CALGA SAND QUARRY SOUTHERN EXTENSION

Offsets Report

(Supplementary Report to an Ecological Assessment prepared as Part 3 of the Specialist Consultant Studies Compendium accompanying an Environmental Assessment for the proposed Southern Extension of the Calga Sand Quarry)

For:

R.W. CORKERY & CO. PTY LIMITED

ON BEHALF OF

ROCLA PTY LIMITED

December 2009

Final Report

Cumberland Ecology
PO Box 2474, Carlingford Court 2118

Report No. 8050RP2

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology

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Date:	*11 December, 2009*

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PURPOSE

The purpose of this report is to assess the ecological values of the proposed biodiversity offset areas for the Calga Sand Quarry Southern Extension, located on land owned by Rocla Pty Ltd ("the Project Site") and referred to hereafter as the Project Site offset area, as well as on the "Glenworth Valley" property ("Glenworth Valley offset area"). The impacts of the proposed quarry extension have been assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report provides a comparison of the ecology of the offsets to that of the proposed impact area.

BACKGROUND

Rocla Pty Ltd currently owns and operates the Calga Sand Quarry and is proposing to extend the quarry to the south. This proposal has been identified as a Major Project and is currently being assessed under Part 3A of the *Environmental Planning and Assessment Act 1979*. An Ecological Assessment has been prepared by Cumberland Ecology and submitted to the Department of Planning as part of the assessment process[1]. The proposed offset strategy for the proposed quarry extension includes land in the Project Site unaffected by the Project, and land on the neighbouring "Glenworth Valley" property. The offsets will be conserved with a covenant or restriction on the use of land under Section 88B of the *Conveyancing Act 1919*, Division 12 of the *National Parks and Wildlife Act 1974*, or similar.

METHODS

The Ecological Assessment (Cumberland Ecology 2009[1]) has previously assessed some of the ecological values of the Project Site and Glenworth Valley offset areas but additional surveys have been conducted to provide a more detailed assessment of these areas. Surveys included random meander searches for threatened flora species, tree hollow assessments, targeted threatened frog searches and habitat mapping, and hair funnel surveys for terrestrial and arboreal mammals. These were conducted on 6, 13 and 16 October 2009. During these surveys, notes were also made on other habitat values present in the offset areas.

RESULTS AND COMPARISON OF ECOLOGICAL VALUES

The combined offset areas provide 76.4ha of native vegetation, which is more than twice the area of native vegetation that would be cleared for the proposed extraction areas and access roads (34.7ha). The offset areas contain all but one of the same vegetation communities as the impact areas and include two additional vegetation communities.

Additional individuals of threatened plant species *Darwinia glaucophylla, Hibbertia procumbens* and *Callistemon linearifolius* were recorded from the offset areas. One individual of *Tetratheca glandulosa,* a threatened species predicted to occur but not previously recorded on the Project Site was also recorded in the Project Site offset area.

Hollow-bearing trees occur within all treed communities in the offset areas. A range of hollow sizes are available for fauna species dependent on this habitat feature. Habitat in the offset areas is in good condition and has had minimal human disturbance.

Habitat assessment for the Red-crowned Toadlet determined that the Project Site and Glenworth Valley offset areas provide more potential habitat for this species than the impact areas. This is because more feeder gully streams and soaks which the species prefers occur in these steeper sandstone slopes.

The Giant Burrowing Frog could also potentially occur throughout much of the Project Site and Glenworth Valley offset areas, although the best quality habitat is found on deeper sandy soils. Breeding habitat for this species is concentrated around Creek B, which would be conserved.

Potential habitat is available for Rosenberg's Goanna in the offset areas. This species requires termite mounds for breeding. Although few termite mounds were located during surveys, it is likely that there is a sparse but even distribution of this feature through the Project Site and Glenworth Valley offset area.

Tall eucalypt forest and rainforest occur in the gully of Creek C in the offset areas. Tall hollow-bearing eucalypts provide suitable nesting habitat for the Powerful Owl and Glossy Black Cockatoo. The Powerful Owl would forage throughout the offset areas and foraging habitat is available for the Glossy Black Cockatoo in forest communities.

Potential habitat for threatened mammals that have been recorded on the Project Site (Eastern Pygmy Possum, Grey-headed Flying-fox and Large-footed Myotis) is provided throughout the offset areas. Flowering shrubs and trees provide suitable foraging habitat for the Eastern Pygmy Possum and Grey-headed Flying-fox. The habitat available in the Study Area is not typical for the Large-footed Myotis, but the Glenworth Valley offset area is in close proximity to Cabbage Tree Creek, which would provide suitable foraging habitat for the species.

Potential habitat is also available in the offset areas for a range of other threatened flora and fauna species that are likely to occur in the Study Area. The offset areas provide a

wide range of sandstone habitats including woodland, scrub and forest vegetation communities, rocky outcropping, creeks and swamps.

CONCLUSION

Due to the abundance of similar habitats available and the recorded presence of threatened flora species, it is considered that the package including the Project Site offset area and the Glenworth Valley offset area is suitable for offsetting the impacts of the Project.

Chapter 1

Introduction

1.1 Purpose

The purpose of this report is to assess the ecological values of the proposed biodiversity offset areas for the Calga Sand Quarry Southern Extension, located on land owned by Rocla Pty Ltd ("the Project Site") and referred to hereafter as the Project Site offset area, as well as on the "Glenworth Valley" property ("Glenworth Valley offset area"). The impacts of the proposed quarry extension have been assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report provides a comparison of the ecology of the offsets to that of the proposed impact area.

The types of ecological values that have been analysed in this report include:

- the area of the proposed offsets and representation of vegetation communities;
- the presence of threatened flora species;
- the fauna habitat values such as size, number and distribution of tree hollows;
- the presence of habitat for threatened fauna species recorded on the Project Site including Red-crowned Toadlet, Giant Burrowing Frog, Eastern Pygmy Possum and microchiropteran bats; and
- the suitability of habitat provided in offsets for other threatened fauna species predicted to occur on the Project Site.

1.2 Background

1.2.1 Development and Assessment of the Proposed Calga Sand Quarry Southern Extension

Rocla Pty Ltd (Rocla) currently owns and operates the Calga Sand Quarry located off Peats Ridge Road, 1.7km north-northwest of the Calga Interchange on the F3 Freeway. Sand extraction from Stages 1 and 2 of the Calga Sand Quarry was undertaken between 1991 and 2004, with an application to extend the quarry onto land immediately north of

existing operations (Stage 3) approved as DA 94-4-2004 in November 2005. Stage 3 extraction commenced in early 2006 with production ongoing since this time.

Rocla now proposes to develop and operate a southern extension to the Calga Sand Quarry (Stages 4 and 5) to allow for an increase in sand production. The proposed southern extension (the "Project" or "Southern Extension") has been classified as a "Major Project" under State Environmental Planning Policy (Major Projects) 2005. In order for the combined existing quarry and proposed Southern Extension to be managed in accordance with a single approval, Rocla is seeking Project Approval over both the existing Calga Sand Quarry and the land on which the proposed Southern Extension would be undertaken (herein referred to as the "Project Site").

The Project is currently being assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2.2 Biodiversity Offsets

The proposed offset strategy developed for the Project primarily involves the conservation of native vegetation unaffected by the Project, on the Project Site itself in two blocks (east and west) as well as an area on the neighbouring "Glenworth Valley" property (see **Figure 1.1**). A total of 83.8ha are included in the offsets, of which 76.4 ha comprises native vegetation in order to offset the clearing of approximately 34.7ha of vegetation as part of the Project.

The area of native vegetation included in the offsets equates to a total offset ratio of approximately 2ha of offset for every 1ha of native vegetation to be cleared. Approximately half the offset required (39.1ha) is present on the Project Site offset area and the remaining land (44.7ha) on the "Glenworth Valley" offset area. The areas of vegetation to be conserved would be protected in perpetuity from future disturbance through the implementation of an enduring covenant or restriction on the use of the land under Section 88B of the *Conveyancing Act 1919,* Part 4, Division 12 of the *National Parks and Wildlife Act 1974* or similar arrangement.

To compensate the owners of "Glenworth Valley" for this long-term conservation of land on their property, Rocla will provide the owners of "Glenworth Valley" with unrestricted access to the remainder of the property via a road corridor on Lot 2, DP805358, which is owned by Rocla.

1.3 Terminology

This report uses the following terminology:

- **The Project** is the combined operation of the existing Calga Sand Quarry (Stage 3) and the proposed Southern Extension (Stages 4 and 5).

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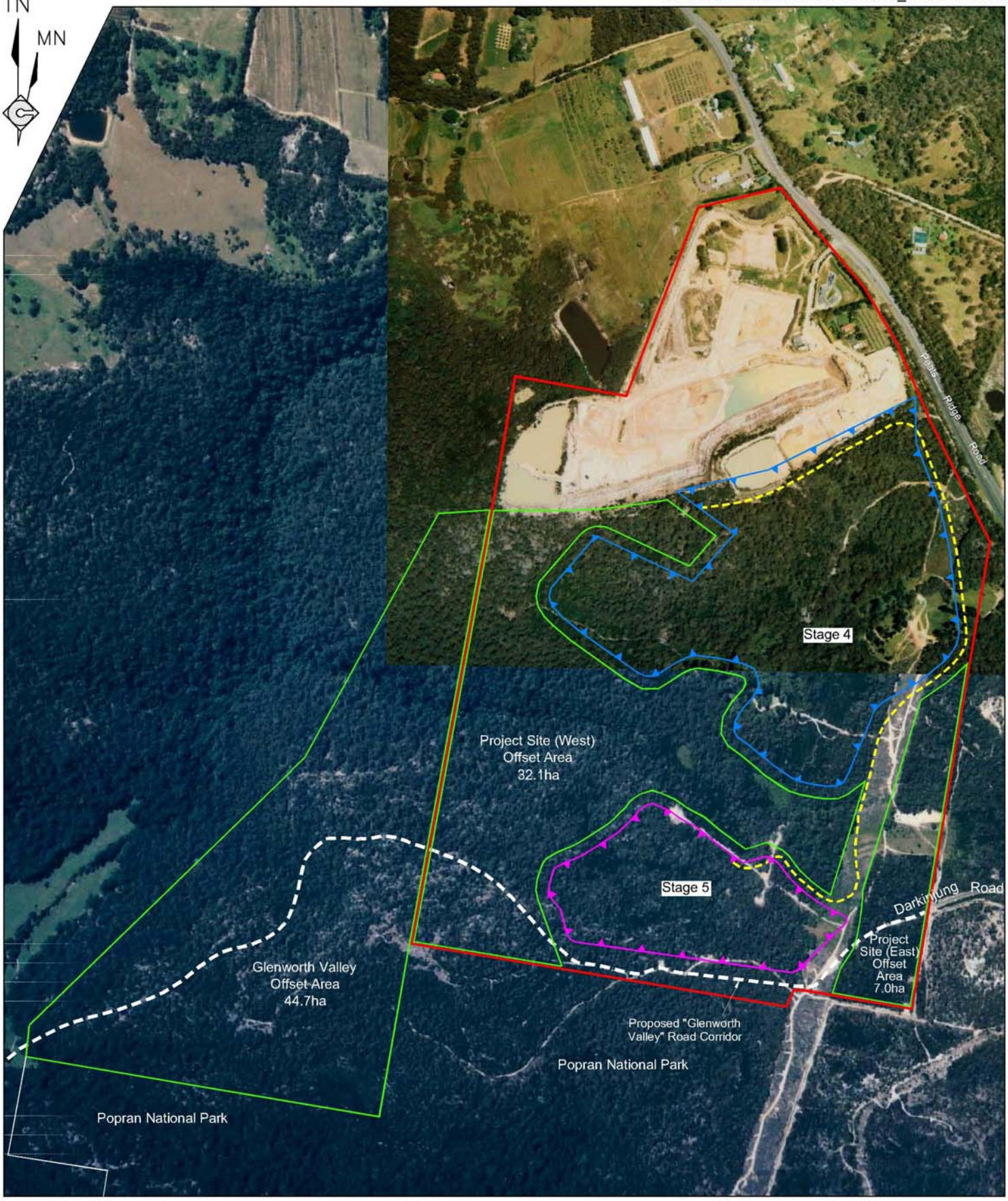

REFERENCE

- Project Site Boundary
- Proposed Limit of Extraction - Stage 4
- Proposed Limit of Extraction - Stage 5
- Offset Area
- Internal Haul Route
- "Glenworth Valley" Access Route

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Base Photo Source: Dept. of Lands: 02/04/ 06 & Geo-spectrum: 28/11/08

Figure 1.1
BIODIVERSITY OFFSET STRATEGY

- **The Project Site** is the area within Lot 2, DP 229889 and Lots 1 and 2, DP 805358 (including all disturbance associated with the approved Calga Sand Quarry and proposed Southern Extension).

