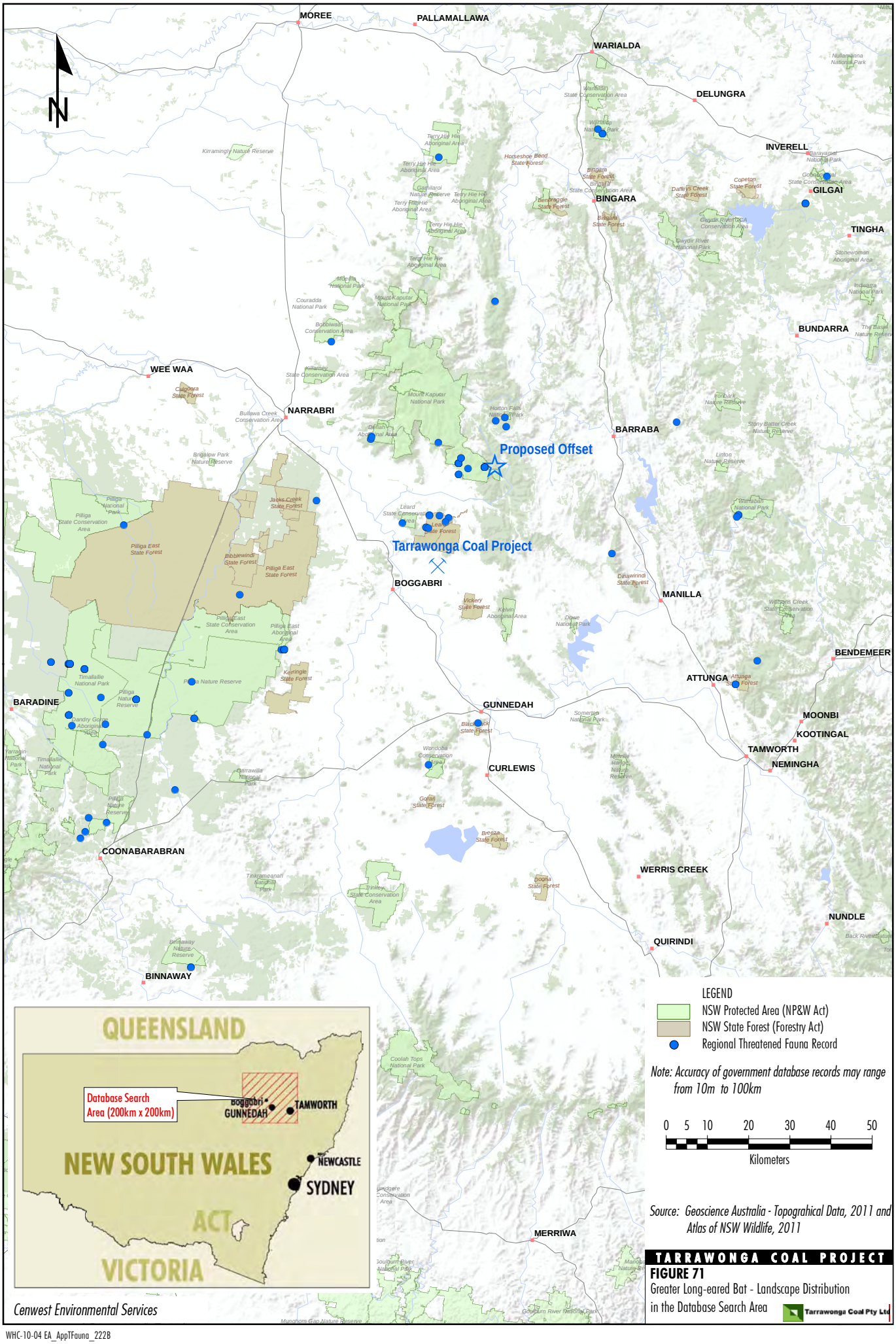
FIGURE 70

Potential Habitat for the Eastern Bentwing-bat, Large-eared Pied Bat, Eastern False Pipistrelle, Little Pied Bat and Eastern Cave Bat in the Offset Area

Tarrawonga Coal Pty Ltd

Cenwest Environmental Services

WHC-01-04_EA_AppTFauna_152D



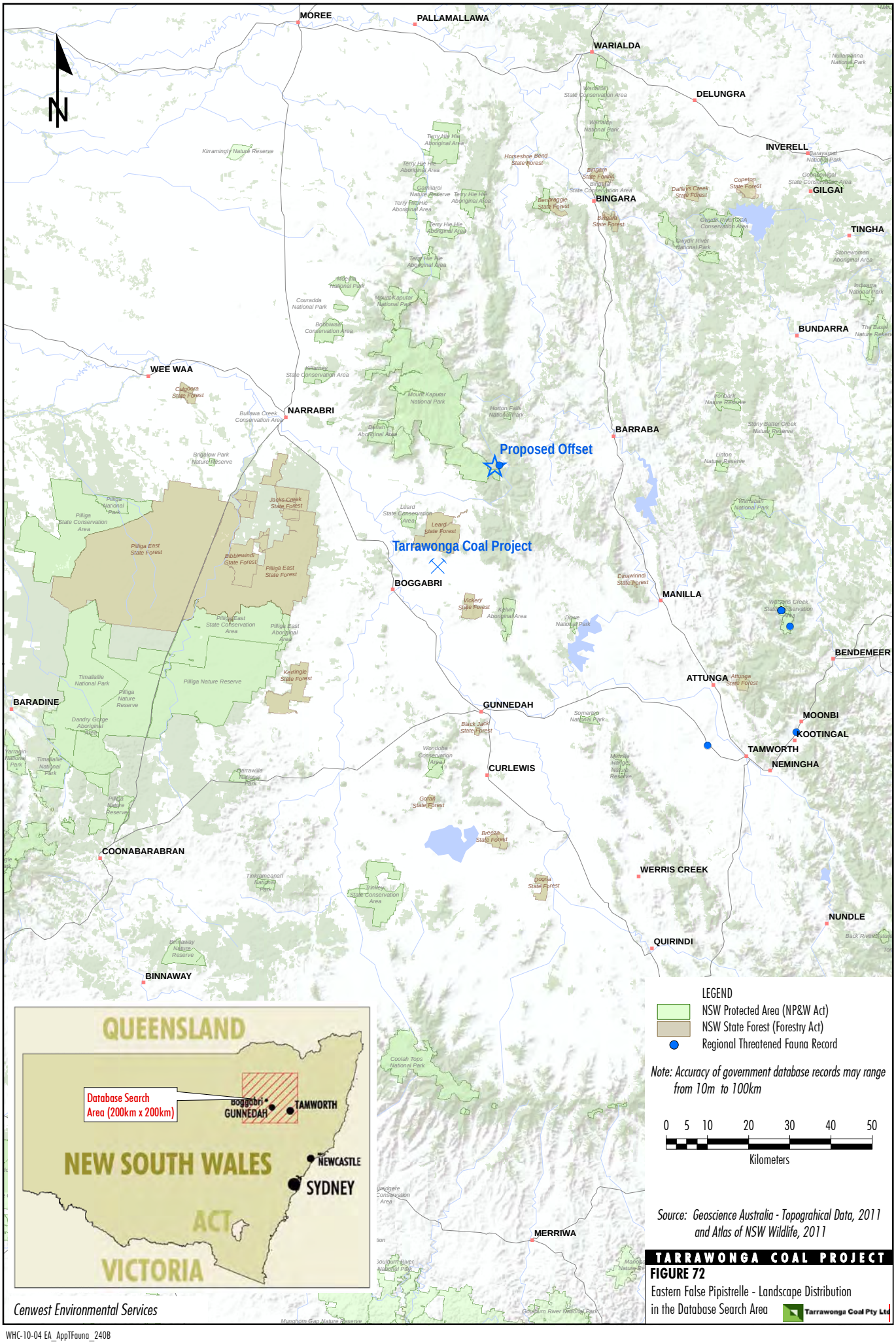
Cenwest Environmental Services

TARRAWONGA COAL PROJECT

FIGURE 71

Greater Long-eared Bat - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd



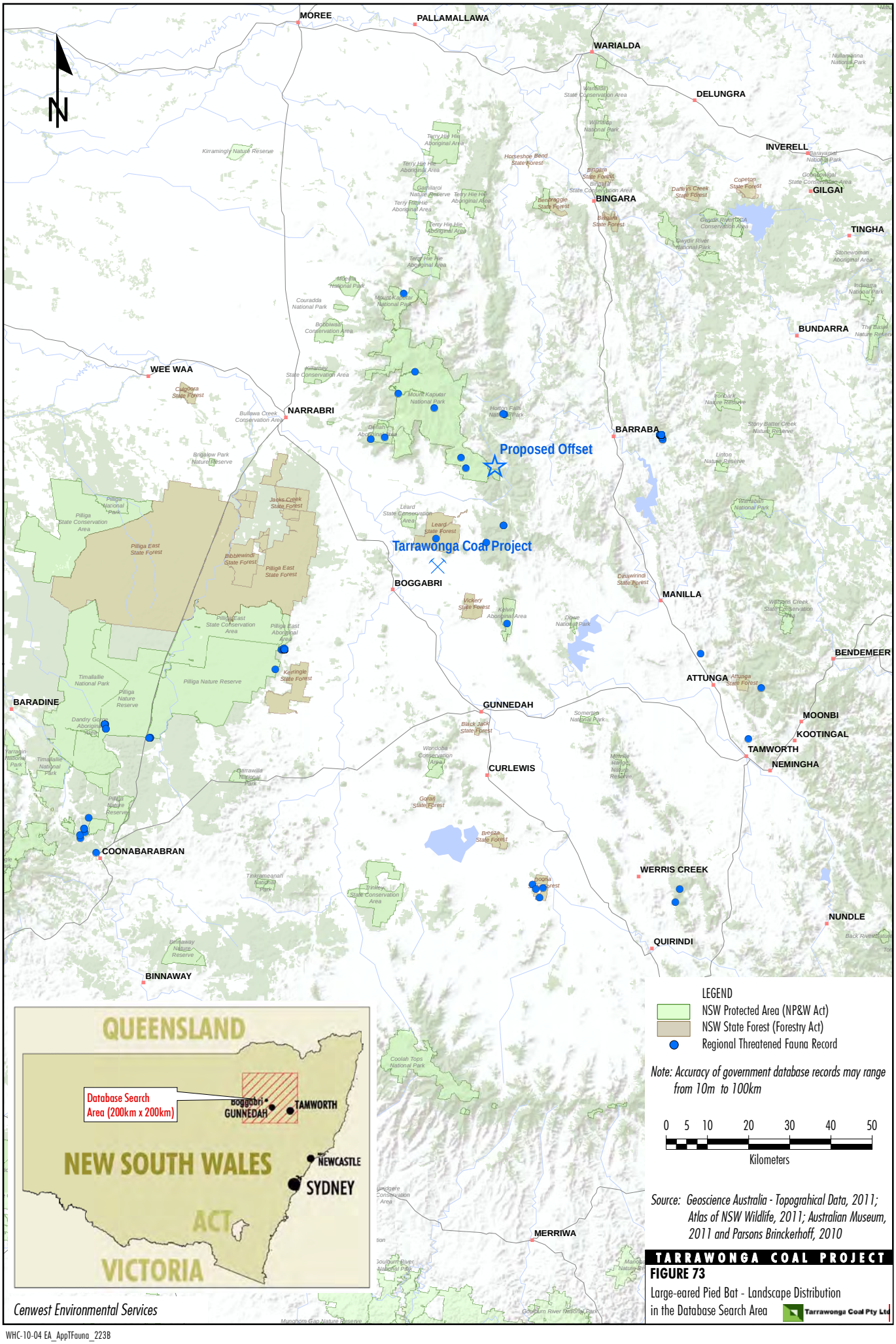
Cenwest Environmental Services

TARRAWONGA COAL PROJECT

FIGURE 72

Eastern False Pipistrelle - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd



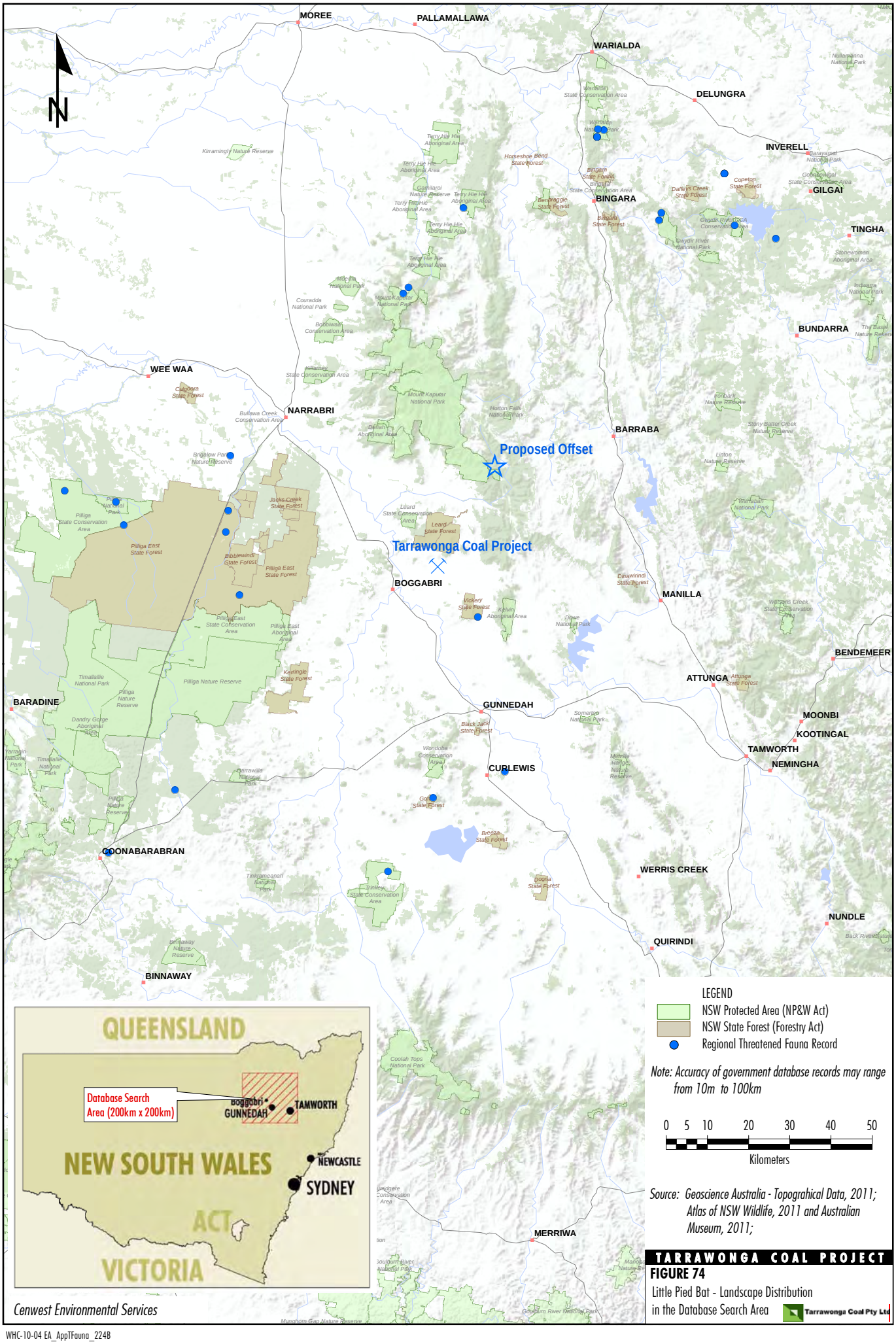
Cenwest Environmental Services

TARRAWONGA COAL PROJECT

FIGURE 73

Large-eared Pied Bat - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd



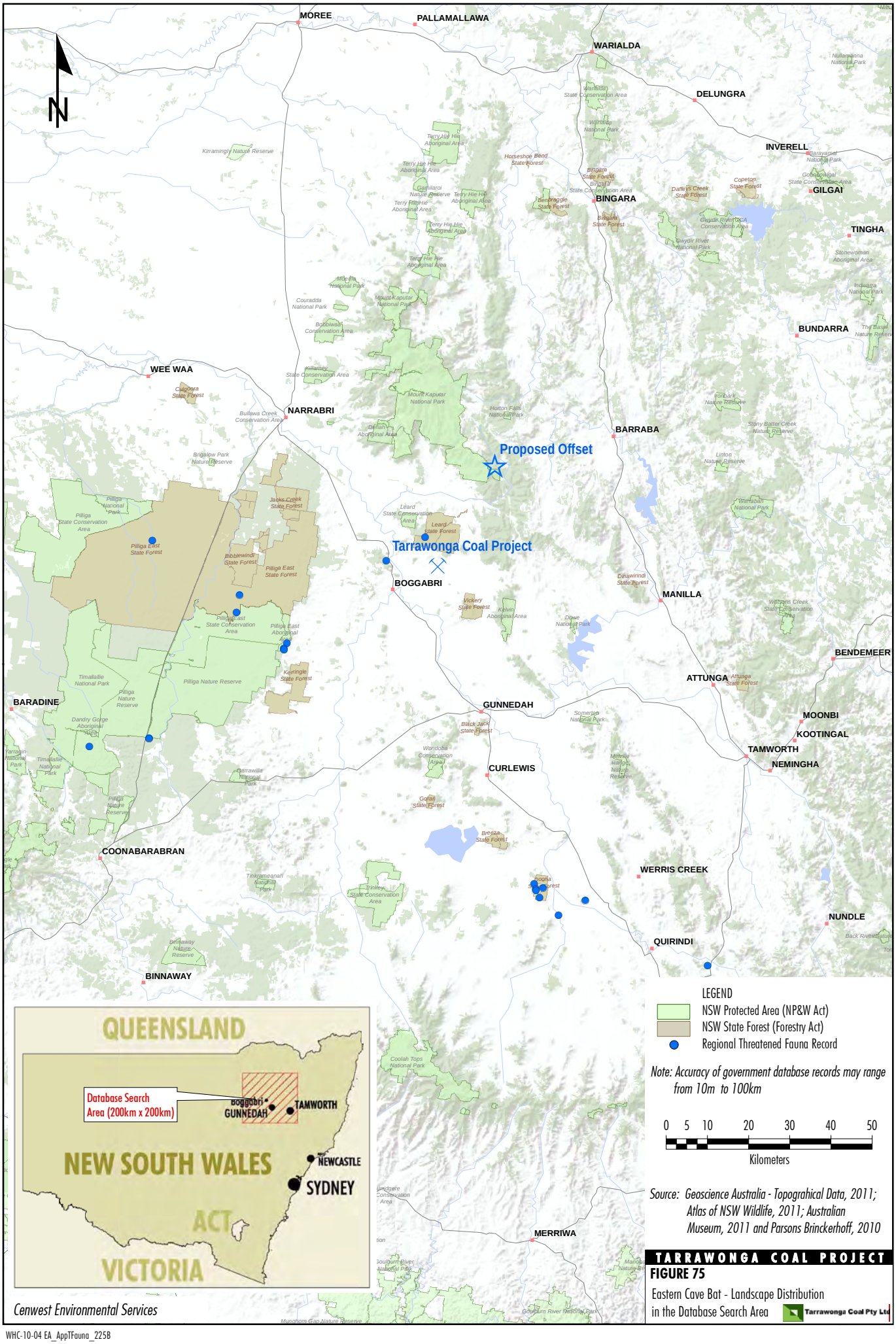
Cenwest Environmental Services

TARRAWONGA COAL PROJECT

FIGURE 74

Little Pied Bat - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd



Cenwest Environmental Services

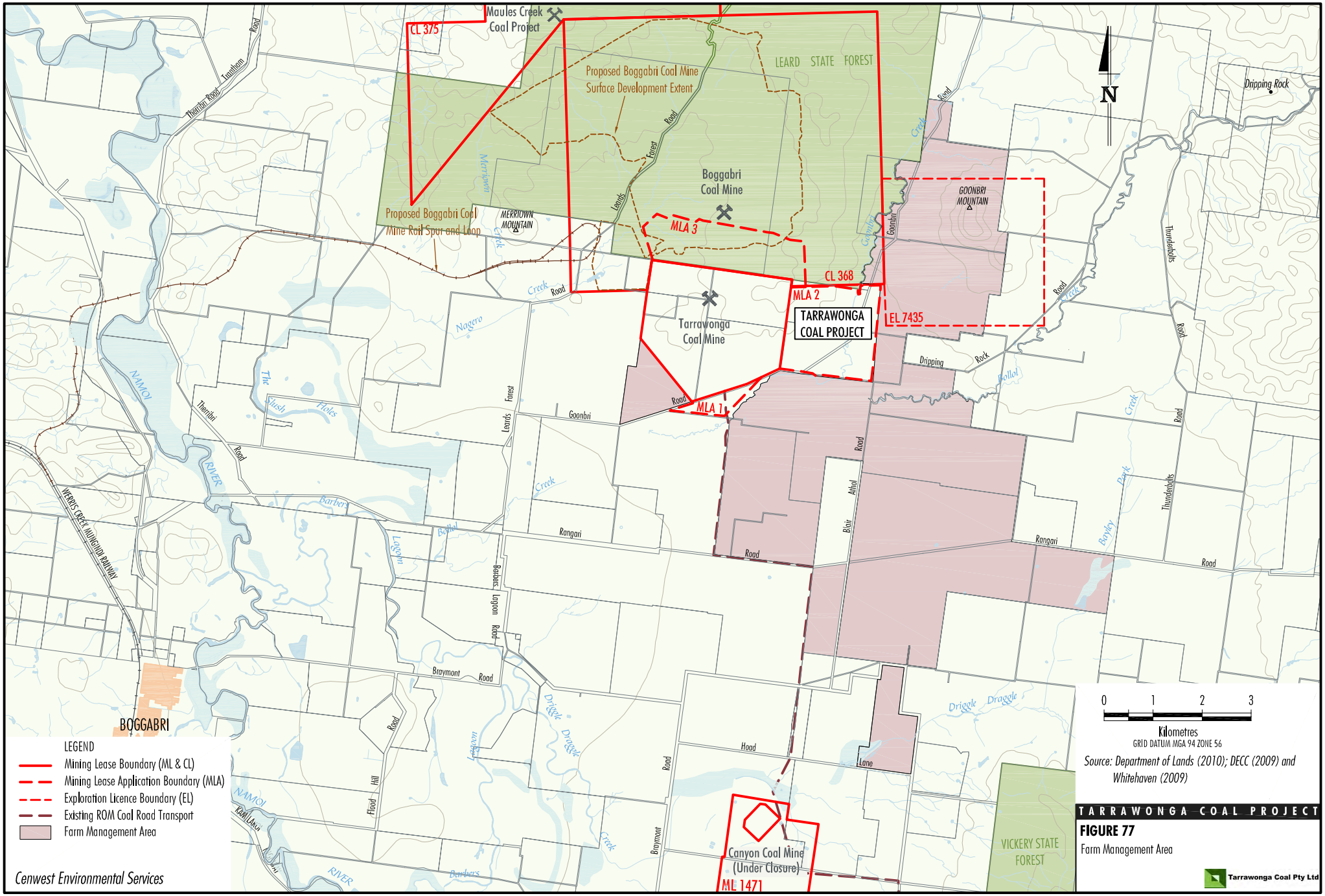
TARRAWONGA COAL PROJECT

FIGURE 75

Eastern Cave Bat - Landscape Distribution in the Database Search Area

Tarrawonga Coal Pty Ltd

WHC-01-04_EA_AppTFauna_161B



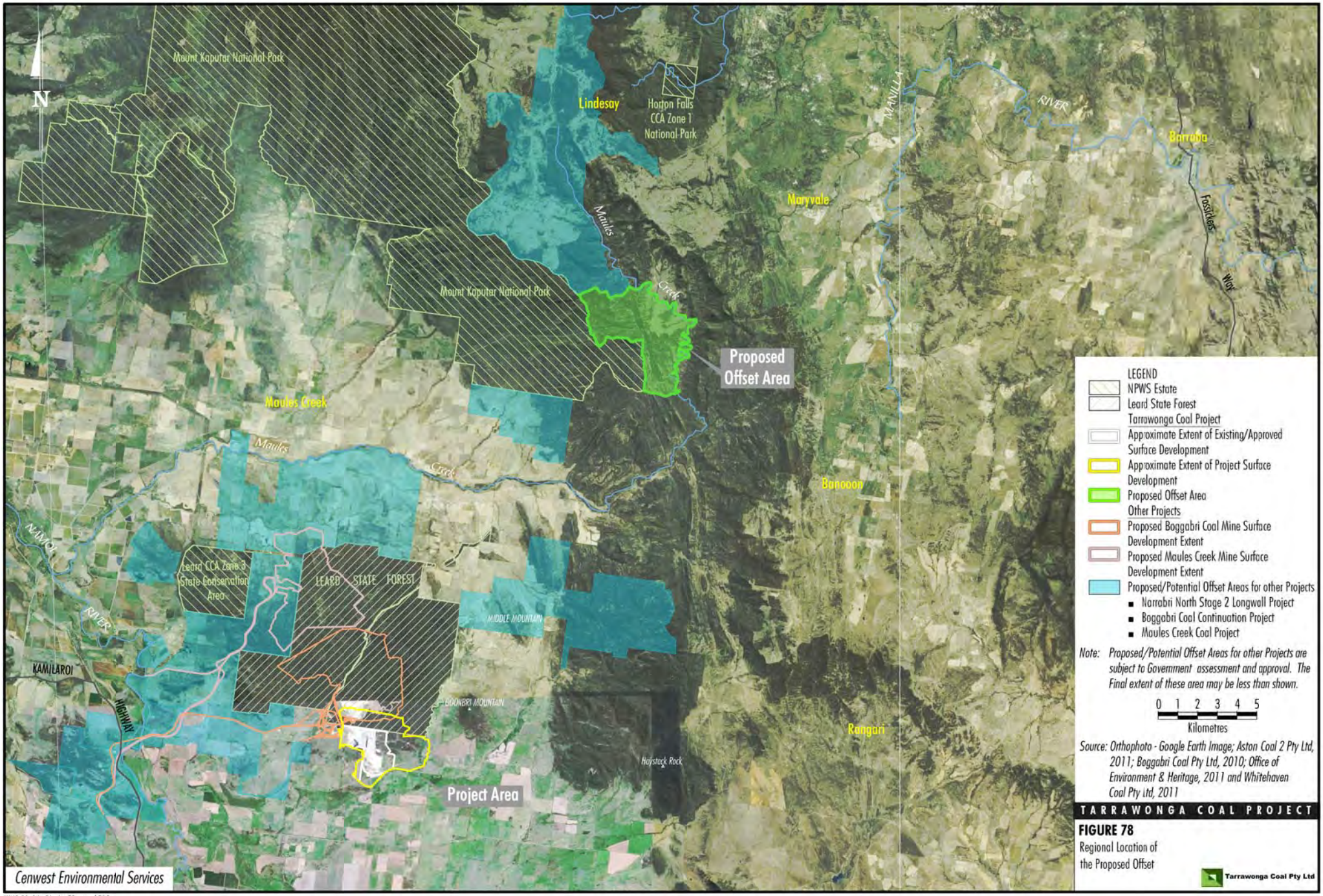
TARRAWONGA COAL PROJECT

FIGURE 77

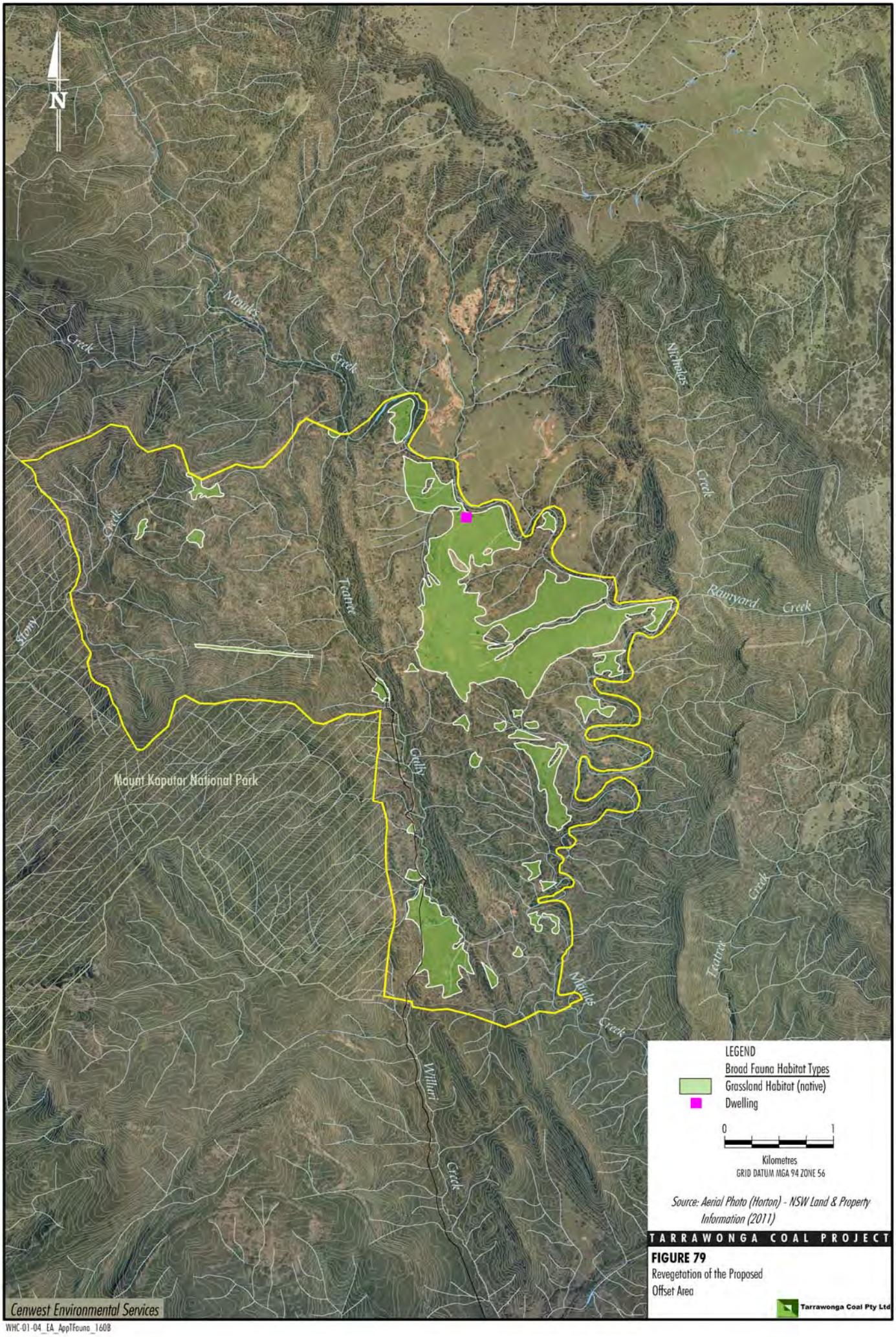
Farm Management Area

Tarrawonga Coal Pty Ltd

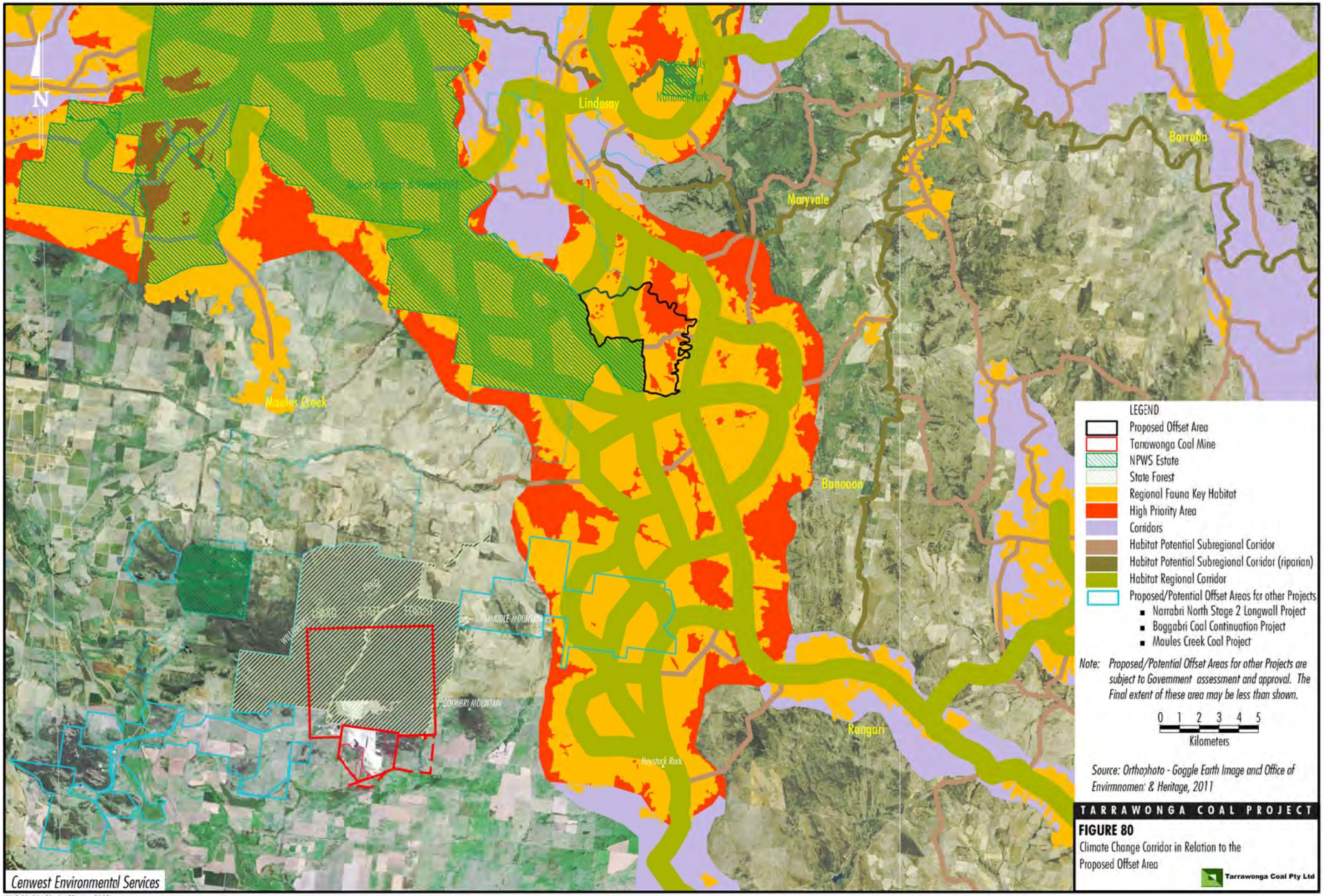
WHC-01-04_EA_AppTFauna_156C



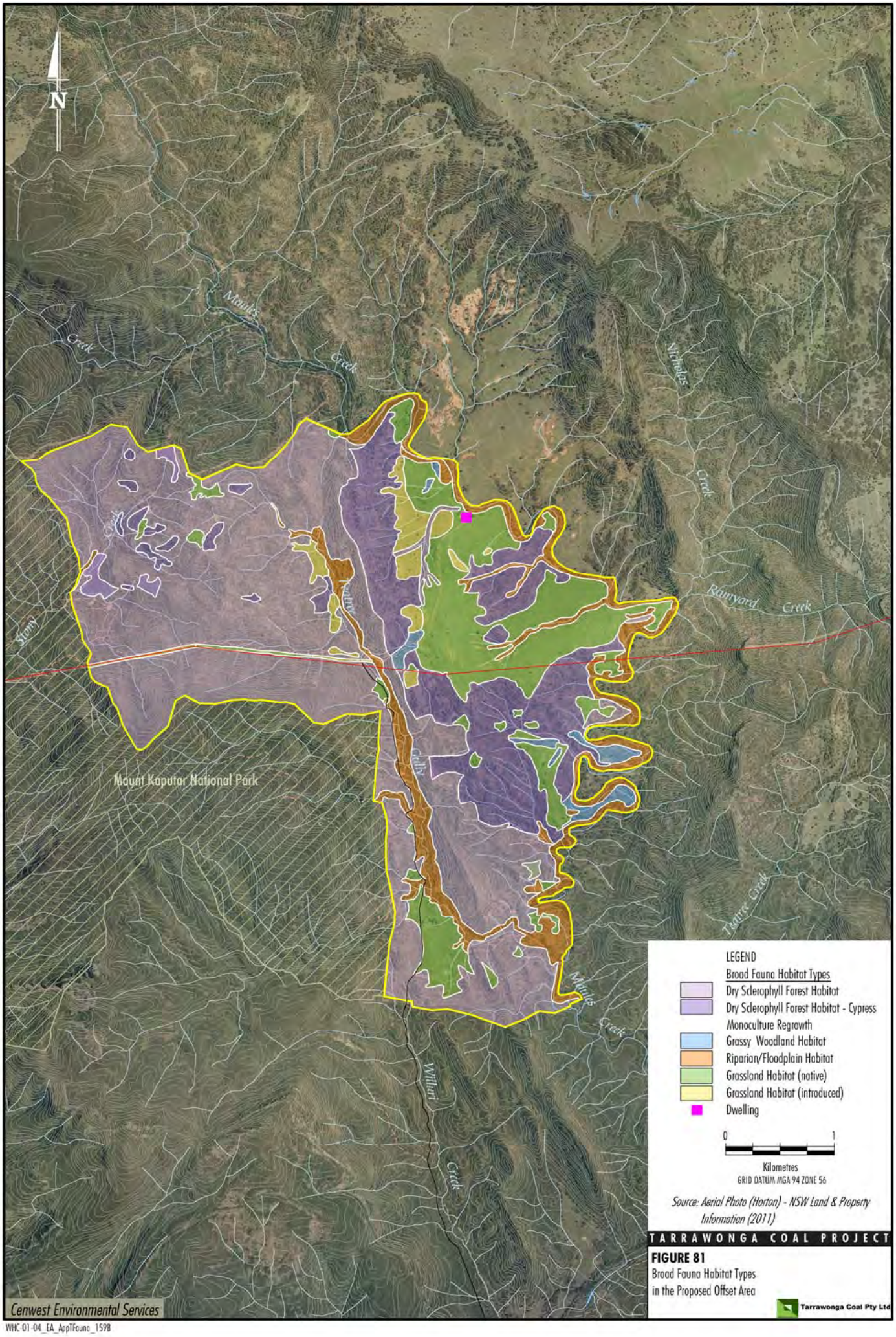
WHC-01-04_EA_AppTFauna_158C



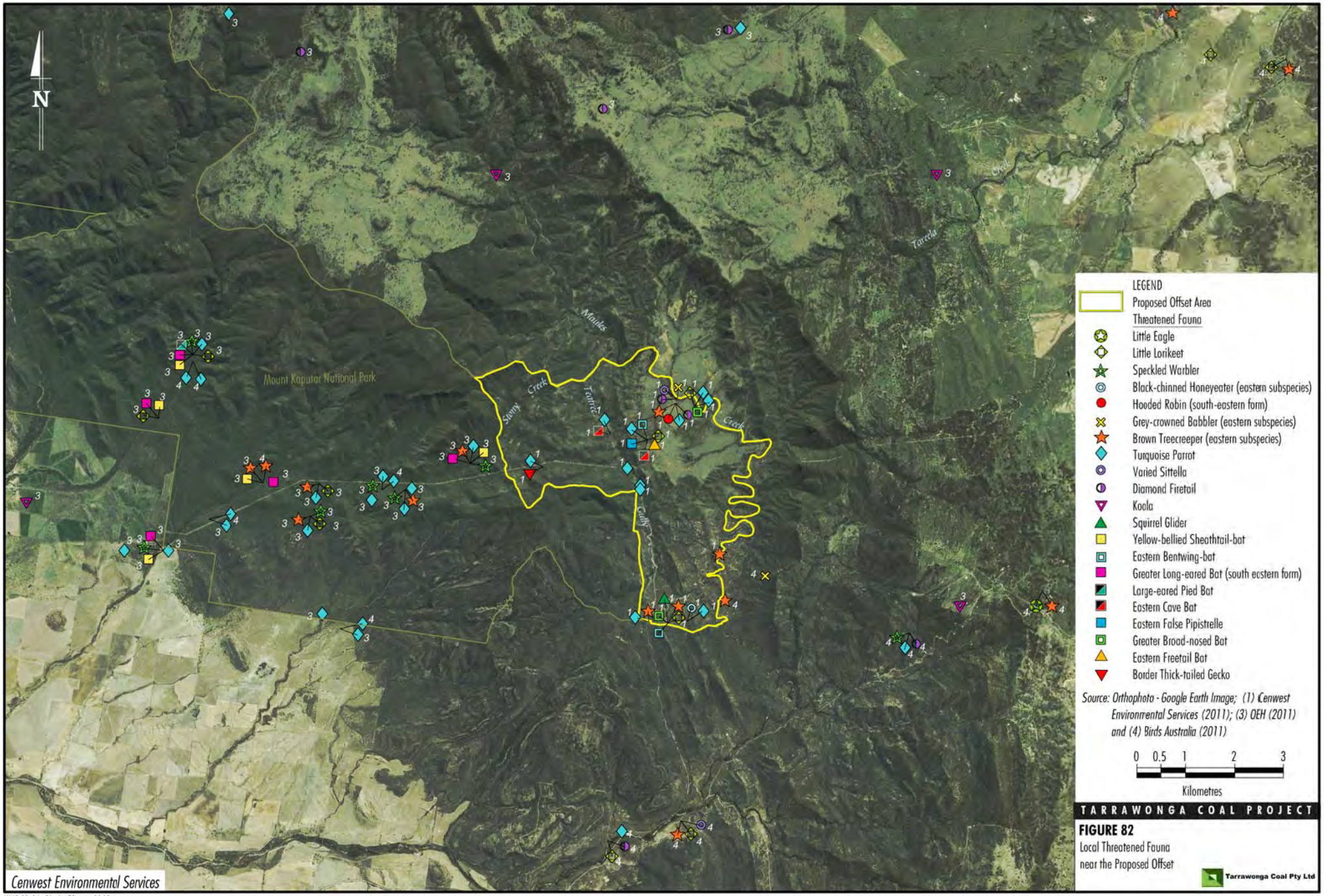
WHC-01-04_EA_AppTFauna_160B



WHC-01-04_EA_AppTFauna_113B



WHC-01-04_EA_AppTFauna_159B



WHC-01-04_EA_AppTFauna_114C

ATTACHMENT A

THREATENED SPECIES DATABASE SEARCH RESULTS

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
FAUNA											
Fish											
PERCICHTHYIDAE											
Maccullochella peelii peelii	Murray Cod	-	V	-	-	●	-	-	-	-	No suitable habitat. Goonbri Creek is ephemeral. Mostly dry, very degraded and does not link with Namoi River.
Amphibians											
MYOBATRACHIDAE											
Crinia sloanei	Sloane's Froglet	V	-	-	●	-	-	-	-	-	Some marginal habitat present. Closely associated with temporary ponds in grassland, woodlands and disturbed habitat following heavy rainfall.
HYLIDAE											
Litoria booroolongensis	Booroolong Frog	E	E	-	-	●	-	-	-	-	Mostly associated with flowing rocky streams on the slopes and tablelands of the Great Dividing Range. Goonbri Creek is ephemeral. Mostly dry, very degraded and does not link with Namoi River.
Reptiles											
GEKKONIDAE											
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	V	V	●	●	●	-	-	-	-	Mainly restricted to cool highland granite belt in the New England area and where elevations are greater than 500 m.
PYGOPODIDAE											
Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	●	-	-	-	-	-	-	Lack of suitable part buried rocky habitat and out of expected range for this species.

