Sutton Forest Quarries Pty Ltd

ABN 66 158 999 994

Flora and Fauna Surveys and Assessments

Specialist Consultant Studies Compendium

Volume 2, Part 5

February 2018

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Flora and Fauna Survey and Assessment of the Site

Specialist Consultant Studies Compendium

Volume 2, Part 5A

Prepared by

Kevin Mills & Associates

February 2018

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Sutton Forest Quarries Pty Ltd

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Part 5A:
Flora and Fauna
Survey and Assessment of the Site

Prepared for: R.W. Corkery & Co. Pty Limited
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Email: brooklyn@rwcorkery.com

On behalf of: Sutton Forest Quarries Pty Ltd
PO Box 2499
BONDI JUNCTION NSW 1355

Tel: (02) 9387 5900
Fax: (02) 9386 5249
Email: finance@tulla.com.au

Prepared by: Kevin Mills & Associates
Ecological and Environmental Consultants
12 Hyam Place
JAMBEROO NSW 2533

Tel: (02) 4236 0620
Email: kevinmillskma@gmail.com

February 2018

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FLORA AND FAUNA SURVEY AND ASSESSMENT OF THE SITE

SUTTON FOREST SAND QUARRY PROPOSAL
HUME HIGHWAY
SHIRE OF WINGECARRIBEE

prepared by

KEVIN MILLS & ASSOCIATES
ECOLOGICAL AND ENVIRONMENTAL CONSULTANTS
12HYAM PLACE
JAMBEROO NSW 2533
ABN 346 816 238 93

in association with

LESRYK ENVIRONMENTAL CONSULTANTS
PO POX 3001
BUNDEENA NSW 2230

for

R W CORKERY & CO PTY LIMITED
Level 1, 12 Dangar Road
BROOKLYN NSW 2083

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Kevin Mills & Associates
Ecological and Environmental Consultants
12 Hyam Place
Jamberoo NSW 2533
ABN 346 816 238 93

Ph: (02) 4236 0620 or 0429 848094
Email: kevinmillskma@gmail.com

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Summary

This survey and report provides a description of the flora and fauna identified within a study area that included the location of a proposed quarry and associated facilities (the Site) and adjacent properties at Sutton Forest, located immediately to the north of the Hume Highway in the Shire of Wingecarribee. An intensive field survey programme was carried out in spring 2012, resulting in the compilation of comprehensive lists of the plants and animals recorded on the property. Supplementary surveys were undertaken in 2013 and 2016. The plant communities present are described and mapped, and fauna groups and local habitats have been comprehensively surveyed.

Targeted surveys for threatened species likely to occur in the locality were undertaken using species-specific techniques. A comprehensive field survey of the vegetation, based on extensive transects across the area together with detailed floristic plot surveys, were completed to identify, describe and map the plant communities occurring in the area. The survey methods employed meet or exceed the minimum survey effort as set out in the DECC (now OEH) assessment and survey guidelines.

Biosis (2018) surveyed and assessed the proposed Quarry Access Road corridor. This report is included as Part 5B of the *Specialist Consultant Studies Compendium.* A separate stream of investigation involved the use of the BioBanking Assessment Methodology (DECC 2009) to gather relevant information for a biodiversity offsetting assessment that has been undertaken by Niche Environment and Heritage; see Part 11 of the *Specialist Consultant Studies Compendium*.

The study located two species of threatened plant, four species of threatened bird, four threatened bats and one threatened plant community in the study area. These are listed under the *Threatened Species Conservation Act 1995* (NSW) (now *Biodiversity Conservation Act 2016*) or the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). The threatened community is swamp vegetation known as Temperate Highland Swamps on Sandstone. The vulnerable mallee *Eucalyptus aquatica* occurs in the swamp community outside the extraction area, while three scattered plants of the vulnerable shrub *Phyllota humifusa* occur within the extraction area. A larger population of *Phyllota humifusa* occurs outside the proposed extraction area to the west. One listed rare plant species (Rare or Threatened Australian Plants ROTAP), *Eucalyptus apiculata*, was also located in association with rock outcrops within the Quarry Operations Area and to the north and west of the area of disturbance.

The forest, including the regrowth forest, is utilised by the following threatened bird species, Glossy Black-Cockatoo, Gang-gang Cockatoo, Varied Sittella and Scarlet Robin. The latter three species are itinerant in the forest within the Site, while the local Glossy Black-Cockatoo population regularly feed on the stands of *Allocasuarina littoralis* within that area. A record of the Powerful Owl was also made; this species is well known to inhabit the Sutton Forest area and is likely to inhabit a wider area than the study area. Four threatened bats were recorded; namely, Eastern False Pipistrelle, Eastern Bentwing Bat, Greater Broadnosed Bat and Large-eared Pied Bat. There are no endangered populations or any critical habitat in the area.

In summary, the impact assessment found that the Proposal:

- would not directly impact upon the listed swamp community;
- would not directly affect the endangered plant species *Eucalyptus aquatica*;
- would remove three plants of the endangered *Phyllota humifusa* but avoids the main populations.
- would remove habitat known to be utilised by nine threatened animals, as listed above;
- would directly affect some stands of the rare plant *Eucalyptus apiculata*.

The proposal would remove approximately 63.2 hectares of forest and woodland, much of which (28.5 hectares, 46% percent) is regrowth forest resulting from clearing in the 1960s. Because of the presence of several threatened species on the Site and loss of their habitat, residual impacts to native vegetation need to be offset in accordance with the Biodiversity Offset Scheme of the Biodiversity Conservation Act 2016.

Other recommendations contained in the report aim to improve biodiversity outcomes associated with the Proposal.

An assessment was also undertaken under the guidelines relevant to the *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth). The assessment identified a listed threatened community, namely 'Temperate Highland Peat Swamps on Sandstone', downstream of the Site. This swamp community occurs along the valley of Long Swamp Creek, which forms the northern boundary of the study area. The proposed quarry is within the catchment of this swamp.

The Proposal is not likely to have a significant impact on Commonwealth listed migratory species. There is no "important habitat" in the area for such species and the habitats near the site are not likely to support an "ecologically important proportion of a population" of such species. It is therefore considered that referral to the Commonwealth is not warranted.

Internal drainage controls are recommended to ensure that contaminated or turbid water does not enter the swamp, located about 100 metres downslope of the Site at its closest point. An assessment by Larry Cook Consulting (2018) of potential impacts to the groundwater system concluded that base flow to Long Swamp Creek would not be significantly affected by the excavation of the quarry and be within natural variation in flows.

* * * * *

1. INTRODUCTION

1.1 Background

This flora and fauna survey and assessment was undertaken under instructions from R W Corkery & Co Pty Limited, on behalf of Sutton Forest Quarries Pty Limited. The company is proposing to establish a sand quarry on land on the northern side of the Hume Highway, opposite Penrose State Forest on the Central Tablelands of New South Wales, in the far south-western part of the Shire of Wingecarribee. Kevin Mills & Associates Pty Limited and Lesryk Environmental Consultants undertook the surveys during spring 2012.

The “study area” is primarily the property known as "The Farm" (Lot DP 253435) and includes land directly to the east of this property; see **Figure 1**. The study area is located immediately north of the Hume Highway, between Long Swamp Creek to the north and Penrose State Forest to the south. The highway forms the southern boundary and Long Swamp Creek forms the northern boundary of the property. The “Site” is that area covered by the proposed quarry and the associated facilities and is located within the above property and along an access route to the east.

The aquatic flora and fauna within Long Swamp Creek adjoining the Study Area is the subject of a separate assessment prepared by Cardno (2018).

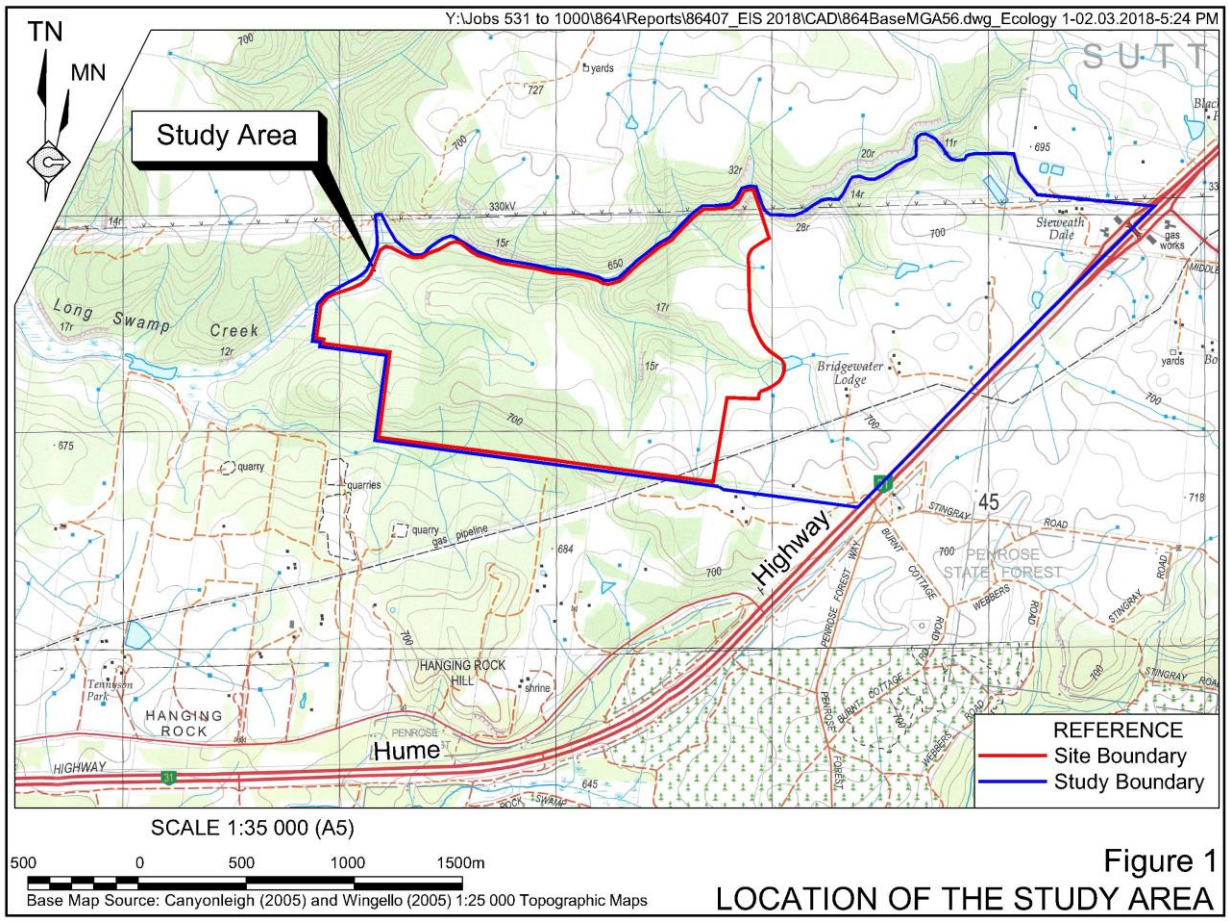


Figure 1
LOCATION OF THE STUDY AREA

1.2 Purpose of the Study

The purpose of the flora and fauna study was to carry out a comprehensive field survey of the study area to identify the species, communities and habitats of the plants and animals present in the area. Particular attention was given to the location and assessment of threatened and rare plants and animals, as listed in relevant legislation, viz. *Threatened Species Conservation Act 1995* (NSW) (now Biodiversity Conservation Act 2016), *Fisheries Management Act 1994* (NSW) and *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Where appropriate, the survey methods employed are consistent with those methods set out in the document titled *Threatened Species Survey & Assessment: Guidelines for Developments and Activities* (DEC 2004).

It is noted that the commencement of the Biodiversity Conservation Act 2016 on 25 August 2017, triggered the repeal of the Threatened Species Conservation Act 1995. All threatened species listings for NSW are now listed in the schedules of the Biodiversity Conservation Act 2016. However, as the Threatened Species Conservation Act 1995 is specifically referenced in the Director-General's requirements for the proposal, reference to the Threatened Species Conservation Act 1995 is retained throughout this document.

1.3 The Quarry Proposal

The quarry proposal is fully described in the EIS; the following are the key components of the proposal; these are shown on **Figure 11 and 12** later in the report.

- An extraction area covering approximately 47 hectares with its footprint typically between 660 metres AHD and 700 metres AHD; see **Figure 11**.
- A processing and stockpiling area covering approximately 12 hectares incorporating a fixed wash plant involving washing, screening, dewatering and product stockpiling beneath radial and fixed stackers.
- Two mobile brickies sand plant would also be located within this area incorporating a vibrating screen to remove oversize from brickies sand products.
- A temporary topsoil and mulch stockpile area within the footprint of the extraction area for the storage of topsoil recovered from the early extraction stages and mulched timber from the areas cleared.
- Two fines storage areas to contain fines produced from the sand washing process during the first 3 stages of extraction.
- Two water storage dams located to the east and west of the stockpiling area to provide water for dust suppression as well as supplementary supply for the wash plant.
- A diversion drain along the southern boundary of the proposed Quarry Operations Area to divert runoff away from operational areas.
- The site weighbridge and office would be positioned adjacent to the processing and stockpiling area. One weighbridge would be constructed initially with provision for a second weighbridge, should it be required in the future.
- Access to and from the Quarry Operations Area would be from the Hume Highway via the Quarry Interchange and Quarry Access Road. Product despatch would involve the use of mainly Quad-dog trucks as well as other configurations.

At maximum production, it is proposed that product despatched from the Quarry would reach approximately 860 000 tpa. However, initial stages of extraction would be lower and increase over time to satisfy market demand.

2. THE STUDY AREA

2.1 Location of the Study Area

The primary "study area" is located adjacent to the northern side of the Hume Highway; the locality name is Sutton Forest. The study area extends into the adjoining land for the purposes of assessment, including an access road route to the east and into the roundabout near the Sallys Corner Interchange. The core study area is the quarry footprint and the immediately adjoining land.

The property is surrounded by private land; in the east, this is cleared and is used for grazing while in the north and southwest the adjoining land is forested. Tributaries of Long Swamp Creek drain the land; this watercourse forms the northern boundary of the property.

In the broader context, the study area is located in the following relevant regions:

Bio-Region:	Sydney Basin
Geological Province:	Sydney Basin
Botanical Subdivision:	Central Tablelands
Planning Region:	Illawarra
LGA:	Shire of Wingecarribee

2.2 Climate

The study area is located near the boundary of the central and southern tablelands and has a cool temperate climate. The average temperatures at the township of Moss Vale, about 17 kilometres to the northeast and the closest weather station with a long record, ranges from 11.1^{O}C to 25.8^{O}C in summer, and from 1^{O}C to 12^{O}C in winter; these figures are based on 64 years of record. The average annual rainfall at Moss Vale is 963 mm, based on the last 137 years of record (Source: Australian Bureau of Meteorology website).

2.3 Topography, Geology and Soils

The study area mostly has a gentle topography, with some steep gullies leading into the valley of Long Swamp Creek, to which the land drains and in turn flows westwards into Paddys River. Altitude ranges from 600 metres to 710 metres above sea level.

The geology of the higher parts of the study area is the Hawkesbury Sandstone, with the northern gullies of the property underlain by the Illawarra Coal Measures and Berry Siltstone. Low sandstone cliffs occur in most of the gullies and ridge sides. Deep sand deposits formed from the above sandstone are a feature of much of the area. Alluvial material underlies Long Swamp Creek swamp, much of it forming a deep, peaty soil. The area is covered by the Moss Vale 1:100,000 geological map sheet produced by the Geological Survey of NSW.

2.4 Current and Past Land Use

Much of the property has been used for grazing for many years and the forest has previously been logged. Much of the forest within the Site was cleared in the 1960s; the regrowth forest is characterised by the presence of a high density of smallish trees, open areas, the presence of pine trees and wind-rowed logs from the original forest.

3. SURVEY METHODS

3.1 Flora Survey Method

The flora survey involved several key components, aimed at describing and mapping the plant communities present and preparing a comprehensive plant species list for the whole of the study area. Particular attention was given to the identification, location and assessment of threatened and rare plants and communities. The survey methods adopted are consistent with the guidelines in the document mentioned in Section 1.2 (DEC 2004) and the Bio-Banking methods (DECC 2009). The flora survey targeted all vascular plant species, including indigenous (native) and exotic (introduced or weed) species of plant. The flora survey methods employed, and the effort expended, are summarised in **Table 1.**

Dates of Survey
The flora survey was undertaken in the study area over several days including 3, 4, 11, 18 and 26 September 2012,17 October 2012, 10 September 2013 and 3 May 2016. In total, the flora survey occurred over eight different days in the study area; each of these days involved a full day on site. Maps used in the study included the 1:25,000 Wingello and Canyonleigh topographic map sheets produced by the Central Mapping Authority of New South Wales, a colour aerial photograph of the study area and surrounding area and site plans provided by R W Corkery & Co. Pty Limited. These resources allowed a detailed targeted survey to be undertaken to cover all variations in geology, topography and aspect across the study area. Additional surveys in 2013 and 2016 support initial field survey results and indicate that the habitat and vegetation communities within the Site have remained unchanged since the 2012 surveys. This confirms that the results presented in this assessment remain reliable.

Purpose
The purpose of the flora survey was to classify and describe the vegetation, to map the distribution of the plant communities, to record as many as possible of the plant species present and to search for threatened and rare plant species.

A separate stream of investigation involved the use of BioBanking Assessment Methodology (DECC 2009) to gather relevant information for a biodiversity offsetting assessment to be carried out by others. The methods employed to gather bio-banking data are indicated in **Table 2**.

Survey Techniques
The vegetation survey combined multiple traverses of the study area with disciplined vegetation sampling on specific sites (plots). The traverses, which were undertaken on foot, were targeted to cover the full topographic variation of the site, the full range of plant communities and potential habitat for threatened plant species. The traverses were also random because of their exploratory purpose.

Survey plots were employed to gather floristic information at selected sites, sampling the range of vegetation types present in the study area. These are full floristic surveys on 20 metre by 20 metre plots, following the methods required under the BioBanking Assessment Methodology, including the required density of plots indicated in the manual. Field identification was made of the plant community type and a photograph was taken looking across each plot. Plots were not permanently marked in the field. The following information was recorded on each of the plots.

Plot Data:

- plot identification number
- date of survey
- plot location (name of location and GPS reading for centre of plot)
- topography, geology and soil type
- slope (gentle, moderate, steep, very steep), aspect, altitude
- site notes (e.g. special observations on habitat, disturbance, etc.)
- obvious human disturbance (e.g. clearing, logging, weeds).

Table 1
Summary of flora survey methods and effort

Survey Methods	Applicability to Proposal	Summary of Survey Effort	Complying[1]	Limitations
1. General				
1.1 Location of background information. Database search, state and commonwealth web sites, previous studies (published and unpublished), legislation.	Standard methods relevant to all projects.	All relevant databases searched; (e.g. NSW Wildlife Atlas, reports from the region, published papers).	Complying in full.	Nil
1.2 Locate records of significant species etc. and identify likely occurrence in locality.	Standard methods relevant to all projects.	Databases searched for relevant significant species; (e.g. NSW Wildlife Atlas). All potential significant species identified.	Complying in full.	Nil
1.3 Inspection and analysis of all relevant topographic, geological and photographic maps and images.	Standard methods relevant to all projects.	All relevant material located and analysed; e.g. identifying likely habitat for significant plants and communities.	Complying in full.	Nil
1.4 Develop initial survey program based on above. Aim for maximum information gain, habitat coverage and targeting sites likely to contain significant features.	Standard methods relevant to all projects.	Initial survey program identified; modified as surveys proceeded.	Complying in full.	Nil

Table 1 (Cont'd)
Summary of flora survey methods and effort

Survey Methods	Applicability to Proposal	Summary of Survey Effort	Complying[1]	Limitations
2. Plant Species				
2.1 Compilation of a comprehensive plant species list for the site.	Standard methods relevant to all projects.	Continual recording of plant species during all field surveys; targeted searches in habitat likely to contain unrecorded species.	Complying in terms of site coverage and time spent on surveys.	Nil
2.2 Surveys targeting significant plant species.	Standard method relevant to all projects.	Targeted searches in habitat likely to contain relevant significant species. Target sites based on aerial photograph and ground observations.	Complying in full. See Table 3.	Nil
3. Plant Communities				
3.1 Identification of all plant communities present on the Proposal area.	Standard methods relevant to all projects.	Communities identified based on extensive traverses of the site combined with survey plots.	Complying in full.	Nil
3.2 Preparation of plant community map.	Standard methods relevant to all projects.	Map based on extensive traverses of the site combined with aerial photographic interpretation.	Complying in full.	Nil
3.3 Identification of significant vegetation communities present.	Standard method relevant to all projects.	Targeted searches in sites likely to contain significant plant communities.	Complying in full.	Nil

1. Complying with DEC (2004); if not mentioned in the guidelines then 'complying in full' is stated.

Table 2
Survey effort employing bio-banking Methods

Survey Methods	Requirements	Summary of Survey Effort	Complying[1]
Floristic plot-based surveys of 20 m by 20 m	1 plot for 1-4 ha 4 plots for 4-20 ha	2 plots in vegetation type 2 2 plots in vegetation type 3 4 plots in vegetation type 4 4 plots in vegetation type 5	Complying in full.
Vegetation type 50 m transect	1 plot for 1-4 ha 4 plots for 4-20 ha	2 plots in vegetation type 2 1 plots in vegetation type 3 4 plots in vegetation type 4 4 plots in vegetation type 5	Complying in full.
Physical characteristics 50 m by 20 m plots	1 plot for 1-4 ha 4 plots for 4-20 ha	2 plots in vegetation type 2 1 plots in vegetation type 3 4 plots in vegetation type 4 4 plots in vegetation type 5	Complying in full.

1. Complying with DECC (2009) Bio-Banking Guidelines.

Floristic Data:

- dominant three species in each vegetation layer, including height and percentage cover
- full listing of all plants within the plot
- cover abundance score for each species, estimated as follows:
    - 1 – uncommon, <5% cover.
    - 2 – common, <5% cover.
    - 3 – 5% to 25% cover.
    - 4 – 26% to 50% cover.
    - 5 – 51% to 75% cover.
    - 6 – 76% to 100% cover.

Transect surveys, as described in the BioBanking Manual, were employed at the density indicated in the manual. These transects are aimed at recording information on the floristic and physical features of each of the vegetation units (communities) identified on the site. Transects are 50 metres in length, marked out using a 50 metre tape; an adjoining plot of 50 metres by 20 metres was also marked out by tape. Along the 50 metre transect, the type of plant at one metre intervals is recorded; i.e. shrub, grass, other native, exotic or bare ground (litter but no living plant). At each five metres, the percentage cover of the over-storey and the mid-storey are recorded. The above recordings allow average figures to be calculated for each transect and for each vegetation type.

Within the 50 metre by 20 metre plot, all tree hollows are counted and the lengths of all logs lying on the ground over 10 cm diameter are measured.

Identification and description of the plant communities in the study area were prepared based on the field investigations undertaken across the whole of the study area and the detailed plot surveys. Copies of the completed plot survey sheets, eight in all, are provided in **Appendix 1**.

The area of the potential quarry was targeted more than outlying parts of the study area, so that survey plots were concentrated on and near the quarry footprint.

Vegetation Mapping

The native vegetation occurring in an area is determined largely by biophysical attributes such as landform, elevation, aspect, geology, drainage and soil type. These variables strongly influence the structure and floristic composition of the vegetation. With the aid of topographic and geological maps and good aerial photographs, coupled with reasonable coverage of the site on the ground, an accurate map of the plant communities was prepared.

Using this approach, a vegetation map for the study area was prepared by marking the boundaries of the various communities directly onto a copy of the aerial photograph during the field study and then transferring this information to a topographic map to produce the final plant community map. The boundaries on the vegetation map are reasonably accurate, but it should be kept in mind that there is usually an ecotone or transition zone between plant communities, where the vegetation changes gradually from one community to another and species are well mixed over the ecotone, which in some cases may be quite wide.

In addition to the extant vegetation cover, a review of past aerial photographs was undertaken to investigate the changes in vegetation cover over time. Historic aerial photographs from the following dates were inspected: 1949, 1969 and 1979.

Vegetation Classification
Based on the structural classification system of Walker and Hopkins (1990), the plant communities occurring in the study area were classified on the basis of their structure and the name(s) of the dominant species in the tallest stratum. The various vegetation classes within the system; these include closed forest (rainforest), open forest, woodland, shrubland, grassland and sedgeland, depending on the growth form of the plants in the tallest stratum and the crown separation between these plants (whether touching, overlapping, separated, isolated, etc.).

Where appropriate, nomenclature from other studies is used in the identification of the plant communities. For example, names applied to endangered ecological communities under the *Threatened Species Conservation Act 1995*(NSW) (now Biodiversity Conservation Act 2016) are used where relevant.

Threatened Species
A particular aim of the field study was the location and assessment of threatened plant species. Those threatened species recorded within ten kilometres of the Site, identified in the NSW Wildlife Atlas (BioNet on line, hosted by OEH), are listed in **Table 3**. The table also identifies the methods used to survey for individual species. Survey methods are based upon the likely habitat of the species as well as its growth habit. All relevant species are visible all year round so that seasonal factors are not important for finding these plant species.

Plant Species Nomenclature
The plant species names in this report are the current names published by the National Herbarium of New South Wales in the *Flora of New South Wales* (Harden 1992-2002). Most of the common names are from the *Flora of New South Wales* (op. cit.), *Australian Plant Genera* by Baines (1981) and *Weeds of the South-east* by Richardson, Richardson and Shepherd (2006).

3.2 Fauna Survey Method

The fauna survey paralleled and was influenced by the flora survey, the latter contributing significantly to the identification and assessment of the habitats present and of locations for targeted fauna surveys. In a similar way to the flora survey, the fauna survey aimed at describing and mapping the habitats in the study area and preparing a comprehensive animal species list. Particular attention was given to the identification, location and assessment of threatened or rare animal species and their habitat. The survey methods adopted were heavily influenced by the survey guidelines outlined in the document mentioned in Section 1.2**.**

The fauna survey targeted all vertebrate animal species, including indigenous (native) and exotic (introduced) species of fauna. The survey methods and survey effort are summarised in **Tables 5 and 6** and are expanded upon below, where relevant. **Figure 2** displays the fauna survey effort graphically. A particular aim of the field study was the location and assessment of threatened animal species. Those threatened species listed in New South Wales recorded within a ten kilometres radius centred on the study area and identified in the NSW Wildlife Atlas, are listed in **Appendix 12**; with the relevant species annotated in **Table 3**. A list of matters of national environmental significance within five (5) kilometres of the study area, obtained through the Protected Matter Search Tool of the Commonwealth Department of the Environment, are listed in **Appendix 13**. Many of the species in these lists would not occur on the study area because of a lack of suitable habitat. The most likely species are discussed in **Table 4** (plants) and **Table 6** (animals) and appropriate surveys techniques used in an attempt to find them; see **Tables 4 to 6**.

Table 3
Listed species within a ten (10) kilometre square centred on the study area

Source: NSW Wildlife Atlas (TSC Act) and Protected Matters Search Tool (EPBC Act). The species in **bold** were recorded during the surveys.

Species	**Common Name**	**TSC Act**	**EPBC Act**	**Notes**
Frogs				
Litoria littlejohni	Littlejohn's Tree Frog	V	V	No habitat present in study area.
Mixophyes balbus	Stuttering Frog	E	V	No habitat present in study area.
Birds				
Callocephalon fimbriatum	**Gang-gang Cockatoo**	V	-	Habitat present; recorded.
Calyptorhynchus lathami	**Glossy Black-Cockatoo**	V	-	Habitat present; recorded.
Daphoenositta chrysoptera	**Varied Sittella**	V	-	Habitat present; recorded.
Hieraaetus morphnoides	Little Eagle	V	-	Foraging habitat present.
Ninox connivens	Barking Owl	V	-	Some habitat present.
Ninox strenua	**Powerful Owl**	V	-	Habitat present; recorded.
Oxyura australis	Blue-billed Duck	V	-	No suitable habitat present.
Petroica boodang	**Scarlet Robin**	V	-	Habitat present; recorded.
Petroica phoenicea	Flame Robin	V	-	Habitat present.
Stagonopleura guttata	Diamond Firetail	V	-	Minor habitat present.
Tyto tenebricosa	Sooty Owl	V	-	Some habitat present.
Mammals				
Cercartetus nanus	Eastern Pygmy-possum	V	-	Some habitat present.
Chalinolobus dwyeri	**Large-eared Pied Bat**	V	V	Habitat present; recorded.
Dasyurus maculatus	Spotted-tailed Quoll	V	-	Habitat present.
Falsistrellus tasmaniensis	**Eastern Falsistrelle**	V	-	Habitat present; recorded.
Miniopterus schreibersii oceanensis	**Eastern Bentwing-bat**	V	-	Habitat present; recorded.
Myotis macropus	Southern Myotis	V	-	No habitat present on quarry area.
Petalura gigantea	Giant Dragonfly	V	-	No habitat in quarry area or nearby.
Petaurus australis	Yellow-bellied Glider	V	-	Habitat present, not recorded despite surveys.
Petaurus norfolcensis	Squirrel Glider	V	-	Habitat present, not recorded despite surveys.

Table 3 (Cont'd)
Listed species within a ten (10) kilometre square centred on the study area

Source: NSW Wildlife Atlas (TSC Act) and Protected Matters Search Tool (EPBC Act). The species in **bold** were recorded during the surveys.

Species	**Common Name**	**TSC Act**	**EPBC Act**	**Notes**
Frogs				
Phascolarctos cinereus	Koala	V	-	Food trees present, not recorded despite targeted surveys.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Foraging forest present; not a significant area for this species.
Scoteanax rueppellii	**Greater Broadnosed Bat**	V	-	Habitat present; recorded.
Plants				
Acacia bynoeana	Bynoe's Wattle	E	-	Not recorded during surveys.
Baloskion longipes	Dense Cord-rush	V	--	Not recorded during surveys, no suitable habitat on quarry site.
Carex klaphakei	Klaphake's Sedge	E	-	Not recorded during surveys, no suitable habitat on quarry site.
Commersonia prostrata	Dwarf Kerrawang	E	-	Not recorded during surveys.
Eucalyptus aggregata	Black Gum	V, EP	-	Not recorded during surveys.
Eucalyptus aquatica	**Broad-leaved Sally**	V	V	Habitat in swamp to north, recorded, not near proposed quarry.
Eucalyptus macarthurii	Camden Woollybutt	V	-	Not recorded during surveys.
Gentiana wingecarribiensis	Wingecarribee Gentian	CE	-	Not recorded during surveys.
Grevillea molyneuxii	Wingello Grevillea	V	E	Not recorded during surveys.
Phyllota humifusa	**Dwarf Phyllota**	V	V	Recorded on the site, 3 plants in proposed extraction area.
Pomaderris cotoneaster	Cotoneaster Pomaderris	E	E	Not recorded during surveys.
Swainsona sericea	Silky Swainson-pea	V	-	Not recorded during surveys; habitat probably not suitable.
Zieria murphyi	Velvet Zieria	V	V	Not recorded during surveys.

CE – critically endangered; E – endangered; V – vulnerable; EP – endangered population in Wingecarribee LGA.

Table 4
Summary of survey methods for threatened plant species

Species[1]	TSC Act[2]	Method of Survey	Effort in this Study
Dense Cord-rush *Baloskion longipes*	V	Searches in swamps and watercourses and on the edges of swampy ground.	Edges of the swamp was searched. This species was not found. No wet areas are in or close to quarry footprint.
Klaphake's Sedge *Carex klaphakei*	E	Searches in swamps and watercourses and on the edges of swampy ground.	The upper swamp was searched. This species was not found. No wet areas are in or close to quarry footprint.
Broad-leaved Sally *Eucalyptus aquatica*	V	Searches in swamps and on the edges of swampy ground, an obvious mallee.	The upper swamp was searched. This species was found (a large population) and is documented in this report.
Paddys River Box *Eucalyptus macarthurii*	V	Searches of valley flats; a large, an obvious tree.	The upper swamp was searched. This species was not found. No habitat in or close to quarry footprint.
Dwarf Kerrawang *Rulingia prostrata*	E	Searches in gullies and elsewhere.	All areas of habitat searched. This species was not found.
Dwarf Phylotta *Phyllota humifusa*	V	Searches of woodland areas, particularly on deep sand; an obvious prostrate shrub.	All suitable habitat searched. Three plants occur on the extraction area and a large population occurs to the west; this species is documented in this report.
Cotoneaster Pomaderris *Pomaderris cotoneaster*	E	Searches of forest areas; an obvious shrub.	All areas of habitat searched. This species was not found.
Wingecarribee Gentian *Gentiana wingecarribiensis*	E	Searches in and on the edges of swamp.	The upper swamp was searched. Species not found. No wet areas are in or close to quarry footprint.
Elusive Bush-pea *Pultenaeaelusa*	E	Searches in and on the edges of swampy ground, an obvious shrub.	Edges of swamp searched. Species not found. No wet areas are in or close to quarry footprint.

1. Species in bold were recorded in the study area.
2. Listed under the *Biodiversity Conservation Act 2016* (NSW); E – endangered; V – vulnerable.

Table 5
Summary of fauna survey methods and effort

Survey Methods	Applicability to Proposal	Summary of Survey Effort	Complying	Limitations
1. General				
1.1 Location of background information. Database search, state and commonwealth web sites, previous studies (published and unpublished), legislation.	Standard methods relevant to all projects.	All relevant databases searched; (e.g. NSW Wildlife Atlas, reports of fauna of the region, published papers).	Complying in full.	Nil
1.2 Locate records of significant species etc. and identify likely occurrence in locality.	Standard methods relevant to all projects.	Databases searched for relevant significant species; (e.g. NSW Wildlife Atlas).	Complying in full.	Nil
1.3 Inspection and analysis of all relevant topographic, geological and photographic maps and images.	Standard methods relevant to all projects.	All relevant material located and analysed; e.g. identifying likely habitat for significant species and habitats.	Complying in full.	Nil
1.4 Develop initial survey program based on above. Aim for maximum information gain, habitat coverage and targeting sites likely to contain significant habitats.	Standard methods relevant to all projects.	Initial survey program identified; modified as surveys proceeded.	Complying in full.	Nil
2. Mammals				
2.1 Small mammal (box) traps, 100 trap nights over three consecutive nights.	Trapping justified by quality and large extent of the forest in the area.	Total of 340 trap nights undertaken.	Complying in full.	Nil
2.2 Medium-sized carnivores (cage trap), 25 trap nights over three nights.	Justified by quality and large extent of the forest in the area.	Total of 24 trap nights undertaken. Plus 22 camera days with infrared cameras.	Complying in full.	Nil

Table 5 (Cont'd)
Summary of fauna survey methods and effort

Survey Methods	Applicability to Proposal	Summary of Survey Effort	Complying	Limitations
2. Mammals (Cont'd)				
2.3 Spotlighting arboreal mammals, one hour per 100 hectares on two separate nights.	Justified by quality and large extent of the forest in the area.	Total of 8 hours of spotlighting over four nights.	Complying in full.	Nil
2.4 Call playback, one site on two occasions in identified habitat.	Yellow-bellied Glider only relevant species, Grey Gum habitat most likely.	Playback on 11 occasions totally 10 hrs throughout the study area.	Complying in full.	Nil
2.5 Diurnal searches for larger species and signs of presence, 30 minute searches in each identified habitat.	Relevant to all parts of the study area.	Almost all of study area was searched at least once over a two month survey period.	Complying in terms of site coverage and time spent on surveys.	Nil
2.6 Bats – 'call' recordings, minimum two sites per 100 hectares, minimum of 4 hours recording starting at dusk.	Justified by quality and large extent of the forest in the area.	Recordings on site over 196 hrs of recording time, over five nights.	Complying in full.	Nil
2.7 Bats – harp trap, minimum of four trap-nights over two consecutive nights.	Justified by quality and large extent of the forest in the area.	Total of four trap-nights.	Complying in full.	Nil
3. Birds				
3.1 Diurnal searches in all habitats, 30 mins. Searches along transects, at least two per habitat. Cumulative species curve used to identify survey completeness.	Relevant to all parts of the study area.	Total of 31 hours of observation along 21 transects on 11 separate days. Species accumulation curve created.	Complying in full.	Nil

Table 5 (Cont'd)
Summary of fauna survey methods and effort

Survey Methods	Applicability to Proposal	Summary of Survey Effort	Complying	Limitations
3. Birds (Cont'd)				
3.2 Nocturnal spotlighting surveys, in conjunction with mammal survey.	Justified by quality and large extent of the forest in the area.	Total of 8 hours of spotlighting over four nights. SongMeter deployed for 11 nights.	Complying in terms of site coverage and time spent on surveys.	Nil
3.3 Call playback, one site per km² for at least five nights.	Target Powerful Owl, Masked Owl and Baking Owl	Playback on 11 occasions totally 10 hrs throughout the study area.	Complying in full.	Nil
3.4 Searches for presence of birds, e.g. nests, roost trees, feeding evidence.	Standard methods relevant to all projects.	Continual observations over 11 days of field work.	Complying in full.	Nil
4. Reptiles				
4.1 Diurnal habitat searches, 30 min. search on two separate days in identified habitat.	Most applicable to rock outcrops and wet areas.	Searches at seven sites over four days, as well as vigilance during all other survey work (11 days).	Complying in terms of site coverage and time spent on surveys.	Nil
4.2 Nocturnal spotlighting searches, 30 min. Search on two separate nights in identified habitat.	Most applicable to rock outcrops and wet areas.	Searches made as part of spotlighting surveys.	Complying in terms of site coverage and time spent on surveys.	Nil
5. Frogs				
5.1 Diurnal habitat searches, centred on wet sites; one hour per site on two occasions.	Applicable to creek, swamp and river sites in the Site.	Searches made on several occasions; no wet areas on development site.	Complying in terms of site coverage and time spent on surveys.	Nil
5.2 Nocturnal habitat searches and call recognition; one hour per site on two occasions.	Applicable to creek, swamp and river sites in the Site.	Searches made as part of spotlighting surveys.	Complying in terms of site coverage and time spent on surveys.	Nil

Table 6
Summary of survey methods for threatened animal species

Species[1]	TSC Act[2]	Method of Survey	Achieved in this Study
Mammals			
Eastern Bentwing-Bat *Miniopterus schreibersii*	V	Anabat recording techniques. Harp trapping. Cave searches for dung.	Recorded. Total of 196 hrs of recording on the site. Recorded at seven sites. Search of cliff lines for caves.
Eastern Falsistrelle *Falsistrellus tasmaniensis*)	V	Anabat recording techniques.	Recorded. Total of 196 hrs of recording on the site. Recorded at seven sites.
Greater Broadnosed Bat *Scoteanax rueppellii*	V	Anabat recording techniques. Harp trapping.	Recorded. Total of 196 hrs of recording on the site. Recorded at one site.
Koala *Phascolarctos cinereus*	V	Daytime searches in potential food trees. Spotlighting. Call playback.	Potential food trees in the area, Grey Gum, searched for scratch marks/ animals. Total of 8 hours of spotlighting on the Site.
Large-eared Pied Bat *Chalinolobus dwyeri*	V	Anabat recording techniques. Harp trapping.	Recorded. Total of 196 hrs of recording on the site. Total of two sites on four nights. Recorded at one site.
Large-footed Myotis *Myotis adversus*	V	Anabat recording techniques. Harp trapping.	Total of five nights at 11 different sites throughout the Site. Total of three sites on five nights
Squirrel Glider *Petaurus norfolcensis*	V	Spotlighting, tree trapping. Call playback.	Total of 8 hours of spotlighting in the Site. Tree-mounted Elliot traps were deployed and call playback used.
Yellow-bellied Glider *Petaurus australis*	V	Spotlighting, tree trapping, inspection of Grey Gum for evidence of sap feeding activity. Call playback.	Total of 8 hours of spotlighting in the Site. Tree-mounted Elliot traps used, Grey Gums checked for feeding scars and call playback used.
Birds			
Barking Owl *Ninox connivens*	V	Call playback. Call recognition during night; spotlighting.	Call playback carried out on 11 sites over four nights (c.10 hrs). Vigilance at night for birds and calls failed to locate the species.
Blue-billed Duck *Oxyura australis*	V	Observation on potential wetlands.	No habitat in the study area.
Diamond Firetail *Stagonopleura guttata*	V	Vigilance when undertaking bird surveys.	Total of 31 hours of targeted bird surveys, plus observations throughout the survey periods.

Table 6 (Cont'd)
Summary of survey methods for threatened animal species

Species[1]	TSC Act[2]	Method of Survey	Achieved in this Study
Gang-gang Cockatoo *Callocephalon fimbriatum*	V	Vigilance when undertaking bird surveys.	Recorded. Birds recorded on a few occasions.
Glossy Black-Cockatoo *Calyptorhynchuslathami`*	V	Vigilance when undertaking bird surveys. Searches for chewed cones below food trees.	Total of 56.35 hours of targeted bird surveys. Stands of *Allocasuarina littoralis* searched for signs of feeding.
Powerful Owl *Ninox strenua*	V	Call playback. Call recognition during night. Spotlighting. Checking potential nest trees (hollows and ground below).	Call playback carried out on 11 sites over four nights (c.10 hrs). Calls recorded by SongMeter. A Ringtail carcass could have been left by the owl. Total of 8 hours of spotlighting in the Site. Continuous throughout all surveys.
<u>Invertebrates</u> Giant Dragonfly *Petalura gigantea*	E	Identification of potential habitat.	The potential swamp habitat does not occur on the study area.
Flame Robin *Petroica phoenicea*	V	Vigilance when undertaking bird surveys.	Total of 56.35 hours of targeted bird surveys, plus observations throughout survey periods.
Little Lorikeet *Glossopsitta pusilla*	V	Vigilance when undertaking bird surveys.	Total of 56.35 hours of targeted bird surveys, plus observations throughout survey periods.
Little Eagle *Hieraaetus morphnoides*	V	Vigilance when undertaking bird surveys.	Total of 56.35 hours of targeted bird surveys, plus observations throughout survey periods.
Scarlet Robin *Petroica boodang*	V	Vigilance when undertaking bird surveys.	Recorded. Total of 56.35 hours of targeted bird surveys, plus observations throughout survey periods.
Varied Sittella *Daphoenositta chrysoptera*	V	Vigilance when undertaking bird surveys.	Recorded. Total of 56.35 hours of targeted bird surveys, plus observations throughout survey periods.
White-browed Woodswallow *Artamus superciliosus*	V	Vigilance when undertaking bird surveys.	Total of 56.35 hours of targeted bird surveys, plus observations throughout survey periods.