- **The Study Area** Lots 1 and 2, DP 805358 within which the proposed Southern Extension would be undertaken, and the Glenworth Valley offset area.

- **Subject Area** is the area directly impacted by the construction and operation of the proposed Southern Extension, including the existing quarry and associated infrastructure.

- **Locality** is the area within a 5km radius of the Project Site.

- **Subject species** means those threatened species, populations and Endangered Ecological Communities (EECs) that are listed in either the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), NSW *Fisheries Management Act 1994*, (FM Act) or NSW *Threatened Species Conservation Act 1995* (TSC Act) and are known to occur, or considered likely to occur in the Locality.

Chapter 2

Methods

2.1 Vegetation Communities

Vegetation communities have previously been mapped and surveyed by East Coast Flora Surveys (see **Figure 3.1**). The methods for these surveys are described in the Ecological Assessment for the proposed Southern Extension[1].

2.2 Threatened Flora Species

A desktop review of previous surveys in the Study Area and database analysis were conducted as part of the Ecological Assessment[1] to identify threatened flora species that were likely to occur in the Study Area.

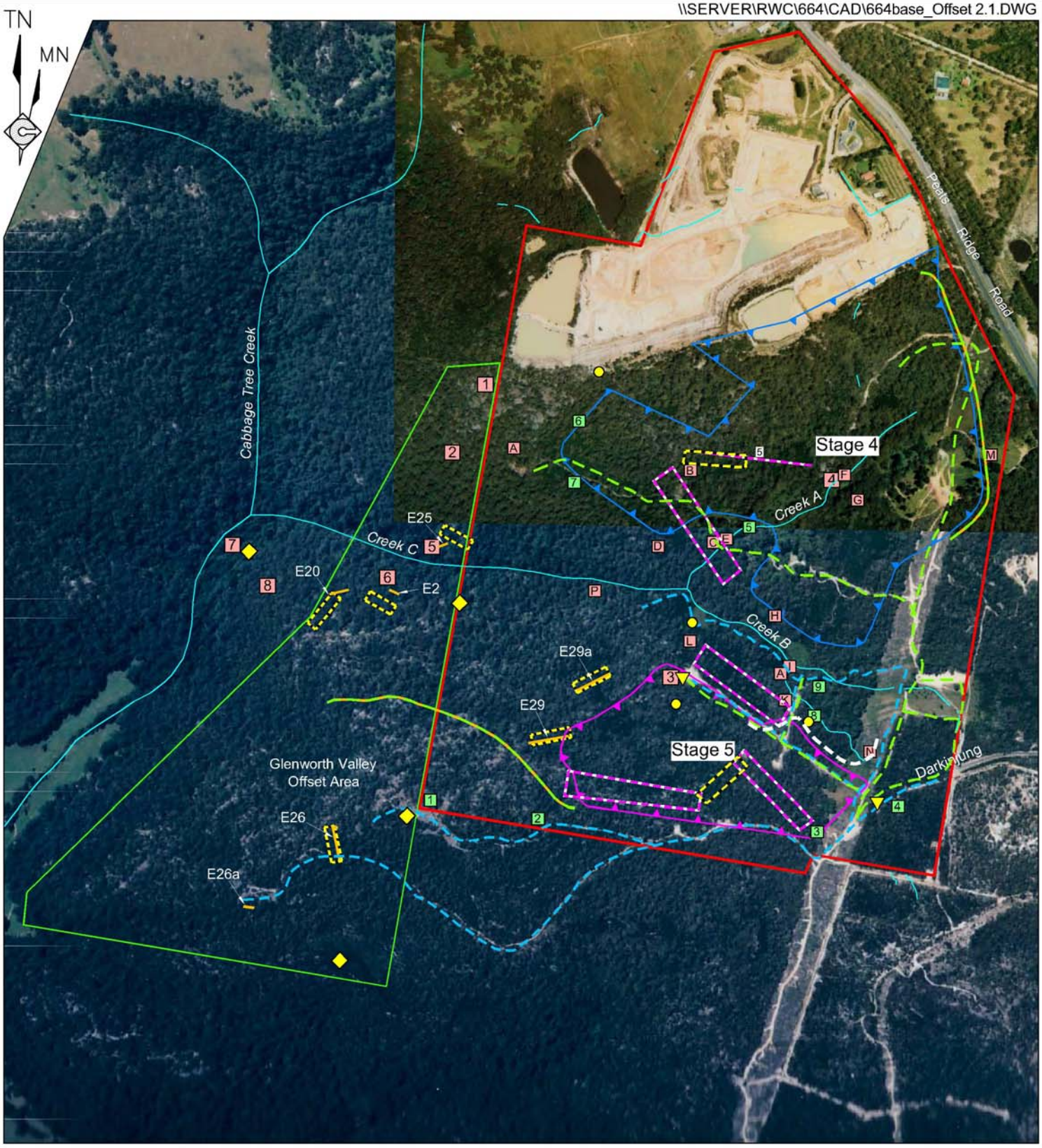
Targeted threatened flora searches were previously conducted via random meander by East Coast Flora Surveys in 2006 and 2008. The methods for these surveys are described in the Ecological Assessment[1]. Some of these searches covered parts of the Project Site offset area.

Additional targeted threatened flora surveys were undertaken on 6, 13 and 16 October 2009 by Cumberland Ecology. During these days any incidental observations of threatened plants were recorded whilst conducting other surveys. Targeted random meander searches were also undertaken.

The main area targeted during the random meander searches was the ridgetop and upper sandstone benches in the southern part of the Glenworth Valley offset area and the south western corner of the Project Site offset area.

Access around the Study Area is difficult and generally limited to on-foot surveys. Therefore all survey and habitat assessment sites were accessed by walking, allowing for more incidental observations of the threatened plant species.

The main species targeted were *Hibbertia procumbens, Darwinia glaucophylla, Callistemon linearifolius* and *Tetratheca glandulosa* but other threatened species identified as being at moderate risk from the Project (as determined by the Ecological Assessment[1]) were also targeted.



REFERENCE

- Project Site Boundary
- Proposed Limit of Extraction - Stage 4
- Proposed Limit of Extraction - Stage 5
- Creek / Drainage Line
- Transect Survey for Targeted Flora Species along Proposed Access Road (2009)
- 1 Vegetation Quadrat (Cumberland Ecology)(2005)
- Vegetation Quadrat (Eastcoast Flora Surveys)(2006)
- Vegetation Quadrat (Eastcoast Flora Surveys)(2008)
- A/1 Frog Survey Site (2005)/(2009)
- Mammal Survey (2005)
- E26 Tree Hollow Assessment Point (2009)(reference to Vegetation Community)
- Nocturnal Pedestrian Survey for Frogs (2009)
- Diurnal Pedestrian Survey for Frogs (2009)
- Anabat Unit (2009)
- E26 Hair Funnel Transect (reference to Vegetation Community)

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Base Photo Source: Dept. of Lands: 02/04/ 06 & Geo-spectrum: 28/11/08

Figure 2.1
FLORA AND FAUNA SURVEY SITES OF THE PROJECT SITE AND "GLENWORTH VALLEY" OFFSET AREA

2.3 Tree Hollows

Tree hollows are required by many fauna species for nesting and roosting. Many threatened species are at risk of extinction due to the decline in the availability of tree hollows. Hollows only occur in older trees that are usually at least 100 years old. If land has been cleared at all within the last 100 years (or at all since European settlement), there would be a paucity of tree hollows in any regrowth bushland. This is a common situation across the coastal regions of NSW and is a contributing factor to the vulnerability of fauna that occurs there.

Many of the moderate and high risk fauna species identified in the Ecological Assessment[1] roost or nest in tree hollows. The density and number of tree hollows across the Study Area gives an indication as to its value as habitat for hollow-dependent fauna species.

Due to the large area of the Study Area, the dense vegetation and restricted access to areas due to vegetation and topography, it was not practical to complete a survey of tree hollows over the offset areas in their entirety. Therefore, and in accordance with the methods used for estimating the number and distribution of tree hollows within the impact areas of the Project Site, to obtain an estimate of the size and number of tree hollows within the offset areas, six 100m x 20m plots were surveyed for tree hollows (see **Figure 2.1**). These plots were located in the dominant treed vegetation communities found within the offset areas:

- E25 Hawkesbury Peppermint Apple Forest;
- E2 Sandstone Ranges Gully Rainforest;
- E20 Dharug Footslopes Apple Redgum Forest;
- E29a Hawkesbury Banksia Scrub-Woodland (Scrub);
- E29 Hawkesbury Banksia Scrub Woodland; and
- E26 Exposed Hawkesbury Woodland.

The location of these vegetation communities is presented on **Figure 3.1**.

The plots are considered to provide a representative sample of the size, distribution and number of tree hollows within the offset areas.

The plots were traversed by two ecologists using a hand-held GPS unit to locate the plot as the vegetation was too dense to mark the plots out using a measuring tape. The species, height, diameter at breast height (DBH), number of hollows and approximate size of hollows were recorded for each hollow-bearing tree. The number of hollow-bearing trees within each plot was then multiplied by 5 to provide an approximate per hectare density of hollow-bearing trees for each community.

2.4 Threatened Frog Surveys

A desktop review of previous surveys in the Study Area and database analysis were conducted as part of the Ecological Assessment[1] to identify threatened frog species that were likely to occur in the study area.

Cumberland Ecology staff conducted frog surveys in March 2009, as described in the Ecological Assessment[1]. These surveys were concentrated around Creek B, which is largely contained within the offset, to the top of Creek C. These surveys also covered all the main tracks through the Study Area (see **Figure 2.1**).

Cumberland Ecology staff also conducted surveys on 6, 13 and 16 October 2009. These surveys involved the following activities.

- Diurnal habitat searches and assessment conducted on 6, 13 and 16 October 2009 for adults frogs and tadpoles. Areas targeted include Creek C and the sandstone bench slopes on the northern and southern sides of Creek C in the Project Site offset area, and the northern section of the Glenworth Valley offset area.
- Nocturnal searches conducted on 13 October 2009, along Creek B and established tracks using spotlights. Nocturnal searches were carried out for 2.5 hours commencing at approximately 7.30pm EDST.
- Call playback at points of suitable habitat for threatened frogs during nocturnal and diurnal transect searches.