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
Delma torquata	Adorned Delma	-	V			●					Out of range. No sightings recorded in NSW.
ELAPIDAE											
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	●	-	-	-	-	-	-	Associated with Dry sclerophyll forest on western slopes and associated with watercourses.
Birds											
MEGAPODIIDAE											
Leipoa ocellata	Malleefowl	E	V	●	-	-	-	-	-	-	Lack of suitable habitat including sandy soils/loams.
ANSERANATIDAE											
Anseranas semipalmata	Magpie Goose	V	-	●	-	-	-	-	-	-	Lack of permanent wetlands, swamps and creek lines.
ANATIDAE											
Stictonetta naevosa	Freckled Duck	V	-	●	-	-	-	-	-	-	Lack of permanent wetlands, swamps and creek lines.
Oxyura australis	Blue-billed Duck	V	-	●	-	-	-	-	-	-	Lack of permanent wetlands, swamps and creek lines.
CICONIIDAE											
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	●	●	-	-	-	-	A	Lack of permanent wetlands, swamps and creek lines.
ARDEIDAE											
Botaurus poiciloptilus	Australasian Bittern	E	E	●	-	-	-	-	-	-	Lack of permanent wetlands, swamps and creek lines.
FALCONIDAE											
Falco hypoleucos	Grey Falcon	E	-	●	-	-	-	-	A	-	One observation from the existing mine site.
ACCIPITRIDAE											
Lophoictinia isura	Square-tailed Kite	V	-	●	●	-	●	●	-	B	One observation overhead in the Project area.
Hamirostra melanosternon	Black-breasted Buzzard	V	-	●							Could forage in Project area and be located along Namoi River.

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
Circus assimilis	Spotted Harrier	V	-	●	●	-	-	●	-	A, B	Potential habitat present.
Hieraaetus morphnoides	Little Eagle	V	-	●	●	-	●	●	-	A	Potential habitat present.
OTIDIDAE											
Ardeotis australis	Australian Bustard	E	-	●	-	-	-	-	-	-	Lack of suitable habitat including tussock and hummock grasslands, low shrublands and low open grassy woodlands.
GRUIDAE											
Grus rubicunda	Brolga	V	-	●	-	-	-	-	-	-	Lack of wetlands and shallow swamps within the Project area and the immediate surrounds.
BURHINIDAE											
Burhinus grallarius	Bush Stone-curlew	E	-	●	-	-	-	-	-	-	No nearby records.
ROSTRATULIDAE											
Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E	V	●	-	●	-	-	-	-	Lack of suitable habitat within the Project area and the immediate surrounds including swamps and marshy areas with suitable fringing cover.
SCOLOPACIDAE											
Limosa limosa	Black-tailed Godwit	V	-	●	-	-	-	-	-	-	Out of normal range and also lack of swamps and muddy lakes within the Project area and the immediate surrounds.
PSITTACIDAE											
Calyptorhynchus lathami	Glossy Black-cockatoo	V	-	●	-	-	-	-	A	-	Few feeding resources within the Project area and the immediate surrounds, but other habitat requirements available.
Glossopsitta pusilla	Little Lorikeet	V	-	●	●	-	●	●	A	A, B	Potential habitat present.
Neophema pulchella	Turquoise Parrot	V	-	●	●	-	●	●	A, B	A, B	Located in Project area and/or the immediate surrounds.
Lathamus discolor	Swift Parrot	E	E	●	●	●	-	-	-	-	Some potential habitat present.

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
Polytelis swainsonii	Superb Parrot	V	V	●	-	●	-	-	-	-	Some potential habitat present.
TYTONIDAE											
Tyto novaehollandiae	Masked Owl	V	-	●	●	-	●	-	-	A, B	Located in Project area.
STRIGIDAE											
Ninox strenua	Powerful Owl	V	-	●							Potential habitat present.
Ninox connivens	Barking Owl	V	-	●	●					A, B	Potential habitat present.
CLIMACTERIDAE											
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	●	●		●	●	B	A, B	Located in Project area.
ACANTHIZIDAE											
Pyrrholaemus saggitatus	Speckled Warbler	V	-	●	●	-	●	●	B	A, B	Located in Project area.
MELIPHAGIDAE											
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	●	●	-	●	●	-	A	Located in Project area or the immediate surrounds.
Anthochaera phrygia	Regent Honeyeater	CE	E	●	●	●					Potential habitat present.
Grantiella picta	Painted Honeyeater	V	-	●	●	-	●	-	-	B	Potential habitat present.
Certhionyx variegatus	Pied Honeyeater	V	-	-	●	-	-	-	-	-	Outside of range and only marginal habitat present within the Project area and the immediate surrounds.
PETROICIDAE											
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	●	●	-	●	●	A, D	A, B	Located in the Project area.
Petroica phoenicea	Flame Robin	V	-	●	-	-	-	●	-	-	More likely as a winter migrant.
Petroica boodang	Scarlet Robin	V	-	●	-	-	-	●	-	-	Unlikely to be present.

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
POMATOSTOMIDAE											
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	●	●	-	●	●	A, D	A, B	Located in Project area and the immediate surrounds.
NEOSITTIDAE											
Daphoenositta chrysoptera	Varied Sittella	V	-	-	●	-	●	●	-	A, B	Located in Project area and the immediate surrounds.
ESTRILDIDAE											
Stagonopleura guttata	Diamond Firetail	V	-	●	●		●	●		A, B	Potential habitat present.
Mammals											
DASYURIDAE											
Dasyurus maculatus	Spotted-tailed Quoll	V	E	●	●	-	-	-	-	-	Potential habitat present.
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	●	-	-	-	-	-	-	Unlikely to be present.
Sminthopsis macroura	Stripe-faced Dunnart	V	-	●	-	-	-	-	-	-	Outside of known range and lack of suitable habitat within the Project area.
PHASCOLARCTIDAE											
Phascolarctos cinereus	Koala	V	-	●	●	-	●	-	-	A	Limited potential habitat present.
BURRAMYIDAE											
Cercartetus nanus	Eastern Pygmy-possum	V	-	●	-	-	-	-	-	-	Unlikely to be present.
PETAURIDAE											
Petaurus australis	Yellow-bellied Glider	V	-	●	-	-	-	-	-	-	Suitable habitat lacking.
Petaurus norfolcensis	Squirrel Glider	V	-	●	●	-	-	-	-	-	Located in survey area and in the immediate surrounds.
POTOROIDAE											

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
Aepyprymnus rufescens	Rufous Bettong	V	-	●	-	-	-	-	-	-	South of known range although some suitable habitat present within the Project areas and the immediate surrounds.
MACROPODIDAE											
Macropus dorsalis	Black-striped Wallaby	E	-	●	-	-	-	-	-	-	South of known range although some suitable habitat present within the Project areas and the immediate surrounds.
Petrogale penicillata	Brush-tailed Rock Wallaby	E	V	●	-	●	●	-	-	-	Lack of suitable rocky escarpments, outcrops and cliffs.
EMBALLONURIDAE											
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	●	●	-	●	-	A, C, D	A, B	Located in the Project area and the immediate surrounds.
VESPERTILIONIDAE											
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	-	●	-	-	-	-	A	Suitable habitat available.
Nyctophilus timoriensis (listed as *Nyctophilus corbeni* under the EPBC Act)	Greater Long-eared Bat (south-eastern form)	V	V	●	●	●	●	-	-	B	Suitable habitat available.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	●	●	●	●	-	-	-	Suitable habitat available.
Chalinolobus picatus	Little Pied Bat	V	-	●	●	-	-	-	A	A	Suitable habitat available.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	-	●	-	-	-	-	A	Suitable habitat available.
Vespadelus troughtoni	Eastern Cave Bat	V	-	●	●	-	-	-	-	A	Suitable habitat available.
MURIDAE											
Pseudomys pilligaensis	Pilliga Mouse	V	V	●	-	-	-	-	-	-	Outside of known range and suitable habitat absent.
Endangered Populations											

Scientific Name	Common Name	Conservation Status		OEH (2011a)[3]	NPA (2011)[4]	Species Records			Project Survey Records[8]	Regional Survey Reocrds[9]	Justification for Exclusion
		TSC Act[1]	EPBC Act[2]			EPBC Act Protected Matters Search[5]	Atlas of NSW Wildlife[6]	Birds Australia[7]			
-Alectura lathami endangered population	Australian Brush-turkey population in the Nandewar and Brigalow Belt South bioregions	E	-	●	-	-	-	-	-	-	Project area outside of known range and lacks suitable habitat.
-Adelotus brevis endangered population	Tusked Frog population in the Nandewar and New England Tableland Bioregions	E	-	●	-	-	-	-	-	-	Project area outside of known range and lacks suitable habitat.

Notes:

- Nomenclature consistent with CSIRO (2006) *CSIRO List of Australian Vertebrates A Reference with Conservation Status.*
- No threatened species were recorded in the Australian Museum database for the following search area: -30.55553, 150.0706; -30.56027, 150.2893; -30.74055, 150.2843; -30.73577, 150.0652. Date Accessed: 1 June 2011.
- NPA = National Parks Association.

[1] Threatened species status under the NSW *Threatened Species Conservation Act, 1995* (current as of 18 October 2011).

[2] Threatened species status under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (current as of 18 October 2011)

V = Vulnerable, E = Endangered, CE = Critically Endangered.

[3] Office of Environment and Heritage (2011a) *List of Threatened Species Known or Predicted to occur in the Liverpool Plains (Part B) CMA Sub-region*. Date Accessed: 26 July 2011.

[4] National Parks Association (2011) *Threatened Species Known or Predicted to occur in Leard State Forest.* Date Accessed: 1 June 2011.

[5] Department of Environment, Sustainability, Populations and Communities (2011) *EPBC Act Protected Matters Search*. Search for co-ordinates: -30.55553, 150.0706; -30.56027, 150.2893; -30.74055, 150.2843; -30.73577, 150.0652. Date Accessed: 19 May 2011.

[6] Office of Environment and Heritage (2011b) *Threatened Species - OEH Atlas Database Records for the Following Search Area: Zone 56 - Min E: 218888, Min N: 6595817; Max E: 239888, Max N: 6615817.* Date Received: 24 May 2011.

[7] Birds Australia (2011) *Database Records within the Following Search Area: -29.7074, 149.1586, -31.5551,151.1908.* Data Received: 30 May 2011.

[8] Previous survey results have been sourced from the following:

A = Countrywide Ecological Service (2005) *Proposed East Boggabri Coal Mine Fauna Assessment*.

B = EcoLogical (2010) *Tarrawonga Coal Mine Modification Biobanking and Threatened Species Assessment Report*.

C = Countrywide Ecological Service (2009a) *Tarrawonga Fauna Monitoring Summer 2008/09*.

D = Countrywide Ecological Service (2009b) *Tarrawonga February 2009 Prestart Report*.

[8] Regional survey results have been sourced from the following:

A = Parsons Brickenhoff (2010) *Continuation of Boggabri Coal Mine Biodiversity Impact Assessment*.

B = Cumberland Ecology (2011) *Maules Creek Project Ecological Assessment*. Appendix I of Hansen Bailey (2011) *Maules Creek Project Environmental Assessment*.

ATTACHMENT B

GOONBRI CREEK AQUATIC ASSESSMENT

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ABN 39 146 443 847

Goonbri Creek Aquatic Assessment

August 2011

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

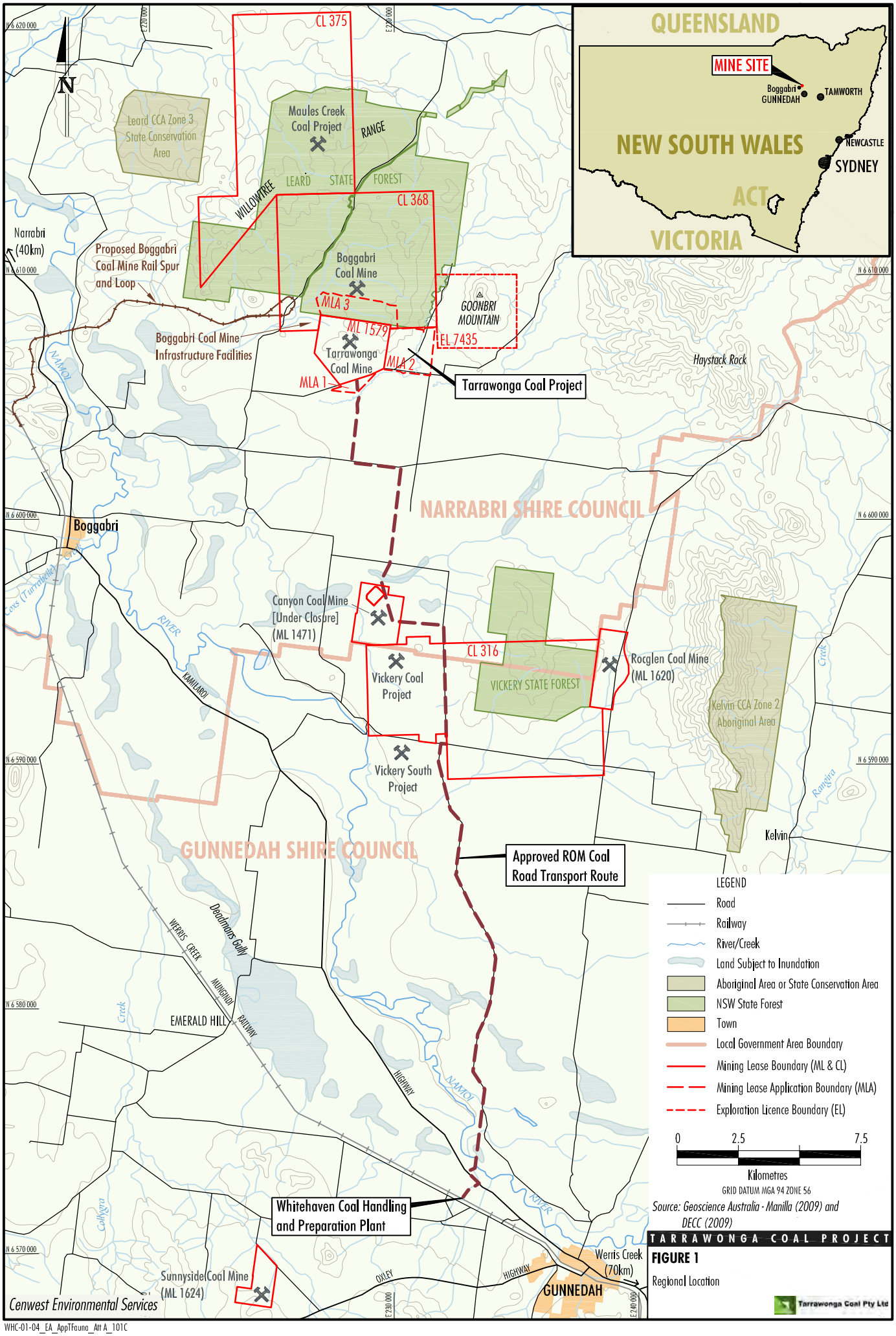
Whitehaven Coal Pty. Ltd. is planning to expand the Tarrawonga Coal Mine (the Project) north of Gunnedah (Figure 1). A terrestrial fauna assessment is required as part of the Project Environmental Assessment and a vertebrate fauna survey was undertaken in March and August 2011. During preliminary inspections in December 2010 it was found that there were a number of pools along Goonbri Creek following substantial rainfall. It was considered a risk that this water would evaporate before the scheduled March surveys. Therefore, a supplementary aquatic survey (macroinvertebrates, amphibians and fish) was undertaken in January 2011. The results of this survey are included in this report.

Goonbri Creek rises on the eastern slopes of the Willowtree Range. It flows generally southward along the eastern boundary of the Leard State Forest. Casual observation and anecdotal evidence from Tarrawonga Coal Pty Ltd staff and local landholders indicate that streamflow in Goonbri Creek is ephemeral, responds quickly to rainfall, flows for relatively short periods after rainfall events and exhibits little flow persistence following rainfall due to limited interaction between a shallow alluvial aquifer and the creek bed. There appeared to be some semi-permanent pools but other larger pools are likely to last for no more than a few months under continuing dry and warm conditions.

1.2 OBJECTIVES

The objectives were to:

- Assess the condition and water quality of Goonbri Creek along its length within the study area.
- Carry out a macroinvertebrate survey of Goonbri Creek and assess taxa richness, EPT (Ephemeropta, Plecoptera and Tricoptera) richness and EPT ratio, FFG (Functional Feeding Groups) ratio and SIGNAL site score (Stream Invertebrate Grade Number – Average Level).
- Carry out an amphibian survey (adult and tadpole stages) including targeting threatened species considered possible occurrences along Goonbri Creek and in dams within the Project area to determine their distribution, relative abundance and evidence of recent reproduction.
- Carry out opportunistic fish surveys within Goonbri Creek.



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2 SURVEY STUDY AREA, WEATHER CONDITIONS AND SURVEY TIMING

2.1 SITE DESCRIPTION

The Project is located approximately 42 kilometres (km) north of Gunnedah and 15 km north-east of Boggabri in the Gunnedah Basin, New South Wales (NSW) (Figure 1). It comprises lands to the north, east and south of the existing Tarrawonga Coal Mine (Figure 2). The Project area includes part of Leard State Forest, part of the adjoining property within Mining Lease Area (MLA) 1 and parts of adjoining Whitehaven owned lands (Figure 2). The study area is traversed by Goonbri and Dripping Rock Roads.

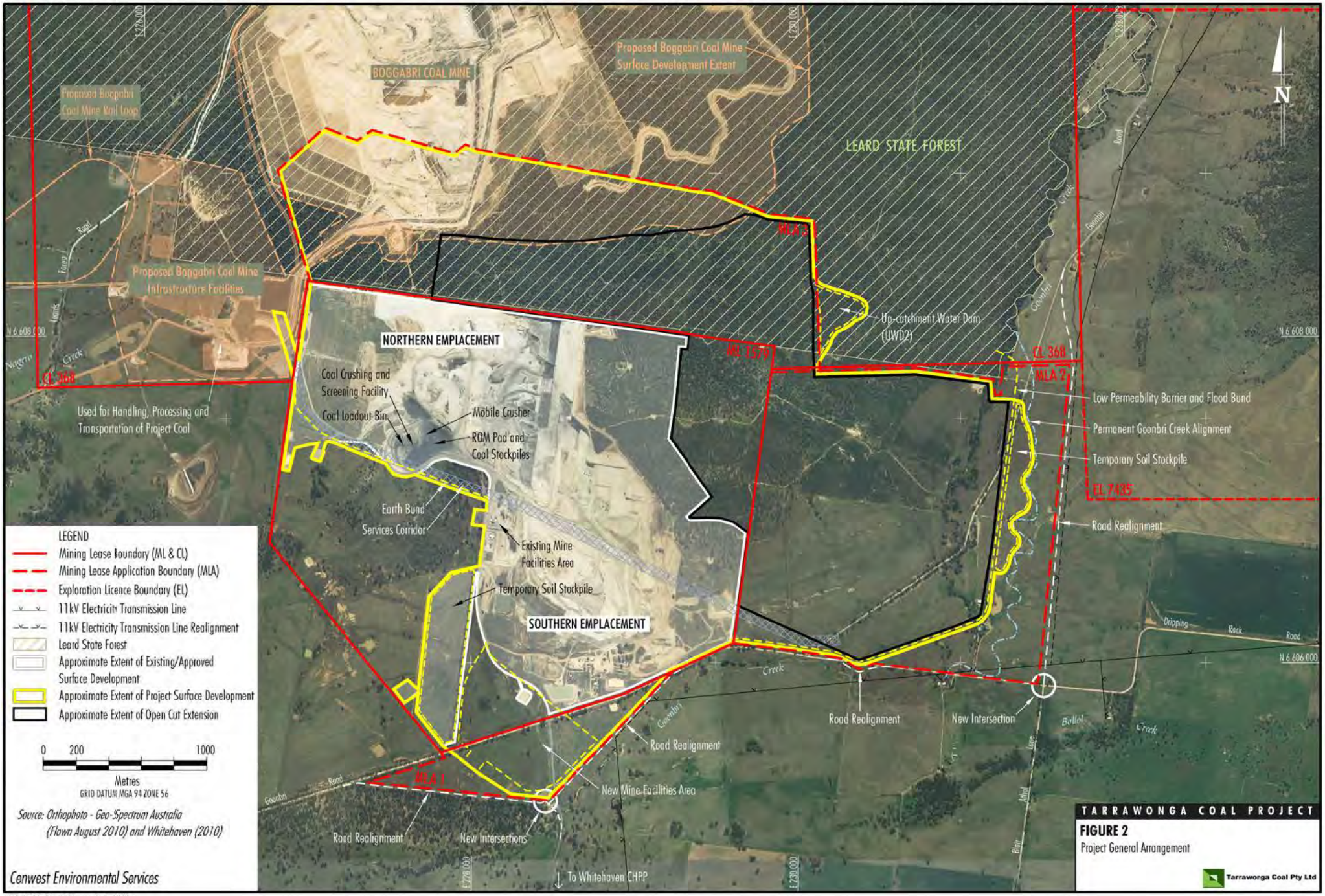
Leard State Forest is a Zone 4 community conservation area. Forestry, recreation and mineral extraction are permissible land use categories within this zone.

A number of fire trails are located within the northern bushland area. The bushland areas are predominantly regrowth or logged areas, with the southern section of bushland in various successional stages. Within the agricultural landscape there are scattered and clumped native trees as well as some remnant patches of regrowth native trees with variable quality understorey. A linear woodland remnant corridor extends along a significant section of the diagonal public road. The Project area and properties to the east, south and west are used for agriculture, cattle grazing and cereal/fodder cropping. The agricultural land is often dominated by a range of weeds, demonstrating significant signs of land degradation and appears to be relatively unproductive. A number of dams and tanks are located within the Project area, the largest on the southern border of the Project area and two smaller dams in the eastern most section of the bushland area west of Goonbri Road.

Goonbri Creek rises on the eastern slopes of the Willowtree Range. Its flow is flanked on its eastern side by Middle Mountain and Goonbri Mountain which form a discontinuous line of hills. Downstream of the Project area, Goonbri Creek flows generally westward and south-westward, crossing the Tarrawonga Coal Mine run-of-mine coal road transport route near the Tarrawonga Coal Mine site access road and ultimately disperses as overland flow on the adjacent alluvial flats and the Namoi River floodplain. Goonbri Creek has a catchment of approximately 34 square kilometers upstream of Dripping Rock Road crossing (Gilbert & Associates, 2011). The dominant land uses in the Goonbri Creek catchment are forestry in the higher elevations associated with Leard State Forest, with agricultural land uses including grazing and cropping within the alluvial floodplains. Where the creek floods out into agricultural land at the south-west boundary of the Project area was very likely part of a significant pre-European wetland area. Several rural residences (including those owned by Tarrawonga Coal Pty Ltd) are located within the catchment.

The altitudinal change in Goonbri Creek from the State Forest boundary to its intersection with the Tarrawonga Mine entry road is about 20 metres (m). Since Goonbri Creek terminates as a flood-out there is no direct connection with the Namoi River. The upper part of Goonbri Creek within the Project area retains a viable Bracteate Honeymyrtle Low Riparian Forest extending more-or-less down to its intersection with Dripping Rock Road and thence into cleared agricultural land, where the creek line is deeply incised, broadened by significant erosion and in a very degraded condition. It is very likely that this degraded system was once a series of swampy meadow formations. The stream bed appears to follow the pre-European flow line but very likely has shifted constantly over the flood plain during recent geomorphic time.

During the survey period the stream had stopped running but there were intermittent small to large pools throughout the length of the creek-line.



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2.2 WEATHER AND OTHER ENVIRONMENTAL CONDITIONS DURING SURVEY PERIOD

Table 1 records the weather and other environmental conditions that were present during the survey period.

Table 1
Weather and Other Environmental Conditions during the Survey Period

Date	Max T ºC	Min T ºC	24 hr sunrise	24 hr sunset	Moon phase	Moon rise	Moon set	Rainfall mm	% Cloud cover	Wind	General comment
Monday 3 Jan 2011	34.9	19.9	0500	1906	Waning crescent 1% full	0336	1810	10.2	5-75	Variable, Zero to light	Warm to hot building up to a thunder-storm
Tuesday 4 Jan 2011	31.4	18.3	0501	1906	New 0% full	0434	1858	0	5- 100	Variable, Zero to light	Warm to hot with evening thunder-storm
Wednesday 5 Jan 2011	23.3	17.8	0501	1906	Waxing crescent 1% full	0534	1940	5.4	0-70	Variable, Zero to light	Mild

Sources: Tarrawonga Coal Mine Metrological Station, 2011. Bureau of Meteorology, 2011.

2.3 SURVEY TIMING

The survey was undertaken from 3 to 5 January 2011.

3 METHODS

The methods used during the survey are described below: determining the condition (health) of Goonbri Creek and associated water quality; aquatic macroinvertebrate, amphibian and fish surveys.

3.1 STREAM CONDITION AND WATER QUALITY ASSESSMENT

The methods used to determine stream condition and water quality are described in this section.

3.2 STREAM CONDITION SITE LOCATIONS AND DESCRIPTIONS

The following stream reaches (SR) are described in descending order from Leard State Forest (SR1) to the terminus of the Creek line near the main Tarrawonga Coal Mine access road (SR9) (Figure 3).

Stream Reach 1 **(SR1):** Approximate length 750 m.

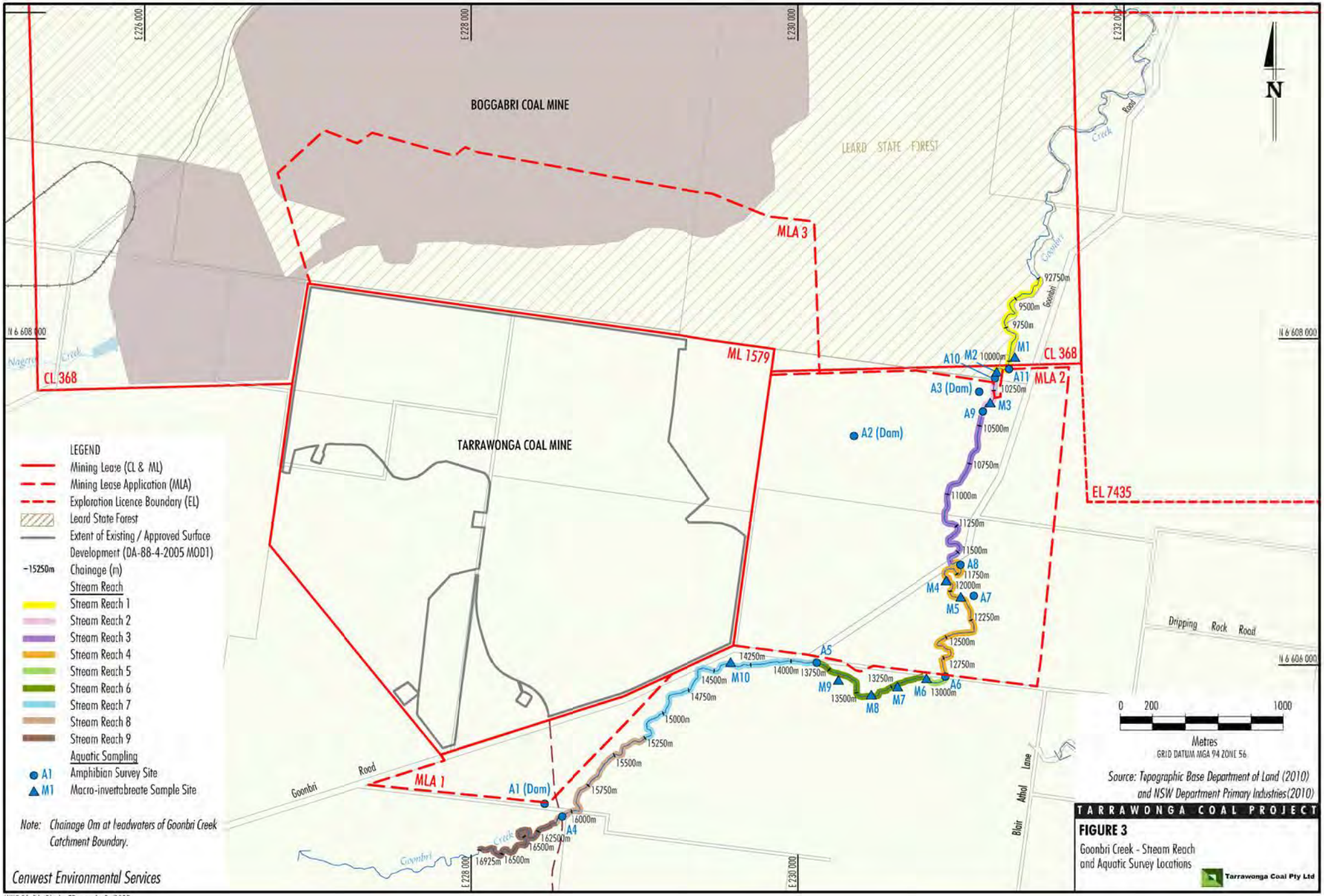
This reach is within or along the edge of the Leard State Forest commencing from approximately 750 m north of the Project north-east boundary (Figure 3). The catchment within this reach includes State Forest and degraded agricultural land. Some grazing appears to occur within the Leard State Forest as has past logging. The dominant riparian tree vegetation consists of ecotonal formations with components of White Cypress Pine (*Callitris columellaris*) – Narrow-leaved Ironbark (*Eucalyptus crebra*) and Poplar Box (*E. populnea*) - Pilliga Box (*E. pilligaensis*) – White Cypress Pine communities together with some components of Bracteate Honeymyrtle (*Melaleuca bracteata*) riparian forest. Trees range in age from mature to early regrowth stages. The understorey consists of shrubs, grasses and herbs along with a significant number of weed species. Various moss species dominate sections of the banks. Intermittent pools 1 to 2 m across and up to 10 to 50 m in length are present within this reach. Scattered logs of variable length and diameter are located throughout the stream. The water is brownish very likely due to tannin leachate. The stream bed comprises coarse sands and gravels. This is a partly degraded 'cut and fill' stream system with both primary and secondary incisions present. Some examples of localised bank undercutting are present.

Stream Reach 2 **(SR2):** Approximate length, 100 m.

SR2 is situated in the north-east section of the Project area within cleared agricultural land with patches of woodland-forest regeneration occurring (Figure 3). The catchment within this reach includes State Forest and degraded agricultural land. The riparian strip is dominated by a narrow band of the Bracteate Honeymyrtle - Blakely's Red Gum (*E. blakelyi*) - Yellow Box (*E. melliodora*) - Rough-barked Apple (*E. floribunda*) - Belah (*Casuarina cristata*) community, with individual trees of varying ages. The understorey consists of shrubs, grasses and herbs along with a significant number of weed species. Various moss species dominate sections of the banks. Intermittent pools 1 to 2 m across and up to 10 to 20 m in length are present within this reach. Scattered logs of variable length and diameter are located throughout the stream. The water is brownish very likely due to tannin leachate. The stream bed is mobile with a sandy-gravel base with little to no established vegetation. Patches of *Carex appressa* are present along the stream bed. This is a partly degraded 'cut and fill' stream system with both primary and secondary incisions present. Some examples of localised bank undercutting are present.

Stream Reach 3 **(SR3):** Approximate length, 1,000 m.

SR3 is situated along the eastern boundary of the Project area and extends from the southern boundary of SR2 to Goonbri Road (Figure 3). The catchment within this reach includes state forest and degraded agricultural land.



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The stream is sinuous across the floodplain. The riparian strip is dominated by a narrow remnant band of the Bracteate Honeymyrtle-Blakely's Red Gum Yellow Box - Rough-barked Apple - Belah community, with individual trees of varying ages. The understorey consists of shrubs, grasses and herbs along with a significant number of weed species. Various moss species dominate sections of the banks. Intermittent pools 2 to 6 m across and up to 10 to 75 m in length are present within this reach. Scattered logs of variable length and diameter are found throughout this reach. The water is brownish very likely due to tannin leachate. The stream bed is reasonably stable with good cover of *C. appressa* and Native Water Couch (*Paspalum distichum*). This is a partly degraded 'cut and fill' stream system with limited primary and secondary incisions present.

Stream Reach 4 **(SR4):** Approximate length, 1,000 m.

SR4 is situated along the eastern boundary of the Project area and extends from the southern boundary of SR3 at Goonbri Road to the intersection with Dripping Rock Road where the stream begins to flow in a westerly direction (Figure 3). The catchment within this reach is confined to degraded agricultural land. The stream is sinuous across the floodplain. The riparian strip is dominated by a narrow degraded remnant band, at times discontinuous, of the Bracteate Honeymyrtle - Blakely's Red Gum Yellow Box - Rough-barked Apple - Belah community, with individual trees of varying ages. A greater proportion of Box trees are present compared with SR3. The understorey consists of shrubs, grasses and herbs along with a significant number of weed species. Intermittent pools are larger than in upstream reaches, 4 to 8 m across and 10 to 75 m in length. Limited scattered logs of variable length and diameter are found throughout this reach. The water is brownish very likely due to tannin leachate. The stream bed demonstrates some signs of instability and *C. appressa* are absent in this reach. This is a degraded 'cut and fill' reach with primary and secondary incisions present to a depth of 1 to 2 m. The stream has broadened due to erosion and the breakdown of the swampy meadow system. Sections of bank collapse, very likely due to stock damage, are reasonably common within this reach.

Stream Reach 5 **(SR5):** Approximate length, 200 m.

SR5 is a short reach from Dripping Rock Road crossing to 200 m west of the existing dwelling, immediately south of the road (Figure 3). The catchment within this reach is confined to degraded agricultural land. The creek flows in a westerly direction from this point. The riparian understorey is weed-dominated, stream banks are mostly devoid of vegetation and broken down by stock and therefore contributing to active erosion within the reach. Extant pools are relatively small and muddy with some Native Water Couch located on the mobile stream bed. The stream is significantly incised to a depth of 4 m and broad due to the breakdown of the pre-European swampy meadow system. The once dominant riparian tree dominated vegetation has been mostly cleared and is now represented by clumps or scattered trees remaining of the substantially cleared Bracteate Honeymyrtle community.

Stream Reach 6 **(SR6):** Approximate length, 800 m.

SR6 is an intermediate reach from the southern extremity of SR5 to approximately the junction of Goonbri Road and Dripping Rock Road (Figure 3). The catchment within this reach is confined to degraded agricultural land. The riparian understorey is weed-dominated, stream banks are mostly devoid of vegetation and broken down by stock and therefore contributing to active erosion within the reach. The few extant pools are relatively small and muddy with some native couch located on the mobile stream bed. The stream is significantly incised to a depth of 3 m and significantly broadened due to the breakdown of the pre-European swampy meadow system. The once dominant Bracteate Honeymyrtle Low Riparian Forest has been reduced by clearing to a few scattered trees or very small remnants. Some stream bed recovery is occurring where water couch has established on the creek bed and bed cutting has been significantly reduced.

Stream Reach 7 **(SR7):** Approximate length, 1,250 m.

SR7 is a stream reach approximately 1,250 m in length that halfway along its length begins to flow south-west and terminates at a rock controlled platform. The stream is slightly sinuous through the floodplain. The reach comes within 50 m of the nearby road, skirting mine infrastructure (Figure 3). The catchment within this reach is confined to degraded agricultural land. The riparian understorey is weed-dominated, stream banks are mostly devoid of vegetation and broken down by stock and therefore contributing to active erosion within the reach. The few extant pools are relatively small and muddy with some Native Water Couch located on the mobile stream bed. Sand bars alternate with small pools. The stream is significantly incised to a depth of 3 m and significantly broadened due to the breakdown of the pre-European swampy meadow system. Patches of active bank collapse are occurring. The once dominant Bracteate Honeymyrtle Low Riparian Forest has been mostly cleared and is now represented by a few scattered trees and clumps of Bracteate Honeymyrtle, Eucalyptus spp. and Belah or in the lower reach by remnants of the Poplar Box-Pilliga Box-White Cypress Pine community. Some stream bed recovery is occurring where Native Water Couch has established on the creek bed. A few patches of native primrose were present. A strip of small to large clumps of *C. appressa* commences in this reach and continues to the terminus of the creek in the flood out zone.

Stream Reach 8 **(SR8):** Approximate length, 750 m.

