Appendix 7

Cumberland Ecology Report May 2013

DIXON SANDS MAROOTA

Flora and Fauna Impact Assessment

For:

Nexus Environmental Planning Pty Ltd

September 2013

Final Report

CUMBERLAND ECOLOGY

PO Box 2474, Carlingford Court 2118
www.cumberlandecology.com.au

CUMBERLAND ECOLOGY

Report No. 11011RP1

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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Approved by: David Robertson

Position: Director

Signed:

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Executive Summary

S1 Introduction

Cumberland Ecology Pty Ltd (Cumberland Ecology) has been commissioned by Dixon Sand (Penrith) Pty Ltd (Dixon Sand) to conduct an ecological assessment of a portion of land within Lots 1 and 2 DP 547255, 4544 and 4572 Old Northern Road, Maroota (the 'Site") (**Figure 1.1**). The extraction of sand from the Site was approved under Development Application (DA) 250-09-01 with conditions. Among these conditions was the establishment of setbacks and buffer zones to exclude quarrying activity from an identified sensitive environmental area. Dixon Sand has lodged a DA (DA 250-09-01 Modification 4) with the Department of Planning and Infrastructure to develop an extension to the approved quarry into this area of exclusion (the "Proposed Modification").

The purpose of this report is to describe the ecological values of the Proposed Modification area and to assess the impacts on flora and fauna, particularly threatened species, populations and communities as listed under the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act).

S2 Methodology

A review of ecological literature relevant to the Proposed Modification area was undertaken as part of this flora and fauna assessment to evaluate the ecological values associated with the Proposed Modification area. Database analysis was conducted for the locality using the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife Database (OEH 2013) and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) EPBC Protected Matters Search Tool (SEWPaC 2013).

Several vegetation mapping studies have been undertaken across the Proposed Modification area and surrounds, including broad scale mapping of The Hills Local Government Area (LGA). The vegetation within the Proposed Modification area was ground-truthed to examine and verify the extent and condition of different vegetation communities.

Flora surveys were conducted within the Proposed Modification area on 20 February and 26 February 2013 and included quadrat sampling, random meander surveys and threatened flora surveys. Threatened flora surveys were initially undertaken as part of the vegetation mapping ground-truthing and quadrat surveys. Targeted searches were also conducted within suitable habitat for several potentially occurring species including *Melaleuca deanei*, *Darwinia fascicularis* subsp. *oligantha* and *Tetratheca glandulosa*.

Fauna surveys were conducted across the Proposed Modification area and adjacent land (the 'Study Area') from 25 February 2013 to 1 March 2013. These fauna surveys were conducted, where appropriate, in accordance with the survey guidelines provided in the OEH Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities

(Working Draft) (DEC (NSW) 2004). The fauna surveys included a general fauna habitat assessment, ultrasonic bat call detection, infrared camera survey and incidental observations.

S3 Results

S3.1 Vegetation Communities

The Proposed Modification area supports a vegetation cover of heath, woodland and grassland communities that reflects topography, geology, drainage and disturbance history. Cumberland Ecology identified four vegetation communities within the Proposed Modification area, none of which are listed under the TSC Act. Shale/Sandstone Transition Forest EEC was previously identified within a portion of the Proposed Modification area, however recent and current investigations have determined this EEC is not present.

S3.2 Flora

Over 150 flora species have been recorded from the Proposed Modification area during surveys undertaken for this assessment. The dominant plant families encountered within the Proposed Modification have consistently been represented by the Myrtaceae, Fabaceae, Poaceae and Proteaceae families. The floral assemblage across the Proposed Modification area is largely typical of dry sclerophyll sandstone vegetation.

The following threatened flora species have been recorded within the Proposed Modification area:

- *Melaleuca deanei* (Deane's Melaleuca) – Vulnerable under the EPBC Act and TSC Act; and
- *Tetratheca glandulosa* – Vulnerable under the EPBC Act and TSC Act.

S3.3 Fauna

The woodland, heath and grassland communities present within the Proposed Modification area provide a range of fauna habitats. Key habitat features recorded within the Proposed Modification area include fallen logs, debris and leaf litter, hollow bearing trees and stags, rocky outcrops and nectar-producing trees and shrubs,

Over 40 vertebrate fauna species have been recorded within or immediately adjacent to the Proposed Modification area during the current surveys, with the majority of species being native. This includes five amphibians, three reptiles, 20 birds and 13 mammals. The following threatened species have been recorded within or adjacent to the Proposed Modification area:

- Glossy Black-cockatoo (*Calyptorhynchus lathami*) – Vulnerable under the TSC Act;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Vulnerable under the EPBC Act and the TSC Act;

- East-coast Freetail-bat (*Mormopterus norfolkensis*) – Vulnerable under the TSC Act;
- Little Bentwing-bat (*Miniopterus australis*) – Vulnerable under the TSC Act; and
- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) – Vulnerable under the TSC Act.

S3.4 Wildlife Corridors

Desktop analysis of aerial photography and field investigations indicate that the Proposed Modification area forms part of a corridor of vegetation connecting vegetated areas within the eastern portion of the Site to extensive areas of vegetation to the west of the Site. Within this wildlife corridor there are several barriers to movement including the existing sand quarry and associated clearing for tracks to the south, north and west of the Proposed Modification area. The corridor is further impacted to the east of the site by agricultural land and Old Northern Road. Areas to the east of the Site, beyond properties along Old Northern Road, are largely conserved within Marramarra National Park.

S4 Impact Assessment

The primary impact resulting from the Proposed Modification is the loss of vegetation and associated habitat within the Proposed Modification area. All vegetation present within the Proposed Modification area will be removed. **Table S.1.1** provides a summary of the areas of each vegetation community to be removed within the Proposed Modification area.

Table S.1.1 Summary of vegetation clearance within the Proposed Modification area

Vegetation Community	Area (ha)
Banksia ericifolia – Leptospermum trinervium Heath	1.86
Angophora costata – Corymbia gummifera Woodland	1.15
Cynodon dactylon – Axonopus fissifolius Exotic Grassland	0.62
Eucalyptus punctata – Acacia parramattensis Woodland	0.67
Cleared Land	0.05
TOTAL	**4.35**

The total footprint of the Proposed Modification area is approximately 4.35 ha, of which 3.68 ha comprises native vegetation communities. The remaining area of the Proposed Modification area supports exotic grassland (0.62 ha) and cleared land (0.05 ha). In addition to the clearance of broad habitats within the Proposed Modification area, a number of specific habitat features will be removed. These include feed trees for various fauna species, bush rock and hollow-bearing trees.

The following is a summary of the likely impacts on threatened biodiversity within the Proposed Modification area:

- Removal of known habitat for *Melaleuca deanei* and *Tetratheca glandulosa*; and
- Removal of known forage habitat for the Glossy Black-cockatoo, Large-eared Pied Bat, East-coast Freetail-bat, Little Bentwing-bat and Eastern Benwing-bat.

Under the currently approved DA for the Site, a number of indirect impacts to vegetation and habitat will occur to the vegetation within the Proposed Modification area. These include habitat fragmentation, edge effects, alteration to hydrological regimes, sedimentation and erosion, weeds and feral animals and physical damage. Given these impacts, it is unlikely that removal of vegetation and associated habitats within the Proposed Modification area will significantly exacerbate these impacts. A precautionary approach has been taken, and Assessments of Significance have been conducted to determine whether the proposal would generate a significant impact to threatened species known or considered likely to occur. These tests found that the removal of the vegetation and associated habitats within the Proposed Modification area is not considered to result in a significant impact to threatened biodiversity.

S5 Mitigation and Compensatory Measures

The following measures will be implemented to mitigate and compensate for the impacts of the project:

- Minimising vegetation and habitat loss by delineating clearing areas prior to construction and avoiding impacts on adjacent vegetation;
- Staged clearing to facilitate collection of propagation material and translocation of threatened plants;
- Translocation of topsoil from the Proposed Modification area to be utilised for rehabilitation;
- Creation of a 6.83 ha revegetation corridor along the southern boundary of the site;
- Pre-clearing surveys including inventory of trees and habitat features, detecting fauna prior to clearing and establishing nest boxes where required;
- Rehabilitation of the Proposed Modification area and additional areas of the Site to native vegetation communities to restore biodiversity and corridor values;
- Monitoring of vegetation, threatened species, weeds and feral animals; and
- Preparation of a Rehabilitation Management Plan.

S6 Conclusion

This assessment has found that there are large areas of nearby known habitats for all of the impacted communities, threatened flora and threatened fauna within the locality. It is recognised that the Proposed Modification area will have a small impact on the habitat for these communities and species. However, the combined mitigation and compensatory measures to be implemented are likely to sufficiently ameliorate these impacts to the extent that no threatened species are likely to become extinct as a result of the Proposed Modification.

Chapter 1

Introduction

1.1 Purpose

Cumberland Ecology Pty Ltd (Cumberland Ecology) has been commissioned by Dixon Sand (Penrith) Pty Ltd (Dixon Sand) to conduct an ecological assessment of a portion of land within Lots 1 and 2 DP 547255, 4544 and 4572 Old Northern Road, Maroota (the 'Site") (**Figure 1.1**). The extraction of sand from the Site was approved under Development Application (DA) 250-09-01 with conditions. Among these conditions was the establishment of setbacks and buffer zones to exclude quarrying activity from an identified sensitive environmental area. Dixon Sand has lodged a DA (DA 250-09-01 Modification 4) with the Department of Planning and Infrastructure to develop an extension to the approved quarry into this area of exclusion (the "Proposed Modification").