1. Species in **bold** were recorded during the surveys.
2. Listed under the *Threatened Species Conservation Act 1995* (NSW); E - endangered; V - vulnerable.

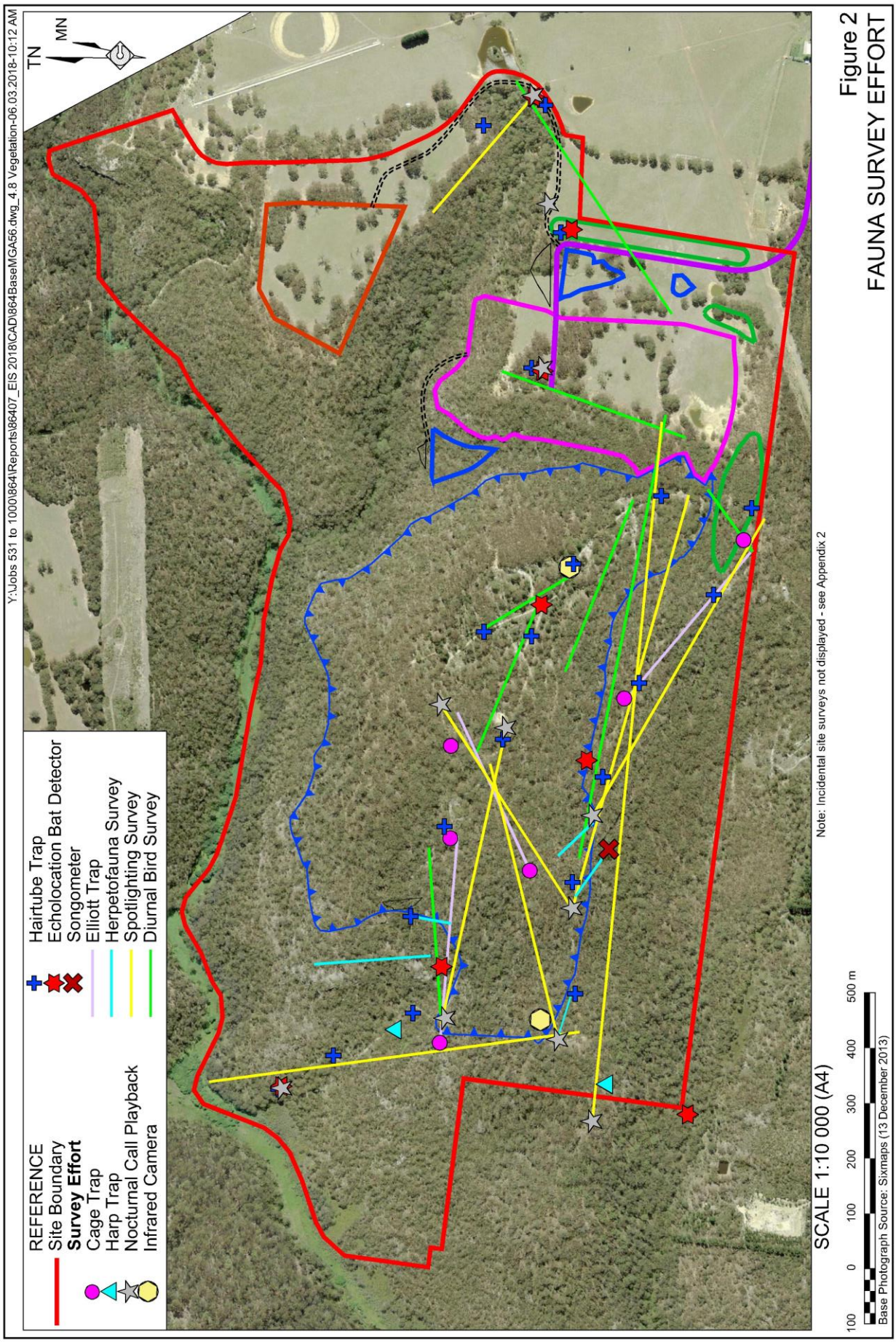


Figure 2
FAUNA SURVEY EFFORT
TN
MN
Y:\Jobs 531 to 1000\864\Reports\86407_EIS 2018\CAD\864BaseMGA56.dwg_4.8 Vegetation-06.03.2018-10:12 AM
REFERENCE
Site Boundary
Survey Effort
Cage Trap
Harp Trap
Nocturnal Call Playback
Infrared Camera
Hairtube Trap
Echolocation Bat Detector
Songometer
Elliott Trap
Herpetofauna Survey
Spotlighting Survey
Diurnal Bird Survey
Note: Incidental site surveys not displayed - see Appendix 2
SCALE 1:10 000 (A4)
100 0 100 200 300 400 500 m
Base Photograph Source: Sixmaps (13 December 2013)

Hollow-bearing trees are important for many native animals, including some listed threatened species. A survey of hollow-bearing trees was undertaken in and around the proposed quarry footprint. All likely trees were inspected and those trees with hollows were numbered, identified, the trunk diameter at chest height (dch) measured and the hollows recorded. Each tree was labelled with a unique number at the time of the survey and its GPS location recorded.

Field survey methods

Intensive animal surveys were carried out in the study area by Deryk Engel (B.Env.Sc.Hons) and Stephen Bloomfield (B.App.Sc.) of Lesryk Environmental Consultants between the 2 and 6 October 2012 with the consultants returning to the study area to collect and examine the hairtube traps, infrared cameras and echolocation devices on 12 October 2012 and 14 October 2012 that had been collecting data over the intervening period. Kevin Mills & Associates also carried out incidental fauna surveys during the flora survey work on the site on 3, 4, 11, 18 and 26 September 2012, 17 October 2012, 10 September 2013 and 3 May 2016. The information gathered during these surveys has been incorporated into the results obtained by Lesryk, with the combined results presented in this section. There is no reason to suggest that the fauna survey work carried in 2012 and 2013 does not remain relevant in 2016. Observations on the Site in May 2016 by KMA found that there had been no change in the habitats present, the area of tree vegetation, or any other feature that may result in a change in the fauna inhabiting and visiting the site.

The survey methods employed during the field investigations are based on the descriptions provided in the following publications:

- Threatened species survey and assessment: Guidelines for developments and activities. Working Draft, (DEC, now OEH, November 2004).
- Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2010a).
- Survey guidelines for Australia's threatened bats: Guidelines for detecting bats listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2010b).

Guidelines have yet to be produced for the use of either infrared cameras or Song Meters™. Therefore, information on the use of these was sourced from: the unit's user manuals, the scientific literature (Claridge *et al*. 2010; Engel & Burcher 2010) and/or discussions held with Mr Alan Campbell of Bernview Environmental Consultants (Mr Campbell regularly hires out these units).

Broadly, the following survey methods were employed during the field investigations. Where required, more detailed descriptions on one or more of these methods is provided.

- The direct observation of animal species present within, or adjacent to, the study area;
- Live trapping using Elliott (sizes A and B), wire mesh cage, hair tube and harp (bat) traps;
- Dedicated bird and herpetofauna searches;
- Use of infrared cameras;
- Use of a Wildlife Acoustics SM2 SongMeter™;
- Diurnal and nocturnal call identifications, with all calls being identified in the field;
- Spotlighting;
- Call playbacks targeting nocturnal threatened animals;
- Echolocation detection targeting insectivorous bats (microchiropterans);
- The identification and/or collection of scats, including those that contain hair and bone material; and
- The identification of any indirect evidence such as tracks and scratchings that would suggest the presence of particular animal species.

The level of survey effort for each technique that was employed was determined based upon the character of the site and the habitats present, the extent to be surveyed and the target animal species/group.

Where live trapping was undertaken, traps were left open for the entire night and checked during the following early morning. As it was unnecessary for this study and as the animals caught were all female *Antechinus stuartii* carrying young, details such as weight, body or tail length were not recorded. This was omitted to minimise stress to the animals.

Elliott box traps
Live trapping for small mammals was undertaken using sizes A and B Elliott box traps. The smaller size A traps were used to target terrestrial species, while the larger size B traps were used to target arboreal species.

The traps were established along three (3) linear transects, each transect containing 25 ground traps and five (5) arboreal (tree-mounted) traps; except for transect 2 that contained 20 ground traps. Each trap was placed between 10 m and 15 m apart, the general pattern established being five ground to one arboreal trap. The transects were located in the following locations (see **Figure 2**):

- atop the southern "ridgeline" (transect E1);
- within the centre of the proposed extraction area (transect E2); and
- across a gully adjacent to the proposed extraction area (transect E3).

All traps were baited with the standard rolled oats, peanut butter and honey mixture, and all were checked each morning for four (4) days. To provide some comfort to those animals that were captured, each trap was lined with leaf litter. To minimise disturbing and continually scenting (i.e. with the smell of the researcher) the Elliott traps, only those that were sprung or held captured animals were re-baited.

The size B traps were placed on wooden brackets, these being fixed where possible to smooth barked mature trees that contained hollows. The brackets were placed at a height of 2m to 4m, a 1.2m high aluminium step ladder being used during trap placement. To entice animals to investigate the arboreal traps, a diluted honey solution was sprayed onto the tree to a height of around 2 m above and below the trap.

Cage trapping
Two (2) wire mesh cages (30 cm x 30 cm x 58 cm in size) were deployed along each of the Elliott trap transects; one near the eastern end, and one near the western end of the line. The traps were baited with chicken carcasses.

Cage traps were checked each morning. As with the Elliott traps, once established the cages were only approached and touched if they required resetting and/or rebaiting. Similarly, the cage traps were left open for a period of four nights.

Hairtube trapping
Hairtube trapping using twenty (20) Faunatech™ traps was undertaken to sample the forested portions of the study area. The traps were all placed on the ground, and all were baited with sardine meat. Where possible, efforts were made to ensure a minimum distance of 200 metres between each hairtube trap. The hairtube traps were left in place for nine (9) days. Any hairs collected within the hairtube traps were sent to Ms Georgeanna Story of "ScatsAbout" (Majors Creek, NSW) for analysis. Similarly, any scats that contained bone or hair material were sent to Ms Story.

Harp trapping

An Austbat™ harp trap was used during the course of the field investigation. This trap was placed at two locations, each of which had the potential to be used by microchiropterans (insectivorous bat) during their movement patterns (i.e. open vehicle tracks that had a low canopy cover). The trap was check each morning, with any captured bats being held in a cloth bag till they could be released on dusk.

The harp trap was erected and left in place at one location for two nights. Subsequent to this, the trap was relocated to another site and left in place for an additional two nights.

Bird surveys

To determine if sufficient survey time was spent on locating the bird fauna in the study area, a species accumulation curve was prepared as the bird counts were undertaken. When the graph shows that no more bird species are being detected in the counts, then the species inhabiting the area is probably close to being fully identified. The graph is shown in **Figure 3**; the result indicates that the bird fauna of the study area has been adequately surveyed.

Nocturnal birds were sought through spotlighting and listening for calls during all nocturnal survey work. Call play-back was used for determining the presence of the Powerful Owl, Barking Owl and Masked Owl, as well as the arboreal mammal the Yellow-bellied Glider. During the call playback sessions, the calls of these threatened species, taken from Buckingham and Jackson (1990) and Stewart (1999), lasted for five minutes per species and were broadcast through a megaphone connected to a compact disc player. To detect any calls or responses made by the targeted threatened species, a ten minute listening period was undertaken following completion of the playback session. After the call playbacks and subsequent listening periods, spotlighting of the area was also undertaken to detect any owls or mammals that may have been attracted to the calls, but which did not respond vocally. Vigilance for birds during all other survey activity in the study area increased the chances of finding species in this group.

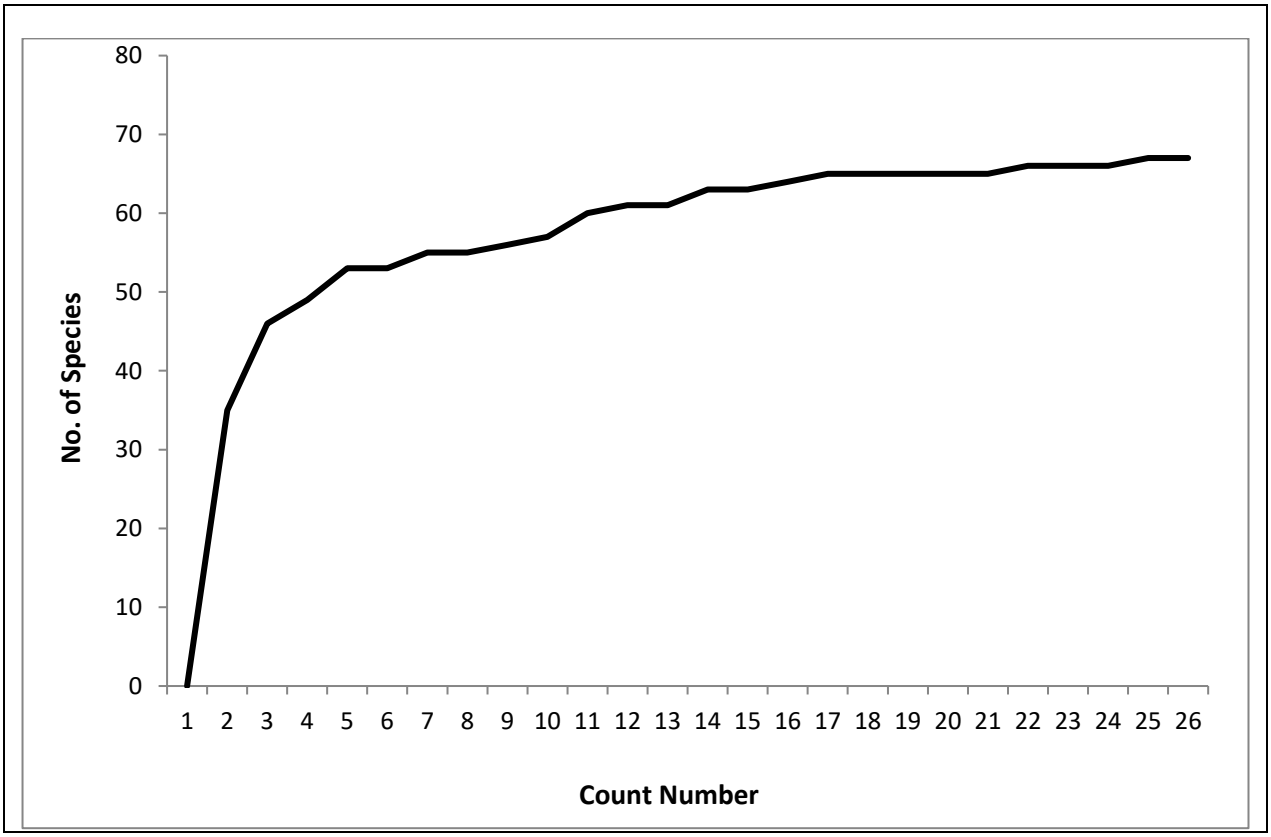


Figure 3 Species Accumulation Curve for Bird Surveys in the Study Area

Herpetofauna surveys
Searches for reptiles and frogs were undertaken at various locations. The searches involved lifting and looking underneath rocks, logs, ground debris, under exfoliated bark and, where present, in crevices/caves/overhangs (a hand torch being used to illuminate these features). The herpetofauna searches lasted for a minimum period of 20 person minutes. Any reptiles or amphibians captured were identified and released at their point of capture.

Infrared cameras
Reconyx™ and Scout Guard™ infrared cameras were deployed during the course of the field investigations. These cameras all employ passive infrared (AIR) systems, requiring an animal to "break" an invisible "beam". The cameras operate diurnally and nocturnally. When established, the cameras were left in place for a minimum of ten days/nine nights. The cameras were located along obvious runways or in association with a distinctive habitat feature (rock outcrop).

Cameras were set to a sensitivity of high and a photograph interval of three/ten seconds. The cameras were placed at a height of around one metre above ground level and angled slightly downwards, as per the directions provided in the unit's instruction manual.

To entice animals into the camera's field of view, chicken carcases were used. In addition, a freshly killed Common Ringtail Possum was found during the field survey, this also being placed in front of one of the cameras. The baits were placed at a distance of around five metres in front of the camera and secured to the ground by a large steel peg. This distance was selected as it is within the unit's motion detector coverage range.

As noted previously, the method selected when using this technique was determined based on reference to the unit's instruction manual, information presented in the scientific literature and the outcomes of surveys/research undertaken by the author (Engel & Burcher 2010; Engel & Engel 2012).

Song Meter
A Wildlife Acoustics SM2 SongMeter™ (essentially a glorified dictaphone) was deployed and set to record calls during two scheduled intervals, these being from:
- 10.00 pm to 12.00 am; and
- 02.00 am to 03.00 am.

The unit was placed at one location, and left operating for a minimum period of eight nights. The unit was attached to a tree at a height of around 1.5 metres, the site was in the top of a gully.

Calls were analysed in-house using Cornell Laboratory of Ornithology's program "Raven Lite 1.0™".

Spotlighting
During the nocturnal surveys, spotlighting was undertaken using 163 lumen hand-held spotlights. Spotlighting was primarily undertaken on foot, with tracks, clearings and access ways being targeted. These environments were targeted to reduce the disturbance of those species present (i.e. through adverse noise generated by pushing through vegetation, stumbling over logs or crunching leaf litter and ground debris).

The spotlighting sessions lasted from 30 to 60 minutes each and were undertaken:
- Concurrently with the call playbacks sessions (one researcher "working" a separate area whilst the other undertook the call playbacks); or
- Once the call playback component of that evening's study had been completed.

Call playbacks

Call playbacks were undertaken targeting the threatened species Squirrel Glider *Petaurus norfolcensis*, Yellow-bellied Glider *Petaurus australis*, Koala *Phascolarctos cinereus*, Powerful Owl *Ninox strenua*, Masked Owl *Tyto novaehollandiae*, Sooty Owl *Tyto tenebricosa* and Barking Owl *Ninox connivens*.

The playback sessions involved broadcasting the characteristic calls of each of the target species, commencing with the mammals, through a loud hailer that was connected to an iPod™. Prior to conducting the call playbacks, a ten minute listening period was undertaken to determine if any of these species were present. The calls, which were taken from either Stewart (1999) or Buckingham and Jackson (1990), were then broadcast for five minutes per species. The sequence of the calls broadcast was as noted above, a short listening period occurred between each species' calls. To detect any responses to the call playbacks, a ten minute listening period was undertaken at the completion of the playback session.

Echolocation

Anabat SDI™, Anabat ZCAIM™ and/or a Wildlife Acoustics SM2Bat™ echolocation detectors were used to identify the possible presence of any microchiropterans that may be present. The echolocation sites selected were those that corresponded to those habitats likely to be used by microchiropterans during their foraging and dispersal periods (i.e. forest and habitat ecotones) or as roosting sites (i.e. hollow-bearing trees where present).

The detectors were generally set prior to dusk and left in place for the duration of the night. As it is waterproof, the SM2Bat unit was left on site. This unit was collected on the 12 October 2012.Any calls recorded were analysed in house using Anabat 6.3 computer software.

Summary of Survey Effort

The following table summarises the survey effort for animal species on the study area. All survey effort was concentrated on the proposed quarry area, although most parts of the property were surveyed.

Table 7
Summary of fauna survey effort

Call playback sessions	11 surveys	~ 10 hours
Diurnal bird surveys	25 surveys on 14 days	56.35 hours
Echolocation	1 to 3 units depending on evening	196 hours
Hairtubes	20 traps	220 trap nights
Herptofauna searches	7 surveys	~ 2 hours and 50 minutes
Infrared cameras	2 units	22 camera days
Live trapping – Cage traps	6 cage traps	24 trap nights
Live trapping – Elliott traps	85 traps total	340 trap nights
Live trapping – Harp trap	1 trap	4 trap nights
SongMeter	1 unit	11 nights (33 hours)
Spotlighting	2 hrs per night, conducted over 4 nights	8 person hours

Animal Species Nomenclature

Most of the fauna species' scientific and common names in this report are from the Australian Museum's *The Mammals of Australia* (Strahan 1995), *Australian Bats* (Churchill 1998), *The Taxonomy and Species of Birds of Australia and its Territories* (Christidis & Boles 1994) and *Reptiles and Amphibians of Australia* (Cogger 1992).

3.3 Survey Team

All team members are experienced in flora and fauna field surveys and are familiar with the plants and/or animals of the Sydney Basin. The survey team was composed of the following staff from Kevin Mills & Associates and Lesryk Environmental Consultants:

Stephen Bloomfield	Fauna surveys (particularly trapping and bat surveys).
Deryk Engel	Fauna surveys.
Kevin Mills	Flora and fauna surveys (particularly vegetation).

3.4 Limitations

As stated in the document Threatened Biodiversity Survey & Assessment: Guidelines for Developments and Activities (DEC 2004), "ideally, surveys would be undertaken during optimal climatic and seasonal conditions . . . In many cases this will not be possible, and the results may not be able to determine conclusively whether a species is present within the survey area" . . . "The absence of a species from survey data does not necessarily mean it does not inhabit the survey area. . . It may simply mean that the species was not detected at that time with the survey method adopted and [in] the prevailing seasonal or climatic conditions."

All likely threatened plant species in the locality are observable during the whole year, so that there are no seasonal limitations on the survey for these species. The species of threatened animal likely to be in the area, other than bats, are also able to be surveyed for all year round. Although the bat surveys were undertaken in March-April, eleven species were recorded, including some threatened species. We do not believe that there is any serious limitation to the flora or fauna surveys in terms of seasonality.

The survey methods set out in the above document (DECC 2004 and 2009) have been followed where relevant. The resulting survey effort meets the minimum described in the *Guidelines* and *Manual***.**

4. FLORA

4.1 Vegetation Patterns

The property is located at a relatively high altitude in the south-western part of Sydney Basin geological and biological regions, on the eastern edge of the Southern Tablelands. The flora of the site is therefore influenced by the floras of the Sydney Basin and the Tablelands. Tree species typical of the Sydney Basin include Grey Gum *Eucalyptus punctata,* Silvertop Ash *Eucalyptus sieberi,* Scribbly Gum *Eucalyptus sclerophylla* and Sydney Peppermint *Eucalyptus piperita.* Other species that are characteristic of the Tablelands include Broad-leaved Peppermint *Eucalyptus dives,* Brittle Gum *Eucalyptus mannifera,* Narrow-leaved Peppermint *Eucalyptus radiata* and Manna Gum *Eucalyptus viminalis*. The main group of plants is associated with the Sydney Basin sandstones.

Forest and woodland are the dominant vegetation types on the property. The main forest is dominated by Blue-leaved Stringybark *Eucalyptus agglomerata*, Silvertop Ash *Eucalyptus sieberi* and Sydney Peppermint *Eucalyptus piperita*. The woodland is dominated by Scribbly Gum *Eucalyptus sclerophylla*, with Brittle Gum *Eucalyptus mannifera* and Broad-leaved Peppermint *Eucalyptus dives* becoming common below the sandstone on the Berry Siltstone. The valleys contain a moister forest dominated mainly by Sydney Peppermint *Eucalyptus piperita,* while the deepest valley of Long Swamp Creek supports a band of tall forest with Manna Gum *Eucalyptus viminalis,* Narrow-leaved Peppermint *Eucalyptus radiata,* River Peppermint *Eucalyptus elata* and Brown Barrel *Eucalyptus fastigata.* Exposed

sandstone clifftops support dry woodland, often with the mallee Narrow-leaved Mallee-ash *Eucalyptus apiculata*. Some treeless heathland occurs in small patches on rock surfaces above the low sandstone cliffs.

The valley floor of Long Swamp Creek is covered in deep peaty soils and supports a swamp community. The vegetation is mainly treeless and covered in typical swamp plants such as Sedges *Carex* spp., Common Reed *Phragmites australis*, Native Gipsywort *Lycopus australis* and the mallee Paddys River Swamp Gum *Eucalyptus aquatica*.

4.2 Plant Communities

Survey Plot Data

The survey results for the thirteen 20 m by 20 m plots are summarised in **Table 8**, while the survey sheets are provided at **Appendix 1**. The location of the survey plots is shown on **Figure 5**, which are on or close to the Site. Additional information on the vegetation is provided by the Bio-Banking transects; these are discussed in Section 4.5.

Table 8
Summary of 20 m by 20 m vegetation survey plots

Plot	Community	Trees/ha	Basal area/ha	Indigenous spp.	Exotic spp.
A	Regrowth Peppermint Forest	459	19.5 m^2	35	1
B	Regrowth Peppermint Forest	1050	31.3 m^2	44	1
C	Peppermint Forest	650	46.1 m^2	48	0
D	Scribbly Gum Woodland	600	19.8 m^2	47	0
E	Scribbly Gum Woodland	350	22.7 m^2	45	0
F	Regrowth Peppermint Forest	500	20.9 m^2	27	0
G	Scribbly Gum Woodland	700	17.1 m^2	41	1
H	Stringybark Forest	825	43.5 m^2	46	0
J	Peppermint Forest	800	26.4 m^2	45	1
K	Scribbly Gum Woodland	600	34.6 m^2	49	2
L	Peppermint Forest	350	50.2 m^2	44	1
M	Stringybark Forest	1325	45.1 m^2	34	0
N	Scribbly Gum Woodland	1350	33.1 m^2	29	0

The Plant Communities

A total of seven plant communities are identified in the study area; these are summarised in **Table 9**, below, where the name of the community, the key species and notes on distribution within the study area are provided. The relationships between the identified plant communities is illustrated in **Figure 4**.

Figure 5 shows how the plant communities are distributed across the study area. Each community is described below. Note that one of the communities, Regrowth Peppermint Forest, is the result of previous forest clearing.

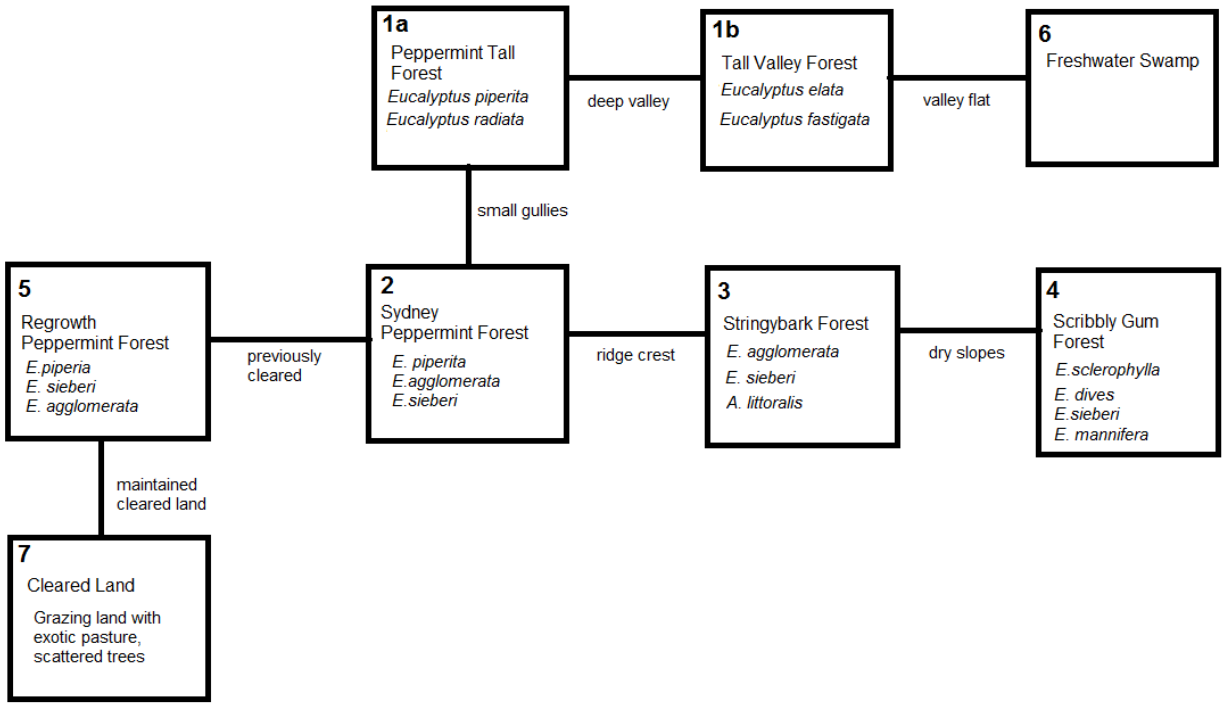


Figure 4 Relationships between Plant Communities

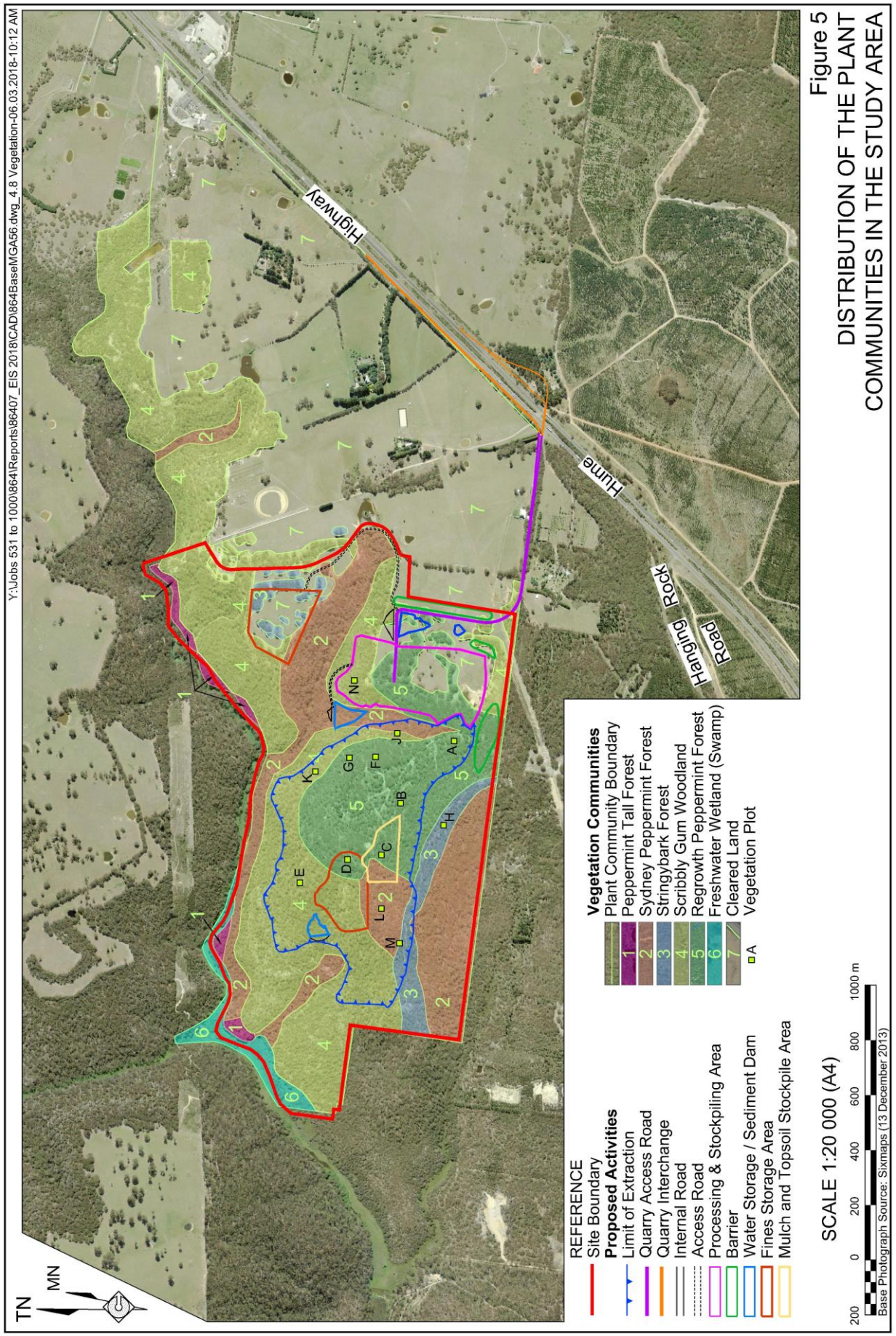


Figure 5
DISTRIBUTION OF THE PLANT COMMUNITIES IN THE STUDY AREA
Y:\Jobs 531 to 1000\864\Reports\86407_EIS 2018\CAD\864BaseMGA56.dwg_4.8 Vegetation-06.03.2018-10:12 AM
Highway
Hume
Hanging Rock
Road
TN
MN
REFERENCE
Site Boundary
Proposed Activities
Limit of Extraction
Quarry Access Road
Quarry Interchange
Internal Road
Access Road
Processing & Stockpiling Area
Barrier
Water Storage / Sediment Dam
Fines Storage Area
Mulch and Topsoil Stockpile Area
Vegetation Communities
Plant Community Boundary
1 Peppermint Tall Forest
2 Sydney Peppermint Forest
3 Stringybark Forest
4 Scribbly Gum Woodland
5 Regrowth Peppermint Forest
6 Freshwater Wetland (Swamp)
7 Cleared Land
A Vegetation Plot
SCALE 1:20 000 (A4)
200 0 200 400 600 800 1000 m
Base Photograph Source: Sixmaps (13 December 2013)

Table 9
Plant communities in the study area

Community/Name	Key Species	Distribution in the Study Area
1. Peppermint Tall Forest	*Eucalyptus radiata* *Eucalyptus fastigata* *Eucalyptus elata*	In sheltered valleys, mainly along Long Swamp Creek.
2. Sydney Peppermint Forest	*Eucalyptus piperita* *Eucalyptus sieberi* *Eucalyptus agglomerata*	Extensive on gentle topography across the property, mainly growing on deep sand.
3. Stringybark Forest	*Eucalyptus agglomerata* *Eucalyptus punctata* *Eucalyptus sieberi*	On the rocky ridge in the south of the area.
4. Scribbly Gum Woodland	*Eucalyptus sclerophylla* *Eucalyptus sieberi* *Eucalyptus mannifera* *Eucalyptus dives*	On dry slopes and ridges, extending into some valleys where Berry Siltstone occurs.
5. Regrowth Peppermint Forest	*Eucalyptus piperita* *Eucalyptus sieberi* *Eucalyptus sclerophylla* *Pinus radiata* *	Previously cleared and left to regenerate.
6. Freshwater Wetland (Swamp)	*Leptospermum* spp. *Carex appressa* *Eucalyptus aquatica* *Phragmites australis*	Peaty alluvium along Long Swamp Creek.
7. Cleared Land	Variable	Across the eastern part of the property.

1. Peppermint Tall Forest
Eucalyptus radiata, Eucalyptus fastigata, Eucalyptus elata

Structure: This is a forest to tall forest to over 30 metres in height, with well-spaced large trees. There is usually a shrubby understorey, which is often quite open.

Floristic Composition: The main trees in this forest are the peppermints *Eucalyptus radiata* and *Eucalyptus elata;* other trees include *Eucalyptus fastigata* and sometimes *Eucalyptus viminalis*. Large shrubs include Silver Banksia *marginata,* River Lomatia *myricoides,* Yellow Teatree *Leptospermum polygalifolium,* Broad-leaved Hickory Wattle *Acacia falciformis,* Tall Shaggy Pea *Oxylobium arborescens* and Mintbush *Prostanthera lasianthos*. Other typical species include Spiny-headed Mat-rush *Lomandra longifolia,* Fireweed Groundsel *Senecio linearifolius,* and Common Cassinia *aculeata.* In some places, the creeksides support many ferns, including King Fern *Todea barbara,* Fishbone Water Fern *Blechnum nudum* and in the deepest valley in the north, Soft Tree Fern *Dicksonia antartica*.

Distribution: This forest grows in sheltered locations in valleys along Long Swamp Creek and its tributaries, and on the south-facing slope in the far south-western part of the property.

2. Sydney Peppermint Forest
Eucalyptus piperita, Eucalyptus sieberi, Eucalyptus agglomerata

Structure: This is an open forest to about 20 metres tall but is quite variable. The understorey is usually shrubby, with a diverse and moderately dense ground cover.

Floristic Composition: The main trees are Sydney Peppermint *Eucalyptus piperita*, Silvertop Ash *Eucalyptus sieberi* and Blue-leaved Stringybark *Eucalyptus agglomerata*, with Hard-leaved Scribbly Gum *Eucalyptus sclerophylla* in some places. The shrubby understorey contains the shrubs geebungs *Persoonia spp,* Stalked Conesticks *Petrophile pedunculata,* Finger Hakea *Hakea dactyloides,* Wattle *Acacia leucolobia*, Prickly Shaggy Pea *Podolobium ilicifolium* and Spiny Bossiaea *Bossiaea obcordata*. Common smaller species include Grey Guinea Flower *Hibbertia obtusifolia*, Bracken *Pteridium esculentum,* Holly Lomatia *Lomatia ilicifolia,* Spreading Flax-lily *Dianella revoluta* and Wiry Panic *Entolasia stricta*.

In sheltered places, the tree Narrow-leaved Peppermint *Eucalyptus radiata* may be common; the understorey in these locations if often ferny and quite open.

Distribution: Grows on the deep sand across much of the property as well as in the valleys.

3. Stringybark Forest
Eucalyptus agglomerata, Eucalyptus sieberi, Eucalyptus punctata

Structure: This is an open forest to about 20 metres tall, with a shrubby understorey.

Floristic Composition: The two dominant trees are and Blue-leaved Stringybark *Eucalyptus agglomerata*, and Silvertop Ash *Eucalyptus sieberi*, with some Grey Gum *Eucalyptus punctata*. Black Sheoak *Allocasuarina littoralis* is common in many places. The shrubs present include Spiny Bossiaea *Bossiaea obcordata*, Silky Hakea *Hakea sericea*, Narrow-leaved Geebung *Persoonia linearis* and Prickly Shaggy Pea *Podolobium ilicifolium*. Smaller plants include Nodding Blue Lily *Stypandra glauca*, Guinea Flower *Hibbertia empetrifolia,* Silky Purple Flag *Patersonia sericea* and Mat-rushes *Lomandra* spp.

Distribution: On the top and rocky ridge on the Hawkesbury Sandstone along the southern edge of the property.

4. Scribbly Gum Woodland
Eucalyptus sclerophylla, Eucalyptus mannifera, Eucalyptus dives

Structure: A woodland to about 15 to 20 metres tall, generally with a shrubby understorey.

Floristic Composition: A variable woodland because it grows on two different substrates; i.e. Hawkesbury Sandstone and the underlying Berry Siltstone. The dominance of Hard-leaved Scribbly Gum *Eucalyptus sclerophylla,* Brittle Gum *Eucalyptus mannifera* and Broad-leaved Peppermint *Eucalyptus dives* is fairly consistent across the community, although the latter two species are more common on the siltstone. Silvertop Ash *Eucalyptus sieberi* and Blue-leaved Stringybark *Eucalyptus agglomerata* may be common on the sandstone. Narrow-leaved Mallee-ash *Eucalyptus apiculata* occurs on the cliff edges.

The woodland on the sandstone is shrub species rich, including Hairpin Banksia *Banksia spinulosa*, Soft Geebung *Persoonia mollis,* Paperbark Teatree *Leptospermum trinervium,* Finger Hakea *Hakea dactyloides*, Slender Wattle *Acacia elongata*. Smaller species include Heathland Mirbelia *Mirbelia rubiifolia,* Curly Wig *Caustis flexuosa,* Heath Platysace *Platysace ericoides,* Silky Purple Flag *Patersonia sericea,* Dwarf Purple Flag *Patersonia longifolia* and Common Aotus *Aotus ericoides*. On the siltstone, the understorey is of lower diversity and the understorey tends to be a taller shrubby layer of species such as the teatrees *Leptospermum polygalifolium* and *L. trinervium*.

Distribution: Generally on ridges and slopes with poor rocky soils, in the western and northern parts of the study area, on the Hawkesbury Sandstone, and on gentle slopes of the underlying Berry Siltstone.

5. Regrowth Peppermint Forest
Eucalyptus piperita, Eucalyptus sieberi, Eucalyptus agglomerata, Pinus radiata

Structure: This is an open forest to about 15 metres tall but is quite variable. The understorey is usually shrubby, with a diverse and moderately dense ground cover.

Floristic Composition: The main trees are Sydney Peppermint *Eucalyptus piperita*, Silvertop Ash *Eucalyptus sieberi* and Blue-leaved Stringybark *Eucalyptus agglomerata*, with Hard-leaved Scribbly Gum *Eucalyptus sclerophylla* in some places. The exotic Radiata Pine *Pinus radiata* occurs in many places, growing from seed originating from the pine plantations nearby.

The shrubby understorey contains the shrubs geebungs *Persoonia spp,* Stalked Conesticks *Petrophile pedunculata,* Finger Hakea *Hakea dactyloides,* Wattles *Acacia leucolobia* and *A. terminalis*, Prickly Shaggy Pea *Podolobium ilicifolium* and Spiny Bossiaea *Bossiaea obcordata*. Common smaller species include Small Parrot Pea *Dillwynia parvifolia*, Guinea Flowers *Hibbertia* spp, Bracken *Pteridium esculentum,* Spreading Flax-lily *Dianella revoluta* and Wiry Panic *Entolasia stricta*.

Distribution: Across the central part of the study area, where clearing several decades ago cleared the original forest.

6. Freshwater Wetland (Swamp)
Sedges - *Eucalyptus aquatica*.

Structure: Mostly a sedgeland to about one metre tall with stands of small trees along edges, particularly *Eucalyptus aquatica*.