SR8 is a stream reach approximately 750 m in length terminating at the Tarrawonga Coal Mine entry road. The stream is slightly sinuous through the floodplain (Figure 3). The catchment within this reach is confined to degraded agricultural land. The riparian understorey is weed-dominated, stream banks are mostly devoid of vegetation and broken down by stock and therefore contributing to active erosion within the reach. The extant pools vary from small to 50 m in length and are muddy with some Native Water Couch located on the mobile stream bed. Sand bars alternate with pools. The stream is significantly incised to a depth of 3 m and significantly broadened due to the breakdown of the pre-European swampy meadow system. Patches of active bank collapse are occurring. The once dominant riparian tree dominated vegetation has been mostly cleared and is now represented by a few scattered trees and clumps of Bracteate Honey Myrtle – Eucalypt – Belah community or in the lower reach by remnants of the Poplar Box-Pilliga Box - White Cypress Pine community. Some stream bed recovery is occurring where Native Water Couch has established on the creek bed. A riparian strip of small to large clumps of *C. appressa* continues along this reach.

Stream Reach 9 **(SR9):** Approximate length, 800 m.

SR9 is a reach approximately 800 m in length terminating within a patch or remnant woodland in the south-west corner of the Project area. Under flood conditions, water spills out across the floodplain. The stream is slightly sinuous through the floodplain (Figure 3). The catchment within this reach is confined to degraded agricultural land. The riparian understorey is weed-dominated, stream banks are mostly devoid of vegetation and broken down by stock and therefore contributing to active erosion within the reach. The reach is devoid of the riparian trees represented in upstream reaches. The extant pools vary from small to 50 m in length and are muddy with some native couch located on the mobile stream bed. The stream is significantly incised to a depth of 3 m and broad due to the breakdown of the pre-European swampy meadow system. Patches of active bank collapse are occurring. The reach is surrounded by regenerating Poplar Box-Pilliga Box - White Cypress Pine vegetation community. Various active head cuts are located in this reach.

3.2.1 Stream Condition Assessment

Stream condition (stream health) was based on a modified version of the rapid assessment method developed by Mactaggart and Goldney (2010) to assess Bathurst's urban waterways. This method uses six key attributes of creeks and their associated visual indicators, that when assessed concurrently in various reaches of a stream, can be used to determine an assessment of stream condition that can be colour mapped along a continuum from 'very good' to 'highly degraded'. The six attributes are:

- riparian vegetation;
- instream habitat;
- hydrology and hydraulics,
- geomorphology;
- water quality; and
- aquatic fauna.

Each attribute is represented by a number of indicators, which when integrated may impact on or reflect the many functional aspects of healthy waterways (Table 2). The indicators used to assess the condition of each attribute are listed in Table 2 as is their relationships; whether they impact or reflect or not with healthy waterway function. Details of the condition assessment indicators and ratings are located in Appendix B. The proforma used in the field is located in Appendix C of this report. This methodology is suitable for small to medium upland streams in urban and rural areas, but may not be suitable for lowland rivers. In this process we gather two types of robust data:

1. Absolute data such as pH that can be measured by using an instrument with a known precision. These data have a high level of precision.
2. Categorical data such as those that are gathered as a basis for assessing vegetation cover and bank stability. This requires the field worker to examine an environmental parameter such as vegetation cover and tick a box, in this example, it might be one of five category choices (0%, 1-5%, 26-50%, 51-75%, 76 -100%). The advantages of using categorical data are that it can be gathered very rapidly, significantly reduces field work and analysis costs, tends to eliminate the adverse impacts of misjudgements in the field because of the wide band within each category, whilst at the same time providing very reliable data with a high degree of precision.

At each stage a series of informed value judgements are made, based on the use of a combination of absolute and categorical data to determine stream section condition and finally stream condition. The final determination of stream condition follows the three steps illustrated below.

Step 1 – Gather a set of relevant absolute and/or categorical data. These data are used to determine by deduction **Indicator Condition** at each sample point.

Step 2 – The data from step 1 are used to determine by deduction **Attribute Condition** at each sample point.

Step 3 – Attribute data are used to determine by deduction **Stream Section Condition**.

The condition assessment at each stream section is colour-coded and rated according to a numerical value: 4 - Very good condition (closest to natural) through to 0 – highly degraded. The condition rating of 'poor' is in between good and degraded and streams may exhibit attributes with a mix of condition ratings.

Table 2
Attributes, their Indicators and Functional Aspects of Healthy Waterways

Attribute	Indicator	Healthy waterways functional aspects										
		Aquatic and Riparian Fauna Habitat	Sediment, Nutrient Trapping	Bank Stability	Instream bed Stability	Habitat Connectivity	Moderating Flood Hydrograph	Water Quality	Ecosystem Processes	Biodiversity	Energy Interception	Nutrient, Carbon and Water Cycles
1 Riparian vegetation	Health & structural integrity of riparian vegetation	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
	Proportion of cover that is indigenous	✓				✓		✓	✓	✓		✓
	Presence of regenerating indigenous spp	✓				✓			✓	✓		
	Vegetation cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Native species diversity	✓				✓			✓	✓		
2 Instream habitat	Health & structural integrity of instream vegetation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Proportion of vegetation that is indigenous	✓				✓		✓	✓	✓		✓
	Habitat complexity & quality	✓	✓			✓			✓	✓		✓
	Instream vegetation cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Native species diversity	✓				✓			✓	✓		
3 Hydrology & hydraulics	Stream-floodplain connectivity	✓	✓			✓	✓	✓	✓	✓		✓
	Percentage of catchment urbanisation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Hydrologic deviation from natural flows	✓	✓	✓	✓		✓	✓	✓	✓		✓
	Hydraulic deviation from natural flows	✓	✓	✓	✓					✓		✓
4 Geomorphology	Bank stability	✓	✓	✓	✓	✓		✓	✓			✓
	Bed stability	✓	✓	✓	✓	✓	✓	✓	✓			✓
	Level of engineering modifications	✓	✓	✓	✓	✓	✓	✓	✓			✓
	Deviation from natural stream characterisation	✓				✓	✓		✓			

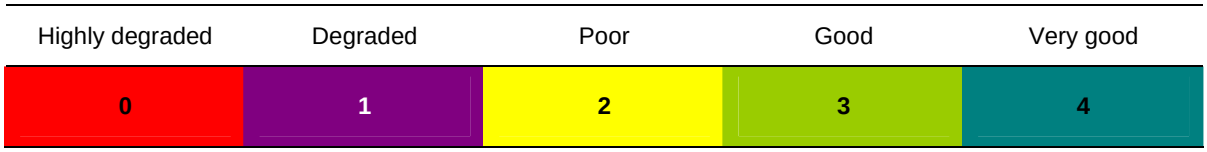
Source: Mactaggart and Goldney (2010).

Table 2 (Continued)
Attributes, their Indicators and Functional Aspects of Healthy Waterways

Attribute	Indicator	Healthy waterways functional aspects										
		Aquatic and Riparian Fauna Habitat	Sediment, Nutrient Trapping	Bank Stability	Instream bed Stability	Habitat Connectivity	Moderating Flood Hydrograph	Water Quality	Ecosystem Processes	Biodiversity	Energy Interception	Nutrient, Carbon and Water Cycles
5 Water quality	pH range	✓				✓		✓	✓	✓		✓
	Electrical conductivity	✓		✓	✓	✓		✓	✓	✓		✓
	Eutrophication, algal blooms	✓				✓		✓	✓	✓		✓
	Water clarity (turbidity &suspended sediments)	✓				✓		✓	✓	✓		✓
	Gross pollution, litter	✓						✓				
	Contaminants –odour, chemicals, surface oils	✓				✓		✓	✓	✓		✓
6 Aquatic fauna	Fauna habitat assessment	✓				✓			✓	✓		
	Indigenous species diversity	✓							✓	✓		
	Proportion of indigenous to alien species								✓	✓		
	Abundance of indigenous species	✓							✓	✓		
	Proportion of spp indicative of poor habitat	✓										

Source: Mactaggart and Goldney (2010).

Condition Rating from Highly Degraded to Very Good



To carry out the assessment the stream was divided into nine reaches chosen for their homogeneity within a particular reach, commencing from within the Leard State forest north of the Project area (Figure 3). These reaches are described in Section 3.1.1 above.

3.2.2 Stream Water Quality Methods

The water quality parameters measured at each sample site included:

- Temperature (^{o}C);
- Conductivity (µS/cm);
- pH;
- Dissolved oxygen (DO mg/L);
- Phosphate (PO_4^- ppm);
- Nitrate/nitrite (NO_3/NO_2 ppm);
- Turbidity (Nephelometric Turbidity Units – NTU); and
- Total Dissolved Solids (g/L).

Temperature, conductivity, TDS and pH were recorded using an Oakton® Multi-parameter PCSTestr^{TM}35 and phosphate and nitrate/nitrite were measured using Hach® colourmetric water quality test strips at the time of macroinvertebrate sampling. Dissolved oxygen (DO) and turbidity values were rated as 1 (very low for DO or very high for turbidity) to 4 (very high for DO and very low for turbidity).

These parameters were measured within each reach and at each macroinvertebrate sampling site.

3.3 AQUATIC MACROINVERTEBRATE SURVEY

A total of 10 sites were selected based on stream stratigraphy and the presence of large and/or small pools along Goonbri Creek that were representative of riparian areas with near natural riparian vegetation (within Leard State Forest – two sites), cleared and grazed agricultural land with remnant fringing riparian over-storey vegetation (mine site – three sites) and cleared, grazed and cropped agricultural land mostly devoid of over storey riparian vegetation (mine site – five sites) (Table 3 and Figure 3). Within these selected areas the sites were restricted to areas with adequate water volumes in the pools.

Table 3
Attributes of each Sample Site

Attribute	Site									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Land tenure – NSW State Forest	•	•								
Land tenure – Freehold			•	•	•	•	•	•	•	•
Near natural riparian vegetation	•	•								
Modified remnant riparian overstorey vegetation			•	•	•					
Mostly cleared remnant riparian overstorey vegetation						•	•	•	•	•
Land management includes livestock grazing				•	•	•	•	•	•	•
Small ephemeral pool (< 3m length at time of sampling)	•	•	•	•		•	•	•		
Relatively large ephemeral to permanent pool (>100m length)					•				•	•
Instream & bank vegetation (reeds, rushes, water couch etc)	•	•	•		•		•		•	
Instream logs & debris	•	•	•	•	•				•	•
Substrate coarse sand, gravels, large pebbles, silt		•		•		•	•	•		
Substrate mostly silty					•				•	•
Substrate mostly coarse sand & gravels	•		•							

3.3.1 Macroinvertebrate Site Locations and Description

The grid coordinates for each sample site are provided in Table 4 and a composite of the survey locations within the study area are shown in Figure 3. In addition, photographic representations of the sites depicted in Plates 1 to 10.

Table 4
Co-ordinate Locations of the Sampling Sites

Site No.	Grid coordinates	
	Eastings	Northings
M1	231330	6607880
M2	231220	6607790
M3	231180	6607600
M4	230910	6606510
M5	231000	6606410
M6	230790	6605910
M7	230610	6605860
M8	230450	6605810
M9	230250	6605900
M10	229590	6606010

Plate 1: Site M1

Plate 2: Site M2

Plate 3: Site M3

Plate 4: Site M4

Plate 5: Site M5

Plate 6: Site M6

Plate 7: Site M7

Plate 8: Site M8

Plate 9: Site M9

Plate 10: Site M10

3.3.2 Macroinvertebrate Sampling Methods

The sampling methods for the macroinvertebrate survey were partially based on a standardised method outlined in the NSW AUSRIVAS Sampling and Processing Manual (Turak *et al.*, 2004). The AUSRIVAS methods of sampling both pools and riffles were modified as no in-stream riffle features were present and the sediment bars downstream of the pools were mostly dry. The methods for this study also included targeted sampling and opportunistic sightings.

The descriptions of the methods used at each site are outlined below:

Opportunistic sightings: At the site any observations of dragonflies, damselflies, mayflies, etc. were recorded as were fauna in the water such as backswimmers and water striders.

Sampling pools: Samples were collected from pool edges: generally for the length of the pool, otherwise, if the pools were relatively long, for a length of approximately 10 m either as a continuous line or in disconnected segments. Sampling in segments was often undertaken to ensure the sampling of sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats. Segmented sampling was also employed where pool length was short and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 micron dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted the suspended fauna. In many of the pools, where it was difficult to scrape the substrate with the net (e.g. due to obstacles), the substrate was disturbed using a kicking motion and the net moved through the water column to collect specimens.

Targeted sampling: This method was site dependent given the availability of in-stream features and included rock turning and scraping algae and periphyton from its substrate (including logs, wood, rocks and water plants).

3.3.3 Macroinvertebrate Identification and Sampling Process

Samples were washed from the nets and collected in storage containers and transferred off-site for identification and counting. The samples were examined under a stereo-microscope with macroinvertebrates (adults, juveniles, larvae, pupae) identified to family level except for Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily).

All macroinvertebrates were identified using the following reference material and keys:

- "Australian freshwater life: the invertebrates of Australian inland waters" (Williams, 1980).
- "The identification and ecology of Australian freshwater invertebrates" (Hawking *et al.*, 2009).
- The taxonomic identification series produced by the Murray Darling Freshwater Research Centre. For example:

  "Dragonfly larvae (Odonata): a guide to the identification of larvae of Australian families and identification and ecology of larvae from New South Wales" (Hawking and Theischinger, 1999);

  "Checklists and guides to the identification, to genus, of adult and larval Australian water beetles of the families Dytiscidae, Noteridae, Hygrobiidae, Haliplidae, Gyrinidae, Hydraenidae and the superfamily Hydrophiloidea (Insecta: Coleoptera)" (Watts, 2002);

  "Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters" (Smith, 1996);

  "Mayfly nymphs of Australia: a guide to genera" (Dean and Suter, 1996); and

  "Guides to the identification keys of Trichoptera" (seven in the series):

  - Cartwright, D.I. (1997); Cartwright, D.I. (1998); Dean, J.C. (1997); Dean, J.C (1999); Jackson, J. (1998); St Clair, R.M. (1997) and Wells, A. (1997).

The principles of a species-volume curve were adopted as the determinant of processing time (i.e. as new species or families were observed the identification and counting procedure continued). If successive sub-samples produced no more faunal diversity and the relative abundance of families remained more-or-less constant then the procedure was terminated. The minimum processing time of picking, identification and counting was 60 minutes per habitat sample.

3.3.4 Macroinvertebrate Data Analysis

A number of analyses were performed on the data to indicate stream health and aquatic macroinvertebrate diversity. Both presence/absence and abundance data were recorded. In each sub-sample the macroinvertebrates were individually counted and when numbers became too large to readily count their numbers were estimated.

The number of organisms recorded represents a sample of the total number of macroinvertebrates at each site. Therefore, abundance data are not absolute; rather it is relative to the sample. As such, ordination data were recorded with the numbers of macroinvertebrates ranked into one of six groups (Table 5).

Table 5
Ordinal Ranks of Macroinvertebrate Abundance

Number of Macroinvertebrates per Taxa per Site Sample	Relative Abundance	Rank
0	Nil	0
1	Very uncommon	1
2-6	Uncommon	2
7-25	Common	3
26-100	Abundant	4
>101	Very abundant	5

SIGNAL Site Score

SIGNAL is an acronym for 'Stream Invertebrate Grade Number – Average Level' and is a biotic index of pollution tolerance or sensitivity within that taxonomic group. A grade 10 indicates a high sensitivity to pollution. A diverse community of high grade taxa indicates a healthy ecosystem. A grade of 1 indicates a greater tolerance to pollution. A community with high numbers of a few low grade taxa indicates a degraded aquatic habitat (Chessman, 2003 cited in Hawking *et al.,* 2009) (Table 6). To calculate the SIGNAL score, first, each type of macroinvertebrate was given a SIGNAL grade, which indicates its tolerance or intolerance to pollution. These grades were available from the "Identification and ecology of Australian freshwater invertebrates" website (The Murray-Darling Freshwater Research Centre, 2010). Secondly, the SIGNAL site score is calculated as the total sum of the SIGNAL grades of the different types of macroinvertebrates collected divided by the total number of different types of macroinvertebrates collected with an available SIGNAL grade.

Table 6
SIGNAL Grade and the Level of Pollution Tolerance

SIGNAL Grade	Pollution Tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Taxa Richness

The richness of macroinvertebrate families (or class/orders if not identified to family level) was calculated as an indicator of stream health and as for EPT richness the higher the number the healthier the aquatic ecosystem.

EPT Richness and EPT Ratio

The EPT (Ephemeroptera, Plecoptera and Tricoptera) index is based on the insect orders that contain a majority of pollution sensitive taxa (Lenat, 1988; Wright *et al.*, 2007). All genera of Ephemeroptera, Plecoptera and Tricoptera were identified and then the number of distinct taxa counted as an indicator of ecosystem health - the higher the number the healthier the aquatic ecosystem. The ratio of EPT to the number of taxa was also calculated as another measure of ecosystem health.

FFG Ratio

The taxa were designated into their functional feeding groups (FFG) *viz*. shredders, filtering collectors, gathering collectors, scrapers/grazers, predators and macrophyte piercers (true bugs). The functional feeding groups of most of the organisms were available from the "Identification and ecology of Australian freshwater invertebrates" website (The Murray-Darling Freshwater Research Centre, 2010). Some taxa are specialist feeders and could be easily categorised into FFGs. The generalist feeders were ordered according to their predominant feeding behaviour.

3.4 AMPHIBIAN SURVEY

3.4.1 Amphibian Site Locations and Descriptions

A stratified random sampling process was used to choose 11 representative Frog Survey (A1-A11) sites (Figure 3) where amphibian surveys could be implemented in the following areas:

A1: Turkey Nest Dam 100 m north of Goonbri Creek intersection with main Tarrawonga Coal Mine entrance road. This is the same as D1 in the March 2011 terrestrial fauna survey.

A2: Large permanent dam, within regrowth remnant woodland, 400 m south of Leard State Forest. This is the same as D2 in the March 2011 terrestrial fauna survey.

A3: Small dam associated with a Borrow Pit, 50 m west of Goonbri Creek immediately south of Leard State Forest. This is the same as D3 in the March 2011 terrestrial fauna survey.

A4: Goonbri Creek intersection with main Tarrawonga Coal Mine entrance road at junction of SR8 and SR9.

A5: Road depression draining water into Goonbri Creek at boundary of SR 7 and SR 6 on dirt road junction with diagonal road.

A6: Goonbri Creek road crossing at junction of SR4 and SR5.

A7: Blakely's Red Gum Pool halfway along SR4. This is the same as S10 in the March 2011 terrestrial fauna survey.

A8: Downstream of diagonal Goonbri Road crossing on Goonbri Creek within SR4.

A9: 200 m downstream of boundary of Leard State Forest and the Project area in SR2. This is the same as S9 in the March 2011 terrestrial fauna survey.

A10: Immediately north of Leard State Forest boundary within SR1.

A11: Goonbri Creek in Leard State Forest at northernmost point of SR1 north of the Project – Leard State Forest boundary. This is the same as S8 in the March 2011 terrestrial fauna survey.

3.4.2 Amphibian Survey Methods

Each site consisted of a linear transect approximately 200 x 50 m or 1 hectare where possible or the length of available pool or in the case of farm dams along the perimeter of the dam. Searches concentrated on free water areas within each transect when targeting adults and juveniles and for assessing the presence or absence of tadpoles. Each survey area enabled a surveyor to clearly hear frog calls, when present, to observe adults and tadpoles using standard survey techniques such as searching a range of habitats, listening, using call play-back signature calls, spotlighting and dip-netting for tadpoles.

Each site was surveyed once during a standard one person hour day search (early morning or late afternoon) supplemented by an evening one person 60 minute search/play-back session, using hand held spotlights and head lamps. Concurrently dip netting for tadpoles was undertaken.

Adults were identified by sight and call characteristics, tadpoles were identified by sight and where necessary keyed out using Anstis (2002). Handling of frogs was minimised and usually unnecessary. Where tadpoles could not be immediately identified, they were captured and transferred to a small white enamel tray and then identified.

Call playback was undertaken at night for possible threatened species.

An estimate of relative abundance of each species was recorded at each site. Species were assigned to the following categories for tadpole and adult stages:

0 No sightings;

1 One sighting of adult or tadpole stage;

U Uncommon, 2 to 10 individuals (adult or tadpole stage);

MC Moderately common, 11 to 20 individuals (adult or tadpole stage);

C Common, 21 to 40 individuals (adult or tadpole stage);

A Abundant, >40 - <100 individuals (adult or tadpole stage); and

SA Super Abundant, > 100 individuals (adult or tadpole stage).

For tadpoles this required an estimation of numbers to the nearest ‘ten’. Adult frogs were counted by direct observation and/or by the number of calls of a particular species that could be heard across a site coming from distinct locations. Minor under or over estimations of frog numbers can occur under these circumstances but this was not an issue in this survey where low numbers were recorded for the majority of species.

3.5 FISH

Goonbri Creek is an ephemeral relatively minor inland creek that in the pre-European landscape enabled small flows, freshes and flood waters to be spread out across the downstream floodplains. There is no physical connection between the Goonbri Creek and the Namoi River or any of its tributaries. The creek itself dries out rapidly into a series of shallow, small to medium sized pools that provide potential habitat for a range of smaller native and exotic fish species that are able to be transported by birds or other vectors between isolated streams and waterways.

The small pools were suited to active visual searching, opportunistic sightings or fish caught during the macroinvertebrate sampling using sweep nets.

4 RESULTS AND DISCUSSION

4.1 STREAM CONDITION AND WATER QUALITY

4.1.1 Stream Condition

Stream condition determined using the rapid assessment method described above varied from Degraded to Good (Table 7). Three reaches were assessed as Degraded (SR6, SR8, SR9), three as Poor (SR4, SR5, SR7), two as Moderately Good (SR2, SR3) and one as Good (SR1). Five reaches were considered to be stable and four to be worsening. Stream resilience varied between 1.5 and 3.5 and only one reach was judged to have not exceeded geomorphological and ecological thresholds. Two (SR1 and SR 2) were judged to have partly exceeded these thresholds.

Moving downstream from the upper most reach, the Stream Condition Rating of Goonbri Creek becomes increasingly worse.

4.1.2 Stream Water Quality

The physio-chemical data from each site is given in Table 8. Values highlighted in bold represent those that exceed, or in the case of DO those that were below, the limits of the default trigger values outlined in the freshwater guidelines (ANZECC and ARMCANZ, 2000) for upland rivers in south-east Australia. These default values relate to substantially natural to slightly disturbed ecosystems (ANZECC and ARMCANZ, 2000).

Many of the creek pools are akin to lentic streams (i.e. non-flowing) or wetlands; however, no data are available for such ecosystems in the guidelines.

For more information on stream water quality refer to the Tarrawonga Coal Project Surface Water Assessment (Gilbert & Associates Pty Ltd, 2011) Appendix B of the Project EA.

4.2 MACROINVERTEBRATE RESULTS

The macroinvertebrate data analysis for each sample site is summarised in Table 9 and the complete list of macroinvertebrates present at each site and their abundance rank is presented in Appendix A of this report. The macroinvertebrates have been ordered into their respective FFG.

From the summary table (Table 9) and the data list in Attachment A the taxa richness, species dominance and composition of the macroinvertebrate assemblages are shown to be relatively homogeneous across sites. Taxa richness varied from 9-17 and SIGNAL scores were in the order of 3 or 4. The overall EPT richness and EPT ratios were low with nil to very few species recorded. Taxa richness in this analysis is not necessarily the same as taxa diversity given the latter is calculated with weightings given to taxa relative abundance using a relative diversity index.

Table 7
Goonbri Creek Stream Reach Condition and Trend

Stream Reach	Reach Attribute Condition 4=Good, 0=Degraded						Stream Resilience	Geomorphology Threshold Exceeded	Ecological Threshold Exceeded	Stream Condition Rating[1]	Stream Condition Trend[2]
	Riparian Vegetation	Instream Habitat	Hydrology	Geomorphology	Water Quality	Aquatic Fauna					
SR1	3	3	3	4	3	2.5	3.5	No	No	G	S
SR2	3	2	2.5	2.5	4	2.5	3	Partly	Partly	MG	S
SR3	2.5	3	3	3	3	2.5	2.5	Partly	Partly	MG	S
SR4	2.5	2	3	3	3	2.5	2.5	Yes	Yes	P	S
SR5	2	2	1	1.5	3	2	2	Yes	Yes	P	W
SR6	1	1	1.5	2	2	1	1.5	Yes	Yes	D	W
SR7	2.5	2	2.5	2.5	2	1	2.5	Yes	Yes	P	S
SR8	2	2	1.5	2	2	1.5	2	Yes	Yes	D	W
SR9	2	2	1.5	2	2	1	1.5	Yes	Yes	D	W

[1] HR=Highly Degraded; D=Degraded; P=Poor; MG=Moderately Good; G=Good; VG=Very Good.

[2] S=Stable; I=Improving; W=Worsening.

Table 8
Physio-chemical Water Quality Data for Each Sample Site

Site	Water Quality Parameter								
	Temp. (°C)	Cond. (µS/cm)	TDS (g/L)	Ph (pH units)	DO (mg/L) (% sat)	PO_4- (ppm)	NO_3 (ppm)	NO_2 (ppm)	Turbidity Score
M1	27	174	123	6.5	**2**	11	neg	neg	1
M2	27	168	127	6.4	**2**	9	neg	neg	1
M3	26	181	139	6.4	**2**	**>50**	neg	neg	1
M4	25	187	135	6.5	**2**	**>50**	neg	neg	1
M5	26	180	140	6.4	**2**	**>50**	neg	neg	1
M6	27	209	150	6.3	**2**	**>50**	neg	neg	1
M7	29	372	262	6.3	**2**	**>50**	neg	neg	1
M8	29	180	134	6.2	**2**	**>50**	neg	neg	1
M9	28	198	143	6.4	**2**	**>50**	neg	neg	1
M10	25	191	130	6.4	**2**	**>50**	neg	neg	1

Note:
1. neg – negligible (below detection).
2. values highlighted in bold represent those that exceed or in the case of DO those that were below the lower limit of the default trigger values outlined in the freshwater guidelines (ANZECC and ARMCANZ, 2000) for upland rivers in south-east Australia.

Table 9
Summary Table of Taxa and EPT Richness, SIGNAL Score and EPT Ratio at each Sampling Site

Analysis	Site									
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Taxa Richness	15	14	15	17	17	12	15	9	11	11
SIGNAL Score	4	3	3	4	4	3	3	3	3	3
EPT Richness	2	0	0	2	2	2	1	1	1	0
EPT Ratio	0.1	0	0	0.1	0.1	0.2	0.1	0.1	0.1	0

Note: The complete list of taxa at each site and their abundance scores is given in Appendix A.

There were a number of taxa that showed relatively high dominance and constancy across sites and these included:

- Gastropoda (Physidae) – exotic species;
- Arachnida;
- Ostracoda;
- Copepoda (Cyclopoida);
- Hemiptera (Veliidae);
- Hemiptera (Notonectidae);
- Chironomidae (Chironominae); and
- Coleoptera (Hydrophilidae).

There were no clear trends in relation to taxa richness, SIGNAL score, EPT ratio and FFG ratio and stream condition or pollution. Overall, the taxa richness was generally low with Site M8 being particularly depauperate. The EPT group of macroinvertebrates were poorly represented and in some sites they were absent altogether. This may partially be due to the summer sampling period, which is not optimal for nymphs.

The FFGs across all sites tended to have a high ratio of predators and to lesser degree shredders, either as specialist or generalist feeders. These included the orders Odonata, Hemiptera and Coleoptera. The proportion of predators in an aquatic fauna assemblage can vary in response to perturbation and, therefore, is not always an indicator of stream health (US Environmental Protection Agency, 2010). Scrapers, belonging to the exotic Physidae (Gastropoda) had relatively high abundance and constancy across many sites. Shredders are generally recognised as contributing most to the breakdown of leaf litter and are thought to be well represented in healthy systems (Cummins and Klug, 1979; Webster and Benfield, 1986). These were generally restricted to two coleopteran families with one species in the Hydrophilidae family being very abundant across all sites.

4.3 AMPHIBIAN RESULTS JANUARY 2011

The results of the amphibian survey are detailed in Table 10(1) and 10(2).

Eleven species were located across the survey sites and within the Project area. These included: Eastern Sign-bearing Froglet, Eastern Banjo Frog, Barking Marsh Frog, Ornate Burrowing Frog, Spotted Grass Frog, Smooth Toadlet, Green Tree Frog, Broad-palmed Frog, Peron's Tree Frog, Desert Tree Frog and Verreaux's Tree Frog. No threatened amphibian species were located.

Species diversity at each site varied between two to eight species. The most diverse sites were A2 (large bushland dam) and A4 (Goonbri Creek at Tarrawonga Coal Mine entry road crossing). The least diverse sites were A7 and A8 within Stream Reach 4.

The most widespread species was Peron's Tree Frog (nine sites), and the least widespread were Eastern Banjo Frog and Smooth Toadlet with two sites each. The remaining eight species present ranged from four to eight sites.

Relative abundance for particular species at each site varied between 0 (all species) and Moderately Common (Spotted Grass Frog and Peron's Tree Frog). Relative abundance of particular species across the Project area varied from Uncommon (Six species) to Abundant (Peron's Tree Frog). However in the latter case this species was not located at two sites and only observed once at five sites.

The tadpoles of only three species were located (Eastern Sign-bearing Frog, Spotted Grass Frog and Broad-palmed Frog) but juvenile frogs of all located species were observed. From this it is inferred that one or two major breeding events had occurred early in the breeding season (2010) associated with spring and summer rains and with the subsequent rapid drying of the Goonbri Creek, breeding had ceased.

4.4 FISH

No fish species were captured in sweep nets. Two fish species were recorded opportunistically during the sampling period, *viz. Macquaria ambigua* and the exotic *Gambusia holbrooki*, with the latter being observed in other pools not sampled during the creek survey. Both species were present in low numbers.

Table 10(1)
Amphibian Species Diversity and Abundance, Tarrawonga Project Area and Immediate Surrounds (Myobatrachidae)

Scientific Name	Common Name	Conservation Status[1]		Site												Relative Abundance On a Site Basis	Relative Abundance Across Survey Area
		TSC Act	EPBC Act	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	Opportunsitic Sightings		
MYOBATRACHIDAE																	
Crinia parasignifera	Eastern Sign-bearing Froglet	P	-	0 0	5 0	5 0	2 0	1 0	2 0	5 0	2 2	0 0	0 0	3 0		0 - U	MC
Limnodynastes dumerilii	Eastern Banjo Frog	P	-	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0 - 1	U
Limnodynastes fletcheri	Barking Marsh Frog	P	-	2 0	4 0	2 0	2 0	5 0	1 0	0 0	0 0	0 0	0 0	0 0		0 – U	MC
Limnodynastes ornatus	Ornate Burrowing Frog	P	-	0 0	0 0	0 0	0 0	1 0	1 0	0 0	1 0	1 0	1 0	0 0	1 0	0 - 1	U
Limnodynastes tasmaniensis	Spotted Grass Frog	P	-	0 0	0 0	0 0	2 0	0 0	0 0	0 0	0 0	2 0	2 15	1 0	1 0	0 - MC	MC
Uperoleia laevigata	Smooth Toadlet	P	-	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0 - 1	U

Table 10(2)
Amphibian Species Diversity and Abundance, Tarrawonga Project Area and Immediate Surrounds (Hylidae)

Scientific Name	Common Name	Conservation Status[1]		Site												Relative Abundance On a Site Basis	Relative Abundance Across Survey Area
		TSC Act	EPBC Act	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	Opportunsitic Sightings		
HYLIDAE																	
Litoria caerula	Green Tree Frog	P	-	0 0	0 0	0 0	1 0	1 0	1 0	0 0	0 0	0 0	0 0	1 0		0 - 1	U
Litoria latopalmata	Broad-palmed Frog	P	-	1 0	1 2	32 2	2 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0		0 - C	C
Litoria peronii	Peron's Tree Frog	P	-	2 0	15 0	15 0	6 0	1 0	1 0	1 0	0 0	1 0	1 0	0 0		0 - MC	A
Litoria rubella	Desert Tree Frog	P	-	0 0	1 0	0 0	1 0	0 0	0 0	0 0	0 0	1 0	0 0	3 0		0 - U	U
Litoria verreauxii	Verreaux's Tree Frog	P	-	0 0	3 0	0 0	1 0	1 0	0 0	0 0	0 0	0 0	0 0	2 0		0 - U	U
Species Diversity at each site				3	8	6	8	6	5	2	2	4	3	6			
Species Diversity across all sites				11													

1. Status under the NSW *Threatened Species Conservation Act, 1995;* Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999.*

5 CONCLUSIONS

5.1 STREAM CONDITION

Goonbri Creek was divided into nine reaches from within Leard State Forest to the stream termination in the floodplain south west of the Project area.

Stream condition determined using a rapid assessment method varied from Degraded to Good.

Three reaches were assessed as Degraded (SR6, SR8, SR9), three as Poor (SR4, SR5, SR7), two as Moderately Good (SR2, SR3) and one as Good (SR1).

Five reaches were considered to be Stable and four to be Worsening.

Stream Condition Rating generally worsens as one descends the creekline.

Water quality is likely impacted by agricultural land use with the contribution of phosphates and suspended sediments in the streams.

5.2 MACROINVERTEBRATE SURVEY

Overall the macroinvertebrate assemblages recorded low species richness. However, some taxa showed relatively high dominance and constancy.

The poor quality of stream habitat, the ephemeral nature of many of the stream reaches and warm summer conditions may negatively impact on healthy macroinvertebrate assemblages.

Thirty-nine macroinvertebrate species were observed.

Species diversity at each site varied from 9 to 17.

The most species diverse sites were M5 and M9 while the least species diverse site was M9.

Coleoptera hydrophilidae sp. 1 occurred across all sites.

5.3 AMPHIBIAN SURVEY

Eleven protected species were observed but no threatened species.

Species diversity at each site varied between two to eight species.

The most species diverse sites were A2 (large bushland Dam) and A4 (Goonbri Creek at Tarrawonga Coal Mine entry road crossing).

The least diverse sites were A7 and A8 within SR4.

The most widespread species was Peron's Tree Frog (nine sites), and the least widespread were Eastern Banjo Frog and Smooth Toadlet with two sites each.

Relative abundance for particular species at each site varied between 0 and Moderately Common. Relative abundance of particular species across the Project area varied from Uncommon to Abundant.

The tadpoles of only three species were located but juvenile frogs of all species were observed.

At least two breeding events had occurred early in the breeding season (2010) associated with spring and summer rains and with the subsequent rapid drying of the Goonbri Creek, breeding ceased.

5.4 FISH SURVEY

Two fish species were recorded *viz.* the native *Macquaria ambigua* and the exotic *Gambusia holbrooki*., both species in low numbers.

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The report was prepared by David Goldney and Barbara Mactaggart.

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7 REFERENCES

Anstis, M. 2002. *Tadpoles of South-eastern Australia: A Guide with Keys*. Reed New Holland, Frenchs Forest.

ANZECC and ARMCANZ (2000). *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Bureau of Meteorology (2011). http://www.bom.gov.au, Accessed August 2011.

Cartwright, D.I. (1997). *Preliminary guide to the identification of late instar larvae of Australian Ecnomidae, Philopotamidae and Tasimiidae (Insecta: Trichoptera)*. *Co-Operative Research Centre for Freshwater Ecology Identification Guide Series No. 10.* Murray-Darling Freshwater Research Centre, Albury.

Cartwright, D.I. (1998). *Preliminary guide to the identification of late instar larvae of Australian Polycentropodidae, Glossosomatidae, Dipseudopsidae and Psychomyiidae (Insecta: Trichoptera)*. *Co-Operative Research Centre for Freshwater Ecology Identification Guide Series No. 15.* Murray-Darling Freshwater Research Centre, Albury.

Chessman, B. (2003). New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research*, **54**, 95-103.

Cummins, K., Klug, M. (1979). Feeding ecology of stream invertebrates. *Annual Review of Ecology and Systematics*, **10**, 147-172.

Dean, J.C., Suter, P. J. (1996). *Mayfly nymphs of Australia: a guide to genera. Identification Guide No, 7*. Co-Operative Research Centre for Freshwater Ecology, Albury.

Dean, J.C. (1997). *Larvae of the Australian Hydrobiosidae (Insecta: Trichoptera). Co-Operative Research Centre for Freshwater Ecology Identification Guide Series No. 11*. Murray-Darling Freshwater Research Centre, Albury.

Dean, J.C. (1999). *Preliminary keys for the identification of Australian Trichoptera larvae of the family Hydropsychidae. Co-Operative Research Centre for Freshwater Ecology Identification Guide Series No. 22*. Murray-Darling Freshwater Research Centre, Albury.

Gilbert & Associates (2011) Tarrawonga Coal Project Surface Water Assessment. Appendix B of the Tarrawonga Coal Project Environmental Assessment.

Hawking, J., Smith, L., Le Busque, K. (2009). Identification and ecology of Australian freshwater invertebrates, http://www.mdfrc.org.au/bugguide, Version January 2009, Accessed 2010.

Hawking, J., Theischinger, G. (1999). *Dragonfly larvae (Odonata): a guide to the identification of larvae of Australian families and identification and ecology of larvae from New South Wales.* Cooperative Research Centre for Freshwater Ecology, Thurgoona and Australian Water Technologies, West Ryde.

Jackson, J. (1998). *Preliminary guide to the identification of late instar larvae of Australian Calocidae, Helicophidae and Conoesucidae (Insecta: Trichoptera). Co-Operative Research Centre for Freshwater Ecology Identification Guide Series No. 16.* Murray-Darling Freshwater Research Centre, Albury.

Lenat, D. (1988). Water quality assessment of streams using a quantitative collection method for benthic macroinvertebrates. *Journal of the North American Benthological Society*, **7**(3), 222-233.

Mactaggart, B.G., Goldney, D.C. (2010) *Bathurst Urban Waterways Management Plan*. Cenwest Environmental Services.

Smith, B.J. (1996). *Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters. Identification Guide No. 6*. Cooperative Research Centre for Freshwater Ecology, Albury.

St Clair, R.M. (1997). *Preliminary guide to the identification of late instar larvae of Australian Philorheithridae, Calamoceratidae and Helicopsychidae (Insecta: Trichoptera). Co-Operative Research Centre for Freshwater Ecology Identification Guide Series No. 12.* Murray-Darling Freshwater Research Centre, Albury.

The Murray-Darling Freshwater Research Centre (2010). Identification and ecology of Australian freshwater invertebrates, http://www.mdfrc.org.au/bugguide/index. htm.

Turak, E., Waddell, N., Johnstone, G. (2004). *New South Wales (NSW) Australian River Assessment System (Ausrivas) Sampling and Processing Manual*. NSW Department of Environment and Conservation, Sydney.

US Environmental Protection Agency (2010). Biological indicators of watershed health, http://www.epa.gov/bioiweb1/html/invertclass.html.

Watts, C. H. (2002). *Checklists and guides to the identification, to genus, of adult and larval Australian water beetles of the families Dytiscidae, Noteridae, Hygrobiidae, Haliplidae, Gyrinidae, Hydraenidae and the superfamily Hydrophiloidea (Insecta: Coleoptera). Identification and Ecology Guide No. 43*. Cooperative Research Centre for Freshwater Ecology.

Webster, J., Benfield, E. (1986). Vascular plant breakdown in freshwater ecosystems. *Annual Review of Ecology and Systematics*, **17**, 567-594.

Wells, A. (1997). *A preliminary guide to the identification of larval Hydroptilidae (Insecta: Trichoptera). CRCFE Identification Guide Series No. 13.* Murray-Darling Freshwater Research Centre, Albury.

Williams, W. (1980). *Australian Freshwater Life: the invertebrates of Australian inland waters*. Macmillan Education Australia, Melbourne.