The purpose of this report is to describe the ecological values of the Proposed Modification area and to assess the impacts on flora and fauna, particularly threatened species, populations and communities as listed under the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act). This ecological assessment will be incorporated into an Environmental Assessment of the Proposed Modification in accordance with the Director General's Requirements (DGRs).

Specifically, the objectives of this ecological assessment are to:

- Describe and map vegetation communities of the Proposed Modification, area identifying threatened communities listed under the TSC Act and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Identify and map the location of threatened flora and fauna species;
- Assess the likelihood as to whether threatened flora and fauna species could occur in the Proposed Modification area;
- Describe the types and extent of potential impacts arising from the Proposed Modification area; and

Prescribe any avoidance, mitigation or compensatory measures proposed to manage impacts on threatened species and areas of high conservation value.

1.2 The Proposed Modification

Approval is being sought under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to include extraction of additional sand resources from an area currently excluded from development within the Site under the existing consent. The objectives of the Proposed Modification are:

- To provide graded sand and gravel products suitable for use in the construction industry and specialty markets;
- To realise the economic potential and maximise the efficient recovery of natural resources ; and
- To successfully rehabilitate the Proposed Modification area on completion of extraction.

The location of the Proposed Modification area is shown in **Figure 1.1**. The Proposed Modification area was previously excluded from development as it contains an area that was previously mapped as Shale/Sandstone Transition Forest Endangered Ecological Community (EEC), as well as containing individuals of the threatened plant *Tetratheca glandulosa*.

The presence of Shale Sandstone Transition Forest was documented in the Flora and Fauna Study conducted by Gunninah Environmental Consultants (Fanning et al. 1998) as part of the Environmental Impact Statement (EIS) for the initial extraction proposal for the Site. This community is listed as an Endangered Ecological Community (EEC) under both the EPBC Act and the TSC Act. As a result the exclusion area within the approved DA for the Site was established to protect sensitive vegetation, including areas of Shale/Sandstone Transition Forest.

A flora and fauna assessment of the Site by Trevor Hawkeswood (2010) disputed the presence of Shale/Sandstone Transition Forest EEC within the Proposed Modification area. A thorough assessment by Cumberland Ecology in 2011 (**Appendix A**) supports the argument that Shale/Sandstone Transition Forest EEC does not occur within the Proposed Modification area.

1.3 Background

1.3.1 Location

The Site covers an area of approximately 24.2 ha within The Hills Local Government Area (LGA). It encompasses two land parcels, namely Lots 1 and 2 of DP 547255, located on the western side of Old Northern Road, Maroota. The Site is wholly contained within the Hawkesbury River Sub-catchment and the Sydney Basin Bioregion.

The Site is bounded to the west and south by existing sand quarry areas, with extensive areas of unreserved vegetation occurring further west. Immediately to the east of the Site

are private land holdings that are primarily used for agriculture. Marramarra National Park adjoins these private land holdings further to the east. There are a number of conservation areas surrounding the Site, including:

- Marramarra National Park – located approximately 1km to the east;
- Dharug National Park - located approximately 6km to the north-east;
- Parr State Conservation Area – located approximately 6km to the north-west;
- Muogamara Nature Reserve – located approximately 17km to the south-east;
- Berowra Valley National Park – located approximately 19km to the south-east; and
- Cattai National Park - located approximately 13 km to the south-west.

The Hawkesbury River winds from the south west, around the Maroota area at Wiseman's Ferry to the north before meandering toward the south-east.

1.3.2 Geology, Soils and Topography

Geology in the locality is dominated by Hawkesbury Sandstone and has some areas of shale capping. The geological landscape of the Site is 'Quartz-sandstone with some shale'. Within 0.34 km to the east lies the geological landscape 'Sand, silt, clay and gravel' {Bryan, 1966 #4498}.

The Site consists of two different soil landscapes. The most widespread soil landscape is 'Sydney Town' with the 'Colo Heights' soil landscape occurring less frequently. Both are erosional soil landscapes characterised by undulating and rolling hills on Hawkesbury Sandstone.

The Hawkesbury area contains rugged rock outcropping and benches with narrow crests and ridges and rugged to rolling hills (Chapman and Murphy 1989). The Maroota area is located on a relatively flat ridge. The Site is located on the western side of this ridge, and is relatively flat with some sections sloping gradually to the west. The topography of the Site has been modified, particularly in the western and northern areas but also where dams have been formed. The Proposed Modification area slopes from north to south, with the lowest area lying in the south eastern corner of the Proposed Modification area.

1.3.3 Hydrology

No major watercourses occur within the Site. A dam occurs to the east of the Proposed Modification area and drains to the south west. The quality of the water within this dam is poor as a result of runoff from the upslope land use and surrounding sand quarrying.

1.3.4 Current Land Use/Zoning within and Adjacent to the Site

The Site is currently zoned as Primary Production (RU1) under The Hills Local Environmental Plan 2012 (LEP). The majority of the surrounding land use is comprised of the Primary Production (RU1) and Rural Landscape (RU2) zoning.

1.4 Legislative and Other Requirements

The following Commonwealth and State legislation and local government requirements are relevant to this report.

1.4.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the Commonwealth legislation relating to the protection and management of biodiversity and threatened species. Under the EPBC Act, any development, Proposal or activity that is considered likely to have a significant impact on matters of national environmental significance (including nationally threatened ecological communities, species and listed migratory species) requires approval from the Commonwealth Minister for the Environment (from the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC).

1.4.2 NSW Threatened Species Conservation Act 1995

The TSC Act is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act through threat abatement and species recovery programs. The TSC Act requires consideration of whether a development or activity is likely to significantly impact threatened species, populations, communities or their habitat.

1.4.3 NSW Environmental Planning and Assessment Act 1979

The EP&A Act is the overarching planning legislation in NSW. The EP&A Act provides for the creation of planning instruments that guide land use and assessment of Proposals. The EP&A Act also provides for the consideration of the environment and biodiversity values.

Director General's Requirements (DGRs) under Section 75W of the EP&A Act have been provided by the Minister on 21 November 2012. The DGRs set out a number of items which require addressing within this assessment. The DGR's require that the assessment addresses the following specific issues:

- Measures taken to avoid, reduce or mitigate impacts on biodiversity;
- Accurate estimates of proposed vegetation clearing;
- A detailed assessment of potential impacts of the modification on any:

- Terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependant ecosystems, and;
- Regionally significant remnant vegetation, or vegetation corridors; and

➢ If necessary, a comprehensive offset strategy to ensure the modification maintains or improves the biodiversity values of the region in the medium to long term.

1.5 Terms and Abbreviations

This report uses the following terminology and abbreviations:

DGRs: Director General's Requirements

EEC: Endangered Ecological Community

EP&A Act: NSW *Environmental Planning and Assessment Act 1979*

EPBC Act: Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

LEP: Local Environmental Plan

LGA: Local Government Area

Locality: The area within a 10 km radius of the Site

MNES: Matters of National Environmental Significance

OEH: NSW Office of Environment and Heritage

Proposed Modification area: The area of land covered by the proposed modification sought under development application DA 250-09-01 Modification 4 (refer to ***Section 1.2***). This includes the area of land previously excluded from development under the existing approval.

RMP: Rehabilitation Management Plan

SEWPaC: Commonwealth Department of Sustainability, Environment, Water, Population and Communities

Site: Land contained within Lots 1 and 2 of DP 547255 which is land covered under DA 250-09-01 (refer to **Figure 1.1**)

Study Area: The area investigated during the current surveys. This includes the Proposed Modification area and adjacent areas that are likely to be affected by the Proposed Modification, either directly or indirectly (refer to **Figure 1.1**).

TSC Act: NSW *Threatened Species Conservation Act 1995*

Figure 1.1. Location of the Proposed Modification

Chapter 2

Methodology

2.1 Literature Review

A review of ecological literature relevant to the Proposed Modification area was undertaken as part of this flora and fauna assessment to evaluate the ecological values associated with the Proposed Modification area. Key documents reviewed for this assessment include:

- Cumberland Ecology (2011) (**Appendix A**). Letter - Advice regarding the presence of Shale Sandstone Transition Forest in the extractions exclusion area at Dixon Sand Quarry, Part Lots 1 & 2, DP 547255, Old Northern Road, Maroota. Cumberland Ecology Pty Ltd, Carlingford Court, NSW;
- Hawkeswood, T. J. (2010). Flora and Fauna Survey and Assessment of parts of Lots 1 & 2, DP 547255, 4610 Wisemans Ferry Road, Maroota, New South Wales. T.J. Hawkeswood Scientific Consulting, Richmond, NSW; and
- Fanning et al. (1998). Proposed Sand Extraction. Old Northern Road, Maroota. Flora and Fauna Constraints. Draft report. Gunninah Environmental Consultants, Crows Nest, NSW.

The information collected during the literature review guided the field surveys undertaken for this flora and fauna assessment. Information within the literature reviewed was also utilised in determining the likelihood of threatened species occurring within the Proposed Modification area and assessing the potential impacts of the proposed project.

2.2 Database Analysis

Database analysis was conducted for the locality using the Office of Environment and Heritage (OEH) Atlas of NSW Wildlife Database (OEH 2013) and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) EPBC Protected Matters Search Tool (SEWPaC 2013). The Atlas of NSW Wildlife Database search facility was used to generate records of threatened flora and fauna species and populations listed under the TSC Act within the locality of the Proposed Modification area. The Protected Matters Search Tool generated a list of potentially occurring Matters of National Environmental Significance (MNES) listed under the EPBC Act within the locality of the Proposed Modification area. The lists generated from these databases were used to assist in designing surveys for threatened species considered likely to occur within the

Proposed Modification area. The abundance, distribution and age of records generated within the search area also provided supplementary information for the assessment of likelihood of occurrence of those threatened species within the Proposed Modification area.