The nocturnal survey was limited to areas previously accessed during other surveys due to the inaccessibility of the Study Area. It was too dangerous to access the lower parts of Creek C in the dark.

2.5 Fauna Habitat Assessment

Notes were made on fauna habitat whilst other surveys were being conducted on 6, 13 and 16 October 2009. The assessment included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, fallen logs, bush rock and wetland areas such as creeks and soaks. Structural features considered included the nature and extent of the understorey and ground stratum and extent of canopy.

2.6 Hair Funnel Survey

Faunatech hair funnels were used to survey for mammals to give an indication of what species are using the offset areas. Hair funnels were used as this was considered to be a

more efficient and successful method than live trapping, based on previous surveys on the Project Site, which yielded more results from hair funnels (including greater species diversity) than Elliott and cage trapping.

Hair funnels were baited with a mixture of rolled oats, honey and peanut butter, and set in seven locations with one transect in each of the following vegetation communities:

- E25 Hawkesbury Peppermint Apple Forest;
- E2 Sandstone Ranges Gully Rainforest;
- E20 Dharug Footslopes Apple Redgum Forest;
- E29a Hawkesbury Banksia Scrub-Woodland (Scrub);
- E29 Hawkesbury Banksia Scrub Woodland;
- E26a Hawkesbury Rock Pavement Heath; and
- E26 Exposed Hawkesbury Woodland.

Each transect contained 15 hair funnels with funnels alternately set on the ground and on tree trunks, (approximately 5m to 10m apart). Usually eight funnels were mounted on trees and seven funnels were pegged to the ground. Hair funnels were set for a total of 10 nights from 6 to 16 October 2009. Results were analysed by Georgeanna Story of Scats About.

Figure 2.1 identifies the location of each transect and notes the relevant vegetation community.

Chapter 3

Results

3.1 Vegetation Communities

Vegetation communities that occur across the Project Site (including the Project Site offset area) and the Glenworth Valley offset area were mapped and described in the Ecological Assessment[1]. The area of each community represented in impact and offset areas was also shown in the Ecological Assessment but is reproduced in this report as a comparison of habitat available in the offset areas to the habitat affected by the Project (**Table 3.1**). The vegetation community map is also provided in this report (**Figure 3.1**).

Table 3.1 VEGETATION CLEARANCE AND OFFSETS

Vegetation Community	Vegetation Disturbance				Vegetation Offset			
	Stage 4	Stage 5	Access Roads	Total Area	Project West	Project East	Glenworth Valley	Total Area
E103 Gahnia-Banksia Swamp	0.4	0	0.0	**0.4**	0.0	0.0	0.0	**0.0**
E2 Sandstone Ranges Gully Rainforest	0	0	0.0	**0.0**	0.5	0.0	0.8	**1.3**
E20 Dharug Footslopes Apple Redgum Forest	0	0	0.0	**0.0**	0.0	0.0	3.3	**3.3**
E25 Hawkesbury Peppermint Apple Forest	0	0	0.0	**0.0**	11.3	0.0	19.2	**30.5**
E26 Exposed Hawkesbury Woodland	8.4	4.1	0.7	**13.2**	10.4	1.0	19.1	**30.5**
E26a Hawkesbury Rock Pavement Heath	0	0	0.0	**0.0**	1.0	0.0	0.8	**1.8**
E29 Hawkesbury Banksia Scrub-Woodland	8	3.1	0.4	**11.5**	0.4	4.0	0.0	**4.4**
E29a Hawkesbury Banksia Scrub-Woodland (Scrub)	4.4	4.2	0.0	**8.6**	2.5	0.0	0.0	**2.5**
E29b Hawkesbury Banksia Wet Scrub	1	0	0.1	**1.1**	0.0	0.0	0.1	**0.1**
E54 Sandstone Hanging Swamp	0	0	0.0	**0.0**	0.6	0.0	1.4	**2.0**
Xr Disturbed- Canopy Only	0.3	0	0.1	**0.4**	0.0	0.0	0.0	**0.0**
Xs Disturbed - Regrowth	2.1	0.1	0.6	**2.8**	0.1	0.0	0.0	**0.1**
Unmapped (exotics)	7.5	0.2	0.0	**7.7**	5.3	2.0	0.0	**7.3**
Total (ha)	24.6	11.5	1.9	**45.7**	32.1	7.0	44.7	**83.8**
Total (native only)	22.2	11.4	1.1	**34.7**	26.7	5.0	44.7	**76.4**

3.2 Threatened Flora Species

Three threatened flora species have been recorded on the Project Site, the details of which are contained in the Ecological Assessment[1]. These species are *Darwinia glaucophylla, Hibbertia procumbens* and *Callistemon linearifolius*. Another threatened flora species, *Tetratheca glandulosa* has been recorded along the northern boundary of Popran National Park, adjacent to the Project Site. The three species recorded from the Project Site were also found to occur within the offset areas. *Darwinia glaucophylla* was recorded in the Glenworth Valley offset area and Project Site offset area, while *Hibbertia procumbens, Callistemon linearifolius* and one individual of *Tetratheca glandulosa* were recorded in the Project Site offset area. The numbers and locations of each species recorded are shown in **Table 3.2** and **Figure 3.2**.

Table 3.2 THREATENED SPECIES RECORDED IN THE STUDY AREA*

Species	Impact Areas	Project Site Offset	Glenworth Valley Offset	Popran National Park	Total recorded plants conserved
Darwinia glaucophylla	59	215	119	144	478
Hibbertia procumbens	91	107	0	9	116
Callistemon linearifolius	1	30	0	unknown	at least 30[1]
Tetratheca glandulosa	0	1	0	unknown	at least 1[2]

*Numbers of individuals

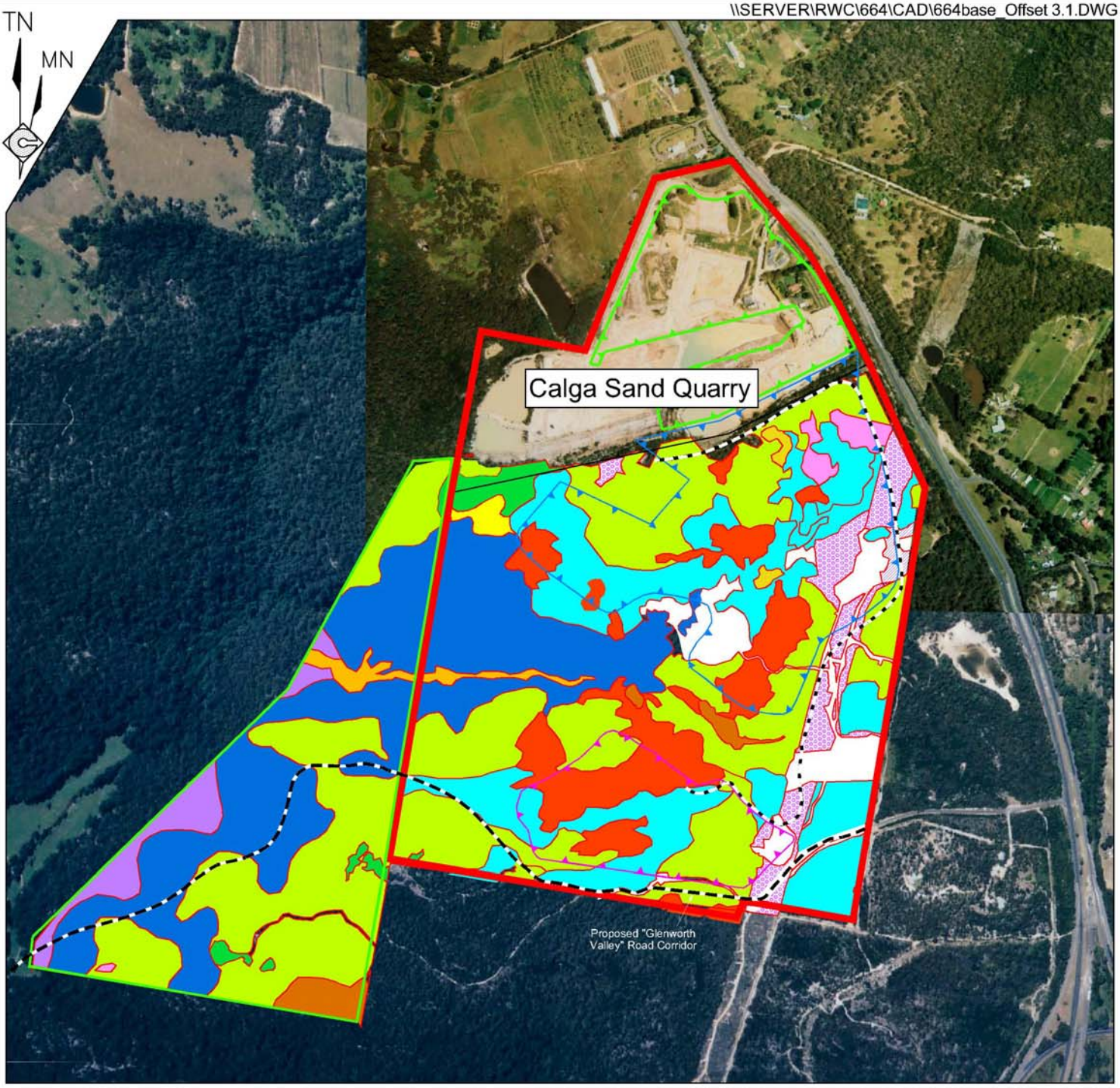
1. There are no Wildlife Atlas records from this section of Popran National Park, however, it may occur.

2. It is not known how many individuals have been recorded from Popran National Park, only that it has been recorded there.

The plant numbers shown in **Table 3.2** and records shown in **Figure 3.2** are only indicative of the numbers present. It is possible that some plants have been counted twice between the surveys conducted by Eastcoast Flora and Cumberland Ecology.

Darwinia glaucophylla forms carpets across rock shelves and it is difficult to discern individual plants. The GPS readings were taken for every separate clump of the plant when the clump seemed to be distinct from other clumps, separated by areas of rock platforms and other plants. At some points, particularly those recorded on 16 October 2009, one waypoint was taken as a location representative of all plants in that close vicinity, then a count taken.

In the case of *Tetratheca glandulosa*, this species is very cryptic when not in flower. The species flowers from July to November but it is possible that the majority of plants had finished flowering for the season when the October 2009 surveys were conducted, in which case there may be more individuals on the Project Site, and possibly also the Glenworth Valley offset areas.