Wright, I. A., Davies, P., Wilks, D., Findlay, S., Taylor, M. (2007). *Aquatic macroinvertebrates in urban waterways: comparing ecosystem health in natural reference and urban streams.* Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. Charles Sturt University, Thurgoona, New South Wales.

APPENDIX A

MACROINVERTEBRATE LIST

Macroinvertebrates and Fishes Recorded at each Site with Numbers Representing Ordinal Abundance Ranks. Ranks of 1 (1 organism); 2 (2-6 organisms); 3 (7-25 organisms); 4 (26-100 organisms) and 5 (>101 organisms). Summary data of taxa and EPT richness, SIGNAL scores and EPT ratios are also presented.

Group Phylum, class, subclass or order)	Family	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Primitive Worms and Allies, Worms and Leeches											
Temnocephalidea	-				1			1			
Nematoda	-					1					1
Hirudinae	-				1		1				
Molluscs											
Gastropoda	Physidae	2			2	3	3	2	1	3	
Arachnids											
Arachnida	sp. 1	1	4	2		2			2	1	2
Arachnida	sp. 2	1				1					
Crustaceans											
Cladocera	Daphniidae		1	1							
Ostracoda	-	5	3	3	3	5	2				
Copepoda- Cyclopoida	-	4	4	4	3	2	3		3		
Decapoda	Parastacidae	2	1	1	2				1		
Insects											
Ephemeroptera (mayflies)	Baetidae	1			3						
	Caenidae						1				
Plecoptera (stoneflies)	Austroperlidae					1					
Tricoptera (caddis-flies)	Leptoceridae	1			2	1	2	2	1	1	
Odonata-Epiproctophora (dragonflies)	Hemicorduliidae	1	2	2	1						
Odonata-Zygoptera (damselflies)	Isostictidae					1					
	Coenagrionidae sp 1	1	1	1	2					1	
	sp. 2				1						
Hemiptera (bugs)	Corixidae		3		3	1		3	2		
	Hydrometridae			1	2						
	Veliidae sp. 1		2	2	3	2	1				3
	sp. 2			2	3						
	Nepidae							1			
	Belostomatidae						1				
	Notonectidae	5	3	2		3		2			2
Diptera (flies)	Culicidae	1	2	1	1						
	Chironomidae										
	Chironominae	3	4	3		3	3	2			2
	Orthocladiinae										3
	Stratiomyidae										1
Coleoptera (beetles)	Dytiscidae sp. 1		2			2	1	2		3	2
	sp. 2							2		2	2
	sp. 3							1		2	
	Noteridae sp. 1					2	1	3	3	2	
	sp. 2							1			
	Haliplidae sp. 1							2	3	2	2
	sp. 2							2			
	hydrophilidae sp. 1	4	5	5	5	5	5	5	5	5	5
	sp. 2					2				2	
	Scirtidae	2		1							
Fish											
Macquaria ambigua		1						3			
Gambusia holbrooki				2							
Number of Macroinvertebrate taxa		15	14	15	17	17	12	15	9	11	11
SIGNAL Total		48	31	39	54	54	28	40	23	27	30
SIGNAL score		4	3	3	4	4	3	3	3	3	3
EPT richness		2	0	0	2	2	2	1	1	1	0
EPT ratio		0.1	0	0	0.1	0.1	0.2	0.1	0.1	0.1	0

SIGNAL Scores and the Functional Feeding Group of the Macroinvertebrates

Group Phylum, Class, Subclass or Order)	Family	SIGNAL	Shredders	Filtering collectors	Gathering collectors	Scrapers	Predators	Scavengers	Macrophyte piercers
Primitive Worms and Allies, Worms and Leeches									
Temnocephalidea	-	5					•		
Nematoda	-	3					•		
Hirudinae	-	1					•		
Molluscs									
Gastropoda	Physidae	1				•			
Arachnids									
Arachnida	sp. 1	6					•		
Arachnida	sp. 2	6					•		
Crustaceans									
Cladocera	Daphniidae	-		•					
Ostracoda	-	-		•					
Copepoda-Cyclopoida	-	-		•					
Decapoda	Parastacidae	4			•				
Insects									
Ephemeroptera	Baetidae	5				•			
	Caenidae	4	•						
Plecoptera	Austroperlidae	10				•			
Tricoptera	Leptoceridae	6	•						
Odonata-Epiproctophora	Hemicorduliidae	5					•		
Odonata-Zygoptera	Isostictidae	3					•		
	Coenagrionidae sp 1	2					•		
	sp. 2	2					•		
Hemiptera	Corixidae	2							•
	Hydrometridae	3					•		
	Veliidae sp. 1	3					•		
	sp. 2	3					•		
	Nepidae	3					•		
	Belostomatidae	1					•		
	Notonectidae	1					•		
Diptera (flies)	Culicidae	1		•					
	Chironomidae								
	Chironominae	3			•				
	Orthocladiinae	4			•				
	Stratiomyidae	2				•			
Coleoptera (beetles)	Dytiscidae sp. 1	2					•		
	sp. 2	2					•		
	sp. 3	2					•		
	Noteridae sp. 1	4					•		
	sp. 2	4					•		
	Haliplidae sp. 1	2	•						
	sp. 2	2	•						
	Hydrophilidae sp. 1	2	•						
	sp. 2	2	•						
	Scirtidae	6	•						
	Total		**7**	**4**	**3**	**4**	**20**	**0**	**1**

APPENDIX B

CONDITION ASSESSMENT INDICATORS

(MACTAGGART AND GOLDNEY, 2010)

RIPARIAN VEGETATION					
Health and Structural Integrity of Riparian Vegetation	**Proportion of Cover that is Indigenous**	**Presence of Regeneration of Indigenous Species**	**Vegetation Cover**	**Native Species Diversity**	**Rating**
No changes in life-form or biomass/density of the communities compared to expected natural state.	High proportion of indigenous vegetation with little or no exotics	Many age classes and many new recruitments	76-100%	Very high	4 Very good
Some changes in life-form or reduction in biomass/density but structural integrity still present.	Widespread occurrence, few exotic species	New recruitments common, mixed age classes present	51-75%	High	3 Good
Significant changes in either life-form or biomass/density. Structural integrity lost.	Mix of exotic and indigenous species	Few and widely scattered new recruitments, mainly old age classes	26-50%	Many	2 Fairy poor
-	Mostly exotic species	-	10-25%	Few	1 Degraded
Dramatic change in life-form and structure from natural state, reduced biomass/density.	Devoid of indigenous species	Only old or senescing vegetation and no new recruitments	<10%	Nil	0 Very degraded

Ratings: 4 (very good); 3 (good), 2 (poor); 1 (poor); 0 (very poor).

INSTREAM HABITAT					
Health and Structural Integrity of Instream Vegetation	**Proportion of Vegetation that is Indigenous**	**Habitat Complexity and Quality** ‡	**Instream Vegetation Cover**	**Native Species Diversity**	**Rating**
Type A: Streambank and stream edge vegetated with macrophytes, forbs, trees and/or shrubs. Vegetation in good health. **Type B**: A dominance of sedges, rushes and grasses, and a general exclusion of shrubs and trees in wetter habitats (if present – widely scattered). Vegetation in good health. Intact carbon, nutrient and water cycles, high ecological resilience, high energy interception.	High proportion of indigenous vegetation with little or no exotics	**Type A Instream**: High habitat complexity. Natural pool/riffle sequences, diversity of geomorphic units (undercut banks, benches, bars), snags if natural to system, substrate complexity (varying size substrate material - coarse to fines). **Type B Invalley**: Valleys or swampy meadows with good structural complexity of groundcover plants, micro-geomorphic units if natural to system. Intact carbon, nutrient and water cycles, high ecological resilience.	**Type A** Abundant **Type B** 76-100%	Very high	4
Some loss of structural intactness (change in life-form, standing biomass) due to disturbance – change in hydrology, grazing, sediment movement and/or vegetation communities showing some signs of impact (e.g. sediment smothering, desiccation due to change in hydrology, stock grazing/trampling), condition stable or improving.	Widespread occurrence, few exotic species	Some loss of habitat complexity or deviation from expected natural state. No artificial barriers affect fish passage.	**Type A** Common **Type B** 51-75%	High	3
Moderate loss of structural intactness and/or vegetation communities showing signs of impact. Condition stable or improving. Some impairment or disruption to carbon, water and nutrient cycles, ecological resilience fair.	Mix of indigenous and exotic species	Moderate habitat complexity or deviation from expected natural state. Downstream artificial barriers moderately affect fish passage. **Type A**: Coarse woody debris not of indigenous origin, loss of geomorphic features, instream bed mining, sediment layer over substrate patchy.	**Type A** Scattered **Type B** 26-50%	Many	2
Dramatic reduction in vegetation community structure from natural conditions. Vegetation severely impacted by land use pressures or change in environmental conditions.	Mostly exotic species	Poor habitat complexity, no coarse organic material, substrate of similar sized material, unstable substrate, major deviation from natural state, bank slumping, high sediment layer over substrate, most downstream artificial barriers affect fish passage.	**Type A** Isolated **Type B** 10-25%	Few	1
Absence of vegetation or no structural integrity of that remaining. V. low energy interception, ecological thresholds exceeded, resilience very low, carbon, nutrient and water cycles impaired or disrupted, condition worsening.	Devoid of indigenous species	Homogeneity of substrate material, sediment flux, no snags or periphyton, blanket sediment layer over substrate, all downstream artificial barriers affect fish passage.	**Type A** Nil **Type B** <10%	Nil	0

‡ An increase in habitat complexity with increasing degradation of swampy meadows and valley-fills (formation of major erosional areas such as nick points, plunge pools, and large volumes of sediment flux) is a deviation from the natural state and is consequently considered a poor reflection of their overall condition. Paradoxically, this same complexity, and at times events such as tree fall, bank erosion and cover of uncharacteristic channel vegetation, may well increase fauna habitat (or at least change faunal assemblages) as well as assist in natural system recovery.

Ratings: 4 (very good); 3 (good), 2 (poor); 1 (poor); 0 (very poor).

HYDROLOGY				
Stream – Floodplain Connectivity	**Catchment Urbanised**	**Hydrologic Deviation from Natural Flows**	**Hydraulic (Fluid Mechanics) Deviation from Natural Flows**	**Rating**
Stream-floodplain connectivity natural for stream characterisation. Maintenance of natural water, nutrient and carbon cycles between hillslopes, floodplain and channel.	0%	No deviation from natural flows. Catchment condition, floodplain and tributary water storage and water cycles in near natural state. No artificial barriers that affect natural flows. Maintenance of natural water cycles.	**Type A**: No deviation from natural flow mechanics. Characteristics variable according to stream type. Likely to have different surface flows, pools, dead zones, areas of turbulence etc. **Type B**: No deviation from natural flows; multiple flow pathways across valley floor, low flow velocity.	4
Minor disruption of water, nutrient and carbon cycles between hillslopes, floodplain and channel. **Type A**: Stream-floodplain connectivity sometimes hampered due to floodplain modification or assisted due to weirs. **Type B**: Some stream-floodplain connectivity though somewhat restricted due to formation of discontinuous channels or gullies or altered vegetation assemblages.	1-10%	Some catchment modification, minor deviation from natural flows, some disruptions to water cycles.	**Type A**: Slight deviation from expected natural flows. Reduced channel roughness. **Type B**: Some areas of water may tend to flow along shallow, vegetated channels.	3
Disruption of water, nutrient and carbon cycles between hillslopes, floodplain and channel. **Type A**: Floodwaters overtop floodplain only during periods of high floods 20 year ARI. **Type B**: Poor stream-floodplain connectivity due to shallow, channel or gully, gently sloping vegetated banks, vegetated floodplain.	11-20%	Downstream artificial barriers are overtopped at least once per year **Type A**: Flood peaks of higher magnitude and duration reduced compared to expected natural, some change in depth and periodicity of flow (reduced base-flows, little/no natural floodplain storage or more rapid water loss; increased number of small-moderate flow events). **Type B**: Discontinuous channel, or shallow channel with some water flow over floodplain, modified catchment conditions (e.g. farm dams, removal of perennial vegetation).	**Type A**: Moderate deviation from expected. **Type B**: Channel more defined and continuous, vegetation patchy or absent, possible physical obstructions, flow velocity increasing beyond natural.	2
Major disruption of water, nutrient and carbon cycles between hillslopes, floodplains and channel. **Type A**: Floodwaters overtop floodplain only during periods of extremely high floods 100 year ARI; floodplain barriers – levees. **Type B**: Very poor stream-floodplain connectivity due to shallow, channel or gully, gently sloping banks, little vegetation on banks or floodplain.	21-50%	**Type A**: Significant change in depth and periodicity of flow due to altered flood hydrograph, presence of engineered structures that act to alter natural hydrology, no natural floodplain storage, marked water level fluctuations. Artificial barriers never overtopped during floods. **Type B**: As for Type A, channelised.	**Type A**: Major deviation from expected. **Type B**: Well-defined channel, devoid of vegetation and obstructions, flow velocity high.	1

HYDROLOGY				
Stream – Floodplain Connectivity	**Catchment Urbanised**	**Hydrologic Deviation from Natural Flows**	**Hydraulic (Fluid Mechanics) Deviation from Natural Flows**	**Rating**
Complete breakdown of water, nutrient and carbon cycles between hillslopes, floodplains and channel. **Type A**: Complete stream disconnection with floodplain even during high flood events. **Type B**: Complete stream disconnection with floodplain, steep-sided banks with no appreciable vegetation.	50-100%	High magnitude/reduced duration flood peaks, significantly altered catchment conditions and water cycle; significantly reduced base flows and increased number of small-moderate flow events. At least one artificial barrier in basin downstream of this reach is not overtopped at least once/year. Major disruption to water cycle. **Type A**: Stormwater inflows, engineered structures that act as weirs, dams, increased frequency of bank-full floods. **Type B**: Channelised, no instream vegetation, dramatic change in velocity, depth and periodicity of flow.	**Type A**: Stream hydraulics dramatically different to natural system (change to riffle/pool features, significant reduced channel roughness, channel width to depth ratio altered, sediment slugs, sediment removal, instream obstructions -groynes, revetments, culverts - change in streambed material, change in channel alignment, channel straightening, water conveyancing and channel roughness, concrete channel, altered channel cross-section, instream engineered structures). **Type B**: As for Type A, flow path along one deeply incised 'v'-shaped channel bed, very high flow velocity for system, reduced channel roughness, concrete channel.	0

Ratings: 4 (natural); 3 (fairly natural), 2 (moderately modified); 1 (highly modified); 0 (extremely modified)

GEOMORPHOLOGY				
Bank Stability‡	**Bed Stability**	**Level of Engineering**	**Deviation from Natural Stream Characterisation**	**Rating**
Banks stable or in natural stage in life-cycle; no evidence of sediment movement; sides and/or floors of bank vegetated. No geomorphic thresholds exceeded, high geomorphic resilience (bed and banks).	Bed substrate movement part of natural processes, stability in width to depth ratio. Small volumes of sediment flux through system.	No alteration of drainage density, channel alignment or channel character compared with expected natural state.	No deviation from expected natural character or stream in natural stage in life-cycle.	4
Limited erosion, some minor isolated erosion, no continuous damage to bank structure. (No geomorphic thresholds exceeded, good geomorphic resilience (bed and banks).	Minor changes to width to depth ratio. Some sediment flux, minor bed erosion or accretion.	Minor alteration of channel such as some bank revetment, instream bed stabilisation structures.	Minor deviation from expected natural character.	3
Banks partly stabilised; evidence of some active erosion and some stabilisation, generally stable toe. Moderate resilience, geomorphic resilience not exceeded (bed and banks).	Changes to the width to depth ratio from pre-European settlement condition. Moderate volumes of sediment deposited from upstream erosion or bed actively eroding.	Moderate alteration of channel character, engineered open channel with battered banks.	Moderate deviation from expected natural character.	2
Extensive erosion, recent bank movement, unstable toe. Poor geomorphic resilience, thresholds possibly exceeded and condition worsening (bed and banks).	Major changes in width to depth ratio. Streambed very unstable with erosion, sediment movement and deposition on a major scale.	Major alteration of channel alignment, character, or drainage density, modified to open channel with low flow pipes, flow diversions.	Major deviation from expected natural character.	1
Extreme active bank erosion. Evidence of sediment movement; sides and/or floors of erosion are relatively bare of vegetation, nick points and bank slumping. Geomorphic thresholds exceeded (bed and banks).	Dramatic deviation from natural cycle, contemporary sediment slugs from upstream erosion, active bed lowering from substrate extraction, unnatural sediment flux; change in width to depth ratios.	Waterway completely altered with streams engineered, straightened, excavated, piped, filled in or placed in underground culverts, concrete open channels.	Significant alteration from original stream character. Channelised, aligned, gullied, engineered, piped, diverted, bank stabilisation, incised swampy meadows.	0

‡ Does not include bank erosion where it is expected such as outer meander bends as per assessment recommendation (Grove *et al.*, 2004).

Ratings: 4 (natural); 3 (fairly natural), 2 (moderately modified); 1 (highly modified); 0 (extremely modified).

WATER QUALITY						
pH Range	**Electrical Conductivity**	**Eutrophication (algal bloom, periphyton or filamentous algae proliferation)**	**Water Clarity (turbidity, suspended sediments) c.f expected natural conditions**	**Litter**	**Low Dissolved O_2, Sewage, Petroleum, Chemicals or Other Contaminates**	**Rating**
6.5-7.5	<100 μScm^{-1}	Near natural cover or abundance.	Low	Nil	No unnatural odours, water well oxygenated, no evidence of chemical pollution, no industry, septics in catchment and roads absent or well buffered, oil cover very low or absent.	4
6.0-6.4 or 7.6-8.0	100 < 350 μScm^{-1}	-	Minor	Limited	Odour indistinct, water mostly oxygenated, minor chemical pollution likely due to waterway being in low density built environment, septic tanks absent or few and at a considerable distance from waterway, low surface oil cover.	3
5.5-5.9 or 8.1-8.5	350 < 500 μScm^{-1}	High cover or abundance.	Moderate	Some	Some odour, abundant decaying material in water from urban sources or exotic riparian vegetation, chemical pollution likely due to waterway being in the built environment, possibly septics in catchment, moderate surface oils.	2
4.5-5.4 or 8.6-9.4	500 < 700 μScm^{-1}	-	High	Many	Odour quite strong, water showing signs of stagnation, high surface oil cover.	1
<4.5 or >9.5	700 μScm^{-1}	Prolific cover or abundance.	Very high	Countless	Odour strong, water stagnant, very high oil cover on water surface, sewer leaks or septic tanks in close proximity to waterway.	0

Ratings: 4 (very good); 3 (good), 2 (poor); 1 (poor); 0 (very poor).

AQUATIC FAUNA	
Habitat assessment ‡	**Rating**
Very good habitat for fauna utilising the riparian zone. Diversity of instream habitat features, riparian vegetation of good structure and species composition, floodplain and stream connectivity: typical of stream type. (e.g. instream habitat features such as logs, rocks, pools, sediment bars, dead zones/flow zones, overhanging trees, good riparian vegetation structure and composition with nesting, roosting, foraging resources, ground layer habitat features such as logs, good ground herbage. Unlikely alien fish species present.	4
Good habitat features present, but some loss of integrity, e.g. stream reach may have good instream qualities, though the riparian vegetation structure and composition may be compromised; or visa versa. Erosion may be reducing habitat quality by scouring bed sediments and instream vegetation, or some habitat features being smothered. Alien fish species likely to be present if habitat available though their impact not highly significant.	3
Moderate habitat quality. Impacts on the riparian zone have caused considerable changes to the quality of the habitat, e.g. remnant riparian vegetation may be scattered, instream vegetation patchy, some remnant pools may persist, instream sediment flux affecting much of the habitat, weeds common but contributing to high vegetation cover. Alien fish species likely to be present if habitat available.	2
Very poor habitat quality due to instream or catchment impacts. Channel or riparian zone modifications significantly altering riparian habitat such as loss of riparian vegetation, urban encroachment, channel engineered into low flow pipes, channels slashed, drained or dredged, dense cover of exotic trees and shrubs causing shading and community composition alteration. Water may be high in nutrients or sediments or have low dissolved O_2 levels. Alien fish species likely to be present if habitat available.	1
Extremely poor habitat quality for riparian fauna. Stream reach may be piped, culverted, engineered into an open concrete channel. These structures create poor quality such as complete or partial shading, high flow velocities, little if any instream vegetation, substrate material and floodplain/riparian zone connectivity. Condition worsening and ecological resilience very low and thresholds exceeded. Large numbers of alien fish likely to be present if habitat available.	0

Aquatic fauna assessment				
Indigenous Species Diversity	**Proportion of Indigenous Species**	**Abundance of Indigenous Species**	**Proportion of Species Indicative of Poor Habitat**	**Rating**
Very high	Very high	Very abundant	Very low	4
High	High	Abundant	low	3
Moderate	Moderate	Many	Moderate	2
Low	Low	few	High	1
Very low	Very low	Nil	Very high	0

‡ This criteria was used if no aquatic fauna observed, the site was not surveyed or aquatic habitat not present. The assessment integrates the other condition assessment attributes outlined above.

Ratings: 4 (very good); 3 (good), 2 (poor); 1 (poor); 0 (very poor)

Cautionary Note Regarding Stream Section Condition Values

The determination of a stream section condition value is determined by deduction and value judgements informed by ecological understanding, using attribute condition values within a stream section. These values of course subsume all Indicator Condition values. The deduction process does not consider the mean, weighted means, median or modal values of attribute condition, since this would very likely mis-represent Stream Section Condition for the following reasons:

- The mean values may not always reflect what is being assessed (i.e. the indicator, attribute or stream reach) when ratings are strongly skewed. For example, if an attribute data set has values of (1, 1, 1, 1, 4, 1) then its mean value of 1.5 (rounding up the value would be '2' – equating to poor condition) may not be a true indication of its condition. This is particularly so when the value of '4' may simply be due to its water quality having a high rating based on the select number of indicators used. It is likely the stream section could be interpreted as '1'-degraded. However, due to the low number of sample sites used to derive the indicator rating (1, 2 or 3), the interpreted values at this level of assessment tends to be the mean value (see point below for using means on ratings values);
- The ratings are ordinal numbers (numbers that are scores) and not numerals; therefore they are not suitable to be averaged to obtain a mean value;
- The condition indicators and attributes are *independent* variables and it cannot be assumed that they are of equal value in contribution to stream condition. Some may have a greater influence on ecosystem function or processes than others and their influence may differ over time and in space (e.g. the presence of instream litter is usually of much less importance to stream condition than are habitat complexity and quality of instream habitat). Therefore, comparing them directly or by using weighted means to obtain a mathematically derived condition rating is likely to result in misleading and/or inappropriate conclusions. Further, the number of indicators per attribute differ, which adds to the problems of using weighted means as a determinant of condition;
- Median values (the middle value from a list of numbers ordered from the lowest to the highest) also may not always appropriately reflect what is being assessed. Again, using the attribute data set example above (1, 1, 1, 1, 1, 4), the median value and indeed the modal value (i.e. the value that occurs the most frequently in a data set) is 1. A degraded rating of '1' may reflect the stream reach but if, for example, the riparian vegetation or instream habitat is so good that it has a rating of '4', then it may be interpreted that the stream is poor with a rating of '2' rather than degraded.

However, despite the direct avoidance of using just one of the above simple statistical methods of deriving a ratings value, the deduced value can be the result of the mean, median or modal score. With an attribute data set comprising (2, 3, 2, 2, 3, 3) the median value (and by chance the mean and modal value) is 2.5. The assessor has to interpret whether the stream reach warrants a '2' or '3' rating. That determination has to be judged on a case-by-case basis from an appreciation of the whole stream reach. There is no hard and fast rule that applies. To illustrate further, with an attribute data set comprising (3, 1, 2, 2, 1, 1) with a median value of (1.5), mean (1.6) and modal (1) the stream section could be interpreted as having a rating of '2' (close to the mean); whereas a data set of (2, 3, 2, 2, 2, 3) the modal value could be the most appropriate.

APPENDIX C

CONDITION ASSESSMENT PROFORMA

(MACTAGGART AND GOLDNEY, 2010)

Urban Waterways Data Sheet	**Subcatchment**

Site		Date	
Observers		Stream type	A B C
Surrounding land use		Photo	
Stream characterisation			

Rapid assessment of waterways – (rating 4 – good, 0 – bad)

Riparian vegetation (R)

Sample No.	Structural Integrity	Proportion Indigenous	Regeneration of Indigenous Species	Vegetation Cover	Native Species Diversity	
1						
2						
3						R condition

Instream habitat (I)

Sample No.	Structural Integrity Veg	Proportion Veg Indigenous	Habitat Complexity and Quality	Vegetation Cover	Native Species Diversity	
1						
2						
3						I condition

Hydrology (H)

Sample No.	Connect w Floodplain	Urbanised	Hydrologic Deviation from Natural Flows	Hydraulic Deviation from Natural Flows	
1					
2					
3					H condition

Geomorphology (G)

Sample No.	Bank Stability	Bed Stability	Level of Engineering	Deviation from Natural Character	
1					
2					
3					G condition

Water quality (W)

Sample No.	pH	EC	Eutrophication	Water Clarity	Litter	Contaminants	
1							
2							
3							W condition

Aquatic fauna (F)

Sample No.	Habitat Assess	Species Diversity	Proportion Indigenous	Abundance Indigenous Species	Indicative of Poor Habitat	
1						
2						
3						F condition

Overall condition rating (Rating 4 – good, 0 – bad)	

Thresholds, Condition Trend

Condition Trend		Stable	Improving	Worsening	Likely Natural Stage in Cycle
Resilience	Geomorphic				
	Ecological				
Thresholds exceeded	Geomorphic	Y/N			
	Ecological	Y?N			

Notes

ATTACHMENT C

HABITAT ASSESSMENT DATA

Table C-1
Habitat Assessment

Site Description	S1			S2	
Eastings	229641			228194	
Northings	6608034			6608241	
Altitude (m)	299			299	
Aspect	North			North	
Tenure	State Forest			State Forest	
Landform	Slope			Slope	
Connectivity (Internal)[1]	2-3			2	
Connectivity (External) [1]	2-3			2	
Habitat Layers (mean units in cm or m)					
– Bare Soil (Yes or No)	Yes			Yes	
– Litter	2 cm			2 cm	
– Rock	No			No	
– Log	50 cm			50 cm	
– Herb	25 cm			25 cm	
– Grass	50 cm			50 cm	
– Shrub	3-5 m			4 m	
– Mid-storey Tree	5-8 m			5-10 m	
– Upper Tree	15-25 m			5-25 m	
– Mistletoe [5]	2			2-3	
% Groundcover					
– Bare Soil	20			20	
– Litter	20			15	
– Rock	0			0	
– Herb	10			15	
– Grass	25			20	
– Shrub	20			20	
– Mid-storey Tree	15			25	
– Upper Tree	65			75	
– Logs (50x20 m plot)					
– Length (m)	5x(1 m)	4x(3 m)	8x(3 m)	6x(5 m)	2x(4 m)
– Diameter (cm)	20	25	10	10	50
– Decay class (1,2,3) [6]	3	2	1	2	3
Classification	Dry Sclerophyll Forest			Dry Sclerophyll Forest	
Successional Stage	Predominantly regrowth from past clearance			Predominantly regrowth from past clearance	
Tree Health	Good			Good	
Water Sources[2]	3			5	
Recent Hot Fires	No			No	
Logging	Past heavy			Past heavy	
Dieback	Few			Few	
Understorey Disturbance	Moderate			Moderate	
Herbaceous Weeds	Light			Light	
Woody Weeds	Light			Light	

Table C-1 (Continued)
Habitat Assessment

Site Description	S1	S2
Other Disturbance Events	Grazing, logging, trails and nearby mining	Fire trails, surrounding mining, hunting, logging, and erosion
Conservation Rating[3]	2.5	2.5
Conservation Trends[4]	2.5	2

[1] (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

[2] (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

[3] (1=high quality, self regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

[4] (1=self sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

[5] (1=0, 2=[2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

[6] (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

[7] (Diameter at breast height)

Table C-2
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	S1								S2						
Species ID	Iron Bark		White Box			White Cypress Pine			Ironbark			White Box	White Cypress Pine		
DBH class	80	20-30	75	20-30	10	30-40	10-20	5-10	75	30-50	5-10	40-60	10-20	5-10	5
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fire Scar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mistletoe (Count)	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Hollows (Count) (Small, Medium, Large)	8,7,4	3,1,0	4,4,1	2,0,0	0,0,0	0	0	0	1,3,2	4,2,0	1,0,0	2,2,1	0,1,0	0	0
Decorticating bark (Present/Absent)	Y	Y	Y	Y	Y	0	0	0	Y	Y	Y	Y	0	0	0
Dieback	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Count (for multiple occurrences of trees with the same characteristics)	1	4	2	3	6	1	6	4	2	5	3	2	4	4	2

Table C-3
Habitat Assessment

Site Description	S3		S4		
Eastings	59008387		231454		
Northings	6605065		6605383		
Altitude (m)	265		287		
Aspect	3^0 West		3^0 West		
Tenure	Private		Private		
Landform	Flat		Flat		
Connectivity (Internal)[1]	1		2		
Connectivity (External)[1]	4		5		
Habitat Layers (mean units in cm or m)					
– Bare Soil (Yes or No)	Yes		Yes		
– Litter	2-3 cm		4 cm		
– Rock	0		0		
– Log	10-20 cm		to 50 cm		
– Herb	10-25 cm		25 cm		
– Grass	20-60 cm		50 cm		
– Shrub	50 cm – 2 m		1.5 m		
– Mid-storey Tree	0		5 m		
– Upper Tree	15 m		25 m		
– Mistletoe	1		1		
% Groundcover					
– Bare Soil	10		10		
– Litter	10		75		
– Rock	0		0		
– Herb	5		15		
– Grass	65		15		
– Shrub	10		20		
– Mid-storey Tree	0		30		
– Upper Tree	20		85		
– Logs (50x20 m plot)					
– Length (m)	1 x10	1 x10	10 x (5-10)	1 x (7.5)	1 x 5
– Diameter (cm)	15	35	15-20	40	10
– Decay class (1,2,3)	2	2	2	3	3
Classification	Dry Sclerophyll Forest		Riparian/Floodplain Habitat		
Successional Stage	Predominantly mixed regrowth/old growth		Predominantly mixed regen./old growth		
Tree Health	Good		2		
Water Sources[2]	1		3		
Recent Hot Fires	No		No		
Logging	Past heavy		None		
Dieback	None		Few		
Understorey Disturbance	Considerable		Considerable		
Herbaceous Weeds	3		4		

Table C-3 (Continued)
Habitat Assessment

Site Description	S3	S4
Woody Weeds	1	1
Other Disturbance Events	Light grazing, recent clearing, land degradation	External grazing and farming, internal grazing/shelter
Conservation Rating[3]	3	3
Conservation Trends[4]	3	2

1 (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

2 (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

3 (1=high quality, self-regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

4 (1=self-sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

5 (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

6 (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

7 (Diameter at breast height)

Table C-4
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	S3							S4				
Species ID	White Box							Red Gum	Bracteate	White Box		
DBH class	50-80	30-40	50-80	5-20	50-80	50-80	30-40	80-100	10-20	80	80	30-40
Dead	0	0	0	0	0	0	0	0	0	Y	0	0
Fire Scar	0	0	0	0	0	0	0	0	0	0	0	0
Mistletoe (Count)	0	0	0	0	0	0	0	2	0	0	0	0
Hollows (Count)(Small, Medium, Large)	1,0,0	2,0,0	4,0,0	2,0,0	3,0,0	1,1,2	0	6,3,5	1,0,0	3,4,7	2,2,2	1,1,0
Decorticating bark (Present/Absent)	Y	Y	Y	Y	Y	Y	Y	Y	0	0	Y	Y
Dieback:	0	0	0	0	0	<30	0	40	30	Dead	30	30
Count (for multiple occurrences of trees with same characteristics)	1	1	1	1	1	1	2	1	10	1	2	4
Logs (50x20m plot)												
Length	1 x 10				1 x 10			10 x (5-10) m	1 x 7.5 m	1 x 5 m		
Diameter	15 cm				35 cm			15-20	40	10		
Decay class (1,2,3)	2				2			2	3	3		

Table C-5
Habitat Assessment

Site Description	S5	S6		
Eastings	230952	230325		
Northings	6606651	6607491		
Altitude	279 at creek, 274 at road junction	342		
Aspect	Road South-west	Runs North-east		
Tenure	Council Road	Project area		
Landform	Flat roadway verge	Gully		
Connectivity (Internal)[1]	4	2		
Connectivity (External)[1]	4	2		
Habitat Layers (mean units in cm or m)				
– Bare Soil (Yes or No)	Yes	Yes		
– Litter	2 cm	2 cm		
– Rock	0	Limited and scattered small to medium sized rock		
– Log	0	to 40 cm		
– Herb	25 cm	to 20 cm		
– Grass	50 cm	to 50 cm		
– Shrub	3 m	To 3 m		
– Mid-storey Tree	5 m	4 m		
– Upper Tree	25 m	20 m		
– Mistletoe	2	1		
% Groundcover				
– Bare Soil	10	20		
– Litter	15	15		
– Rock	0	5		
– Herb	15	10		
– Grass	60	10		
– Shrub	10	5		
– Mid-storey Tree	10	70		
– Upper Tree	10	5		
Logs (50x20 m plot)				
Length (m)	0	1 x 3	1 x 6	1 x 10
Diameter (cm)	0	45	40	20
Decay class (1,2,3)	0	2	2	2
Classification	Dry Sclerophyll Forest	Dry Sclerophyll Forest-Cypress Monoculture Regrowth		
Successional Stage	Predominantly mixed regen/old growth	Predominantly Regrowth		
Tree Health	Good	Good		
Hollows Present (Count trees with hollows in 100 x 10m transect)	3	2		
Water Sources[2]	3	3		
Recent Hot Fires	No	No		
Logging	None	Past heavy		
Dieback	Few	Few		

Table C-5 (Continued)
Habitat Assessment

Site Description	S5	S6
Understorey Disturbance	Considerable	Considerable
Herbaceous Weeds	Light	Light
Woody Weeds	Light	Light
Other Disturbance Events	Roadside timber getting, grazing	Grazing, logging, bank erosion (30cm), rabbits, animal tracks, feral animal
Conservation Rating[3]	3	3
Conservation Trends[4]	3	3

1 (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

2 (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

3 (1=high quality, self regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

4 (1=self sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

5 (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

6 (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

7 (Diameter at breast height)

Table C-6
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	S5				S6					
Species ID	White Box				Iron Bark	White Box			White Cypress Pine	*Acacia* spp.
DBH class	50-60	20-40	50	80	20-40	40	20	80-100	5 to 15	10 to 15
Dead	0	0	0	0	0	Y	Y	0	0	0
Fire Scar	0	0	0	0	0	0	0	0	0	0
Mistletoe (Count)	0	0	0	0	0	0	0	3	0	0
Hollows (Count) (Small, Medium, Large)	5,2,1	4,2,0	3,1,1	4,2,3	3,1,0	3,2,1	2.0.0	5,4,3	0,0,0	0,0,0
Decorticating bark (Present/Absent)	Y	Y	Y	Y	0	0	0	0	0	0
Dieback	<30	<30	<30	<30	<10	dead	dead	<10	<10	<10
Count (for multiple occurrences of trees with same characteristics)	2	3	3	2	5	1	1	1	14	6

Table C-7
Habitat Assessment

Site Description	S7	S8		
Eastings	229744	231482		
Northings	6607099	6608525		
Altitude	324	276		
Aspect	Northeast-east	4 ^{0} South		
Tenure	Mine	State Forest		
Landform	Break of slope	Riparian		
Connectivity (Internal)[1]	2	2		
Connectivity (External)[1]	2	4		
Habitat Layers (mean units in cm or m)				
– Bare Soil (Yes or No)	Yes	Yes		
– Litter	2 cm	2 cm		
– Rock	to 5 cm	N		
– Log	to 25 cm	50 cm		
– Herb	to 25 cm	to 25 cm		
– Grass	to 50 cm	50-70 cm		
– Shrub	to 3 m	< 3 m		
– Mid-storey Tree	to 6 m	2-5 m		
– Upper Tree	to 20 m	15- 18 m		
– Mistletoe	1	1		
% Groundcover				
– Bare Soil	15	15		
– Litter	20	30-40		
– Rock	10	0		
– Herb	15	<5		
– Grass	15	10 to 20		
– Shrub	10 to 30	30 -40		
– Mid-storey Tree	5 to 10	25		
– Upper Tree	5 to 10	80		
Logs (50x20m plot)				
Length (m)	20 x 3 m	3x10 m	5x5 m	1x5 m
Diameter (cm)	5 cm	30	20	45
Decay class (1,2,3)	2	2	2	3
Classification	Dry Sclerophyll Forest	Riparian/Floodplain Habitat		
Successional Stage	Predominantly regrowth	Predominantly mixed regrowth/old growth		
Tree Health	Good	Good		
Hollows Present (Count trees with hollows in 100 x 10 m transect)	2	4		
Water Sources[2]	5	3, 4		
Recent Hot Fires	No	No		
Logging	Past Heavy	Past Heavy		
Dieback	Few	None		

Table C-7
Habitat Assessment

Site Description	S7	S8
Understorey Disturbance	Considerable	Moderate
Herbaceous Weeds	Light	Perimeter only/light
Woody Weeds	Perimeter only	None
Other Disturbance Events	Recent grazing, recent logging, tracks, rabbits, erosion	Recent floods, recent flood debris, logging.
Conservation Rating[3]	3	2.5
Conservation Trends[4]	3	2.5

1 (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

2 (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

3 (1=high quality, self--regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

4 (1=self-sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

5 (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

6 (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

7 (Diameter at breast height)

Table C-8
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	S7			S8					
Species ID	White Cypress Pine	Iron Bark	B. Red Gum	Dead Tree	White Cypress Pine			Melaleuca	*Acacia* spp.
DBH class 5-20, 21-30, 31-40cm dbh	5 to 20	30	40-50	20	20-30	45	20	20-30	10to15
Dead	0	0	0	0	4	0	0	0	0
Fire Scar	0	0	0	0	0	0	0	0	0
Mistletoe (Count)	0	0	3-8/tree	0	0	0	0	0	0
Hollows (Count) (Small, Medium, Large)	0	2,0,0	5,2,0	0	3,3,2	0	0	0	0
Decorticating bark (Present/Absent)	0	0	Y	Y	0	Y	0	Y	0
Dieback:	<10	<10	<10%	<10%	<10%	<10 %	<10%	<10%	0
Count (for multiple occurrences of trees with same characteristics)	44	4	8	3	4	3	16	10	10

Table C-9
Habitat Assessment

Site Description	S9	S10
Eastings	231121	230952
Northings	6607496	6606651
Altitude	290	279
Aspect	Running North to South 3^0 South	Running Due South 3^0 South
Tenure	Mine Land	Mine land
Landform	Sinuous ephemeral stream with broad floodplain	Sinuous stream with riparian woodland and associated floodplain
Connectivity (Internal)[1]	2	4
Connectivity (External)[1]	4	4
Habitat Layers (mean units in cm or m)		
– Bare Soil (Yes or No)	Yes	Yes
– Litter	5 cm	2 cm
– Rock	50 cm	0
– Log	40 cm	to 50 cm
– Herb	25 cm	to 25 cm
– Grass	50 cm	to 50 cm
– Shrub	3-5 m	to 3 m
– Mid-storey Tree	5-8 m	5-8 m
– Upper Tree	10-25 m	10-25 m
– Mistletoe	1	2
% Groundcover		
– Bare Soil	10	15
– Litter	4.5	15
– Rock	5	0
– Herb	15	15
– Grass	15	50
– Shrub	15	10
– Mid-storey Tree	25	15
– Upper Tree	90	20
Logs (50x20 m plot)		
Length (m)	4x (5 m)	0
Diameter (cm)	20	0
Decay class (1,2,3)	2	0
Classification	Open forest – Bracteate riparian woodland-forest with grassy box woodland and cleared land adjacent. Bracteate strip more or less continuous at forest formation and approx. 400—500 trees/ha.	Riparian woodland/forest adjacent to cleared agricultural land.
Successional Stage	Predominantly mixed regrowth/old growth	Predominantly mixed regrowth/old growth
Tree Health	Good	Good
Hollows Present (Count trees with hollows in 100 x 10m transect)	3	3
Water Sources[2]	3	3

Table C-9 (Continued)
Habitat Assessment

Site Description	S9	S10
Recent Hot Fires	No	No
Logging	Past light	Past heavy
Dieback	None	Few
Understorey Disturbance	Moderate	Considerable
Herbaceous Weeds	Light	Heavy
Woody Weeds	Light	Light
Other Disturbance Events	Logging, grazing, erosion, incision – ongoing.	Clearing, grazing, bank collapses, farming, dumping spoil
Conservation Rating[3]	2	3
Conservation Trends[4]	3	3

[1] (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

[2] (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

[3] (1=high quality, self regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

[4] (1=self sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

[5] (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

[6] (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

[7] (Diameter at breast height)

Table C-10
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	S9				S10				
Species ID	Bimble Box	White Cypress Pine	B. Red Gum	*Melaleuca* sp	*Melaleuca* sp	Blakely's Red Gum			White Box
DBH class 5-20, 21-30, 31-40cm dbh	21-30		3 x 80 cm	48 x [5 to 20]	5 to 20	80-100	60	40-60	40-60
Dead	1		2	0	0	0	0	0	0
Fire Scar	0		0	0	0	0	0	0	0
Mistletoe (Count)	1		3	0	0	0	0	0	0
Hollows (Count) (Small, Medium, Large)	3,1,0		4,2,5	3,0,0	10,0,0	4,4,3	2,1,3	3,0,0	2,2,2
Decorticating bark (Present/Absent)	Y	N	0	0	0	Y	Y	Y	Y
Dieback:	0	0	<5%	<10%	<30	<30	<30	<30	<30
Count (for multiple occurrences of trees with the same characteristics)	1	5	3	48	11	3	3	3	2

Table C-11
Habitat Assessment

Site Description	Additional Site – Monoculture White Pine Regrowth
Eastings	560228681
Northings	6607045
Altitude	229
Aspect	3˚ South-east
Tenure	Mine
Landform	Flat
Connectivity (Internal)[1]	1
Connectivity (External)[1]	3.5
Habitat Layers (mean units in cm or m)	
– Bare Soil (Yes or No)	Yes
– Litter	5 cm
– Rock	0
– Log	0
– Herb	0
– Grass	45 cm
– Shrub	0
– Mid-storey Tree	85%
– Upper Tree	No
– Mistletoe	1
% Groundcover	
– Bare Soil	<10
– Litter	60
– Rock	0
– Herb	0
– Grass	85
– Shrub	0
– Mid-storey Tree	85
– Upper Tree	
– Logs (50x20m plot)	
– Length (m)	0
– Diameter (cm)	0
– Decay class (1,2,3)[5]	0
Classification	Monoculture early succession White Pine
Successional Stage	Predominantly regrowth
Regeneration (50x20m plot)	
Species ID	White Cypress Pine
Count ID (1,2,3)	4840 stem/ha)
Tree Health	Good
Hollows Present (Count trees with hollows in 100 x 10m transect)	0
Water Sources[2]	1
Recent Hot Fires	No

Table C-11 (Continued)
Habitat Assessment

Site Description	Additional Site – Monoculture White Pine Regrowth
Logging	None
Dieback	None
Understorey Disturbance	Little
Herbaceous Weeds	None
Woody Weeds	None
Other Disturbance Events	Tracks
Conservation Rating[3]	3
Conservation Trends[4]	4
Comments	Regenerating White Pine 4840 stems/ha varying in height from 50 cm to 10 m.
Habitat Description	Growth locked White Cypress Pine at ~5000 stem/ha dominated by 2-3 m saplings, scattered trees at 10 m. 85% canopy cover, 0 to little regrowth of other shrub, tree, ~ 85% grasscover.