Floristic Composition: Various wetland and moist forest plants are present, in and on the edges of the swamp. These species include Common Reed *Phragmites australis*, Sweet Teatree Leptospermum *obovatum*, Tall Sedge *Carex appressa*, Spiny-headed Mat-rush *Lomandra longifolia*, Paddys River Swamp Gum *Eucalyptus aquatica*, Fishbone Water Fern *Blechnum nudum*, Red-leaved Wattle *Acacia rubida* and Prickly Teatree Teatree *Leptospermum juniperinum*. Small side arms support Button Grass *Gymnoschoenus sphaerocephalus* sedgeland.

Distribution: Along Long Swamp Creek, in water-logged alluvial soil. Below but not near the proposed quarry.

Stand of *E. aquatica* and swamp vegetation on northern edge of the site.

Button Grass swamp vegetation on edge of the Long Swamp Creek swamp.

7. Cleared Land

Variable species mix, primarily exotic grassland.

Structure: Mostly grazed grassland with scattered native trees, lines of trees and occasional shrubs.

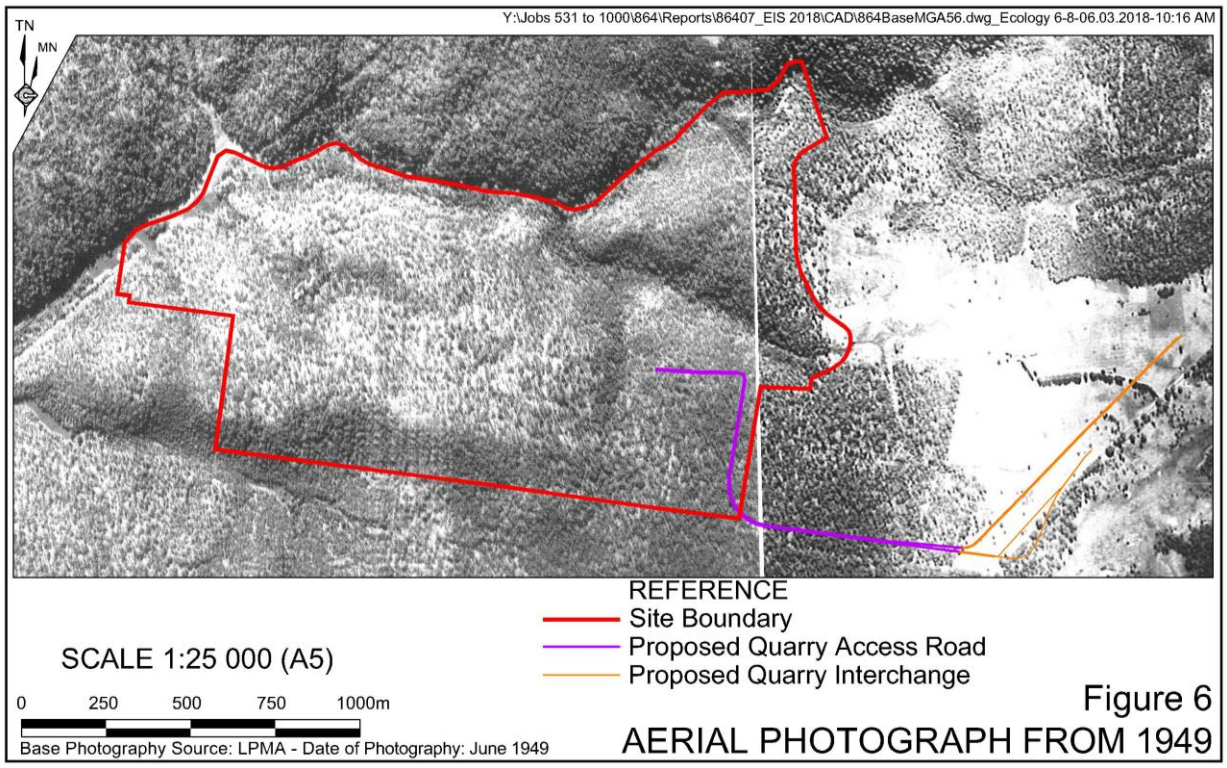
Floristic Composition: A grassland dominated by exotic herbaceous species, particularly pasture grasses.

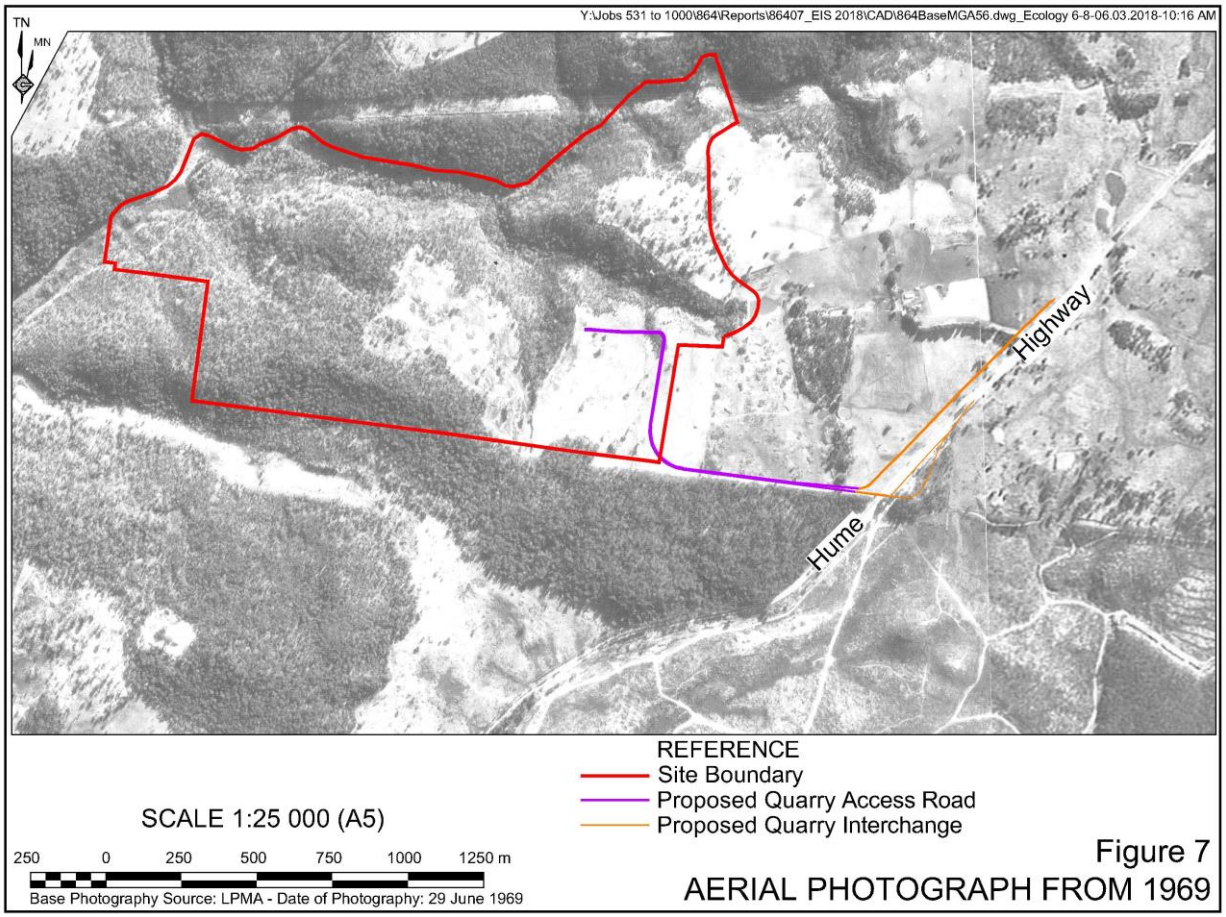
Distribution: In the eastern half of the study area.

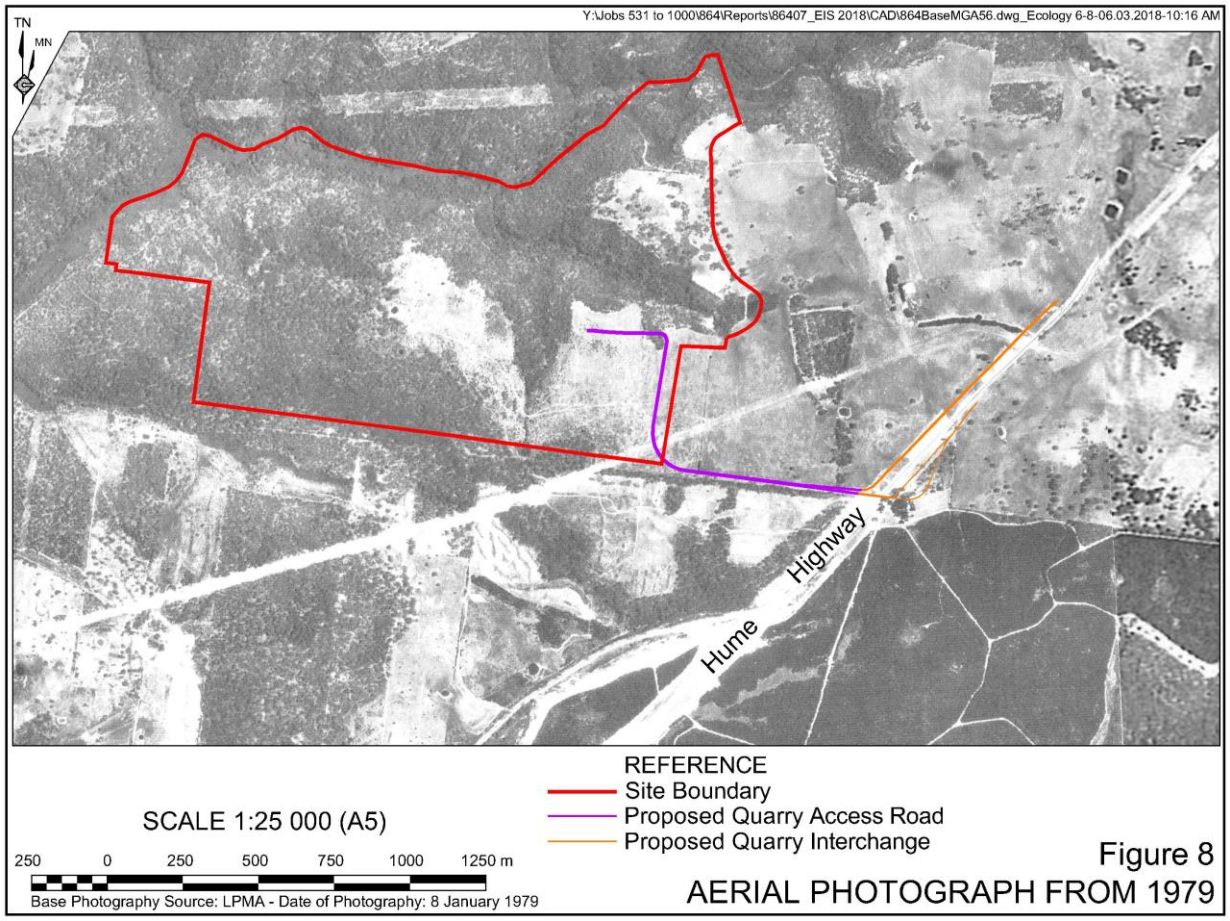
4.3 Historic Aerial Photographs

Historic aerial photographs from 1949, 1969 and 1979 were inspected to investigate the changes in the vegetation cover. These three photographs are reproduced in **Figures 6, 7 and 8**. The outline of the Site is shown on each photograph. **Figure 5** shows the current vegetation cover on and around the proposed extraction area.

The aerials indicate that the forest across much of the Site was cleared between 1949 and 1969. Then by 1979, there was some regrowth of trees in some places. The current area of regrowth forest (vegetation community 5 described and mapped here; see **Figure 5**) matches the areas shown as cleared on the 1969 aerial photograph.







4.4 Plant Species Recorded

Indigenous Species

The indigenous or native plant species recorded across the study area have been listed below, in **Appendix 3**, together with the introduced plant species. In all, 196 indigenous species and 26 exotic species were recorded within the study area.

Exotic Species

Those species of exotic plants (weeds) recorded in the study area are listed together with the indigenous species in **Appendix 2**; A total of 26 exotic species was recorded, although it is likely that more would be found if a complete survey of the cleared land was undertaken. These plants are mainly in the pasture land in the eastern part of the property. Within the forest, woodland and regrowth forest areas there are very few weeds, except for Radiata Pine *Pinus radiata*, which is common in the regrowth forest.

Some of these species are listed as Priority Weeds in Wingecarribee Shire under the *Biosecurity Act 2015*, while others are regarded widely as environmental weeds. Note that environmental weeds have no legislative standing, whereas declared noxious weeds must be controlled according to their control class. All of these species are listed in **Table 10**. The control classes for noxious weeds are explained in **Appendix 10.**

Table 10
Priority and environmental weeds in the study area

Category/Species	Common name	Habitat
Priority Weeds		
Nassella trichotoma	Serrated Tussock	Grass
Rubus fruticosus sp. agg.	Blackberry	Shrub
Salix sp.	Willow	Tree
Senecio madagascariensis	Fireweed	Herb
Environmental Weeds		
Lonicera japonica	Japanese Honeysuckle	Creeper
Pinus radiata	Radiata Pine	Tree
Salix babylonica	Weeping Willow	Tree

4.5 Results of Bio-Banking Surveys

It is anticipated that residual impacts to native vegetation as a result of the Proposal will be offset through an in-perpetuity conservation agreement such as a Bio-Banking Agreement or other mechanism approved by OEH and DPE.

To meet the bio-banking assessment requirements, the guidelines set out in the document *Bio-Banking Assessment Methodology and Credit Calculator Operational Manual* (DECC 2009) must be followed to gather relevant floristic and habitat information. The Bio-Banking Assessment Methodology established in DECC (2009) has been applied as this is consistent with the DGRs for the Proposal. KMA gathered some of the data required for a Bio-Banking assessment during their surveys on the site, with supplementary data gathered by Niche Environment and Heritage in February 2014. The Bio-Banking assessment prepared by Niche Environment and Heritage is provided separately to this document; see Part 11 of the Specialist Consultant Studies Compendium.

The following text is extracted from the above *Manual* (DECC 2009) and sets out the manner in which surveys are to be undertaken.

Vegetation transects and plots
The Site Value assessment is done by using transects and plots. Transects and plots are established in each vegetation zone to collect the site attribute data used to measure Site Value according to the techniques set out in Appendix 2. Transects must be used to assess the site attributes that are measured by percent foliage cover. Other site attributes (except regeneration) are assessed by plots. Regeneration is assessed for the entire zone.

The transects/plots should be established randomly within the zone so that the assessment includes the range of variation in condition in the zone. Vegetation zones should be created as relatively homogeneous units within the proposal. Given there is always variation in native vegetation, transects and plots must be established in each zone in approximate proportion to areas of differing vegetation condition in that zone to achieve a representative sample.

Plots and transects can be placed randomly by:
- marking points randomly on the site imagery within each zone and establishing transects/plots at these points or
- pacing a predetermined and random distance into the zone, establishing a transect/plot at this point, and then repeating the process.

Field data sheets that assessors may use to collect site attribute data were downloaded from the BioBanking website. The methodology sets a minimum number of transects/plots from which data must be collected (see below).

The results obtained from the transect surveys of 50 metres by 20 metres are summarised in **Table 11; t**he completed survey sheets are provided at **Appendix 9**. The results of the 20 metres by 20 metres flora plots are summarised in **Table 8**, above, and those survey sheets are provided at **Appendix 1**.

Minimum number of transects/plots required per zone area

Vegetation zone area (ha)	Minimum number of transects/plots
0–4	1 transect/plot per 2 ha (or part thereof), or 1 transect plot if vegetation is in low condition
>4–20	3 transects/plots or 2 transects/plots if vegetation is in low condition
>20–50	4 transects/plots or 3 transects/plots if vegetation is in low condition
>50–100	5 transects/plots or 3 transects/plots if vegetation is in low condition
>100–250	6 transects/plots or 4 transects/plots if vegetation is in low condition
>250–1000	7 transects/plots or 5 transects/plots if vegetation is in low condition More transects/plots may be needed if the condition of the vegetation is variable across the zone.
>1000	8 transects/plots or 5 transects/plots if vegetation is in low condition or in a homogenous landscape in the Western Division. More transects/plots may be needed if the condition of the vegetation is variable across the zone.

Table 11
Summary of 50 metre transect/plot surveys

No.	Vegetation Type	Log Length	Tree Hollows	Overstorey Cover	Mid-storey Cover	Grasses no (%)	Shrubs no (%)	Forbs, others no (%)	Exotics no (%)	Bare, litter no (%)
2.1	*E.piperita* Open Forest	109.7m	2	30%	4.7%	5(9.8)	12(23.5)	22(43.1)	0(0)	12(3.5)
2.2	*E.piperita* Open Forest	74.5m	nil	45%	1%	5(9.8)	7(13.7)	10(19.6)	0(0)	29(56.9)
3.1	*E.sieberi/E.agglomerata* Open Forest	37m	nil	31.6%	2.2%	11(21.6)	9(17.6)	29(56.9)	0(0)	2(3.9)
4.1	*E.sclerophylla/E.sieberi* Woodland	59.5m	11	28%	4.4%	5(9.8)	11(21.6)	26(51)	0(0)	9(17.6)
4.2	*E.sclerophylla/E.sieberi* Forest/Woodland	54.6m	1	31.4%	1%	6(11.3)	10(19.6)	28(54.9)	0(0)	7(13.7)
4.3	*E.sclerophylla* Woodland	49m	2	30.4%	20.1%	6(11.8)	21(41.2)	15(29.4)	0(0)	9(17.6)
4.4	*E.sclerophylla* Woodland	49.2m	3	25%	20.2%	5(9.8)	5(9.8)	2(3.9)	0(0)	39(76)
5.1	Regrowth *E.sieberi* Open Forest	2.9m	nil	46%	19%	7(13.7)	1(2)	1(2)	0(0)	32(62.7)
5.2	Regrowth *E.sieberi/E.agglomerata* Open Forest	5m	nil	57%	1.4%	3(5.9)	12(23.5)	16(31.4)	0(0)	20(39.2)
5.3	Regrowth *E.sieberi*/*E.piperita* Open Forest	2.1m	nil	22%	3.0%	2(3.9)	10(19.6)	13(25.5)	1(2)	25(49)
5.4	Regrowth *E.sieberi* Open Forest	2.7m	nil	33%	3.6%	5(9.8)	5(9.8)	14(27.5)	0(0)	27(52.9)

5. FAUNA

5.1 Fauna Habitat

The fauna habitat on the subject land consists primarily of forest and tall forest, with stands of woodland and areas of cleared and modified vegetation. The forests that have regrown from earlier clearing are largely composed of small trees growing quite densely compared to the original forest.

Hollow-bearing trees were surveyed and the results are presented in **Appendix 5**. In all, 102 hollow-bearing trees were recorded in and immediately adjacent to the Site.

Sandstone outcrops and cliffs with overhangs are common around the edges of the ridges.

The swamp is located about 100 metres downstream of the closest edge of the Quarry. There are a few dry watercourses in small gullies within the Site.

5.2 Fauna Species Recorded

The raw results of the fauna surveys are provided in **Appendix 2**, while all animal species recorded in the study area during this investigation are listed in **Appendix 4**. In addition to these species, those species previously recorded near the study area are also listed. The latter information has come from studies undertaken nearby and from the NSW Wildlife Atlas. The source of the information is differentiated in the appendix.

The survey effort has produced a reasonable picture of the fauna of the study area; see **Tables 1 to 6** and **Figure 3**. The results are considered to be sufficient to make informed comment upon the conservation values of the site and the potential for development to impact upon the fauna, including threatened fauna.

6. POTENTIAL FOR THREATENED SPECIES TO OCCUR IN THE STUDY AREA

6.1 Threatened Species

Threatened species in New South Wales are listed on schedules under the New South Wales *Threatened Species Conservation Act 1995* (TSC Act) (now Biodiversity Conservation Act 2016), where they are classified "endangered" (Schedule 1, Part 1), "vulnerable" (Schedule 2) or "presumed extinct" (Schedule 1, Part 4). Nationally threatened species are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as "extinct", "critically endangered", "endangered", "vulnerable" or "conservation dependent".

Those species of threatened plants and animals likely to be in the study area were identified in Section 3.1**.** Of these species, two plant species and nine animal species listed as threatened in New South Wales were recorded in the study area. These species are discussed in detail below. A list of locations for each species within the study area is provided in **Appendix 8**; this includes a GPS location for each observation.

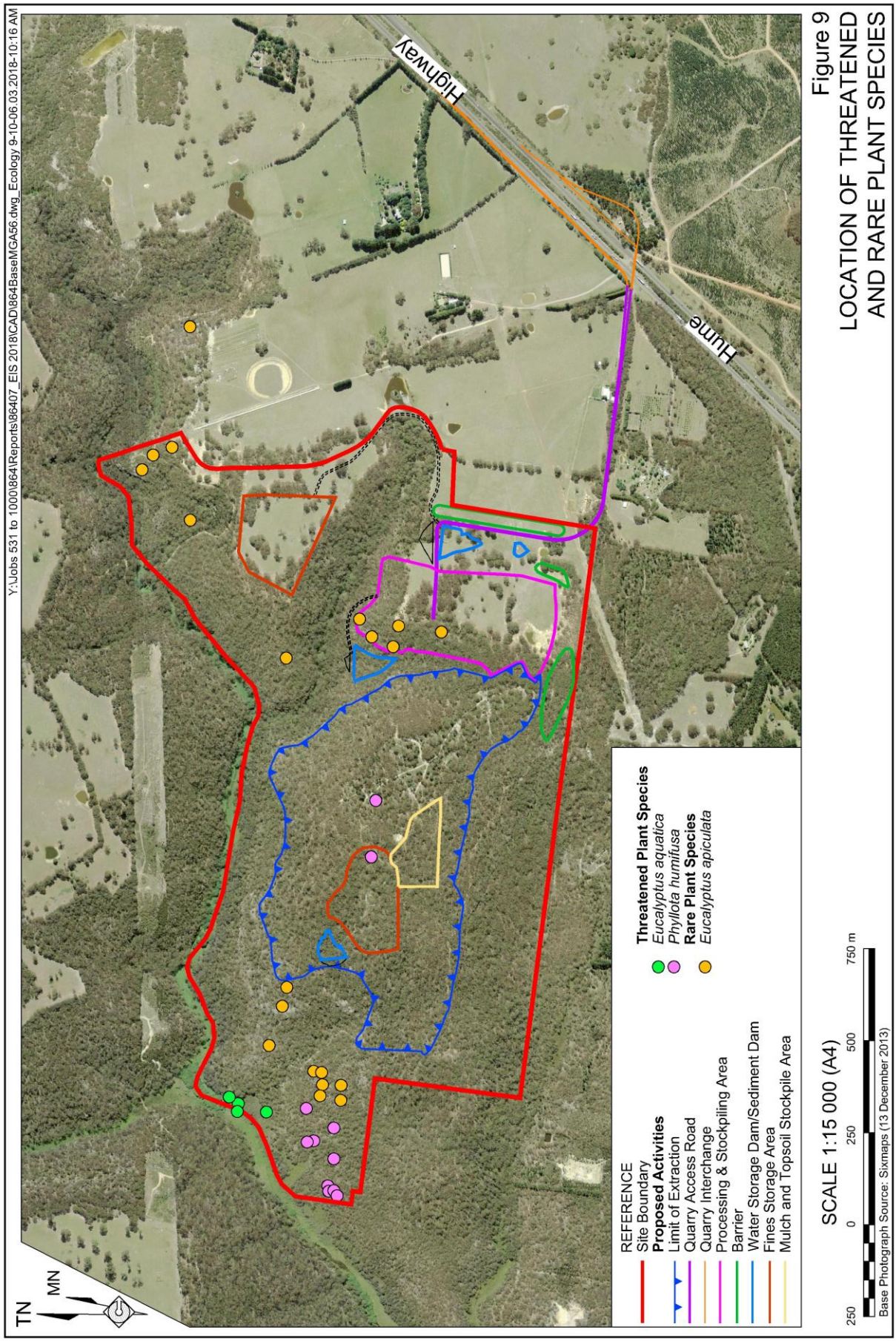
6.1.1 Threatened and Rare Plants Recorded with Study Area

Those species listed in **Table 3** were targeted during the surveys. Two species of threatened plant were recorded in the study area, namely Paddys River Swamp Gum *Eucalyptus aquatic* and Dwarf Phyllota *Phyllota humifusa*. The rare plant Narrow-leaved Mallee-ash *Eucalyptus apiculata* is common in some places. The locations of these species are shown on **Figure 9**.

Name: *Eucalyptus aquatica*

Common Name:	Paddys River Swamp Gum
Family:	Myrtaceae
Habit:	Small tree, growing to about eight metres tall.
Conservation Status:	Vulnerable under the TSC Act 1995 (now Biodiversity Conservation Act 2016); vulnerable under the EPBC Act 1999; a rare plant with a ROTAP code of 2VCa (Briggs & Leigh 1996).
Reserves where Known:	Stingray Swamp Flora Reserve (managed by NSW Forests).
Distribution:	This species is found in the swamps in the vicinity of the Paddys River area and Long Creek Swamp.
Locations in the Locality:	*E. aquatica* grows in the swamps in the above area, including Hanging Rock and Long Creek Swamp.
Occurrence in Study Area:	A population of *E. aquatica* grows along the southern edge of Long Creek Swamp, extending to just inside the property; see **Figure 5** and **Appendix 8** for locations. A search in May 2016 counted at least 250 specimens.
Photograph:	The photograph below was taken on Long Swamp Creek in September 2012.

Eucalyptus aquatica


Y:\Jobs 531 to 1000\864\Reports\86407_EIS 2018\CAD\864BaseMGA56.dwg_Ecology 9-10-06.03.2018-10:16 AM
Figure 9
LOCATION OF THREATENED AND RARE PLANT SPECIES
Highway
Hume
TN
MN
REFERENCE
Site Boundary
Proposed Activities
Limit of Extraction
Quarry Access Road
Quarry Interchange
Processing & Stockpiling Area
Barrier
Water Storage Dam/Sediment Dam
Fines Storage Area
Mulch and Topsoil Stockpile Area
Threatened Plant Species
Eucalyptus aquatica
Phyllota humifusa
Rare Plant Species
Eucalyptus apiculata
SCALE 1:15 000 (A4)
250 0 250 500 750 m
Base Photograph Source: Sixmaps (13 December 2013)

Name: *Phyllota humifusa*

Common Name:	Dwarf Phyllota
Family:	Fabaceae (Sub-Family - Faboidiae)
Habit:	Prostrate shrub, growing to about 30 cm tall and forming extensive spreading mats.
Conservation Stratus:	Vulnerable under the TSC Act 1995 (now Biodiversity Conservation Act 2016); vulnerable under the EPBC Act 1999; ROTAP code of 2VCa (Briggs & Leigh 1996).
Reserves where Known:	Stingray Swamp Flora Reserve (NSW Forests).
Distribution:	This species is restricted to two localities; one in the Penrose-Wingello area and one near the Wombeyan Caves Road. Both sites are predominantly underlain by deep sand.
Locations in the Locality:	This species grows on sites in and near Penrose State Forest.
Occurrence in Study Area:	Three plants were found at two locations within the proposed quarry footprint in 2012. A further survey across the whole of the study area in May 2015 found a population of 105 plants in the far north-western corner of the property. There it is growing on deep white sand on level topography.
Photograph:	The prostrate character of *P. humifusa*; photograph taken in the northwest of the site in May 2016.

Phyllota humifusa

Name: *Eucalyptus apiculata*

Common Name:	Narrow-leaved Mallee Ash
Family:	Myrtaceae
Habit:	Slender mallee to about four metres in height.
Conservation Stratus: code	Not listed under the TSC Act 1995 (now Biodiversity Conservation Act 2016); not listed under the EPBC Act 1999; a rare plant with a ROTAP of 3RC- (Briggs & Leigh 1996).
Reserves where Known:	Blue Mountains, Morton and Nattai National Parks (NPWS).
Distribution:	This species is found scattered across the south-western parts of the Sydney Basin, from the Blue Mountains south to the Paddys River area. Populations are often widely separated. *E. apiculata* grows on sandstone outcrops, usually on exposed ridges and cliff lines.
Locations in the Locality:	Previously found to the southwest, and in Belanglo State Forest, about 22 kilometres to the northeast. The plants in the sturdy area represent an outlying population at the extreme south-western end of the species' distribution.
Occurrence in Study Area:	Populations of *E. apiculata* were found growing on several cliff lines within the study area; these populations are summarised in **Appendix 8**.
Photograph:	The photograph below was taken on a cliff line in the study area in September 2012.

Eucalyptus apiculata

6.1.2 Threatened Animals Recorded within Study Area

The threatened animal species recorded in the study area are discussed below. Several additional species considered in this study and/or surveyed for were not encountered in the study area; these species were listed in the DECC (now OEH) correspondence accompanying the Director General's requirements and are discussed in Section 3.

The following species profiles were prepared for the nine threatened animal species recorded in the study area; the locations where the species were recorded are shown on **Figure 10**.

Name: Gang-gang Cockatoo

Species: *Callocephalon fimbriatum*
Family: Cacatuidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Gang-gang Cockatoo is distributed from southern Victoria through south and central NSW north to the southern parts of the Northern Tablelands.

Habitat
The Gang-gang Cockatoo mostly inhabits forests and occasionally woodlands. It requires large trees with hollows for breeding.

Behaviour
Outside the breeding season the Gang-gang Cockatoo forms small flocks, while in the breeding season pairs are more likely to be encountered, with family groups later in the season. During summer the birds inhabit the forests of the tablelands and mountains, and in winter move to lower altitudes.

Breeding
Spring to summer is the breeding season, the nest being established in a tree hollow, dead or alive, usually high up in the tree. There are usually two eggs. Incubation is about 30 days, the young leaving the nest after about eight weeks.

Diet
The Gang-gang Cockatoo feeds on the seeds of native and introduced trees and shrubs, including eucalypt and wattles. They will sit quietly in a tree pulling eucalypt capsules apart to extract the small seeds.

Threats
The decline in the species in the past two decades is not well understood. The NSW Scientific Committee states that "The late age at which it first breeds and the species' dependence and specificity in its preference for tree hollows may have rendered it vulnerable to decline as a result of habitat loss and degradation. Clearing of native vegetation, which is listed as a key threatening process in NSW, and degradation of habitat e.g. as a result of altered fire regimes, reduces the availability of tree hollows and may reduce the abundance of optimum foraging and roosting habitat. The distribution of the species coincides with cool temperature. (Bassian) vegetation (Emison 1982), and climate change may alter the extent and nature of this vegetation."

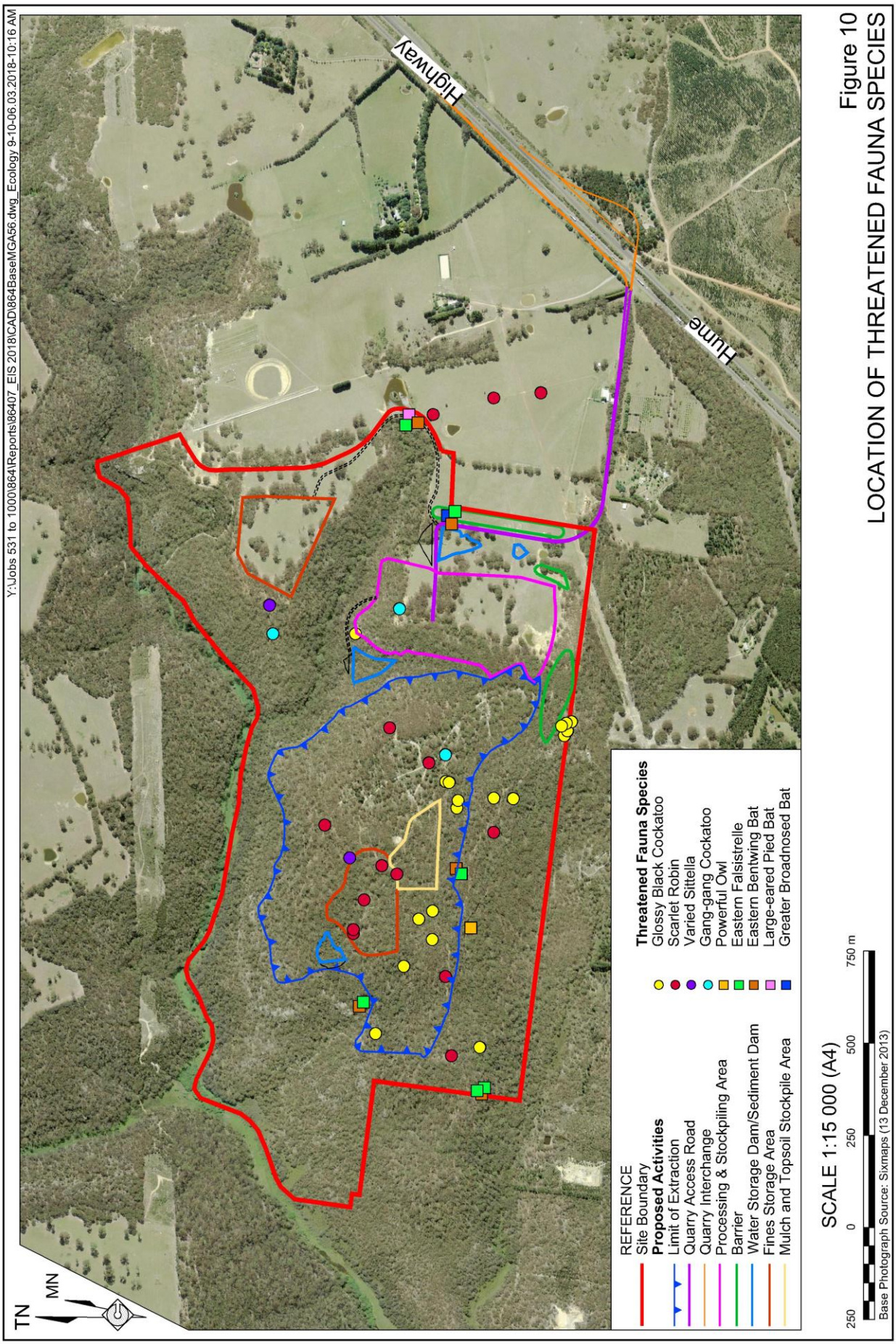


Figure 10
LOCATION OF THREATENED FAUNA SPECIES
Y:\Jobs 531 to 1000\864\Reports\86407_EIS 2018\CAD\864BaseMGA56.dwg_Ecology 9-10-06.03.2018-10:16 AM
Highway
Hume
TN
MN
REFERENCE
Site Boundary
Proposed Activities
Limit of Extraction
Quarry Access Road
Quarry Interchange
Processing & Stockpiling Area
Barrier
Water Storage Dam/Sediment Dam
Fines Storage Area
Mulch and Topsoil Stockpile Area
Threatened Fauna Species
Glossy Black Cockatoo
Scarlet Robin
Varied Sittella
Gang-gang Cockatoo
Powerful Owl
Eastern Falsistrelle
Eastern Bentwing Bat
Large-eared Pied Bat
Greater Broadnosed Bat
SCALE 1:15 000 (A4)
250 0 250 500 750 m
Base Photograph Source: Sixmaps (13 December 2013)

Occurrence in the Wingecarribee Region and in the Locality
The Gang-gang Cockatoo is commonly recorded throughout the region, primarily in forest.

Habitat within the Study Area
All of the forests in the study area are suitable for this cockatoo.

Name: Glossy Black-Cockatoo

Species: *Calyptorhynchus lathami*
Family: Cacatuidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
Glossy Black-Cockatoos occur in three distinct populations, i.e. the Griffith population, the Kangaroo Island population and the eastern population, which is the main population. The eastern population, extends from Eungella in Queensland to Mallacoota in Victoria, 600 kilometres inland to Augathella, west of Noosa, and 500 kilometres inland to Peak Hill near Dubbo. Abundance has declined and the species has disappeared from many parts of its former range.

Habitat
Glossy Black-Cockatoos live in mature eucalypt forests and woodlands containing stands of mature casuarina trees, which are its primary source of food. The species prefers mature forests, because only mature forests contain tall old eucalypts with hollows for nesting and casuarina fruit in sufficient quantities to sustain whole populations. The Glossy Black-Cockatoo feeds almost exclusively on the seeds of casuarina trees but selects only particular species; some species appear to be unsuitable. Black She-oak *Allocasuarina littoralis* is the dominant food tree in New South Wales and eastern Victoria. Although the Glossy Black-Cockatoo is reported to eat the seeds of *Angophora, Acacia* and *Eucalyptus* (Forshaw 1981), it is rarely observed foraging in anything other than casuarinas. It also eats wood-boring grubs.

Behaviour
The Glossy Black-Cockatoo is both nomadic and sedentary in its behaviour. Its movements are mostly local, as the cockatoos roam from one foraging area to another in a district. They are sometimes more wide ranging, probably when food is scarce. The Glossy Black-Cockatoo is sedentary and spends most of each day feeding in casuarinas; it moves infrequently from one tree to another, preferring instead to systematically strip a tree of its cones. Often, the bird will spend several hours diligently feeding in just one tree. A cone is removed from the branch with the beak, transferred to a foot and then, husk removed, pressed firmly against the beak while the seeds are removed with the lower mandible. The ground soon becomes littered with discarded cones, leaves and branchlets.

The Glossy Black-Cockatoo is usually observed in small groups of three birds comprising two adults and one young bird. It is almost totally arboreal and lands on the ground only to drink.

Breeding
Breeding takes place between March and August. The Glossy Black-Cockatoo nests in hollows in the limbs and trunks of eucalypts, where it lays a single egg in wood dust collecting at the bottom of the hollow. Incubation takes approximately one month.

Diet
The Glossy Black-Cockatoo feeds almost exclusively on the seeds of casuarina trees but selects only particular species; some species appear to be unsuitable. In New South Wales and eastern Victoria the dominant food tree is Black She-oak *Allocasuarina littoralis*, in Queensland it is Forest Oak *Allocasuarina torulosa* and on Kangaroo Island it is Drooping She-oak *Allocasuarina verticillata*, formerly known as *Casuarina stricta.* The cockatoo forages in stands of mature casuarinas producing sufficient

quantities of cones and seeds; immature and/or scattered trees do not yield enough food. Although the Glossy Black-Cockatoo is reported to eat the seeds of *Angophora*, *Acacia* and *Eucalyptus* (Forshaw 1981; Hyem 1933), it is rarely observed foraging in anything other than casuarinas. It also eats wood-boring grubs.

Threats
The main threat to this species is the loss of habitat, as stands of mature Casuarinas have been cleared for agriculture and urban development. The species is also adversely affected by the clearing of large trees with hollows, used for nesting.

Occurrence in the Wingecarribee Region and in the Locality
The cockatoo occurs throughout the region, mostly in forest containing their favoured food tree species *Allocasuarina littoralis.*

Habitat within the Study Area
The stands of *Allocasuarina littoralis* provides feeding habitat for the cockatoo. Large old trees with hollows in the gullies may provide suitable nesting sites.

Name: Powerful Owl

Species: *Ninox strenua*
Family: Strigidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Powerful Owl occurs along the coast and ranges of eastern Australia, from near Rockhampton in Queensland, southwards throughout eastern New South Wales and Victoria. It mainly occurs on the coastal side of the Great Dividing Range but in some places its distribution extends inland to the western slopes. The size of the population remains unknown, but the species is thinly distributed across this range. Garnett (1992) rated it as nationally rare. In a review of the species' distribution, habitat, biology and status in New South Wales, Debus and Chafer (1994) collated and analysed 516 records of the Powerful Owl from 267 locations and concluded that, although the species is more numerous than previously thought, it is "probably 'uncommon' in New South Wales (as assessed by Morris *et al.* 1981)".

Habitat
The Powerful Owl prefers tall moist open eucalypt forests on hilly terrain, sometimes with a rainforest component, but is known to occur in a wider range of forest types such as drier forest and woodland, and urban bushland. This summary is supported by Debus and Chafer (1994) who found that, in New South Wales, "tall open and open forest appear to be its most important habitat types, [but] it also uses woodland and riparian habitats". Debus and Chafer (1994) described the species' roosting habitat as "a variety of sites [ranging] from dense canopy and substorey trees within rainforest and open forest, often in gullies, to canopy trees in woodland. Estimates of the species' home range vary from 400-600 hectares per family group (Davey 1993) to 800-1,000 hectares (Schodde & Mason 1980), and neighbouring pairs have been recorded 3-10 kilometres apart (Fleay 1968) and, in one location, as close as 400 metres apart (Quinn 1993). Obviously, the quality of the habitat and the abundance of prey influence the size of the home range.

Behaviour
The Powerful Owl is a reclusive and quite sedentary species that occupies a permanent territory, either singly or in pairs. It roosts on the branches of trees in gullies by day and hunts at night, mainly in forests with an open structure and along the edge of forests.

Breeding
Debus and Chafer (1994) found that the nest trees of Powerful Owls are in tall open forest or open forest, "in live eucalypts, often the largest in a stand and probably among the oldest within a patch of forest". The nesting sites are usually large vertical hollows in tree trunks in gullies in hilly or mountainous country (Beruldsen 1980); large tree hollows are required for nesting, at least 0.5m deep (Schodde & Mason 1980). The species is long lived and is a seasonal breeder; it breeds only once a year and produces only one or two fledglings. Breeding occurs from late autumn to mid winter.

Diet
The Powerful Owl mainly eats arboreal mammals such as the Common Ringtail Possum *Pseudocheirus peregrinus*, Greater Glider *Petauroides volans*, Sugar Glider *Petaurus breviceps*, Grey-headed Flying Fox *Pteropus poliocephalus*, other arboreal mammals, and birds. The species' diet varies from region to region, with the local availability of prey.