REFERENCE
- Project Site Boundary
- Proposed Limit of Extraction Stage 4
- Proposed Limit of Extraction Stage 5
- Approved Limit of Extraction Stage 3
- "Glenworth Valley" Offset Area
- Internal Haul Route
- Proposed Access Road

Vegetation Mapping
- E103 - Gahnia-Banksia Swamp
- E2 - Sandstone Ranges Gully Rainforest
- E20 - Dharug Footslopes Apple Redgum Forest
- E25 - Hawkesbury Peppermint Apple Forest
- E26 - Exposed Hawkesbury Woodland
- E26a - Hawkesbury Rock Pavement Heath
- E29 - Hawkesbury Banksia Scrub-Woodland
- E29a - Hawkesbury Banksia Scrub-Woodland (Scrub)
- E29b - Hawkesbury Banksia Wet Scrub
- E54 - Sandstone Hanging Swamps
- Xr - Disturbed-Canopy Only
- Xs - Disturbed-Regrowth
- Not Mapped

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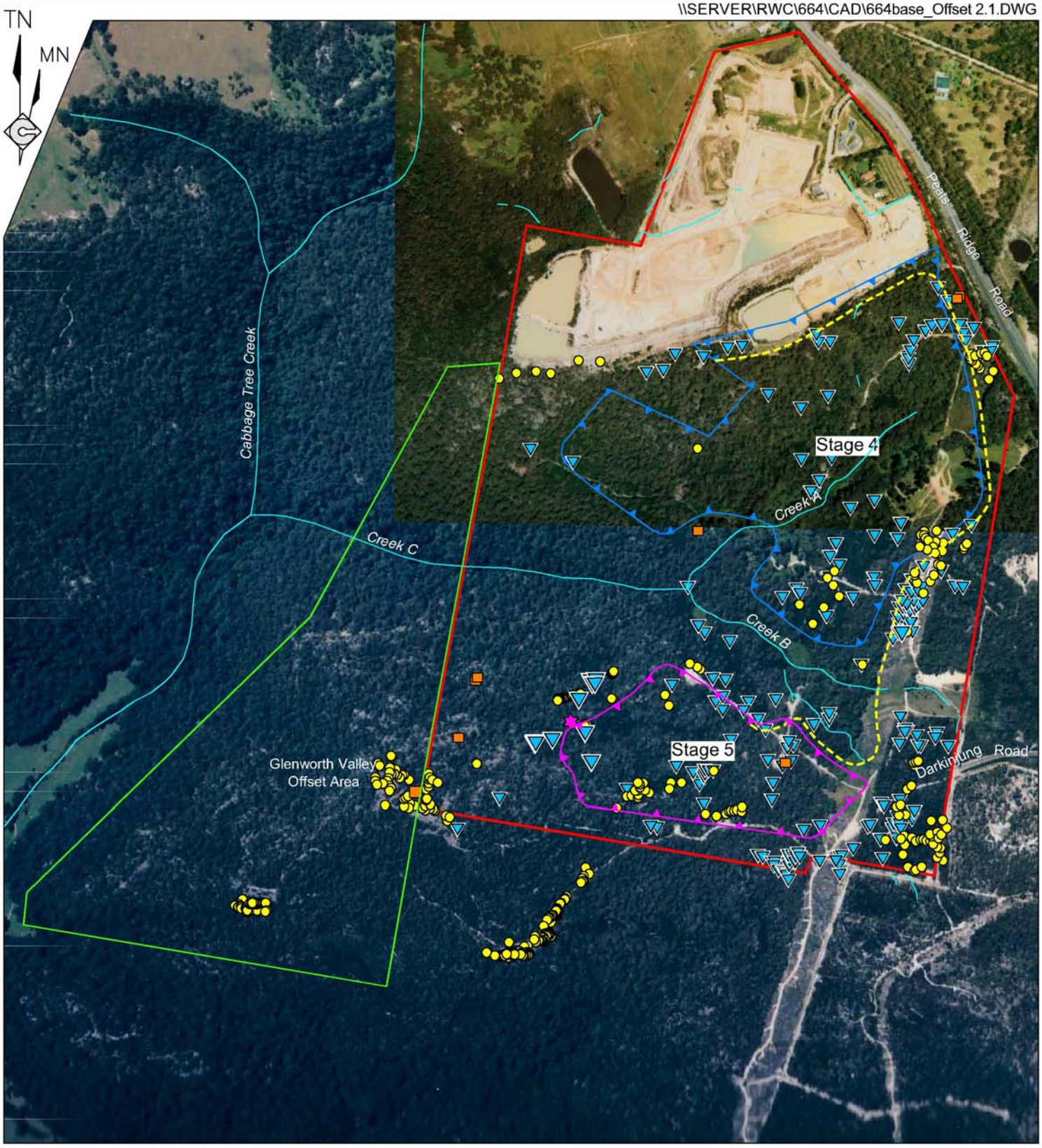
Source: Vegetation Community Mapping provided by Eastcoast Flora Survey

Figure 3.1
VEGETATION COMMUNITIES OF THE PROJECT SITE AND "GLENWORTH VALLEY" OFFSET AREA



REFERENCE

- Project Site Boundary
- Approved Limit of Extraction - Stage 3
- Proposed Limit of Extraction - Stage 4
- Proposed Limit of Extraction - Stage 5
- Internal Haul Route

Threatened Flora

- *Callistemon linearifolius*
- *Darwinia glaucophylla*
- *Hibbertia procumbens*
- *Tetratheca glandulosa*

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200 0 200 400 600 m

Base Photo Source: Dept. of Lands: 02/04/ 06 & Geo-spectrum: 28/11/08

Figure 3.2
THREATENED FLORA OF THE PROJECT SITE AND "GLENWORTH VALLEY" OFFSET AREA

3.3 Habitat Values of the Offset Areas

3.3.1 Overview

The habitat values that have been recognised on the Project Site include the plant communities and their various ecotones, hollow-bearing trees, rock outcrops, logs, leaf litter, creeks and ephemeral drainage lines. Rock outcropping includes sandstone pavements, benches, boulders and floaters. Ephemeral drainage lines include soaks over sandstone pavements and small creeklines feeding the main creeks identified on the Project Site. The Project Site also includes more specific habitats such as *Allocasuarina* species, which are the exclusive food source of the Glossy Black Cockatoo, preferred Koala feed trees (*Eucalyptus punctata, E. haemastoma, E. oblonga, E. capitellata* and *E. sparsifolia*), flowering trees and hanging swamps.

These values are represented across the Project Site offset area. The proposed extraction areas have been modified in some places so that specific features are excluded from the impact area and included in the offset area, including the hanging swamps along Creek B, known habitat for the Red-crowned Toadlet, as well as larger occurrences of threatened flora species. The proposed access road corridors assessed in the Ecological Assessment[1] are wider than would be needed. The final access road locations would be situated so as to avoid hollow-bearing trees.

Additional habitat values represented in the Project Site offset area compared to the impact areas include the steeper gully and Creek C, which contains more permanent water than Creeks A and B as well as rainforest vegetation, Rock Pavement Heath, and substantially more tall eucalypt forest present in the Hawkesbury Peppermint Apple Forest.

The Glenworth Valley offset area contains many of the same habitat values as the Project Site offset area. The main differences are the absence of the vegetation communities that correspond to the deeper sand deposits; namely: Hawkesbury Banksia Scrub Woodland, Hawkesbury Banksia Scrub-Woodland (Scrub); and Gahnia-Banksia Swamp, although the former two communities are represented in the Project Site offset area. There are only small representations of Gahnia-Banksia Swamp in the proposed extraction areas (total of 0.6ha). This community is a potentially groundwater dependent ecosystem but is not a threatened ecological community. Another groundwater dependent ecosystem, Sandstone Hanging Swamp, will be represented in both the Project Site and Glenworth Valley offset areas.

The Glenworth Valley offset area contains some taller gully vegetation that is not provided on the Project Site. This includes Dharug Footslopes Apple Redgum Forest, as well as larger areas of Hawkesbury Peppermint Apple Forest and Sandstone Ranges Gully Rainforest than are contained on the Project Site. There are also substantially larger areas of Hawkesbury Rock Pavement Heath, which is an important habitat for *Darwinia glaucophylla*.

The Glenworth Valley offset area does not contain any groundwater dependent ecosystems including swamps and wetlands as it is freely draining. Most parts of this offset area drain to Creek C but some areas in the west and south form other tributaries to Cabbage Tree Creek.

Both the Glenworth Valley and Project Site offset areas are in good condition. Most parts of each offset area show no history of land clearance. There has been some access by humans recreationally but this is restricted to the tracks because the vegetation is quite dense creating a natural obstruction to bushwalkers, horse riders, mountain bike riders or motor cross riders wandering off tracks. There many hollow-bearing trees and fallen logs in the offset areas as they have not been disturbed.

3.3.2 Tree Hollows

The Project Site and Glenworth Valley offset areas contain significant areas of relatively undisturbed woodland and therefore would be expected to contain a high density of hollow-bearing trees. The tree hollow survey of the six plots within the offset areas identified that woodland and forest communities contained a high proportion of hollow-bearing trees with the main hollow-forming species including:

- Broad-leaved Scribbly Gum (*Eucalyptus haemastoma);*
- Narrow-leaved Stringybark (*E. sparsifolia*);
- Grey Gum (*E. punctata*);
- Sydney Peppermint (*E. piperita*);
- Mountain Blue Gum (*E. deanei*);
- Red Bloodwood (*Corymbia gummifera*); and
- Smooth-barked Apple (*Angophora costata*).

A summary of the number of tree hollows estimated to occur in the combined offset areas is shown in **Table 3.3**, and plot data provided in **Appendix A**. It is estimated that approximately 4904 tree hollows will be conserved in the offset areas. The tree hollows occur within an approximate total of 2497 trees.

Table 3.3 TREE HOLLOWS IN OFFSET AREAS

Hollow size	Per plot	Per hectare	Total within Offset Areas
Plot 1 E25 Hawkesbury Peppermint Apple Forest (30.5ha)			
<5cm	4	20	610
5-10cm	0	0	0
10-15cm	1	5	152.5

Table 3.3 TREE HOLLOWS IN OFFSET AREAS

Hollow size	Per plot	Per hectare	Total within Offset Areas
15-20cm	1	5	152.5
>20cm	0	0	0
Total	6	30	915
Plot 2 E2 Sandstone Ranges Gully Rainforest (1.3ha)			
<5cm	7	35	45.5
5-10cm	5	25	32.5
10-15cm	2	10	13
15-20cm	0	0	0
>20cm	5	25	32.5
Total	19	95	123.5
Plot 3 E20 Dharug Footslopes Apple Redgum Forest (3.3ha)			
<5cm	2	10	33
5-10cm		0	0
10-15cm		0	0
15-20cm		0	0
>20cm		0	0
Total	2	10	33
Plot 4 E29 Hawkesbury Banksia Scrub-Woodland (4.4ha)			
<5cm	9	45	198
5-10cm	3	15	19.5
10-15cm	9	45	58.5
15-20cm	4	20	26
>20cm	9	45	58.5
Total	34	170	360.5
Plot 5 E29a Hawkesbury Banksia Scrub-Woodland (Scrub) (2.5ha)			
<5cm	7	35	87.5
5-10cm	1	5	6.5
10-15cm	3	15	19.5
15-20cm	0	0	0
>20cm	2	10	13
Total	13	65	126.5
Plot 6 E26 Exposed Hawkesbury Woodland (30.5ha)			
<5cm	21	105	3202.5
5-10cm	15	75	97.5
10-15cm	0	0	0

Table 3.3 TREE HOLLOWS IN OFFSET AREAS

Hollow size	Per plot	Per hectare	Total within Offset Areas
15-20cm	6	30	39
>20cm	1	5	6.5
Total	43	215	3345.5

It is important to note that the tree hollows occurred in a range of sizes, predominantly small (less than 5cm entrance diameter) and that not all hollows would be suitable for the full range of hollow-dependent fauna that has the potential to occur in the Study Area. The majority of hollows are not suitable for the Powerful Owl, which requires hollows at least 0.5m deep in trees with DBH of 80cm to 240cm. Various entrance diameters have been reported for the Powerful Owl from greater than 10cm[2] to 45cm[3] to 76-130cm[4]. The Glossy Black Cockatoo has been reported as using hollows of approximately 21cm entrance diameter[4]. Suitable sized hollows occur in the Exposed Hawkesbury Woodland, Hawkesbury Banksia Scrub-Woodland and Hawkesbury Banksia Scrub-Woodland (Scrub) communities but these vegetation types are not typical of nesting habitat because these species prefer to nest in taller trees. The hollows in the Sandstone Ranges Gully Rainforest are more suited to being used for nesting by these larger species.