[1] (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

[2] (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

[3] (1=high quality, self regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

[4] (1=self sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

[5] (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

[6] (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

[7] (Diameter at breast height)

Table C-12
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	Additional Site – Monoculture White Pine Regrowth		
Species ID	White Cypress Pine	White Cypress Pine	White Cypress Pine
DBH class 5-20, 21-30, 31-40cm dbh	5	10	15
Dead (Count)	0	0	0
Fire Scar (Count)	0	0	0
Mistletoe (Count)	0	0	0
Hollows (Count) (Small, Medium, Large)	0	0	0
Decorticating bark (Present/Absent)	0	0	0
Dieback:	<5	<5	<5
Count (for multiple occurrences of trees with same characteristics)	445	37	2

Table C-13
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS1 (New Site 1)			NS2	
Eastings	227135			231131	
Northings	6616947			6607941	
Altitude	271			301	
Aspect	3°North			3°Southg-west	
Tenure	State Forest			State Forest	
Landform	Mostly flat			Flat	
Connectivity (Internal)[1]	2			1	
Connectivity (External)[1]	3			3	
Habitat Layers (mean units in cm or m)					
– Bare Soil (Yes or No)	Yes			Yes	
– Litter	3 cm			3 cm	
– Rock	0			0	
– Log	40 cm			10 to 20	
– Herb	10 cm			15 cm	
– Grass	25 cm			25 cm	
– Shrub	2.5 m			2-3 m	
– Mid-storey Tree	10 m			4 m	
– Upper Tree	15-18 m			15 m	
– Mistletoe	1			2	
% Groundcover					
– Bare Soil	10			<10	
– Litter	60			25	
– Rock	0			0	
– Herb	20			5	
– Grass	15			5	
– Shrub	30			5	
– Mid-storey Tree	20			10	
– Upper Tree	5			75	
Logs (50x20 m plot)					
Length (m)	3 x 4	2 x5	1x 4	3x5 m	1x10 m
Diameter (cm)	10	20	40	10 cm	20 cm
Decay class (1,2,3)	1	1-2	2	2	2
Classification	Shrubby Mixed age White Box woodland			Regrowth Shrubby Ironbark forest	
Successional Stage	Pre-dominantly mixed age, regrowth/old			Predominantly regrowth	
Trees Regenerating (1=none, 5=numerous and often growth locked)	3			2	
Tree Health	High			Good	
Water Sources[2]	5			1	
Recent Hot Fires	No			No	
Logging	Past heavy			Past heavy	
Dieback	None			Few	

Table C-13 (Continued)
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS1 (New Site 1)	NS2
Understorey Disturbance	Little	Little
Herbaceous Weeds	None	Light
Woody Weeds	None	Light
Other Disturbance Events	Road, grazing, hunting	Logging, track, mining to west
Conservation Rating[3]	2	3
Conservation Trends[4]	2	3

1 (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

2 (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

3 (1=high quality, self-regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

4 (1=self-sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

5 (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

6 (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

7 (Diameter at breast height)

Table C-14
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	NS1 (New Site 1)						NS2						
Species ID	White Box				Iron Bark	*Acacia* spp.	White Cypress Pine		Ironbark			White Cypress Pine Stumps	White Cypress Pine
DBH class 5-20, 21-30, 31-40cm dbh	>40	21-30	21-30	>40	5 to 20	5 to 20	5 to 20	5 to 20	10 to 15	20	20-25	40-50	20
Dead	N	N	N	N	Y	N	N	N	0	Y	0	Y	0
Fire Scar	N	N	N	N	N	N	N	N	0	0	0	0	0
Mistletoe (Count)	0	0	0	0	0	0	0	0	0	0	0	0	0
Hollows (Count) (Small, Medium, Large)	0,0,1	0	1,0,0	0	1,0,0	0	0	0	0	2,3,1	2,0,0	0,0,5	0
Decorticating bark (Present/Absent)	N	N	N	N	Y	N	N	N	Y	0	0	N	0
Dieback:	0	0	0	0	0	0	0	0	<10	dead	<10	N	<10
Count (for multiple occurrences of trees with the same characteristics)	2	2	0	0	2	4	18	2	46	1	5	12	1

Table C-15
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS3			NS4		
Eastings	0231094			232619		
Northings	6610420			6611827		
Altitude	362			321		
Aspect	4°South-west			1°South		
Tenure	State Forest			State Forest		
Landform	Flat			Flat		
Connectivity (Internal)[1]	2			2		
Connectivity (External)[1]	4			3		
Habitat Layers (mean units in cm or m)						
– Bare Soil (Yes or No)	Yes			Yes		
– Litter	4 cm			3 cm		
– Rock	0			0		
– Log	40 cm			60 cm		
– Herb	15 cm			15		
– Grass	25 cm			25		
– Shrub	2-4 m			3 m		
– Mid-storey Tree	5-8 m			10 m		
– Upper Tree	15-20 m			18 m		
– Mistletoe	1			1		
% Groundcover						
– Bare Soil	<10			10		
– Litter	65			30		
– Rock	0			0		
– Herb	5			10		
– Grass	45			65		
– Shrub	20			<5		
– Mid-storey Tree	10			5		
– Upper Tree	40			20		
Logs (50x20 m plot)						
Length (m)	3x(3 m)	4x(4 m)	12x(2 m)	1x(10 m)	4x(4 m)	2x(4 m)
Diameter (cm)	25	50	10	75	25	10
Decay class (1,2,3)[6]	2	1	1	2	2	2
Classification	Regrowth shrubby Ironbark Forest in Woodland formation			Regrowth Shrubby White Box Woodland		
Successional Stage	Predominantly regrowth			Pre-dominantly mixed age, regrowth/old growth		
Tree Health	Good			Good		
Hollows Present (Count trees with hollows in 100 x 10m transect)	2			2		
Water Sources[2]	5			1		
Recent Hot Fires	No			No		
Logging	Past heavy			Past heavy		
Dieback	Few			None		

Table C-15 (Continued)
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS3	NS4
Understorey Disturbance	Little	Little
Herbaceous Weeds	Perimeter only	Perimeter only
Woody Weeds	Light	None
Other Disturbance Events	Track, logging	Track, edge clearing
Conservation Rating[3]	3	2
Conservation Trends[4]	3	2

1 (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

2 (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

3 (1=high quality, self-regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

4 (1=self-sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

5 (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

6 (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

7 (Diameter at breast height)

Table C-16
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	NS3				NS4	
Species ID	White Cypress Pine	Ironbark			White Cypress Pine	White Box
DBH class 5-20, 21-30, 31-40cm dbh	10 to 20	15	10	40-50	20-30	30-40
Dead	0	0	2	0	No	0
Fire Scar	0	0	0	0	No	0
Mistletoe (Count)	0	0	0	0	0	1
Hollows (Count) (Small, Medium, Large)	0	1,0,0	4,4,2	6,7,4	0	4,6,2
Decorticating bark (Present/Absent)	0	0	0	0	Yes	Yes
Dieback:	<10	<10	<10	<10	<5	<5
Count (for multiple occurrences of trees with same characteristics)	12	14	2	2	1	12

Table C-17
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS5			NS6			
Eastings	232789			0230390			
Northings	6613328			6614765			
Altitude	402			347			
Aspect	South 10°			5°East			
Tenure	State Forest			State Forest			
Landform	Undulating			Flattish			
Connectivity (Internal)[1]	2			2			
Connectivity (External)[1]	4			2,3			
Habitat Layers (mean units in cm or m)							
– Bare Soil (Yes or No)	Yes			Yes			
– Litter	3 cm			5 cm			
– Rock	0			0			
– Log	50 cm			30 cm			
– Herb	15 cm			15 cm			
– Grass	25 cm			25 cm			
– Shrub	2-3 m			2-5 m			
– Mid-storey Tree	5 m			6 m			
– Upper Tree	20 m			18 m			
– Mistletoe	1			1			
% Groundcover							
– Bare Soil	10			10			
– Litter	35			60			
– Rock	0			0			
– Herb	10			15			
– Grass	20			45			
– Shrub	60			N			
– Mid-storey Tree	5			10			
– Upper Tree	65			55			
Logs (50x20 m plot)							
Length (m)	8x(4 to 6 m)	2x(4 m)	3x(5 m)	3x(5 m)	6x(3 m)	4x(3 m)	2x(4 m)
Diameter (cm)	5-10 cm	50 cm	25 cm	15	20	25	50
Decay class (1,2,3)	2	1	2	3	2	3	2
Classification	Regrowth Shrubby Ironbark Woodland			Shrubby White Box Woodland			
Successional Stage	Pre-dominantly mixed age, regrowth/old			Pre-dominantly mixed age, regrowth/old			
Tree Health	Good			Good			
Hollows Present (Count trees with hollows in 100 x 10m transect)	2			Some			
Water Sources[2]	1			2			
Recent Hot Fires	No			No			
Logging	Past heavy			Past heavy			
Dieback	None			None			

Table C-17 (Continued)
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS5	NS6
Understorey Disturbance	Little	Little
Herbaceous Weeds	Perimeter Only	Light
Woody Weeds	Light	Light
Other Disturbance Events	Track, logging	Grazing, track, logging
Conservation Rating[3]	2	2
Conservation Trends[4]	2	2

1 (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

2 (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

3 (1=high quality, self-regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

4 (1=self-sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

5 (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

6 (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

7 (Diameter at breast height)

Table C-18
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	NS5			NS6			
Species ID	Iron Bark			White Box		White Cypress Pine	
DBH class 5-20, 21-30, 31-40cm dbh	80cm	20-30	5to10	50-60	20-30	25	5 to 10
Dead	0	0	0	0	0	0	0
Fire Scar	0	0	0	0	0	0	0
Mistletoe (Count)	0	0	0	0	0	0	0
Hollows (Count) (Small, Medium, Large)	8,4,6	2,0,0	0	6,8,5	2,2,0	0	0
Decorticating bark (Present/Absent)	Y	Y	0	Y	Y	0	0
Dieback:	<10	<10	<10	<10	<10	<10	<10
Count (for multiple occurrences of trees with the same characteristics)	2	53	25	6	3	1	10

Table C-19
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS7				NS8		
Eastings	2307610				2304490		
Northings	6609681				6614389		
Altitude	380				363		
Aspect	4°South				3°South		
Tenure	State Forest				State Forest		
Landform	Undulating				Flat		
Connectivity (Internal)[1]	1,2				1,2		
Connectivity (External)[1]	2				3		
Habitat Layers (mean units in cm or m)							
– Bare Soil (Yes or No)	Yes				Yes		
– Litter	4 cm				5 cm		
– Rock	0				0		
– Log	40 cm				30 cm		
– Herb	15 cm				15 cm		
– Grass	25 cm				25 cm		
– Shrub	2-4 m				2-4 m		
– Mid-storey Tree	5 m				5 m		
– Upper Tree	16 m				20 m		
– Mistletoe	1				1		
% Groundcover							
– Bare Soil	5				10		
– Litter	65				75		
– Rock	0				0		
– Herb	10				10		
– Grass	60				65		
– Shrub	40				10		
– Mid-storey Tree	20				10		
– Upper Tree	45				20		
Logs (50x20m plot)							
Length (m)	4x(5 m)	1x(6 m)	3x(3 m)	5x(2 m)	2x(4-6 m)	1x(5 m)	6x(5 m)
Diameter (cm)	30 cm	40 cm	20 cm	30 cm	20 cm	25 cm	10 cm
Decay class (1,2,3)	2	3	3	2	3	2	1
Classification	Shrubby Ironbark regrowth woodland				Mixed Age Shrubby White Box woodland		
Successional Stage	Predominantly regrowth				Predominantly mixed age, regrowth/old		
Tree Health	Good				Good		
Water Sources[2]	5				1		
Recent Hot Fires	No				No		
Logging	Past heavy				Past heavy		
Dieback	None				Few		
Understorey Disturbance	Little				Little		
Herbaceous Weeds	None				None		

Table C-19 (Continued)
Additional Habitat Assessment Sites in Leard State Forest

Site Description	NS7	NS8
Woody Weeds	None	None
Other Disturbance Events	Grazing, logging, track	Grazing, logging, road
Conservation Rating[3]	3	3
Conservation Trends[4]	3	3

[1] (1=homogenous and/or continuous habitat(s); 2=low level of fragmentation including roads; 3=intermediate fragmentation and clearing with adequate stepping stones; 4=significant fragmentation and clearing with inadequate habitat stepping stones; 5=cleared land.)

[2] (1= at least one dam/500ha; 2=permanent stream present; 3= perennial stream; 4= nearby permanent Water Sources1; 5= no permanent water source nearby.)

[3] (1=high quality, self-regenerating, high resilience; 2=some disturbance and loss of resilience; 3=some conservation value but with significant levels of disturbance; 4=degraded with significant loss of resilience, no regeneration occurring; 5=highly degraded, restoration needed rather than regeneration.)

[4] (1=self-sustaining and pristine to near pristine under current management; 2=under appropriate management, will return to 1 through regeneration strategies; 3=balanced between being able to return to 2 and then to 1 or further degrade and eventually require restoration; 4/5=trending to localised extinction. Requires high cost restoration strategies.)

[5] (1=0, 2= [2-5] plants, 3=[5-20], 4=20+, 5=significant infestation and tree dying)

[6] (1=solid log, 2= hollow log and solid, 3=crumpled and decayed)

[7] (Diameter at breast height)

Table C-20
Tree Height, Diameter, Density, Hollow Availability and Condition (50 X 20 m plot)

Site Description	NS7			NS8				
Species ID	Iron Bark		White Cypress Pine	White Box		White Cypress Pine		*Acacia* spp.
DBH class 5-20, 21-30, 31-40cm dbh	30	10 to 20	10 to 15	40-50	20	10 to 15	5 to 10	5 to 10
Dead	0	0	0	0	0	0	0	0
Fire Scar	0	0	0	0	0	0	0	0
Mistletoe (Count)	0	0	0	0	0	0	0	0
Hollows (Count) (Small, Medium, Large)	4,0,0	0	0	5,3,0	2,0,0	0	0	0
Decorticating bark (Present/Absent)	0	0	0	Yes	Yes	Yes	Yes	Yes
Dieback:	<10	<10	<10	<10	<10	<10	<10	<10
Count (for multiple occurrences of trees with the same characteristics)	3	48	8	6	2	6	8	2

ATTACHMENT D

TERRESTRIAL VERTEBRATE FAUNA SPECIES RECORDED IN THE TARRAWONGA PROJECT AREA AND IMMEDIATE SURROUNDS - 7 TO 18 MARCH 2011

Terrestrial Vertebrate Fauna Species Recorded In Tarrawonga Project Area and the Immediate Surrounds 7 to 18 March 2011

Scientific Name	Common Name	Conservation Status[1]		Survey Transects										Dam Sites				Opportunistic Sightings	Relative Abundance[2]
		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
Amphibians[3]																			
MYOBATRACHIDAE																			
Limnodynastes fletcheri	Long-thumbed Frog	-	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x	x	A
Limnodynastes ornatus	Ornate Burrowing Frog	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
HYLIDAE																			
Litoria caerulea	Green Tree Frog	-	-	x	-	-	-	-	-	-	x	-	-	-	-	-	-	x	U
Litoria latopalmata	Broad-palmed Frog	-	-	-	-	-	-	-	-	-	x	-	x	-	x	x	x	-	C
Litoria peronii	Peron's Tree Frog	-	-	-	-	-	-	-	-	-	-	-	x	-	x	x	x	-	MC
Litoria rubella	Desert Tree Frog	-	-	x	-	-	-	-	-	-	-	-	x	-	x	x	-	-	MC
Reptiles																			
CHELIDAE																			
Chelodina longicollis	Snake-necked Turtle	-	-	-	-	-	-	-	-	-	-	-	x	-	-	x	-	x	U
Diplodactylus williamsi	Soft-tailed Gecko	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
GEKKONIDAE																			
Gehyra dubia	Dubious Dtella	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Gehyra lazelli	Dtella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Gehyra variegata	Tree Dtella	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x	U
Heteronotia binoei	Bynoe's Gecko	-	-	x	x		x	-	-	-	-	-	-	-	-	-	-	x	MC
Oedura robusta	Robust Velvet Gecko	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
PYGOPODIDAE																			
Lialis burtonis	Burton's Snake-lizard	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
SCINCIDAE																			
Cryptoblepharus australis	Inland Snake-eyed Skink	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	x	U
Cryptoblepharus pulcher	Wall Lizard	-	-	x	-	-	x	x	-	x	-	-	x	-	-	-	-	x	C
Cryptoplepharus virgatus	Cream-striped Shinning-skink	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ctenotus allotropis	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Scientific Name	Common Name	Conservation Status[1]		Survey Transects										Dam Sites				Opportunistic Sightings	Relative Abundance[2]
		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
Amphibians (Continued)																			
Ctenotus robustus	Robust Ctenotus	-	-	x	x	-	x	x	-	x	x	x	x	-	-	x	-	x	A
`Egernia striolata	Tree Skink	-	-	x	x	-	x	x	x	x	x	x	-	-	-	-	-	x	A
Lerista bougainvillii	South-eastern Slider	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	U
Lygisaurus foliorum	Tree-base Litter-skink	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-	-	-	U
Menetia greyii	Common Dwarf Skink	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	1
Morethia boulengeri	South-eastern Morethia Skink	-	-	x	x	x	x	-	x	x	x	x	-	-	-	-	-	x	A
AGAMIDAE																			
Amphibolurus burnsi	Burn's Dragon	-	-	x	-	-	x	-	x	-	x	-	-	-	-	-	-	-	U
Pogona barbata	Bearded Dragon	-	-	-	-	-	x	-	-	x	x	-	-	-	-	-	-	x	U
VARANIDAE																			
Varanus gouldii	Gould's Goanna	-	-	x	x	-	-	-	-	-	x	-	-	-	-	-	-	x	MC
Varanus varius	Lace Monitor (including Bell's form)	-	-	-	x	-	x	x	-	x	x	-		-	-	-	-	x	MC
ELAPIDAE																			
Pseudechis guttatus	Spotted Black Snake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Pseudonaja textilis	Eastern Brown Snake	-	-	x	-	-	x	-	x	x	-	x	-	-	-	-	-	-	U
Vermicella annulata	Bandy-bandy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Birds																			
PHASIANIDAE																			
Coturnix pectoralis	Stubble Quail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Coturnix ypsilophora	Brown Quail	-	-	-	-	-	x	x	x	-	-	-	x	-	x	-	-	x	MC
ANATIDAE																			
Chenonetta jubata	Australian Wood Duck	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	x	x	U
Anas superciliosa	Pacific Black Duck	-	-	-	-	-	-	-	-	-	x	-	x	x	-	-	x	x	U
Anas gracilis	Grey Teal	-	-	-	-	-	x	-	-	-	-	-	x	x	-	-	-	x	U
PODICIPEDIDAE																			
Tachybaptus novaehollandiae	Australian Grebe	-		-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Scientific Name	Common Name	Conservation Status[1]		Survey Transects										Dam Sites				Opportunistic Sightings	Relative Abundance[2]
		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
ARDEIDAE																			
Egretta novaehollandiae	White-faced Heron	-	-	-	-	-	-	-	-	x	-	-	x	-	-	-	-	x	U
FALCONIDAE																			
Falco cenchroides	Australian Kestrel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Falco longipennis	Australian Hobby	-	-	-	-	x	x	x	-	-	-	-	-	x	-	-	-	-	U
Falco berigora	Brown Falcon	-	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-	-	U
Falco peregrinus	Peregrine Falcon	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x	U
ACCIPITRIDAE																			
Elanus axillaris	Black-shouldered Kite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Lophoictinia isura	Square-tailed Kite	V	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	1
Haliastur sphenurus	Whistling Kite	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	1
Accipiter fasciatus	Brown Goshawk	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1
Accipiter cirrocephalus	Collared Sparrowhawk	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-	-	-	U
Aquila audax	Wedge-tailed Eagle	-	-	-	-	-	-	-	-	-	-	x	-	-	-	x	-	-	U
TURNICIDAE																			
Turnix varius	Pained Button-quail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
CHARADRIIDAE																			
Vanellus miles	Masked Lapwing		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
COLUMBIDAE																			
Phaps chalcoptera	Common Bronzewing	-	-	-	x	-	-	-	x	-	x	x	-	x	-	-	-	x	MC
Ocyphaps lophotes	Crested Pigeon	-	-	-	-	x	x	x	-	-	x	x	x	x	-	-	-	x	MC
Geopelia cuneata	Diamond Dove	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-	U
Geopella striata	Peaceful Dove	-	-	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	C
Geopelia humeralis	Bar-shouldered Dove	-	-	x	-	-	x	x	-	x	x	x	-	-	-	-	-	x	U
PSITTACIDAE																			
Eolophus roseicaplla	Galah	-	-	-	-	x	x	x	-	-	x	x	x	x	-	-	-	x	C
Cacatua sanguineae	Little Corrella	-	-	-	-	-	-	x	-	-	x	x	x	-	-	x	-	x	MC
Cacatua galerita	Sulphur-crested Cockatoo	-	-	-	-	x	-	-	-	-	x	-	-	x	-	-	-	-	U
Nymphicus hollandicus	Cockatiel	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	1
Glossopsitta concinna	Musk Lorikeet	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	U

Scientific Name	Common Name	Conservation Status[1]		Survey Transects										Dam Sites				Opportunistic Sightings	Relative Abundance[2]
		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
Barnardius zonarius	Australian Ringneck	-	-	-	-	x	-	x	-	-	-	x	-	-	-	-	-	-	U
Platycercus adscitus	Eastern Rosella	-	-	x	-	x	x	x	-	-	-	x	x	-	-	-	-	x	MC
Northiella haematogaster	Blue Bonnet	-	-	-	-	x	x	-	-	-	-	-	-	x	-	-	-	-	U
Psephotus haematonotus	Red-rumped Parrot	-	-	-	-	x	x	x	-	-	x	-	x	x	-	-	-	x	MC
Neophema pulchella	Turquoise Parrot	V	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	x	U
Alisterus scapularis	Australian King-Parrot	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-	-	U
Aprosmictus erythropterus	Red-winged Parrot	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-	-	-	U
CUCULIDAE																			
Cuculus pallidus	Pallid Cuckoo	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	U
Cacomantis variolosus	Brush Cuckoo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Eudynamys scolopacea	Brush Cuckoo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
TYTONIDAE																			
Tyto alba	Barn Owl	-	-	-	-	x	-	-	-	-	x	-	-	-	x	-	-	x	U
Tyto novaehollandiae	Masked Owl	V	-	-	-	-	-	x	-	-	x	-	-	-	-	-	-	x	U
STRIGIDAE																			
Ninox boobook	Southern Boobook	-	-	-	-	x	-	-	-	-	x	-	x	-	x	-	-	x	U
PODARGIDAE																			
Podargus strigoides	Tawny Frogmouth	-	-	-	x	x	-	-	-	-	x	x	-	-	-	-	-	x	U
CAPRIMULGIDAE																			
Eurostopodus mystacalis	White-throated Nightjar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
AEGOTHELIDAE																			
Aegotheles cristatus	Australian Owlet-nightjar	-	-	-	x	-	-	-	-	-	x	-	-	-	x	-	-	x	U
APODIDAE																			
Hirundapus caudacutus	White-throated Needletail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
CORACIIDAE																			
Eurystomus orientalis	Dollarbird	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x	U
ALCEDINIDAE																			
Dacelo novaeguineae	Laughing Kookaburra	-	-	-	x	x	x	-	-	-	x	x	x	-	-	-	-	x	U
Todiramphus sanctus	Sacred Kingfisher	-	-	-	-	-	-	-	-	-	x	x	-	-	-	-	-	x	U

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		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
MEROPIDAE																			
Merops ornatus	Rainbow Bee-eater		M	-	-	-	-	-	-	-	x	x		x	-	-	-	x	U
CLIMACTERIDAE																			
Cormobates leucophaea	White-throated Treecreeper	-	-	x	x	-	x	-	-	-	x	x	-	-	-	-	-	-	U
Climacteris picumnus victoriae	Brown Treecreeper (Eastern subspecies)	V	-	x	x	-	x	-	x	x	-	-	-	-	-	-	-	x	U
MALURIDAE																			
Malurus lamberti	Variegated Fairy-wren	-	-	x	-	-	-	-	-	-	x	-	-	-	-	-	-	-	U
Malurus cyaneus	Superb Fairy-wren	-	-	-	x	-	x	-	-	x	x	x	x	-	-	-	-	x	MC
Malurus leucopteris	White-winged Fairy-wren	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
PARDALOTIDAE																			
Pardalotus puctatus	Spotted Pardalote	-	-	x	x	-	x	-	-	-	x	-	-	-	-	-	-	-	U
Pardalotus striatus	Striated Pardalote	-	-	x	x	x	-	-	-	-	x	-	-	-	-	-	-	-	U
ACANTHIZIDAE																			
Pyrrholaemus sagittatus	Speckled Warbler	V	-	x	x	-	x	-	x	x	-	x	-	-	-	-	-	x	MC
Sericornis frontalis	White-browed Scrubwren	-	-	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-	U
Smicrornis brevirostris	Weebill	-	-	x	x	-	x	-	-	x	-	-	-	-	-	-	-	-	U
Gerygone fusca	Western Gerygone	-	-	x	-	-	x	-	-	-	x	-	-	-	-	-	-	-	U
Acanthiza pusilla	Brown Thornbill	-	-	x	-	-	x	-	x	-	x	x	-	-	-	-	-	-	U
Acanthiza uropygialis	Chestnut-rumped Thornbill	-	-	x	-	-	-	-	-	x	-	-	-	-	-	-	-	-	U
Acanthiza reguloides	Buff-rumped thornbill	-	-	-	x	-	x	-	x	x	x	-	-	-	-	-	-	-	U
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	-	-	-	x	-	x	-	-	x	-	-	-	-	-	-	-	x	U
Acanthiza nana	Yellow Thornbill	-	-	x	x	-	x	-	x	-	x	-	-	-	-	-	-	-	U
Acanthiza lineata	Striated Thornbill	-	-	-	-	x	-	-	-	-	x	x	-	-	-	-	-	-	U
Aphelocephala leucopsis	Southern Whiteface	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	1
MELIPHAGIDAE																			
Lichenostomus chrysops	Yellow-faced Honeyeater	-	-	x	x	-	x	-	x	-	x	x	-	-	-	-	-	-	U
Lichenostomus virescens	Singing Honeyeater	-	-	-	x	-	-	-	x	x	-	-	-	-	-	-	-	x	U
Lichenostomus leucotis	White-eared Honeyeater	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	U

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		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
Lichenostomus fuscus	Fuscous Honeyeater	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x	U
Lichenostomusc pencillatus	White-plumed Honeyeater	-	-	x	x	-	-	-	-	-	x	x	-	-	-	-	-	-	U
Manorina melanocephala	Noisy Minor	-	-	x	-	x	x	x	-	-	x	-	x	x	-	-	-	x	MC
Entomyzon cynaotis	Blue-faced Honeyeater	-	-	-	-	-	-	x	-	-	x	-	-	x	-	-	-	x	U
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
Melithreptus brevirostris	Brown-headed Honeyeater	-	-	-	x	-	x	-	-	-	x	-	-	-	-	-	-	-	U
Melithreptus lunatus	White-naped Honeyeater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
Philemon corniculatus	Noisy Friarbird	-	-	-	-	-	-	x	-	-	x	x	-	-	-	-	-	x	U
Plectorhyncha lanceolata	Striped Honeyeater	-	-	x	x	-	-	-	-	-	-	x	-	-	-	-	-	-	U
Acanthagerys rufogularis	Spiny-cheeked Honeyeater	-	-	x	-	-	-	x	-	x	x	x	x	-	-	-	-	-	U
Anthochaera carunculate	Red Wattlebird	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	1
Acanthorhychus tenuirostris	Eastern Spinebill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	U
PETROICIDAE																			
Eopsaltria australis	Eastern Yellow Robin	-	-	x	-	-	x	-	-	x	x	x	x	-	-	-	-	x	MC
Melanodryas cucullata	Hooded Robin (south-eastern form)	V	-	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-	U
Microeca fascinans	Jacky Winter	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	U
Petroica goodenovii	Red-capped Robin	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1
POMATOSTOMIDAE																			
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	-	x	x	x	x	x	x	x	-	x	-	-	-	-	x	MC
Pomastomus superciliosus	White-browed Babbler	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1
NEOSITTIDAE																			
Daphoenositta chrysoptera	Varied Sittella	V	-	x	-	-	-	-	-	-	x	-	-	-	-	-	-	-	U
PACHYCEPHALIDAE																			
Pachycephala pectoralis	Golden Whistler	-	-	-	-	-	-	-	x	-	x	x	-	-	-	-	-	x	U
Pachycephala rufiventris	Rufous Whistler	-	-	x	x	x	x	-	x	x	x	x	-	-	-	-	-	x	MC
Colluriclincla harmonica	Grey Shrike-thrush	-	-	x	x	-	-	-	-	-	x	x	-	-	-	-	-	x	U
Falcunculus frontatus	Eastern Shrike-tit	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Scientific Name	Common Name	Conservation Status[1]		Survey Transects										Dam Sites				Opportunistic Sightings	Relative Abundance[2]
		TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	10	D1	D2	D3	D4 to D6		
DICRURIDAE																			
Rhipidura albiscapa	Grey Fantail	-	-	x	x	-	-	-	x	-	x	x	-	-	-	-	-	-	U
Rhipidura leucophrys	Willie Wagtail	-	-	-	x	-	x	-	x	x	x	x	x	x	-	-	-	x	MC
Grallina cyanoleuca	Magpie-lark	-	-	x	x	x	x	x	-	-	x	x	x	-	-	-	-	x	MC
Myiagra inquieta	Restless Flycatcher	-	-	-	-	-	-	-	x	-	x	-	x	-	-	-	-	-	U
ARTAMIDAE																			
Cracticus torquatus	Grey Butcherbird	-	-	x	-	x	x	x	-	-	x	-	x	-	-	-	-	x	MC
Cracticus nigrogularis	Pied Butcherbird	-	-	-	-	x	-	x	-	-	x	x	x	-	-	-	-	x	MC
Gymnorhina tibicen	Australian Magpie	-	-	x	x	x	x	x	-	-	x	-	x	-	-	-	-	x	MC
Strepera graculina	Pied Currawong	-	-	x	-	-	x	-	-	-	x	-	x	-	-	-	-	-	U
Artamus superciliosus	White-browed Woodswallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
Artamus cyanopterus	Dusky Woodswallow	-	-	x	-	x	x	-	-	-	x	-	-	-	-	-	-	-	U
CAMPEPHAGIDAE																			
Coracina tenuirostris	Cicada Bird	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	1
Coracina novaehollandiae	Black-faced Cuckoo-shrike	-	-	x	x	x	-	-	-	-	-	x	x	-	-	-	-	-	U
Coracina papuensis	White-bellied Cuckoo-shrike	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	1
Coracina maxima	Ground Cuckoo-shrike	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	1
CORVIDAE																			
Corvus coronoides	Australian Raven	-	-	x	x	-	x	x	x	-	x	x	x	-	-	-	-	x	MC
CORCORACIDAE																			
Corcorax melanorhamphos	White-winged Chough	-	-	-	x	x	x	x	x	-	x	x	x	x	-	-	-	-	MC
Struthidea cinerea	Apostlebird	-	-	-	x	x	x	x	-	-	x	x	x	x	-	-	-	x	MC
HIRUNDINIDAE																			
Hirundo neoxena	Welcome Swallow	-	-	-	-	-	x	-	-	x	x	x	x	-	-	x	-	x	U
Petrochelidon ariel	Fairy Martin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
Petrochelidon nigricans	Tree Martin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
ZOSTEROPIDAE																			
Zosterops lateralis	Silvereye	-	-	x	x	-	x	-	-	-	x	-	-	-	-	-	-	-	U

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DICAEIDAE																			
Dicaeum hirundinaceum	Mistletoebird	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	U
ESTRILDIDAE																			
Neochmia temporalis	Red-browed Finch	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	1
Taeniopygia guttata	Zebra Finch	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	U
Taeniopygia bichenovii	Double-barred Finch	-	-	x	x	-	x	-	x	x	x	x	x	x	-	x	-	x	C
Anthus novaeseelandiae	Richard's Pipit	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-	-	U
Introduced Birds																			
STURNIDAE																			
*Sturnus vulgaris**	Common Starling*	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	U
Native Mammals																			
TACHYGLOSSIDAE																			
Tachyglossus aculeatus	Short-beaked Echidna	-	-	-	x	-	-	-	-	-	x	x	-	-	-	-	-	x	U
DASYURIDAE																			
Antechinus flavipes	Yellow-footed Antechinus	-	-	x	x	x	x	-	x	-	x	x	-	-	-	-	-	-	MC
Antechinus stuartii	Brown Antechinus	-	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-	U
Sminthopsis murina	Common Dunnart	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	1
PETAURIDAE																			
Petaurus breviceps	Sugar Glider	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	x	U
Petaurus norfolcensis	Squirrel Glider	V	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	x	U
PSUEDOCHEIRIDAE																			
Pseudocheirus peregrinus	Common Ringtail Possum	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	x	U
ACROBATIDAE																			
Acrobates pygmaeus	Feathertail Glider	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
PHALANGERIDAE																			
Trichosurus vulpecula	Common Brushtail Possum	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-	-	x	U
MACROPODIDAE																			
Macropus giganteus	Eastern Grey Kangaroo	-	-	x	-	-	x	-	-	-	x	-	x	-	-	-	-	x	MC
Macropus robustus	Euro	-		x	x	-	-	-	x	x	-	-	-	-	-	-	-	x	MC

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Macropus rufogriseus	Red-necked Wallaby	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
Wallabia bicolor	Swamp Wallaby	-	-	x	x	-	-	-	-	x	x	-	-	-	-	-	-	x	U
EMBALLONURIDAE																			
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	x	x	x	-	-	-	-	x	-	x	-	-	-	-	-	MC
Mormopterus sp. 3 (little penis)	Inland Freetail Bat	-	-	-	x	-	x	-	-	-	-	x	-	-	-	-	-	x	U
Mormopterus sp. 4 (big penis)	Southern Freetail-bat	-	-	x	x	-	x	-	-	x	-	-	-	-	-	-	-	x	MC
Tadarida australis	White-striped Freetail-bat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
VESPERTILIONIDAE																			
Nyctophilus geoffroyi	Lesser Long-eared Bat	-	-	x	x	x	x	-	x	x	-	-	-	-	-	-	-	x	MC
Nyctophilus gouldi	Gould's Long-eared Bat	-	-	x	x	-	x	-	-	-	-	x	-	-	-	-	-	-	MC
Chalinolobus gouldii	Gould's Wattled Bat	-	-	-	-	x	x	-	x	x	-	-	-	-	-	-	-	x	MC
Chalinolobus morio	Chocolate Wattled Bat	-	-	-	-	-	x	-	-	x	-	x	-	-	-	-	-	-	U
Scotorepens balstoni	Inland Broad-nosed Bat	-	-	-	x	x	x	-	x	x	-	x	-	-	-	-	-	-	MC
Scotorepens greyii	Little Broad-nosed Bat	-	-	-	-	x	x	-	x	x	-	x	-	-	-	-	-	-	MC
Vespadelus vulturnus	Little Forest Bat	-	-	x	x	x	x	-	x	x	-	-	-		-	-	-	-	MC
Introduced Mammals																			
MURIDAE																			
*Mus musculus**	House Mouse*	-	-	x	x	x	x	-	x	x	x	x	-	-	-	-	-	x	C
*Rattus rattus**	Black Rat*	-	-	-	x	-	x	-	x	x	x	x	-	-	-	-	-	x	MC
CANIDAE																			
*Vulpes vulpes**	Red Fox*	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
FELIDAE																			
*Felis catus**	Feral Cat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	1
LEPORIDAE																			
*Lepus capensis**	Brown Hare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	U
*Oryctolagus cuniculus**	Rabbit*	-	-	-	-	x	x	-	-	x	-	-	-	-	-	-	-	x	U

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SUIDAE																			
Sus scrofa	Feral Pig	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	x	U
Animal Group	**Number of species**																		
Amphibians[3]	**6**																		
Reptiles	**25**																		
Native Birds	**120**																		
Native Mammals	**24**																		
Total Native Animals	**175**																		
Threatened Species	**12**																		
Introduced Birds	**1**																		
Introduced Mammals	**7**																		

Notes:

- Nomenclature in accordance with CSIRO (2006).