2.3 Flora Survey

Cumberland Ecology conducted flora surveys within the Proposed Modification area on 20 February and 26 February 2013. These flora surveys included vegetation mapping, quadrat sampling and threatened species searches, which are described in detail in the following sections.

2.3.1 Vegetation Mapping

Several vegetation mapping studies have been undertaken across the Proposed Modification area and surrounds, including broad scale mapping of The Hills LGA. The vegetation within the Proposed Modification area was ground-truthed to examine and verify the extent and condition of different vegetation communities. Records were made of proposed boundaries using a hand-held Global Positioning System (GPS) and mark-up of aerial photographs.

The resultant information was synthesised using Geographical Information Systems (GIS) to create a spatial database that was used to interpret and interpolate the data to produce a vegetation map of the Proposed Modification area. Mapping was completed using MapInfo Version 11.5.2.

2.3.2 Vegetation Sampling

Vegetation sampling conducted within the Proposed Modification area included:

- Quadrat sampling (20m x 20m) to obtain information on species composition and community structure; and
- Random meander surveys to detect additional flora species not recorded during quadrat sampling.

A total of four quadrats were sampled during the flora survey period. The locations of flora quadrats were recorded using a GPS and are shown in **Figure 2.1**. The locations of these quadrats were stratified so that sampling was conducted in all of the major vegetation types discernable across the Proposed Modification area. The process of quadrat sampling included the following:

- Identifying and recording all vascular flora species present in each strata within the plot or directly adjacent to the plot;
- Assigning a cover-abundance value to each species recorded within the plot, using a modified Braun-Blanquet scoring system (Braun-Blanquet 1927), to reflect their relative cover and abundance in the plot;

- Recording details about vegetation structure such as percentage foliage cover and height of each strata; and
- Taking photographs of the quadrat to provide a record of vegetation condition and appearance.

'Random meanders' were undertaken throughout the Proposed Modification area in conjunction with vegetation mapping surveys in order to maximise the census of vascular plant species. Additional species not recorded during quadrat sampling were noted during the random meanders to assist in the compilation of a species list for the Proposed Modification area.

All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (Harden 1990-1993). Recent name changes to plant names have been incorporated into this report, and the names are derived from PlantNET (Botanic Gardens Trust 2013). Specimens that required further investigation were sampled in the field, given a voucher number, pressed and then lodged for identification with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney.

2.3.3 Threatened Species Searches

Threatened flora surveys were undertaken across the Proposed Modification area. These surveys were initially undertaken as part of the vegetation mapping ground-truthing and quadrat surveys. Targeted searches were also conducted within suitable habitat for several potentially occurring species including *Melaleuca deanei*, *Darwinia fascicularis* subsp. *oligantha* and *Tetratheca glandulosa*. Patches of observed threatened flora species were traversed and the boundaries of each patch were recorded using a GPS. Following delineation of each patch, an estimate was made of the number of individuals present.

2.4 Fauna Survey

Cumberland Ecology conducted fauna surveys across the Study Area from 25 February 2013 to 1 March 2013. These fauna surveys were conducted, where appropriate, in accordance with the survey guidelines provided in the OEH Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities (Working Draft) (DEC (NSW) 2004). The fauna surveys included a general fauna habitat assessment, ultrasonic bat call detection, infrared camera survey and incidental observations. All survey methods utilised within the ecological assessment are described in detail in the following sections. The location of all fauna survey sites are shown in **Figure 2.1**.

2.4.1 General Habitat Assessment

Key areas of investigation were delineated on an aerial photograph and targeted for general habitat assessments. The general habitat assessment included a traverse of the Study Area and the recording of notes on habitat. Notes were taken on the presence of suitable nesting, roosting and foraging habitat features suitable for threatened species known from the locality. Features noted include hollow-bearing trees, termite mounds, bush rock and soaks.

The general habitat assessment provided assistance in the determination of targeted fauna survey types and locations.

2.4.2 Microchiropteran Bat Survey

Surveys for microchiropteran bats were undertaken using "Anabat" units to record ultrasonic bat calls. A total of three locations within the Study Area were surveyed for four nights. Anabat units were positioned in suitable habitat, such as along tracks and near edges of vegetation. Anabat units were set to activate before dusk each evening and switch off after dawn. Ultrasonic calls collected from the Anabat units were subsequently identified. Scientific naming of microchiropteran bats within this assessment follows Churchill (2008).

2.4.3 Infrared Camera Survey

One infrared camera was deployed for four nights targeting medium to large mammals along an existing track. Images recorded during this period were then reviewed to determine which fauna species were present.

2.4.4 Incidental fauna observations

Any incidental vertebrate fauna species that was observed, heard calling or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for the Study Area.

2.5 Survey Effort

Flora and fauna survey methods and survey effort for the Study Area are summarised in **Table 2.1**.

Table 2.1 Survey Effort

Method	Dates	Effort
Vegetation mapping	20/2/2013 and 26/2/2013	12 person hours
Vegetation quadrat surveys	20/2/2013	12 person hours
Targeted threatened flora searches	20/2/2013 and 26/2/2013	24 person hours
Fauna habitat assessment	25/2/2013	11 person hours
Incidental fauna observations	25/2/2013 and 26/2/2013	16 person hours
Ultrasonic bat call recording	25/2/2013 to 1/3/2013	12 nights
Infrared camera recording	25/2/2013 to 1/3/2013	4 nights

2.6 Weather Conditions

A summary of weather conditions in the locality of the Study Area during the current field surveys is shown in **Table 2.2**.

Table 2.2 Weather conditions during the current surveys

Date	Minimum Temperature (ºC)	Maximum Temperature (ºC)	Rainfall (mm)
20/02/2013	17.3	29.5	0
25/02/2013	20.8	30.8	1.4
26/02/2013	21.0	28.8	0.2
27/02/2013	19.3	31.5	0
28/02/2013	19.9	29.6	0
1/03/2013	15.7	18.5	45.6

Source: Bureau of Meteorology Daily Weather Observations for Richmond, NSW (2012)

2.7 Survey Limitations

The vertebrate fauna and vascular flora of the locality are well known based on the database of past records and various published reports. The survey methods applied by Cumberland Ecology add to the existing database and have assisted in providing a clear indication of the likelihood of occurrence of various species within the Proposed Modification area. The data obtained from database assessment and surveys of the Proposed Modification area are believed to have furnished an appropriate level of information to support this assessment.

The weather conditions at the time of the flora surveys were generally favourable for plant growth and production of features required for identification of most species. Shrubs, grasses, herbs and creepers were readily identifiable in most instances. Although considerable survey effort has taken place throughout the Proposed Modification area, it is possible that some flora species have not been detected, particularly cryptic species. The timing of these surveys was not suitable for detecting some threatened flora species, particularly *Tetratheca glandulosa*. However, investigations within the Proposed Modification area in previous years were conducted in different seasons, allowing for detection of species that were not recorded during current surveys. It is however considered that substantial information has been collected to assess issues including conservation significance of the flora, condition and viability of bushland and likely impact on native and threatened vegetation.

The weather conditions leading up to and on the dates of amphibian and bat surveys were generally favourable. Only limited fauna surveys were undertaken owing to the size and contextual location of the Proposed Modification area. Due to the nature of the Proposed Modification area, previous experience and extensive records available from the Atlas of NSW Wildlife, it is considered that adequate fauna data was collected to meet the requirements of the investigation.

Figure 2.1. Survey Locations

Chapter 3

Results

3.1 Introduction

This chapter presents the findings of flora and fauna investigations across the Proposed Modification area. A wide variety of flora and fauna are known to occur in the locality, and have the potential to occur within the Proposed Modification area.

3.2 Vegetation Communities

3.2.1 Introduction

The Proposed Modification area supports a vegetation cover of heath, woodland and grassland communities that reflects topography, geology, drainage and disturbance history. The Hills Shire Council has mapped the vegetation communities in the Proposed Modification area as Map Unit 11 - Shale/Sandstone Transition Forest (High Sandstone Influence) and Map Unit 21 - New Unclassified 2005 (Baulkham Hills Shire Council 2008). Cumberland Ecology has subsequently identified the following communities within the Proposed Modification area, which have been mapped by the dominant species present:

- *Banksia ericifolia – Leptospermum trinervium* Heath;
- *Angophora costata – Corymbia gummifera* Woodland;
- *Eucalyptus punctata – Acacia parramattensis* Woodland; and
- *Cynodon dactylon – Axonopus fissifolius* Exotic Grassland.

Descriptions of these communities are provided below. The distribution of these communities within the Proposed Modification area is shown in **Figure 3.1**. The area occupied by each of the communities is shown in **Table 3.1**.

Table 3.1 Area of each vegetation community recorded within the Proposed Modification area

Vegetation Community	Area (ha)
Banksia ericifolia – Leptospermum trinervium Heath	1.86
Angophora costata – Corymbia gummifera Woodland	1.15
Eucalyptus punctata – Acacia parramattensis Woodland	0.67
Cynodon dactylon – Axonopus fissifolius Exotic Grassland	0.62
Cleared land	0.05
TOTAL	**4.35**

Shale/Sandstone Transition Forest EEC is known from the locality and has been mapped within the Proposed Modification area by Fanning et al. (1998) and The Hills Shire Council (2008). Recent detailed investigations by Hawkeswood (2010) and Cumberland Ecology (2011) have determined that Shale/Sandstone Transition Forest EEC is not present within the Proposed Modification area. Cumberland Ecology (2011) determined that the vegetation within the Proposed Modification area does not conform to Shale/Sandstone Transition Forest EEC for the following reasons (see **Appendix A**):

- Does not conform to the Final Determination for Shale/Sandstone Transition Forest;
- Does not conform to or pass the test prescribed in Tozer *et al.* (2010) (REF) for Shale/Sandstone Transition Forest;
- Does not occur on geology suitable for the development of Shale/Sandstone Transition Forest; and
- Conforms best to non-listed sandstone dominated vegetation.