Possums and gliders are able to use the smaller hollows from about 5cm entrance diameter or larger, and microchiropteran bats may use the smallest hollows including those of less than 5cm entrance diameter[4].

3.4 Threatened Frog Surveys

3.4.1 Introduction

Surveys were focused on the drainage lines and adjacent vegetation of the offset areas but also occurred throughout the Project Site. Creeks B and C were surveyed intensely during this period, as these were predicted to contain the most suitable habitat for the majority of amphibian species.

Diurnal and nocturnal searches for adult frogs and tadpoles, combined with habitat assessment, indicate that the Project Site and Glenworth Valley offset areas provide suitable habitat for a range of amphibians. A number of common amphibian species were detected within the offset areas during the October survey period. The offset areas also provide suitable habitat for five of the EPBC Act and/or TSC Act listed threatened amphibians, although none were detected during surveys of the offset areas. These species are discussed below.

3.4.2 Red-crowned Toadlet

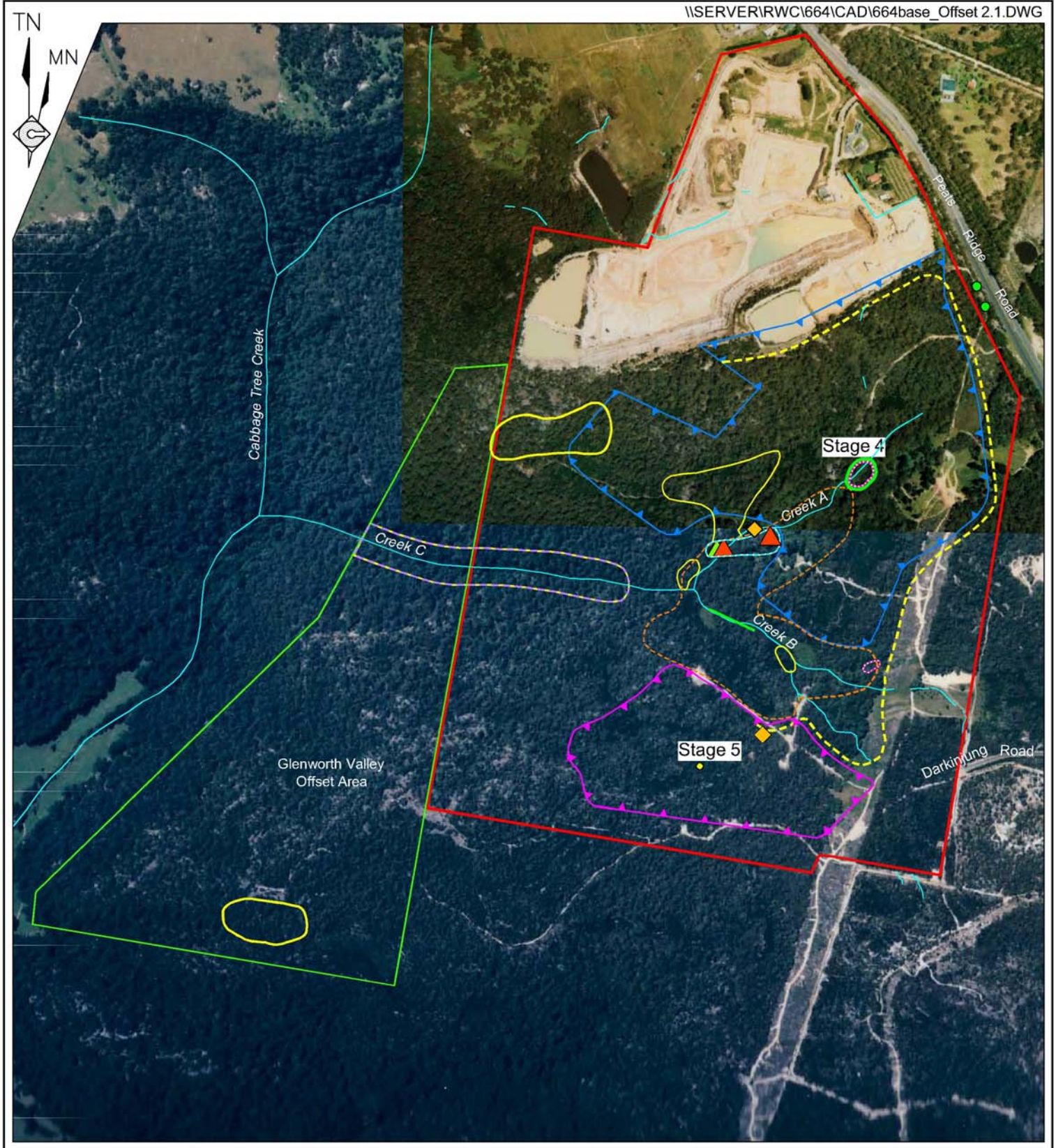
The Red-crowned Toadlet (*Pseudophryne australis*) has a restricted distribution that is confined to the Sydney Basin. This species occurs in open forests, primarily on Hawkesbury and Narrabeen Sandstones. It inhabits periodically wet drainage lines below sandstone ridges, and shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Eggs are laid in moist leaf litter, from where they are washed by heavy rain. The Red-crowned Toadlet disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter[5].

No Red-crowned Toadlets were detected within the offset areas during surveys. Conditions were suitable for detecting this species, as Red-crowned Toadlets were recorded calling during the survey period at a reference site at Strickland State Forest, approximately 12km to the northeast of the Project Site. Despite the absence of records, areas of suitable habitat for this species were identified during field surveys (see **Figure 3.3**). The areas identified in **Figure 3.3** contain sheltered slopes that are largely dissected by small gullies and contain locally more mesic groundcover species. However, throughout most parts of the offset areas, there is suitable micro-habitat for the Red-crowned Toadlet in the form of small gullies and the heads of feeder creeks on or below the sandstone ridges.

3.4.3 Giant Burrowing Frog

The Giant Burrowing Frog (*Heleioporus australiacus*) occurs from the NSW Central Coast to eastern Victoria, but is most common on the Sydney sandstone. This species is found in heath, woodland and open forest with sandy soils. Generally the Giant Burrowing Frog lives in the heath or forest and will travel several hundred metres to creeks to breed. Adults burrow into deep litter or loose soil, emerging to feed or breed after rain. The Giant Burrowing Frog breeds from August to March and the eggs are laid in a white foam-mass under vegetation in creeks or in yabby holes[6].

Despite survey efforts involving diurnal and nocturnal searches for adults and tadpoles, no Giant Burrowing Frogs were detected within the offset areas during the survey period. Habitat assessment indicates that the most suitable breeding habitat for the Giant Burrowing Frog within the offset areas occurs along Creek B where it flows through wet heathland vegetation. In particular, deep pools within and adjacent to Creek B provide ideal habitat for Giant Burrowing Frog tadpoles. Adult frogs may shelter and forage in other areas of the Project Site but the deeper sands are likely to provide the best burrowing conditions. Suitable habitat for this species is identified in **Figure 3.3**.



REFERENCE

- Project Site Boundary
- Proposed Limit of Extraction - Stage 4
- Proposed Limit of Extraction - Stage 5
- Internal Haul Route
- Red-crowned Toadlet
- Eastern Pygmy Possum
- Glossy Black Cockatoo
- Termite Mound
- Glossy Black Cockatoo Feed Trees
- Potential Habitat for Littlejohn's Tree Frog
- Potential Habitat fot Red-crowned Toadlet
- Potential Habitat for Green and Golden Bell Frog
- Potential Habitat for Giant Burrowing Frog
- Potential Habitat for Stuttering Barred Frog
- Known Habitat for Red-crowned Toadlet

SCALE 1:12 500

200 0 200 400 600 m

Base Photo Source: Dept. of Lands: 02/04/ 06 & Geo-spectrum: 28/11/08

Figure 3.3
THREATENED FAUNA AND HABITAT FEATURES OF THE PROJECT SITE AND "GLENWORTH VALLEY" OFFSET AREA

3.4.4 Littlejohn's Tree Frog

Littlejohn's Tree Frog (*Litoria littlejohni*) has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest south to Buchan in Victoria. It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. It hunts either in shrubs or on the ground. Breeding is triggered by heavy rain and can occur from late winter to autumn, but is most likely to occur in spring when conditions are favourable. Males call from low vegetation close to slow flowing pools, and eggs are laid in loose gelatinous masses attached to small submerged twigs. Eggs and tadpoles are mostly found in slow flowing pools that receive extended exposure to sunlight, but will also use temporary isolated pools[7].

No Littlejohn's Tree Frogs were detected within the offset areas during the survey period. Habitat assessment indicates that suitable, albeit limited, breeding habitat for this species occurs in the lower sections of Creek B within the offset area (**Figure 3.3**). The nearest DECC Wildlife Atlas database records for Littlejohn's Tree Frog are from Ourimbah State Forest, approximately 15km north east of the Project Site[8].

3.4.5 Green and Golden Bell Frog

The Green and Golden Bell Frog (*Litoria aurea*) occurs from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Most records throughout this range are now widely separated and isolated. This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha spp.)* or spikerushes (*Eleocharis spp.).* Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation[9].

No Green and Golden Bell Frogs were detected within the offset areas during the survey period. Habitat assessment indicates that one small pool running into Creek B provides potential habitat for this species (**Figure 3.3**). The nearest DECC Wildlife Atlas database records for Green and Golden Bell Frog are from Mangrove Mountain, approximately 10km north of the Project Site[8].

3.4.6 Stuttering Barred Frog

The Stuttering Barred Frog (*Mixophyes balbus*) occurs along the east coast of Australia from southern Queensland to the north-eastern Victoria. The species has suffered a marked decline in distribution and abundance, particularly in south east NSW. It is found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of

the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Stuttering Barred Frogs breed in streams during summer after heavy rain, and eggs are laid on rock shelves or shallow riffles in small, flowing streams. As the tadpoles grow they move to deep permanent pools and take approximately 12 months to metamorphose[10].

No Stuttering Barred Frogs were detected within the offset areas during surveys. Habitat assessment indicates that the lower reaches of Creek C may provide occasional breeding habitat for the Stuttering Barred Frog, especially when this creek is flowing after extended rainfall periods (**Figure 3.3**). Cabbage Tree Creek, to the west of the Glenworth Valley offset area, provides more suitable habitat for the Stuttering Barred Frog, and adults may move upstream into Creek C during favourable conditions.

3.5 Hair Funnel Results

Faunatech hair funnels were used to provide an overall indication of the types of mammals that may be using the offset areas.

The species that were recorded in the hair funnels are Brown Antechinus (*Antechinus stuartii*), Dusky Antechinus (*A. swainsonii*), Bush Rat (*Rattus fuscipes*), Swamp Rat (*R. lutreolus*), European Fox (*Vulpes vulpes*), a brushtail possum species, probably Common Brushtail Possum (*Trichosurus sp*) and a glider species (*Petaurus norfolcensis/breviceps*). The Swamp Rat is an additional species that was not recorded during previous surveys.