Threats
Historically, the main threat to the Powerful Owl was the loss of habitat when forests were cleared on a large scale for farming purposes. Debus and Chafer (1994) made the following assessment of the threats to the Powerful Owl: "Given that about 20% of the tall open forest and 50% of the open forest in NSW has been cleared (from Lunney 1991), populations of the Powerful Owl may have declined by up to 50% through habitat loss; its remaining habitat is fragmented and subjected to logging, grazing, burning etc. However, Owls may be more abundant in high site-quality (tall open forest) than in lower site-quality (open) forest, meaning that populations may have declined by somewhat less than 50%. The concern is whether it can survive in forest that is converted from old growth to regrowth or plantations (exotic or native), because intensive forestry practices removed many hollows which are potential nest sites for the Owls or den sites for their prey. Intensive logging also causes a decline in arboreal hollow-dependent marsupials, particularly the Greater Glider."

Occurrence in the Wingecarribee Region and in the Locality
The Powerful Owl has been recorded from most of the large areas of forest throughout the region (NSW Wildlife Atlas); this includes the Sutton Forest area, where the presence of the owl has been known for many years (Mills 1981).

Habitat in the Study Area
Forest throughout the study area is likely habitat for a pair of Powerful Owls. It is expected that the owls utilise all parts of the study area from time to time, as the known home territory is at least 450 hectares in extent.

Name: Scarlet Robin

Species: *Petroica boodang*
Family Petroicidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Scarlet Robin is found from southeast Queensland to southeast South Australia and is also in Tasmania and southwest Western Australia. In NSW, this robin occurs from the coast to the inland slopes.

Habitat
The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat.

Behaviour
After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees.

Breeding
Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub.

Diet
Birds forage from low perches, from where they pounce on small insects and other invertebrates that are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer.

Threats
The clearing and degradation of woodland habitat has historically been the key threat; modification by grazing and other agricultural pursuits also may threaten the species. Fragmentation of woodland habitat is a major problem in many areas, as is the reduction in the structural complexity of the habitat, such as shrub cover and fallen timber.

Occurrence in the Wingecarribee Region and in the Locality
The Scarlet Robin is found throughout the region, except in denser forest and across extensive treeless land.

Habitat within the Study Area
The woodland and the open vegetation across the study area is suitable habitat for this species. The surveys found the species mainly in the regrowth forest, which is more open than the adjoining, unmodified forest.

Name: Varied Sittella

Species: *Daphoenositta chrysoptera*
Family Neosittidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but has apparently undergone a moderate reduction over the past several decades.

Habitat
The Sittella inhabits a wide range of eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland.

Behaviour
Birds are usually found in small flocks foraging in the upper parts of trees, particularly on dead branches.

Breeding
Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.

Diet
Birds feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.

Threats
Threats include habitat degradation through small-scale clearing for fence lines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms and firewood collection. Apparent decline has been attributed to declining habitat. The sedentary nature of the Varied Sittella makes cleared land a potential barrier to movement.

Occurrence in the Wingecarribee Region and in the Locality
The Varied Sittella is found throughout the region, except in denser forest and across extensive treeless land.

Habitat within the Study Area
The Varied Sittella occurs through the region, except in completely cleared landscapes and other treeless areas.

Name: Eastern Bentwing-bat

Species: *Miniopterus schreibersii*
Family Vespertilionidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Eastern Bentwing-bat *Miniopterus schreibersii* occurs in southern Europe, Africa, Asia, New Guinea, Australia and the Pacific. The subspecies in the Kiama district, the Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*, occurs all along the eastern seaboard, from north Queensland to New South Wales, Victoria and the south-eastern corner of South Australia.

Research by Dwyer (1966, 1969), Dwyer and Hamilton-Smith (1965) and Hamilton-Smith (1965, 1972) showed discrete populations of Eastern Bentwing-bats in New South Wales and Victoria, each dependent on a particular nursery site. Population dispersal was throughout a widespread but defined geographical range. There was some overlap of populations and some mingling, but the unity of each population was generally preserved.

Habitat
The Eastern Bentwing-bat is a cave dwelling species. It roosts in caves, old mines, stormwater channels and comparable structures, including buildings (Dwyer 1995). Breeding and nurturing take place in nursery caves. This species forages above the tree canopy in well-timbered valleys, where it feeds on insects.

Behaviour
As expected, the Eastern Bentwing-bat rests by day and hunts at night, foraging over large areas. It flies high, fast and mainly horizontally. The species disperses over long distances from nursery caves and roost sites and has a very large home range; one bat is known to have move 1300km (Menkhorst 1995). The pattern of movement varies with climatic conditions, the distribution of roost sites and seasonal changes in the availability of food.

Breeding
The bats use cold roosts in winter, when they are torpid. The females travel to suitable nursery caves in spring where the temperature, humidity and physical dimensions permit breeding. The nursery caves may support up to 150,000 females and juveniles (Hall & Richards 1979) and are used year after year. A single young is born in early summer and is reared in the nursery caves. The nursery colony disbands in late summer or early autumn and the bats disperse over distances of many hundreds of kilometres.

Diet
The species is insectivorous; the species mainly feeds on moths above the tree canopy.

Threats
The main threat to the Eastern Bentwing-bat is the degradation of nursery caves, which are vulnerable because of the mining of limestone and recreational cave exploration. Disturbance threatens the ability of some populations to breed. Dwyer (1995) commented that "because of its dependence upon relatively few nursery caves, threats to the existence or structural integrity of any of these may place the survival of widespread populations in jeopardy".

Occurrence in the Wingecarribee Region and in the Locality
The Eastern Bentwing-bat has been recorded from throughout the region; it is generally a commonly recorded bat, but the important nursery caves are limited in number.

Habitat in the Study Area
The Eastern Bentwing-bat no doubt forages over the whole of the study area. There is some possibility of roost sites in the low cliffs on the property, although inspections of the crevices there found no evidence of roost sites.

Name: Eastern False Pipistrelle

Species: *Falsistrellus tasmaniensis*
Family: Vespertilionidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Eastern False Pipistrelle *Falsistrellus tasmaniensis* occurs along the coast and ranges in south-eastern Queensland, New South Wales and Victoria, and throughout Tasmania. Phillips (1995) commented that the species is low in number throughout its range and is more common at cool elevations.

Habitat
Preferring gullies with tall, wet sclerophyll vegetation in high rainfall areas, this species hawks for insects below the tree canopy. Phillips (1995) however, comments that "it is not very manoeuvrable and probably forages above the forest canopy, in woodland or over water". There also appears to be some confusion about the species' winter activities; some authors suggest that the Eastern False Pipistrelle migrates towards the coast in winter while others comment that it is a sedentary hibernator. Although not much is known about this species, it inhabits wet and dry eucalypt forests, especially in cool climates.

Behaviour
This bat roosts in tree hollows, caves and buildings, and usually forages above the forest canopy, in open woodland or above water (Phillips 1995). The bat hibernates in winter.

Breeding
Breeding occurs at roost sites. Females are pregnant in late spring to early summer.

Diet
Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy.

Threats
Although our knowledge of the Eastern False Pipistrelle is far from complete, the main threat is expected to be the loss of trees with hollows and the consequential loss of roosting sites. Application of pesticides in or adjacent to foraging areas has also been mentioned.

Occurrence in the Wingecarribee Region and in the Locality
The Eastern False Pipistrelle has been recorded from a few scattered sites across the northern part of the region (NSW Wildlife Atlas), although it is doubtless more common in the region than these few records may suggest.

Habitat in the Study Area
The Eastern False Pipistrelle would utilise the majority of the study area for foraging and may also roost in hollow-bearing trees.

Name: Greater Broadnosed Bat

Species: *Scoteanax rueppellii*
Family Vespertilionidae

Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution and Abundance
The Greater Broad-nosed Bat *Scoteanax rueppellii* occurs along the east coast and Great Dividing Range from the Atherton Tablelands in Queensland to north-eastern Victoria, generally below 500 metres altitude. The species usually occurs in the gullies and river systems draining the Great Dividing Range; in many places, its range extends all the way to the coast (Hoye & Richards 1995).

Habitat
This species is found in a variety of habitats including woodland, eucalypt forest and rainforest; it prefers forests on high nutrient soils. It also forages over creeks and small rivers, and roosts in tree hollows. It

usually roosts in tree-hollows and forages over water bodies, along tree-lined creeks and along the edge of woodlands and forests. Females congregate at maternity sites in suitable trees.

Behaviour
The Greater Broadnosed Bat is a sedentary, tree hollow dependant but found mostly in moist forests where it forages for flying insects at night.

Breeding
Females congregate to breed, usually in tree hollows; one young is born in summer.

Diet
The species feeds at night on slow-moving prey such as large moths and beetles; these are taken in the air usually fairly close to the ground. Other bats have also been known to have been taken (Churchill 1998).

Threats
This species has probably suffered greatly as a result of habitat loss, for it is highly dependent on mature forests on high nutrient soils. Such forests have been extensively logged for timber production and agriculture. The availability of foraging habitat, roosting sites and nesting hollows has decreased.

Occurrence in the Wingecarribee Region and in the Locality
The Greater Broad-nosed Bat has been recorded from a few scattered sites across the northern part of the region (NSW Wildlife Atlas), although it is doubtless more common in the region than these few records may suggest.

Habitat in the Study Area
The Greater Broad-nosed Bat would utilise the majority of the study area for foraging and may also roost in hollow-bearing trees.

Name: Large-eared Pied Bat

Species: *Chalinolobus dwyeri*
Family Vespertilionidae
Conservation Status
Threatened Species Conservation Act 1995 (Schedule 2) (now Biodiversity Conservation Act 2016); threatened species (vulnerable)

Distribution
The Large-eared Pied Bat *Chalinolobus dwyeri* is endemic to the east coast of Australia, ranging from about Central Queensland to southern New South Wales, occurring along the coast to the western slopes.

Habitat
Most commonly encountered in dry forests and woodlands, as well as along the edges of rainforest and moist eucalypt forest (Churchill 1998). The bats roost by day in the twilight areas of caves and mine tunnels, rather than deep within, and in the abandoned mud nests of fairy martins (Hoye & Dwyer 1995). At night, they forage for small insects.

Behaviour
The bat roost in small colonies in caves, mostly towards the entrance. They forage at night, flying relatively slowly close to the ground.

Breeding
Females usually produce twins in November and the young are independent by late February (Churchill 1998).

Diet
This species is insectivorous, but the details of its diet are little known.

Threats
The loss of nursery sites is probably the main threat to this species.

Occurrence in the Wingecarribee Region and in the Locality
The Large-eared Pied Bat has been recorded at scattered sites across the northern part of the region (NSW Wildlife Atlas); this is probably more a reflection of bat survey locations and intensity rather than an expression of the species true distribution.

Habitat in the Study Area
The Large-eared Pied Bat would utilise the majority of the study area for foraging, but there are probably few roosting opportunities in the area as deep crevices are rare.

6.2 Migratory Species

In addition to threatened species, the EPBC Act allows for the listing of internationally protected migratory species, i.e. species listed under the Japan - Australia Migratory Bird Agreement (JAMBA), the China - Australia Migratory Bird Agreement (CAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Various internationally protected migratory species occur in every part of Australia, at least from time to time, as many of the listed species are common and widespread Australian species. These include all species of native duck and diurnal birds of prey. Several species were recorded in this study and there are other species recorded in the vicinity of the study area; see **Appendix 13**. The study area contains no important habitat for such species and the habitat within the Site is not likely to support an ecologically important proportion of a population of such species.

6.3 Endangered Ecological Communities

Endangered ecological communities in New South Wales are listed under the TSC Act (Schedule 1, Part 3) (now Biodiversity Conservation Act 2016). Nationally threatened ecological communities are listed under the EPBC Act.

No endangered ecological communities occur within the Site or the study area. The swamp lower in the Long Creek catchment, just outside the property, is listed under the TSC Act (now Biodiversity Conservation Act 2016) as ‘Montane Peatlands and Swamps’, and under the EPBC Act as ‘Temperate Highland Peat Swamps on Sandstone’. Two other communities, namely ‘Basalt Eucalypt Forests of the Sydney Basin Bioregion’ and ‘White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland’, are recorded within five kilometres of the study area (see **Appendix 13**), but do not occur on the study area.

A copy of the NSW Scientific Committee's Final Determination for this community is provided in **Appendix 6** and information on the Commonwealth listing is provided in **Appendix 7**.

6.4 Endangered Populations

Endangered populations in New South Wales are listed under the TSC Act (Schedule 1, Part 2) (now Biodiversity Conservation Act 2016). There are no provisions under the EPBC Act for the listing of endangered populations. No endangered populations have been declared on or near the Site.

6.5 Critical Habitat

Critical habitat is listed under the TSC Act (now Biodiversity Conservation Act 2016). No critical habitat is declared in the Sutton Forest locality.

7. IMPACT ASSESSMENT

7.1 General Impact

The footprint of the proposed quarry and associated infrastructure is 75 hectares in area; see **Figure 11** and **Table 12**; this infrastructure includes dams, roads, processing area and bund wall. The total area of forest of all types to be cleared would be 63.2 hectares. The relevant areas of each identified vegetation type in the study area and the areas impacted by all aspects of the quarry proposal are set out in **Table 12**. This does not include an area of 2.6 ha that would be disturbed for the Quarry Access Road and Quarry Interchange and has been assessed by Biosis (2018).

Table 12
Proposed areas of vegetation to be cleared (KMA Study Area only)

No.	Plant community (see Section 4.2)	Area of community removed during life of proposal (ha)	Total area of community on site	Proportion removed in life of proposal
1.	Peppermint Tall Forest	nil	2.3 ha	nil
2.	Sydney Peppermint Forest	7.6 ha	43.6ha	17.4%
3.	Stringybark Forest	2.7ha	9.3ha	29.0%
4.	Scribbly Gum Woodland	23.1ha	72.4ha	31.9%
5.	Regrowth Peppermint Forest	28.5ha	33.6 ha	84.8%
6.	Freshwater Wetland (Swamp)	nil	2.0ha	nil
	Total Native	61.9 ha	163.2 ha	37.9 %
7.	Cleared Land	12.3ha	20 ha	69.5%

The potential impact on the Long Swamp Creek was assessed by Larry Cook Consulting (2018) who looked at the groundwater system and concluded that baseflow to Long Swamp Creek would not be significantly affected by the excavation of the quarry and be within natural variation in flows. Internal drainage control ensures that contaminated or turbid water does not enter the swamp, located about 100 metres downslope of the Site at its closest point.

The Cook Consulting report stated, "The numerical computer groundwater model predicts a maximum reduction of 0.052 ML/day in baseflow to Long Swamp Creek and Long Swamp over the 45 years of extraction. This equates to a reduction for Long Swamp Creek and Long Swamp of 2.6% of the modelled baseflow which is considered to be a minimal impact and within the range of natural variation in flows for this type of GDE.

In addition, the numerical groundwater model also predicts maximum drawdown of the water table at the eastern end of Long Swamp of less than 0.5m at the end of Stage 5 - Year 28 and the same prediction at the end of Stage 7 - Year 45. This amount of drawdown is not considered significant and within the range of natural fluctuations."

7.2 Assessment under the BC Act

Under the provisions of the *Biodiversity Conservation Act 2016*, the impact of a proposed action, development or activity on species, populations and communities (and their habitats) is assessed by applying various factors set out under Section 7.3 of the *Biodiversity Conservation Act 2016* (BC Act). Commonly referred to as the "five part test", these factors assist the proponent and the determining authority to decide whether the impact is likely to be significant in accordance with Section 7.2 of the *Biodiversity Conservation Act 2016.*

The Assessment

The "assessment of significance" is considered in this section to assist in determining whether the proposed development is likely to have a significant effect on species, populations and communities (and their habitats) listed under the BC Act.

Subject site means the area directly affected by the proposal.
Study area means the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as is necessary to take all potential impacts into account.

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

The Proposal would remove at least some habitat known to be utilised by the following threatened animal species:

- Eastern Bentwing Bat
- Eastern False Pipistrelle
- Gang-Gang Cockatoo
- Glossy Black-Cockatoo
- Greater Broadnosed Bat
- Large-eared Pied Bat
- Powerful Owl
- Scarlet Robin
- Varied Sittella

The proposed quarry will also remove habitat containing the threatened plant species *Phyllota humifusa*, albeit in a very small way.

A viable local population of the above species would not be significantly impacted by the removal of the habitat within the Site because of the relatively small area of habitat involved in relation to the large areas inhabited by these species in the locality.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its occurrence is likely to be placed at risk of extinction

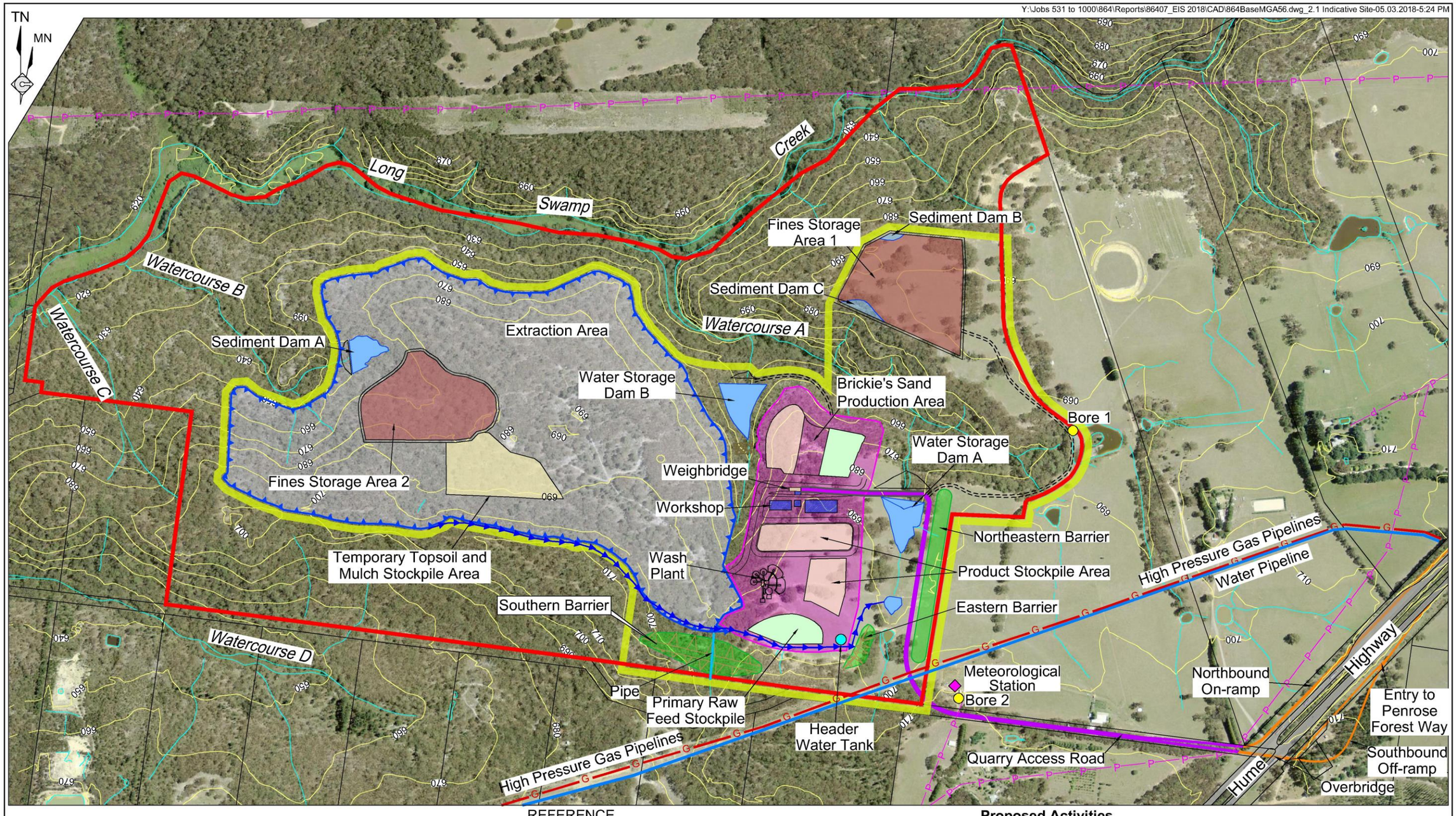


Figure 11
INDICATIVE SITE LAYOUT

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The existing vegetation on the Site is not listed as an endangered ecological community. The swamp along Long Swamp Creek is a listed community known as Montane Peatlands and Swamps; see **Appendix 6**. However, the swamp community is about 100 metres north of the closest edge of the Site. The swamp may be impacted by changes in hydrological characteristics of its catchment. A groundwater impact assessment has been undertaken that concluded that baseflow impacts to Long Swamp Creek would be minor and not result in significant impacts to riparian and potentially groundwater dependent vegetation.

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

The area of woodland/forest habitat to be removed is 63.2 hectares, composed of the vegetation types listed in **Table 12**, above. Forty-six percent of this forest is regrowth from clearing in the 1970s. All of this forest is habitat for the threatened birds recorded in the study. Due to the relatively large area impacted, over 60 hectares, this forest is likely to be significant to the local populations of these birds.

(d) whether the action proposed is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

Areas of outstanding biodiversity value replaces what was formerly referred to as declared critical habitat and refers only to those areas of land listed in the *Biodiversity Conservation Regulation 2017*. No areas of outstanding biodiversity value has been declared on the study area.

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

Key threatening processes in New South Wales are listed under the *Threatened Species Conservation Act1995* (TSC Act) and *Fisheries Management Act 1994* (FMA Act). Key threatening processes are the things that threaten, or could threaten, the survival or evolutionary development of species, populations or ecological communities. The listed threatening processes can be divided into several categories.
Key threatening processes are the things that threaten - or could threaten - the survival or evolutionary development of species, populations or ecological communities. They are listed in the *Threatened Species Conservation Act*, and include:
Pest animals. Introduced animal species can compete with, and prey upon, native animals. They can also damage native plants and degrade natural habitats.
Weeds. Weeds compete with native plants for resources such as light and nutrients. They can aggressively invade areas, displacing native plants and animals.
Diseases. Exotic fungal infections, viruses and other pathogens can weaken and kill native species.
Habitat loss/change. From large-scale land clearing to the gathering of bushrock for suburban gardens, humans have degraded many native environments across the state.

The “clearing of native vegetation” is a key threatening process; as determined above, approximately 61.9 hectares of native vegetation will be cleared. The other relevant key threatening processes are “loss of hollow-bearing trees” and “removal of dead wood and dead trees”.

Conclusion of Significance Assessment
The Proposal would not result in a significant impact to any individual threatened species such that a viable local population of the species would be at risk of extinction. However, it is our opinion that the

removal of 63.2 ha of native vegetation, that includes known and potential habitat for threatened species as well as hollow-bearing trees and dead wood or dead trees, would exacerbate existing key threatening processes. This has the potential to adversely impact the threatened fauna species recorded within the Site and listed under the *Biodiversity Conservation Act 2016.* This conclusion is consistent with Section 7.2(1a) of the Biodiversity Conservation Act 2016 that refers to significant impacts to the habitat of threatened species. The Proposal therefore represents a significant impact to threatened species. The Applicant has chosen to proceed with a biodiversity offset to manage the residual impacts to native vegetation and threatened flora species.

7.3 Commonwealth Legislation, the EPBC Act

Environment Protection and Biodiversity Conservation Act 1999

The impact of a proposed action on matters of national environmental significance is assessed under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Matters of national environmental significance are World Heritage properties, National Heritage places, wetlands of international importance (RAMSAR wetlands), threatened species and ecological communities listed under the EPBC Act, migratory species listed under the EPBC Act, Commonwealth marine environment, and nuclear actions (including uranium mining).

An "action" is a project, a development, an undertaking, an activity or a series of activities, and an alteration of any of the above. An action can be on Commonwealth land, State land council land, private land, or water.

Approval is required from the Commonwealth Environment Minister for actions that are likely to have a significant impact on a matter of national environmental significance; these are called "controlled actions". A proposed action is a "controlled action" if:

- is likely to have a significant impact on a matter of national environmental significance,
- is likely to have a significant impact on the environment of Commonwealth land,
- is to be undertaken on Commonwealth land and is likely to have a significant impact on the environment anywhere, and
- is an action to be taken by the Commonwealth that is likely to have a significant impact on the environment anywhere.

Only the Commonwealth can advise definitively whether a proposed action is a controlled action; however, the Department of the Environment and Heritage has prepared guidelines to facilitate a self-assessment process to help proponents decide whether an action is likely be a controlled action that should be referred to the Minister for assessment and approval. The *Significant Impact Guidelines: Matters of National Environmental Significance* (DEWR May 2006) replaced the *EPBC Act Administrative Guidelines on Significance* (DEH 2000).

Assessment under the EPBC Act

The following questions in the *Significant Impact Guidelines* (DEWR May 2006) must be addressed when deciding whether or not to refer a proposed action to the Commonwealth Minister for the Environment:

1. Are there any matters of national environmental significance located in the area of the proposed action (noting that ‘the area of the proposed action’ is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?

2. Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?

3. Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?

4. Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?
An action must be referred to the Commonwealth Minister if the action has, will have, or is likely to have a significant impact on matters of national environmental significance. In addition to setting out "significant impact criteria" for the various matters of national environmental significance, e.g. endangered species, vulnerable species, endangered ecological communities and listed migratory species, the *Guidelines* provide the following important definitions.

"A *significant impact* is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance."

"To be *likely*, it is not necessary for a significant impact to have a greater than 50% chance of happening, it is sufficient if a significant impact on the environment is a real or not remote chance or possibility."

"*Population*, in relation to critically endangered, endangered or vulnerable, threatened species, means:
- a geographically distinct regional population, or collection of local populations; or
- a regional population, or collection of local populations occurring within a particular bioregion."

"An *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:
- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species' range.

"*Habitat critical to the survival of a species or ecological community*" refers to areas that are necessary:
- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community."

Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

Significant Impact Criteria for Critically Endangered and Endangered Ecological Communities
An action is likely to have a significant impact on a critically endangered or endangered community if there is a real chance or possibility that it will:
- reduce the extent of an ecological community;
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- adversely affect habitat critical to the survival of an ecological community;

- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;
- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;
- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - assisting invasive species, that are harmful to the listed ecological community, to become established; or
  - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or
  - interfere with the recovery of an ecological community.

Impact of the Proposed 'Temperate Highland Peat Swamps on Sandstone'

This swamp community occurs along Long Swamp Creek, downstream of the Site, approximately 200 metres to the west. A groundwater impact assessment undertaken for the Proposal has concluded that the Proposal would not directly impact upon this swamp. The groundwater impact assessment also considers the potential for indirect impact upon the swamp; see Part 2 of the Specialist Consultant Studies Compendium.

Significant Impact Criteria for Vulnerable Species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

Impact of the Proposed on recorded Vulnerable Species

The species known and possibly occurring in the study area are indicated in Table 3. Of these species, two have been recorded on the quarry site; these species are discussed below.

The population of *Eucalyptus aquatica* is well away from the proposed development; see Figure 9. There is unlikely to be a direct impact upon this population from the Proposal.

Three plants of *Phyllota humifusa* were located in the footprint of the proposed quarry; many other plants were found in the western part of the property, outside the area of impact and within the offset area. Many thousands of plants occur on land on the southern side of the highway. The three plants to be lost is not considered to be an important population. The loss of these three plants would not fragment an existing important population, adversely affect habitat critical to the survival of a species or interfere substantially with the recovery of the species. The plants do not represent an important population of the species.

Significant Impact Criteria for Listed Migratory Species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

An area of "important habitat" for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. An "ecologically significant proportion" of a population therefore varies from species to species. In relation to migratory species, "population" means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

Impact of the Proposed development on Listed Migratory Species

The Proposal is not likely to have a significant impact on listed migratory species. There is no "important habitat" in the area for such species and the habitats in the vicinity of the site are not likely to support an ecologically important proportion of a population of such species.

Conclusion, EPBC Act

In our opinion, the development of the Sutton Forest Sand Quarry at Sutton Forest (the 'action') is not likely to have a significant impact on matters of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act*. Referral to the Commonwealth Minister for the Environment for assessment and approval is therefore not warranted.

7.4 Illawarra Regional Environmental Plan

The study area is located within a wildlife corridor identified in the *Illawarra Regional Environmental Plan No. 1,* as amended (Department of Planning 2010, on line). The provisions in the Plan that relate to wildlife corridors appear below. The extent of the wildlife corridor in the area is shown in **Figure 13**, the figure also shows the boundaries of the property.

The following extracts are from the *Illawarra Regional Environmental Plan No. 1.*

11 Objectives

The objectives relating to rural lands are:

(c) to provide for wildlife movement between major protected wildlife habitats,

15 Wildlife corridors

(1) The consent authority shall not grant consent to the carrying out of development having the effect of bridging, obstructing or otherwise affecting waterways on land shown on the map as a wildlife corridor unless it is satisfied that reasonable opportunities for wildlife movement will be maintained.

(2) The consent authority must not grant development consent to an application to carry out development on land shown on the map as a wildlife corridor that, in the opinion of the consent authority, will involve significant tree felling or vegetation clearance unless it is satisfied that:
(a) the development will be so managed as to not have any long-term detrimental impact on opportunities for wildlife movement, or
(b) the development is designed to enhance the retention and augmentation of vegetation native to the area.
(3) Subclause (2) does not apply to land zoned for urban purposes.

17 Wildlife corridors
A draft local environmental plan applying to land shown on the map as wildlife corridor shall not alter the provisions in existing planning instruments applying to the land if, in the opinion of the Director, such new provisions would jeopardise the function of the corridor."
The purpose of the designated wildlife corridor in the Sutton Forest area is to facilitate the interaction of fauna species through the upper Wollondilly River catchment to the north, including the extensive natural areas in the Warragamba Water Catchment Area, and Morton National Park to the south of Bundanoon and Wingello. The study area covers a substantial part of the forested section of the wildlife corridor between Paddys River in the west and Penrose State Forest in the east. The potential impact of the development proposal, particularly in relation to the cumulative impact of this development, requires assessment.

The property occurs on the eastern side of the delineated wildlife corridor; as shown in **Figure 13**. The proposed quarry area extends across about one kilometre (13%) of the corridor width at that point. The mitigation and offsetting proposals are designed in such a way that the Proposal will not significantly interrupt this corridor. The bushland area not removed by the proposed quarry (part of the offset area) will be retained in perpetuity and secure a large portion of this corridor. Once quarrying is completed, revegetation of the quarry site will return some areas of native vegetation to forest and hence re-instate function as a wildlife corridor. A connectivity assessment is provided in Section 3.1.2 of the *Biodiversity Offsets Assessment* prepared by Niche Environment and Heritage (2016) and presented as Part 11 of Volume 3 of the *Specialist Consultant Studies Compendium* and concludes that the connectivity width would remain greater than 500 metres before and after the development.

7.5 SEPP No.44 - Koala Habitat Protection

State Environmental Planning Policy No.44 - Koala Habitat Protection (SEPP 44) (New South Wales 1995) encourages the conservation and management of natural vegetation providing habitat for Koalas, to ensure a permanent free-living population over the species' present range and to reverse the current trend of Koala population decline. SEPP 44 applies in the local government areas listed under Appendix 1 of the policy.

SEPP 44 helps to identify "potential Koala habitat", i.e. "areas of native vegetation where the trees of the types listed in Schedule 2 [of SEPP 44] constitute at least 15% of the total number of trees in the upper or lower strata of the tree component". If no Schedule 2 tree species are present or if they constitute less than 15% of the total number of trees present, then no further provisions of the Policy apply.

If more than 15% of the trees in the area are Schedule 2 tree species, then an assessment must be made by a qualified person to determine whether the area contains "core Koala habitat", a term applied to "an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

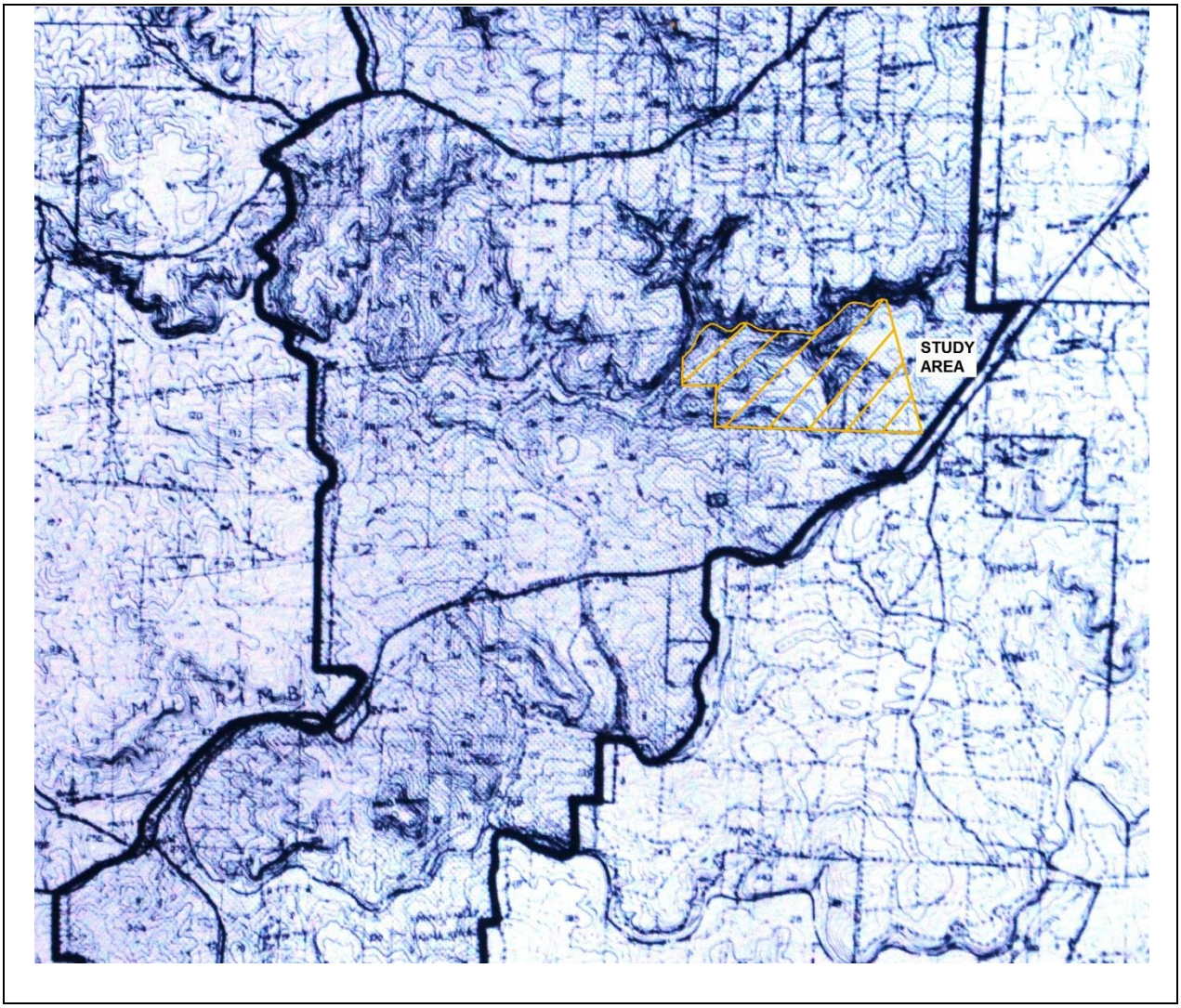

Figure 12 Location of the Study Area in Relation to the Wildlife Corridor

Wingecarribee is one of the local government areas in which *State Environmental Planning Policy No.44 - Koala Habitat Protection* (SEPP 44) applies. As already concluded in Section 6.1 of this report (see **Table 3**), Koalas are not likely to occur within the site.

Two Schedule 2 Koala food trees occur in the study area, Ribbon Gum *Eucalyptus viminalis* and Grey Gum *Eucalyptus punctata*. However, less than 15% of the trees present are of these tree species. The area is therefore not "potential Koala habitat" and no further provisions of the SEPP 44 apply.

7.6 Mitigation and Offsetting Measures

Biodiversity offsetting is being investigated by others for the impact of the Quarry; this will be described in other documents accompanying the EIS. Because a section of the wildlife corridor is affected by the proposed Proposal, mitigation is also required for the clearing that will take place as a result of the Quarry. Essentially, this mitigation requires the staged reforestation of part of the quarry land once quarrying has been completed and the careful use of animal-proof fencing.

The reforestation will take place progressively as the quarry is worked. Maximum use will be made of the material being cleared, i.e. timber debris, litter, cleared vegetation and 'topsoil'. These matters will be specifically covered in the Quarry Environmental Management Plan. The primary method of introducing

plants to the reforestation area is through the spreading of propagation material in the 'topsoil' and in the cleared vegetation (e.g. seeds, rhizomes) gained from the clearing operations. **Table 13** lists trees and shrubs that would be suitable and that are available locally for revegetation activities. Other suitable species can be chosen from the plant list in the appendices to this report.

Table 13
Indigenous species suitable for quarry area

Species	Common Name	Mature Height
Trees		
Acacia mearnsii	Black Wattle	15m
Allocasuarina littoralis	Black Sheoak	15m
Banksia marginata	Silver Banksia	6m
Eucalyptus agglomerata	Blue-leaved Stringybark	20m+
Eucalyptus dives	Broad-leaved Peppermint	15m+
Eucalyptus mannifera	Brittle Gum	15m+
Eucalyptus piperita	Sydney Peppermint	20m+
Eucalyptus punctata	Grey Gum	20m+
Eucalyptus radiata	Narrow-leaved Peppermint	20m+
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum	15m+
Eucalyptus sieberi	Silvertop Ash	20m+
Shrubs		
Acacia longifolia	Golden Wattle	3m
Acacia terminalis	Sunshine Wattle	2m
Banksia spinulosa	Hairpin Banksia	1.5m
Dodonaea triquetra	Large-leaved Hop-bush	2m
Hakea dactyloides	Finger Hakea	1.5m
Hakea sericea	Silky Hakea	1.5m
Indigofera australis	Austral Indigo	1m
Kunzea ambigua	White Kunzea	2m
Leptospermum polygalifolium	Yellow Teatree	2m

8. CONCLUSION

This report documents the results of a comprehensive flora and fauna field survey of the study area, including the employment of targeted survey techniques to locate threatened species of plants and animals, and ecological communities. Other significant conservation values, such as rare plants, locally significant communities, and a regional wildlife corridor, have also been investigated and assessed as part of the investigation.

The study identified two threatened plants and one threatened ecological community on or adjacent to the property, along with one additional plant species considered to be of conservation importance. One species occurs on the quarry footprint, namely *Phyllota humifusa*; that population is of three plants. The study also identified nine threatened animal species; habitat for all of the recorded threatened animal species is present on the Site. These species are Powerful Owl, Gang-gang Cockatoo, Glossy Black-Cockatoo, Scarlet Robin, Varied Sittella and four species of bat, namely Large Bentwing-bat, Greater Broad-nosed Bat, Eastern Falsistrelle and Large-eared Pied Bat. The locations of all relevant significant conservation values, such as threatened species and communities, have been mapped.

The impact of the proposed quarry upon the above features of conservation value has been assessed under the relevant legislation and polices, namely the *EP&A Act 1979* (Part 3A matters), the document titled *Threatened Species Survey & Assessment: Guidelines for Developments and Activities*(DECC 2004), *SEPP No. 44 - Koala Habitat Protection*, the Director-General's Requirements for this Proposal, and the *EPBC Act 1999* (Commonwealth).

The following main conclusions have been reached regarding the impact of the Proposal.

- The Quarry is substantially located on land supporting forest, including regrowth forest several decades old. The Proposal will result in the clearing of approximately 62.3 hectares of forest, 46 percent of which is regrowth forest.

- The forest and other habitats on the property support at least nine (9) species of vulnerable animal and two threatened plant species.

- Removal of over 60 hectares of habitat is a significant loss of local habitat. An assessment under Section 7.2 and Section 7.3 of the Biodiversity Conservation Act 2016 found that the Proposal is likely to have a significant impact on listed threatened birds and thus this area should be subject to a Biodiversity Offsetting Assessment and calculated impacts (credits) offset in accordance with the Biodiversity Offset scheme of the Biodiversity Conservation Act 2016.

- Assessment under the *EPBC Act 1999* (Commonwealth) found that the Proposal is not likely to significantly impact upon a matter of national environmental significance (NES) so it is not likely that it is a 'controlled action' under the act.

- The study area is within a regional wildlife corridor identified in the *Illawarra Regional Environmental Plan No. 1*; see **Figure 8**. The mitigation and offsetting proposals are designed in such a way that the Proposal will not significantly interrupt this corridor in the long term.

- An assessment under *SEPP No. 44 - Koala Habitat Protection*, found that the Proposal would not impact upon the Koala or its habitat.

Recommendations

1) Because of the residual impacts of the Proposal, biodiversity offset strategy should be developed. The latter is the chosen course and this has been set out in the EIS (Section 2.19) in a report by Niche (2016).

2) The footprint of the quarry and infrastructure should minimise incursion into the natural forests and woodlands as these provide habitat for several threatened animal species. Of particular note are the stands of tall forest in the gullies, the woodland on deep sandy soils supporting *Phyllota humifusa* in the northwest, the large rock outcrops and the swamp vegetation in the Long Swamp Creek valley. These areas are largely within the 'offset area'.

3) A Landscape and Rehabilitation Management Plan should be prepared that deals with, as a minimum, reducing direct and indirect impact and avoiding significant ecological features within the Site and to establish and guide protocols for progressively rehabilitating the Site.

4) Those parts of the property not required for quarry operations or farming pursuits should be rehabilitated to forest, with a strong emphasis on planting/encouraging *Allocasuarina littoralis*, the Glossy Black-Cockatoo food tree species. This and other relevant matters should be specifically covered in the Landscape and Rehabilitation Management Plan.