As such, Shale/Sandstone Transition Forest is not considered to occur within the Proposed Modification area and is not assessed further in this report.

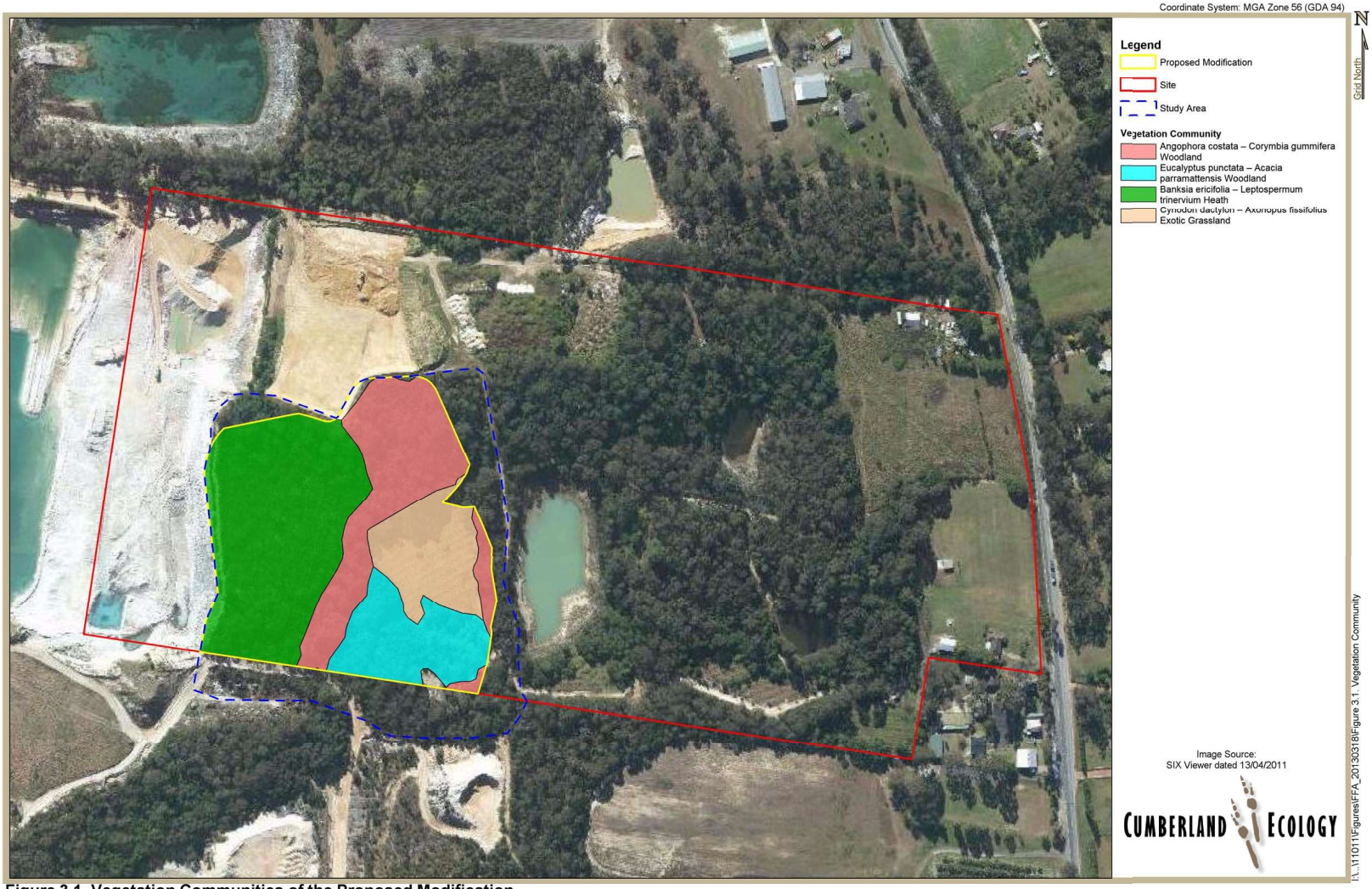

Figure 3.1. Vegetation Communities of the Proposed Modification

3.2.2 Banksia ericifolia – Leptospermum trinervium Heath

TSC Act Status: Not listed.

EPBC Act Status: Not listed.

This community occurs within the western portion of the Proposed Modification area and is located between woodland vegetation and the existing quarry operations. Trees occurring within this community include *Corymbia gummifera* (Red Bloodwood), *Eucalyptus haemastoma* (Broad-leaved Scribbly Gum) and *Corymbia eximia* (Yellow Bloodwood). Trees within this community have a patchy distribution, with a higher occurrence at the edge of the community where it transitions into adjacent woodland communities. The tree stratum ranges in height from 5-12m with a Projected Foliage Cover (PFC) of 5%. The small tree stratum is primarily comprised of regenerating canopy species and also includes *Allocasuarina littoralis* (Black She-Oak), *Angophora hispida* (Dwarf Apple) and *Eucalyptus squamosa* (Scaly Bark). The small tree stratum ranges in height from 3-5m with a PFC of 5-10%. A high diversity of shrub species occurs within this community. The dominant species within the shrub stratum include *Banksia ericifolia* (Heath-leaved Banksia) and *Leptospermum trinervium* (Flaky-barked Tea-tree). Other common species within the stratum include *Calytrix tetragona* (Common Fringe-myrtle), *Darwinia fascicularis* subsp. *oligantha*, *Grevillea buxifolia* (Grey Spider Flower), *Epacris pulchella* (Wallum Heath), *Persoonia lanceolata* (Lance Leaf Geebung). The shrub stratum ranges in height from 0.2-2m with a PFC of 50-70%. The ground stratum is largely dominated by monocots, including *Lepyrodia scariosa*, *Cyathochaeta diandra*, *Caustis pentandra* (Thick Twist Rush), *Lomandra glauca* (Pale Mat-rush). Others species occurring within the ground stratum includes *Actinotus minor* (Lesser Flannel Flower) and *Scaevola ramosissima* (Purple Fan-flower). The ground stratum ranges in height from 0-0.7m with a PFC of 10-30%. *Cassytha pubescens* is a commonly occurring climber within this community. The main structural features of this community are shown in **Photograph 3.1**.

Photograph 3.1 ***Banksia ericifolia – Leptospermum trinervium*** **Heath**

3.2.3 Angophora costata – Corymbia gummifera Woodland

TSC Act Status: Not listed.

EPBC Act Status: Not listed.

This community occurs within the eastern portion of the Proposed Modification area. Trees occurring within this community include *Angophora costata* (Smooth-barked Apple), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus piperita* (Sydney Peppermint) and *Eucalyptus punctata* (Grey Gum). The tree stratum ranges in height from 10-18m with a PFC of 15-25%. The small tree stratum is primarily comprised of regenerating canopy species and also includes *Allocasuarina littoralis* (Black She-Oak), *Angophora bakeri* (Narrow-leaved Apple), *Acacia parramattensis* (Parramatta Wattle) and *Ceratopetalum gummiferum* (Christmas Bush). The small tree stratum ranges in height from 3-8m with a PFC of 5-25%. Common shrub species include *Hibbertia diffusa* (Wedge Guinea Flower), *Bossiaea obcordata* (Spiny Bossiaea), *Allocasuarina littoralis* (Black She-Oak), *Persoonia linearis* (Narrow-leaved Geebung), *Banksia spinulosa* (Hairpin Banksia) and *Epacris pulchella* (Wallum Heath). The shrub stratum ranges in height from 0.2-3m with a PFC of 10-20%. Common species within the ground stratum include *Pteridium esculentum* (Bracken), *Imperata cylindrica* (Blady Grass), *Entolasia stricta* (Wiry Panic), *Dianella caerulea* var. *producta*, *Cyathochaeta diandra*, *Austrostipa pubescens* and *Dampiera stricta*. The ground stratum ranges in height from 0-1m with a PFC of 20-50%. *Cassytha pubescens* and *Billardiera scandens* (Hairy Apple Berry) are commonly occurring climbers within this community. The main structural features of this community are shown in **Photograph 3.2**.

Photograph 3.2 ***Angophora costata – Corymbia gummifera*** **Woodland**

3.2.4 Eucalyptus punctata – Acacia parramattensis Woodland

TSC Act Status: Not listed.

EPBC Act Status: Not listed.

This community occurs in the south eastern portion of the Proposed Modification area and has been impacted by previous land use, with the northern portion of this community occurring in an area previously used as an orchard. Species recorded within the tree stratum include *Eucalyptus punctata* (Grey Gum), *Eucalyptus piperita* (Sydney Peppermint), *Angophora costata* (Smooth-barked Apple) and *Eucalyptus resinifera* (Red Mahogany). The occurrence of these canopy species is restricted to the southern portion of the community. The tree stratum ranges in height from 15-20m with a PFC of 10%. The small tree stratum is dominated by *Acacia parramattensis* (Parramatta Wattle), particularly in the northern portion of the community where is occurs within the area previously used as an orchard. The small tree stratum ranges in height from 6-15m with a PFC of 20-60%. The exotic *Lantana camara* (Lantana) dominates the shrub stratum. Other species within the shrub stratum include *Pultenaea flexilis* (Graceful Bush-pea), *Polyscias sambucifolia* (Elderberry Panax), *Lomatia silaifolia* (Crinkle Bush) and *Ozothamnus diosmifolius* (White Dogwood). The shrub stratum ranges in height from 1-2.5m with a PFC of 15-25%. Species within the ground stratum include *Pteridium esculentum* (Bracken), *Entolasia stricta* (Wiry Panic), *Microlaena stipoides* (Weeping Grass), *Schoenus melanostachys* (Black Bog-rush), *Imperata cylindrica* (Blady Grass) and *Pratia purpurascens* (Whiteroot). Exotic species recorded within the groundcover include *Solanum nigrum* (Blackberry Nightshade), *Sida rhombifolia* (Paddy's Lucerne), *Asparagus asparagoides* (Bridal Creeper), *Araujia sericifera* (Moth Vine) and

Conyza bonariensis (Flaxleaf Fleabane). The ground stratum ranges in height from 0-1m with a PFC of 25-50%. *Clematis glycinoides* (Headache Vine) and *Stephania japonica* (Snake Vine) are commonly occurring climbers within this community. The main structural features of this community are shown in **Photograph 3.3**.