Chapter 4

Comparison of Ecological Values

This chapter provides a comparison of the habitat values that will be lost for the Project with the habitat values that will be conserved within offset areas for threatened species identified as being at high risk. Habitat values for moderate risk species are also discussed in this chapter more generally.

4.1 Threatened Flora Species

For each threatened flora species more individuals have been recorded in the offset areas than in impact areas.

Darwinia glaucophylla occurs commonly along sandstone pavements and benches. Larger areas of this type of habitat occur in the higher parts of the Project Site and Glenworth Valley offset area, particularly in the Hawkesbury Rock Pavement Heath, and along open areas where there is exposed rock.

Hibbertia procumbens occurs in the woodland and scrub communities but also occurs in disturbed habitats. Larger areas of potential habitat are available in the offsets than would be impacted. The powerline easement is not included in the offset areas but includes large numbers of the species, which are promoted by the slashing regime in this corridor. The offset areas would need to be managed in such a way that promotes the conservation of this species through use of fire at appropriate intervals.

Callistemon linearifolius occurs less frequently and in lower numbers than the aforementioned species. However, the majority of known individuals in the Study Area would be conserved, with modifications made to the impact areas in order to conserve more plants. It is possible that there are more undetected occurrences of the species within the Study Area. More potential habitat occurs for this species in the offset areas than would be impacted.

Tetratheca glandulosa is a species that may occur throughout ridgetop and upper slope habitats in the Study Area. This species responds to disturbance and large numbers are often counted after fire. It is possible that the species occurs predominantly as a seed bank on the Project Site with rare above ground individuals. Dense growth of *Banksia ericifolia, Hakea teretifolia* and other tall shrubs would have overshaded the species, which prefers open habitats. The conditions resulting after fire, which kills some of these tall shrubs, is ideal for the germination of *T. glandulosa*. Larger areas of potential habitat are

available for this species in the offset areas. It is also conserved in Popran National Park, where it is known to occur.

The range of vegetation communities, aspect, topography, soils and geology in the offset areas allows the provision and conservation of potential habitat for the moderate risk flora species identified in the Ecological Assessment[1]. A summary of the likelihood of occurrence of these species is provided in Appendix B. Details on the habitat values and areas of suitable habitat conserved for each individual species including within the Glenworth Valley offset area are provided in the Ecological Assessment[1].

4.2 Threatened Fauna Species

A summary table of the availability of habitat in the impact and offset areas for threatened fauna species previously recorded in the Gosford Local Government Area is provided in **Appendix C**.

4.2.1 Amphibians

Suitable forage, shelter and breeding habitat for threatened amphibian species in the form of semi-permanent creeks is largely restricted to the Project Site and Glenworth Valley offset areas. The impact areas of the Project Site provide comparatively less habitat for these species.

Unlike other threatened frogs, breeding habitat for the Red-crowned Toadlet is not restricted to creeks. Depressions, soaks and small gullies that may be used for the species occur throughout the Project Site and Glenworth Valley offset area. Potential habitat occurs in both the impact and offset areas, although suitable habitat is more abundant within the offset areas.

The soft sands found within the Project Site provide an ideal substrate for adult Giant Burrowing Frogs to dig burrows. Suitable forage habitat for this species occurs throughout the Project Site and Glenworth Valley offset areas. Suitable breeding habitat for the Giant Burrowing Frog is restricted to the slow-flowing water and adjacent pools of Creek B within the Project Site offset area.

One small pool running into Creek B provides suitable habitat for the Green and Golden Bell Frog. Several small pools along Creek B may also provide suitable habitat for Littlejohn's Tree Frog. The impact area supports one small pool area along Creek A that would also provide limited habitat for both of these species. Although both of these species are unlikely to occur within the Project Site or the Glenworth Valley offset area, suitable habitat is most abundant within Creek B of the Project Site offset area.

Suitable habitat for the Stuttering Barred Frog is restricted to Creek C in the Project Site and Glenworth Valley offset areas. More suitable habitat for this species occurs in Cabbage Tree Creek downstream of Creek C and to the west of the Glenworth Valley

offset area. No suitable habitat for the Stuttering Barred Frog occurs within the impact areas of the Project Site.

4.2.2 Reptiles

Suitable forage and shelter habitat for the Rosenberg's Goanna occurs throughout the impact and offset areas of the Project Site and the Glenworth Valley offset area. Suitable breeding habitat, in the form of terrestrial termite mounds, was rarely encountered within the Project Site or Glenworth Valley offset area. It is likely that, although scarce, this breeding resource occurs throughout all impact and offset areas.

4.2.3 Birds

Suitable forage habitat for the Glossy Black Cockatoo occurs throughout the impact and offset areas of the Project Site and within the Glenworth Valley offset area. The lower sections of Creek C provide the most abundant forage habitat for this species. Suitable nesting habitat for the Glossy Black Cockatoo is restricted to the tall hollow-bearing eucalypts around Creek C. Suitable nesting habitat within the impact areas is comparatively scarce as the species does not usually nest in shorter trees where the hollows are closer to the ground.

As with the Glossy Black Cockatoo, suitable forage habitat for the Gang-gang Cockatoo occurs throughout the Project Site and Glenworth Valley offset area, but is most abundant within the offset areas. Also, suitable nesting habitat for the Gang-gang Cockatoo is restricted to these two offset areas.

All impact and offset areas of the Project Site and Glenworth Valley provide suitable forage habitat for the Powerful Owl and, to a lesser extent, the Barking and Masked Owls. Tall vegetation adjacent to Creek C within the Project Site offset area, and forest communities of the Glenworth Valley offset area provide the greatest abundance and quality of forage habitat for all of these species. Tall hollow-bearing trees and dense riparian vegetation along Creek C within the Project Site and Glenworth Valley offset areas provide the only suitable nesting and roosting habitat for Powerful, Barking and Masked Owls in the Study Area as these species nest in taller trees where the hollows are further from the ground.

4.2.4 Mammals

The Eastern Pygmy Possum was recorded within vegetation along Creek A within the Project Site offset area. Potential habitat for this species occurs throughout the impact and offset areas, although suitable forage, shelter and breeding habitat for the Eastern Pygmy Possum is most abundant within the Project Site and Glenworth Valley offset areas.

The impact and offset areas of the Project Site and Glenworth Valley provide an abundance of tree hollows suitable as shelter habitat for gliders. Habitat for the Yellow-bellied Glider is restricted to the taller forest communities along Creek C. Suitable habitat for the Squirrel Glider occurs throughout the woodland and forest communities of the Project Site and Glenworth Valley offset areas. However, the Project Site offsets and Glenworth Valley offset area are likely to support the largest areas of suitable forage and shelter habitat for this species.

Suitable forage and shelter habitat for the Spotted-tail Quoll and the Long-nosed Potoroo occur throughout Project Site and Glenworth Valley offset area. Terrestrial shelter and forage habitat for both of these species is more abundant in the offset areas of the Project Site and Glenworth Valley.

The Large-footed Myotis was recorded within the Project Site offset area. No parts of the Project Site or Glenworth Valley offset area provide significant forage habitat for this species, and it is therefore likely that the Large-footed Myotis utilises the Project Site only as diurnal roosting habitat. Similar roost habitat occurs throughout the Study Area, however the Glenworth Valley offset area is in closer proximity to suitable forage habitat (Cabbage Tree Creek) than other areas and is therefore likely to provide the most suitable roost habitat for the Large-footed Myotis.

A range of additional threatened microbats are known or likely to occur within the Project Site and Glenworth offset area. There is limited roost habitat for cave-dependent species, most of which occurs within the steeper sections of the Project Site and Glenworth Valley offset areas. Suitable roost habitat for tree hollow-dwelling microbats occurs throughout the Study Area. The Glenworth Valley and Project Site offset areas (particularly along Creek C) provide the greatest range and abundance of suitable forage and roost habitat for threatened microbat species because of the diversity of vegetation communities available and the abundance of tree hollows.

The Grey-headed Flying Fox forages throughout Project Site and the Glenworth Valley offset area when eucalypts and other blossom trees are in flower. No roosting/breeding camps were detected in any of these areas. The Glenworth Valley and Project Site offset areas provide the greatest diversity and abundance of suitable forage habitat for the Grey-headed Flying-fox because of the diversity of vegetation communities available.

Chapter 5

Conclusion

The Project Site and Glenworth Valley offset areas are suitable to offset the impacts of the proposed Calga Sand Quarry Southern Extension. The combined offset areas provide 76.4ha of native vegetation, which is more than twice the area of native vegetation that would be cleared for the proposed extraction areas and access roads.

Almost all vegetation communities that are to be cleared for the Project are represented in the offset areas, with the exception of Gahnia-Banksia Swamp. The offset areas also include the additional vegetation communities: Sandstone Ranges Gully Rainforest, Hawkesbury Rock Pavement Heath and much greater areas of Hawkesbury Peppermint Apple Forest.

All threatened flora species recorded on the Project Site have a greater representation outside the impact areas. Large numbers of *Darwinia glaucophylla* and *Hibbertia procumbens* occur in the offset areas, as do the majority of records for *Callistemon linearifolius* and the one record of *Tetratheca glandulosa* from the Project Site. Potential habitat for these species is also provided within Popran National Park.

The types of fauna habitats that would be removed for the Project are also represented in the offset areas, including woodland, scrub and forest vegetation, swamps and creeks, and rocky outcropping. Hollow-bearing trees occur abundantly throughout the Project Site and Glenworth Valley offset areas. An estimated 2,497 hollow-bearing trees would be conserved in the offset areas compared to an estimated 2,798 hollow-bearing trees to be cleared from the proposed extraction areas. However, the offset areas contain taller vegetation that includes higher and larger tree hollows preferred by threatened owls and cockatoos.

The offset areas provide more suitable habitat for the Red-crowned Toadlet as there are more small gullies and soaks dissecting the sandstone slopes in these areas. Habitat for the Giant Burrowing Frog is also provided in the offset areas, particularly in sandy areas surrounding Creek B, but it could also forage across other areas.

Potential habitat is provided in the offset areas for the Eastern Pygmy Possum, which would forage in flowering Banksias and other flowering shrubs that occur in the woodland, scrub and forest communities. The Grey-headed Flying-fox, although it does not roost in the Study Area, would also forage in flowering trees and shrubs in the offset areas.

Microchiropteran bats would occur within the offset areas, particularly to forage. Roosting habitat is also available as there is an abundance of hollow-bearing trees. Cave-roosting species may also use cracks and overhangs in the sandstone outcropping.

Due to the abundance of similar habitats available and the recorded presence of threatened flora species, it is considered that the package including the Project Site and Glenworth Valley offset areas is suitable for offsetting the impacts of the Project.

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9. DEC (NSW) (2005) **Green and Golden Bell Frog - profile** Department of Enviroment and Conservation, Hurstville, NSW.