* * * * *

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Appendices

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* Note: This Appendix is only available on the digital version of this document

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Appendix 1
Flora survey sheets for the study area

Survey Sheet - Vegetation Plot			**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose			**Plot No.** A	**Photo:** yes
Location: East end of quarry footprint.			**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Regrowth Peppermint Forest			
GPS (centre): 56 0243272 6165996 (WGS84)			**Soil:** Deep sand.	
Land Tenure: Freehold	**Alt:** 690 metres		**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north		**Topography:** Broad flat.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.				
Trees (2 spp.)	dch measurements			
Eucalyptus piperita (17)	34.29.19.31.36.31.8.9.3.4.27.29.26.5.32.28.10			
Allocasuarina littoralis (1)	6			
Shrubs (6 spp.)				
Acacia terminalis	3	*Leptospermum polygalifolium*	1	
Cassinia aculeata	1	*Persoonia linearis*	1	
Eucalyptus piperita	1	*Persoonia mollis*	2	
Ground Cover (32 spp.)				
Acacia longifolia	1	*Lomamdra longifolia*	2	
Acacia terminalis	2	*Lomabdra multiflora*	1	
Acacia ulicifolia	1	*Lomandra obliqua*	1	
Amperea xiphoclada	1	*Lomatia ilicifolia*	1	
Austrostipa sp.	1	*Microlaena stipoides*	2	
Billardiera scandens	1	*Monotoca scoparia*	1	
Cassinia aculeata	2	*Patersonia sericea*	1	
Dianella revoluta	3	*Persoonia mollis*	2	
Dillwynia parvifolia	1	*Platyscae linearifolia*	2	
Entolasia stricta	2	*Polyscias sambucifolia*	1	
Gahnia sieberiana	1	*Pomax umbellata*	1	
Gonocarpus teucrioides	1	*Poranthera microphylla*	1	
Goodenia hederacea	3	*Pteridium esculentum*	4	
Hibbertia empetrifolia	2	*Stypandra glauca*	1	
Lepidosperma filiforme	1	*Viola hederacea*	2	
Leucopogon lanceolatus	1	* *Hypochaeris radicata*	1	

Survey Sheet - Vegetation Plot		**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose		**Plot No.** B	**Photo:** yes
Location: Southern-central side of quarry footprint.		**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Regrowth Peppermint Forest		
GPS (centre): 56 0243046 6166190 (WGS84)		**Soil:** Deep sand.	
Land Tenure: Freehold	**Alt:** 690 metres	**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north	**Topography:** Broad flat.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.			
Trees (3 spp.)	dch measurements		
Eucalyptus piperita (31)	16.25.12.26.11.19.12.20.14.26.22.11.33.22.21.23.17.12.8.25.23.10.8. 18.9.15.7.6.23.9.		
Eucalyptus agglomerata (9)	39.26.24.19.7.8.26.22.25		
Eucalyptus sieberi (2)	25.22		
Shrubs (9 spp.)			
Acacia terminalis	3	*Persoonia linearis*	3
Allocasuarina littoralis	1	*Petrophile pedunculata*	1
Bossiaea obcordata	1	*Podolobium ilicifolium*	3
Eucalyptus piperita	2	*Pomaderris andromedifolia*	1
Hakea sericea	1		
Ground Cover (39 spp.)		*Lepidosperma laterale*	1
Acacia terminalis	1	*Leucopogon lanceolatus*	1
Allocasuarina littoralis	1	*Lomandra sp.*	1
Amperea xiphoclada	1	*Lomatia ilicifolia*	1
Bossiaea obcordata	2	*Mirbelia platylobioides*	2
Bracteantha bracteata	1	*Monotoca scoparia*	1
Cassytha pubescens	1	*Patersonia sericea*	1
Caustis flexuosa	1	*Persoonia laurina*	1
Dampiera purpurea	1	*Persoonia linearis*	1
Daviesia alata	1	*Persoonia mollis*	1
Dianella revoluta	1	*Platysace linearifolia*	1
Dillwynia parvifolia	4	*Podolobium ilicifolium*	1
Entolasia stricta	1	*Pomax umbellata*	1
Eucalyptus piperita	1	*Poranthera microphylla*	1
Eucalyptus sieberi	1	*Pteridium esculentum*	3
Gompholobium huegelii	1	*Stackhousia monogyna*	1
Goodenia hederacea	1	*Rhytidosporum procumbens*	1
Hibbertia empetrifolia	1	*Xanthorrhoea concava*	1
Hibbertia obtusifolia	1	Sedge	1
Hovea linearis	1	* *Hypochaeris radicata*	1

Survey Sheet - Vegetation Plot				**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose				**Plot No.** C	**Photo:** yes
Location: Southern-western side of quarry footprint.				**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Peppermint Forest (largely undisturbed)				
GPS (centre): 56 0242857 6166260 (WGS84)				**Soil:** Deep sand.	
Land Tenure: Freehold	**Alt:** 680 metres			**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north			**Topography:** Broad flat.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.					
Trees (4 spp.)		dch measurements			
Eucalyptus piperita (19)		35.15.93.38.12.78.13.13.51.13.10.8.6.6.4.13.38.8.4			
Eucalyptus dives (4)	10.8.6.9		*Eucalyptus agglomerata* (2)	12.15	
Allocasuarina littoralis (1)	4				
Shrubs (14 spp.)					
Acacia leucolobia	1		*Hakea sericea*	1	
Acacia elongata	2		*Isopogon anemonifolius*	1	
Acacia terminalis	2		*Persoonia levis*	1	
Allocasuarina littoralis	1		*Persoonia linearis*	1	
Banksia spinulosa	3		*Persoonia mollis*	1	
Eucalyptus piperita	1		*Petrophile pedunculata*	4	
Hakea dactyloides	1		*Podolobium ilicifolium*	1	
Ground Cover (40 spp.)					
Acacia leucolobia	1		*Hibbertia empetrifolia*	2	
Acacia elongata	1		*Hibbertia obtusifolia*	1	
Acacia longifolia	1		*Hovea linearis*	1	
Acacia terminalis	1		*Isopogon anemonifolius*	1	
Acacia ulicifolia	1		*Lomandra obliqua*	1	
Amperea xiphoclada	2		*Lomatia ilicifolia*	2	
Austrostipa sp.	1		*Mirbelia platylobioides*	1	
Banksia spinulosa	1		*Monotoca scoparia*	1	
Bossiaea obcordata	4		*Patersonia longifolia*	1	
Brachyloma daphnoides	1		*Patersonia sericea*	2	
Bracteantha bracteata	1		*Persoonia levis*	1	
Cassytha pubescens	1		*Persoonia laurina*	1	
Dampiera stricta	1		*Pimelea linifolia*	1	
Daviesia ulicifolia	1		*Platysace linearifolia*	2	
Dillwynia parvifolia	1		*Pomax umbellata*	1	
Entolasia stricta	1		*Poranthera microphylla*	1	
Eucalyptus piperita	1		*Pteridium esculentum*	2	
Gompholobium huegelii	1		*Tetratheca thymifolia*	1	
Goodenia hederacea	2		*Xanthorrhoea concava*	1	
Hakea sericea	1		sedge	1	

Survey Sheet - Vegetation Plot			**Plot Size:** 20m x 20m	**Kevin Mills & Associates**
Site Name: Proposed Sutton Quarry, Penrose			**Plot No.** D	**Photo:** yes
Location: Western-central side of quarry footprint.			**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Scribbly Gum Woodland (undisturbed)			
GPS (centre): 56 0242841 6166383 (WGS84)			**Soil:** Deep sand.	
Land Tenure: freehold	**Alt:** 670 metres		**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north		**Topography:** Broad flat.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.				
Trees (3 spp.)	dch measurements			
Eucalyptus sclerophylla (13)	18.26.35.14.34.38.15.24.30.22.20.4.30			
Eucalyptus piperita (1)	6			
Eucalyptus dives (10)	32.10.11.11.5.5.4.8.5.6			
Shrubs (11 spp.)				
Acacia leucolobia	1	*Eucalyptus sclerophylla*	1	
Acacia terminalis	1	*Hakea dactyloides*	1	
Acacia ulicifolia	1	*Hakea sericea*	3	
Allocasuarina nana	1	*Persoonia mollis*	1	
Banksia spinulosa	1	*Petrophile pedunculata*	4	
Eucalyptus dives	2			
Ground Cover (39 spp.)		*Hakea dactyloides*	1	
Acacia leucolobia	1	*Hibbertia* sp.	1	
Amperea xiphoclada	1	*Hovea linearis*	1	
Austrostipa sp.	1	*Isopogon anemonifolius*	1	
Banksia spinulosa	1	*Lepyrodia scariosa*	1	
Billardiera scandens	1	*Lomatia ilicifolia*	1	
Bossiaea heterophylla	1	*Mirbelia platylobioides*	1	
Bossiaea obcordata	3	*Monotoca scoparia*	1	
Brachyloma daphnoides	1	*Patersonia longifolia*	1	
Caustis flexuosa	1	*Patersonia sericea*	2	
Cassytha pubescens	1	*Persoonia mollis*	1	
Conospermum taxifolium	1	*Persoonia laurina*	1	
Dampiera purpurea	1	*Persoonia levis*	1	
Dampiera stricta	1	*Persoonia linearis*	1	
Dianella revoluta	3	*Phyllota humifusa*	1	
Dillwynia parvifolia	3	*Pimelea linifolia*	1	
Entolasia stricta	1	*Platysace linearifolia*	1	
Eucalyptus dives	1	*Pomax umbellata*	1	
Gompholobium huegelii	1	*Poranthera microphylla*	1	
Goodenia hederacea	2	*Tetratheca thymifolia*	1	

Survey Sheet - Vegetation Plot			**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose			**Plot No.** E	**Photo:** yes
Location: North-westren corner of quarry footprint.			**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Scribbly-Gum - Stringybark Forest			
GPS (centre): 56 0242756 6166556 (WGS84)			**Soil:** Deep sand., some sandstone.	
Land Tenure: freehold	**Alt:** 680 metres		**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north		**Topography:** Ridge crest.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.				
Trees (4 spp.)	dch measurements			
Eucalyptus agglomerata (1)	88	*Eucalyptus sclerophylla* (3)	7.14.47	
Eucalyptus dives (9)	14.6.9.12.12.10.6.5.11	*Leptospermum trinervium* (1)	22	

Shrubs (11 spp.)		*Banksia spinulsoa*	1
Acacia leucolobia	1	*Eucalyptus agglomerata*	1
Acacia elongata	1	*Eucalyptus dives*	1
Acacia obtusifolia	1	*Hakea sericea*	3
Acacia terminalis	2	*Persoonia levis*	2
Allocasuarina littoralis	1	*Petrophile pedunculata*	3
Ground Cover (42 spp.)		*Hakea sericea*	2
Acacia elongata	1	*Hibbertia empetrifolia*	1
Acacia obtusifolia	1	*Hibbertia obtusifolia*	1
Acacia terminalis	1	*Isopogon anemonifolius*	2
Acacia ulicifolia	1	*Leptospermum trinervium*	1
Amperea xiphoclada	1	*Lomandra glauca*	1
Banksia spinulosa	1	*Lomatia ilicifolia*	1
Billardiera scandens	1	*Melichrus urceolaris*	1
Bossiaea obcordata	3	*Monotoca scoparia*	1
Brachyloma daphnoides	1	*Patersonia longifolia*	1
Cassytha pubescens	1	*Patersonia sericea*	2
Caustis flexuosa	1	*Persoonia laurina*	1
Dampiera purpurea	1	*Persoonia levis*	1
Dampiera stricta	1	*Persoonia linearis*	1
Daviesia ulicifolia	1	*Persoonia mollis*	1
Dianella revoluta	3	*Petrophile pedunculata*	1
Dillwynia parvifolia	2	*Pimelea linifolia*	1
Entolasia stricta	1	*Platysace linearifolia*	1
Eucalyptus agglomerata	1	*Pteridium esculentum*	3
Eucalyptus dives	1	*Xanthorrhoea concava*	1
Gompholobium huegelii	1	*Sedge*	1
Goodenia hederacea	2		

Survey Sheet - Vegetation Plot			**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose			**Plot No.** F	**Photo:** yes
Location: Norethern-central side of quarry footprint.			**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Regrowth Peppermint Forest			
GPS (centre): 56 0243214 6166281 (WGS84)			**Soil:** Deep sand.	
Land Tenure: freehold	**Alt:** 680 metres		**Geology:** Sandstone	
Slope: slight slope.	**Aspect:** north		**Topography:** Small knoll.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.				
Trees (1 spp.)	dch measurements			
Eucalyptus sieberi (20)	12.25.18.23.35.19.22.26.18.25.35.10.10.10.22.11.30.21.33.28			
Shrubs (2 spp.)				
Hakea sericea	1	*Petrophile pedunculata*	1	
Ground Cover (24 spp.)				
Amperea xiphoclada	1	*Monotoca scoparia*	1	
Bossiaea obcordata	2	*Patersonia sericea*	1	
Caustis flexuosa	1	*Persoonia laurina*	1	
Dampiera stricta	1	*Persoonia levis*	1	
Dillwynia parvifolia	3	*Persoonia linearis*	1	
Entolasia stricta	1	*Persoonia mollis*	1	
Hakea dactyloides	1	*Pimelea linifolia*	1	
Hibbertia obtusifolia	1	*Platysace linearifolia*	1	
Lomandra glauca	1	*Pomax umbellata*	1	
Lomandra obliqua	1	*Pteridium esculentum*	1	
Lomatia ilicifolia	1	*Rhytidosporum procumbens*	1	
Mirbelia platylobioides	1	*Xanthorrhoea concava*	2	

Survey Sheet - Vegetation Plot		**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose		**Plot No.** G	**Photo:** yes
Location: Northern-central side of quarry footprint.		**Recorder:** K. Mills	
Date: 11/09/12	**Community:** Regrowth Peppermint Forest		
GPS (centre): 56 0243211 6166376 (WGS84)		**Soil:** Deep sand.	
Land Tenure: freehold	**Alt:** 680 metres	**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north	**Topography:** Broad flat.	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.			
Trees (6 spp.)	dch measurements		
Eucalyptus sclerophylla (16)	35.9.7.12.21.10.12.4.7.32.28.24.25.28.28.19		
Eucalyptus dives (4)	10.6.7.8		
Eucalyptus mannifera (2)	19.22		
Hakea sericea (3)	9.6.9		
Persoonia linearis (2)	12.8		
Pinus radiata * (1)	5		
Shrubs (11 spp.)		*Hakea dactyloides*	1
Acacia elongata	1	*Hakea sericea*	3
Banksia spinulosa	2	*Isopogon anemonifolius*	1
Bossiaea obcordata	1	*Persoonia linearis*	1
Eucalyptus dives	1	*Persoonia levis*	1
Eucalyptus sclerophylla	1	*Petrophile pedunculata*	3
Ground Cover (36 spp.)			
Acacia leucolobia	1	*Isopogon anemonifolius*	1
Amperea xiphoclada	1	*Lepidosperma laterale*	1
Billardeira scandens	1	*Lomabdra glauca*	1
Bossiaea obcordata	2	*Lomandra obliqua*	1
Brachyloma daphnoides	1	*Lomandra sp.*	1
Bracteantha bracteata	1	*Lomatia ilicifolia*	1
Conospermum taxifolium	2	*Monotoca scoparia*	1
Dampiera stricta	1	*Patersonia longifolia*	1
Dianella revoluta	1	*Patersonia sericea*	2
Eucalyptus sclerophylla	1	*Persoonia laurina*	1
Gompholobium huegelii	1	*Persoonia mollis*	1
Gonocarpus teucrioides	1	*Petrophile pedunculata*	1
Goodenia hederacea	2	*Pimelea linifolia*	1
Hakea dactyloides	1	*Pinus radiata**	1
Hakea sericea	1	*Platysace linearifolia*	1
Hardenbergia violacea	1	*Poa* sp. *(small)*	1
Hibbertia obtusifolia	1	*Pteridium esculentum*	2
Hibbertia sp.	1	*Xanthorrhoea concava*	2

Survey Sheet - Vegetation Plot		**Plot Size:** 20m x 20m	**Kevin Mills & Associates**
Site Name: Proposed Sutton Quarry, Penrose		**Plot No.** H	**Photo:** yes
Location: Ridge south of quarry footprint.			**Recorder:** K. Mills
Date: 18/09/12	**Community:** Stringybark Forest		
GPS (centre): 56 0242965 6166034 (WGS84)		**Soil:** Rocky and sandy.	
Land Tenure: freehold	**Alt:** 710 metres	**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north	**Topography:** Ridge crest	

Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.

Trees (3 spp.)	dch measurements
Eucalyptus agglomerata (18)	48.47.72.16.3.7.17.6.6.73.14.11.11.14.15.20.21.47
Eucalyptus sieberi (13)	22.7.8.18.10.11.6.13.10.4.6.6.16
Allocasuarina littoralis (2)	16.21

Shrubs (10 spp.)			
Acacia longifolia	1	*Hakea sericea*	3
Acacia terminalis	1	*Persoonia linearis*	1
Acacia ulicifolia	1	*Persoonia mollis*	1
Allocasuarina littoralis	1	*Petrophile pedunculata*	1
Eucalyptus agglomerata	3	*Podolobium ilicifolium*	2
Ground Cover (43 spp.)		*Helichrysum leucopsidium*	1
Arrhenechthites mixta	1	*Hibbertia empetrifolia*	3
Acacia terminalis	1	*Lepidosperma laterale*	1
Acacia ulicifolia	1	*Leucopogon lanceolatus*	1
Allocasuarina littoralis	1	*Lomandra multiflora*	1
Austrostipa sp.	1	*Lomandra filiformis*	1
Billardiera scandens	1	*Lomandra obliqua*	1
Bossiaea obcordata	2	*Lomatia ilicifolia*	1
Brachyloma daphnoides	1	*Opercularia aspera*	1
Comesperma volubile	1	*Patersonia sericea*	2
Coopernookia barbata	3	*Persoonia linearis*	1
Dampiera purpurea	1	*Petrophile pedunculata*	1
Dampiera stricta	2	*Phyllanthus hirtellus*	1
Daviesia ulicifolia	1	*Pimelea linifolia*	1
Dianella revoluta	3	*Platysace linearifolia*	1
Entolasia stricta	1	*Platysace lanceolata*	1
Eucalyptus agglomerata	1	*Pomaderris andromedifolia*	1
Eucalyptus sieberi	1	*Pomax umbellata*	1
Gahnia sieberiana	1	*Pultenaea linifolia*	1
Gonocarpus teucrioides	1	*Stypandra glauca*	3
Goodenia hederacea	3	*Tetratheca thymifolia*	1
Hakea sericea	1	*Xanthosia tridentata*	1

Survey Sheet - Vegetation Plot				**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose				**Plot No.** J	**Photo:** yes
Location: Edge of gully to east of quarry site				**Recorder:** K. Mills	
Date: 10/09/13	**Community:** *E. piperita – E. agglomerata* Open Forest				
GPS (centre): 56 0243300 6166202 (WGS84)				**Soil:** Sandy.	
Land Tenure: freehold	**Alt:** 675 metres			**Geology:** Sandstone	
Slope: gentle slope	**Aspect:** east			**Topography:** Upper gully side	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.					
Trees (8 spp.)	dch measurements				
Eucalyptus piperita (7)	9.10.6.7.4.8.7.35				
Eucalyptus agglomerata (12)	48.17.20.17.9.16.18.20.26.21.54.18				
Eucalyptus dives (1)	10	*Hakea sericea* (1)	4		
Eucalyptus sclerophylla (5)	12.31.30.27.8	*Persoonia levis* (1)	8		
Allocasuarina littoralis (1)	5	*Persoonia linearis* (4)	6.7.3.3		
Shrubs (10 spp.)					
Acacia obtusifolia	1	*Hakea sericea*	3		
Acacia terminalis	3	*Persoonia linearis*	3		
Banksia spinulosa	1	*Persoonia levis*	3		
Eucalyptus agglomerata	1	*Petrophile pedunculata*	3		
Hakea dactyloides	2	*Podolobium ilicifolium*	3		
Ground Cover (37 spp.)		*Lomandra multiflora*	1		
Arrhenechthites mixta	1	*Lomandra cylindrica*	2		
Acacia terminalis	1	*Lomandra obliqua*	2		
Acacia ulicifolia	1	*Lomatia ilicifolia*	1		
Amperea xiphoclada	1	*Monotoca scoparia*	1		
Billardiera scandens	1	*Patersonia sericea*	1		
Bossiaea obcordata	2	*Persoonia laurina*	1		
Cassinia aculeata	1	*Persoonia levis*	1		
Dampiera purpurea	1	*Persoonia linearis*	1		
Dianella revoluta	1	*Persoonia mollis*	1		
Dillwynia parvifolia	1	*Pimelea linifolia*	1		
Entolasia stricta	2	*Platysace linearifolia*	1		
Goodenia hederacea	2	*Pteridium esculentum*	3		
Hakea sericea	1	*Poa* small tussock	1		
Hakea dactyloides	1	*Pomax umbellata*	1		
Hardenbergia violacea	1	*Poranthera microphylla*	1		
Hibbertia empetrifolia	1	*Tetratheca thymifolia*	1		
Hybanthus monopetalus	1	*Viola hederacea*	1		
Lagenifera stipitata	1	* *Hypochaeris radicata*	1		

Survey Sheet - Vegetation Plot			**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose			**Plot No.** K	**Photo:** yes
Location: Central-northern edge of quarry footprint			**Recorder:** K. Mills	
Date: 10/09/13	**Community:** *E. sclerophylla – E. dives* Woodland			
GPS (centre): 56 0243161 6166500 (WGS84)			**Soil:** Rocky and sandy.	
Land Tenure: freehold	**Alt:** 660 metres		**Geology:** Sandstone	
Slope: gentle slope	**Aspect:** north		**Topography:** Mid-slope	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.				
Trees (2 spp.)	dch measurements			
Eucalyptus sclerophylla (9)	48.32.101.10.14.8.29.22.27			
Eucalyptus dives (15)	6.12.13.4.4.12.4.8.3.16.9.8.11.9.21			
Shrubs (8 spp.)				
Acacia elongata	3	*Hakea dactyloides*	3	
Banksia spinulosa	4	*Hakea sericea*	1	
Bossiaea obcordata	3	*Leptospermum polygalifolium*	1	
Eucalyptus dives	3	*Persoonia linearis*	3	
Ground Cover (42 spp.)		*Petrophile pedunculata*	3	
Acacia brownii	1	*Lomandra cylindrica*	1	
Acacia buxifolia	1	*Lomandra glauca*	1	
Amperea xiphoclada	1	*Lomandra longifolia*	1	
Billardiera scandens	1	*Lomabdra mutliflora*	1	
Bracteantha bracteata	1	*Lomandra obliqua*	1	
Caesia parviflora	1	*Lomatia ilicifolia*	1	
Cassinia aculeata	1	*Microlaena stipoides*	1	
Caustis flexuosa	1	*Mirbelia platylobioides*	1	
Dampiera purpurea	1	*Monotoca scoparia*	1	
Dampiera stricta	1	*Patersonia sericea*	1	
Diuris sulphurea	1	*Persoonia mollis*	1	
Dianella revoluta	3	*Petrophile pedunculata*	1	
Dillwynia sericea	1	*Platysace linearifolia*	2	
Gonocarpus teucrioides	1	*Poranthera microphylla*	1	
Goodenia hederacea	1	*Pomax umbellata*	1	
Hakea sericea	1	*Poa* small tussock	1	
Hardenbergia violacea	1	*Pteridium esculentum*	1	
Hibbertia empetrifolia	1	*Tetratheca thymifolia*	1	
Hovea linearis	1	**Conyza* sp. (leaves only)	1	
Lagenifera stipitata	1	* *Hypochaeris radicata*	1	
Lepidosperma laterale	1			

Survey Sheet - Vegetation Plot		**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose		**Plot No.** L	**Photo:** yes
Location: Southwest corner of quary footprint		**Recorder:** K. Mills	
Date: 10/09/13	**Community:** *E. piperita – E. agglomerata* Open Forest		
GPS (centre): 56 0242662 6166260 (WGS84)		**Soil:** Rocky and sandy.	
Land Tenure: freehold	**Alt:** 680 metres	**Geology:** Sandstone	
Slope: very gentle slope	**Aspect:** north	**Topography:** Upper slope	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.			
Trees (4 spp.)	dch measurements		
Eucalyptus agglomerata (6)	16.18.17.8.51.22		
Eucalyptus piperita (4)	137.13.35.30		
Eucalyptus sieberi (2)	9.20		
Persoonia linearis (2)	5.3		
Shrubs (11 spp.)		*Hakea sericea*	1
Acacia obtusifolia	1	*Persoonia levis*	1
Acacia terminalis	2	*Persoonia linearis*	2
Allocasuarina littoralis	1	*Persoonia mollis*	1
Eucalyptus agglomerata	1	*Petrophile pedunculata*	1
Hakea dactyloides	1	*Podolobium ilicifolium*	1
Ground Cover (38 spp.)			
Arrhenechthites mixta	1	*Lepidosperma laterale*	3
Acacia terminalis	1	*Leucopogon lanceolatus*	1
Allocasuarina littoralis	1	*Lomandra longifolia*	3
Amperea xiphoclada.	1	*Lomandra glauca*	1
Billardiera scandens	1	*Lomandra multiflora*	1
Bossiaea obcordata	3	*Lomandra obliqua*	1
Cassytha pubescens	1	*Lomatia ilicifolia*	1
Comesperma volubile	1	*Patersonia sericea*	1
Coopernookia barbata	2	*Persoonia linearis*	1
Dampiera purpurea	1	*Phyllanthus hirtellus*	1
Dianella revoluta	1	*Platysace linearifolia*	2
Entolasia stricta	1	*Podolobium ilicifolium*	1
Eucalyptus agglomerata	1	*Polyscias sambucifolia*	1
Goodenia hederacea	1	*Pomax umbellata*	1
Hibbertia empetrifolia	2	*Poranthera hirtellus*	1
Hibbertia obtusifolia	1	*Pteridium esculentum*	3
Hybanthus monopetalus	1	*Stackhousia monogyna*	1
Melichrus urceolatus	1	*Tetratheca thymifolia*	1
Lepidosperma filiforme	1	* *Hypochaeris radicata*	1

Survey Sheet - Vegetation Plot		**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose		**Plot No.** M	**Photo:** yes
Location: Ridge southwest of quary footprint		**Recorder:** K. Mills	
Date: 10/09/13	**Community:** *E. agglomerata – E. sieberi – Allocasuarina littoralis* Open Forest		
GPS (centre): 56 0242536 6166194 (WGS84)		**Soil:** Rocky and sandy.	
Land Tenure: freehold	**Alt:** 700 metres	**Geology:** Sandstone	
Slope: almost level.	**Aspect:** north	**Topography:** Ridge crest	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.			
Trees (4 spp.)	dch measurements		
Eucalyptus agglomerata (10)	75.41.54.38.13.21.9.15.25.46		
Eucalyptus sieberi (33)	15.19.7.21.15.10.12.14.20.11.17.18.22.10.22.10.16.10.16.14.17.6.8.20.11.10.11.15. 10.9.		
Allocasuarina littoralis (6)	5.8.7.3.15.13		
Persoonia levis (4)	7.13.12.19		
Shrubs (4 spp.)			
Acacia elongata	1		
Acacia terminalis	1	*Helichrysum empetrifolia*	1
Allocasuarina littoralis	3	*Hibbertia obtusifolia*	1
Bossiaea obcordata	1	*Lepidosperma laterale*	2
Ground Cover (27spp.)		*Lomandra cylindrica*	1
Allocasuarina littoralis	1	*Lomandra obliqua*	1
Amperea xiphoclada	1	*Lomatia ilicifolia*	2
Bossiaea obcordata	1	*Patersonia sericea*	1
Brachyloma daphnoides	1	*Persoonia laurina*	1
Coopernookia barbata	2	*Persoonia linearis*	1
Dampiera purpurea	1	*Phyllanthus hirtellus*	1
Entolasia stricta	1	*Pimelea linifolia*	1
Eucalyptus agglomerata	1	*Platysace linearifolia*	1
Gonocarpus teucrioides	1	*Podolobium ilicifolium*	1
Goodenia hederacea	2	*Poranthera microphylla*	1
Hakea sericea	1	*Pomax umbellata*	1
Persoonia linearis	3	*Stypandra glauca*	3
Podolobium ilicifolium	2	*Xanthorrhoea concava*	1

Survey Sheet - Vegetation Plot		**Plot Size:** 20m x 20m **Kevin Mills & Associates**	
Site Name: Proposed Sutton Quarry, Penrose		**Plot No.** N	**Photo:** yes
Location: northeast of quarry footprint			**Recorder:** K. Mills
Date: 10/09/13	**Community:** *E. sclerophylla* Woodland		
GPS (centre): 56 0243492 6166358 (WGS84)		**Soil:** Rocky and sandy.	
Land Tenure: freehold	**Alt:** 660 metres	**Geology:** Sandstone	
Slope: gentle slope	**Aspect:** north	**Topography:** upper slope	
Species Cover: 1:<5% (uncommon); 2:<5% (common), 3:5-25%; 4:25-50%; 5:50-75%; 6:75-100%.			
Trees (4 spp.)	dch measurements		
Eucalyptus sclerophylla (11)	42.37.15.44.34.60.26.31.24.24.41		
Leptrospermum trinervium (39)	4.6.14.6.6.6.12.8.8.7.5.5.14.7.8.7.6.6.4.4.7.6.5.7.5.6.8.6.5.8.6.7.9.7.7.6.7.7.5		
Allocasuarina littoralis (3)	10.4.13		
Persoonia levis (1)	9		
Shrubs (10 spp.)			
Acacia elongata	1	*Bossiaea obcordata*	1
Acacia terminalis		*Hakea dactyloides*	3
Acacia ulicifolia	1	*Hakea sericea*	1
Allocasuarina littoralis	1	*Leptospermum trinervium*	3
Banksia spinulosa	3	*Petrophile pedunculata*	2
Ground Cover (30 spp.)			
Acacia ulicifolia	1	*Isopogon anemonifolius*	1
Allocasuarina littoralis	1	*Lomandra cylindrica*	1
Amperea xiphoclada	1	*Lomatia ilicifolia*	1
Billardiera procumbens	1	*Mirbelia rubiifolia*	1
Bossiaea obcordata	2	*Monotoca scoparia*	1
Caustis flexuosa	1	*Patersonia sericea*	1
Dillwynia parvifolia	2	*Persoonia mollis*	1
Entolasia stricta	1	*Petrophile pedunculata*	1
Eucalyptus sclerophylla	1	*Pimelea linifolia*	1
Gonocarpus teucrioides	1	*Platysace linearifolia*	2
Goodenia hederacea	1	*Xanthorrhoea concava*	1
Hakea dactyloides	1	Grass ?	1
Hakea sericea	1		

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Appendix 2
Fauna survey sheets for the study area

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose		**Site No. 01**
Location: Whole of the site.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 03/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 09.00	Finish: 12.30	EST or EDST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		
Australian Magpie		
Australian Raven		
Australian Wood Duck		
Black-faced Cuckoo-shrike		
Black-fronted Dotterel		
Brown Thornbill		
Brown-headed Honeyeater		
Buff-rumped Thornbill		
Crimson Rosella		
Eastern Rosella		
Eastern Spinebill		
Eastern Yellow Robin		
Fantailed Cuckoo		
Grey Butcherbird		
Grey Shrike-thrush		
Grey Teal		
Jacky Winter		
Laughing Kookaburra		
Noisy Friarbird		
Pied Currawong		
Red Wattlebird		
Scarlet Robin	female – 56 0244106 6165920	
Spotted Pardalote		
Spotted Quail-thrush		
Straw-necked Ibis		
Striated Pardalote		
Superb Fairy-wren		
Superb Lyrebird		
Welcome Swallow		
White-throated Treecreeper		
Willie Wagtail		
Yellow-faced Honeyeater		
Yellow-rumped Thornbill		
Yellow-tailed Black-cockatoo		
Crinia signifera	calls	
Common Ringtail Possum	dung	
Common Wombat	burrows, dung	
Eastern Grey Kangaroo	observed	
Swamp Wallaby	observed	
*Domestic Cattle	observed	

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 02**
Location: Whole of the property.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 04/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 11.10	Finish: 16.40	EST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		
Australian Magpie		
Australian Raven		
Australian Wood Duck		
Black-faced Cuckoo-shrike		
Black-fronted Dotterel		
Brown Goshawk		
Brown Thornbill		
Buff-rumped Thornbill		
Crimson Rosella		
Eastern Rosella		
Eastern Spinebill		
Eastern Yellow Robin		
Glossy Black-Cockatoo	feed trees at several locations.	
Golden Whistler		
Grey Butcherbird		
Grey Fantail		
Grey Shrike-thrush		
Grey Teal		
Laughing Kookaburra		
Magpie-lark		
Nankeen Kestrel		
Noisy Friarbird		
Pacific Black Duck		
Pied Currawong		
Red Wattlebird		
Scarlet Robin	Pair - 0242307 6166163. F - 0242639 6166429	
Shining Bronze-Cuckoo		
Spotted Pardalote		
Spotted Quail-thrush		
Straw-necked Ibis		
Striated Pardalote		
Welcome Swallow		
White-browed Scrubwern		
White-eared Honeyeater		
White-faced Heron		
White-throated Treecreeper		
Yellow-faced Honeyeater		
*Common Starling		
Crinia signifera	calls	
Common Ringtail Possum	dung	
Common Wombat	burrows, dung	
Eastern Grey Kangaroo	observed	
*Rabbit	observed	
*Domestic Cattle	observed	

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 03**
Location: Proposed quarry footprint.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 11/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start:	Finish: na	
Time: Start: 07.30	Finish: 08.30	EST

Species	**Notes** (breeding, etc.)	**No.**
Australian Magpie		3
Australian Raven		1
Australian Wood Duck		11
Black-faced Cuckoo-shrike		1
Brown Thornbill		3
Buff-rumped Thornbill		4
Crimson Rosella		1
Eastern Spinebill		1
Glossy Black-Cockatoo	chewed cones	
Golden Whistler		1
Grey Butcherbird		1
Grey Currawong		1
Grey Fantail		2
Grey Shrike-thrush		1
Grey Teal		2
Laughing Kookaburra		2
Pied Currawong		2
Silvereye		2
Spotted Pardalote		1
Striated Pardalote		1
Striated Thornbill		1
Superb Fairy-wren		3
White-throated Treecreeper		1
Yellow-faced Honeyeater		4
Common Ringtail Possum	dung	
Common Wombat	burrows, dung	
Eastern Grey Kangaroo	observed	

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 04**
Location: Incidental survey, most of site.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 11/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 8.30	Finish: 13.00	EST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		x
Australian Magpie		x
Australian Raven		x
Australian Wood Duck		x
Brown Falcon		x
Brown Thornbill		x
Crimson Rosella		x
Eastern Rosella		x
Eastern Whipbird		x
Grey Butcherbird		x
Grey Fantail		x
Grey Shrike-thrush		x
Grey Teal		x
Noisy Friarbird		x
Pied Currawong		x
Red Wattlebird		x
Red-browed Treecreeper		x
Richards Pipit		x
Spotted Pardalote		x
Striated Pardalote		x
Welcome Swallow		x
White-browed Scrubwren		x
White-throated Treecreeper		x
Willie Wagtail		x
Yellow-faced Honeyeater		x
*Common Starling		x
Eastern Long-necked Tortoise	observed	x
Common Ringtail Possum	dung, jaw bone, fur	x
Common Wombat	dung, burrows	x
Eastern Grey Kangaroo	observed	x

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 05**
Location: Mainly proposed quarry footprint.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 11/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 15.00	Finish: 17.00	EST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		x
Australian Magpie		x
Australian Raven		x
Australian Wood Duck		x
Brown-headed Honeyeater		x
Brown Thornbill		x
Common Starling *		x
Crimson Rosella		x
Eastern Yellow Robin		x
Glossy Black-Cockatoo	chewed cones – 56 0242330 6166086	x
Grey Butcherbird		x
Grey Shrike-thrush		x
Grey Teal		x
Laughing Kookaburra		x
Nankeen Kestrel		x
Noisy Friarbird		x
Pied Currawong		x
Red Wattlebird		x
Scarlet Robin	male – 56 0243197 6166331	x
Spotted Pardalote		x
Striated Pardalote		x
White-throated Treecreeper		x
Yellow-faced Honeyeater		x
Common Ringtail Possum	dung	
Common Wombat	burrows	
Eastern Grey Kangaroo	observed	
Red-throated Skink	observed	
Rabbit *	dung	

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 06**
Location: Quarry footprint.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Broad flat	
Date: 18/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start:	Finish: na	
Time: Start: 07.45	Finish: 09.00	EST

Species	**Notes** (breeding, etc.)	**No.**
Australian King-Parrot		3
Australian Magpie		1
Australian Raven		1
Australian Wood Duck	pair with young on dam	14
Brown-headed Honeyeater		1
Brown Thornbill		4
Buff-rumped Thornbill		5
Crimson Rosella		6
Golden Whistler		1
Grey Butcherbird		1
Grey Fantail		3
Grey Shrike-thrush		2
Rufous Whistler		2
Scarlet Robin	56 0243102 6166224	female
Scarlet Robin	56 0242800 6166311	pair
Spotted Pardalote		1
Striated Pardalote		2
Varied Sittella	56 0242844 6166439	1
White-throated Treecreeper		3
Yellow-faced Honeyeater		5
Yelow-tailed Black-Cockatoo		2
Common Bruhtail Possum	dung	
Common Wombat	burrows, dung common	

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 07**
Location: Mainly proposed quarry footprint.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 18/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 14.15	Finish: 15.30	EST

Species	**Notes** (breeding, etc.)	**No.**
Australian Raven		2
Brown Thornbill		1
Buff-rumped Thornbill	nest building	2
Crimson Rosella		2
Glossy Black-Cockatoo	feed tree: 56 0242979 6166148(3), 0243000 6166145	
Golden Whistler		1
Grey Butcherbird		1
Laughing Kookaburra		1
Pied Currawong		1
Spotted Pardalote		1
Striated Pardalote		1
Superb Lyrebird		1
White-throated Treecreeper		2
Yellow-faced Honeyeater		4

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 08**
Location: Property generally.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 18/09/12	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 07.30 + 09.00	Finish: 7.45 + 14.15	EST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		x
Australian Magpie		x
Australian Raven		x
Australian Wood Duck		x
Black-faced Cuckoo-shrike		x
Black-fronted Dotteral		x
Brown Thornbill		x
Buff-rumped Thornbill		x
Crimson Rosella		x
Eastern Rosella		x
Eastern Spinebill		x
Eastern Yellow Robin		x
Glossy Black-Cockatoo	feed trees: 56 0242622 6166215, 0242550 6166292 0243005 6165995, 0243006 6166048	x
Golden Whistler		x
Grey Butcherbird		x
Grey Fantail		x
Grey Shrike-thrush		x
Laughing Kookaburra		x
Little Pied Cormorant		x
Magpie-lark		x
Pied Currawong		x
Red Wattlebird		x
Scarlet Robin	56 0242522 6166179 (male)	x
Spotted Pardalote		x
Spotted Quail-thrush		x
Striated Pardalote		x
Superb Lyrebird		x
Welcome Swallow		x
White-browed Scrubwern		x
White-throated Treecreeper		x
Yellow-faced Honeyeater		x
*Common Blackbird		x
*Common Starling		x
*Little Corella		x
Common Ringtail Possum	dung	
Common Wombat	burrows, dung common	
Eastern Grey Kangaroo	observed	
Eastern Long-necked Tortoise	observed	
Red-throated Skink	observed	
Jacky Lizard	observed	
Common Eastern Froglet	calls	
Uperoleia sp.	calls	
Litoria phylochloa	calls	
*Rabbit	observed	

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose		**Survey No. 09**
Location: Accessable eastern part of property.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 26/09/12	**Habitats:** Forest, cleared land, dams	
GPS (WGS84): Start: area search	Finish: na	
Time: Start: 8.20	Finish: 9.00	EST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		2
Australian Magpie		10
Australian Raven		2
Australian Wood Duck	2+4 young; 2+3 young	11
Black-fronted Dotterel		1
Brown-headed Honeyeater		3
Crimson Rosella		7
Eastern Rosella		2
Jacky Winter		1
Grey Shrike-thrush		2
Grey Teal		3
Laughing Kookaburra		1
Pacific Black Duck		1
Pied Currawong		1
Red Wattlebird		2
Rufous Whistler		3
Striated Pardalote		4
Willie Wagtail		1
White-throated Treecreeper		1
Yellow-faced Honeyeater		1
Crinia signifera	calls at dam	

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose		**Survey No. 10**
Location: Proposed quarry footprint.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridges and small valleys.	
Date: 26/09/12	**Habitats:** Forest, some woodland and open areas.	
GPS (WGS84): Start: total search of area	Finish: na	
Time: Start: 09.00	Finish: 09.45	EST

Species	**Notes** (breeding, etc.)	**No.**
Australian Raven		1
Brown Thornbill		4
Buff-rumped Thornbill		3
Crimson Rosella	Pair at tree hollow.	6
Eastern Spinebill		2
Grey Fantail		5
Grey Shrike-thrush		2
Olive-backed Oriole		1
Rufous Whistler		1
Scarlet Robin	male - 56 0242913 6166048	1
Spotted Pardalote		1
Striated Pardalote		1
Striated Thornbill		3
Superb Fairy-wren		3
Wedge-tailed Eagle		1
White-winged Chough		4
White-throated Treecreeper		3
Yellow-faced Honeyeater		2
Yellow-tailed Black-Cockatoo	off to the south	1

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 03/10/12 **No. 11**
General description of location: Entrance gate to main extraction area, near proposed crushing plant.
AMG Zone: 56 **Start Easting:** 243400 **Start Northing:** 6165971
Finish Easting: 243520 **Finish Northing:** 6166304
Start time: 07:40 **Finish time:** 08:22
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** Light and South