Photograph 3.3 *Eucalyptus punctata – Acacia parramattensis* Woodland

3.2.5 Cynodon dactylon – Axonopus fissifolius Exotic Grassland

TSC Act Status: Not listed.

EPBC Act Status: Not listed.

This community occurs predominately within the south eastern portion of the Proposed Modification area in an area previously used as an orchard. Additional occurrences of this community occur along tracks. This community is predominately comprised of exotic species and is dominated by *Cynodon dactylon* (Couch) and *Axonopus fissifolius* (Narrow-leaved Carpet Grass). Other exotic grasses within this community include *Setaria parviflora*, *Paspalum dilatatum* (Paspalum), *Paspalum urvillei* (Vasey Grass) and *Andropogon virginicus* (Whiskey Grass). The native *Microlaena stipoides* (Weeping Grass) occurs infreuqently within this community. Other exotic species within this community include *Plantago lanceolata* (Plantain), *Verbena officinalis* (Common Verbena), *Hypochaeris radicata* (Flatweed) and *Sida rhombifolia* (Paddy's Lucerne). The ground stratum ranges in height from 0- 0.8m with a PFC of 90%. A shrub stratum is sparse and is largely comprised of Lantana camara (Lantana). The shrub stratum is ranges in height from 1-3m with a PFC of 5%. The main structural features of this community are shown in **Photograph 3.4**.

Photograph 3.4 ***Cynodon dactylon – Axonopus fissifolius*** **Exotic Grassland**

3.3 Flora

3.3.1 General Species

Over 150 flora species have been recorded from the Proposed Modification area during surveys undertaken for this assessment. The dominant plant families encountered within the Proposed Modification area have consistently been represented by the Myrtaceae, Fabaceae, Poaceae and Proteaceae families. The floral assemblage across the Proposed Modification area is largely typical of dry sclerophyll sandstone vegetation. Approximately 15% of the flora species recorded within the Proposed Modification area are exotic species. These occurred predominately within the area previously used as an orchard, along tracks and adjacent to cleared areas. A total species list for the Proposed Modification area is provided in **Appendix B**.

3.3.2 Threatened Species

A number of threatened flora species are known to occur in the locality of the Site. Comprehensive vegetation surveys have been conducted within the Proposed Modification area over a number of years and during different seasons. It is therefore likely that sufficient survey effort has been conducted to detect any threatened flora species that may be present within the Proposed Modification area. The likelihood of occurrence of threatened flora species within the Proposed Modification area is outlined in **Appendix C**. The following threatened species have been recorded within the Proposed Modification area:

- *Melaleuca deanei* (Deane's Melaleuca) – Vulnerable under the EPBC Act and TSC Act; and
- *Tetratheca glandulosa* – Vulnerable under the EPBC Act and TSC Act.

The location of threatened species detected during the most recent surveys is shown in **Figure 3.2**. A discussion of the species and their occurrence within the Proposed Modification area is provided below.

i. Melaleuca deanei

Melaleuca deanei (Deane's Melaleuca) is listed as Vulnerable under both the TSC Act and EPBC Act. This species is a shrub to 3m high (DEC (NSW) 2005a). *Melaleuca deanei* is distributed from St. Albans in the north, to Nowra in the south and west to Faulconbridge (DECCW 2010). Within its extent, *Melaleuca deanei* is known from broad flat ridgetops, dry ridges and slopes and is strongly associated with sandy loam soils that are low in nutrients and sometimes containing ironstone (DECCW 2010). As *Melaleuca deanei* is a clonal species, it has the ability to re-sprout from a swollen rootstock to produce coppiced growth and can also sucker from its rootstock (DECCW 2010).

This species was recorded at one location within the Proposed Modification area within *Angophora costata* – *Corymbia gummifera* Woodland. Due to the suckering nature of this species, obtaining counts of plants was difficult, so clumps of stems considered to represent one individual were recorded. A total of 18 clumps were recorded within the Proposed Modification area.

The Atlas of NSW Wildlife holds 1 record of *Melaleuca deanei* within the locality. *Melaleuca deanei* is conserved in the locality within Marramarra National Park and Dharug National Park.

ii. Tetratheca glandulosa

Tetratheca glandulosa is listed as Vulnerable under both the TSC Act and EPBC Act. This species is a small spreading shrub to 20-50cm high (DEC (NSW) 2005c). *Tetratheca glandulosa* is distributed from Sampons Pass (Yengo National Park) in the north to West Pymble (Lane Cover National Park) in the south and Ingleside (Pittwater LGA) in the east and East Kurrajong (Wollemi National Park) in the west (DEC (NSW) 2005c). It is associated with shale-sandstone transition habitat where shale-cappings occur over sandstone and it typically occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches (DEC (NSW) 2005c).

This species was not recorded within the Proposed Modification area during current surveys. However, approximately 40 to 50 plants were recorded by Gunninah Environmental Consultants (Fanning et al. 1998) and five plants were recorded by Hawkeswood (2010) within the Proposed Modification area.

The Atlas of NSW Wildlife holds 130 records of *Tetratheca glandulosa* within the locality. *Tetratheca glandulosa* is conserved in the locality within Marramarra National Park and

Dharug National Park. Populations south of the Hawkesbury are considered to be adequately conserved in Berowra Valley National Park, Marramarra National Park and Ku-ring-gai Chase National Park (NSW NPWS 2000).

Figure 3.2. Threatened Species Locations

3.4 Fauna

3.4.1 Fauna Habitat

The woodland, heath and grassland communities present within the Proposed Modification area provide a range of fauna habitats. Habitat features within these vegetation communities provide potential foraging, shelter and breeding opportunities for fauna. No permanent or ephemeral drainage lines (breeding habitat for amphibians) were recorded within the Proposed Modification area. Key habitat features recorded within the Proposed Modification area include:

- Fallen logs, debris and leaf litter – shelter habitat for amphibians, reptiles and terrestrial mammals;
- Hollow-bearing trees and stags – providing shelter and breeding habitat for a range of reptiles, birds, arboreal mammals and microchiropteran bats (microbats);
- Sandstone rock outcrops – shelter and breeding habitat for amphibians, reptiles and terrestrial mammals; and
- Nectar-producing trees and shrubs – foraging habitat for insects, blossom-dependant birds, arboreal mammals and megachiropteran bats (flying-foxes).

These key habitat features provide habitat for a range of fauna, including some species that are listed as threatened under the EPBC Act and/or the TSC Act.

i. Fallen logs, debris and leaf litter

Features such as fallen logs, debris and leaf litter has the potential to provide shelter for many of the common small to medium sized terrestrial fauna species known from the locality. These features are most abundant within the woodland communities, where structural complexity is highest. However, these features are limited within the Proposed Modification area due to the small area of woodland present.

ii. Hollow-bearing trees and stags

The mature living trees and stags within the Proposed Modification area provide a limited number of small to medium-sized hollows for fauna species dependant on this resource, such as microchiropteran bats. The woodland communities provide the greatest abundance and diversity of hollows within the Proposed Modification area, although only a small number of hollows were observed. The Proposed Modification area does not support suitable large hollows in tall mature trees that would provide roosting or nesting habitat for large gliders, large forest owls or Glossy Black-cockatoo (*Calyptorhynchus lathami*).

iii. Sandstone rock outcrops

Rocky outcrops are limited within the Proposed Modification area to small areas of exposed sandstone within heath. There are only small cracks, crevices and rocks present that provide shelter for small reptiles. There are no caves, large crevices or substantial areas of

exfoliating rock that would provide suitable shelter and/or breeding habitat for microbats and threatened terrestrial mammals.

iv. Nectar-producing trees and shrubs

The vegetation within woodland and heath of the Proposed Modification area would provide suitable foraging habitat for a range of nectivorous birds, bats and arboreal mammals during blossom periods. It is expected that a number of nectar-dependant species would be attracted to the Proposed Modification area during the blossom periods of dominant trees and shrubs.

3.5 Fauna

3.5.1 General Fauna Species

Over 40 vertebrate fauna species have been recorded within or immediately adjacent to the Proposed Modification area during the current surveys, with the majority of species being native. A total list of fauna species recorded from the Study Area during the current surveys is provided in **Appendix D**.

i. Amphibians

The Proposed Modification area does not support permanent or ephemeral water that would provide suitable breeding habitat for amphibians. There are currently small dams adjacent to the Proposed Modification area that provide breeding habitat for a range of common amphibians. Five common frog species were recorded within the Study Area during the current surveys.

ii. Reptiles

A range of habitat features suitable for common reptiles occurs throughout the Proposed Modification area. A total of three reptile species were recorded within the Study Area, although additional common species are predicted to occur.

iii. Birds

The vegetation communities within the Proposed Modification area support a number of common bird species. Over 20 bird species were recorded within the Study Area during the current surveys, and the results of habitat assessment and previous surveys indicate that a number of additional common birds are likely to occur. A variety of small to medium sized birds including finches, honeyeaters and lorikeets utilise the nesting and foraging habitat with the heath, woodland and grassland vegetation. No threatened birds were observed within the Study Area during the current surveys. Chewed cones of *Allocasuarina littoralis* indicate the presence of foraging Glossy Black-cockatoo within the Proposed Modification area.

iv. Mammals

The Proposed Modification area supports a limited range of terrestrial or arboreal mammal species, with only three species being recorded during the current surveys. One of these, the European Rabbit (*Oryctogalus cuniculus*), is an introduced species. Previous surveys indicate that several additional common terrestrial and arboreal mammals are likely to occur within the Proposed Modification area.