* Introduced species.

[1] Threatened species status under the NSW *Threatened Species Conservation Act, 1995*. and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (current as at 31 August 2011).
V = Vulnerable.

[2] Relative Abundance: Presented for both autumn and spring surveys: 0 = no sightings, 1 = one sighting of a species, U = Uncommon, C = Common, MC = Moderately Common, A = Abundant.

[3] Amphibian species located in March 2011. An additional 5 species were located in January 2011 in a targeted survey under optimal conditions. See Attachment A.

ATTACHMENT E

WILLEROI FAUNA REPORT

WILLEROI

FAUNA SURVEY REPORT

PREPARED BY
CENWEST ENVIRONMENTAL SERVICES

OCTOBER 2011
Project No. WHC-04
Document No. 00413574

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

LIST OF PLATES

EXECUTIVE SUMMARY

Cenwest Environmental Services were commissioned by Whitehaven Coal Pty. Ltd. to undertake a fauna survey at the 'Willeroi' property, located approximately 20 kilometres (km) east of Maules Creek, 39 km north-east of Boggabri and 57 km north of Gunnedah in the Gunnedah Basin, New South Wales (NSW).. The 'Willeroi' property adjoins Mount Kaputar National Park to the west.

The purpose of this report is to provide the results of the fauna survey and habitat assessment.

Fauna Surveys and Habitat Assessments

Terrestrial fauna surveys were undertaken within the study area in August 2011. The surveys were conducted over seven days and survey techniques included: Anabat detectors, hair tubes, spotlighting, herpetological searches, bird surveys, call playback, opportunistic observations and searches for tracks and traces. A conservative list of potentially occurring threatened fauna species were targeted during the surveys. The survey team was led by Anne Kerle.

During the surveys, a habitat assessment was undertaken to characterise the fauna habitat resources present at survey sites and surrounds. This included identifying floristic and vegetation structure and condition and, subsequently, broad habitat types within the study area.

Fauna and Their Habitats

A total of 137 vertebrate fauna species were recorded in the study area, including 129 native species (comprising five amphibians, 22 reptiles, 82 birds and 20 mammals), as well as eight introduced species. Fauna species are represented by amphibians, reptiles, woodland and forest birds, and arboreal and ground dwelling mammals.

Six broad fauna habitat types were identified in the study area. These included Dry Sclerophyll Forest, Dry Sclerophyll Forest – Cypress Pine Monoculture Regrowth, Grassy Woodland, Riparian/Floodplain, Grassland (native), Farm Dams and Grassland (introduced).

Of the broad habitat types present in the study area, only two are listed as a threatened ecological community. The grassy woodland habitat and a component of the derived native grassland in the Project area meet the criteria for listing as *White Box-Yellow Box-Blakely's Red Gum Woodland Endangered Ecological Community* listed under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and the *White Box–Yellow Box–Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands Critically Endangered Ecological Community* listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) (i.e. the Box-Gum Woodland EEC/CEEC) as identified by FloraSearch in 2011. They provide some habitat resources (e.g. nectar, pollen, invertebrates, hollows, etc.) likely to be used by some threatened and other native fauna.

Threatened Fauna

A total of 15 threatened fauna species listed under the TSC Act were recorded during the survey. These comprise eight birds, six mammals and one reptile:

- Turquoise Parrot (*Neophema pulchella*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnis*);
- Diamond Firetail (*Stagonopleura guttata*);
- Black-chinned Honeyeater (*Melithreptus gularis*);
- Hooded Robin (*Melanodryas cucullata cucullata*);

- Grey-crowned Babbler (*Pomatostomus temporalis*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Squirrel Glider (*Petaurus norfolcensis*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Eastern Bentwing Bat (*Miniopterus oceanensis*);
- Eastern Cave Bat (*Vespadelus troughtoni*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*); and
- Border Thick-tailed Gecko (*Underwoodisaurus sphyrus*).

One threatened fauna species that was recorded in the proposed offset area is also listed under the EPBC Act, namely, the Border Thick-tailed Gecko (*Underwoodisaurus sphyrus*).

1 INTRODUCTION

Cenwest Environmental Services were commissioned by Whitehaven Coal Pty. Ltd. to undertake a fauna survey at the 'Willeroi' property, located approximately 20 kilometres (km) east of Maules Creek, 39 km north-east of Boggabri and 57 km north of Gunnedah in the Gunnedah Basin, New South Wales (NSW) (Figure 1). The 'Willeroi' property adjoins Mount Kaputar National Park to the west.

The study area is located within the Namoi Catchment Management Authority (CMA) Region. It occurs within the Gunnedah Basin geological formation on the NSW North West Slopes and Plains.

The objectives of the survey were to:

- document resident threatened and protected species likely to be present under winter conditions using a range of survey strategies at specific survey sites as well as opportunistic sightings;
- assess the relative abundance of each species located and whether or not a viable population is likely to be present within the study area;
- develop a generalised broad fauna habitat map of the study area based on field work and existing vegetation mapping;
- develop specific habitat maps for each threatened species present or potentially likely to be present; and
- prepare a draft terrestrial fauna report.

FIGURE 1
Regional Location of the
Willeroi Property

Tarrawonga Coal Pty Ltd

Cenwest Environmental Services

2 METHODS

The field survey methodology was developed in accordance with the *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna - Amphibians* (NSW Department of Environment, Climate Change and Water [DECCW], 2009), *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (Department of Environment and Conservation [DEC], 2004), *Threatened Species Survey and Assessment Guideline for Developments and Activities* (NSW Office of Environment and Heritage [OEH], 2011) and relevant Commonwealth survey guidelines.

Where necessary, species identifications were checked using the following references: Marchant and Higgins (1993); Pizzey and Knight (1999); Churchill (2008); Cogger (2000); Menkhorst and Knight (2001); Barret *et al*. (2003); Morcombe (2004); Strahan (2000); and Swan *et al*. (2004). Playback calls were selections from Stewart (1999a; 1999b) and mammalian tracks and traces were identified where possible using Triggs (2004).

2.1 ENVIRONMENTAL CONDITIONS

The survey was carried out from 1 to 7 August 2011. The weather conditions experienced during the survey are found in Table 1.

Table 1
Weather and Other Environmental Conditions during the Survey Period

Date 2011	Max temp (^{o}C)[1]	Min temp (^{o}C)[1]	24 hr sunrise[1]	24 hr sunset[1]	Moon phase[2]	Moon rise[2]	Moon set[2]	Rainfall (mm)[1]	Wind (max km/hr)[1]
1/08	17.2	4.2	0646	1727	First Quarter	0723	1907	0	52
2/08	13.9	3.7	0645	1727	First Quarter	0801	2013	0	41
3/08	18.4	4.5	0644	1728	First Quarter	0838	2118	0	41
4/08	17.7	1.7	0644	1729	First Quarter	0916	2224	0	24
5/08	17.3	4.2	0643	1729	First Quarter	0955	2330	0	28
6/08	15.7	1.1	0642	1730	First Quarter	1038	NA	0	31
7/08	15.9	-1.8	0641	1730	First Quarter	1125	0036	0	28

Notes:

[1] Bureau of Meteorology. Website: www.bom.gov.au Airport AWS {station 054038}.

[2] Geoscience Australia Website: http://www.ga.gov.au/geodesy/astro/sunrise.jsp

hr = hour, mm = millimetres, km/hr = kilometres per hour.

2.2 SURVEY TECHNIQUES

Nine sites were chosen for systematic survey of vertebrate fauna on Willeroi. Criteria for site selection included:

- sampling of the range of broad vegetation and habitat types found on the property; and
- sites to be distributed broadly across the property.

The plot for systematic faunal survey is 2 hectares (ha) (100 metres [m] x 200 m) with the habitat plot nested in the corner from the standardised reference corner. While the object of this method is that the plot incorporate relatively homogenous habitat this was not always possible with several of the sites being heterogeneous in character. There were nine systematic survey sites within the study area, sites 1 to 9 (Figure 2). The survey team was led by Anne Kerle.

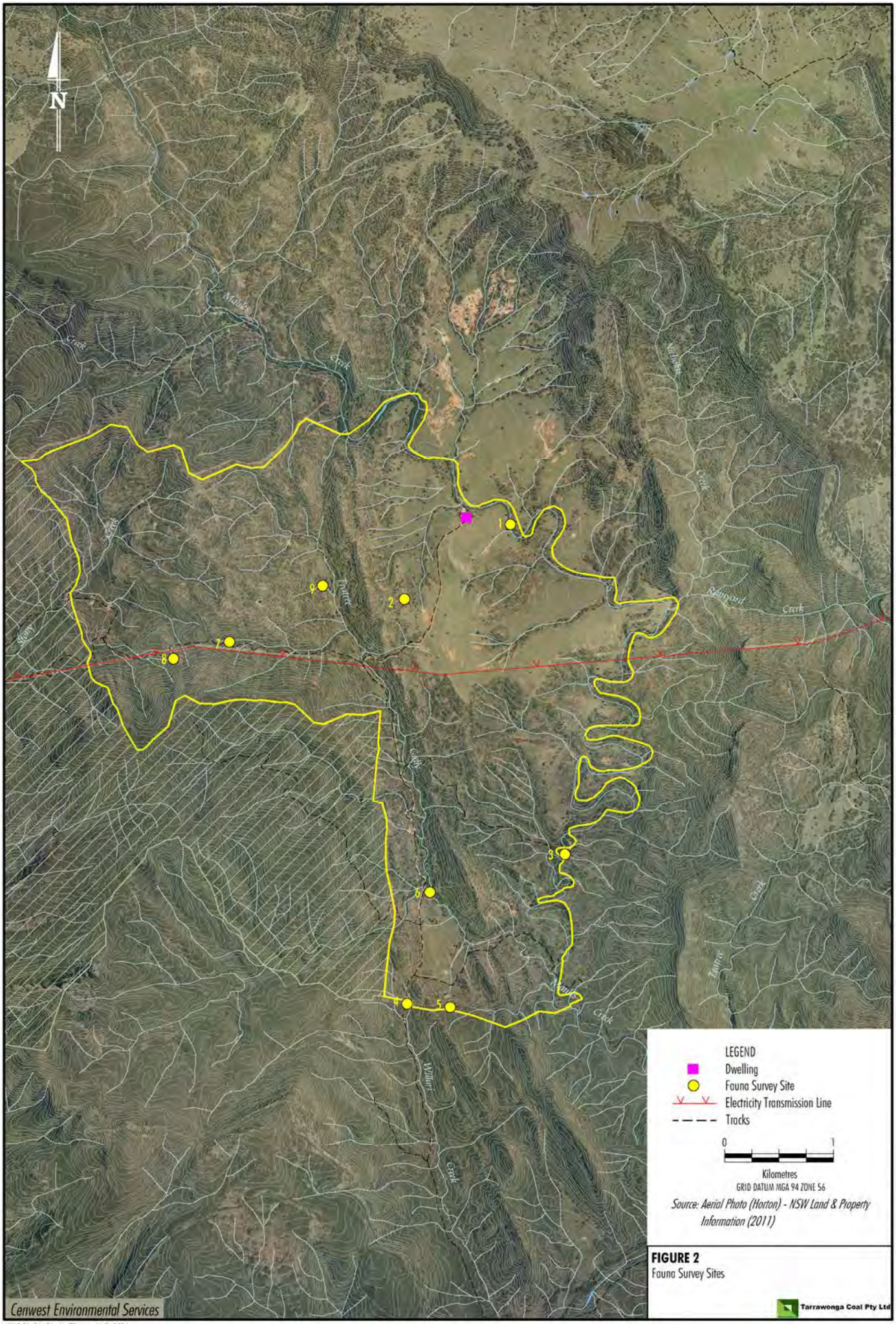

FIGURE 2
Fauna Survey Sites

Cenwest Environmental Services

Tarrawonga Coal Pty Ltd

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Anabat Detectors

During the surveys Anabat detectors were set at sites 1 to 5, 7 and 9. The recording time varied between each site, ranging from approximately one hour from dusk to being left overnight in the more accessible sites. The Anabat detectors were then collected and Anabat call analysis was carried out by Dr Harry Parnaby (Attachment A). The varying time occurred because of the difficulty in accessing some sites.

Hair Tubes

Twenty-five hair funnels (Fauna Tech) were placed at suitable locations at eight of the nine sites. Sites 3 and 4 were adjacent to each other and both habitats were included in the 25 traps. The hair funnels are designed to hold the bait and arouse inquisitive behaviour through wafting odour but be resistant to removal by an investigating animal. Hair tubes were left out for four nights. The sticky wafers found to have hairs were sent to Barbara Triggs for species identification (Attachment B).

Spotlighting

The primary targets of this activity were arboreal and ground dwelling larger mammals, nocturnal birds, nocturnal amphibians and reptiles. Call playback for a range of nocturnal species was undertaken prior to commencement of spotlighting at each survey site. Targeted species included the Koala and Squirrel Glider.

Each site (1 to 9) (Figure 2) was searched on foot for two person hours walking at around 1 km per hour (two people spotlighting for one hour). Amphibians, where present, were identified by call and direct observation.

Herpetological Searches

Systematic searches were conducted for reptiles and amphibians at each site (1 to 9) during daylight hours at a time of day when reptiles and amphibians were likely to be most active (Figure 2).

One person hour of herpetological searching was undertaken at each site on two separate days. Bark was prised from trees, ground litter was raked, logs were turned over and cavities examined, fallen branches were moved, where present rocks were turned and slow walking facilitated the flushing out of any reptiles or amphibians present.

Species and number of individuals was recorded. Opportunistic reptile and amphibian searches were also carried out in other parts of the study area. Any other species observed within the site outside the systematic survey was recorded.

Bird Surveys

During the surveys, one-hour area bird surveys were conducted in and around the 2 ha site at each of sites 1 to 9 (Figure 2). These surveys were conducted after dawn and before dusk. Birds were recognised by sight, calls and flight patterns. All other species observed within the site outside the systematic surveys were also recorded. Numbers of each species observed within the hour long survey were recorded to enable relative abundance of species to be determined. Opportunistic bird observations were also recorded across the property at other times.

Call Playback

Nocturnal and diurnal call playbacks were conducted on one evening at each of the survey sites S1 to S9 (Figure 2) on the same evening as the spotlighting survey. Calls played included those of the Squirrel Glider and the Koala. Each playback session commenced with a short listening period, followed by spotlighting of the surrounding vegetation. Following the completion of calls, a further spotlight scan was made of the surrounding vegetation.

Opportunistic Observations

Any sightings of fauna while travelling throughout the study area were recorded. To maximise such sightings the routes to various locations were varied as much as possible. The location (Australian Map Grid [AMG]) of any threatened species was recorded.

Tracks and Traces

Searches for tracks and traces were combined with other activities, particularly herpetological searches. Searches were conducted for hair samples, skulls, scats, diggings and scratch marks, etc. Some areas were particularly suited to identifying animal tracks. Particular attention was given to searches for signs of Koala presence. Fox and dog scats were collected for hair analysis. Scat and hair analysis was carried out by Barbara Triggs (Attachment B).

Survey Effort

Survey effort for the August terrestrial vertebrate surveys is summarised in Table 2.

Table 2
Summary of Terrestrial Vertebrate Survey Effort – August 2011

Survey Technique	Site Location									Combined Effort
	1	2	3	4	5	6	7	8	9	
Anabat detector	1AP	1AP	1AP	1AP	1AP		1AP		1AP	7AP
Hair Tube	100TN	100TN	50TN	50TN	100TN	100TN	100TN	100TN	100TN	800TN
Spotlighting	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	9 hr
Herpetological searches	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	18 hr
Bird Survey	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	2 hr	18 hr
Call playback	1	1	1	1	1	1	1	1	1	9 occasions
Opportunistic Observations	Significant but not quantified									

Notes:

AP = Anabat passes.

TN = trap nights.

2.3 HABITAT ASSESSMENT

The study area was divided into broad habitat types. Broad habitat mapping differs from vegetation mapping in the following ways. Vegetation mapping focuses on communities of plants whereas fauna habitat mapping focuses on habitat resources available to fauna, focussing on the structural attributes of the vegetation, the topography and ground attributes (soil, rock, etc.). Woodland and forests are differentiated not by plant species diversity but rather by physical attributes such as life form, height, and dominance, life form density (woodland or forest) that in varying proportions and combinations provide niche spaces for various fauna species.

The broad habitat types that were recognised included the following six categories:

- Dry Sclerophyll Forest Habitat;
- Dry Sclerophyll Forest Habitat – Cypress Monoculture Regrowth;
- Grassy Woodland Habitat;
- Riparian/Floodplain Habitat;
- Grassland Habitat (native and introduced); and
- Farm Dams.

The ecological quality and condition trend of each habitat type was assessed using a rapid assessment method based on a range of parameters considering the OEH *Threatened Species Survey and Assessment Guideline: for Developments and Activities* (OEH, 2011). The major components of the assessment procedure included:

- habitat layers present and heights (e.g. litter, logs, grass-herb layer, understoreys, canopy);
- percentage ground cover of all vegetation layer components as well as bare soil and bush rock;
- dominant life form classification (e.g. grassland. woodland, forest);
- distribution and abundance of hollow bearing trees, including dead stags;
- dominant life-form density (e.g. tree stems or shrub stems per ha);
- presence of water (dams, stream, etc.); and
- habitat condition and trends.

Plots were randomly located at each site. In the 50 x 20 m plot, tree size (diameter at breast height over bark [dbh]), density and condition, log volume (length and diameter) and decay class, regeneration of trees and tall shrubs were recorded. The cover of litter, bare ground, cryptogams, rocks, logs and plant growth to 5 centimetres (cm) were measured and the projected foliage cover to 2 m, 2-4 m 4-6 m and greater than 6 m was estimated (Walker & Hopkins, 1984) in 10 x 1 m evenly spaced sections.

The groundcover measures, including cover 0-5 cm should total 100%. In the 20 x 20 m sub-plot the cover of the three dominant species in the upper, mid and ground strata were estimated and the growth forms of the species recorded.

2.4 RELATIVE ABUNDANCE

The relative abundance of each species recorded was estimated as follows:

1	One sighting of the species, or at least one trace found.
U	Uncommon, two to five observations of the species, as well as an assessment of how widespread and persistent the species was.
C	Common, six to 30 observations of the species, as well as an assessment of how widespread and persistent the species was.
MC	Moderately Common, 31 to 50 observations.
A	Abundant, > 50 observations.
?	Relative abundance cannot be estimated when a species presence is identified solely from tracks and traces, or sometimes in the case where Anabat records of bat calls are relied on.

Hence the determination of relative abundance was based on empirical data as well as being a value judgement made by an experienced surveyor.

3 RESULTS

3.1 BROAD FAUNA HABITAT TYPES

Six broad habitat types were located at the study area (Figure 3). These included Dry Sclerophyll Forest, Dry Sclerophyll Forest – Cypress Pine Monoculture Regrowth, Grassy Woodland, Riparian/ Floodplain, Grassland (native), Farm Dams and Grassland (introduced), which are described below.

Dry Sclerophyll Forest Habitat

Sites: 4, 5, 7 and 8

The Dry Sclerophyll Forest Habitat is made up of a dominant area of White Cypress Pine – Narrow-leaved Ironbark Shrubby Open Forest (mature community) a variant of this community, regenerating White Cypress Pine – Narrow-leaved Ironbark Shrubby Open Forest. This Broad Habitat Type is usually limited to hills and ridges with sandy skeletal soils. It tends to have a south-western/southerly aspect and occupies hill and ridge landscapes.

Tree densities within the Dry Sclerophyll Forest Habitat ranged from 40 to 170 trees/ha (average of 198 trees/ha). Tree dbh range from <20 to 129 cm, with the majority being <20 cm and some in the 21 to 30 cm range. Seven structural layers are usually present including litter, log, herb, grass, shrub, mid-storey and upperstorey. No rocky habitat is usually present. Dominant trees grow to approximately 20 m. The tree layer is in forest formation. The herb-grass-shrub layer is at around 20 to 50% of the ground cover. Log lengths average at about 1,580 metres per hectare (m/ha) and is often the residue from past logging.

Soils appear to be impoverished, compacted and low in organic matter. Mature grasses and herbs occupy around 15 to 90% ground cover in spring-summer as well as providing a limited source of seed.

Within the area, the Dry Sclerophyll Forest Habitat contained mostly medium hollows with 15 hollows present across five trees (0.34 hollows per ha). Twelve large hollows were present across seven trees (0.27 hollows per ha) and nine small tree hollows were found across three trees (0.20 hollows per ha).

Dry Sclerophyll Forest – Cypress Pine Monoculture Regrowth

Sites: 2 and 9

The Dry Sclerophyll Forest is composed of large areas of White Cypress Pine – Narrow-leaved Ironbark shrubby open forest and is characterised by dense regeneration of White Cypress Pine of various ages that is often expressed as a forest formation monoculture. It occurs in patchy large areas on footslopes and hills and is characterised by the presence of dense, even-aged stands of monospecific White Cypress Pine regeneration.

These stands tend to have similar shrub and ground cover layers to the original community, but native species diversity and cover levels are lower and sometimes absent, due to competition from the pines. Furthermore the numbers of introduced species tend to be higher (FloraSearch, 2011).

Large areas are confined to three structural layers (litter, herb-grass, and White Cypress Pine). However there are areas with greater understorey diversity including limited shrubs and herbs. White Cypress Pine heights were in the range of 15 m with large areas dominated by short, locked regrowth. There are occasional emergent pine trees present. Canopy cover is around 25% and whilst tree density can be patchy, at around 245 stems per ha.

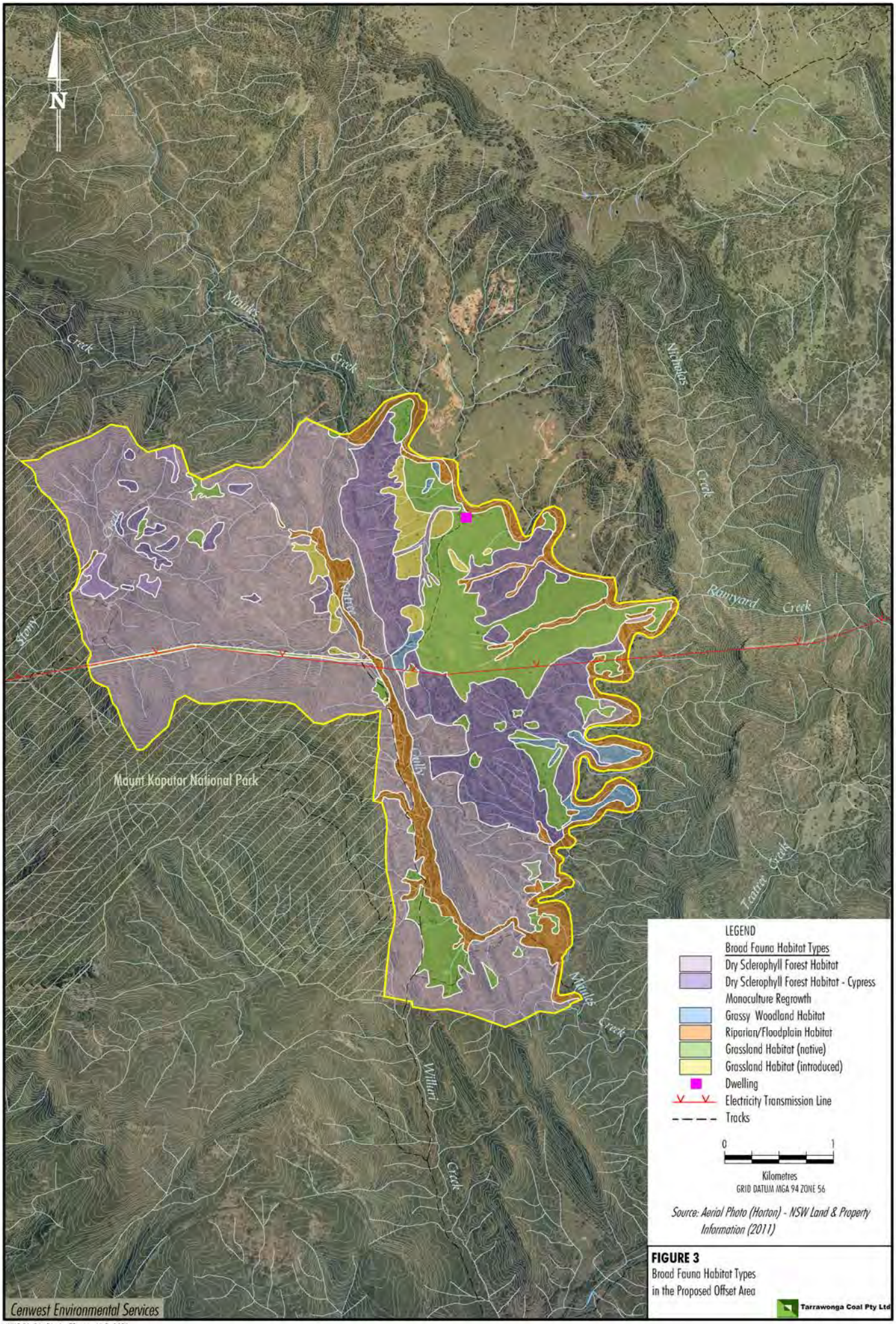

FIGURE 3
Broad Fauna Habitat Types
in the Proposed Offset Area

Tarrawonga Coal Pty Ltd

Cenwest Environmental Services

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Litter is confined to the residue of herbs and grasses. Soils appear to be impoverished, compacted and low in organic matter. Mature grasses (and limited herbs) tend to form a continuous ground cover in spring-summer as well as providing a limited source of seed. Decorticating bark is absent but some small cryptic species may be able to utilise the rough bark as shelter. Pine seed can and is utilised by a number of parrot species. Hollows were present; large at 0.17 per ha, medium at 2 per ha and small at 2 per ha.

Grassy Woodland Habitat

This Broad Habitat Type equates with vegetation community White Box – White Cypress Pine grassy woodland.

This Broad Habitat Type is highly disturbed (FloraSearch, 2011). This community is dominated by White Box *(Eucalyptus albens)* and White Cypress Pine *(Callitris glaucophylla)* with occasional Poplar Box (*Eucalyptus populnea*), as well as an occasional Rosewood (*Alectryon oleifolius*).

Shrubs are never continuous and scattered. The ground layer of this community is heavily dominated by various native grasses and lower numbers of ferns, spindly shrubs and forbs. Introduced species are common in this remnant.

The site data from the habitat assessment are provided in Attachment C. The habitat area is a regrowth area following clearing Seven habitat layers are present including litter, log, herb, grass, shrub, mid-storey and upperstorey trees. White Cypress Pine is represented by patchy regeneration areas and in very dense formations.

The value of these remnants, albeit degraded and regenerating is in providing greater patchiness within the landscape with different structural and floristic components compared with other forest and woodland habitats.

Several very large trees were recorded within the proposed offset area. One White Box tree (AMG 56 E241794 N6629178) was measured to be 243 cm diameter at breast height (Plates 1 and 2). This is extremely large for a White Box tree especially considering that this tree was growing in the higher western side of the property on skeletal soils.

Plate 1 – Example of a Very Large Old White Box

Plate 2 – Example of a Very Large Old White Box

Riparian/Floodplain Habitat

Sites: 1, 3 and 6

The Riparian/Floodplain Habitat is confined to sections of Maules Creek and Teatree Gully that have not been cleared for agriculture or located in wet paddock depressions fed by short truncated flood-out creeks. Maules Creek borders the study area to the east. Maules Creek drains the eastern side of the central range which includes all of the north east and southern blocks of the study area. Maules Creek has a low gradient throughout the study area, falling only approximately 90 m from north to south. Teatree Gully parallels the central range on its western side and drains much of the western block. The upper reaches of Stony Creek drain the western third of the western block through Mount Kaputar National Park before joining Maules Creek to the north of Leard State Forest.

Quite different communities occupy the alluvial flats and riparian zones of the major watercourses, Maules Creek and Teatree Creek. Maules Creek is lined by River Oak – River Red Gum, while Teatree Creek and tributaries are dominated by Bracteate Honeymyrtle.

The riparian and adjacent native vegetation communities have been almost completely cleared leaving a few remnant pockets of this Broad Habitat Type. This habitat type corresponds with vegetation, Bracteate Honeymyrtle Low Riparian Forest (FloraSearch, 2011).

The site data from the habitat assessment are provided in Attachment C. Typically this Broad Habitat Type has seven habitat layers present comprising litter, log, herb, grass, shrub, mid-storey trees and upper trees. Loose rock is usually absent but exposed conglomerate bedrock can be present within the creek bed or present as bankside ledges. Bracteate Honeymyrtle dominates the canopy at forest formation but is often overtopped by emergent Eucalypts or Rough-barked Apple. Tree densities vary but is always configured in a linear strip. The successional stages present varies from mixed regeneration formations to old growth formations but much of the remaining components of this Broad Habitat Type appear never to have been cleared. Few dead stag trees are present. Average tree dbhs vary from 17 to 22 cm.

The Riparian/Floodplain Forest Habitat surveyed contained only one tree with hollows. Although, it contained six large, six medium and two small hollows.

Tree densities within the Riparian/Floodplain Forest Habitat ranged from an average of 220 to 270 trees/ha. Decorticating bark from Eucalypt trees in particular is reasonably common.

Grassland Habitat (Native)

This habitat component is entirely derived from clearing of forest and woodland associated with agriculture. Some scattered trees and shrubs are also associated with this Broad Habitat Type.

White Cypress Pine is actively invading and regenerating in cleared paddocks. A range of native herbs and ground covers are located in the Broad Habitat Type.

There are usually about three habitat layers present (litter, herb and grass), with an occasional shrub and/or a regenerating White Cypress Pine.

These areas tend to have a south-western/southerly aspect in the study area. There are a few scattered rocks and very limited log cover associated with this Broad Habitat Type. Litter is confined to the residue of herbs and grasses. Soils appear to be impoverished, compacted and low in organic matter. Mature grasses and herbs tend to form a continuous ground cover in spring-summer as well as providing a limited source of seed. Signs of invertebrate life such as insects, earthworms, spiders and ants were minimal. Ecosystem processes such as the water, nutrient and carbon cycles were assessed as being dysfunctional and their associated resources appeared to be diminishing associated with resource leakage. Under summer conditions upper soil temperatures appear to rise much more than was likely in the pre-European landscape due to factors such as soil compaction, diminished soil water holding capacity and the malfunctioning of the water cycle at a point and landscape scale. Such factors likely feed back into sub-optimal productivity outcomes.

The habitat values of this Broad Habitat Type are associated with its patchiness in the landscape, edge components associated with adjacent woodland and forest habitats, and the provision of limited breeding, sheltering and feeding resources. The presence of adjacent forest and woodland habitats create niche space for a range of edge species that would not normally be located in broad grassland expanses. Hence the limited areas of the enclosed grassland patches are likely to be of greater value to edge species rather than to grassland species. Habitat connectivity for grassland species is limited to non-existent within the enclosed patches. For vertebrate grassland species, the extent and configuration of the scattered patches have limited value and are unlikely to provide the resources for viable populations but could provide resources for limited breeding pairs that are part of a wider population or meta-population.

This Broad Habitat Type has limited value for grassland species *per se* and likely more value for edge species and forest and woodland species that use grasslands as a component of their feeding resources. However there is the potential for grassland species to be present and breeding resources for a limited number of breeding pairs.

It is likely that few grassland dependent species differentiate between derived grasslands, native grasslands and introduced grasslands.

Farm Dams

There are many farm dams scattered across the entire property showing that grazing occurred throughout. These provide resources for a range of vertebrate species.

Grassland Habitat (introduced)

This habitat component is entirely derived from clearing of forest and woodland associated with agriculture and subsequently replacing native grasses and herbs with introduced species.

There are usually about four habitat layers present (litter, herb, weed and grass), with an occasional shrub and/or a regenerating Eucalypt species.

These areas tend to be in the valley floor on mainly stagnant alluvial soils. There are a few scattered rocks and very limited to no log cover associated with this Broad Habitat Type. Litter is confined to the residue of herbs and grasses. Soils appear to be impoverished, and in some cases compacted and low in organic matter. Mature grasses and a range of weed species form a continuous ground cover in spring-summer as well as providing a source of seed for a range of seed-eating species. At this time of the year grasses reach 1 to 2 m in height and weed species between 0.25 to 4 m. Signs of invertebrate life such as insects, earthworms, spiders and ants were minimal. Ecosystem processes such as the water, nutrient and carbon cycles were assessed as being dysfunctional and their associated resources appeared to be diminishing associated with resource leakage. Under summer conditions upper soil temperatures appear to rise much more than was likely in the pre-European landscape due to factors such as soil compaction, diminished soil water holding capacity and the malfunctioning of the water cycle at a point and landscape scale. Such factors likely feed back into sub-optimal productivity outcomes.

The habitat values of this Broad Habitat Type are associated with potential feeding, nesting and sheltering resources associated with grasses and herbs in the broader landscape as well as edge components associated with adjacent woodland and forest habitats. The presence of adjacent forest and woodland habitats create niche space for a range of edge species that would not normally be located in broad grassland expanses.

3.2 SITE HABITAT ASSESSMENTS

The attributes determined for the habitat assessments are provided in full in Attachment D.

Tree regeneration and log litter is summarised in Table 3. Trees were in good condition with die back only recorded for one tree. Mistletoe was infrequent and fire scars were all old and generally uncommon except for site 4 where there were several scars on the large old trees. While the old large trees had large, medium and small hollows evident this was only when the branches were large. Coppiced trees had no visible hollows. Site 4 had the highest number of hollows in the large old box trees and this is where most evidence (scats) and sightings of Brushtail Possums was found.

As a result of the extensive clearing that had occurred in the past there were many large windrows, including on steep slopes and relatively inaccessible places. While windrows were avoided for the habitat assessment plots there was generally a large quantity of logs litter on the ground (Table 3). Regeneration was generally fairly limited except at sites 5 and 7 both of which had been cleared previously.

Table 3
Regeneration and Log Litter at Each Habitat Site

Site Number	Length of Logs (m/ha)	Regeneration (No stems < 5 cm dbh/ha)
1	480	0
2	880	80
3	1170	20
4	2730	4
5	1400	290
6	0	0
7/1	1240	100
7/2	940	610
8	1100	20
9	1010	70

3.3 FAUNA

During the August 2011 survey, a total of 142 vertebrate fauna species were identified in the study area including 129 native and 8 introduced species (Attachment E). The total number of native species located in each of four vertebrate groups included five amphibians, 22 reptile species, 82 bird species and 20 mammal species. A summary of the species located and their relative abundance is provided in Attachment E.

Native species diversity varied between 14 and 58 species per site. This included range of diversity for each site of:

- zero to four amphibian species;
- zero to 14 reptile species;
- 11 to 34 bird species; and
- two to 15 mammal species.

Amphibia

In August 2011 five native amphibian species were located at 6 sampling sites with the majority at site 2. No threatened species were recorded. The Common Eastern Froglet (*Crinia signifera*) was present at six of the nine survey sites and opportunistically, the Wrinkled Toadlet (*Uperoleia rugosa*) at five and opportunistically, while the Spotted Grass Frog (*Limnodynastes tasmaniensis*), Peron's Tree Frog (*Litoria peroni*) and the Brown Toadlet (*Pseudophryne bibroni*) were only recorded at one site and/or opportunistically (Attachment E). The most diverse site was site 2 (south of the Willeroi house) (Figure 2) with most species being associated with a dam. No amphibians were recorded at sites 5, 7 and 8 . This was surprising for site 7 which encompassed a moist gully compared with sites 5 and 7 which were not near wet areas. Despite this the diversity of amphibians was high for the winter timing of the survey.

Reptiles

During the survey, 22 native species were recorded and no introduced species. No species were found at all terrestrial sampling sites but the Tree Skink and Tree-base Litter-skink were located at five sites and opportunistically each (Attachment E) and, the Leaden Delma and South-eastern Morethia Skink were recorded across four sites each. The Eastern Brown Snake and the Robust Ctenotus were only recorded opportunistically and the remainder were recorded at one and three sites (Attachment E). The most species diverse site was site 8 (Figure 2) with 14 species whereas none were recorded at the adjacent sites 3 (River Oak community) or site 4 (mature Yellow Box community).

One threatened species was observed, the Border Thick-tailed Gecko, which was recorded at site 8 (nearby to Teatree Gully) and opportunistically (Attachment E).

Birds

During the survey 83 birds were recorded with only one, the Common Starling, being introduced. The most common were Pied Currawong and Noisy Friarbird which were recorded at eight and nine sites respectively. Grey Shrike-thrush, Sulphur-crested Cockatoo and Eastern Rosella were recorded at seven sites each and 17 species were only recorded opportunistically. A total of 57 species were recorded opportunistically. The most species diverse site was site 2 with 34 species. Sites 1 and 5 had 25 and 24, respectively. Site 3, in River Oak had the lowest diversity with 11 species and the majority of these were passing through from the adjoining mature Yellow Box habitat. (Attachment E).

Eight threatened bird species were recorded at most of the sites and opportunistically (Attachment F).

Mammals

Twenty-seven mammal species were recorded during the survey including seven introduced species (Attachment E). The most frequently recorded species were the Common Brushtail Possum which was recorded at all sites and the Swamp Wallaby and at seven sites. The Domestic Dog, Gould's Wattled Bat, Eastern False Pipistrelle, Eastern Freetail bat, Squirrel Glider, Black Rat and Inland Broad-nosed Bat were all recorded at only one site (Attachment E). The most species diverse site was site 2 with 20 species present (including 12 species of microbat) and site 8 was the least diverse with only two species recorded.

3.4 THREATENED SPECIES

Fifteen threatened vertebrate fauna species were located during the survey. These species together with the location(s) where they were observed and other relevant data are summarised in Table 4 and Attachment F.

A Black Cockatoo (*Calyptorhynchus* sp.) was also observed twice during the surveys of the study area but both observers were unable to determine the species with confidence. Three species of Black Cockatoo could occur in this area, two of which are listed under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) are also possible.

Table 4
Threatened Fauna Species Recorded

Scientific Name	Common Name	Conservation Status[1]		Description of the Record
		TSC Act	EPBC Act	
Neophema pulchella	Turquoise Parrot	V	-	This species appeared to be widespread across the study area. They were mostly in pairs but a flock was also observed at the southern edge of the property.
Climacteris picumnis	Brown Treecreeper (eastern subspecies)	V	-	Brown Treecreepers were observed at several locations. These sites ranged from the house at the northern end of the study area to the southern boundary fence.
Stagonopleura guttata	Diamond Firetail	V	-	A substantial flock of Diamond Firetails lives around the house and adjacent to Maules Creek; some were also observed at site 6
Melithreptus gularis	Black-chinned Honeyeater	V	-	This species was observed on the top of a hill close to the southern boundary the study area. It was observed feeding in Eucalypts.
Melanodryas cucullata cucullata	Hooded Robin	V	-	A pair of Hooded Robins were resident at the house near in the north-east of the study area and site 6.
Pomatostomus temporalis	Grey-crowned Babbler	V	-	Six observed along Maules Creek behind the house
Daphoenositta chrysoptera	Varied Sittella	V	-	Two Varied Sittella were observed along Maules Creek behind the house
Glossopsitta pusilla	Little Lorikeet	V	-	This species was observed at various locations in the study area
Petaurus norfolcensis	Squirrel Glider	V	-	One record at the southern boundary of the property (site 5).
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Possible calls of this species were recorded. This is a possible identification with a low confidence assigned to it.
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Possible calls of this species were recorded. This is a possible identification with a low confidence assigned to it.
Miniopterus oceanensis	Eastern Bentwing Bat	V	-	Calls likely to be this species were identified adjacent to a pool in Maules Creek and in the White Box woodland.
Vespadelus troughtoni	Eastern Cave Bat	V	-	Call sequences possibly from this species were recorded.
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Likely call sequences of this species were detected at site 2.
Underwoodisaurus sphyrus	Border Thick-tailed Gecko	V	V	Under granite exfoliation at site 8.