Species	Number	Detection method
Australian Wood Duck	1	Observed
Brown Thornbill	3	Observed
Crimson Rosella	2	Observed
Eastern Spinebill	2	Observed
Eastern Yellow Robin	1	Observed
Fan-tailed Cuckoo	1	Heard calling
Gang-gang Cockatoo	1	Heard calling
Grey Butcherbird	1	Heard calling
Grey Fantail	1	Observed
Grey-shrike Thrush	1	Observed
Australian King Parrot	1	Heard calling
Laughing Kookaburra	1	Heard calling
Pied Currawong	2	Observed
Red Wattlebird	1	Heard calling
Rufous Whistler	1	Heard calling
Silvereye	>6	Observed
Spotted Pardalote	1	Heard calling
Striated Pardalote	1	Heard calling
Superb Fairy-wren	1	Heard calling
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	3	Observed
Yellow-tailed Black-Cockatoo	1	Heard calling

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 03/10/12 **No. 12**
General description of location: Commenced east of Transect 2 and finished near eastern end of transect 2.
AMG Zone: 56 **Start Easting:** 243287 **Start Northing:** 6166066
Finish Easting: 242976 **Finish Northing:** 6166189
Start time: 08:36 **Finish time:** 08:52
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** Light increasing to moderate and south

Species	Number	Detection method
Black-faced Cuckoo-shrike	1	Heard calling
Buff-rumped Thornbill	5	Observed
Crimson Rosella	2	Observed
Eastern Yellow Robin	1	Observed
Grey Fantail	2	Observed
Grey Shrike-thrush	1	Heard calling
Red Wattlebird	1	Heard calling
Silvereye	>6	Observed
Superb Fairy-wren	3	Observed
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	>6	Observed

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and Stephen Bloomfield **No. 13**
Date: 04/10/12
General description of location: Commenced at the dam in north of property and finished near gate to quarry area.
AMG Zone: 56 **Start Easting:** 244046 **Start Northing:** 6166278
Finish Easting: 243624 **Finish Northing:** 6165996
Start time: 07:00 **Finish time:** 07:23
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	Number	Detection method
Australian Magpie	2	Observed
Australian Raven	1	Observed
Australian Wood Duck	2	Observed
Black-faced Cuckoo-shrike	1	Heard calling
Black-fronted Dotterel	2	Observed
Crimson Rosella	6	Observed
Eastern Rosella	2	Observed
Eurasian Coot	1	Observed
Galah	1	Observed
Grey Butcherbird	1	Heard calling
Grey Fantail	1	Observed
Grey Shrike-thrush	1	Heard calling
Grey Teal	6	Observed
Laughing Kookaburra	1	Heard calling
Pacific Black Duck	2	Observed
Pied Currawong	1	Heard calling
Red Wattlebird	1	Heard calling
Spotted Pardalote	1	Heard calling
Superb Fairy-wren	1	Observed
Welcome Swallow	2	Observed
White-throated Treecreeper	1	Heard calling
Wilie Wagtail	1	Heard calling
Yellow-faced Honeyeater	1	Observed
Yellow-rumped Thornbill	7	Observed
*Common Starling	>12	Observed

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 04/10/12 **No. 14**
General description of location: Commenced east of Transect 3 and finished near western end of transect 3.
AMG Zone: 56 **Start Easting:** 242657 **Start Northing:** 6166436
Finish Easting: 242349 **Finish Northing:** 6166414
Start time: 07:28 **Finish time:** 07:51
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	Number	Detection method
Brown Thornbill	1	Observed
Crimson Rosella	1	Heard calling
Grey Fantail	1	Heard calling
Grey Shrike-thrush	1	Heard calling
Red-browed Treecreeper	1	Observed
Rufous Whistler	1	Observed
Shining Bronze-Cuckoo	1	Heard calling
Silvereye	1	Heard calling
Spotted Pardalote	1	Heard calling
Striated Pardalote	1	Heard calling
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	1	Heard calling

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and Stephen Bloomfield **No. 15**
Date: 04/10/12
General description of location: 'Swamp".
AMG Zone: 56 **Start Easting:** 242221 **Start Northing:** 6166702
Finish Easting: N/A **Finish Northing:** N/A
Start time: 08:21 **Finish time:** 08:40
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	Number	Detection method
Grey Fantail	2	Observed
Grey Shrike-thrush	1	Heard calling
New-holland Honeyeater	2	Observed
Noisy Friarbird	1	Heard calling
Red Wattlebird	1	Heard calling
Red-browed Firetail	3	Observed
Silvereye	2	Heard calling
Spotted Pardalote	1	Heard calling
Striated Pardalote	1	Heard calling
Superb Fairy-wren	2	Observed
Wedge-tailed Eagle	1	Observed
White-browed Scrubwren	2	Observed
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	>6	Observed
*Common Blackbird	1	Heard calling

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** Stephen Bloomfield **No. 16**
Date: 05/10/12
General description of location: Centre of woodland, east of large dry dam finishing near transect 3.
AMG Zone: 56 **Start Easting:** 243096 **Start Northing:** 6166239
Finish Easting: 242823 **Finish Northing:** 6166352
Start time: 06:46 **Finish time:** 07: 34
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** moderate to strong winds - south

Species	Number	Detection method
Australian Hobby	1	Observed
Australian Raven	1	Heard calling
Brown Thornbill	2	Observed
Crimson Rosella	3	Observed
Eastern Spinebill	1	Observed
Grey Butcherbird	1	Heard calling
Grey Fantail	5	Observed
Olive-backed Oriole	1	Observed
Rufous Whistler	1	Heard calling
Scarlet Robin	1	Observed
Spotted Pardalote	1	Heard calling
Striated Pardalote	2	Heard calling
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	1	Heard calling

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel/Stephen Bloomfield. **No. 17**
Date: 05/10/12
General description of location: Southern ridgeline.
AMG Zone: 56 **Start Easting:** 242638 **Start Northing:** 6166164
Finish Easting: 243441 **Finish Northing:** 6166007
Start time: 07:37 **Finish time:** 07:52
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	Number	Detection method
Australian Raven	1	Observed in nest
Brown Thornbill	2	Observed
Crimson Rosella	2	Observed in nest
Grey Fantail	2	Observed
Rufous Whistler	1	Observed
Spotted Pardalote	1	Heard calling
Striated Thornbill	3	Observed
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	1	Heard calling

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** Stephen Bloomfield. **No. 18**
Date: 05/10/12
General description of location: Start (eastern end) of transect 1 and heading east.
AMG Zone: 56 **Start Easting:** 243193 **Start Northing:** 6165849
Finish Easting: 243306 **Finish Northing:** 6165931
Start time: 07:59 **Finish time:** 08:07
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** moderate to strong winds - south

Species	Number	Detection method
Crimson Rosella	1	Heard calling
Fan-tailed Cuckoo	2	Heard calling
Grey Fantail	1	Heard calling
Noisy Friarbird	1	Heard calling
Red Wattlebird	1	Heard calling
Scarlet Robin	1	Heard calling
Yellow-faced Honeyeater	1	Heard calling

DIURNAL BIRD CENSUS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 06/10/12 **No. 19**
General description of location: Centre of wooded portion of site, near eastern infrared camera and heading north.
AMG Zone: 56 **Start Easting:** 243147 **Start Northing:** 6166184
Finish Easting: 243046 **Finish Northing:** 6166349
Start time: 09:09 **Finish time:** 09:30 Abandoned, increased drizzle
Cloud cover: 100% **Rain:** Fog / heavy mist / very light drizzle **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** still

Species - *Birds*	**Number**	**Detection method**
Australian Wood Duck	1	Heard calling
Brown Thornbill	2	Observed
Crimson Rosella	1	Observed
Eastern Spinebill	1	Heard calling
Fan-tailed Cuckoo	1	Heard calling
Grey Butcherbird	1	Heard calling
Grey Fantail	1	Heard calling
Grey-shrike Thrush	1	Heard calling
Pied Currawong	1	Observed
Red Wattlebird	1	Heard calling
Rufous Whistler	1	Heard calling
Shining Bronze-Cuckoo	1	Heard calling
Spotted Quail-thrush	1	Observed
Striated Pardalote	1	Heard calling
Superb Fairy-wren	1	Heard calling
White-throated Treecreeper	1	Heard calling

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose		**Survey No. 20**
Location: Eastern part of property.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridges and small valleys.	
Date: 17/10/12	**Habitats:** Forest, some woodland, cleared land.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 08.00	Finish: 08.30	EDST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		2
Australian Magpie		5
Australian Raven		1
Australian Wood Duck	Pair with 7 young	18
Crimson Rosella		7
Eastern Rosella		2
Eurasian Coot		1
Grey Shrike-thrush		1
Grey Teal	Pair with 7 young	6
Magpie-lark		1
Masked Lapwing		2
Olive-backed Oriole		1
Pied Currawong		1
Red Wattlebird		1
Striated Pardalote		4
Sulphur-crested Cockatoo		3
Welcome Swallow		2
White-throated Treecreeper		1
*Common Starling		2
Incidental		
Richards Pipit		
White-faced Heron		
Crinia signifera	calls	

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose		**Survey No. 21**
Location: Proposed quarry footprint and immediate area		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 17/10/12	**Habitats:** Forest, some woodland, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 08.30	Finish: 09.30	EDST

Species	**Notes** (breeding, etc.)	**No.**
Australian Magpie		1
Australian Raven		3
Brown Thornbill		3
Buff-rumped Thornbill		2
Crimson Rosella		2
Eastern Rosella		3
Glossy Black-Cockatoo	2 feed trees: 56 0242393 6166242	-
Golden Whistler		3
Grey Fantail		3
Grey Shrike-thrush		1
Laughing Kookaburra		1
Olive-backed Oriole		1
Red Wattlebird		2
Red-browed Treecreeper		1
Red-capped Robin	M - 56 0243114 6166227	1
Rufous Whstler		3
Shining Bronze-Cuckoo		1
Spotted Pardalote		1
Spotted Quail-thrush		1
Striated Pardalote		2
White-Winged Chough		5
White-throated Treecreeper		2
Yellow-faced Honeyeater		3
Incidental		
Gang-gang Cockatoo	56 0242882 6166443	1
Black-faced Cuckoo-shrike		1

Survey Sheet - Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose		**Survey No. 22**
Location: Whole of property		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 03/12/12	**Habitats:** Forest, some woodland, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 13.00	Finish: 14.30	EDST

Species	**Notes** (breeding, etc.)	**No.**
Australasian Grebe		2
Australian Magpie		10
Australian Raven		4
Australian Wood Duck		39
Black-faced Cuckoo-shrike		2
Buff-rumped Thornbill		2
Common Starling*		1
Crimson Rosella		9
Eastern Rosella		2
Eastern Spinebill		1
Grey Butcherbird		1
Grey Shrike-thrush		2
Grey Teal		2
Laughing Kookaburra		2
Olive-backed Oriole		1
Pacific Black Duck		1
Pied Currawong		1
Rufous Whstler		3
Striated Pardalote		2
Superb Lyrebird		1
White-throated Treecreeper		1

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 23**
Location: Property generally.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 03.10.13	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 07.15	Finish: 15.45	EST

Species	**Notes** (breeding, etc.)	**No.**
Australian Magpie		10
Australian Raven		2
Australian Wood Duck	pair with chicks	32
Australian King-parrot		1
Black-faced Cuckoo-shrike		1
Black-fronted Dotteral		2
Brown Thornbill		5
Buff-rumped Thornbill		4
Crimson Rosella		4
Eastern Spinebill		2
Fan-tailed Cuckaoo		1
Glossy Black-Cockatoo	56 0243209 6165851	3
Golden Whistler		1
Grey Fantail		2
Grey Shrike-thrush		2
Grey Teal		3
Laughing Kookaburra		2
Magpie-lark		2
Masked Lapwing		2
Pacific Black Duck		2
Pied Currawong		2
Red Wattlebird		2
Richards Pipit		2
Rufous Whistler		1
Scarlet Robin	56 0242649 6166429 (male)	1
Spotted Pardalote		1
Striated Pardalote		3
Striated Thornbill		2
Sulphur-crested Cockatoo		1
Welcome Swallow		2
White-winged Chough		5
Yellow-faced Honeyeater		6
Yellow-tumped Thornbill		2
*Common Starling		2
Common Ringtail Possum	dung	
Common Wombat	burrows, dung common	
Eastern Grey Kangaroo	observed	
*Falow Deer	dung, rubbings on trees	
Crinia signifera	calls	
*Rabbit	dung	

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 24**
Location: Property generally.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Ridge and small valleys.	
Date: 10.10.13	**Habitats:** Forest, some woodland, cleared land, rocky ridges.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 11.40	Finish: 16.40	EDST

Species	**Notes** (breeding, etc.)	**No.**
Australian Magpie		8
Australian Raven		1
Australian Wood Duck	2 pairs with chicks	31
Australasian Grebe		2
Brown Thornbill		2
Buff-rumped Thornbill		2
Crimson Rosella		10
Eastern Rosella		2
Eastern Spinebill		1
Fan-tailed Cuckaoo		1
Glossy Black-Cockatoo	feather-0242678 6166252; feed tree-024270 6166214	-
Golden Whistler		1
Grey Butcherbird		1
Grey Fantail		8
Grey Shrike-thrush		4
Grey Teal		2
Laughing Kookaburra		2
Leaden Flycatcher		1
Magpie-lark		2
Pacific Black Duck		2
Pied Currawong		1
Red Wattlebird		1
Rufous Whistler		1
Spotted Pardalote		5
Striated Pardalote		3
White-throated Treecreeper		1
White-winged Chough		5
Yellow-faced Honeyeater		3
*Common Starling		25
Common Ringtail Possum	dung, dreys	
Common Wombat	burrows, dung common	
Swamp Wallaby	observed	

Survey Sheet – Birds		**Kevin Mills & Associates**
Site Name: Sutton Quarry proposal, Penrose.		**Survey No. 25**
Location: Access road route.		**Observer: K. Mills**
Land Tenure: freehold	**Topography:** Generally level.	
Date: 15.10.13	**Habitats:** Woodland, cleared land.	
GPS (WGS84): Start: incidental site survey	Finish: na	
Time: Start: 14.00	Finish: 15.30	EDST

Species	**Notes** (breeding, etc.)	**No.**
Australian Magpie		6
Australian Raven		3
Australian Wood Duck	3 pairs with chicks	25
Australasian Grebe	Nest on dam	2
Back-fronted Dotterel		1
Brown Thornbill		4
Buff-rumped Thornbill		1
Crimson Rosella		4
Eastern Rosella		2
Eastern Spinebill		1
Grey Fantail		1
Grey Shrike-thrush		2
Grey Teal		5
Little Pied Cormorant		1
Magpie-lark		3
Masked Lapwing		1
Pacific Black Duck		1
Pied Currawong		1
Rufous Whistler		2
Striated Pardalote		3
Striated Thornbil		2
Supern Fairy-wren		2
Syperb Lyrebird		1
Welcome Swallow		1
White-throated Gerygone		1
White-throated Treecreeper		1
Yellow-faced Honeyeater		3
*Common Starling		7
Common Wombat	burrows, dung common	
“Fox	observed	

INCIDENTAL RECORDS

Project: Sutton Forest Sand Quarry. **Observers:** D.Engel and/or S.Bloomfield
Species recorded whilst traversing the site and establishing /checking traps.

Date / Species	Number	Detection Method
02/10/12		
Australian Magpie	2	Observed
Australian Raven	1	Heard calling
Crimson Rosella	2	Observed
Eastern Rosella	2	Observed
Eastern Yellow Robin	2	Observed
Fan-tailed Cuckoo	1	Heard calling
Glossy Black Cockatoo	n/a	Crushed casuarina cones located along Transect 3
Glossy Black Cockatoo	n/a	Crushed casuarina cones located along Transect 1
Grey Fantail	1	Observed
Grey Shrike-thrush	1	Heard calling
Laughing Kookaburra	1	Observed
Pallid Cuckoo	1	Heard calling
Red Wattlebird	1	Heard calling
Scarlet Robin	1	Observed : E – 242730 N – 6166400
Spotted Pardalote	1	Heard calling
Spotted Quail-thrush	2	Observed
Striated Pardalote	1	Heard calling
White-throated Treecreeper	1	Heard calling
Yellow-faced Honeyeater	1	Heard calling
Yellow-tailed Black-Cockatoo	1	Heard calling
Lampropholis delicata	1	Observed
03/10/12		
*Common Starling	> 30	Observed
Australasian Grebe	2	Observed
Australian Raven	1	Observed
Australian Wood Duck	> 10 (breeding	Observed
Black-faced Cuckoo-shrike	1	Observed
Black-fronted Dotterel	1	Observed
Crimson Rosella	2	Observed
Grey Butcherbird	1	Observed
Grey Teal	2 adults, 6 you	Observed
Little Pied Cormorant	1	Observed
Magpie-lark	2	Observed
Sacred Kingfisher	1	Heard calling
Yellow-faced Honeyeater	>6	Observed
Yellow-rumped Thornbill	5	Observed
Short-beaked Echidna	n/a	Characteristic diggings in termite mounds and ant nests observed
*European Fox	n/a	Tracks found in soft sand
Litoria peronii	2	Observed
04/10/12		
*Common Myna	2	Observed
Nankeen Kestrel	1	Observed
Richards Pipit	1	Observed
Sulphur-crested Cockatoo	1	Observed
Glossy Black Cockatoo	n/a	Crushed casuarina cones located during herp search on southern ridge E - 242654; N - 6166110
Common Ringtailed Possum carcass found; head and upper torso missing. Found western end of Transect 1 near cage trap.		Photographs taken. Powerful Owl kill?

Date / Species	**Number**	**Detection Method**
*Feral Goat	n/a	Tracks found in soft sand
*European Fox	1	Road kill on Hume Highway
05/10/12		
*Black Rat	1	Road kill on Illawarra Highway
14/10/12		
Gang-gang Cockatoo	2	On site, east of large dry dam at 0243124 6166179.
White-winged Chough	5	Observed on site

LIVE TRAPPING SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Dates traps set: 02/10/12 **Dates traps collected:** 06/10/12
Bait: Elliott traps – Rolled oats, peanut butter and honey mixture
Cage traps – chicken carcasses.
Arboreal traps placed at a height of around 3.5m. Trees sprayed with diluted honey solution.
Number: Transect 1: [25 traps] 20 size A Elliott traps on ground and 5 size B Elliott traps arboreal.
Transect 2: [30 traps] 25 size A Elliott traps on ground and 5 size B Elliott traps arboreal.
Transect 3: [30 traps] 25 size A Elliott traps on ground and 5 size B Elliott traps arboreal.
Weather at time traps were established:
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 20ºC **Wind speed and direction:** still

Elliott traps				
Transect 1	Start	243192	6165853	Ridge, southern boundary of site
	Finish	242922	6166082	
Transect 2	Start	242902	6166384	Centre of site
	Finish	242615	6166253	
Transect 3	Start	242679	6166384	Gully northern portion of site
	Finish	242303	6166416	
Cage 1		243214	6165866	Associated with Elliott trans 1
Cage 2		242927	6166082	Associated with Elliott trans 1
Cage 3		242841	6166396	Associated with Elliott trans 2
Cage 4		242615	6166253	Associated with Elliott trans 2
Cage 5		242674	6166397	Associated with Elliott trans 3
Cage 6		242303	6166416	Associated with Elliott trans 3
Harp trap	Evenings 1 & 2	242228	6166118	Trap to south western corner “spur”
	Evenings 3 & 4	242327	6166501	Positioned on track to ‘swamp”

RESULTS

Date	**Technique**	**Trap Number**	**Species captured**
03/10/12	Transect 1	Arboreal trap 5	Female *Antechinus stuartii* with pouch young
03/10/12	Transect 2	Ground trap 20	Female *Antechinus stuartii* with pouch young
03/10/12	Harp trap	n/a	Female Little Forest Bat *Vespadelus vulturnus*
03/10/12	Cage traps		No captures and all traps open
04/10/12	Transect 2	Ground trap 25	Female *Antechinus stuartii* with pouch young
04/10/12	Transect 2	Ground trap 15	Female *Antechinus stuartii* with pouch young
04/10/12	Transect 2	Ground trap 13	Female *Antechinus stuartii* with pouch young
04/10/12	Cage traps		No captures and all traps open
04/10/12	Harp trap		No captures
05/10/12	Transect 3	Ground trap 22	Female *Antechinus stuartii* with pouch young
05/10/12	Harp trap	n/a	Female Little Forest Bat *Vespadelus vulturnus*
05/10/12	Harp trap	n/a	Female Chocolate Wattled Bat *Chalinolobus morio*
05/10/12	Harp trap	n/a	Male Chocolate Wattled Bat *Chalinolobus morio*
05/10/12	Cage traps		No captures and all traps open
06/10/12	Transect 2	Ground trap 16	Female *Antechinus stuartii* with pouch young
06/10/12	Cage traps		No captures and all traps open
06/10/12	Harp trap		No captures

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 02/10/12
General description of location: North of dry dam, east of eastern end, transect 2.
AMG Zone: 56 **Easting:** 242916 **Northing:** 6166414
Start time: 18:45 **Finish time:** 19:40
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** n/a

Southern Boobook	1	Heard calling before playback session
Australian Wood Duck	1	Heard calling before playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 02/10/12
General description of location: Atop southern ridgeline in the vicinity of the harp trap.
AMG Zone: 56 **Easting:** 242309 **Northing:** 6166202
Start time: 19:50 **Finish time:** 20:45
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** n/a

Southern Boobook	2	Heard calling before playback session
Australian Owlet Nightjar	1	Heard calling before playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 03/10/12
General description of location: "Swamp" (drainage line) north-west of study area.
AMG Zone: 56 **Easting:** 242221 **Northing:** 6166702
Start time: 18:55 **Finish time:** 19:50
Cloud cover: 10% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling before playback session
Sugar Glider	1	Heard calling before playback session
Striped Marsh Frog *Limnodynastes peronii*	several	Heard calling before playback session
Common Eastern Froglet *Crinia signifera*	several	Heard calling before playback session
Verreaux's Tree Frog *Litoria verreauxii*	several	Heard calling before playback session
Blue Mountains Tree Frog *Litoria citropa*	2	Heard calling before playback session
Broadcast:		
Squirrel Glider, Koala		
Yellow-bellied Glider		*No response from any of the target species*
Powerful Owl, Barking Owl		Greater Glider spotlight in hollow during session
Masked Owl		
Sooty Owl		

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 03/10/12
General description of location: Top of southern ridge between harp trap and transect 1.
AMG Zone: 56 **Easting:** 242547 **Northing:** 6166176
Start time: 19:55 **Finish time:** 20:50
Cloud cover: 10% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling before playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 03/10/12
General description of location: Haul Road, atop gully at ecotones cleared paddock and bushland.
AMG Zone: 56 **Easting:** 243823 **Northing:** 6166219
Start time: 21:00 **Finish time:** 21:55
Cloud cover: 0% **Rain:** 0 **Moon:** 0 (see note)
Temperature: 15ºC **Wind speed and direction:** still

Broadcast:		Moon rise around 21.15 hours.
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 04/10/12
General description of location: western side large dam, haul road.
AMG Zone: 56 **Easting:** 244020 **Northing:** 6166246
Start time: 18:38 **Finish time:** 19:33
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 19ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling during playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 04/10/12
General description of location: Centre of site at large dry dam.
AMG Zone: 56 **Easting:** 242874 **Northing:** 6166296
Start time: 19:40 **Finish time:** 20:30
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 19ºC **Wind speed and direction:** moderate and south

Owlet Nightjar	1	Heard calling before playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 04/10/12
General description of location: Southern ridgeline, west of Transect 1.
AMG Zone: 56 **Easting:** 242715 **Northing:** 6166139
Start time: 20:40 **Finish time:** 21:30
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 17ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling after playback session
Owlet Nightjar	1	Heard calling after playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 05/10/12
General description of location: NW corner of cleared paddock (western of two) atop of gully.
AMG Zone: 56 **Easting:** 243526 **Northing:** 6166230
Start time: 18:45 **Finish time:** 19:40
Cloud cover: 80% **Rain:** 0 **Moon:** 0
Temperature: 16ºC **Wind speed and direction:** still

Masked Lapwing	1	Heard calling before playback session
Southern Boobook	1	Heard calling during playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 05/10/12
General description of location: "Intersection" western end of Transect 3 – track to swamp.
AMG Zone: 56 **Easting:** 242348 **Northing:** 6166406
Start time: 19:45 **Finish time:** 20:40
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** light and south

Dog (feral?)	2	Heard calling before to the northwest
Greater Glider	1	Spotlight before call playback session
Southern Boobook	1	Heard calling during playback session
Owlet Nightjar	1	Heard calling during playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

NOCTURNAL CALL PLAYBACKS

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 05/10/12
General description of location: "spur track" to west, southern ridgeline.
AMG Zone: 56 **Easting:** 242161 **Northing:** 6166140
Start time: 20:50 **Finish time:** 21:45
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** light and south

Dog (feral?)	1	Heard calling after playback session to the south
Southern Boobook	1	Heard calling after playback session
Owlet Nightjar	1	Heard calling after playback session
Verreaux's Tree Frog *Litoria verreauxii*	Several	Heard calling after playback session
Broadcast:		
Squirrel Glider		
Koala		*No response from any of the target species*
Yellow-bellied Glider		
Powerful Owl		
Barking Owl		
Masked Owl		
Sooty Owl		

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 02/10/12
General description of location: Commenced at Call playback location 1. **Method:** On foot
AMG Zone: 56 **Start Easting:** 242916 **Start Northing:** 6166414
Finish Easting: 242550 **Finish Northing:** 6166179
Start time: 18:45 **Finish time:** 19:42
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** n/a

Southern Boobook	1	Heard calling
White-striped Mastiff-bat	1	Heard calling
Litoria verreauxii		Heard calling

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 02/10/12
General description of location: Commenced at Call playback location 2. **Method:** On foot
AMG Zone: 56 **Start Easting:** 242309 **Start Northing:** 6166202
Finish Easting: 242809 **Finish Northing:** 6166325
Start time: 19:50 **Finish time:** 20:47
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** n/a

Southern Boobook	1	Heard calling
Australian Owlet-nightjar	1	Heard calling
White-striped Mastiff-bat	1	Heard calling
Greater Glider	2	Observed
		New moon rose at 20.20 hours
Swamp Wallaby	1	*Observed as leaving site*
Eastern Grey Kangaroo	6	*Observed as leaving site*
Common Wombat	2	*Observed as leaving site*
*Rabbit	1	*Observed as leaving site*

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 03/10/12
General description of location: Commenced at Call playback location 1, included swamp and headed south along tracks. **Method:** On foot
AMG Zone: 56 **Start Easting:** 242233 **Start Northing:** 6166834
Finish Easting: 242323 **Finish Northing:** 6166163
Start time: 18:45 **Finish time:** 19:52
Cloud cover: 10% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling
Common Ringtailed Possum	1	Observed

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel **Date:** 03/10/12
General description of location: Commenced at Call playback site 2, and headed east along track.
Method: On foot
AMG Zone: 56 **Start Easting:** 242547 **Start Northing:** 6166176
Finish Easting: 243296 **Finish Northing:** 6165965
Start time: 19:55 **Finish time:** 20:52
Cloud cover: 10% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling
Common Ringtailed Possum	1	Observed

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 03/10/12
General description of location: Commenced at Call playback location 3, and walked ecotone.
Method: On foot
AMG Zone: 56 **Start Easting:** 243823 **Start Northing:** 6166219
Finish Easting: 243823 **Finish Northing:** 6166219
Start time: 21:00 **Finish time:** 21:55
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** still

Southern Boobook	1	Heard calling
Australian Owlet-nightjar	1	Heard calling

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 04/10/12
General description of location: Commenced at Call playback location 1 near dam and headed west.
Method: On foot
AMG Zone: 56 **Start Easting:** 244020 **Start Northing:** 6166246
Finish Easting: 243808 **Finish Northing:** 6166429
Start time: 18:38 **Finish time:** 19:35
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 19ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling
White-striped Mastiff-bat	1	Heard calling
Spotted Marsh Frog *L. tasmaniensis*	Several	Heard calling
Crinia signifera	Several	Heard calling
Tyler's Toadlet *Uperoleia tyleri*	Several	Heard calling
Litoria verreauxii	Several	Heard calling

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 04/10/12
General description of location: Commenced at Call playback location 2, and walked west toward Trans 3.
Method: On foot
AMG Zone: 56 **Start Easting:** 242874 **Start Northing:** 6166296
Finish Easting: 242337 **Finish Northing:** 6166414
Start time: 19:40 **Finish time:** 20:33
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 19ºC **Wind speed and direction:** moderate and south

Southern Boobook	1	Heard calling
Australian Owlet-nightjar	1	Heard calling
Greater Glider	1	Observed
Common Ringtailed Possum	1	Observed

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** S.Bloomfield **Date:** 04/10/12
General description of location: Commenced at Call playback site 1, southern ridgeline headed east.
Method: On foot
AMG Zone: 56 **Start Easting:** 242715 **Start Northing:** 6166139
Finish Easting: 243253 **Finish Northing:** 6165828
Start time: 20:40 **Finish time:** 21:32
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 17ºC **Wind speed and direction:** light and south

Southern Boobook	1	Heard calling
Australian Owlet-nightjar	1	Heard calling

SPOTLIGHTING

Project: Sutton Forest Sand Quarry. **Researcher:** D. Engel **Date:** 05/10/12
General description of location: Commenced at Call playback location 3, and drove east towards cleared paddocks.
Method: Vehicle
AMG Zone: 56 **Start Easting:** 242161 **Start Northing:** 6166140
Finish Easting: 243429 **Finish Northing:** 6166014
Start time: 21:50 **Finish time:** 22:15
Cloud cover: 100% **Rain:** Fog / heavy mist / very light drizzle setting in **Moon:** 0
Temperature: 14ºC **Wind speed and direction:** still

Nothing seen or heard calling		

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Date: 04/10/12
General description of location: Southern ridgeline near SongMeter. Rocky outcrop / bench.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 242654 **Start Northing:** 6166110
Finish Easting: 242568 **Finish Northing:** 6166171
Start time: 9:43 **Finish time:** 9:53
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	No.	Habitat	No. of items investigated
None			96

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Date: 04/10/12
General description of location: Woodland - rocky outcrop / bench near western infrared camera.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 242307 **Start Northing:** 6166204
Finish Easting: 242401 **Finish Northing:** 6166175
Start time: 10:00 **Finish time:** 10:10
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	No.	Habitat	No. of items investigated
None			92

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Date: 04/10/12
General description of location: Large rock outcrop and cave network north of transect 3 “aboriginal carvings”.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 242461 **Start Northing:** 6166433
Finish Easting: 242446 **Finish Northing:** 6166644
Start time: 10:16 **Finish time:** 10:45
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** Strong winds

Species	No.	Habitat	No. of items investigated
Black Rock Skink *Egernia saxatilis*	1	In crevice	185
Eastern Water Skink *Eulamprus quoyii*	1	In crevice	
Lampropholis delicata	1	On surface	

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Date: 05/10/12
General description of location: North of Transect 3. Rocky outcrop / bench.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 242533 **Start Northing:** 6166469
Finish Easting: 242520 **Finish Northing:** 6166396
Start time: 08:14 **Finish time:** 08:24
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 18ºC **Wind speed and direction:** Strong winds, south

Species	No.	Habitat	No. of items investigated
None			66

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel
Date: 05/10/12
General description of location: North of Transect 1. Woodland with surface rock.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 243146 **Start Northing:** 6166052
Finish Easting: 243146 **Finish Northing:** 6166052
Start time: 09:10 **Finish time:** 09:30
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 22ºC **Wind speed and direction:** Moderate & SW

Species	No.	Habitat	No. of items investigated
None			49

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel
Date: 05/10/12
General description of location: North of Transect 1. Woodland over rocky bench.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 243213 **Start Northing:** 6165837
Finish Easting: 243213 **Finish Northing:** 6165837
Start time: 09:32 **Finish time:** 09:42
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 22ºC **Wind speed and direction:** Moderate & SW

Species	No.	Habitat	No. of items investigated
Lampropholis delicata	1	On surface	44
Copper-tailed Skink *Ctenotus taeniolatus*	1	Under rock	

NOTES: Swamp Wallaby flushed; Glossy Black-cockatoo feed trees found.

HERPETOFAUNA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel
Date: 05/10/12
General description of location: Ridgeline west of Transect 1. Woodland over rocky bench.
Method: Turning of rocks and logs. Investigation of loose bark. Checking caves and crevices with a hand torch.
AMG Zone: 56 **Start Easting:** 242642 **Start Northing:** 6166202
Finish Easting: 242703 **Finish Northing:** 6166138

Start time: 09:48 **Finish time:** 10:10
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 22ºC **Wind speed and direction:** Moderate & SW

Species	No.	Habitat	No. of items investigated
None			39

NOTES: Glossy Black-cockatoo feed trees found.

INFRARED CAMERA SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Dates cameras set: 03/10/12 **Dates cameras collected:** 14/10/12
Lure: Chicken carcasses

Camera 1	Telfon	243165	6166181	Near dry dam, centre of site
Camera 2	Large Reconyx	242345	6166234	Western limits of site

Weather at time cameras were set:
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** light and south
Weather at time cameras were collected:
Cloud cover: 100% **Rain:** 0 **Moon:** 0
Temperature: 11ºC **Wind speed and direction:** still

	Images recorded
Camera 1	
4/10/12 @ 13.50	Australian Raven
5/10/12 @ 7.59	Pied Currawong
11/10/12 @10.03	Fallow Deer *Dama dama*
12/10/12 @ 19.27	Swamp Wallaby
Camera 2	
3/10/12 @ 11.54	Australian Raven – images of Raven removing bait
7/10/12 @ 7.33	Echidna

Note: Bait at Reconyx gone 4/10/12. Rebaited with Ringtail Carcass.

HAIRTUBE TRAPPING SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield
Dates traps set: 3/10/12 **Dates traps collected:** 14/10/12
Bait: Sardines
Weather at time traps were established:
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 13ºC **Wind speed and direction:** light and south
Weather at time traps were collected:
Cloud cover: 100% **Rain:** 0 **Moon:** 0
Temperature: 11ºC **Wind speed and direction:** still
Notes: All traps placed on the ground. Traps 1 – 15 placed approximately 200 metres apart. Traps 16 – 20 placed c. 500m apart. Samples analysed by Ms Georgiana Story, "Scats About", Majors Creek, NSW.

	Easting	Northing	Species identified
HT1	243048	6166336	*No hairs present*
HT2	243171	6166174	*No hairs present*
HT3	243294	6166015	*No hairs present*
HT4	243272	6165851	*No hairs present*
HT5	243115	6165920	*No hairs present*
HT6	242955	6166055	*No hairs present*
HT7	242785	6166121	*No hairs present*
HT8	242594	6166176	*No hairs present*
HT9	242392	6166171	*No hairs present*
HT10. track to swamp	242357	6166465	*No hairs present*
HT11	242280	6166609	*No hairs present*
HT12	242219	6166709	*No hairs present*
HT13	242532	6166469	Hairs present
HT14	242695	6166408	*No hairs present*
HT15	242853	6166302	*No hairs present*
HT16	243040	6166250	*No hairs present*
"Haul Road"			
HT17	243526	6166250	*No hairs present*
HT18	243771	6166197	*No hairs present*
HT19	244002	6166225	*No hairs present*
HT20	243965	6166337	*No hairs present*

MICROCHIROPTERAN SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield

Calls analysed by: Kirsty Bloomfield (02 9523 2016). **Units:** Set and left for entire duration of evening.

Weather on dusk:

Date	Cloud cover	Temperature (°C)	Rain	Wind	Moon
2/10/12	0%	13	0	0	0
3/10/12	10%	18	0	Light – South	0
4/10/12	0%	19	0	Light – South	0
5/10/12	80%	16	0	Still	0

Notes: Units generally set on or prior to dusk [18.00 hours at the time of the site investigation] and collected at completion of trap check.

Date	Unit	Easting	Northing	General description
2/10/12	SD	242815	6166150	West of western end of Transect 1
2/10/12	SM2Bat	242203	6166081	South of harp trap overlooking gully
2/10/12	ZCaim1	242441	6166413	Rock outcrop downslope for Transect 3
3/10/12	ZCaim1	244046	6166278	Large farm dam
3/10/12	ZCaim2	242221	6166702	Swamp – NW corner
3/10/12	SM2Bat	242203	6166081	South of harp trap overlooking gully
4/10/12	ZCaim1	243773	6166174	Woodland belt in clear paddock
4/10/12	ZCaim2	243097	6166232	Centre of woodland, east of large dry dam
4/10/12	SM2Bat	242203	6166081	
5/10/12	ZCaim2	243526	6166230	NW corner of cleared paddock
5/10/12 – 12/10/12	SM2Bat	242203	6166081	

Date	Unit	Positive identification	Probable identification
2/10/12	SD	Eastern Horseshoe Bat (*Rhinolophus megaphyllus*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) Little Bentwing Bat (*Miniopterus australis*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Large Forest Bat (*Vespadelus darlingtoni*) Southern Forest Bat (*Vespadelus regulus*) Little Forest Bat (*Vespadelus vulturnus*) White-striped Freetail Bat (*Austronomus australis*) Eastern Freetail Bat (*Mormopterus ridei*)	

[0] Collected at 22:08 hours due to onset of mist / fine drizzle.

Date	Unit	Positive identification	Probable identification
2/10/12	SM2Bat	Gould's Wattled Bat (*Chalinolobus morio*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Large Forest Bat (*Vespadelus darlingtoni*) Little Forest Bat (*Vespadelus vulturnus*)	Southern Forest Bat (*Vespadelus regulus*)
2/10/12	ZCaim1	Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Large Forest Bat (*Vespadelus darlingtoni*) Southern Forest Bat (*Vespadelus regulus*) Little Forest Bat (*Vespadelus vulturnus*)	Eastern Broadnosed Bat (*Scotorepens orion*)
3/10/12	ZCaim2	*No identifiable calls recorded*	
3/10/12	SM2Bat	Chocolate Wattled Bat (*Chalinolobus morio*) Southern Forest Bat (*Vespadelus regulus*)	Eastern Bentwing Bat (*Miniopterus (schreibersii) orianae oceansis)*
3/10/12	ZCaim1	**Large-eared Pied Bat** (*Chalinolobus dwyeri*) Gould's Wattled Bat (*Chalinolobus gouldii*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Long-eared Bat (*Nyctophyllus sp*.) Eastern Broadnosed Bat (*Scotorepens orion*) Large Forest Bat (*Vespadelus darlingtoni*) Southern Forest Bat (*Vespadelus regulus*) Little Forest Bat (*Vespadelus vulturnus*) White-striped Freetail Bat (*Austronomus australis*) Eastern Freetail Bat (*Mormopterus ridei*)	Greater Broadnosed Bat (*Scoteanax rueppellii*)
4/10/12	SD	*No identifiable calls recorded*	

Date	Unit	Positive identification	Probable identification
4/10/12	SM2Bat	Gould's Wattled Bat (*Chalinolobus gouldii*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) Large Forest Bat (*Vespadelus darlingtoni*) Little Forest Bat (*Vespadelus vulturnus*)	Eastern Bentwing Bat (*Miniopterus (schreibersii) orianae oceansis)*
4/10/12	ZCaim1	Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* **Greater Broadnosed Bat** (*Scoteanax rueppellii*) Large Forest Bat (*Vespadelus darlingtoni*) Little Forest Bat (*Vespadelus vulturnus*)	
5/10/12	SM2Bat	Chocolate Wattled Bat (*Chalinolobus morio*)	Southern Forest Bat (*Vespadelus regulus*)
5/10/12	ZCaim2	*No identifiable calls recorded*	
6/10/12	SM2Bat	Gould's Wattled Bat (*Chalinolobus gouldii*) Little Forest Bat (*Vespadelus vulturnus*)	
7/10/12	SM2Bat	Gould's Wattled Bat (*Chalinolobus gouldii*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Large Forest Bat (*Vespadelus darlingtoni*)	
8/10/12	SM2Bat	Gould's Wattled Bat (*Chalinolobus gouldii*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Little Forest Bat (*Vespadelus vulturnus*)	
9/10/12	SM2Bat	Chocolate Wattled Bat (*Chalinolobus morio*)	

Date	Unit	Positive identification	Probable identification
	SM2Bat	Gould's Wattled Bat (*Chalinolobus gouldii*) Chocolate Wattled Bat (*Chalinolobus morio*) **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) **Eastern Bentwing Bat** (*Miniopterus (schreibersii) orianae oceansis)* Eastern Broadnosed Bat (*Scotorepens orion*) Large Forest Bat (*Vespadelus darlingtoni*) Little Forest Bat (*Vespadelus vulturnus*)	Southern Forest Bat (*Vespadelus regulus*)
11/10/12	SM2Bat	Chocolate Wattled Bat (*Chalinolobus morio*)	

SONGMETER SURVEY

Project: Sutton Forest Sand Quarry. **Researcher:** D.Engel and S.Bloomfield

Dates meter set: 4/10/12 **Dates meter collected:** 14/10/12

AMG Zone: 56 **Easting:** 242654 **Northing:** 6166110

General description: Southern ridgeline between Transect 1 and harp trap, atop rock "cliffline" overlooking gully.

Intervals meter set to record from: 22:00 – 12:00 and 02:00 – 03:00 hours.