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Appendix A

Tree Hollow Plot Data

Table A.1 TREE HOLLOW PLOT DATA

Common Name	Scientific Name	DBH (cm)	Height (m)	Number of Hollows	Hollow entrance diameter (cm)	
Plot 1						
Sydney Peppermint	*Eucalyptus piperita*	70	25	3	<5cm	Apple Gum/Peppermint woodland
Smooth-barked Apple	*Angophora costata*	50	10	1	20cm	semi/stag
Smooth-barked Apple	*Angophora costata*	50	20	1	<5cm	
Sydney Peppermint	*Eucalyptus piperita*	50	10	1	15cm	semi/stag
Total hollows				6		
Plot 2						
Mountain Blue Gum	*Eucalyptus deanei*	120	30	4	<5cm	very large, at edge of creek
				1	30cm	
				2	30cm	
Mountain Blue Gum	*Eucalyptus deanei*	120	30	3	<5cm	very large, at edge of creek
				1	15cm	
				1	15cm	
Mountain Blue Gum	*Eucalyptus deanei*	150	35	5	5-10cm	huge tree
				2	>30cm	
Total hollows				19		

Table A.1 TREE HOLLOW PLOT DATA

Common Name	Scientific Name	DBH (cm)	Height (m)	Number of Hollows	Hollow entrance diameter (cm)	
Plot 3						
Grey Gum	*Eucalyptus punctata*	20	6	0		
Smooth-barked Apple	*Angophora costata*	40	20	2	<5cm	
Total hollows				2		
Plot 4						
Red Bloodwood	*Corymbia gummifera*	42	18	1	5-10cm	
				1	<5cm	
Grey Gum	*Eucalyptus punctata*	43	16	0		Scratches on trunk
Red Bloodwood	*Corymbia gummifera*	41	19	1	10-15cm	
				1	<5cm	
Scribbly Gum	*Eucalyptus haemastoma*	90	12	1	>40cm	Hollow trunk
Narrow-leaved Stringybark	*Eucalyptus sparsifolia*	115	17	1	20-25cm	Dead wood - more small hollows could also form
				1	15-20cm	
				2	10-15cm	
Red Bloodwood	*Corymbia gummifera*	35	13	1	<5cm	
Narrow-leaved Stringybark	*Eucalyptus sparsifolia*	40	8	2	10-15cm	
Grey Gum	*Eucalyptus punctata*	25	12	1	<5cm	

Table A.1 TREE HOLLOW PLOT DATA

Common Name	Scientific Name	DBH (cm)	Height (m)	Number of Hollows	Hollow entrance diameter (cm)	
Smooth-barked Apple	*Angophora costata*	45	14	1	15-20cm	
				1	10-15cm	
				1	<5cm	
Red Bloodwood	*Corymbia gummifera*	45	20	2	<5cm	
Grey Gum	*Eucalyptus punctata*	60	15	1	20-25cm	
Smooth-barked Apple	*Angophora costata*	70	15	1	15-20cm	
				1	10-15cm	
Smooth-barked Apple	*Angophora costata*	80	16	1	20-25cm	Scratches on trunk
				1	10-15cm	
Red Bloodwood	*Corymbia gummifera*	50	20	1	10-15cm	
				1	5-10cm	
				1	<5cm	
Red Bloodwood	*Corymbia gummifera*	70	15	1	>40cm	Burnt out stag - hollow not enclosed
Scribbly Gum	*Eucalyptus haemastoma*	115	14	1	>40cm	Hollow trunk - hollows are entrances to main trunk hollow including a basal hollow
				2	25-30cm	
				1	15-20cm	
				1	5-10cm	
Smooth-barked Apple	*Angophora costata*	45	14	1	<5cm	

Table A.1 TREE HOLLOW PLOT DATA

Common Name	Scientific Name	DBH (cm)	Height (m)	Number of Hollows	Hollow entrance diameter (cm)	
Scribbly Gum	*Eucalyptus haemastoma*	50	10	1	20-25cm	Hollow trunk
Total hollows				34		
Plot 5						
Scribbly Gum	*Eucalyptus haemastoma*	30	15	1	<5cm	
Red Bloodwood	*Corymbia gummifera*	60	12	2	10-15cm	
				1	<5cm	
Scribbly Gum	*Eucalyptus haemastoma*	162	10	1	20-25	Hollow trunk
Scribbly Gum	*Eucalyptus haemastoma*	120	10	1	<5cm	Hollow trunk
				1	10-15cm	
Red Bloodwood	*Corymbia gummifera*	50	12	1	<5cm	
				1	5-10cm	
Scribbly Gum	*Eucalyptus haemastoma*	100	10	1	<5cm	Hollow trunk
				1	20-25cm	
Smooth-barked Apple	*Angophora costata*	35	12	2	<5cm	
Total hollows				13		
Plot 6						
Smooth-barked Apple	*Angophora costata*	60	18	4	<5cm	
				1	20-25cm	

Table A.1 TREE HOLLOW PLOT DATA

Common Name	Scientific Name	DBH (cm)	Height (m)	Number of Hollows	Hollow entrance diameter (cm)
Grey Gum	*Eucalyptus punctata*	80	15	1	<5cm
				2	5-10cm
Red Bloodwood	*Corymbia gummifera*	80	12	1	<5cm
				3	5-10cm
Red Bloodwood	*Corymbia gummifera*	40	8	1	5-10cm
Dead stag		35	7	3	5-10cm
Red Bloodwood	*Corymbia gummifera*	60	12	3	<5cm
				2	15-20cm
Red Bloodwood	*Corymbia gummifera*	70	12	3	<5cm
				3	15-20cm
Red Bloodwood	*Corymbia gummifera*	80	14	3	<5cm
				1	5-10cm
				1	15-20cm
Red Bloodwood	*Corymbia gummifera*	20	8	2	<5cm
Red Bloodwood	*Corymbia gummifera*	70	15	1	<5cm
				4	5-10cm
Dead stag		25	8	3	<5cm
				1	5-10cm
Total hollows				43	

Appendix B

Threatened Flora Likelihood of Occurrence

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Olearia cordata		V	V	N	N	N	N	Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges.	Habitat available, low potential to occur	Habitat available, low potential to occur
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	N	N	N	N	Occurs on sandstone in dry sclerophyll woodlands near Patonga and the Woronora Plateau, with an outlying record near Glen Davis	Habitat available, low potential to occur	Habitat available, low potential to occur
Senecio spathulatus	Coast Groundsel	E1		N	N	N	N	Grows on primary dunes.	No	No
Hibbertia procumbens	Spreading Guinea Flower	E1		Y	Y	Y	Y	Usually occurs within *Banksia ericifolia - Angophora hispida - Allocasuarina distyla* scrub/heath on skeletal soils.	Habitat available, recorded in impact area	Habitat available, recorded in offset
Tetratheca glandulosa		V	V	Y	Y	N	Y	Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches.	Habitat available, potential to occur	Habitat available, recorded in offset

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Tetratheca juncea	Black-eyed Susan	V	V	N	N	N	N	Usually occurs in low open forest/woodland with mixed scrub and grassy ground cover but is also found in moist forest and heathland.	Habitat available, potential to occur	Habitat available, potential to occur
Epacris purpurascens var. *purpurascens*		V		N	N	N	N	Found in a range of habitat types, most of which have a strong shale soil influence.	No	No
Chamaesyce psammogeton	Sand Spurge	E1		N	N	N	N	Found on the foredunes and headlands of the eastern coast from Jervis Bay to Queensland	No	No
Acacia bynoeana	Bynoe's Wattle	E1	V	N	N	N	N	Found in heath and woodland on sandy soils. Prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches.	Habitat available, potential to occur	Habitat available, potential to occur
Acacia pubescens	Downy Wattle	V	V	N	N	N	N	Occurs on alluviums, shales and at the intergrade between shales and sandstones. Associated with gravelly soils.	No	No

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Haloragodendron lucasii		E1	E	N	N	N	N	Associated with dry sclerophyll forest.	Habitat available, low potential to occur	Habitat available, low potential to occur
Maundia triglochinoides		V		N	N	N	N	Grows in swamps, creeks or shallow freshwater on heavy clay.	No	No
Prostanthera askania	Tranquility Mintbush	E1	E	N	N	N	Y	Found in moist sclerophyll forests or warm temperate rainforest but occurs only adjacent to creeks or drainage lines on Narrabeen sandstone or its associated alluvial soils.	No	Habitat available, potential to occur
Prostanthera junonis	Somersby Mintbush	E1	E	N	N	N	Y	The species is restricted to the Somersby Plateau. It occurs on both the Somersby and Sydney Town soil landscapes on gently undulating country over weathered Hawkesbury sandstone within open forest/low woodland/open scrub. It occurs in both disturbed and undisturbed sites.	Habitat available, potential to occur	Habitat available, potential to occur

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Callistemon linearifolius	Netted Bottle Brush	V		N	Y	Y	Y	Grows in dry sclerophyll forest on the coast and adjacent ranges.	Habitat available, recorded in impact area	Habitat available, recorded in offset
Darwinia biflora		V	V	N	N	N	N	Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone.	No	No
Darwinia glaucophylla		V		Y	Y	Y	Y	Occurs in sandy heath, scrub and woodland and is associated with sandstone rock platforms or hanging swamps.	Habitat available, recorded in impact area	Habitat available, recorded in offset
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	N	N	N	Y	Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges.	Habitat available, potential to occur	Habitat available, potential to occur
Kunzea rupestris		V	V	N	N	N	N	Grows in shallow depressions on large flat sandstone rock outcrops. Characteristically found in short to tall shrubland or heathland.	Habitat available, potential to occur	Habitat available, potential to occur

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Melaleuca biconvexa	Biconvex Paperbark	V	V	N	N	N	N	Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	No	No
Melaleuca deanei	Deane's Paperbark	V	V	N	N	N	N	The species grows in heath on sandstone. Occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas.	Habitat available, potential to occur	Habitat available, potential to occur
Micromyrtus blakelyi		V	V	N	N	N	Y	Typically occurs within heathlands in shallow sandy soil in cracks and depressions of sandstone rock platforms.	Habitat available, potential to occur	Habitat available, potential to occur
Syzygium paniculatum	Magenta Lilly Pilly	V	V	N	N	N	N	Occurs on gravels, sands, silts and clays in riverside gallery rainforest and remnants of littoral rainforest.	Habitat available, potential to occur	Habitat available, potential to occur

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Caladenia tessellata	Thick Lip Spider Orchid	E1	V	N	N	N	N	Generally found in grassy sclerophyll woodland on clay loam or sandy soils.	No	Low
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	N	N	N	N	Known from a range of habitats including swamp-heath and woodland.	Habitat available, low potential to occur	Habitat available, low potential to occur
Diuris bracteata		E1		N	N	N	N	Occurs in dry sclerophyll woodland	Habitat available, potential to occur	Habitat available, potential to occur
Diuris praecox	Rough Double Tail	V	V	N	N	N	N	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey.	No	No
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E	N	N	N	N	Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest.	Habitat available, low potential to occur	Habitat available, low potential to occur

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Ancistrachne maidenii		V		N	N	N	Y	Populations occur in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes. Grows in dry sclerophyll forest on sandstone-derived soils.	Habitat available, potential to occur	Habitat available, potential to occur
Grevillea parviflora subsp parviflora		V	V	N	N	N	N	Grows in sandy or light clay soils over thin shales in a range of vegetation types from heath and shrubby woodland to open forest.	No	No
Grevillea shiressii		V	V	N	N	N	Y	Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils.	No	Habitat available, potential to occur
Persoonia hirsuta	Hairy Geebung	E1	E	N	N	N	N	Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	Habitat available, potential to occur	Habitat available, potential to occur
Baloskion longipes	Dense Cord-rush	V		N	N	N	N	Found in swamps or depressions in sandy alluvium or in swales in tall forest.	Habitat available, low potential to occur	Habitat available, low potential to occur