The Study Area supports a diversity of microchiropteran bats (microbats), with ten species being positively identified from ultrasonic calls. Calls that could not be identified to species indicate that a small number of additional microbats occupy the Study Area. A number of microbats recorded within the Study Area are listed as Vulnerable under the EPBC Act and/or the TSC Act.

3.5.2 Threatened Fauna Species

The current condition of habitat within the Proposed Modification area is a significant determining factor in the likelihood of occurrence of many of the threatened fauna species known to occur in the locality. The Proposed Modification area has been historically disturbed and remains relatively isolated from larger, more intact habitats in the wider locality as a result of surrounding clearing and quarrying. Habitat values of the Proposed Modification area are therefore limited to more mobile species such as birds and bats. Other threatened fauna, particularly smaller terrestrial or arboreal species, are less likely to occur within the Proposed Modification area as these species are less able to re-colonise isolated habitats. The likelihood of occurrence of threatened fauna known to occur in the locality of the Proposed Modification area is outlined in **Appendix E**.

The following threatened species have been recorded within the Study Area:

- Glossy Black-cockatoo (*Calyptorhynchus lathami*) – Vulnerable under the TSC Act;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – Vulnerable under the EPBC Act and the TSC Act;
- East-coast Freetail-bat (*Mormopterus norfolkensis*) – Vulnerable under the TSC Act;
- Little Bentwing-bat (*Miniopterus australis*) – Vulnerable under the TSC Act; and
- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) – Vulnerable under the TSC Act.

The locations these species are shown in **Figure 3.2**. A discussion of these species and their occurrence within the Study Area is provided below.

i. Glossy Black-cockatoo

The Glossy Black-cockatoo is listed as Vulnerable under the TSC Act. It is a dusky brown to black cockatoo, about 50cm in length with a massive bill (DEC (NSW) 2005b). The Glossy

Black-cockatoo is distributed from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW (DEC (NSW) 2005b). Within its extent, it inhabits open forest and woodlands in which stands of she-oak species occur, particularly *Allocasuarina littoralis* (Black She-oak), *Allocasuarina torulosa* (Forest Oak) and *Allocasuarina verticillata* (Drooping Sheoak) (DEC (NSW) 2005b). The Glossy Black-cockatoo also requires large hollow-bearing eucalypts for nest sites (DEC (NSW) 2005b).

The Proposed Modification area provides suitable forage habitat for the Glossy Black-cockatoo. A preferred feed tree for this species, *Allocasuarina littoralis*, is present in all woodland and heath communities within the Proposed Modification area. There are no large hollow trees within the Proposed Modification area that would provide suitable nesting habitat for the Glossy Black-cockatoo. It is therefore likely that this species would only occasionally visit the Proposed Modification area to forage as part of a much larger range.

The Glossy Black-cockatoo has been recorded in most conservation areas in the locality, including Marramarra National Park, Dharug National Park, Parr State Conservation Area and Berowra Valley National Park. These conservation areas provide large areas of intact forage and breeding habitat for this species in the locality.

ii. Microchiropteran Bats

A total of four threatened microchiropteran bats (microbats) were recorded within or adjacent to the Proposed Modification area during the current surveys. These are; Large-eared Pied Bat, East-coast Freetail-bat, Little Bentwing-bat and Eastern Bentwing-bat.

The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW (DEC (NSW), 2005k). This species roosts in caves, crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Hirundo ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features (DEC (NSW), 2005k). This species is found in well-timbered areas containing gullies.

The East-coast Freetail-bat occurs from southern Queensland to southern NSW, in dry sclerophyll forest and woodland. It roosts in tree hollows and sometimes under bark or in man-made structures (DEC (NSW), 2005e).

The Little Bentwing-bat is distributed along the east coast of Australia from Cape York in Queensland to Wollongong in NSW (DEC (NSW), 2005m). This species inhabits moist eucalypt forest, rainforest or dense coastal banksia scrub (DEC (NSW), 2005m). Little Bentwing-bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats (DEC (NSW), 2005m).

The Eastern Bentwing-bat occurs along the east and north west coasts of Australia. It roosts in caves, derelict mines, stormwater tunnels, buildings and other man-made structures. It forages above the canopy in forested areas. This species also can potentially roost in some

rock crevices and overhangs (DEC (NSW), 2005c). The Eastern Bentwing-bat forms maternity colonies in caves and populations usually centre on such caves (DEC (NSW), 2005c)

All vegetation communities within the Proposed Modification area and surrounding lands provide suitable forage habitat for these species.

Three of the threatened microbats recorded are cave-dependant species. There are no caves or culverts within the Proposed Modification area, so these species are highly unlikely to roost or breed here. Only one species, the East-coast Freetail-bat, is not dependant on caves for roosting or breeding habitat. Although suitable roosting hollows are present within the Proposed Modification area for the East-coast Freetail-bat, these are relatively scarce. It is therefore likely that all threatened microbats travel from suitable roosting habitat elsewhere in the locality to forage within the Proposed Modification area and adjacent lands.

All four of the threatened microbats recorded within the Study Area are known to occur in conservation areas of the locality, including Marramarra National Park, Dharug National Park, Parr State Conservation Area, Berowra Valley National Park and Cattai National Park. These conservation areas provide large areas of intact forage and breeding habitat for threatened microbat species in the locality.

3.6 Wildlife Corridors

Wildlife corridors are generally areas of habitat that connect reserves or blocks of disjunct habitat. Wildlife corridors allow wildlife to disperse and provide for gene flow between populations or subpopulations (Primack 1993). Wildlife corridors are of varying relevance to fauna, and are of greatest relevance to ground dwelling species that cannot fly. Highly mobile birds and bats can fly between patches of habitat, over human developments and clearings. Notwithstanding that, retention of corridors or stepping stone patches of habitat can also greatly aid in the conservation of such mobile species.

Desktop analysis of aerial photography and field investigations indicate that the Proposed Modification area forms part of a corridor of vegetation connecting vegetated areas within the eastern portion of the Site to extensive areas of vegetation to the west of the Site. Areas to the east of the Site, beyond properties along Old Northern Road, are largely conserved within Marramarra National Park.

Within the wildlife corridor on the Site there are several barriers to movement. These include the existing sand quarry and associated clearing for tracks to the south, north and west of the Proposed Modification area. The corridor is further impacted to the east of the site by agricultural land and Old Northern Road. These features are likely to impede movement of many smaller terrestrial and arboreal fauna species through this corridor. The Proposed Modification area and surrounding lands are likely to provide wildlife corridor values primarily for highly mobile species (e.g. birds and bats) or common and adaptable species (e.g. wallabies, possums, feral mammals).

The maintenance or creation of wildlife corridors has become an important planning consideration as landscapes are developed. If due consideration is given, provisions can be made to retain and/or enhance wildlife corridors present within the Proposed Modification area and surrounding land and to retain viability of habitats.

Chapter 4

Impact Assessment

4.1 Introduction

This chapter discusses the potential impacts of the proposed project on the biodiversity values of the Proposed Modification area. Impacts are primarily related to vegetation and habitat removal, with indirect impacts such as increase edge effects and alteration to hydrological regimes, resulting from such impacts. Impacts to endangered ecological communities, threatened flora and threatened flora are also discussed within this chapter. A number of mitigation and compensatory measures have been proposed to address the impacts of the Proposed Modification, and are provided in **Chapter 5**.

4.2 General

4.2.1 Vegetation and Habitat Removal

The primary impact resulting from the Proposed Modification is the loss of vegetation and associated habitat within the Proposed Modification area. All vegetation present within the Proposed Modification area will be removed. **Table 4.1** provides a summary of the areas of each vegetation community to be removed within the Proposed Modification area.

Table 4.1 Summary of vegetation clearance within the Proposed Modification area

Vegetation Community	Area (ha)
Banksia ericifolia – Leptospermum trinervium Heath	1.86
Angophora costata – Corymbia gummifera Woodland	1.15
Cynodon dactylon – Axonopus fissifolius Exotic Grassland	0.62
Eucalyptus punctata – Acacia parramattensis Woodland	0.67
Cleared Land	0.05
TOTAL	**4.35**

The total footprint of the Proposed Modification is approximately 4.35 ha, of which 3.68 ha comprises native vegetation communities. The remaining area of the Proposed Modification area supports exotic grassland (0.62 ha) and cleared land (0.05 ha).

The native vegetation communities present within the Proposed Modification area are well represented and well conserved in the wider locality. Removal of this vegetation under the Proposed Modification will not therefore result in a significant reduction in any of these vegetation communities in the locality.

No EECs listed under the EPBC Act and/or the TSC Act will be removed under the Proposed Modification area (see ***Section 4.3***).

4.2.2 Loss of Specific Habitat Features

In addition to the clearance of broad habitats within the Proposed Modification area, a number of specific habitat features will be removed. These include feed trees for various fauna, bushrock and hollow-bearing trees. These features provide suitable forage, shelter and breeding habitat for a range of native fauna, including threatened species. The primary areas of fauna habitat occur within the woodland and heath communities. The exotic grassland and cleared areas of the Proposed Modification area provide only limited habitat value.