[1] Threatened species status under the TSC Act and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

E Endangered

V Vulnerable

3.5 EXOTIC VERTEBRATE FAUNA

Eight introduced species were located during the survey (Attachment E). These included one bird (Common Starling [*Sturnus vulgaris*] observed only at site 1), and seven mammal species; Domestic Dog (*Canis lupus familiaris*) at site 7, Goat (*Capra hircus*) at sites 1, 2, 3 and opportunistically, Rabbit (*Oryctolagus cuniculus*) at sites 1, 2, 4 and opportunistically, Mouse (*Mus musculus*) at sites 2 and 5, Black Rat (*Rattus rattus*) at sites 3, 5 and 9, Pig (*Sus scrofa*) at sites 2, 3, 4, 6 and opportunistically and the Red Fox (*Vulpes vulpes*) at sites 1, 2 and 4.

4 CONCLUSION

Faunal Species Diversity and Abundance

Total number of species recorded during the August fauna survey in the 'Willeroi' proposed offset area was 137 vertebrate fauna species, including 129 native species (five amphibians, 22 reptiles, 82 bird species and 20 mammal species), and eight introduced species. Given that the survey was conducted during winter it could be expected that this is a minimum species diversity for the property. Both the number and abundance of reptile, amphibian, microbat and bird species could reasonably be expected to increase if resurveyed when the animals are more active and migratory or nomadic species are likely to be present.

Habitats

Seven broad habitat types have been identified: Dry Sclerophyll Forest, Dry Sclerophyll Forest – Cypress Pine Monoculture Regrowth, Grassy Woodland, Riparian/Floodplain, Grassland (native), Farm Dams and Grassland (introduced). One of which is listed as a threatened ecological community; the grassy woodland habitat and a component of the derived native grassland in the study area meet the criteria for listing as *White Box – Yellow Box – Blakely's Red Gum Woodland Endangered Ecological Community* listed under the TSC Act and the *White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands Critically Endangered Ecological Communities* listed under the EPBC Act. Survey sites were located in all of the broad habitat types except for the cypress monoculture regrowth and introduced grassland.

Threatened Fauna Species

Fifteen threatened fauna species listed under the TSC Act have been recorded using habitat in the study area; eight birds, six mammals and one reptile species. These include the Turquoise Parrot (*Neophema pulchella*), Brown Treecreeper (eastern subspecies) (*Climacteris picumnis*), Diamond Firetail (*Stagonopleura guttata*), Black-chinned Honeyeater (*Melithreptus gularis*), Hooded Robin (*Melanodryas cucullata cucullata*), Grey-crowned Babbler (*Pomatostomus temporalis*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Squirrel Glider (*Petaurus norfolcensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Eastern Bentwing Bat (*Miniopterus oceanensis*), Eastern Cave Bat (*Vespadelus troughtoni*), Eastern Freetail-bat (*Mormopterus norfolkensis*) and Border Thick-tailed Gecko (*Underwoodisaurus sphyrus*).

One fauna species listed under the EPBC Act has been recorded in the study area; the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*).

5 REFERENCES

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulte, R. (2003) *The New Atlas of Australian Birds.* Birds Australia, Melbourne.

Churchill, S. (2008) *Australian Bats*. Second Edition. Allen & Unwin, Crows Nest, NSW, Australia.

Cogger, H.G. (2000*) Reptiles and Amphibians of Australia* (Sixth Edition). Reed New Holland, Sydney.

Department of Environment, Climate Change and Water (2009) *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians.*

Department of Environment and Conservation (2004) *Threatened Species Survey and Assessment: Guidelines for Developments and Activities.*

FloraSearch (2011) *Willeroi Report.* Report prepared for Tarrawonga Coal Pty Ltd.

Pennay, M., Law, B. and Reinhold, L. (2004) *Bat calls of New South Wales: regional based guide to the echolocation calls of Microchiropteran bats.* NSW Department of Environment and Conservation, Hurstville.

Marchant, S. and Higgins, P.J. (Eds.) (1993) *Handbook of Australian, New Zealand and Antarctic Birds (HANZAB): Volume 2, Raptors to Lapwings*. Oxford University Press, Melbourne.

Menkhorst, P. and Knight, F. (2001) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.

Morcombe, M. (2004) *Field Guide to Australian Birds*. Steve Parish Publishing Pty Ltd, Archerfield, Australia.

Office of Environment and Heritage (2011) Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities.

Pizzey, G. and Knight, F. (1999) *Field Guide to the Birds of Australia*. Harper Collins Publishers, Sydney, Australia.

Stewart, D.A. (1999a) *Bird and Mammal Calls of NE-NSW Western Slopes and Plains*. Nature Sound, Mullumbimby.

Stewart, D.A. (1999b) *Australian Frog Calls*. Subtropical East, Nature Sound, Mullumbimby.

Strahan, R. (2000) (Ed.) *The Mammals of Australia*. Reed New Holland, Sydney.

Swan, G., Shea, G. and Sadlier, R. (2004) *A Field Guide to the Reptiles of NSW*. Second Edition, Reed New Holland.

Triggs, B. (2004) *Tracks, Scats and Other Traces. A Field Guide to Australian Mammals.* Revised edition, Oxford University Press, Melbourne.

Walker and Hopkins (1984)

Walker, J. and Tunstall, B.R. (1981). Field estimation of foliage cover in Australian woody vegetation. CSIRO Aust. Div. Land Use Res. Tech. Memo. 81/19.

ATTACHMENT A

ANABAT BAT CALL ANALYSIS

Anabat Bat Call Analysis – Willeroi Property, Mount Kaputar, New South Wales.

H. Parnaby, 19 August, 2011.
parn@ozemail.com.au
ABN: 68 571 985 330

Summary

1. A rich and diverse bat fauna was detected in a total of 783 call files, across sites in August 2011, with at least 14 different bat species being present. More species could be expected to occur, e.g. Long-eared bats, the species of which cannot be distinguished using Anabat analysis.

2. Calls of one species listed as vulnerable on the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act)were considered likely to be present: the Eastern bentwing bat. Calls of a further three vulnerable listed species could be present, but were identified with a low level of confidence and require confirmation before they can be demonstrated to occur in the study area. These are the Greater broad-nosed bat, Eastern cave bat and Eastern false pipistrelle.

3. The number of bat calls detected and number of species recorded varied greatly between sites and nights, as did survey duration at each site. Overall, the ability to confidently identify species was diminished by a combination of call quality and the expected occurrence in the area of several species which are difficult to discriminate from calls. This can only be resolved by capturing bats.

4. Surprisingly, two large species that would be expected to occur in the region were not identified from calls: the White-striped freetail bat and the Yellow-bellied sheathtail bat, the latter listed as vulnerable on the TSC Act.

The Brief

To provide bat species lists per bat detector per night.

Methods

Calls were analysed using the AnalookW software (Chris Corben, version 3.8m).

Bat calls are assigned three levels of confidence in species identification: **C** = confident identification; **L** = likely identification; **P** = possible identification, low confidence. Bat names follow Churchill (2008).

Calls are discussed in terms of species characteristic frequency (kHz), e.g. K30 means the call sequence has a characteristic frequency around 30 kHz. Call characteristic frequency is defined as per Pennay *et al.* (2004).

Results

A total of 14 bat species were recorded from the area, when results are pooled across all sites and nights (Table A-1). Note that survey duration at each site was variable. Species lists are provided for each of the three bat detectors across nights in Table A-2.

Table A-1
Results

Total number of call files	783
Minimum number of species present	14
Bat Species:	
Gould's wattled bat (*Chalinolobus gouldii*)	C
Chocolate wattled bat (*Chalinolobus morio*)	C
Long-eared bats (*Nyctophilus* species)	C
Eastern broad-nosed bat (*Scotorepens orion*)	L
Inland broad-nosed bat (*Scotorepens balstoni*)	P
Eastern false pipistrelle (*Falsistrellus tasmaniensis*)	**P**
Greater broad-nosed bat (*Scoteanax rueppellii*)	**P**
Eastern bentwing bat (*Miniopterus oceanensis*)	**L**
Little forest bat (*Vespadelus vulturnus*)	L
Southern forest bat (*Vespadelus regulus*)	P
Eastern cave bat (*Vespadelus troughtoni*)	**P**
Eastern freetail bat (*Mormopterus ridei*)	**L**
Southern freetail bat (*Mormopterus* species 4)	L
Eastern horseshoe bat (*Rhinolophus megaphyllus*)	C

Notes:

C = confident identification

L = likely identification

P = possible identification, low confidence.

Species in bold are listed as Vulnerable under the TSC Act.

Notes on Recording Sessions

Detector Unit SN05206

Site 1: 2 August 2011 – Most calls were faint and steep, and could not be identified. One short sequence was consistent with the Eastern bentwing bat in call shape, but the identification cannot be confirmed on the basis of such a short sequence.

Site 3: 3 August 2011 – Only two bat call sequences were recorded, both of poor quality. One was likely to be a fragmentary call of the Eastern horseshoe bat, the other call was around K48-50 and could not be identified from the fragmentary sequence.

Site 5: 4 August 2011 – At least nine species are recognized. The majority of calls were around the K45-50 band, and of poor quality – they were most likely to be a species of Forest bat (*Vespadelus* spp). Several clearer sequences were at K50 (e.g. Figure 1) and could possibly be of the Eastern cave bat, but this identification is of low confidence. A number of call sequences around K45 were possibly of the Southern forest bat, but are similar to and thus difficult to distinguish from the Eastern bentwing bat, and should it occur in the area, Large forest bat (*V. darlingtoni*). There were three call files of the Eastern horseshoe bat, several call sequences that are likely to be the Eastern bentwing bat and several around K25 likely to be of the Southern freetail bat. Several short sequences at K30-34 represented a further species which could not be identified with confidence: possibilities include the Greater broad-nosed bat or the Inland broad-nosed bat. A limited number of short and incomplete call sequences around K38 could not be meaningfully assigned to species.

Site 7: 5 August 2011- All 11 bat call files had characteristic frequencies around K28-30, which could not be identified to species because they consisted of short sequences of indistinct calls.

Site 9: 6 August 2011 – A third of all call files were of Eastern horseshoe bat (15 definite and 4 likely calls of a total of 69 call files). The fuzziness of most recorded calls made species recognition impossible other than the highly distinctive Eastern horseshoe bat calls and a few sequences at K50, which were possibly of the Eastern cave bat. It is likely that the detector sensitivity setting was incorrect, or perhaps moisture had accumulated on the microphone. Calls were in the K45-50 band.

Detector Unit CF00982

Site 2 dam:

2 August 2011 – At least 12 different species were detected. Calls were dominated by Gould's wattled bat, species of Freetail bat, and species of forest bat (*Vespadelus* spp). There were fewer calls of the Chocolate wattled bat and very few passes by Long-eared bats. Several call sequences were likely to be the Eastern broad-nosed bat (e.g. Figure 2), although some of these sequences could not be reliably distinguished between the latter species and the Eastern false pipistrelle, if that species was present.

Site 4:

3 August 2011 – Brief call sequences at K45 and around K50. Two were possibly the Chocolate wattled bat but the remaining sequences were very steep, and could not be assigned to a species.

Site 7:

6 August 2011 – Of the three short call sequences, two contained sequences that could not be identified, both around K46, the other is likely to be a species of Long-eared Bat.

Detector Unit CF00981

Site 2 uphill:

2 August 2011 – The majority of calls were around K45: at least two of which were likely to be of the Eastern bentwing bat (e.g. Figure 3), the rest could not be distinguished between the Eastern bentwing bat and the Southern forest bat, the latter therefore included as a possible occurrence. The remaining species were represented by a small number of call sequences: the Chocolate wattled bat; calls likely to be of the Southern freetail bat; and incomplete sequences of two further species that could not be assigned, around K30 and K34-38.

Limitations of bat call identification using Anabat

Reliable separation of a number of species in the region can be difficult. This includes the following sets of species that are relevant to this analysis:

- three species of long-eared bat are likely to occur in the region, but the different long-eared bat species cannot at present be discriminated using the Anabat system;
- the Eastern broad-nosed bat and Eastern false pipistrelle;

- the Southern forest bat from the Eastern bentwing bat. Some call sequences of the Large forest bat (*Vespadelus darlingtoni*), if present in the area, could also be difficult to distinguish from the latter two species;
- the two unnamed freetail bats, *Mormopterus* species 4 (large penis form) and the *Mormopterus* species 3 (small penis form). In this report, calls are assigned to *Mormopterus* species 4 on distributional grounds (Terry Reardon, South Australian Museum, pers. comm.);
- some call sequences of the Greater broad-nosed bat can be confused with the Inland broad-nosed bat, and in some cases with the Eastern false pipistrelle; and
- extensive experience indicates that typically a significant majority of calls cannot be reliably assigned to a species. This particularly applies to unmanned detectors, were many call sequences tend to either be too short, or of poor recording quality due to distance of the bat from the microphone.

It is important to appreciate that for these difficult species, some call sequences that exhibit typical call characteristics can be confidently identified, but the wide variation in call characteristics causes overlap in variation between species, leading to ambiguity in some call sequences that deviate from typical characteristics.

Concluding remarks

Significant points to arise from the call inventory are:

1. Calls of one species listed as vulnerable on the TSC Act were recorded as being likely – the Eastern bentwing bat. Calls of a further three vulnerable listed species are possible, but are given a low confidence and require confirmation, either from further call recording or bat capture: the Greater broad-nosed bat, the Eastern cave bat and Eastern false pipistrelle.
2. The ability to confidently identify species was diminished in this region, which is an overlap zone between eastern and western faunal elements, by a combination of call quality and the expected occurrence in the area of several species which are difficult to discriminate by calls.
3. The species total is comparatively high, particularly given that the survey was done in the cooler months when bat activity is generally lowest.
4. It is surprising that two large species that would be expected to occur in the region, were not identified from these calls: the White-striped freetail bat and the Yellow-bellied sheathtail bat, the latter listed as vulnerable on the TSC Act.

Table A-2
Bat Call Identification for each Bat Detector and Night

Bat detector unit	**SN05206**					**CF00982**			**CF00981**
Date	2/08/11	3/08/11	4/08/11	5/08/11	6/08/11	2/08/11	3/08/11	6/08/11	2/08/11
Number of sound files	33	2	110	11	69	481	29	3	45
Minimum number of species present	3	2	9	1	3	12	2	2	5
Bat Species:									
Gould's wattled bat *Chalinolobus gouldii*						C			
Chocolate wattled bat *Chalinolobus morio*						C	P		C
Long-eared bats *Nyctophilus species*						C		L	
Eastern broad-nosed bat *Scotorepens orion*			P			L			
Inland broad-nosed bat *Scotorepens balstoni*			P						
Eastern false pipistrelle *Falsistrellus tasmaniensis*						**P**			
Greater broad-nosed bat *Scoteanax rueppellii*	**P**		**P**						
Eastern bentwing bat *Miniopterus oceanensis*	**L**		**L**			**P**			**L**
Little forest bat *Vespadelus vulturnus*			L			L			
Southern forest bat *Vespadelus regulus*			P			P			P
Eastern cave bat *Vespadelus troughtoni*					**P**	**P**			
Eastern Freetail bat *Mormopterus ridei*						**L**			
Southern Freetail bat *Mormopterus species 4*			L			L			P
Eastern horseshoe bat *Rhinolophus megaphyllus*		C	C		C				

Notes:

Species in bold are listed as Vulnerable under the TSC Act.

C = confident identification.

L = likely identification.

P = possible identification, low confidence.

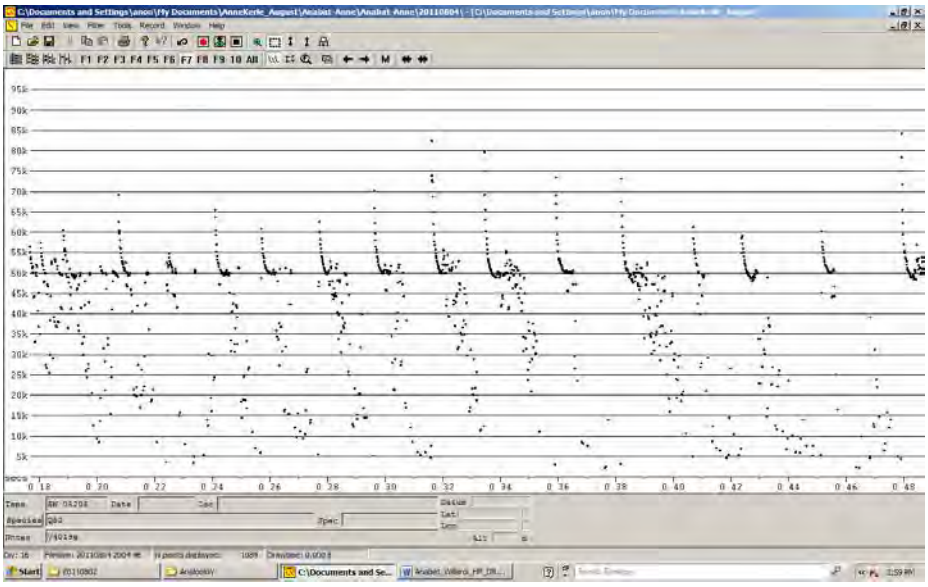

Figure 1. Anabat call sequence possibly of the Eastern cave bat.
Recorded 4 August, 2011 (compressed mode, F8).

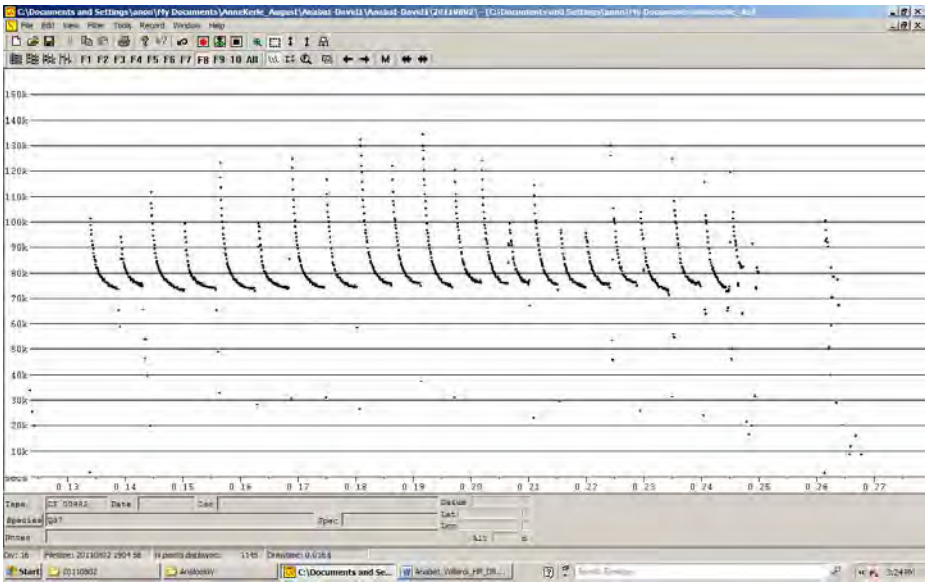

Figure 2. Anabat call sequence likely to be of the Eastern broad-nosed bat.
Recorded 2 August, 2011 (compressed mode, F8).
[NB: all frequencies on vertical axis are half of that displayed,
i.e. 70k=35k, due to file download calibration error.]

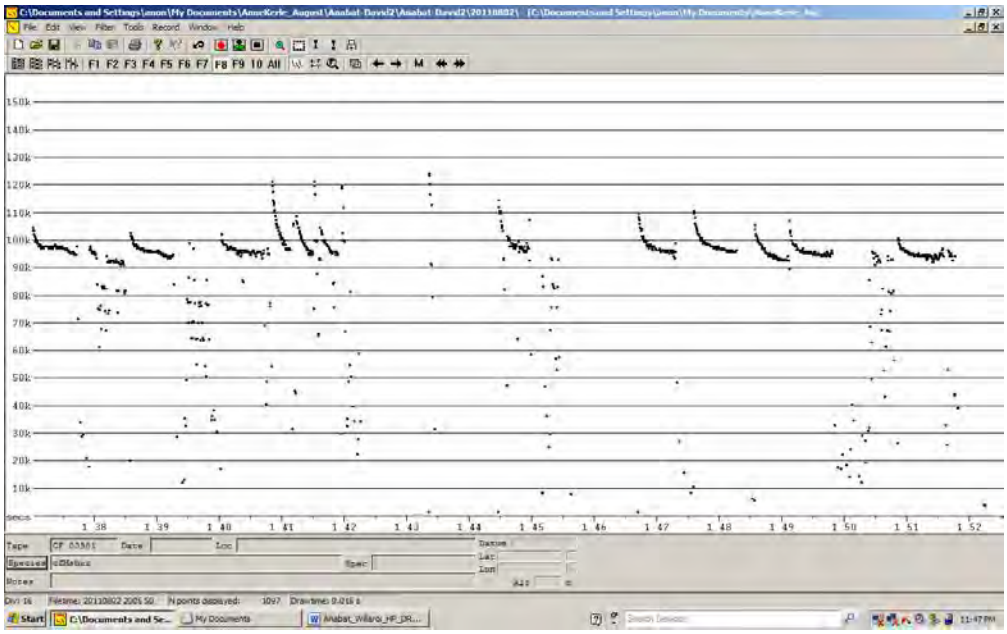

Figure 3. Anabat call sequence likely to be of the Eastern bentwing bat.
Recorded 2 August, 2011 (compressed mode, F8).
[NB: all frequencies on vertical axis are half that displayed,
i.e. 70k=35k, due to file download calibration error.]

ATTACHMENT B

SCAT AND HAIR ANALYSIS BY BARBARA TRIGGS

Scat Analysis

Carried out by Barbara Triggs

Scats

No.	Location	Scat	Mammal ID - definite	Mammal ID - probable
1	Site 1	fox	Insect material only	
2	Site 1 creek	fox	*Wallabia bicolor*	
3	Site 1 creek	fox	Insect material only	
4	Site 1 creek	fox	*Oryctolagus cuniculus*	
5	Site 2	macropod	*W. bicolor*	
6	HT6	fox/dog	*Macropus giganteus*	
7	Site 3	dog	*W. bicolor*; *Capra hircus*	
8	Site 5	dog	*Trichosurus vulpecula*	
9	Site 5	fox/dog	*W. bicolor*	
10	Near Willeroi gate	fox	*C. hircus*	
11	Site 7	fox	*Canis familiaris* (prey)	
12	Site 7	fox	*W. bicolor*	

Hair funnel analysis

Carried out by Barbara Triggs

Hair tubes

No.	Site	Hair trap	Mammal ID - definite	Mammal ID - probable
1	2	grassland	*Mus musculus*	
2	2	3	no hairs	
3	2	99	no hairs	
4	2	20	human hair	
5	2	24	no hairs	
6	2	unknown	no hairs	
7	4	9	human hair	
8	4	11	no hairs	
9	4	unknown	no hairs	
10	5	2	*M. musculus*	
11	5	3	*M. musculus*	
12	5	4	*M. musculus*	
13	5	4	*M. musculus*	
14	5	5	*M. musculus*	
15	5	7	*M. musculus*	
16	5	9	*M. musculus*	
17	7	unknown	human hair	
18	8	15	no hairs	
19	8	15	Trichosurus sp.	*Trichosurus vulpecula*
20	9	11	*Rattus rattus*	
1	9	12	*R. rattus*	
22	9	13	*R. rattus*	
23	9	14	human hair	

ATTACHMENT C

SURVEY SITE DESCRIPTIONS

Site 1: Riparian and Grassland (native)

AMG: 56 243566E; 6629757N; Altitude: 542 m **Date:** 4/8/2011

Bearing of Transect: 160^0

Locality description:

West bank of Maules Creek and water course, east of house. Watercourse generally flat with smooth stone and sandy bed and steep banks. Some small waterholes still present. Flat topography with rocky hill to the south of the survey site. Due to the narrow nature of the riparian vegetation the vegetation plot was only 10 metres (m) in width along the top of the bank.

Soil: Clayey loam

Broad vegetation description:

Narrow band of fringing River Red Gum, River Oak and Melaleuca. Vegetation confined to the steep bank and on the upper bank. Beyond the River Red Gum band the vegetation is made up of a dense grass cover with widely scattered large Angophora (2 Angophora >100 centimetres (cm) diameter at breast height (dbh) 50 m west of the bank). Native grassland more than 10 m from the bank.

Vegetation description:

Upper canopy: River Red Gum to >25 m in height on upper bank with River Oak to 15 m. Melaleuca to 10 m, mostly lower on bank.

Mid canopy: Smaller Melaleuca with Sweet briar and Bursaria scattered in the grassland on the upper bank.

Ground layer: Predominantly a dense sward of grasses with some patches of herbs and weeds (20% cover).

Disturbance:

Probable clearing of timber historically but little evidence remaining. No regrowth of mid or upper canopies. No evidence of fire.

Weeds: Species include Vittadinnia, Stinging nettle, Noogoora burr, Cobblers Pegs (*Bidens pilosa*), Purple top (*Verbena*).

Fauna:

Grey Kangaroo, Common Wallaroo and Common Brushtail Possum scats. Evidence of a variety of species eating the rosehips from the sweet briar including Currawongs.

Vertebrate pests: Goat, pig and fox scats.

Conservation value:

Some conservation value but with significant levels of disturbance. Potential to regenerate of degrade depending on management.

Site 2: Dry Sclerophyll Forest

AMG: 56 242591E; 6629067N; Altitude: 604 m **Date: 4**/8/2011

Bearing of Transect: 270^0

Locality description:

South of the Willeroi house on the eastern slope of the Willeroi 'spine'. The overall site, including the faunal observations and location of hair funnels extends from the swale below the dam, continuing uphill and crossing two gullies. Vegetation plot located midway up the slope.

Soil: Skeletal

Broad vegetation description:

White Box/Cypress woodland with some dense patches of cypress. Dense growth of cypress and sweet briar in the swale below the dam. Mistletoe fruiting.

Vegetation description:

Upper canopy: White Box to 15 m (taller lower on slope, especially near the dam) (25% cover), Callitris (10%) cover.

Mid canopy: 15% cover dominated by Callitris and Dodonaea in addition to Olearia and Acacia.

Ground layer: 50% cover by tussock grasses, 10% herb species.

Disturbance:

Moderate disturbance; past heavy clearing with remnant logs and evidence of fire. Currently no firewood cutting or stock but grazing by goats.

Weeds: Prickly pear.

Fauna:

Common Brushtail Possum, Grey Kangaroo and Common Wallaroo scats.

Vertebrate pests: Feral goats.

Conservation value:

Some conservation value but with significant levels of disturbance. Self sustaining with regeneration.

Site 3: Riparian (River Oak Monoculture)

AMG: 56 244067E; 6626726N; Altitude: 468 m **Date:** 3/8/2011

Bearing of Transect: 240^0

Locality description:

Western bank of meander bend of Maules Creek.

Broad vegetation description:

River oak forest.

Soil: Some large river rocks with alluvial soils.

Vegetation description:

Upper canopy: River oak - 60% cover, 20 m height. Occasional River Red Gum in creek and adjacent to vegetation plot.

Mid canopy: Scattered occasional Bursaria and Acacia (<10%).

Ground layer: Grasses, herbs and nettles (90% cover).

Disturbance:

No recent evidence of logging, clearing, firewood cutting or fire. Goats common and grazed by stock previously

Fauna:

Goanna tracks, Common Brushtail Possum, Grey Kangaroo, Common Wallaroo and Swamp wallaby scats.

Vertebrate pests: Goats, goat scats, pig diggings and scats, strong odour of fox.

Conservation value:

Some disturbance with some lost resilience but self sustaining with regeneration.

Site 4: Grassy Box Woodland

AMG: 56 242616E; 6625351N; Altitude: 500 m **Date**: 4/8/2011

Bearing of Transect: 260^0

Locality description:

Terrace above River Oak in Maules Creek meander and up the adjacent hill slope.

Broad vegetation description:

Yellow Box woodland.

Soil: Loamy clay.

Vegetation description:

Upper canopy: Yellow Box and Angophora to 20 m height, 50% canopy cover.

Mid canopy: Shrub cover of Acacia, Bursaria and Callitris – 30% shrub cover.

Ground layer: 90% grass cover with 10% forbs.

Disturbance:

Little disturbance with some light logging in the past, no evidence of firewood cutting, fire scars and fallen limbs as the result of past fire.

Fauna:

Common Brushtail Possum, Grey Kangaroo, Common Wallaroo scats.

Vertebrate pests: Goats, goat scats, pig digging and scats, fox scent.

Conservation value:

Some disturbance and resilience lost; self-sustaining, currently disturbed by feral goats and pigs.

Site 5: Dry Sclerophyll Forest (Ironbark)

AMG: 56 243012E; 6625320N; Altitude: 517 m Date: 4/8/2011

Bearing of Transect: 0^0 N

Locality description:

Just north of the southern boundary fence of the Willeroi property, east of the gate.

Broad vegetation description:

Silver-leafed Ironbark with White Box and White Cypress Pine open woodland, interspersed with patches of grassland. To the south of the boundary fence the vegetation is starkly different with moderately dense regrowth Silver-leafed Ironbark. Many of the smaller bird species were more common in this habitat, coming across to feed in the study site.

Soil: Loamy.

Vegetation description:

Upper canopy: Silver-leafed Ironbark, White Box and White Cypress Pine 45% cover, 16-20 m high. Two large old remnant White Box in the 2 hectare (ha) fauna plot.

Mid canopy: White Cypress Pine, Acacia, Olearia 15% cover.

Ground layer: Grasses (Cymbopogon and others) 80% cover, forbs 20% cover.

Disturbance:

Considerable disturbance with heavy clearing in the past leaving substantial windrows of logs and very few large trees; no stock currently but evidence of cattle; no evidence of fire.

Weeds: Thistles and prickly pear.

Fauna:

Grey Kangaroo and Common Wallaroo scats, swallow nest on abandoned Land Rover.

Vertebrate pests: Fox scat and scent of fox.

Conservation value:

Some conservation value but with considerable level of past disturbance: potential to regenerate or degrade depending on management.

Site 6: Riparian (Teatree/Melaleuca)

AMG: 56 242826E; 6626379N; Altitude: 494 m **Date**: 5/8/2011

Bearing of Transect: Followed south-east along creek from waypoint.

Locality description:

Myrtle Creek and banks with terraces in parts before opening onto gently undulating plain area to the west and rising up a hill slope to the east.

Due to the narrowness of the Myrtle Creek vegetation and the close association of the adjacent dry sclerophyll open forest the vegetation plot data is limited for this survey site. Groundcover has been measured within the myrtle community. Descriptions are provided for the surrounding communities due to lack of time to do three vegetation plots for this survey site.

Broad vegetation description:

Along the creek: Mono specific melaleuca community.

Western bank: Ironbark (Silver-leafed and Narrow-leafed) woodland.

Eastern bank: Angophora and White Cypress Pine grading into Hill Red Gum to the east.

Vegetation description:

Upper canopy: Along creek channel Melaleuca 6-8 m in height and to 40% projected foliage cover (pfc); west bank Silver-leafed Ironbark (40% pfc, 20-30 cm dbh mostly or <20 cm, 1 x 80 cm), Narrow-leafed Ironbark (10% pfc, 60 cm dbh), White Box (5% pfc, 30-40 cm dbh), White Cypress Pine and Angophora 5% pfc; east bank Angophora and cypress 50% pfc, 15-20 m high, height decreasing in the Hill Red Gum Community.

Mid canopy: Occasional Bursaria, Acacia and Whitewood in the creek community; scattered shrubs in surrounding open forests including Hibiscus and Acacia (5-10% pfc). Some regenerating eucalypt and cypress.

Ground layer: 100% grass cover under Melaleuca; Ironbark open forest (west bank) – 70% tussock grass, 10% rock, 20% litter; east bank 100% tussock grass and lily. Very few logs.

Disturbance:

Evidence of human use of this area with a well, some posts and iris plants. Some evidence of past logging.

Fauna:

Grey Kangaroo and Common Wallaroo scats.

Vertebrate pests: Fox scent, goat scats.

Conservation value:

Some disturbance, some resilience lost; self sustaining, currently undisturbed except for feral species.

Site 7: Dry Sclerophyll Forest (White Box, White Cypress Pine, Hill Red Gum)
Sub-site 7/1

AMG: 56 240982E; 6628676N; Altitude: 628 m **Date**: 5/8/2011

Bearing of Transect: 80^0

Locality description:

Western Willeroi, west of the main north/south track. Creekline/gully below (to north) of the powerline easement. Plot width 10 m along the creekline and sloping bank.

Broad vegetation description:

Dry sclerophyll forest of White Box, Hill Red Gum and White Cypress Pine.

Soil: Stony soil and rock shelving along the creek.

Vegetation description:

Upper canopy: To 15 m high: White Box (20% pfc), Hill Red Gum (20% pfc) and White Cypress Pine (25% pfc).

Mid canopy: Olearia, Dodonaea and Acacia - 60% pfc.

Ground layer: Tussock grass, Lily, Xanthorroea - 60% cover.

Disturbance:

Some past clearing and timber cutting (old stump and some logs) and probably light grazing. Goats common in this area.

Weeds: Prickly pear.

Fauna:

Common Brushtail Possum, Common Wallaroo and Grey Kangaroo scats; chewed White Cypress Pine cones.

Vertebrate pests: Large goat herd heard nearby.

Conservation value:

Some disturbance, some resilience lost but probably self sustaining.

Site 7: Dry Sclerophyll Forest (White Box, White Cypress Pine, Hill Red Gum)
Sub-site 7/2

AMG: 56 241031E; 6628700N: Altitude: 627 m **Date:** 5/8/2011

Bearing of Transect: 70^0

Locality description:

Western Willeroi, west of the main north/south track. Slope adjacent to creekline/gully below (to north) powerline easement.

Broad vegetation description:

Dry sclerophyll forest of White Box and White Cypress Pine. Trees spindly regrowth after clearing with sparse crowns.

Soil: Friable, crumbly and rocky.

Vegetation description:

Upper canopy: White Box and White Cypress Pine - 50% pfc. Some occasional large old White Cypress Pine.

Mid canopy: Olearia, White Cypress Pine and Dodonaea – 15% pfc.

Ground layer: Tussock grasses 50% cover. Other species include Five Corners (*Styphelia*), Xanthorroea and yellow flowered daisy.

Disturbance:

Extensive past clearing (despite the steep terrain) with large windrows still present within the 2 ha survey site. No recent evidence of fire or stock. Trees mostly post clearing regrowth.

Fauna:

Common Brushtail Possum and grey Kangaroo scats.

Vertebrate pests: Large goat herd heard nearby.

Conservation value:

Extensive disturbance but active regeneration of tree canopy – self sustaining without further disturbance.

Site 8: Dry Sclerophyll Forest (White Cypress Pine, Ironbark, White Box)

AMG: 56 240467E; 6628522N; Altitude: 668 m **Date:** 5/8/2011

Bearing of Transect: 220^0

Locality description:

Western Willeroi, west of the main north/south track. West of site 7, south of power line easement. Rugged dissected topography with deep gullies.

Soil: Skeletal with some cryptogam (moss) cover; scattered large rocks and boulders.

Broad vegetation description:

Dry sclerophyll forest dominated by White Cypress Pine, Narrow-leafed Ironbark and White Box.

Vegetation description:

Upper canopy: White Cypress Pine (50% pfc), Narrow-leafed Ironbark (20% pfc) and White Box (10% pfc) to 15 m high.

Mid canopy: 40% pfc including two species of Olearia, Five corners (*Styphelia*).

Ground layer: Tussock grasses – 15% pfc.

Disturbance:

Heavy past clearing for powerline and more extensively. No recent evidence of grazing or fire.

Fauna:

Common Brushtail Possum, Common Wallaroo and Grey Kangaroo scats.

Vertebrate pests: Large goat herds.

Conservation value:

Site 9: Dry Sclerophyll Forest (White Box, Angophora, White Cypress Pine)

AMG: 56 241839E; 6629189N; Altitude: 584 m **Date:** 6/8/2011

Bearing of Transect: 240^0

Locality description:

West of central north/south 'spine' ridge on Willeroi above Myrtle Creek.

Soil: Loam.

Broad vegetation description:

Open forest/woodland of White Box, Angophora and White Cypress Pine.

Vegetation description:

Upper canopy: To 15 m; Angophora (15% pfc), White Cypress Pine (20% pfc), White Box (15% pfc).

Mid canopy: White Cypress Pine, Dodonaea, Olearia – 25% pfc; Other species include Bursaria, Acacia, Sweet Briar, Five Corner, etc.

Ground layer: 70% cover - Tussock Grass (60% cover), Dianella, Umbrella Grass, fern, forbs.

Disturbance:

Extensive past clearing, no recent evidence of fire or stock grazing.

Weeds: Sweet Briar, Prickly Pear.

Fauna:

Common Brushtail Possum, Grey Kangaroo, Common Wallaroo scats, Swamp Wallaby.

Vertebrate pests: Feral Goats

Conservation value:

Very large white box 243 cm dbh and others present; patches of more dense regenerating White Cypress Pine with a grassy understorey, creekline/gully with large Angophora and a patchy, more dense shrub growth. Disturbed with some lost resilience and potential to regenerate or degrade depending on management.