Table B.1 ANALYSIS OF LIKELIHOOD OF THREATENED FLORA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific Name	Common Name	TSC Status	EPBC Status	Popran NP	Study Area	Project Site	Locality	Habitat	Habitat present in Impact Area	Habitat present in Offset Area
Lasiopetalum joyceae		V	V	N	N	N	N	Grows in heath on sandstone.	Habitat available, potential to occur	Habitat available, potential to occur

Appendix C

Threatened Fauna Likelihood of Occurrence

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
INSECTS										
Petalura gigantea	Giant Dragonfly	E1						Permanent swamps, bogs - some free water, open vegetation.	Habitat present. Low potential to occur	No habitat present. Low potential to occur
FISH										
Prototroctes maraena	Australian Grayling		V					Mid-water species-clear, gravelly streams-moderate flow. Prefers deep, slow flowing pools.	No habitat present. Low potential to occur	Habitat present. Low potential to occur
Macquaria australiacus	Macquarie Perch	E1	E					River, lake habitats- upper reaches of rivers and tributaries.	No habitat present. Low potential to occur	Habitat present. Low potential to occur
AMPHIBIANS										
Heleioporus australiacus	Giant Burrowing Frog	V	V		Y			Small creeks, pools- sandstone ridgetop woodland, heath	Habitat present. Possible occurrence.	Habitat present. Possible occurrence
Litoria aurea	Green and Golden Bell Frog	E1	E					Open areas with non-permanent waterways and cover (e.g. Typha)	Habitat present. Low potential to occur.	No habitat present. Low potential to occur

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Litoria brevipalmata	Green-Thighed Frog	V						Rainforest to woodland, breeds in grassy semi-permanent ponds and flood-prone grassy areas	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Mixophyes balbus	Stuttering Frog	E1	V					Rainforest, wet, tall open forest	No habitat present. Low potential to occur.	Habitat present. Possible occurrence
Mixophyes iteratus	Giant Barred Frog	E1	E					Rainforests, moist eucalypt forest, nearby dry eucalypt forest, breed -shallow, flowing rocky streams	No habitat present. Low potential to occur.	Habitat present. Low potential to occur.
Pseudophryne australis	Red-Crowned Toadlet	V			Y		Y	Triassic sandstones-Sydney basin permanently moist soaks, ephemeral headwater stream beds.	Habitat present. Recorded during surveys.	Habitat present. Probable occurrence.
REPTILES										
Hoplocephalus stephensii	Stephens' Banded Snake	V						Rainforest, eucalypt forests, rocky areas - to 950 m, shelters under bark.	Habitat present. Possible occurrence.	Habitat present. Possible occurrence.

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Varanus rosenbergi	Rosenberg's Goanna	V				Y		Heath, open forest, woodland habitats. Termite mounds-critical-nesting. shelter-hollow logs, rock crevices, burrows	Habitat present. Probable occurrence	Habitat present. Probable occurrence
BIRDS										
Pterodroma nigripennis	Black-winged Petrel	V						Marine, nests in burrows on the coast	No habitat present Low potential to occur	No habitat present Low potential to occur
Puffinus assimilis	Little Shearwater	V						Marine, breeds on islands	No habitat present Low potential to occur	No habitat present Low potential to occur
Ixobrychus flavicollis	Black Bittern	V						Terrestrial, estuarine wetlands-permanent water, dense vegetation	No habitat present Low potential to occur	No habitat present Low potential to occur
Botaurus poiciloptilus	Australasian Bittern	V						Permanent freshwater wetlands-tall, dense vegetation	No habitat present Low potential to occur	No habitat present Low potential to occur
Pandion haliaetus	Osprey	V						Clear, open water of large rivers, lagoons, lakes-coastal areas	No habitat present Low potential to occur	No habitat present Low potential to occur

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Burhinus grallarius	Bush Stone-curlew	E1						Open forests and woodlands with sparse grassy groundlayer	No habitat present Low potential to occur	No habitat present Low potential to occur
Haematopus longirostris	Pied Oystercatcher	V						Intertidal flats, beaches	No habitat present Low potential to occur	No habitat present Low potential to occur
Haematopus fuliginosus	Sooty Oystercatcher	V						Rock shelves, rocky headlands	No habitat present Low potential to occur	No habitat present Low potential to occur
Sterna albifrons	Little Tern	E1	MMB					Almost exclusively coastal, also inlets and rivers	No habitat present Low potential to occur	No habitat present Low potential to occur
Sterna fuscata	Sooty Tern	V						Marine, breeds on islands	No habitat present Low potential to occur	No habitat present Low potential to occur
Gygis alba	White Tern	V						Vagrant to coastal NSW	No habitat present Low potential to occur	No habitat present Low potential to occur
Ptilinopus superbus	Superb Fruit-dove	V						Rainforest, closed forest; forage high in the canopy	No habitat present Low potential to occur	No habitat present Low potential to occur

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Ptilinopus regina	Rose-crowned Fruit-dove	V						Subtropical rainforest to swamp forest where fruit is plentiful	No habitat present Low potential to occur	No habitat present Low potential to occur
Calyptorhynchus lathami	Glossy Black-cockatoo	V			Y	Y	Y	Dry forests-*Allocasuarina,* nest in tree hollows	Habitat present. Recorded during surveys.	Habitat present. Recorded during surveys.
Lathamus discolor	Swift Parrot	E1	E					Box-ironbark forests, woodlands	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Neophema pulchella	Turquoise Parrot	V						Eucalypt woodlands, open forests- grasses and shrubs understorey	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Ninox strenua	Powerful Owl	V			Y	Y		Woodland, open sclerophyll forest, tall open wet forest, rainforest	Forage habitat present. Probable occurrence	Nesting, roosting and forage habitat present. Probable occurrence
Ninox connivens	Barking owl	V						Swamp, eucalypt woodland, open forests.	Forage habitat present. Possible occurrence	Nesting, roosting and forage habitat present. Possible occurrence
Tyto tenebricosa	Sooty Owl	V			Y			Dry, subtropical, warm temperate rainforests, moist	No habitat present Low potential to	Nesting, roosting and forage habitat

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
								eucalypt forests; very large tree hollows-for nesting.	occur	present. Low potential to occur.
Tyto novaehollandiae	Masked Owl	V						Eucalypt forests, woodlands, nesting tree hollows, caves	Forage habitat present. Possible occurrence	Nesting, roosting and forage habitat present. Possible occurrence
Climacteris picumnus	Brown Treecreeper	V						Open grassy understorey-eucalypt woodlands, dry open forests and mallee;	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Pyrrholaemus sagittatus (Chthonicola sagittata)	Speckled Warbler	V						Eucalyptus-dominated communities with grassy understorey	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Xanthomyza phrygia	Regent Honeyeater	E1	E, MTS					Box-ironbark eucalypt associations, wet lowland coastal forests	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Melithreptus gularis gularis	Black-chinned Honeyeater	V						Dry open forests and woodlands	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Apus pacificus	Fork-tailed Swift		MMB					Species or species habitat may occur within area	Habitat present. Possible occurrence	Habitat present. Possible occurrence
	White-bellied		MTS					Estuaries, inlets, coastlines	No habitat present	No habitat present

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
	Sea-Eagle							inland lakes.	Low potential to occur	Low potential to occur
Hirundapus caudacutus	White-throated Needletail		MTS					Non-breeding migrant to eastern Australia	Habitat present. Probable occurrence.	Habitat present. Probable occurrence
Merops ornatus	Rainbow Bee-eater		MTS					Open forest, woodland, and farmland; nests excavated in creek banks, walls of quarries etc	Habitat present. Possible occurrence	Low Habitat present. Possible occurrence
Monarcha melanopsis	Black-faced Monarch		MTS					Rainforests, moist eucalypt forests and gullies	Habitat present. Possible occurrence	Habitat present. Probable occurrence.
Myiagra cyanoleuca	Satin Flycatcher		MTS					Wet forests -.Great Dividing Range.	No habitat present. Low potential to occur	Habitat present. Possible occurrence
Rhipidura rufofrons	Rufous Fantail		MTS					Undergrowth of forest gullies	Habitat present. Possible occurrence	Low Habitat present. Probable occurrence
Ardea alba	Great Egret		MWS, MMB					Shallow water, including damp grasslands	No habitat present Low potential to occur	No habitat present Low potential to occur

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Ardea ibis	Cattle Egret		MWS, MMB					Follows feeding cattle	No habitat present Low potential to occur	No habitat present Low potential to occur
Gallinago hardwickii	Latham's Snipe		MWS					Permanent and ephemeral wetlands	No habitat present Low potential to occur	No habitat present Low potential to occur
MAMMALS										
Cercartetus nanus	Eastern Pigmy-possum	V					Y	Heath, woodland, sclerophyll forest, rainforest habitats .	Habitat present. Recorded during surveys.	Habitat present. Probable occurrence
Dasyurus maculatus	Tiger Quoll	V	E (SE mainland population)		Y			Rainforest, open forest, woodland, coastal heath, inland riparian forest roost: tree hollows, small caves,	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Isoodon obesulus obesulus	Southern Brown Bandicoot	E1						Heathland, shrubland, dry sclerophyll forest -heathy understorey, sedgeland, woodland habitats;	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Macropus parma	Parma Wallaby	V						Moist eucalypt forest	Habitat present. Low potential to occur	Habitat present. Low potential to occur

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Petaurus australis	Yellow-bellied Glider	V						Tall mature eucalypt forest coastal forests, dry escarpment forests, moist coastal gullies, creek flats	Habitat present. Low potential to occur	Habitat present. Possible occurrence
Petaurus norfolcensis	Squirrel Glider	V			Y			Blackbutt-Bloodwood forest-heath understorey-coastal areas/old growth Box, Box-Ironbark woodlands	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Phascolarctos cinereus	Koala	V						Eucalypt woodlands, forests.	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Potorous tridactylus	Long-nosed Potoroo	V	V					Coastal heaths, dry, wet sclerophyll forests sandy loam soil.	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V						Heathland, dense wet heath, swamps.	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Chalinolobus dwyeri	Large-eared Pied Bat	V	V					Roosts in caves or crevices in cliffs, frequents low to mid elevation dry open forest and woodland	Habitat present. Possible occurrence	Habitat present. Possible occurrence

Table C.1 ANALYSIS OF LIKELIHOOD OF THREATENED FAUNA OCCURRING IN IMPACT AREAS AND OFFSET AREAS

Scientific name	Common Name	TSC Status	EPBC Status	Locality	Popran NP	Study Area	Project Site	Habitat	Likelihood of Occurrence – Impact Areas	Likelihood of Occurrence – Offset Areas
Falsistrellus tasmaniensis	Great Pipistrelle	V						Moist habitats, trees taller than 20 m. roosts in hollows, under loose bark, or in buildings.	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Kerivoula papuensis	Golden-tipped Bat	V						Rainforest and adjacent sclerophyll forest, roost in Yellow-throated Scrubwren or Brown Gerygone nests	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Miniopterus australis	Little Bent-wing Bat	V						Moist eucalypt forest, rainforest, dense coastal banksia scrub. roost in caves, sometimes tree hollows	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V			Y			Roost in caves; hunt above canopy in forested areas.	Habitat present. Possible occurrence	Habitat present. Possible occurrence
Mormopterus norfolkensis	Eastern Little Mastiff-bat	V						Dry sclerophyll forest, woodland; roost in tree hollows or under bark.	Habitat present. Possible occurrence	Habitat present. Possible occurrence