The following key threatening processes are applicable to the habitat to be removed from the Proposed Modification area:

- Clearing of native vegetation;
- Loss of hollow-bearing trees;
- Bushrock removal; and
- Removal of dead wood and dead trees.

Some of the important habitat features listed in ***Section 3.4.1*** will be removed from the Proposed Modification area. However, as discussed in ***Section 3.4.1*** the Proposed Modification area is relatively small and provides limited habitat features when compared to larger, more intact examples of habitat within the locality. Further, the resulting fragmentation and isolation of these habitat features under the approved DA for the Site would impact many of the fauna that would otherwise utilise these habitat features.

4.2.3 Other Impacts to Vegetation Communities and Habitat

i. Habitat fragmentation

Habitat fragmentation is the process whereby habitat loss results in the division of large, continuous habitats into small, isolated habitat fragments (Ewers and Didham 2006). The area between the fragments is typically man-made and largely uninhabitable by the species that previously existed in the area. The ecological impacts of habitat fragmentation include (Bennett 1990):

- Changes in the number of species in fragments;
- Changes to the composition of faunal assemblages; and

- Changes to ecological processes in fragments such as food chains, predator-prey interactions, plant-animal pollination and dispersal associations.

Fragmentation of a community can also result in the isolation of vegetation patches both locally and regionally. Isolation of patches can decrease the amount of genetic exchange between remaining patches of vegetation by severing the small-scale potential genetic transfer mechanisms such as seed dispersal by ants and reproductive root suckering.

The Site consists of land that has been approved for sand mining, and which will soon be extensively disturbed. Under the approved DA for the Site, the surrounding areas will first be mined, and then rehabilitated to a final landscape of farming land, with no requirement for the replacement of trees. Accordingly, under the existing approval, the Proposed Modification area would comprise an island of vegetation in first a mined landscape, and then a farming landscape. As a result, removal of vegetation within the Proposed Modification area is not considered to significantly exacerbate habitat fragmentation.

ii. Edge effects

"Edge effects" are impacts occurring at an interface between natural environments and disturbed or developed land. The following are types of edge effects that can occur (Murcia 1995):

- Abiotic effects, involving changes in the environmental conditions that result from proximity to a structurally dissimilar matrix;
- Direct biological effects, which involve changes in the abundance and distribution of species caused directly by the physical conditions near the edge; and
- Indirect biological effects which involve changes in species interactions, such a predation, competition, herbivory and biotic pollination and seed dispersal.

Under the approved DA for the Site the edges of the retained vegetation communities within the Proposed Modification area will be impacted by microclimate changes (e.g. increased sunlight, air temperature and soil temperature). Alteration of the microclimates within each vegetation community is likely to result in changes in species composition, including increased weed invasion, which in turn can lead to changes in community structure. Some species will be more susceptible to these changes than others. Edge effects can also result from the increase in noise and artificial light from the approved quarry extension.

Under the approved DA for the Site utilisation of the edge habitat by edge specialists is likely to increase. This has subsequent implications for the interaction between existing species at the edge. Other edge effects can include increased susceptibility to infection, such as infection of native plants by the fungus *Phytophthora cinnamoni*.

Edge effects will occur at the interface between the approved DA for the Site and the Proposed Modification area. These edge effects can potentially have an adverse impact on the vegetation and associated habitat of the Proposed Modification area. Impacts from edge effects can reduce the quality and integrity of the retained communities. Numerous edges

will be created around the Proposed Modification area as a result of the approved DA for the Site. It is primarily where edges are created between the approved quarrying of the Site and intact vegetation within the Proposed Modification area that impacts will occur.

Habitat within the Proposed Modification area does not lie at the edge of any vegetation that will remain under the approved DA for the Site. However, the removal of vegetation with the Proposed Modification area has the potential to increase edge effects to vegetation occurring along the southern boundary.

iii. Alteration of hydrological regime

Quarrying under the approved DA for the Site will result in significant alteration to hydrology necessary for vegetation and habitat survival within the Proposed Modification area. Removal of the vegetation within the Proposed Modification area will not result in any significant changes to hydrology additional to those that would already occur under the approved DA for the Site.

iv. Increased erosion and sedimentation

Erosion is already occurring at the interface between the existing quarry and the Site, particularly along the western boundary of the Proposed Modification area. Under the approved DA an extension of quarrying into the remainder of the Site will result in increased erosion along all sides of the Proposed Modification area. The removal of vegetation from the Proposed Modification area would not result in any significant erosion or sedimentation on adjoining lands additional to those impacts already occurring under the approved DA for the Site.

v. Weeds and feral animals

Alterations to habitat conditions often favour introduced and/or hardy native plant and animal species that can proliferate in disturbed conditions. Such species have potential to impact upon the original local native plant and animal species. Weeds such as exotic grasses and other introduced plants have potential to outcompete regenerating native plant species. Feral animals such as foxes, rabbits and some species of birds can also breed in the more open areas following clearance of forest and woodland. They can cause problems for native fauna species by preying upon them or by competing with them for food and resources.

Weed and feral animal species are already present within the Site, including the Proposed Modification area. Under the approved DA, an extension of quarrying activities into the remainder of the Site will result in increased competition from weeds and feral animals on vegetation within the Proposed Modification area. Removal of vegetation from within the Proposed Modification area will not result in any weed and feral animal impacts on adjacent lands additional to those already likely to occur under the approved DA.One threatened flora species was recorded within the Proposed Modification area during the current surveys. One additional species is known to occur based on previous studies within the Proposed Modification area. The following sections outline impacts to the threatened flora species within the Proposed Modification area. Mitigation and compensatory measures to address

impacts to threatened flora are provided in **Chapter 5**, including provisions for translocation and ongoing management.

4.2.4 Melaleuca deanei

Melaleuca deanei (Deane's Paperbark) is listed as Vulnerable under both the TSC Act and EPBC Act. This species was recorded at one location within the Proposed Modification area.

Removal of the known occurrence of 18 clumps of *Melaleuca deanei* is not considered likely to result in the extinction of the species in the locality.Within the locality, *Melaleuca deanei* is conserved within Marramarra National Park and Dharug National Park, and occurs in other bushland areas in the locality (e.g. near Wiseman's Ferry).

Approximately 1.15 ha of suitable habitat, comprising *Angophora costata – Corymbia gummifera* Woodland is proposed to be cleared from the Proposed Modification area. The loss of this vegetation would result in a very small decrease in the amount of suitable habitat available to this species. The habitat to be removed within the Proposed Modification area is not considered important for the long-term survival of the species. Sufficient potential habitat will be rehabilitated within the Proposed Modification area and other parts of the Site on completion of quarrying activities.

4.2.5 Tetratheca glandulosa

Tetratheca glandulosa is listed as Vulnerable under both the TSC Act and EPBC Act. This species was not recorded within the Proposed Modification area during current surveys, however *Tetratheca glandulosa* was recorded within the Proposed Modification area during surveys by Gunninah Environmental Consultants (Fanning et al. 1998) and Trevor Hawkeswood (2010).

Approximately 40 to 50 individual *Tetratheca glandulosa* were detected within the Proposed Modification area (Fanning et al. 1998). However, only five specimens were recorded within this area by Trevor Hawkeswood in 2010. As suggested by T. Hawkeswood (2010) this may be a result of changes in condition of vegetation between the times of the two surveys, resulting in a decline of *Tetratheca glandulosa* within the Proposed Modification area due to competition with other species.

Despite the absence of records, it is likely that *Tetratheca glandulosa* persists within the Proposed Modification area, albeit at significantly reduced abundance. *Tetratheca glandulosa* is conserved within Marramarra National Park and Dharug National Park, and Atlas of NSW Wildlife records indicate that this species is well represented in the locality. Given the abundant records for this species in the locality, removal of *Tetratheca glandulosa* within the Proposed Modification area is not considered likely to result in the extinction of the species in the locality.

Although not clearly defined in previous surveys, it is likely that woodland supporting *Corymbia gummifera* (DEC (NSW) 2005c) would provide habitat for *Tetratheca glandulosa* within the Proposed Modification area. Approximately 1.15 ha of suitable habitat, comprising

Angophora costata – *Corymbia gummifera* Woodland is proposed to be cleared from the Proposed Modification area. The loss of this vegetation would result in a very small decrease in the amount of suitable habitat available to *Tetratheca glandulosa*. The habitat to be removed within the Proposed Modification area is not considered important for the long-term survival of the species. Sufficient potential habitat will be rehabilitated within the Proposed Modification area and other parts of the Site on completion of quarrying activities.

4.3 Impacts to Threatened Fauna Species

Five threatened fauna species have been recorded within the Proposed Modification area during the current surveys. The following sections outline impacts to the threatened fauna species known within the Proposed Modification area. Mitigation and compensatory measures to address impacts to threatened fauna are provided in **Chapter 5**, including provisions for ongoing management.

4.3.1 Glossy Black-cockatoo

The Glossy Black-cockatoo (*Calyptorhynchus lathami*) is listed as Vulnerable under the TSC Act. Evidence of feeding by Glossy Black-cockatoo was recorded during current surveys indicating that the Proposed Modification area and surrounding Site currently provide forage habitat for this species. However, habitat assessment indicates that the Proposed Modification area does not provide suitable breeding habitat for the Glossy Black-cockatoo.

The Glossy Black-cockatoo has been recorded from Marramarra National Park, Dharug National Park, Parr State Conservation Area and Berowra Valley National Park. Forage and breeding habitat for this species is well conserved in the locality within these protected lands.