Weather at time meter were set:
Cloud cover: 0% **Rain:** 0 **Moon:** 0
Temperature: 15ºC **Wind speed and direction:** strong and south

Weather at time meter was collected:
Cloud cover: 100% **Rain:** 0 **Moon:** 0
Temperature: 11ºC **Wind speed and direction:** still

Date	Time	Species calling
04/10/12	22:00-12:00	**Powerful Owl**, Maned Wood Duck
05/10/12	02:00-03:00	Southern Boobook
05/10/12	22:00-12:00	Southern Boobook, Masked Lapwing
06/10/12	02:00-03:00	n/a, rain periods
06/10/12	22:00-12:00	Southern Boobook, rain periods
07/10/12	02:00-03:00	n/a, rain periods
07/10/12	22:00-12:00	Australian Owlet-nightjar, Southern Boobook
08/10/12	02:00-03:00	n/a
08/10/12	22:00-12:00	Australian Owlet-nightjar, Southern Boobook, Sugar Glider, (White-throated Nightjar 10:50:50?)
09/10/12	02:00-03:00	Australian Owlet-nightjar
09/10/12	22:00-12:00	10:38:39? same as one @ 10:50:50 above
10/10/12	02:00-03:00	Australian Owlet-nightjar
10/10/12	22:00-12:00	n/a
11/10/12	02:00-03:00	n/a, rain
11/10/12	22:00-12:00	n/a
12/10/12	02:00-03:00	n/a, rain periods
12/10/12	22:00-12:00	Australian Owlet-nightjar
13/10/12	02:00-03:00	n/a
13/10/12	22:00-12:00	Southern Boobook
14/10/12	02:00-03:00	Southern Boobook

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Appendix 3
Plant species list for the study area

PTERIDOPHYTA (Ferns)

ASPLENIACEAE	
Asplenium flabellifolium	Necklace Fern
BLECHNACEAE	
Blechnum ambiguum	Fern
Blechnum cartilagineum	Gristle Fern
Blechnum nudum	Fishbone Water Fern
CYATHEACEAE	
Cyathea australis	Rough Tree Fern
DENNSTAEDTICEAE	
Hypolepis glandulifera	Downy Ground Fern
Pteridium esculentum	Bracken
DICKSONIACEAE	
Calochlaena dubia	Common Ground Fern
Dicksonia antarctica	Soft Tree fern
GLEICHENIACEAE	
Gleichenia dicarpa	Pouched Coral Fern
GRAMMITACEAE	
Notogrammitis billardieri	Finger Fern
HYMENOPHYLLACEAE	
Hymenophyllum cupressiforme	Common Filmy Fern
LINDSAEACEAE	
Lindsaea linearis	Screw Fern
Lindsaea microphylla	Lacy Wedge Fern
LYCOPODIACEAE	
Lycopodium deuterodensum	Bushy Clubmoss
OSMUNDACEAE	
Todea barbara	King Fern
PTERIDACEAE	
Adiantum aethiopicum	Common Maidenhair
Cheilanthes sieberi	Mulga Fern

GYMNOSPERMAE (Conifers)

PINACEAE	
**Pinus radiata*	Radiata Pine

ANGIOSPERMAE (Flowering Plants)

ANTHERICACEAE	
Caesia parviflora	Pale Grass-lily

APIACEAE	
Actinoltus helianthii	
Hydrocotyle laxiflora	Stinking Pennywort
Platysace lanceolata	Shrubby Platysace
Platysace linearifolia	Narrow-leaved Platysace
Xanthosia tridentata	Xanthosia
APOCYNACEAE	
Parsonsia straminea	Monkey-rope Vine
ARALIACEAE	
Polyscias sambucifolia ssp. *decomposita*	Ferny Panax
ASPARAGACEAE	
Lomandra glauca	Pale Mat-rush
Lomandra longifolia	Spiny-headed Mat-rush
Lomandra multiflora	Many-flowered Mat-rush
Lomandra obliqua	Twisted Mat-rush
ASTERACEAE	
Arrhenechthites mixta	Purple Fireweed
Bracteantha bracteata	Golden Everlasting
Cassinia aculeata	Common Cassinia
Cotula australis	Common Cotula
Helichrysum leucopsidium	Satin Everlasting
Olearia asterotricha	Rough Daisy Bush
Olearia erubescens	Daisy-bush
Olearia microphylla	Bridal Daisy-bush
Olearia viscidula	Brush Daisy-bush
Ozothamnus diosmifolius	Everlasting
Senecio linearifolius	Fireweed Groundsel
Senecio velioides	Forest Groundsel
Senecio sp. 'E'	Fireweed
**Arctotheca calendula*	Capeweed
**Carduus nutans*	Nodding Thistle
**Cirsium vulgare*	Spear Thistle
**Conyza bonariensis*	Tall Fleabane
**Hypochaeris radicata*	Flatweed
**Senecio madagascariensis*	Fireweed
**Sonchus oleraceus*	Common Sowthistle
BRASSICACEAE	
**Capsella bursa-pastoris*	Shepherd's Purse
**Lepidium sp.*	Peppercress
CAMPANULACEAE	
Wahlenbergia gracilis	Australian Bluebell
CAPRIFOLIACEAE	
**Lonicera japonica*	Honeysuckle
CARYOPHYLLACEAE	
Scleranthus biflora	Twin-flowered Knawel
Stellaria flaccida	Forest Starwort
Stellaria pungens	Prickly Starwort
**Cerastium glomeratum*	Mouse-ear Chickweed
**Paronychila brasiliana*	Brazilian Whitlow
**Petrorhagia nanteuilii*	Proliferous Pink

CASUARINACEAE	
Allocasuarina littoralis	Black Sheoak
Allocasuarina nana	Stunted Sheoak
CHENOPODIACEAE	
Einadia trigonos	Fishweed
CLUSIACEAE	
Hypericum gramineum	Small St John's Wort
CRASSULACEAE	
Crassula sieberiana	Stonecrop
CYPERACEAE	
Carex appressa	Tall Sedge
Eleocharis sphacelata	Tall Spike-rush
Caustis flexuosa	Curly Wig
Gahnia sieberiana	Red-fruited Saw-sedge
Lepidosperma filiforme	Common Rapier-sedge
Lepidosperma laterale	Variable Sword-sedge
DILLENIACEAE	
Hibbertia empetrifolia	Guinea Flower
Hibbertia obtusifolia	Grey Guinea Flower
Hibbertia sp.	Guinea Flower
ERICACEAE	
Brachyloma daphnoides	Daphne Heath
Epacris calvertiana	Calvert's Heath
Leucopogon lanceolatus	Lance Beard-heath
Leucopogon ericoides	Beard-heath
Leucopogon virgatus	Beard-heath
Melichrus urceolatus	Urn Heath
Monotoca scoparia	Prickly Broom-heath
EUPHORBIACEAE	
Amperea xiphoclada	Broom Spurge
Phyllanthus hirtellus	Thyme Spurge
Poranthera microphylla	Small Poranthera
FABACEAE	
FABOIDEAE (subfamily)	
Bossiaea buxifolia	Matted Bossiaea
Bossiaea heterophylla	Variable Bossiaea
Bossiaea obcordata	Spiny Bossiaea
Daviesia alata	Winged Bitter Pea
Daviesia ulicifolia	Gorse Bitter Pea
Dillwynia ramosissima	Bushy Parrot Pea
Dillwynia parvifolia	Parrot-pea
Dillwynia retorta	Parrot-pea
Dillwynia sericea	Showy Parrot Pea
Glycine sp.	Glycine
Gompholobium huegelii	Wedge-pea
Gompholobium minus	Dwarf Wedge Pea
Hardenbergia violacea	Native Sarsaparilla
Hovea linearis	Erect Hovea
Mirbelia platylobioides	Tableland Mirbelia
Mirbelia rubiifolia	Heathland Mirbelia
Oxylobium arborescens	Tall Shaggy Pea
Phyllota humifusa	Phyllota
Podolobium ilicifolium	Prickly Shaggy Pea

Pultenaea linophylla	Bush Pea
**Trifolium repens*	White Closer
**Trifolium subterraneum*	Subterranean Clover
MIMOSOIDEAE (subfamily)	
Acacia brownii	Heath Wattle
Acacia dealbata	Silver Wattle
Acacia decurrens	Sydney Green Wattle
Acacia elongata	Slender Wattle
Acacia falciformis	Broad-leaved Hickory Wattle
Acacia gunni	PloughshareWattle
Acacia leucolobia	Wattle
Acacia longifolia	Golden Wattle
Acacia mearnsii	Black Wattle
Acacia obtusifolia	Wattle
Acacia rubida	Red-leaved Wattle
Acacia terminalis	Sunshine Wattle
Acacia ulicifolia	Prickly Moses
GERANIACEAE	
Geranium solanderi	Native Geranium
GOODENIACEAE	
Coopernookia barbata	Coopernookia
Dampiera purpurea	Mountain Dampiera
Dampiera stricta	Blue Dampiera
Goodenia hederacea	Ivy Goodenia
HALORAGACEAE	
Gonocarpus micranthus	Creeping Raspwort
Gonocarpus teucrioides	Germander Raspwort
IRIDACEAE	
Patersonia longifolia	Dwarf Purple Flag
Patersonia sericea	Silky Purple Flag
JUNCACEAE	
Juncus prismatocarpus	Branching Rush
Luzula sp. (leaves only)	Woodrush
LAMIACEAE	
Ajuga australis	Austral Bugle
Prostanthera lasianthos	Mintbush
**Lavandula* sp.	Lavender
**Mentha* sp.	Mint
LAURACEAE	
Cassytha pubescens	Downy Dodder-laurel
LOBELIACEAE	
Isotoma axillaris	Rock Isotoma
LOGANIACEAE	
Mitrasacme polymorpha	Varied Mitrewort
LORANTHACEAE	
Amyema pendulum	Drooping Mistletoe
MYRTACEAE	
Calytrix tetragona	Common Fringe-myrtle
Eucalyptus agglomerata	Blue-leaved Stringybark

Eucalyptus apiculata	Narrow-leaved Mallee-ash
Eucalyptus aquatica	Paddys River Swamp Gum
Eucalyptus dives	Broad-leaved Peppermint
Eucalyptus elata	River Peppermint
Eucalyptus fastigata	Brown Barrel
Eucalyptus mannifera	Brittle Gum
Eucalyptus piperita	Sydney Peppermint
Eucalyptus punctata	Grey Gum
Eucalyptus radiata	Narrow-leaved Peppermint
Eucalyptus rubida	Candlebark
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum
Eucalyptus sieberi	Silvertop Ash
Eucalyptus viminalis	Ribbon Gum
Leptospermum arachnoides	Spider teatree
Leptospermum juniperinum	Prickly Teatree
Leptospermum obovatum	Sweet Teatree
Leptospermum parvifolium	Teatree
Leptospermum polygalifolium	Yellow Teatree
Leptospermum rotundifolium	Teatree
Leptospermum trinervium	Paperbark Teatree
Micromyrtus ciliata	Heath-myrtle
ONAGRACEAE	
**Oenothera stricta*	Evening Primrose
ORCHIDACEAE	
Cryptostylis sp. (leaves only)	Orchid
Caladenia sp.	Caladenia
Pterostylis sp. (leaves only)	Greenhood
PHORMIACEAE	
Dianella caerulea	Flax-lily
Dianella revoluta	Spreading Flax-lily
Dianella tasmanica	Tasman Flax-lily
Stypandra glauca	Nodding Blue Lily
PHYTOLACCACEAE	
**Phytolacca octandra*	Inkweed
PITTOSPORACEAE	
Billardiera scandens	Apple Berry
Bursaria spinosa	Blackthorn
Rhytidosporum procumbens	White Marianth
PLANTAGINACEAE	
**Plantago lanceolata*	Ribbed Plantain
POACEAE	
Bothriochloa macra	Red-leg Grass
Cynodon dactylon	Couch Grass
Entolasia marginata	Bordered Panic
Entolasia stricta	Wiry Panic
Microlaena stipoides	Weeping Grass
Phragmites australis	Common Reed
Poa (small tussock)	Tussock
**Anthoxanthum odoratum*	Sweet Vernal Grass
**Axonopus fissifolius*	Carpet grass
**Nassella trichotoma*	Serrated Tussock
**Phalaris* sp.	Phalaris
**Poa annua*	Winter Grass

POLYGALACEAE	
Comesperma ericinum	Matchheads
Comesperma volubile	Love Creeper
POLYGONACEAE	
**Acetosella vulgaris*	Sheep Sorrel
PROTEACEAE	
Banksia marginata	Silver Banksia
Banksia serrata	Old Man Banksia
Banksia spinulosa	Hairpin Banksia
Conospermum taxifolium	Variable Smoke-bush
Grevillea baueri	Grevillea
Hakea dactyloides	Finger Hakea
Hakea sericea	Silky Hakea
Isopogon anemonifolius	Drumsticks
Isopogon anethifolius	Drumsticks
Lomatia ilicifolia	Holly Lomatia
Lomatia myricoides	River Lomatia
Lomatia silaifolia	Crinkle Bush
Persoonia laurina ssp. *leiogyna*	Laurel Geebung
Persoonia levis	Broad-leaved Geebung
Persoonia linearis	Narrow-leaved Geebung
Persoonia mollis ssp. *livens*	Soft Geebung
Petrophile pedunculata	Stalked Conesticks
Petrophile sessilis	Conesticks
RANUNCULACEAE	
Clematis aristata	Traveller's Joy
RESTIONACEAE	
Chordifex dimorphus	Cord Rush
Lepyrodia scariosa	Scale-rush
RHAMNACEAE	
Cryptandra spinescens	Cryptandra
Pomaderris andromedifolia	Andromeda Pomaderris
Pomaderris elliptica	Pomaderris
Pomaderris lanigera	Woolly Pomaderris
ROSACEAE	
**Prunus laurocerasus*	Cherry laurel
**Rubus fruticosus* sp. agg.	Blackberry
RUBIACEAE	
Opercularia aspera	Thin Stinkweed
Pomax umbellata	Pomax
SALICACEAE	
**Salix sp.*	Willow
SANTALACEAE	
Choretrum pauciflorum	Dwarf Sour-bush
Exocarpos cupressiformis	Native Cherry
Exocarpos strictus	Pale-fruited Ballart
SAPINDACEAE	
Dodonaea multijuga	Hop-bush
SCROPHULARIACEAE	
Veronica plebeia	Trailing Speedwell

STACKHOUSIACEAE	
Stackhousia monogyna	Creamy Stackhousia
STERCULIACEAE	
Lasiopetalum ferrugineum	Brown Velvet-bush
STYLIDIACEAE	
Stylidium graminifolium	Grass Triggerplant
Stylidium laricifolium	Triggerplant
THYMELAEACEAE	
Pimelea linifolia	Slender Rice-flower
TREMANDRACEAE	
Tetratheca thymifolia	Pink Bells
TYPHACEAE	
Typha orientalis	Cumbungi
URTICACEAE	
Urtica incisa	Stinging Nettle
VERBENACEAE	
**Verbena bonariensis*	Purpletop
VIOLACEAE	
Hybanthus monopetalus	Slender Violet-bush
Viola hederacea	Native Violet
XANTHORRHOEACEAE	
Xanthorrhoea concava	Grass-tree
XYRIDACEAE	
Xyris sp.	Yellow-eye

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Appendix 4
Animal species lists for the Study Area

Source of Record:
P: Previously recorded in the vicinity of the study area (see text).
N: Recorded in the NSW Wildlife Atlas within ten kilometres of the study area.
S: Recorded in study area in 2012 (this study).
* Introduced species are indicated by an asterisk.

LIST OF MAMMAL SPECIES		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
ORNITHORHYNCHIDAE				
Platypus	*Ornithorhynchus anatinus*	P	N	
TACHYGLOSSIDAE				
Short-beaked Echidna	*Tachyglossus aculeatus*	P	N	X
DASYURIDAE				
Brown Antechinus	*Antechinus stuartii*	P		X
Common Dunnart	*Sminthopsis murina*	P	N	
PHASCOLARCTIDAE				
Koala	*Phascolarctos cinereus*		N	
VOMBATIDAE				
Common Wombat	*Vombatus ursinus*	P	N	X
PETAURIDAE				
Sugar Glider	*Petaurus breviceps*	P		X
Squirrel Glider	*Petaurus norfolcensis*	P		
PSEUDOCHEIRIDAE				
Greater Glider	*Petauroides volans*	P		X
Common Ringtail Possum	*Pseudocheirus peregrinus*	P		X
PHALANGERIDAE				
Common Brushtail Possum	*Trichosurus vulpecula*	P	N	X
MACROPODIDAE				
Eastern Grey Kangaroo	*Macropus giganteus*	P	N	X
Red-necked Wallaby	*Macropus rufogriseus*	P		
Swamp Wallaby	*Wallabia bicolor*	P		X
MOLOSSIDAE				
White-striped Freetail Bat	*Nyctinomus australisi*	P		X
Eastern Freetail Bat	*Moropterus* sp. 2	P		
VESPERTILIONIDAE				
Eastern Bentwing Bat	*Miniopterus schreibersii*	P	N	X
Eastern Falsistrelle	*Falsistrellus tasmaniensis*			X
Longeared Bat	*Nyctophilus* sp.	P		X
Gould's Wattled Bat	*Chalinolobus gouldii*	P		X
Chocolate Wattled Bat	*Chalinolobus morio*	P		X
Large-eared Pied Bat	*Chalinolobus dwyeri*	P	N	X
Large-footed Myotis	*Myotis adversus*		N	
Greater Broad-nosed Bat	*Scoteanax rueppelli*	P		X
Eastern Broadnosed Bat	*Scotorepens orion*		N	X
Forest Bat	*Vespadelus* sp.	P		
Large Forest Bat	*Vespadelus darlingtoni*		N	X
Little Forest Bat	*Vespadelus vulturnus*	P		X
Southern Forest Bat	*Vespadelus regulus*	P		X

LIST OF MAMMAL SPECIES cont...		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
MURIDAE				
House Mouse*	*Mus musculus*	P		
Bush Rat	*Rattus fuscipes*	P		
Swamp Rat	*Rattus lutreolus*	P	N	
Black Rat*	*Rattus rattus*	P	N	X
CANIDAE				
Feral Dog*	*Canis lupus familiaris*		N	X
Fox*	*Vulpes vulpes*	P		X
FELIDAE				
Feral Cat*	*Felis catus*	P		
LEPORIDAE				
Rabbit*	*Oryctolagus cuniculus*	P		X
CERVIDAE				
Fallow Deer*	*Dam dama*			X
SUIDAE				
Feral Pig*	*Sus scrofa*	P		
BOVIDAE				
Feral Goat*	*Capra hircus*	P		X
LIST OF BIRD SPECIES				
PHASIANIDAE				
Stubble Quail	*Coturnix pectoralis*	P		
ANATIDAE				
Blue-billed Duck	*Oxyura australis*		N	
Black Swan	*Cygnus atratus*	P		
Australian Wood Duck	*Chenonetta jubata*	P		X
Pacific Black Duck	*Anas superciliosa*	P	N	X
Grey Teal	*Anas gracilis*	P		X
PODICIPEDIDAE				
Australasian Grebe	*Tachybaptus novaehollandiae*	P		X
PHALACROCORACIDAE				
Little Pied Cormorant	*Phalacrocorax melanoleucos*	P		X
Little Black Cormorant	*Phalacrocorax sulcirostris*	P		
ARDEIDAE				
White-faced Heron	*Egretta novaehollandiae*	P		X
White-necked Heron	*Ardea pacifica*	P		
THRESKIORNITHIDAE				
Australian White Ibis	*Threskiornis molucca*	P		
Straw-necked Ibis	*Threskiornis spinicollis*	P		X

LIST OF BIRD SPECIES cont...		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
ACCIPITRIDAE				
Black-shouldered Kite	*Elanus axillaris*	P		
Brown Goshawk	*Accipiter fasciatus*	P		X
Grey Goshawk	*Accipiter novaehollandiae*	P		
Collared Sparrowhawk	*Accipiter cirrhocephalus*	P		
Wedge-tailed Eagle	*Aquila audax*	P		X
Little Eagle	*Hieraaetus morphnoides*	P		
FALCONIDAE				
Brown Falcon	*Falco berigora*	P		X
Australian Hobby	*Falco longipennis*	P		X
Nankeen Kestrel	*Falco cenchroides*	P		X
RALLIDAE				
Purple Swamphen	*Porphyrio porphyrio*	P		
Eurasian Coot	*Fulica atra*	P		X
CHARADRIIDAE				
Masked Lapwing	*Vanellus miles*	P		X
COLUMBIDAE				
Rock Dove*	*Columba livia*	P		
Common Bronzewing	*Phaps chalcoptera*	P		
Brush Bronzewing	*Phaps elegans*	P		
Crested Pigeon	*Ocyphaps lophotes*	P		
Peaceful Dove	*Geopelia striata*	P		
Wonga Pigeon	*Leucosarcia melanoleuca*	P		
CACATUIDAE				
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	P	N	X
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	P	N	X
Gang-gang Cockatoo	*Callocephalon fimbriatum*	P	N	X
Galah	*Cacatua roseicapilla*	P	N	X
Sulphur-crested Cockatoo	*Cacatua galerita*	P	N	X
Little Corella*	*Cacatua sanguinea*			X
PSITTACIDAE				
Australian King-Parrot	*Alisterus scapularis*	P	N	X
Crimson Rosella	*Platycercus elegans*	P	N	X
Eastern Rosella	*Platycercus eximius*	P		X
CUCULIDAE				
Brush Cuckoo	*Cacomantis variolosus*	P		
Pallid Cuckoo	*Cuculus pallidus*	P		X
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	P		X
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	P		
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	P		X
STRIGIDAE				
Powerful Owl	*Ninox strenua*	P	N	X
Southern Boobook	*Ninox novaeseelandiae*	P		X
PODARGIDAE				
Tawny Frogmouth	*Podargus strigoides*	P		
AEGOTHELIDAE				
Australian Owlet-nightjar	*Aegotheles cristatus*	P		X

LIST OF BIRD SPECIES cont...		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
APODIDAE				
White-throated Needletail	*Hirundapus caudacutus*	P		
HALCYONIDAE				
Laughing Kookaburra	*Dacelo novaeguineae*	P	N	X
Sacred Kingfisher	*Todiramphus sanctus*	P		X
CORACIIDAE				
Dollarbird	*Eurystomus orientalis*	P		
MENURIDAE				
Superb Lyrebird	*Menura novaehollandiae*	P		X
CLIMACTERIDAE				
White-throated Treecreeper	*Cormobates leucophaeus*	P	N	X
Red-browed Treecreeper	*Climacteris erythrops*	P		X
MALURIDAE				
Superb Fairy-wren	*Malurus cyaneus*	P	N	X
Southern Emu-wren	*Stipiturus malachurus*	P		
PARDALOTIDAE				
Spotted Pardalote	*Pardalotus punctatus*	P		X
Striated Pardalote	*Pardalotus striatus*	P		X
Pilotbird	*Pycnoptilus floccosus*	P		
Rockwarbler	*Origma solitaria*	P		
White-browed Scrubwren	*Sericornis frontalis*	P		X
Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*	P		
Weebill	*Smicrornis brevirostris*	P		
Brown Gerygone	*Gerygone mouki*	P		
Brown Thornbill	*Acanthiza pusilla*	P	N	X
Buff-rumped Thornbill	*Acanthiza reguloides*	P		X
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	P		X
Yellow Thornbill	*Acanthiza nana*	P		
Striated Thornbill	*Acanthiza lineata*	P	N	X
MELIPHAGIDAE				
Red Wattlebird	*Anthochaera carunculata*	P		X
Little Wattlebird	*Anthochaera chrysoptera*	P		
Noisy Friarbird	*Philemon corniculatus*	P		X
Noisy Miner	*Manorina melanocephala*	P		X
Lewin's Honeyeater	*Meliphaga lewinii*	P		
Yellow-faced Honeyeater	*Lichenostomus chrysops*	P		X
White-eared Honeyeater	*Lichenostomus leucotis*	P		X
Fuscous Honeyeater	*Lichenostomus fuscus*	P	N	
Brown-headed Honeyeater	*Melithreptus brevirostris*	P		X
White-naped Honeyeater	*Melithreptus lunatus*	P		
New Holland Honeyeater	*Phylidonyris novaehollandiae*	P		X
Eastern Spinebill	*Acanthorhynchus tenuirostris*	P		X
PETROICIDAE				
Jacky Winter	*Microeca fascinans*			X
Scarlet Robin	*Petroica multicolor*	P		X
Red-capped Robin	*Petroica goodenovii*	P		X
Flame Robin	*Petroica phoenicea*	P		
Rose Robin	*Petroica rosea*	P		
Eastern Yellow Robin	*Eopsaltria australis*	P	N	X

LIST OF BIRD SPECIES cont...		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
CINCLOSOMATIDAE				
Eastern Whipbird	*Psophodes olivaceus*	P		X
Spotted Quail-thrush	*Cinclosoma punctatum*	P		X
NEOSITTIDAE				
Varied Sittella	*Daphoenositta chrysoptera*	P		X
PACHYCEPHALIDAE				
Crested Shrike-tit	*Falcunculus frontatus*	P		
Golden Whistler	*Pachycephala pectoralis*	P		X
Rufous Whistler	*Pachycephala rufiventris*	P		X
Grey Shrike-thrush	*Colluricincla harmonica*	P	N	X
DICRURIDAE				
Black-faced Monarch	*Monarcha melanopsis*	P		
Leaden Flycatcher	*Myiagra rubecula*	P		X
Magpie-lark	*Grallina cyanoleuca*	P	N	X
Rufous Fantail	*Rhipidura rufifrons*	P		
Grey Fantail	*Rhipidura fuliginosa*	P		X
Willie Wagtail	*Rhipidura leucophrys*	P	N	X
CAMPEPHAGIDAE				
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	P		X
Cicadabird	*Coracina tenuirostris*	P		
ORIOLIDAE				
Olive-backed Oriole	*Oriolus sagittatus*	P		X
ARTAMIDAE				
White-browed Woodswallow	*Artamus superciliosus*	P		
Dusky Woodswallow	*Artamus cyanopterus*	P		
Grey Butcherbird	*Cracticus torquatus*	P		X
Australian Magpie	*Gymnorhina tibicen*	P	N	X
Pied Currawong	*Strepera graculina*	P	N	X
Grey Currawong	*Strepera versicolor*	P		X
CORVIDAE				
Australian Raven	*Corvus coronoides*	P	N	X
CORCORACIDAE				
White-winged Chough	*Corcorax melanorhamphos*	P		X
PTILONORHYNCHIDAE				
Satin Bowerbird	*Ptilonorhynchus violaceus*	P	N	
MOTACILLIDAE				
Richard's Pipit	*Anthus novaeseelandiae*	P		X
PASSERIDAE				
House Sparrow*	*Passer domesticus*	P		
Red-browed Finch	*Neochmia temporalis*	P		X
Diamond Firetail	*Stagonopleura guttata*		N	
FRINGILLIDAE				
European Goldfinch*	*Carduelis carduelis*	P		
DICAEIDAE				
Mistletoebird	*Dicaeum hirundinaceum*	P		

LIST OF BIRD SPECIES cont...		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
HIRUNDINIDAE				
Welcome Swallow	*Hirundo neoxena*	P		X
Tree Martin	*Hirundo nigricans*	P		
SYLVIIDAE				
Clamorous Reed-Warbler	*Acrocephalus stentoreus*	P		
ZOSTEROPIDAE				
Silvereye	*Zosterops lateralis*	P		X
MUSCICAPIDAE				
Bassian Thrush	*Zoothera lunulata*	P		
Common Blackbird*	*Turdus merula*	P		X
STURNIDAE				
Common Starling*	*Sturnus vulgaris*	P		X
Common Myna*	*Acridotheres tristis*	P	N	X

LIST OF FROG SPECIES		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
MYOBATRACHIDAE				
Common Eastern Froglet	*Crinia signifera*	P	N	X
Eastern Banjo Frog	*Limnodynastes dumerilii*	P		
Striped Marsh Frog	*Limnodynastes peronii*			X
Spotted Marsh Frog	*Limnodynastes tasmaniensis*			X
Tyler'sToadlet	*Uperoleia tyleri*			X
HYLIDAE				
Blue Mountains Tree Frog	*Litoria citropa*	P		X
Bleeting Tree Frog	*Litoria dentata*	P		
Verreaux's Tree Frog	*Litoria verreauxii*	P		X
Lesueur's Frog	*Litoria lesueuri*	P		
Leaf Green Tree Frog	*Litoria phyllochroa*	P		X

LIST OF REPTILE SPECIES		Previous Surveys Nearby	NSW Wildlife Atlas	This Study (2012)
AGAMIDAE				
Jacky Lizard	*Amphibolurus muricatus*	P		X
SCINCIDAE				
Black Rock Skink	*Egernia saxatilis*	P		X
Southern Water Skink	*Eulamprus heatwolei*	P		
Eastern Water Skink	*Eulamprus quoyii*	P		X
Delicate Skink	*Lampropholis delicata*	P		X
Grass Skink	*Lampropholis guichenoti*	P		
Wall Skink	*Cryptoblepharus carnabyi*	P		
Copper-tailed Skink	*Ctenotus taeniolatus*	P		X
Red-throated Skink	*Eulepis platynota*	P		X
Weasel Skink	*Saproscincus mustelinus*	P		
Eastern Blue-tongued Lizard	*Tiliqua scincoides*	P		
ELAPIDAE				
Eastern Brown Snake	*Pseudonaja textilis*	P		
White-lipped Snake	*Drysdalia coronoides*	P		
Red-bellied Black Snake	*Pseudechis porphyriacus*	P		
Eastern Small-eyed Snake	*Rhinoplocephalus nigrescens*	P		
CHELIDAE				
Eastern Long-necked Tortoise	*Chelodina longicollis*			X

Appendix 5
Hollow-bearing trees on the proposed quarry site

No.	Species	Hollows small	medium	large	dch (cm)	GPS (WGS84)
01	*Eucalyptus piperita*	2	-	1	57,82	0243202 6165863
02	dead tree	2	-	-	90	0243210 6165860
03	dead tree	-	-	1	50	0243200 6165862
04	dead tree	-	-	4	83	0243197 6165876
05	dead tree	-	-	1	65	0243189 6165895
06	*Eucalyptus piperita*	2	-	2	126	0243172 6165936
07	*Eucalyptus piperita*	4	-	-	105	0243165 6165958
08	*Eucalyptus piperita*	-	1	-	51	0243158 6165965
09	*Eucalyptus piperita*	1	-	-	68	0243157 6165977
10	*Eucalyptus piperita*	1	-	-	68	0243166 6166005
11	*Eucalyptus piperita*	1	-	2	100	0243164 6166018
12	*Eucalyptus piperita*	2	1	2	93	0243156 6166040
13	*Eucalyptus piperita*	1	-	-	72	0243144 6166030
14	*Eucalyptus sieberi*	1	-	1	98	0243092 6166084
15	*Eucalyptus piperita*	3	1	-	97	0243076 6166093
16	*Eucalyptus piperita*	2	-	-	108	0243070 6166110
17	*Eucalyptus piperita*	2	-	-	70	0243056 6166101
18	*Eucalyptus piperita*	1	-	1	74	0243053 6166103
19	*Eucalyptus agglomerata*	-	-	1	55	0243041 6166120
20	*Eucalyptus piperita*	2	-	-	108	0243012 6166133
21	*Eucalyptus piperita*	2	1	-	90	0243037 6166151
22	*Eucalyptus agglomerata*	-	-	1	104	0243012 6166170
23	dead tree	-	-	1	148	0242985 6166190
24	dead tree	3	1	-	49,55	0242988 6166196
25	*Eucalyptus piperita*	-	1	1	149	0242954 6166173
26	*Eucalyptus piperita*	2	-	1	97	0242945 6166172
27	*Eucalyptus piperita*	2	-	1	147	0242920 6166187
28	*Eucalyptus piperita*	1	-	-	78	0242909 6166213
29	*Eucalyptus sclerophylla*	1	3	1	95	0242887 6166250
30	*Eucalyptus piperita*	3	-	-	94	0242913 6166263
31	*Eucalyptus piperita*	4	-	-	98	0242863 6166284
32	*Eucalyptus piperita*	1	2	1	90	0242843 6166273
33	*Eucalyptus sclerophylla*	3	-	1	65	0242862 6166259
34	*Eucalyptus piperita*	-	-	2	66	0242865 6166243
35	*Eucalyptus sieberi*	-	-	1	77	0242829 6166272
36	*Eucalyptus sclerophylla*	1	2	-	91	0242811 6166268
37	*Eucalyptus agglomerata*	-	-	1	108	0242814 6166302
38	*Eucalyptus piperita*	1	-	-	65,47	0242818 6166221
39	*Eucalyptus agglomerata*	4	1	1	67	0242814 6166185
40	*Eucalyptus piperita*	1	1	-	81	0242771 6166220
41	*Eucalyptus piperita*	2	1	1	116	0242751 6166219
42	*Eucalyptus piperita*	2	-	-	100	0242756 6166236
43	*Eucalyptus piperita*	4	2	2	95	0242770 6166269
44	*Eucalyptus agglomerata*	1	-	-	74	0242752 6166277
45	*Eucalyptus piperita*	2	-	-	113	0242741 6166289
46	*Eucalyptus piperita*	-	1	-	74	0242720 6166276
47	*Eucalyptus piperita*	1	-	-	92	0242726 6166324
48	*Eucalyptus agglomerata*	3	-	-	105	0242737 6166341
49	*Eucalyptus piperita*	1	-	3	153	0242723 6166387
50	*Eucalyptus piperita*	1	-	-	53	0242805 6166317
51	*Eucalyptus sieberi*	-	-	1	72	0242801 6166311
52	*Eucalyptus sieberi*	1	-	-	74	0242790 6166347
53	*Eucalyptus piperita*	1	-	-	74	0242790 6166347
54	*Eucalyptus piperita*	-	1	-	86	0242750 6166355
55	*Eucalyptus scelrophylla*	4	-	-	57	0242748 6166378
56	*Eucalyptus piperita*	-	-	1	130	0243301 6166089

No.	Species	Hollows small	medium	large	dch (cm)	GPS (WGS84)
57	*Eucalyptus piperita*	1	-	-	100	0243327 6166076
58	*Eucalyptus piperita*	1	2	-	96	0243328 6166100
59	*Eucalyptus piperita*	2	-	1	109	0243342 6166131
60	dead tree	4	-	-	100	0243287 6166137
61	*Eucalyptus piperita*	2	-	-	99	0243295 6166150
62	*Eucalyptus piperita*	1	2	-	80	0243319 6166176
63	*Eucalyptus sclerophylla*	1	-	-	55	0243307 6166196
65	*Eucalyptus piperita*	1	-	1	86	0243309 6166200
66	*Eucalyptus scleropylla*	2	-	-	55	0243290 6166195
67	*Eucalyptus sieberi*	2	-	-	86	0243280 6166253
68	*Eucalyptus sclerophylla*	2	1	-	93	0243283 6166270
69	*Eucalyptus sieberi*	2	2	-	110	0243269 6166280
70	*Eucalyptus sclerophylla*	2	-	-	80	0243217 6166349
71	*Eucalyptus sieberi*	2	-	-	72	0243191 6166359
72	*Eucalyptus sclerophylla*	1	1	-	73	0243176 6166397
73	*Eucalyptus sclerophylla*	3	1	2	136	0243176 6166402
74	*Eucalyptus sclerophylla*	1	-	-	50	0243123 6166399
75	*Eucalyptus sclerophylla*	2	-	-	79	0243064 6166412
76	*Eucalyptus sclerophylla*	2	2	4	103	0242773 6166528
77	*Eucalyptus sclerophylla*	3	-	-	64	0242773 6166514
78	*Eucalyptus sclerophylla*	3	-	-	72	0242796 6166518
79	*Eucalyptus sieberi*	2	-	-	85	0242824 6166536
80	*Eucalyptus sclerophylla*	3	-	-	74	0242859 6166529
81	*Eucalyptus sieberi*	3	-	-	128	0242913 6166497
82	*Eucalyptus sieberi*	1	1	1	90	0242869 6166500
83	*Eucalyptus sclerophylla*	2	2	-	109	0242866 6166506
84	*Eucalyptus agglomerate*	-	1	1	110	0242790 6166552
85	*Eucalyptus piperita*	2	-	-	110	0242882 6166443
86	*Eucalyptus piperita*	2	-	-	86	0242871 6166436
87	*Eucalyptus sieberi*	1	-	2	100	0242885 6166458
88	*Eucalyptus sieberi*	-	1	-	73	0242834 6166454
89	dead tree	4	-	-	66	0242793 6166467
90	*Eucalyptus piperita*	2	-	-	56	0242799 6166450
91	*Eucalyptus sieberi*	2	-	-	85	0242765 6166438
92	*Eucalyptus peperita*	2	-	-	102	0242766 6166415
93	*Eucalyptus sclerophylla*	3	-	-	62	0242740 6166406
94	*Eucalyptus sclerophylla*	2	-	-	75	0242742 6166415
95	*Eucalyptus sclerophylla*	2	-	-	45	0242789 6166408
96	*Eucalyptus sieberi*	2	-	1	134	0242816 6166403
97	*Eucalyptus sieberi*		-	-	130	0242806 6166381
98	*Eucalyptus piperita*	3	-	1	114	0242798 6166360
99	*Eucalyptus piperita*	2	-	-	150	0242843 6166353
100	dead tree		-	-	94	0242877 6166382
101	*Eucalyptus piperita*	-	1	-	76	0242877 6166352
102	*Eucalyptus piperita*	1	-	-	58	0242891 6166368

Appendix 6
Final Determination for Montane Peatlands and Swamps

NSW Scientific Committee - Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.
The Scientific Committee has found that:

1. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is the name given to the plant community associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateaus, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite. Montane Peatlands and Swamps is characterised by the assemblage of species listed in paragraph 2 and comprises a dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. It is the only type of wetland that may contain more than trace amounts of *Sphagnum* spp., the hummock peat-forming mosses. Small trees may be present as scattered emergents or absent from the community.

2. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is characterised by following assemblage of species:

Acaena novae-zelandiae	*Arthropodium milleflorum*
Asperula gunnii	*Baeckea gunniana*
Baeckea utilis	*Baloskion australe*
Baloskion stenocoleum	*Baumea rubiginosa*
Blechnum nudum	*Blechnum penna-marina*
Brachyscome graminea	*Callistemon pityoides*
Carex appressa	*Carex fascicularis*
Carex gaudichaudiana	*Comesperma retusum*
Deyeuxia gunniana	*Deyeuxia quadriseta*
Drosera binata	*Drosera peltata*
Eleocharis acuta	*Eleocharis sphacelata*
Empodisma minus	*Epacris breviflora*
Epacris microphylla	*Epacris paludosa*
Epilobium billardierianum	*Epilobium gunnianum*
Eucalyptus ovata	*Eucalyptus pauciflora*
Eucalyptus stellulata	*Gahnia sieberiana*
Geranium neglectum	*Gleichenia dicarpa*
Gonocarpus micranthus	*Gratiola latifolia*
Gratiola peruviana	*Hakea microcarpa*
Hydrocotyle peduncularis	*Hypericum gramineum*

Hypericum japonicum	*Hypoxis hygrometrica*
Isotoma fluviatilis	*Juncus falcatus*
Juncus planifolius	*Juncus sarophorus*
Lagenifera stipitata	*Leptospermum juniperinum*
Leptospermum lanigerum	*Leptospermum myrtifolium*
Leptospermum obovatum	*Leptospermum polygalifolium* subsp*. polygalifolium*
Lepyrodia anarthria	*Lythrum salicaria*
Mitrasacme serpyllifolia	*Myriophyllum pedunculatum*
Myriophyllum propinquum	*Neopaxia australasica*
Oreomyrrhis ciliata	*Phragmites australis*
Poa costiniana	*Poa labillardieri*
Poa sieberiana var*. sieberiana*	*Prasophyllum canaliculatum*
Pratia pedunculata	*Prunella vulgaris*
Pteridium esculentum	*Ranunculus lappaceus*
Ranunculus pimpinellifolius	*Scaevola hookeri*
Schoenus apogon	*Scirpus polystachyus*
Sphagnum cristatum	*Sphagnum novo-zelandicum*
Spiranthes sinensis subsp*. australis*	*Stellaria pungens*
Stylidium graminifolium	*Utricularia dichotoma*
Viola betonicifolia	*Viola caleyana*
Viola hederacea	*Wahlenbergia ceracea*
Xerochrysum palustre	

3. The total species list of the community is larger than that given above, with many species present only in one or two sites, or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including grazing, land clearing and fire) history. The number and relative abundance of species will change with time since fire, and may also change in response to changes in fire frequency or water regime. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is mainly of vascular plant species, however the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

4. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions typically has an open to very sparse layer of shrubs, 1-5 m tall, including species of *Baeckea, Callistemon* and *Leptospermum*. Species of *Epacris* and *Hakea microcarpa* are also common shrubs. In some peatlands and swamps, particularly those with a history of disturbance to vegetation, soils or hydrology, the shrub layer comprises dense thickets of *Leptospermum* species. In other peatlands and swamps with a history of grazing by domestic livestock, the shrub layer may be very sparse or absent. Montane Peatlands typically have a dense groundcover of sedges, grasses and forbs, except where a dense cover of tall shrubs casts deep shade. Soft-leaved species of *Carex* and *Poa* typically make up most of the groundcover biomass, while other common sedges include *Baloskion* spp*., Baumea rubiginosa, Empodisma minus*, *Juncus* spp. and *Schoenus apogon*. Forbs growing amongst the sedges include *Drosera* spp., *Geranium neglectum*, *Gratiola* spp., *Mitrasacme serpyllifolia, Ranunculus* spp. and *Viola*

spp. Hummocks of *Sphagnum* moss may occur amongst other components of the ground layer. The continuity of the ground layer may be interrupted by erosion, trampling, partial clearing or earthworks. There may be considerable variation in soils and species composition between and within individual peatlands and swamps. Regionally, a number of species are confined to the northern or southern parts of the community's distribution. Locally, toward the margins of any particular peatland or swamp, the average watertable depth typically declines, the mineral content of surface soils increases and hydrophilic plant species are replaced by species that are less tolerant of waterlogged conditions.

5. Montane Peatlands and Swamps may be distinguished from Upland Wetlands of the Drainage Divide of the New England Tableland bioregion, also listed on Schedule 1 of the Threatened Species Conservation Act 1995, by several biological and physical characteristics. The latter community has fewer woody plants, a greater component of aquatic herbs, is based on substrates with less peat and higher mineral content, and has shallow temporary to near-permanent standing water, cf. a varying depth of seeping water within Montane Peatlands and Swamps.

6. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions provides habitat for a number of endangered plant species including *Carex klaphakei, Diuris pedunculata, Eucalyptus approximans, Euphrasia scabra, Gentiana baueriana*, *G. bredboensis, G. wingecarribiensis , Grevillea acanthifolia* subsp*. paludosa, Lysimachia vulgaris* var. *davurica* and *Prasophyllum uroglossum*; and vulnerable plant species including *Baloskion longipes, Boronia deanei, Callitris oblonga, Diuris venosa, Eucalyptus aquatica, Leptospermum thompsonii, Prasophyllum fuscum, Pultenaea parrisiae* subsp*. parrisiae, Ranunculus anemoneus*, *Tasmannia purpurascens* and *T. glaucifolia*. Some of these species are associated with ecotones of adjoining forests or watercourses. Montane peatlands and swamps provide habitat for a range of threatened fauna, particularly amphibians and, notably the Northern and Southern corroboree frogs (*Pseudophryne pengilleyi* and *P. corroboree*) and the Giant Dragonfly (*Petalura gigantea*).

7. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is currently known from parts of the Local Government Areas of Armidale Dumaresq, Bega Valley, Bellingen, Blue Mountains, Bombala, Cooma-Monaro, Eastern Capital City, Eurobodalla, Gloucester, Greater Argyle, Guyra, Hawkesbury, Lithgow, Oberon, Severn, Shoalhaven, Snowy River, Tenterfield, Tumbarumba, Tumut, Upper Lachlan and Wingecarribee but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995).

8. A number of vegetation surveys and mapping studies have been conducted across the range of Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions. In Whinam and Chilcott's (2002) classification of peatland vegetation, this community includes 'Tea-tree *Sphagnum* Peatlands' (Group 3), 'Shrubby herbaceous *Sphagnum* peatlands' (Group 4), 'Shrubby-sedgey *Sphagnum* peatlands' (Group 5), 'Heathy *Sphagnum* Peatlands' (Group 6), 'Barrington drainage line *Sphagnum* Swamps' (Group 7), 'Degraded *Sphagnum* Moss Beds' (Group 8) and 'Alpine *Sphagnum* peatlands' (Group 9). In the New England bioregion, this community includes 'Heath Swamps on Leucogranite and Granite' (map unit 20) of Benson and Ashby (2000), 'Plateau Wet Herbfield' (map unit 1) and 'Wet Heath' (map unit 5) of Clarke *et. al*. (2000), and the *Sphagnum* bogs described by Millington (1954). In the Barrington Tops area, this community includes the swamps described by Mort (1983), 'Sedgeland' (Community 12) of Zoete (2000) and 'Subalpine bogs' of Fraser and Vickery (1939). On the central tablelands, this community includes 'Coxs River swamps' (map unit 20b) and 'Boyd plateau bogs' (map unit 26b) of Keith and Benson (1988) and Benson and Keith (1990); 'Highlands peat swamp' (map unit 25a) and 'Bindook highlands grassland' (map unit 18) of NPWS (2003); and the swamps and bogs described by Black (1976) and Kodela *et al*. (1996). On the southern tablelands, this community includes peatlands described by Hope and Southern (1981), including Wingecarribee swamp (Kodela *et al*. 2001); 'Montane Wet Heath/Bog' (map unit 123), 'Western Montane Wet Heath/Herb Grass Woodland' (map unit 124), 'Montane Wet Heath/Herb Grassland' (map unit 125), and 'Montane Wet Sedgeland' (map unit 126) of Thomas *et al*. (2000); and 'Tableland Bog' (map unit 53) and 'Shrubby Swamp Meadow' (map unit 5557) of Tindall *et al*. (2004); 'Subalpine Bog' (map unit 59) of Keith and Bedward (1999); and '*Carex gaudichaudiana* Alliance', *Epacris paludosa – Sphagnum cymbifolium* Alliance' and '*Carex gaudichaudiana – Sphagnum cymbifolium* Alliance' of Costin (1954). In the Kosciusko-Monaro district, this community also includes the *Sphagnum* peatlands of Clarke and Martin (1999), the '*Carex gaudichaudiana'* and '*Epacris paludosa'* alliances of Costin (1954), 'Bog and Fen'

(map unit 9) of Wimbush and Costin (1973) and the '*Poa* association', '*Poa-Restio* ecotone', '*Restio* associes', '*Hypolaena* associes', '*Richea* associes', '*Epacris* associes', '*Callistemon* consociation' and '*Baeckea* consociation' of McLuckie and Petrie (1927). Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is included within the 'Montane Bogs and Fens' and 'Alpine Bogs and Fens' vegetation classes of Keith (2002, 2004). There may be additional or unmapped occurrences of Montane Peatlands and Swamps within and beyond these surveyed areas.

9. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions are threatened by land clearing; grazing, trampling and soil disturbance caused by feral pigs, goats, deer, horses and domestic livestock; damage to vegetation and soils by off-road vehicles; peat mining; frequent or high-intensity fires; pollution and eutrophication from urban areas, cropping and improved pastures in the catchment; weed invasion; changes to water tables and surface flows caused by drainage works or altered flows in the catchment; erosion and sedimentation; and climate change.

10. Losses of Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions due to land clearing are difficult to estimate. However, estimates vary from about 20% in the Guyra district (Benson and Ashby 2000) to more than 75% in the far southeast of NSW (Keith and Bedward 1999). Clearing of catchments for pastures or plantations, and earthworks associated with road or track construction may also adversely affect peatlands by causing erosion, sedimentation or changes in hydrology (Whinam and Chilcott 2002). Clearing of native vegetation is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).

11. Overgrazing may cause changes in species composition by reducing the abundance of the most palatable plants, as well as woody species with poor regenerative capacity (Whinam and Chilcott (2002). Trampling by hooved animals, such as pigs, goats, deer, horses or cattle, causes channelling of water flow, which may lead to erosion or drying in different parts of a peatland (Whinam and Chilcott 2002). Digging and rooting by feral pigs and horses may also cause severe damage to vegetation and soils, even in conservation reserves, such as Koscuiszko and Kanangra-Boyd National Parks, where control measures are carried out (Whinam and Chilcott 2002). Predation, habitat destruction, competition and disease transmission by feral pigs, Competition and habitat degradation by feral goats, and Herbivory and environmental degradation caused by feral deer are listed as a Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Peat mining, although localised, may have catastrophic impacts on the hydrology and ecological function of Montane Peatlands and Swamps. For example, peat was extracted from Wingecarribee Swamp, the largest peatland on mainland Australia, for 25 years until it underwent a massive structural collapse in 1998 (Arachchi and Lambkin 1999). The collapse left only 20% of the swamp intact, with the remainder affected by drying, fissuring and oxidation of the peat, loss of *Sphagnum* and herbaceous flora and the expansion of *Leptospermum juniperinum* and exotic woody species such as *Rubus fruticosis* agg. and *Salix* spp. (Kodela *et al.* 2001). Underground mining of coal may also affect the hydrology of Montane Peatlands and Swamps where subsidence causes fissuring and subsequent drying or erosion (Young 1982), or where mine water is disposed into swamps and alters surface flows or causes erosion or sedimentation. Changes to hydrology may also result from the construction of drainage channels for agricultural land use or earthworks associated with infrastructure, such as roads, pipelines or other constructions. Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).

13. Some areas of Montane Peatlands and Swamps are exposed to high frequency fire, which alters species composition by favouring fire-tolerant sedges at the expense of woody plants that are slow to regenerate after fire (Keith 1996) and by creating exposed conditions unsuitable for the recovery of *Sphagnum* (Whinam *et al*. 1989, 2001). Survival of rhizomatous species, such as *Baloskion australe* and *Empodisma minus*, and tussock sedges, such as *Carex gaudichaudiana*, is important for the maintenance of substrate integrity after fire. Elimination of woody species by frequent burning is likely to be accelerated by grazing. Under dry conditions, fires may consume peat, resulting in the complete death of surface vegetation and seed banks, and exposure of the remaining substrate to further erosion. Changes that follow peat fires may therefore be long-lasting (Keith 1996). High frequency fire is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).

14. Pollution and eutrophication of peatlands is caused by run off or drift of fertilisers, pesticides, waste water, storm water and other pollutants from adjacent pastures and developed industrial or urban areas. This results in the replacement of native peatland vegetation by exotic weeds at a rate determined by the chemical composition and input rate of the pollutants. Common weed species include *Rubus fruticosis* agg. (blackberries), *Salix* spp. (willows), *Pinus radiata, Dactylis glomerata* (cocksfoot), *Cirsium vulgare* (spear thistle), *Conyza bonariensis* (fleabane), *Hypochaeris radicata* (cats ear), *Lotus uliginosus, Ranunculus repens* (creeping buttercup), *Taraxacum officinale* (dandelion), *Anthoxanthum odoratum* (sweet vernal grass), *Holcus lanatus* (Yorkshire fog), *Paspalum dilatatum, Juncus articulatus*. Invasion of native plant communities by exotic perennial grasses is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).

15. Climate change may threaten the persistence of Montane Peatlands and Swamps through the alteration of hydrological budgets (Hughes 2003). Reduced precipitation and increased evaporation rates are likely to cause drying and contraction of peatlands (Whinam *et al*. 2003). There may also be indirect impacts if climate change results in higher fire frequencies and greater incidence of peat fires. Anthropogenic climate change is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).

16. Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is currently known from conservation reserves including Werrikimbee, Barrington, Kanangra-Boyd, Monga, Wadbilliga, South East Forests and Kosciusko National Parks. However, these examples are generally small, unrepresentative of the range of variation in the community, affected by past disturbances and continue to be threatened by some of the processes described above (Whinam and Chilcott 2002, Whinam *et al*. 2003). Analogous communities occur in Victoria, where the community is listed as threatened under the Flora and Fauna Guarantee Act, and in the Australian Capital Territory.

17. In view of the above, the Scientific Committee is of the opinion that Montane Peatlands and Swamps of the of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions is facing a high risk of becoming extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam
Chairperson
Scientific Committee

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Appendix 7
Information on Commonwealth listed community Temperate Highland Peat Swamps on Sandstone

What are the Temperate Highland Peat Swamps?

The Temperate Highland Peat Swamps on Sandstone are temporary or permanent swamps in the Blue Mountains, Lithgow, Southern Highlands and Bombala regions. They include the:

- Blue Mountains Swamps;
- Butler's Swamp;
- Jackson's Bog (also known as Mila Swamp);
- Newnes Plateau Swamps;
- Paddy's River Swamps (also known as Hanging Rock, Long, Mundego and Stingray Swamps);
- Wildes Meadow Swamp; and
- Wingecarribee Swamp.

The Temperate Highland Peat Swamps all occur on sandstone and share similar vegetation. Sphagnum bogs and fens occupy the wetter parts while sedge and shrub associations occur in the drier parts of the swamps. Some, like the Blue Mountains Swamps, are hanging swamps that are prominent on steep valley sides, where water exits the ground between sandstone and claystone layers of rock. Other swamps, like Wingecarribee Swamp, occur in natural depressions or along watercourses.
A variety of native plants and animals make their homes in the Temperate Highland Peat Swamps. These include the nationally endangered Blue Mountains Water Skink, Giant Burrowing Frog and Wingecarribee Leek Orchid. The Giant Dragonfly, which is threatened in NSW, also occurs in this ecological community.

Why is the Temperate Highland Peat Swamps included on the list of nationally threatened ecological comunities?

The Temperate Highland Peat Swamps was listed as an endangered ecological community, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), due to its restricted distribution and vulnerability to ongoing threats. Only 3,000 hectares of this ecological community remains. Many of the swamps have been damaged by introduced animals, such as cattle, horses, rabbits and pigs. Swamps may also be at risk from the impacts of increased fertiliser runoff, residential development, clearing, weeds and fire. In the past peat mining has caused severe damage to some swamps.
National listing of the Temperate Highland Peat Swamps recognises that its long-term survival is under threat. The listing aims to prevent its further decline and assist community and land manager efforts toward its recovery.

The Australian Minister for the Environment and Heritage decided to list the Temperate Highland Peat Swamps after considering advice from the Threatened Species Scientific Committee. The Committee is an independent scientific body that advises the Minister on the conservation status of native species and ecological communities.

This ecological community also is listed as endangered under the NSW *Threatened Species Conservation Act 1995* as a part of the 'Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions' ecological community

What does the listing of the Temperate Highland Peat Swamps mean for land managers?

Protection under the EPBC Act applies to all swamps identified as part of the Temperate Highland Peat Swamps.

Two hundred years of land use, including vegetation clearing and stock use, has severely affected the Temperate Highland Peat Swamps. However, listing the swamps under the EPBC Act will not prevent land managers from continuing to use their land in the same way they were before, as long as their activities do not change or intensify.

National protection means that activities which are likely to have a significant impact upon the Temperate Highland Peat Swamps should be referred to the Minister for assessment and approval (unless they are subject to an exemption under the EPBC Act). Activities that may have a significant impact include, but are not restricted to, urban development, hydrological changes, grazing and peat mining.
The process for making a referral under the EPBC Act is easy and without charge. All you have to do is complete and submit the relevant form, which can be obtained from the Department of the Environment and Heritage.

Based on your referral, the Minister will determine if assessment and approval is required. If it is not required, then you are free to take action in accordance with your referral. If it is required, strict timeframes in the EPBC Act ensure the assessment and approval process is conducted in a timely manner.
The EPBC Act allows for some exemptions to the requirement for assessment and approval. This means that some activities may not need an assessment or approval if you meet certain requirements. Information on exemptions can be found at:

- www.deh.gov.au/epbc/publications/exemptions.html

What are the conservation priorities for the Temperate Highland Peat Swamps?

Priority conservation actions that can assist in the recovery of the ecological community are to:

- develop conservation covenants with relevant land managers;
- fence important remnants to control the impacts of certain introduced animals;
- identify seasonal and long-term fluctuations in water flows and water quality regimes within the swamps;
- minimise impacts from changes to water flow and water quality;
- manage weeds within and immediately adjacent to existing remnants; and
- rehabilitate degraded remnants with local species known to occur in those swamps.

Funding is available for projects to recover threatened species and ecological communities.

- Information about the Threatened Species Network Community grants is available at: www.wwf.org.au/tsn
- Information about Envirofund grants is available at www.nht.gov.au/envirofund

You may also wish to participate in the development and implementation of your region's Natural Resource Management Plan. In this case, contact your local land management agency.

Where can I get further information?

Further information is available from the Department of the Environment and Heritage.

- EPBC Act website: www.deh.gov.au/epbc
- EPBC Act Administrative Guidelines on Significance:
- www.deh.gov.au/epbc/assessmentsapprovals/guidelines/index.html
- Referral form: www.deh.gov.au/epbc/assessmentsapprovals/referrals/form.html
- Community Information Unit: free call **1800 803 772**

Information about wetlands in general is available from:

- The Department's wetlands website: www.deh.gov.au/water/wetlands
- Wetland Care Australia, a not-for-profit company dedicated to on-ground action to repair wetlands: www.wetlandcare.com.au
- The Wetlands Website of the NSW Department of Infrastructure, Planning and Natural Resources also has a lot of useful information on how to manage and conserve wetlands: www.dlwc.nsw.gov.au/care/wetlands/index.html

Appendix 8
GPS locations for threatened and rare plant and animal species

Species	GPS Location (WGS 84)	Location	No.	Date	LGA	Tenure	Observer
PLANTS - threatened							
Eucalyptuys aquatica	56 0242149 6166747	Long Swamp	large stand	04.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptuys aquatica	56 0242188 6166769	Long Swamp	1	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptuys aquatica	56 0242170 6166745	West of point	225+	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptuys aquatica	56 0242147 6166668	Swamp edge	5	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242841 6166383	Quarry site	2	11.09.12	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242994 6166371	Quarry site	1	26.09.12	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0241947 6166501	Northwest	2	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0241932 6166499	Northwest	11	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0241934 6166485	Northwest	3	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0241920 6166476	Northwest	44	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242020 6166485	Northwest	2	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242069 6166539	Northwest	8	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242066 6166557	Northwest	10	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242157 6166560	Northwest	7	03.05.16	Wingecarribee	Freehold	K. Mills
Phyllota humifusa	56 0242104 6166485	Northwest	18	03.05.16	Wingecarribee	Freehold	K. Mills
PLANTS - rare					Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242328 6166661		c.50	04.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242435 6166625		5	04.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242486 6166613		3	04.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243412 6166323		c.40	11.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243439 6166381		c12	11.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243487 6166415		c.6	11.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243954 6166925		5	18.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243933 6166976		3	18.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243893 6167006		50+	18.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243756 6166875		10+	18.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243381 6166614		30+	18.09.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243452 6166192		7+	03.12.12	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0244282 6166876		4	15.10.13	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0243468 6166309		30	03.05.16	Wingecarribee	Freehold	K. Mills

Species	GPS Location (WGS 84)	Location	No.	Date	LGA	Tenure	Observer
Eucalyptus apiculata	56 0242258 6166539		1	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242255 6166518		3	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242221 6166516		15	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242191 6166522		1	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242179 6166466		6	03.05.16	Wingecarribee	Freehold	K. Mills
Eucalyptus apiculata	56 0242220 6166465		10	03.05.16	Wingecarribee	Freehold	K. Mills
ANIMALS - listed					Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243176 6165856		2 feed trees	04.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243189 6165848		1 feed tree	04.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242367 6166369		1 feed tree	04.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243051 6166178		feed tree	11.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243049 6166169		feed tree	11.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242330 6166086		3 feed trees	11.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242622 6166215		2 feed trees	18.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242550 6166292		1 feed tree	18.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243005 6165995		1 feed tree	18.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243006 6166048		1 feed tree	18.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242979 6166148		3 feed tree	18.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243000 6166145		1 feed tree	18.09.12	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243213 6165837		feed trees	05.10.12	Wingecarribee	Freehold	D. Engel
Glossy Black-Cockatoo	56 0243209 6165851		3 birds	03.10.13	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243202 6165864		feed tree	03.10.13	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242700 6166214		feed tree	10.10.13	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0242678 6166252		feather	10.10.13	Wingecarribee	Freehold	K. Mills
Glossy Black-Cockatoo	56 0243452 6166424		feed tree	03.05.16	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0244106 6165920		female	03.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0242307 6166163		pair	04.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0242639 6166429		female	04.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0242933 6166507		male	11.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0243197 6166331		male	11.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0242800 6166311		pair	18.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0243102 6166224		female	18.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0242522 6166179		male	18.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0242913 6166048		male	26.09.12	Wingecarribee	Freehold	K. Mills
Scarlet Robin	c. 56 0242823 6166352		1	05.10.12	Wingecarribee	Freehold	S.

Species	GPS Location (WGS 84)	Location	No.	Date	LGA	Tenure	Observer
							Bloomfield
Scarlet Robin	c. 56 0243193 6165849		1	05.10.12	Wingecarribee	Freehold	S. Bloomfield
Scarlet Robin	56 0242730 6166400		1	02.10.12	Wingecarribee	Freehold	D.Engel
Scarlet Robin	56 0242649 6166429		male	03.10.13	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0244092 6166048		female	03.05.16	Wingecarribee	Freehold	K. Mills
Scarlet Robin	56 0244047 6166213		male	03.05.16	Wingecarribee	Freehold	K. Mills
Varied Sittella	56 0242844 6166439	quarry footprint	1	18.09.12	Wingecarribee	Freehold	K. Mills
Varied Sittella	56 0243530 6166657		2	18.09.12	Wingecarribee	Freehold	K. Mills
Gang-gang Cockatoo	56 0243452 6166648	north of quarry site	2	18.09.12	Wingecarribee	Freehold	K. Mills
Gang-gang Cockatoo	c. 56 0243520 6166304	eastern property	calls	03.10.12	Wingecarribee	Freehold	D.Engel
Gang-gang Cockatoo	56 0243124 6166179	near large dam	2	14.10.12	Wingecarribee	Freehold	D.Engel
Powerful Owl	56 0242654 6166110		calls	04.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0242815 6166150		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0242203 6166081		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0242441 6166413		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0244046 6166278		calls	03.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0243773 6166174		calls	04.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0242203 6166081		calls	04.10.12	Wingecarribee	Freehold	D.Engel
Eastern Falsistrelle	56 0242203 6166081		calls	10.10.12	Wingecarribee	Freehold	D.Engel
Eastern Bentwing Bat	56 0242815 6166150		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Bentwing Bat	56 0242203 6166081		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Bentwing Bat	56 0242441 6166413		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Bentwing Bat	56 0244046 6166278		calls	02.10.12	Wingecarribee	Freehold	D.Engel
Eastern Bentwing Bat	56 0243773 6166174		calls	04.10.12	Wingecarribee	Freehold	D.Engel
Eastern Bentwing Bat	56 0242203 6166081		calls	10.10.12	Wingecarribee	Freehold	D.Engel
Large-eared Pied Bat	56 0244046 6166278		calls	03.10.12	Wingecarribee	Freehold	D.Engel
Greater Broadnosed Bat	56 0243773 6166174		calls	04.10.12	Wingecarribee	Freehold	D.Engel

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Appendix 9
Survey sheets for vegetation transect surveys

Site No.: 2.1 **Date:** 03.10.2013
GPS: 56 0242770 6166298 **Photo**.: yes
Vegetation Type: *E.piperita* Open Forest, with *E. sieberi* and *E. agglomerata*

50 metre transect

Survey points at 5m (% cover estimate) – total 11 points

Over-storey	10.25.40.25.40.30.20.25.40.40.40. Av. = 30%
Mid-storey (>1m)	0.10.5.2.30.5.0.0.0.0.0. Av. = 4.7%

Survey points at 1m (presence/absence) – total 51 points

Grasses	5 (9.8%)
Shrubs (<1m)	12 (23.5%)
Forbs, others	22 (43.1%)
Exotics	0 (0%)
Bare	12 (23.5%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
41,34,223,244,250,610,358,52,91,720,56,173,141,410,458,91,100,184,130,210,242,536,32,112,98,382, 89,50,318,320,82,34,297,86,62,156,86,75,40,67,190,250,870,142,386,90,68,236,480,120,216,33,150. Total = 109.7 metres

Tree Hollows:
2 in *E. piperita* (Tree no. 45)

Site No.: 2.2 **Date:**03.10.2013
GPS: 56 0242330 6166126 **Photo**.: yes
Vegetation Type: *E.piperita* Open Forest, with *E. punctata*

50 metre transect

Survey points at 5m (% cover estimate) – total 10 points

Over-storey	40.40.45.35.30.45.60.50.60.45. Av. = 45%
Mid-storey (>1m)	0.0.0.0.0.10.0.0.0.0.0 Av. = 1%

Survey points at 1m (presence/absence) – total 51 points

Grasses	5 (9.8%)
Shrubs (<1m)	7 (13.7%)
Forbs, others	10 (19.6%)
Exotics	0 (0%)
Bare	29 (56.9%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
57,1580,910,30,130,96,278,120,325,180,330,110,54,86,81,1256,287,161,164,220,226,332,105,301,32.
Total = 74.5 metres

Tree Hollows:
nil

Site No.: 3.1 **Date:** 03.10.2013
GPS: 56 0242318 6165982 **Photo**.: yes
Vegetation Type: *E. agglomerata – E. sieberi* Open Forest, with *Allocasuarina littoralis*

50 metre transect

Survey points at 5m (% cover estimate) – total 11 points

Over-storey	60.25.15.15.30.40.30.30.25.40.35. Av. = 31.6%
Mid-storey (>1m)	2.0.0.0.0.0.10.0.0.5.5. Av. = 2.2%

Survey points at 1m (presence/absence) – total 51 points

Grasses	11 (21%)
Shrubs (<1m)	9 (17.6%)
Forbs, others	29 (56.9%)
Exotics	0 (0%)
Bare	2 (3.9%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
92.135.435.45.73.55.59.245.293.115.73.60.429.160.66.100.55.368.217.670.810.60.510.560.128.122.308.330.53.44.307.600.875.280.250.23.160.342.157.157.930.38.117.92.57.259.535.125.177.98.35.760.152.
158.171.180. Total = 137 metres

Tree Hollows:
Nil.

Site No.: 4.1 **Date:** 03.10.2013
GPS: 56 0242809 6166507 **Photo**.: yes
Vegetation Type: *E. sclerophylla - E. sieberi* Woodland

50 metre transect

Survey points at 5m (% cover estimate) – total 10 points

Over-storey	20.15.30.40.20.40.20.15.40.40. Av. =
Mid-storey (>1m)	10.0.10.5.10.0.0.2.2.5. Av. = 2.2%

Survey points at 1m (presence/absence) – total 51 points

Grasses	5 (9.8%)
Shrubs (<1m)	11 (21.6%)
Forbs, others	26 (51%)
Exotics	0 (0%)
Bare	9 (17.6%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
520,700,430,87,86,80,430,265,325,60,62,380,248,232,134,255,177,160,326,152,170,100,166,87,250,40. Total = 59.2 metres.

Tree Hollows:
3 in *E. sclerophylla* (tree no.78), 8 in *E. sclerophylla* (tree no.76).
Note - tree 77 has blown over since survey.

Site No.: 4.2 **Date:** 03.10.2013
GPS: 56 0242646 6166422 **Photo**.: yes
Vegetation Type: *E.sclerophylla* Woodoland/ Open Forest with *E. sieberi, E. agglomerata*

50 metre transect

Survey points at 5m (% cover estimate) – total 11 points

Over-storey	25.30.15.40.40.35.25.35.40.25.35. Av. = 31.4%
Mid-storey (>1m)	0.5.2.2.0.0.0.0.0.2.0. Av. = 1%

Survey points at 1m (presence/absence) – total 51 points

Grasses	6 (11.8%)
Shrubs (<1m)	10 (19.6%)
Forbs, others	28 (54.9%)
Exotics	0 (0%)
Bare	7 (13.7%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
150,100,115,618,176,470,420,507,122,169,168,422,400,42,90,178,398,111,142,134,200,142,190.
Total = 54.6 metres.

Tree Hollows:
1 in *E. sieberi*

Site No.: 4.3 **Date:** 03.10.2013
GPS: 56 0243184 6166469 **Photo**.: yes
Vegetation Type: *E. scelrophylla* Woodland

50 metre transect

Survey points at 5m (% cover estimate) – total 11 points

Over-storey	35.20.35.40.25.30.40.30.30.20.30. Av. = 30.4%
Mid-storey (>1m)	5.40.10.1.0.2.2.30.70.1.60. Av. = 20.1%

Survey points at 1m (presence/absence) – total 51 points

Grasses	6 (11.8%)
Shrubs (<1m)	21 (41.2%)
Forbs, others	15 (?%)
Exotics	0 (0%)
Bare	9 (17.6%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
96,126,70,101,360,150,136,210,74,795,82,37,360,75,120,338,254,407,62,28,770,45,163,40.
Total = 49 metres.

Tree Hollows:
2 in *E. scelrophylla*

Site No.: 4.4 **Date:** 03.10.2013
GPS: 56 0243552 6166345 **Photo**.: yes
Vegetation Type: *E. sclerophylla* Woodland

50 metre transect

Survey points at 5m (% cover estimate) – total 10 points

Over-storey	30.30.20.20.40.35.35.25.20.10.5. Av. = 25%
Mid-storey (>1m)	30.25.70.0.2.20.30.25.0.0. Av. = 20.2%

Survey points at 1m (presence/absence) – total 51 points

Grasses	5 (9.8%)
Shrubs (<1m)	5 (9.8%)
Forbs, others	2 (3.9%)
Exotics	0 (0%)
Bare	39 (76.0%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
120,260,50,180,54,738,86,148,550,144,186,285,160,136,246,70,89,950,90,84,266,30.
Total = 49.2 metres.

Tree Hollows:
2 in *E. scelrophylla*; 1 in dead tree.

Site No.: 5.1 **Date:** 02.10.2013
GPS: 56 0243400 6165985 **Photo**.: yes
Vegetation Type: Regrowth *E. sieberi* Open Forest

50 metre transect

Survey points at 5m (% cover estimate) – total 10 points

Over-storey	10.20.60.40.50.50.50.60.60.60 Av. = 46%
Mid-storey (>1m)	0.0.80.20.80.0.0.10.0.0 Av. = 19%

Survey points at 1m (presence/absence) – total 51 points

Grasses	7 (13.7%)
Shrubs (<1m)	1 (2.0%)
Forbs, others	11 (21.6%)
Exotics	0 (0%)
Bare	32 (52.7%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
69,30,77,117. Total 2.9 metres.

Tree Hollows:
Nil.

Site No.: 5.2 **Date:** 03.10.2013
GPS: 56 0242092 6165062 **Photo**.: yes
Vegetation Type: Regrowth *E.agglomerata, E.piperita, E. sieberi, A. littoralis* Open Forest

50 metre transect

Survey points at 5m (% cover estimate) – total 11 points

Over-storey	40.40.50.60.60.60.50.55.55.60.40. Av. = 57%
Mid-storey (>1m)	0.0.0.0.5.0.0.0.10.0.0. Av. = 1.4%

Survey points at 1m (presence/absence) – total 51 points

Grasses	3 (5.9%)
Shrubs (<1m)	12 (23.5%)
Forbs, others	16 (31.4%)
Exotics	0 (0%)
Bare	20 (39.2%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
40,43,280,61,72. Total = 5 metres.

Tree Hollows:
Nil.

Site No.: 5.3 **Date:** 03.10.2013
GPS: 56 0243161 6166315 **Photo**.: yes
Vegetation Type: Regrowth *E.piperiota, E. sieberi* Open Forest with *Pinus radiata**

50 metre transect

Survey points at 5m (% cover estimate) – total 10 points

Over-storey	70.10.10.10.20.40.10.20.20.10. Av. = 22%
Mid-storey (>1m)	0.0.0.0.0.0.0.0.30.0. Av. = 3.0%

Survey points at 1m (presence/absence) – total 51 points

Grasses	2 (3.9%)
Shrubs (<1m)	10 (19.6%)
Forbs, others	13 (25.5%)
Exotics	1 (2.0%)
Bare	25 (49.0%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
211. Total = 2.1 metres.

Tree Hollows:
Nil.

Site No.: 5.4 **Date:** 03.10.2013
GPS: 56 0242954 6166447 **Photo**.: yes
Vegetation Type: Regrowth *E. sieberi* Open Forest

50 metre transect

Survey points at 5m (% cover estimate) – total 11 points

Over-storey	50.45.45.40.55.55.45.20.5.0.5. Av. = 33%
Mid-storey (>1m)	0.0.0.0.2.0.0.2.0.0.0. Av. = 3.6%

Survey points at 1m (presence/absence) – total 51 points

Grasses	5 (9.8%)
Shrubs (<1m)	5 (9.8%)
Forbs, others	14 (27.5%)
Exotics	0 (0%)
Bare	27 (52.9%)

50 x 20 metre plot

Lengths of fallen logs (>10cm diam. and >0.5 m long)
19,88,65,50,30,32,14. Total = 2.7 metres

Tree Hollows:
Nil.

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Appendix 10
Conservation codes for Rare or Threatened Australian Plants

The Distribution Category

1 Known by one collection only.

2 Geographic range in Australia is less than 100 km.

3 Geographic range in Australia is greater than 100 km.

The Conservation Status

X Presumed Extinct: taxon not collected or otherwise verified over the past 50 years despite thorough searching in all known and likely habitats, or of which all known wild populations have been destroyed more recently.

E Endangered: taxon in serious risk of disappearing from the wild within 10-20 years if present land use and other threats continue to operate. This category includes taxa with populations possibly too small (usually less than 100 individuals) to ensure survival even if present in proclaimed reserves.

V Vulnerable: taxon not presently Endangered, but at risk over a longer period (20-50 years) of disappearing from the wild through continued depletion, or which occurs on land whose future use is likely to change and threaten its survival.

R Rare: taxon which is rare in Australia (and hence usually in the world) but which currently does not have any identifiable threat. Such species may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wide range or some intermediate combination of distribution pattern.

K Poorly Known: taxon that is suspected, but not definitely known, to belong to one of the above categories. At present, accurate field distribution information is inadequate.

C Reserved: indicates taxon has at least one population within a national park, other proclaimed conservation reserve or in an area other-wise dedicated for the protection of flora. The taxon may or may not be considered adequately conserved within the reserve(s), as reflected by the conservation status assigned to it. Where applicable, the 'C' symbol immediately follows the conservation status symbol in the written code, e.g. 2RC.

The Size-class of all Reserved Populations

a 1000 plants or more are known to occur within a conservation reserve(s).
i Less than 1000 plants are known to occur within a conservation reserve(s).
- The reserved population size is not accurately known.
t Total known population reserved.
+ Overseas occurrence (included if the taxon has a natural occurrence overseas).

Based on Briggs & Leigh (1996).

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Appendix 11
Control classes for noxious weed species

Weed control classes

(1) The following weed control classes may be applied to a plant by a weed control order:
- (a) Class 1, State Prohibited Weeds,
- (b) Class 2, Regionally Prohibited Weeds,
- (c) Class 3, Regionally Controlled Weeds,
- (d) Class 4, Locally Controlled Weeds,
- (e) Class 5, Restricted Plants.

(2) The characteristics of each class are as follows:
- (a) Class 1 noxious weeds are plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.
- (b) Class 2 noxious weeds are plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.
- (c) Class 3 noxious weeds are plants that pose a serious threat to primary production or the environment of an area to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.
- (d) Class 4 noxious weeds are plants that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.
- (e) Class 5 noxious weeds are plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.

(3) A noxious weed that is classified as a Class 1, 2 or 5 noxious weed is referred to in this Act as a *notifiable weed*.

(4) Legal Requirements

Class 1. The plant must be eradicated from the land and the land must be kept free of the plant.
Class 2. The plant must be eradicated from the land and the land must be kept free of the plant.
Class 3. The plant must be fully and continuously suppressed and destroyed.
Class 4. The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
Class 4*. The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed.
Class 5. The requirements in the *Noxious Weeds Act* for a notifiable weed must be complied with.

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Appendix 12
Records with 10 km extracted from NSW Wildlife Atlas

Extracted May 2016.

Animals

Animalia	Amphibia	Myobatrachidae	3073	^*Mixophyes balbus*	Stuttering Frog	E1,P,2
Animalia	Amphibia	Hylidae	3039	*Litoria littlejohni*	Littlejohn's Tree Frog	V,P
Animalia	Aves	Anatidae	0216	*Oxyura australis*	Blue-billed Duck	V,P
Animalia	Aves	Accipitridae	0225	*Hieraaetus morphnoides*	Little Eagle	V,P
Animalia	Aves	Falconidae	0238	*Falco subniger*	Black Falcon	V,P
Animalia	Aves	Cacatuidae	0268	^^*Callocephalon fimbriatum*	Gang-gang Cockatoo	V,P,3
Animalia	Aves	Cacatuidae	0265	^*Calyptorhynchus lathami*	Glossy Black-Cockatoo	V,P,2
Animalia	Aves	Strigidae	0246	^^*Ninox connivens*	Barking Owl	V,P,3
Animalia	Aves	Strigidae	0248	^^*Ninox strenua*	Powerful Owl	V,P,3
Animalia	Aves	Tytonidae	9924	^^*Tyto tenebricosa*	Sooty Owl	V,P,3
Animalia	Aves	Neosittidae	0549	*Daphoenositta chrysoptera*	Varied Sittella	V,P
Animalia	Aves	Petroicidae	0380	*Petroica boodang*	Scarlet Robin	V,P
Animalia	Aves	Petroicidae	0382	*Petroica phoenicea*	Flame Robin	V,P
Animalia	Aves	Estrildidae	0652	*Stagonopleura guttata*	Diamond Firetail	V,P
Animalia	Mammalia	Dasyuridae	1008	*Dasyurus maculatus*	Spotted-tailed Quoll	V,P
Animalia	Mammalia	Phascolarctidae	1162	*Phascolarctos cinereus*	Koala	V,P
Animalia	Mammalia	Burramyidae	1150	*Cercartetus nanus*	Eastern Pygmy-possum	V,P
Animalia	Mammalia	Petauridae	1136	*Petaurus australis*	Yellow-bellied Glider	V,P
Animalia	Mammalia	Petauridae	1137	*Petaurus norfolcensis*	Squirrel Glider	V,P
Animalia	Mammalia	Pteropodidae	1280	*Pteropus poliocephalus*	Grey-headed Flying-fox	V,P
Animalia	Mammalia	Vespertilionidae	1353	*Chalinolobus dwyeri*	Large-eared Pied Bat	V,P
Animalia	Mammalia	Vespertilionidae	1372	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V,P
Animalia	Mammalia	Vespertilionidae	1834	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V,P
Animalia	Mammalia	Vespertilionidae	1357	*Myotis macropus*	Southern Myotis	V,P
Animalia	Insecta	Petaluridae	I007	*Petalura gigantea*	Giant Dragonfly	E1

Plants

Plantae	Flora	Cyperaceae	10902	*Carex klaphakei*	Klaphake's Sedge	E1,P
Plantae	Flora	Fabaceae (Faboideae)	2957	*Phyllota humifusa*	Dwarf Phyllota	V,P
Plantae	Flora	Fabaceae (Faboideae)	12267	*^^Pultenaea elusa*	Elusive Bush-pea	E4A,P,3
Plantae	Flora	Fabaceae (Faboideae)	12224	*Pultenaea parrisiae*	Parris' Bush-pea	V,P
Plantae	Flora	Fabaceae (Faboideae)	8538	*Swainsona sericea*	Silky Swainson-pea	V,P
Plantae	Flora	Fabaceae (Mimosoideae)	3728	*Acacia bynoeana*	Bynoe's Wattle	E1,P
Plantae	Flora	Gentianaceae	7631	*^^Gentiana wingecarribiensis*	Wingecarribee Gentian	E4A,P,3
Plantae	Flora	Malvaceae	14618	*Commersonia prostrata*	Dwarf Kerrawang	E1,P
Plantae	Flora	Myrtaceae	4038	*Eucalyptus aggregata*	Eucalyptus aggregata H.Deane & Maiden population in the Wingecarribee local government area	E2,V,P
Plantae	Flora	Myrtaceae	4038	*Eucalyptus aggregata*	Black Gum	V,P
Plantae	Flora	Myrtaceae	8850	*Eucalyptus aquatica*	Broad-leaved Sally	V,P
Plantae	Flora	Myrtaceae	4119	*Eucalyptus macarthurii*	Paddys River Box, Camden Woollybutt	E1,P
Plantae	Flora	Proteaceae	8307	*Grevillea molyneuxii*	Wingello Grevillea	V,P
Plantae	Flora	Restionaceae	10608	*Baloskion longipes*	Dense Cord-rush	V,P
Plantae	Flora	Rhamnaceae	5576	*Pomaderris cotoneaster*	Cotoneaster Pomaderris	E1,P
Plantae	Flora	Rhamnaceae	5593	*Pomaderris sericea*	Silky Pomaderris	E1,P
Plantae	Flora	Rutaceae	5843	*Zieria murphyi*	Velvet Zieria	V,P

Appendix 13
Matters of national environmental significance

The Protected Matter Search Tool of the Commonwealth Department of the Environment was interrogated to generate a report listing matters of national environmental significance or other matters protected by the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). The matters listed within five (5) kilometres of the centre of the project area are shown below; accessed May 2016.

List of matters of national environmental significance within 5 km of the project area

Threatened Ecological Communities
Temperate Highland Peat Swamps on Sandstone Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (E)
White Box-Yellow Box-Blakely's Red Gum Grassy (E)
Woodland and Derived Native Grassland (CE)

Listed Animals
Australian Painted Snipe *Rostratula australis* (E)
Regent Honeyeater *Anthochaera phrygia* (E)
Australasian Bittern *Botaurus poiciloptilus* (E)
Painted Honeyeater *Grantiella picta* (V)
Swift Parrot *Lathamus discolour* (E)
Australian Painted Snipe *Rostratula australis* (E)
Giant Burrowing Frog *Heleioporus australiacus* (V)
Littlejohn's Tree Frog, Heath Frog *Litoria littlejohni* (V)
Large-eared Pied Bat, Large Pied Bat *Chalinolobus dwyeri* (V)
Spotted-tail Quoll *Dasyurus maculatus maculatus* (southeastern mainland population) (E)
Southern Brown Bandicoot *Isoodon obesulus obesulus* (V)
Brush-tailed Rock-wallaby *Petrogale penicillata* (V)
Koala *Phascolarctos cinereus* (combined populations of QLD, NSW, ACT) (V)
Long-nosed Potoroo (SE mainland) *Potorous tridactylus tridactylus* (V)
Smoky Mouse *Pseudomys fumeus* (E)
New Holland Mouse *Pseudomys novaehollandiae* (V)
Grey-headed Flying-fox *Pteropus poliocephalus* (V)
Broad-headed Snake Hoplocephalus bungaroides (V)

Listed Plants
Asterolasia elegans (E)
Dense Cord-rush *Baloskion longipes* (V)
Thick-lipped Spider-orchid *Caladenia tessellata* (V)
Leafless Tongue-orchid *Cryptostylis hunteriana* (V)
Mountain Swamp Gum, *Eucalyptus aquatica* (V)
Yellow Gnat-orchid *Genoplesium bauera* (E)
Wingecarribee Gentian *Gentiana wingecarribiensis* (E)
Kunzea cambagei (V)
Leucochrysum albicans var. *tricolor* Hoary Sunray (E)
Omeo Stork's-bill *Pelargonium* sp. *striatellum* (G.W.Carr 10345) (E)
Dwarf Phyllota *Phyllota humifusa* (V)
Dwarf Kerrawang *Commersonia prostrata* (E)
Kangaloon Sun-orchid *Thelymitra* sp. Kangaloon (D.L.Jones 18108) (CE)
Austral Toadflax *Thesium australe* (V)

List of matters of national environmental significance within 5 km of the project area cont...

Fish
Macquarie Perch *Macquaria australasica* (E)

Migratory Species
Fork-tailed Swift *Apus pacificus*
White-throated Needletail *Hirundapus caudacutus*
Rainbow Bee-eater *Merops ornatus*
Black-faced Monarch *Monarcha melanopsis*
Satin Flycatcher *Myiagra cyanoleuca*
Rufous Fantail *Rhipidura rufifrons*
Great Egret, White Egret *Ardea alba*
Cattle Egret *Ardea ibis*
Latham's Snipe, Japanese Snipe *Gallinago hardwickii*
Eastern Osprey *Pandion cristatus*

CE – critically endangered; E – endangered; V – vulnerable.