ATTACHMENT D

HABITAT ASSESSMENT DATA

Table D-1
Willeroi Line Transect 50 m

Site	Measure	00 m	05 m	10 m	15 m	20 m	25 m	30 m	35 m	40 m	45 m	Comments
1	Litter[1]	90										
1	Bare Ground[1]											
1	Cryptogram[1]											
1	Rock[1]											
1	Log[1]	10										
1	pfc[2] 0-0.5m		100	100	100	100	100	100	100	100	100	This represents dense grass cover with litter
1	pfc 0.5-2m										60	
1	pfc 2-4m									60	20	
1	pfc 4-6m								55	10	5	
1	pfc Canopy (>6)	50	50	0	10	40	0	0	0	55	50	
2	Litter	55	100	90	85	100	50	30	90	90	60	
2	Bare Ground	15								5		
2	Cryptogram											
2	Rock	20							10			
2	Log											
2	pfc 0-0.5m	10		10	15		50	70		5	40	
2	pfc 0.5-2m		10						3			
2	pfc 2-4m		10		40	5			20			
2	pfc 4-6m				40	20		30	30			
2	pfc Canopy (>6)		5	50	45	45	45	50	50	40	20	
3	Litter				60		50	45	30	50	20	
3	Bare Ground				15							
3	Cryptogram											
3	Rock						40		15	10	10	
3	Log			10				10				
3	pfc 0-0.5m	100	100	90	25	100	10	45		40	70	
3	pfc 0.5-2m											
3	pfc 2-4m								10			
3	pfc 4-6m											
3	pfc Canopy (>6)	45	45	35	40	40	40	45	50	40	10	

Table D-1 (Continued)
Willeroi Line Transect 50 m

Site	Measure	00 m	05 m	10 m	15 m	20 m	25 m	30 m	35 m	40 m	45 m	Comments
4	Litter	60	60				20			50	50	
4	Bare Ground											
4	Cryptogram											
4	Rock											
4	Log						10				10	
4	pfc 0-0.5m	40	40	100	100	100	70	100	100	50	40	Dense grass cover mostly, some forbs
4	pfc 0.5-2m	10	30									
4	pfc 2-4m	10	10									
4	pfc 4-6m											
4	pfc Canopy (>6)	35	35	35	45		10		35	55	50	
5	Litter	60	60		100	95	95	80		100	90	
5	Bare Ground											
5	Cryptogram										5	
5	Rock											
5	Log								100			
5	pfc 0-0.5m	10				5	5	20			5	
5	pfc 0.5-2m	30	40	100								
5	pfc 2-4m								100			
5	pfc 4-6m											
5	pfc Canopy (>6)	50	50	50		30						
6	Litter											
6	Bare Ground											
6	Cryptogram											
6	Rock											
6	Log											
6	pfc 0-0.5m	100	100	100	100	100	100	100	100	100	100	Grass cover
6	pfc 0.5-2m			10	20			10	5	10	10	
6	pfc 2-4m	50	30	40	40			10	20	20	15	
6	pfc 4-6m	50	30	30	30	50	5	30	30	20	40	
6	pfc Canopy (>6)			30	30	40	50	40	50		50	

Table D-1 (Continued)
Willeroi Line Transect 50 m

Site	Measure	00 m	05 m	10 m	15 m	20 m	25 m	30 m	35 m	40 m	45 m	Comments
7	Litter	60	55	70	70	50	80	50	60	60	10	
7	Bare Ground		20			20						
7	Cryptogram									10	20	
7	Rock								10			
7	Log	10	15	10					10			
7	pfc 0-0.5m	30	10	20	30	30	20	50	20	30	70	
7	pfc 0.5-2m		15		10			5				
7	pfc 2-4m	15	15					10	5			
7	pfc 4-6m	15	15		10	5		5			5	
7	pfc Canopy (>6)	35	35	35	30	30	35	20			30	
7	Litter	100	80	55	100	70	90	65	50	100	80	
7	Bare Ground		10	30					50		10	
7	Cryptogram		10	10		20						
7	Rock											
7	Log								35			
7	pfc 0-0.5m					10	10				10	
7	pfc 0.5-2m	20	40	5	40		30			5	5	
7	pfc 2-4m				15					5	10	
7	pfc 4-6m			10	25						15	
7	pfc Canopy (>6)	35	35	20	30	35	35		35	35	35	
8	Litter	70		60	70	60	75	70	70	20	80	
8	Bare Ground						15		10	65	10	
8	Cryptogram		10						10	20		
8	Rock	25			10	30			15		10	
8	Log				10	10	10					
8	pfc 0-0.5m	5	10	40	10			30	5	5		
8	pfc 0.5-2m		10			20	50				5	
8	pfc 2-4m											
8	pfc 4-6m				10	20		30	40		50	
8	pfc Canopy (>6)	25	50	40	30	40	50	40	50			

Table D-1 (Continued)
Willeroi Line Transect 50 m

Site	Measure	00 m	05 m	10 m	15 m	20 m	25 m	30 m	35 m	40 m	45 m	Comments
9	Litter	95	90	100	90	100	95	90	90	100	90	
9	Bare Ground											
9	Cryptogram											
9	Rock											
9	Log											
9	pfc 0-0.5m	5	10		10		5	10	10		10	
9	pfc 0.5-2m		10			10	10	20	50	40	50	
9	pfc 2-4m				40	10	10		5	10	10	
9	pfc 4-6m			55	40	50					10	
9	pfc Canopy (>6)			55	50			55	40	45	50	

1 Pfc is the average projected foliage cover (%).

2 Number of centimetres covered with respective substrate within transect.

Table D-2
Willeroi Tree Size Density Condition

Site	Plot Size (m^2)	Species	DBH[1] (cm)	Live/Dead	Fire Scar	Mistletoe	Hollows[2]	Decorating Bark	Dieback	Count-Main Trunk	Count-Second Trunk
1	500	River Oak	21-30	Live	N	N	N	N	N	3	
1	500	River Oak	31-40	Live	Y	Y	N	N	N	5	
1	500	River Red Gum	81-90	Live	N	N	2L/3S	Y	N	1	
1	500	River Red Gum	91-100	Live	N	N	1L	Y	N		1
1	500	River Oak	101-110	Live	N	Y	N	N	N	1	
1	500	Angophora	148	Live	Y	N	N	Y	N	1	
1	500	River Red Gum	164	Live	N	N	3S	Y	N	1	
1	500	River Oak	31-40	Dead	N					3	
2	1000	White Box	20<	Live	N	N	N	N	N	5	1
2	1000	White Box	21-30	Live	N	N	N	N	N	3	
2	1000	Cypress	20<	Live	N	N	N	N	N	8	
2	1000	Cypress	21-30	Live	N	N	N	N	N	1	
2	1000	Kurrajong	51-60	Live	N	N	N	N	N	1	
3	1000	River Oak	20<	Live	N	N	N	N	N	34	
3	1000	River Oak	21-30	Live	N	N	N	N	N	41	
3	1000	River Oak	31-40	Live	N	N	N	N	N	12	
3	1000	River Oak	51-60	Live	N	N	N	N	N	2	
3	1000	River Oak	61-70	Live	N	N	N	N	N	1	
4	1000	Yellow Box	99	Live	N	N	2M	Y	N	1	
4	1000	Yellow Box	73	Live	N	N	1L/1S	Y	N	1	
4	1000	Yellow Box	64	Live	Y	N	1L	Y	N	1	
4	1000	Yellow Box	55	Live	Y	N	1L	Y	N		1
4	1000	Yellow Box	123	Live	Y	N	3L	Y	N	1	
4	1000	Angophora	101	Live	N	N	3L/3M	N	N	1	
4	1000	Angophora	120	Live	Y	N	N	N	N	1	
4	1000	Angophora	54	Live	N	N	N	Y	N		1
4	1000	Angophora	129	Live	Y	N	N	Y	N	1	
4	1000	Angophora	20<	Live	N	N	N	Y	N	1	

Table D-2 (Continued)
Willeroi Tree Size Density Condition

Site	Plot Size (m^2)	Species	DBH[1] (cm)	Live/Dead	Fire Scar	Mistletoe	Hollows[2]	Decorating Bark	Dieback	Count-Main Trunk	Count-Second Trunk
5	1000	Silver-leafed Ironbark	20<	Live	N	N	N	N	N	9	
5	1000	Silver-leafed Ironbark	21-30	Live	N	N	N	N	N	1	
5	1000	White Cypress	20<	Live	N	N	N	N	N	6	
5	1000	White Box	20<	Live	N	N	N	N	N	3	
5	1000	White Box	21-30	Live	N	N	N	N	N	1	
5	1000	White Box	41-570	Live	N	N	N	N	N	1	
5	1000	White Box	90	Live	N	Y	N	N	N	1	
5	1000	White Box	41-50	Live	N	N	N	N	N		2
5	1000	White Box	31-140	Live	N	N	N	N	N		3
5	1000	White Box	200	Live	N	Y	2M	N	N	1	
7	500	Hill Red Gum	20<	Live	N	N	N	N	N	5	
7	500	Hill Red Gum	21-30	Live	N	N	N	Y	30-70%	2	
7	500	Cypress	20<	Live	N	N	N	N	N	12	
7	500	Cypress	31-40	Live	N	N	N	N	N	2	
7	500	White Box	20<	Live	N	N	N	N	N	2	
7	500	White Box	31-40	Live	N	N	N	Y	N	1	
7	500	White Box	99	Live	Y	N	3S/2M	N	N		
7	500	Cypress	20<	Dead	N	N	N	N		1	
7	500	Hill Red Gum	21-30	Dead	N	N	1L	Y		1	
7	1000	White Box	20<	Live	N	N	N	N	N	20	
7	1000	White Box	21-30	Live	N	N	N	N	N	6	
7	1000	White Box	31-40	Live	N	N	N	N	N	1	
7	1000	Cypress	20<	Live	N	N	N	N	N	41	
7	1000	Cypress	21-30	Live	N	N	N	N	N	2	
7	1000	Cypress	21-30	Dead	Y					1	

Table D-2 (Continued)
Willeroi Tree Size Density Condition

Site	Plot Size (m^2)	Species	DBH[1] (cm)	Live/Dead	Fire Scar	Mistletoe	Hollows[2]	Decorating Bark	Dieback	Count-Main Trunk	Count-Second Trunk
8	1000	NL Ironbark	20<	Live	N	N	N	N	N	20	
8	1000	NL Ironbark	21-30	Live	N	N	N	N	N	12	
8	1000	NL Ironbark	31-40	Live	N	N	N	N	N	2	
8	1000	Black Cypress	20<	Live	N	N	N	N	N	111	
8	1000	Black Cypress	21-30	Live	N	N	N	N	N	23	
8	1000	White Box	20<	Live	N	N	N	N	N	4	
8	1000	White Box	21-30	Live	N	N	N	N	N	4	
8	1000	Hill Red Gum	20<	Live	N	N	N	N	N	1	
8	1000	Hill Red Gum	21-30	Live	N	N	N	Y	N	1	
8	1000	NL Ironbark	20<	Dead						1	
8	1000	Cypress	20<	Dead						11	
8	1000	White Box	21-30	Dead						1	
8	1000	NL Ironbark	51-60	Dead						1	
8	1000	White Box	71-80	Dead						1	
9	1000	White Box	20<	Live	N	N	N	N	N	13	
9	1000	White Box	20<	Live	N	N	N	N	N		3
9	1000	White Box	20<	Live	N	Y	N	N	N	3	
9	1000	White Box	21-30	Live	N	N	N	N	N	9	9
9	1000	White Box	31-40	Live	N	N	N	N	N	1	1
9	1000	White Box	243	Live	Y	Y	2L/6M/6S	N	N	1	
9	1000	Ironwood	20<	Live	N	N	N	N	N	2	

Notes:

[1] Diameter at breast height.

[2] S – small; M – medium; L – large

N = No

Y = Yes

Table D-3
Willeroi Logs in Plot

Site	Plot Size (m^2)	Length (m)	Diameter (cm)	Decay Class[1]
1	500	2	10	1
1	500	6	20	2
1	500	8	10	2
1	500	6	5	2
2	1000	6	40	3
2	1000	2	15	3
2	1000	1	30	3
2	1000	3	15	3
2	1000	4	15	3
2	1000	1	30	3
2	1000	2	25	3
2	1000	2	20	3
2	1000	4	20	3
2	1000	6	20	3
2	1000	2	25	3
2	1000	4	50	3
2	1000	4	10	2
2	1000	5	20	2
2	1000	4	15	2
2	1000	1	20	3
2	1000	3	15	2
2	1000	1	15	3
2	1000	7	55	3
2	1000	3	40	3
2	1000	2	10	2
2	1000	5	20	2
2	1000	4	15	3
2	1000	2	20	3
2	1000	3	10	1
2	1000	2	15	1
2	1000	5	20	1
3	1000	8	40	3
3	1000	4	10	2
3	1000	10	35	3
3	1000	4	15	2
3	1000	6	10	2
3	1000	4	15	3
3	1000	1	30	3
3	1000	11	15	3
3	1000	3	10	2
3	1000	4	20	3
3	1000	5	10	2
3	1000	1	30	3
3	1000	6	20	3
3	1000	4	30	3
3	1000	2	20	3
3	1000	6	40	3
3	1000	4	20	2
3	1000	15	15	2
3	1000	3	10	2
3	1000	1	15	3

Table D-3 (Continued)
Willeroi Logs in Plot

Site	Plot Size (m^2)	Length (m)	Diameter (cm)	Decay Class[1]
3	1000	7	25	2
3	1000	2	15	3
3	1000	4	10	3
4	1000	4	10	2
4	1000	10	15	2
4	1000	3	10	2
4	1000	10	15	3
4	1000	8	25	2
4	1000	6	10	3
4	1000	1	10	2
4	1000	3	10	3
4	1000	6	40	2
4	1000	6	15	3
4	1000	8	10	2
4	1000	6	30	3
4	1000	4	15	2
4	1000	6	40	3
4	1000	10	15	2
4	1000	5	20	3
4	1000	3	20	2
4	1000	3	10	3
4	1000	2	10	2
4	1000	4	10	3
4	1000	4	30	3
4	1000	10	30	3
4	1000	4	60	3
4	1000	5	20	3
4	1000	6	40	3
4	1000	22	15	3
4	1000	5	20	3
4	1000	8	20	2
4	1000	3	35	3
4	1000	7	15	2
4	1000	3	30	3
4	1000	2	20	2
4	1000	7	10	3
4	1000	8	10	2
4	1000	30	15	1
4	1000	6	30	3
4	1000	5	25	3
4	1000	3	20	2
4	1000	6	30	3
4	1000	4	15	3
4	1000	5	15	1
4	1000	3	15	2
4	1000	4	10	1
4	1000	6	25	2
4	1000	6	10	3

Table D-3 (Continued)
Willeroi Logs in Plot

Site	Plot Size (m^2)	Length (m)	Diameter (cm)	Decay Class[1]
5	1000	60	25	2
5	1000	50	10	2
5	1000	20	15	2
5	1000	10	20	2
7	500	2	10	2
7	500	9	15	2
7	500	5	20	3
7	500	5	10	3
7	500	8	20	3
7	500	12	15	3
7	500	13	30	3
7	500	4	20	2
7	500	4	15	3
7	1000	7	10	3
7	1000	4	15	3
7	1000	5	20	3
7	1000	10	10	3
7	1000	5	15	3
7	1000	31	10	3
7	1000	10	15	3
7	1000	12	20	3
8	1000	9	15	3
8	1000	8	80	3
8	1000	6	25	2
8	1000	10	15	2
8	1000	12	10	2
8	1000	12	20	1
8	1000	15	10	1
8	1000	6	25	3
8	1000	7	10	3
8	1000	3	15	2
8	1000	6	15	3
8	1000	5	40	3
8	1000	11	20	3
9	1000	10	20	2
9	1000	6	20	2
9	1000	7	20	3
9	1000	15	10	3
9	1000	6	10	2
9	1000	3	15	2
9	1000	2	15	1
9	1000	1	20	3
9	1000	3	15	3
9	1000	2	10	2
9	1000	1	20	3
9	1000	2	10	2
9	1000	2	15	2
9	1000	4	40	3
9	1000	5	20	3
9	1000	6	15	2

Table D-3 (Continued)
Willeroi Logs in Plot

Site	Plot Size (m^2)	Length (m)	Diameter (cm)	Decay Class[1]
9	1000	5	10	2
9	1000	2	30	2
9	1000	4	15	3
9	1000	5	10	3
9	1000	6	10	2
9	1000	4	15	2

Notes;

[1] Decay Class:

1: No cracking

2: Cracking and decaying

3: Breaks when kicked

m^2 = square metres; m = metres; cm = centimetres.

Table D-4
Willeroi Regeneration in Plot

Site	Plot Size (m^2)	Species	Regeneration Stems Count
2	1000	White Cypress Pine	8
3	1000	River Oak	2
5	1000	White Box	10
5	1000	White Cypress Pine	19
5	1000	Silver-leaved Ironbark	1
7	500	White Cypress Pine	5
7	1000	White Cypress Pine	36
7	1000	White Box	25
8	1000	White Cypress Pine	1
8	1000	Ironbark	1
9	1000	White Cypress Pine	6
9	1000	White Box	5
9	1000	Angophora	2

ATTACHMENT E

1. TERRESTRIAL VERTEBRATE FAUNA SPECIES RECORDED IN "WILLEROI" OFFSET AREA 1 TO 7 AUGUST 2011

2. RESULTS OF TIMED BIRD COUNTS AT EACH SITE

3. NUMBER OF REPTILES & AMPHIBIANS RECORDED AT EACH SITE

Table E-1
Terrestrial Vertebrate Fauna Species Recorded in "Willeroi" Offset Area 1 to 7 August 2011

Scientific Name	Common Name	Relative Abundance	Conservation Status[1]		Site Number									Opportunistic Sightings
			TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	
Amphibian														
Crinia signifera	Common Eastern Froglet	C			X	X	X	X	-	X	-	-	X	X
Limnodynastes tasmaniensis	Spotted Grass Frog	U			-	X	-	-	-	-	-	-	-	X
Litoria peroni	Peron's Tree Frog	1			-	-	-	-	-	-	-	-	-	X
Pseudophryne bibroni	Brown Toadlet	U			-	X	-	-	-	-	-	-	-	-
Uperoleia rugosa	Wrinkled Toadlet	C			X	X	-	X	-	X	-	-	X	X
Reptiles														
Amphibolurus nobbi	Nobbi	U			-	-	-	-	-	-	X	X	X	X
Anomolopus leuckartii	Two-clawed Worm-skink	1			-	-	-	-	-	X	-	-	-	X
Brachyurophis australis	Coral Snake	1			-	-	-	-	-	-	-	X	-	X
Carlia vivax	Tussock Rainbow-skink	1			-	-	-	-	-	X	-	-	-	X
Cryptoblepharus pulcher	Elegant Snake-eyed Skink	U			-	X	-	-	X	-	-	X	-	-
Ctenotus robustus	Robust Ctenotus	U			-	-	-	-	-	-	-	-	-	X
Ctenotus taeniolatus	Copper-tailed Skink	1			-	-	-	-	-	-	-	X	-	X
Delma plebeia	Leaden Delma	U			-	X	-	-	-	X	-	X	X	X
Delma tincta	Excitable Delma	U			-	-	-	-	-	-	X	X	-	-
Demansia psammophis	Yellow-faced Whipsnake	U			-	-	-	-	X	-	-	-	X	-
Egernia modesta	Eastern Ranges Rock-skink	1			-	-	-	-	-	-	-	X	-	-
Egernia striolata	Tree Skink	U			X	-	-	-	X	X	X	X	-	X
Furina diadema	Red-naped Snake	1			-	-	-	-	-	-	-	-	-	X
Heteronotia binoei	Bynoe's Gecko	U			-	X	-	-	-	-	-	X	-	X
Lerista bougainvillii	South-eastern Slider	U			-	-	-	-	-	X	-	-	X	-
Lophognathus burnsi	Burns' Dragon	1			-	-	-	-	-	-	-	X	-	-
Lygisaurus foliorum	Tree-base Litter-skink	C			-	X	-	-	-	X	X	X	X	X
Morethia boulengeri	South-eastern Morethia Skink	U			-	X	-	-	X	-	X	X	-	X

Table E-1 (Continued)
Terrestrial Vertebrate Fauna Species Recorded in "Willeroi" Offset Area 1 to 7 August 2011

Scientific Name	Common Name	Relative Abundance	Conservation Status[1]		Site Number									Opportunistic Sightings
			TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	
Amphibian (Continued)														
Pseudechis porphyriacus	Red-bellied Black Snake	U			-	X	-	-	-	-	-	-	-	-
Pseudonaja textilis	Eastern Brown Snake	1			-	-	-	-	-	-	-	-	-	X
Underwoodisaurus milii	Thick-tailed Gecko	1			-	-	-	-	-	-	-	X	-	-
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	U	V	V	-	-	-	-	-	-	-	X	-	X
Birds														
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	C			X	-	-	-	X	-	-	-	X	X
Acanthiza nana	Yellow Thornbill	U			-	-	-	-	X	-	X	X	-	X
Acanthiza reguloides	Buff-rumped Thornbill	U			-	-	-	-	-	-	-	-	-	X
Acanthiza uropygialis	Chestnut-rumped Thornbill	U			-	-	-	-	-	-	X	-	-	-
Acanthorhynchus tenuirostris	Eastern Spinebill	U			-	-	-	X	-	-	X	X	-	X
Aegotheles cristatus	Australian Owlet-nightjar	U			X	-	-	-	X	-	-	-	-	-
Anas superciliosa	Pacific Black Duck	U			-	-	-	-	-	-	-	-	-	X
Anthochaera carunculata	Red Wattlebird	U			-	X	-	-	X	-	-	-	X	X
Anthus australis	Australian Pipit	U			-	X	-	-	-	-	-	-	-	-
Aprosmictus erythropterus	Red-winged Parrot	U			-	X	-	-	X	X	-	-	X	-
Aquila audax	Wedge-tailed Eagle	U			-	-	-	-	-	-	-	-	-	X
Cacatua galerita	Sulphur-crested Cockatoo	C			X	X	X	X	X	X	-	X	-	X
Cacatua sanguinea	Little Corella	U			-	X	-	-	-	-	-	-	-	X
Cacomantis flabelliformis	Fan-tailed Cuckoo	U			X	-	-	X	-	-	-	-	X	-
Chalcites basalis	Horsfield's Bronze-Cuckoo	C			-	X	-	-	-	-	-	-	-	-
Chenonetta jubata	Australian Wood Duck	U			-	X	-	-	-	-	-	-	-	X
Cinclosoma punctatum	Spotted Quail-thrush	1			-	-	-	-	-	-	X	-	-	-
Climacteris picumnus	Brown Treecreeper	C	V	-	-	-	X	X	X	X	-	-	-	X
Colluricincla harmonica	Grey Shrike-thrush	C			X	X	X	X	X	-	X	-	X	X

Table E-1 (Continued)
Terrestrial Vertebrate Fauna Species Recorded in "Willeroi" Offset Area 1 to 7 August 2011

Scientific Name	Common Name	Relative Abundance	Conservation Status[1]		Site Number									Opportunistic Sightings
			TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	
Birds (Continued)														
Coracina novaehollandiae	Black-faced Cuckoo-shrike	U			X	X	-	-	X	X	-	-	-	-
Corcorax melanorhamphos	White-winged Chough	U			-	X	-	-	-	-	-	-	-	X
Cormobates leucophaea	White-throated Treecreeper	U			-	-	-	-	-	-	X	X	X	X
Corvus coronoides	Australian Raven	C			X	-	X	X	-	X	X	-	-	X
Coturnix ypsilophora	Brown Quail	U			-	-	-	-	-	X	-	-	-	-
Cracticus nigrogularis	Pied Butcherbird	C			X	X	-	X	X	-	-	X	-	X
Cracticus torquatus	Grey Butcherbird	U			-	X	X	-	-	-	-	-	-	X
Cuculus pallidus	Australian Pallid Cuckoo	U			-	-	-	-	-	-	-	-	-	X
Dacelo novaeguineae	Laughing Kookaburra	C			X	-	-	X	X	-	X	-	-	X
Daphoenositta chrysoptera	Varied Sitella	U	V	-	-	-	-	-	-	-	-	-	-	X
Egretta novaehollandiae	White-faced Heron	C			-	-	-	X	-	-	-	-	-	X
Eolophus roseicapilla	Galah	C			-	X	X	X	-	X	-	-	-	X
Eopsaltria australis	Eastern Yellow Robin	U			-	X	-	-	-	-	-	-	-	X
Falco berigora	Brown Falcon	U			-	-	-	-	-	-	-	-	-	X
Falco hypoleucos	Grey Falcon	1			-	-	-	-	-	-	-	-	-	X
Falco longipennis	Australian Hobby	1			-	-	-	-	-	-	-	-	-	X
Falcunculus frontatus frontatus	Eastern Shrike-tit	1			-	X	-	-	-	-	-	-	-	-
Geopelia placida	Peaceful Dove	U			-	-	-	-	-	-	-	-	-	X
Gerygone olivacea	White-throated Gerygone	1			X	-	-	-	-	-	-	-	-	-
Glossopsitta pusilla	Little Lorikeet	U	V	-	-	X	-	-	X	-	-	-	-	-
Grallina cyanoleuca	Magpie-lark	U			-	X	-	-	-	-	-	-	-	X
Gymnorhina tibicen	Australian Magpie	C			X	X	-	X	X	-	-	X	-	X
Hirundo neoxena	Welcome Swallow	C			-	-	-	-	X	X	-	-	-	X
Lichenostomus chrysops	Yellow-faced Honeyeater	C			-	-	X	-	-	-	X	X	X	X

Table E-1 (Continued)
Terrestrial Vertebrate Fauna Species Recorded in "Willeroi" Offset Area 1 to 7 August 2011

Scientific Name	Common Name	Relative Abundance	Conservation Status[1]		Site Number									Opportunistic Sightings
			TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	
Birds (Continued)														
Lichenostomus fuscus	Fuscous Honeyeater	C			-	-	-	-	X	-	-	-	X	X
Lichenostomus leucotis	White-eared Honeyeater	U			-	X	-	-	-	-	X	-	-	-
Lichenostomus penicillatus	White-plumed Honeyeater	C			X	X	X	X	X	-	-	-	X	-
Malurus cyaneus	Superb Fairy-wren	C			X	X	-	-	X	-	-	X	X	X
Manorina melanocephala	Noisy Miner	U			-	-	-	-	-	-	-	-	X	-
Melanodryas cucullata	Hooded Robin	U	V	-	-	-	-	-	-	-	-	-	-	X
Melithreptus brevirostris	Brown-headed Honeyeater	U			-	-	-	-	-	-	-	-	-	X
Melithreptus gularis gularis	Black-chinned Honeyeater	-	V	-	-	-	-	-	-	-	-	-	-	X
Melithreptus lunatus	White-naped Honeyeater	C			-	-	X	-	-	X	X	X	X	-
Microeca fascinans	Jacky Winter	C			X	X	-	X	X	-	-	-	-	X
Myiagra inquieta	Restless Flycatcher	U			-	-	-	-	-	-	-	-	-	X
Neochmia temporalis	Red-browed Finch	C			X	X	-	X	-	X	-	X	-	X
Neophema pulchella	Turquoise Parrot	C	V	-	X	-	-	X	-	-	-	X		X
Ninox boobook	Southern Boobook	U			X	-	-	-	X	X	-	-	-	-
Ocyphaps lophotes	Crested Pigeon	MC			-	X	-	-	X	-	-	-	-	X
Pachycephala pectoralis	Golden Whistler	U			-	-	-	-	-	X	X	-	-	-
Pardalotus punctatus	Spotted Pardalote	C			-	X	-	X	-	X	-	X	-	X
Pardalotus striatus	Striated Pardalote	C			-	-	-	X	-	X	X	-	-	x
Petrochelidon ariel	Fairy Martin	U			-	-	-	-	-	-	-	-	-	X
Phaps chalcoptera	Common Bronzewing	U			-	-	-	X	-	-	-	-	-	X
Philemon corniculatus	Noisy Friarbird	MC			X	X	X	X	X	X	X	X	X	X
Platycercus adscitus	Eastern Rosella	C			X	X	-	X	X	X	-	X	X	X
Platycercus elegans	Crimson Rosella	U			-	X	-	-	-	X	-	-	-	X
Plectorhyncha lanceolata	Striped Honeyeater	1			X	-	-	-	-	-	-	-	-	-

Table E-1 (Continued)
Terrestrial Vertebrate Fauna Species Recorded in "Willeroi" Offset Area 1 to 7 August 2011

Scientific Name	Common Name	Relative Abundance	Conservation Status[1]		Site Number									Opportunistic Sightings
			TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	
Birds (Continued)														
Podargus strigoides	Tawny Frogmouth	U			-	-	-	X	-	-	-	-	-	X
Pomatostomus temporalis temporalis	Grey-crowned Babbler	U	V	-	-	-	-	-	-	-	-	-	-	X
Psephotus haematonotus	Red-rumped Parrot	U			-	-	-	-	-	-	-	-	-	X
Rhipidura albiscapa	Grey Fantail	U			-	X	-	-	-	-	X	-	-	X
Rhipidura leucophrys	Willie Wagtail	U			-	X	-	-	X	-	-	-	-	X
Sericornis frontalis	White-browed Scrubwren	U			X	-	X	-	-	-	X	X	-	-
Smicrornis brevirostris	Weebill	U			-	-	-	-	-	-	X	-	-	-
Stagonopleura guttata	Diamond Firetail	C	V	-	-	X	-	-	-	X	-	-	-	X
Strepera graculina	Pied Currawong	C			X	X	-	X	X	X	X	X	X	X
Struthidea cinerea	Apostlebird	C			-	X	-	-	-	-	-	-	-	X
*Sturnus vulgaris**	Common Starling	U			-	X	-	-	-	-	-	-	-	-
Tachybaptus novaehollandiae	Australasian Grebe	C			X	-	-	-	-	-	-	-	-	-
Taeniopygia bichenovii	Double-barred Finch	C			X	-	-	-	-	-	-	-	-	X
Taeniopygia guttata	Zebra Finch	U			-	-	-	-	-	X	-	-	-	-
Threskiornis molucca	Australian White Ibis	U			X	-	-	-	-	-	-	-	-	-
Vanellus miles miles	Masked Lapwing	U			-	-	-	-	-	-	-	-	-	X
Zosterops lateralis	Silvereye	C			-	-	-	-	-	X	-	X	-	-
Mammals														
*Canis lupus familiaris**	Domestic Dog	1			-	-	-	-	-	-	X	-	-	-
*Capra hircus**	Goat	A			X	X	X	-	-	-	-	-	-	X
Chalinolobus gouldii	Gould's Wattled Bat	?			-	X	-	-	-	-	-	-	-	-
Chalinolobus morio	Chocolate Wattled Bat	?			-	X	-	X	-	-	-	-	-	-
Falsistrellus tasmaniensis	Eastern False Pipistrelle	?	V	-	-	X	-	-	-	-	-	-	-	-

Table E-1 (Continued)
Terrestrial Vertebrate Fauna Species Recorded in "Willeroi" Offset Area 1 to 7 August 2011

Scientific Name	Common Name	Relative Abundance	Conservation Status[1]		Site Number									Opportunistic Sightings
			TSC Act	EPBC Act	1	2	3	4	5	6	7	8	9	
Mammals (Continued)														
Macropus giganteus	Eastern Grey Kangaroo	MC			-	X	-	X	X	X	-	X	-	X
Macropus robustus	Euro	C			X	X	-	X	-	X	X	-	-	-
Miniopterus schreibersii	Eastern Bentwing-bat	?	V	-	X	X	-	-	X	-	-	-	-	-
Mormopterus norfolkensis	Eastern Freetail Bat	?	V	-	-	X	-	-	-	-	-	-	-	-
Mormopterus planiceps	Southern Freetail bat	?			-	X	-	-	X	-	-	-	-	-
*Mus musculus**	House Mouse	C			-	X	-	-	X	-	-	-	-	-
Nyctophilus spp.	Long-eared Bat	?			-	X	-	-	-	-	X	-	-	-
*Oryctolagus cuniculus**	Rabbit	C			X	X	-	X	-	-	-	-	-	X
Petaurus norfolcensis	Squirrel Glider	1	V	-	-	-	-	-	X	-	-	-	-	-
*Rattus rattus**	Black Rat	C			-	-	-	-	-	-	-	-	X	-
Rhinolophus megaphyllus	Eastern Horseshoe-bat	?			-	-	X	-	X	-	-	-	X	-
Scoteanax rueppellii	Greater Broad-nosed Bat	?	V	-	X	-	-	-	X	-	-	-	-	-
Scotorepens balstoni	Inland Broad-nosed Bat	?			-	-	-	-	X	-	-	-	-	-
Scotorepens orion	Eastern Broad-nosed Bat	?			-	X	-	-	X	-	-	-	-	-
*Sus scrofa**	Pig	MC			-	X	X	X	-	X	-	-	-	X
Tachyglossus aculeatus	Short-beaked Echidna	?			-	-	-	X	-	-	-	-	X	X
Trichosurus vulpecula	Common Brushtail Possum	C			X	X	X	X	X	X	X	X	X	-
Vespadelus regulus	Southern Forest Bat	?			-	X	-	-	X	-	-	-	-	-
Vespadelus troughtoni	Eastern Cave Bat	?	V	-	-	X	-	-	-	-	-	-	X	-
Vespadelus vulturnus	Little Forest Bat	?			-	X	-	-	X	-	-	-	-	-
*Vulpes vulpes**	Red Fox	A			X	X	-	X	-	-	-	-	-	-
Wallabia bicolor	Swamp Wallaby	MC			X	X	X	X	X	-	X	-	X	X

Notes:

[1] Conservation Status under the NSW *Threatened Species Act, 1995* (TSC Act) and the Commonwealth *Environmental Protection and Biodiversity Act, 1999* (EPBC Act).

V Vulnerable.

*	Introduced Species.
1	One sighting or trace found.
U	Uncommon - two to eight observations of the species.
C	Common – six to 30 observations of the species.
MC	Moderately Common – 31 to 50 observations of the species.
A	Abundant - >50 observations of the species.
?	Relative abundance cannot be determined.

Table E-2
Results of Timed Bird Counts at Each Site

Common Name	Site and Time of Count (am or pm)																	
	1		2		3		4		5		6		7		8		9	
	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
Australasian Pipit	1																	
Australian Raven	2	1			1		1	1					1					
Black-faced Cuckoo-shrike	1			1					1			1						
Brown Quail											1							
Brown Thornbill													1		1			
Brown Treecreeper					1		1		1		1							
Common Bronzewing							1	1										
Common Starling				1														
Crested Pigeon			1	1						1								
Crimson Rosella			1								1							
Currawong	1																	
Diamond Firetail											1							
Double-bar Finch	1	1																
Eastern Rosella	1	1	1				1	1	1	1	1				1	1		1
Eastern Shrike-tit			1															
Eastern Spinebill							1						1		1			
Eastern Yellow Robin			1															
Fantail Cuckoo																	1	
Fan-tailed Cuckoo		2					1											
Fuscous Honeyeater									3	4							1	1
Galah				1	1						1							
Golden Whistler											1			1				
Grey Butcherbird					1													
Grey Fantail			1										1					
Grey Shrike-thrush	1		1			1		1	1				2				1	1

Table E-2 (Continued)
Results of Timed Bird Counts at Each Site

Common Name	Site and Time of Count (am or pm)																	
	1		2		3		4		5		6		7		8		9	
	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
Horsfield's Bronze-Cuckoo			1															
Jacky Winter	1			1				1	1	1								
Laughing Kookaburra	1	1					1		1	1				1				
Little Lorikeet			1	1					1									
Magpie	1		1	1			1		1						1	1		
Magpie-lark			1															
Noisy Friarbird	3	4	1	1	1	1	1	1	2	3	1	1	1		1	1	3	2
Noisy Miner																		1
Owlet-nightjar		2								1								
Pied Butcherbird	1	1	1	1			1		1						1			
Pied Currawong	1			1			1		1		1		1	1	1	1		1
Pipit				1														
Red Wattlebird			1						1								1	
Red-browed Firetail Finch	1	1	1				1				1	1			1			
Red-winged Parrot			1							1								2
Silvereye											1	1			1			
Southern Boobook		1										1						
Spiny Cheeked Honeyeater	1																	
Spiny-cheeked Honeyeater	1	2								1							3	2
Spotted Pardalote			1				1	1			1	1			1	1		
Spotted Quail-thrush													1					
Striated Pardalote							1	1				1	2					
Striped Honeyeater	1																	
Sulphur-crested Cockatoo	2	1	1			1	1	1	1		1					1		
Superb Fairy-wren	3	2	1												1		1	
Tawny Frogmouth								1										

Table E-2 (Continued)
Results of Timed Bird Counts at Each Site

Common Name	Site and Time of Count (am or pm)																	
	1		2		3		4		5		6		7		8		9	
	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
Turquoise Parrot		2					1								1			
Weebill													1					
Welcome Swallow									1	1	1							
White plumed honeyeater	4																	
White-browed Scrubwren					1									1		1		
White-browed Scrub-wren	1	1																
White-eared Honeyeater			1										1					
White-naped Honeyeater					1						1	1		2	1	1	1	
White-plumed Honeyeater	1	6	1	1	2	1	1	1	1								1	
White-throated Gerygone	1																	
White-throated Treecreeper													1	1	1		2	1
Willie Wagtail			1						1									
Wood Duck			1															
Yellow Robin	1			1			1	1			1	1	1	1	1	1		1
Yellow Thornbill									1				2					
Yellow-faced Honeyeater					1								3	2	1		5	1
Zebra Finch											1							
Grand Total	**33**	**29**	**23**	**13**	**10**	**4**	**18**	**12**	**21**	**15**	**17**	**9**	**20**	**10**	**16**	**9**	**20**	**14**

Table E-3
Number of Reptiles and Amphibians Recorded at Each Site

Scientific Name	Site and Count Number									Grand Total
	1	2	3	4	5	6	7	8	9	
Amphibolurus nobbi	-	-	-	-	-	-	1	2	-	3
Anomolopus leuckartii	-	-	-	-	-	1	-	-	-	1
Brachyurophis australis	-	-	-	-	-	-	-	1	-	1
Carlia foliorum	-	-	-	-	-	-	-	2	-	2
Carlia vivax	-	-	-	-	-	1	-	-	-	1
Crinia signifera	1	2	1	2	-	1	-	-	2	9
Cryptoblepharus pulcher	-	1	-	-	1	-	-	1	-	3
Ctenotus taeniolatus	-	-	-	-	-	-	-	1	-	1
Delma plebia	-	1	-	-	-	1	-	2	1	5
Delma tincta	-	-	-	-	-	-	1	1	-	2
Demansia psammophis	-	-	-	-	1	-	-	-	1	2
Egernia modesta	-	-	-	-	-	-	-	1	-	1
Egernia striolata	1	-	-	-	1	1	1	1	-	5
Heteronotia binoei	-	1	-	-	-	-	-	3	-	4
Lerista bougainvillii	-	-	-	-	-	1	-	-	1	2
Limnodynastes tasmaniensis	-	1	-	-	-	-	-	-	-	1
Lophognathus burnsi	-	-	-	-	-	-	-	1	-	1
Lygisaurus foliorum	-	1	-	-	-	1	2	3	2	9
Morethia boulengeri	-	1	-	-	1	-	1	1	-	4
Pseudechis porphyriacus	-	1	-	-	-	-	-	-	-	1
Pseudophryne bibroni	-	2	-	-	-	-	-	-	-	2
Underwoodisaurus milii	-	-	-	-	-	-	-	1	-	1
Underwoodisaurus sphyrurus	-	-	-	-	-	-	-	1	-	1
Uperoleia rugosa	2	2	-	1	-	1	-	-	1	7
Grand Total	**4**	**13**	**1**	**3**	**4**	**8**	**6**	**22**	**8**	**69**

ATTACHMENT F

WILLEROI THREATENED SPECIES LIST

Table F-1
Willeroi Threatened Species List

	Scientific Name	Common Name	TSC Act Conservation Status[1]	Site									Opportunistic Sightings
				1	2	3	4	5	6	7	8	9	
Birds													
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V	-	2	-	-	2	2	-	-	-	-
	Neophema pulchella	Turquoise Parrot	V	4	-	-	2	-	-	-	2	-	56 E243405 N6625360 - Many 56 E242443 N6628142 - 2 56 E242183 N6628491 - 2 56 E242444 N6628061 - 2 House – 2
	Climacteris picumnus	Brown Treecreeper	V	-	-	1	2	1	2	-	-	-	House – 3
Meliphagidae	*Melithreptus gularis gularis*	Black-chinned Honeyeater (eastern subspecies)	V	-	-	-	-	-	-	-	-	-	56 E243405 N6625360
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V	-	-	-	-	-	-	-	-	-	Maules Creek near House - 6
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V	-	-	-	-	-	-	-	-	-	Maules Creek near House – 2
Passeridae	*Stagonopleura guttata*	Diamond Firetail	V	-	Obs	-	-	-	2	-	-	-	House – 13 Maules Creek near House – 25
Petroicidae	*Melanodryas cucullata*	Hooded Robin	V	-	-	-	-	-	1	-	-	-	House – 2
Reptiles													
Gekkonidae	*Underwoodisaurus sphyrus*	Border Thick-tailed Gecko	V	-	-	-	-	-	-	-	(?)	-	(?)
Mammals													
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V	-	-	-	-	1	-	-	-	-	-
Molossidae	*Mormopterus norfolkensis*	Eastern Freetail-bat	V	-	(?)	-	-	-	-	-	-	-	-
Miniopteridae	*Miniopterus oceanensis*	Eastern Bentwing-bat	V	L	P/L	-	-	L	-	-	-	-	-
Vespertilionidae	*Vespadelus troughtoni*	Eastern Cave Bat	V	-	P	-	-	-	-	-	-	P	-
	Scoteanax rueppellii	Greater Broad-nosed Bat	V	P	-	-	-	P	-	-	-	-	-
	Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	P	-	-	-	-	-	-	-	-

Notes:

[1] Conservation Status under the NSW *Threatened Species Act, 1995*.

V - Vulnerable; Obs – Observation; P - Possible identification; L - Likely identification, low confidence; ? - Recorded but number of individuals not known.