All woodland and heath vegetation within the Proposed Modification area supports *Allocasuarina littoralis* which is a preferred feed tree species for the Glossy Black-cockatoo. Approximately 1.82 ha of woodland and 1.86 ha of heath providing forage habitat for the Glossy Black-cockatoo will be removed under the Proposed Modification. Given the extent of high quality forage and breeding habitat for this species in conservation areas in the locality, the removal of a small area of forage habitat from within the Proposed Modification area is not considered important for the long-term survival of the Glossy Black-cockatoo. Larger areas of forage habitat will be rehabilitated within the Proposed Modification area and other areas of the Site on completion of quarrying.

4.3.2 Microchiropteran Bats

The following threatened microchiropteran bats (microbats) were recorded within or adjacent to the Proposed Modification area during the current surveys:

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- East-coast Freetail-bat (*Mormopterus norfolkensis*);
- Little Bentwing-bat (*Miniopterus australis*); and

- Eastern Bentwing-bat (*Miniopterus orianae oceanensis*).

The Large-eared Pied Bat is listed as Vulnerable under both the EPBC Act and the TSC Act. All other threatened species recorded are listed as Vulnerable under the TSC Act.

All vegetation communities within the Proposed Modification area provide suitable forage habitat for threatened microbats. It should be noted that three of the four threatened species recorded are cave-roosting species. As the Site does not provide suitable roosting habitat for these species it is highly likely that these bats travel to the Proposed Modification area to forage from other areas in the locality. The Proposed Modification area provides suitable roost habitat for the East-coast Freetail-bat, which is known to roost in tree hollows. There is no suitable breeding habitat for any threatened microbats within the Proposed Modification area.

The four threatened microbats recorded within the Proposed Modification area have been recorded from conservation areas in the locality, including Marramarra National Park, Dharug National Park, Parr State Conservation Area, Berowra Valley National Park and Cattai National Park. These conservation areas provide extensive forage, roosting and breeding habitat for all of the species recorded within the Proposed Modification area.

Approximately 4.3 ha of suitable forage habitat for threatened microbats (including 1.82 ha of woodland providing suitable roosting habitat for the East-coast Freetail-bat) will be removed under the Proposed Modification. There is extensive forage, roosting and breeding habitat for these species in the locality, much of this conserved in protected lands. It is therefore unlikely that the small area of habitat within the Proposed Modification area is important for the long-term survival of any threatened microbats.

4.4 Wildlife Corridors

The wildlife corridor values of the Proposed Modification area are limited due to historical disturbance, clearing and quarrying in the surrounding lands. The Proposed Modification area currently forms a component of a corridor from south-west to north-east passing through the Site. This corridor is not large enough to provide significant habitat for threatened species, but may be utilised by mobile species such as birds and bats between larger areas of intact habitat. Wildlife corridor values for small terrestrial and arboreal species are limited due to clearing, quarrying and roads in surrounding lands that provide substantial barriers to these species.

Under the approved DA for the Site the wildlife corridor values of the Proposed Modification area will be significantly reduced as all connecting habitat to the north and east will be removed. Further, the current intent is to rehabilitate these lands to farmland, which will substantially limit corridor values for flora and fauna in the long term.

The Proposed Modification will remove approximately 4.3 ha of habitat that currently provides limited wildlife corridor values, mostly for birds and bats. More substantial wildlife corridors exist within the locality to the north and south of the Site, connecting large areas of bushland in the west to Marramarra National Park in the east. These important wildlife areas

will not be significantly impacted by clearing of vegetation within the Proposed Modification area.

Chapter 5

Mitigation and Compensatory Measures

The purpose of this chapter is to outline the mitigation measures proposed to ameliorate the loss of vegetation and associated habitat within the Proposed Modification area. Approximately 3.68 ha of native vegetation will be removed from the Proposed Modification area, which provides known habitat for two threatened plant species; *Tetratheca glandulosa* and *Melaleuca deanei*, as well as the Glossy Black-cockatoo and four threatened bat species.

This chapter outlines the proposed impact mitigation measures for the Proposed Modification, most significantly involving the rehabilitation of all disturbed areas in the Proposed Modification area and other parts of the Site. Other mitigation measures include staged clearing, re-use of topsoil, and the development of an ecological monitoring program to monitor the ongoing status and health of rehabilitated areas in order to assess the success of the mitigation and compensation measures.

5.1 Measures to Mitigate Impacts

The following measures will be implemented to mitigate the impacts of the project.

5.1.1 Minimising Vegetation and Habitat Loss

In order to minimise clearing impacts and unnecessary disturbance to native vegetation that occurs outside of the Proposed Modification area, the following procedures will be implemented:

- The limits of clearing will be delineated during the construction process and marked clearly on plans and on the ground;
- Native vegetation to the south of the identified clearing areas will not be disturbed; and
- Ancillary facilities such as stockpile sites, site compounds and construction zones will not be located beyond the limits of clearing.

5.1.2 Staged Clearing

Under the approved extraction plan for the site clearing and extraction will be completed in stages. Within this approved extraction plan it is proposed that clearing of vegetation in proximity to *Melaleuca deanei* should be avoided until stage 2. This will aim to avoid

individuals of *Melaleuca deanei* as long as possible. The aim of this is to enable cuttings and seed to be collected from individuals in the Proposed Modification area to be planted in the rehabilitated areas post extraction (see **Section 5.1.5**). Immediately prior to clearing of the second stage, all *Melaleuca deanei* within the Proposed Modification area will be carefully removed and translocated to existing rehabilitated lands within the quarry lease area.

5.1.3 Translocation of Topsoil

Topsoil from the Proposed Modification area will be removed to a depth of between 50 and 100 mm and stockpiled for use in rehabilitation. This is a well recognized method for conducting post- extraction rehabilitation. The topsoil contains native seeds, rhizomes and bacteria and has been shown to be highly effective at remediating disturbed sites if it is applied as soon as possible after being removed. Topsoil removed from the Proposed Modification area may contain viable seed of *Tetratheca glandulosa* that could germinate in rehabilitated areas. More details of rehabilitation are provided in **Section 5.1.5**.

5.1.4 Pre-clearing Surveys

Prior to any clearing of vegetation in the Proposed Modification area, pre-clearing protocols will be followed to avoid injuring native fauna, including:

- Preparation of an inventory of trees and hollows to be removed, prior to clearing;
- Checking hollow-bearing trees for the presence of bird nests and arboreal mammals, such as possums, gliders and bats, prior to felling;
- Animals found to be occupying trees and habitat will be safely removed before the clearing of trees and relocated into nearby woodlands;
- Nest boxes or salvaged tree hollows will be provided in nearby woodland or stored for re-use when the area is rehabilitated to compensate for the hollows to be removed due to vegetation clearance, and the numbers will be directly proportional to the number of hollows removed; and
- If present, boulders and large logs will be placed in nearby areas of retained vegetation to allow their continued use as fauna habitat, or for re-use in rehabilitation.

A fauna ecologist will be on hand at all times to supervise clearing and to rescue any animals still remaining in the clearing area following the pre-clearance surveys. The fauna ecologist will handle any animals injured during the process and will determine whether veterinary help is needed.

5.1.5 Rehabilitation

A plan showing the proposed final landform for the Site after rehabilitation has been prepared by McKinlay Morgan Surveyors (see **Figure 5.1**). All areas disturbed by extraction activities in the Proposed Modification area will be rehabilitated after extraction. It is

understood that the already approved extraction areas will be rehabilitated to a farming landscape, however in recognition of the biodiversity values in the Proposed Modification area, it is proposed to be rehabilitated with the objective of recreating and establishing a self-sustaining landscape that resembles the original vegetation communities and is able to support a diverse range of viable flora and fauna populations, including those threatened species recorded from the Proposed Modification area.

In order to further enhance biodiversity in the Site, it is proposed that additional strategic areas in the Site be rehabilitated to woodland, instead of the previously proposed farmland. These areas are those that are in the approved extraction areas to the east and north of the Proposed Modification area but which currently contain native vegetation and link to existing native vegetation outside of the Site to the north that will not be disturbed by the project (see **Figure 1.1**). The rehabilitation of these areas to contain woodland communities will re-create vegetated corridors in the landscape that will facilitate fauna movement, and genetic flow between populations. It will provide connectivity between the areas of remnant vegetation in and near the Site and the large areas of intact vegetation to the east (see **Figure 1.1**).

5.1.6 Rehabilitation Corridor

Figure 5.2 shows the location of the proposed rehabilitation corridor. This corridor occurs partially outside the site assessed within this assessment, but is part of a broader rehabilitation strategy for the quarry. The corridor will create 6.83 ha of full-structured vegetation, approximately 100m in width and approximately 650m in an east-west direction.

This will create a link between the remnant native vegetation to the west of the site, and the vegetation retained within the 250m buffer. This vegetation has connectivity to vegetation to the east of the site, and more broadly to Marramarra National Park. This vegetation corridor has previously been identified as being restored to agricultural land, therefore the proposed revegetation and restoration of this area is a positive outcome for biodiversity within the site and locality. The vegetated corridor will be created using stockpiled topsoil from the clearing of other areas, with the topsoil being stored in accordance with guidelines to ensure the viability of the seed within the soil in the long term. Revegetation will be a staged process, with areas rehabilitated following extraction of sand. Vegetation communities currently existing on the site will be replicated through the use of stored topsoil from the original communities. Where topsoil is not available to be translocated, such as in previously cleared areas, common species from the vegetation community will be planted. An analysis of vegetation communities adjacent to the site and the underlying geology have been used to determine the vegetation communties to be restored. The vegetation communties to be restored will include:

- *Banksia ericifolia – Leptospermum trinervium* Heath (4.66 ha);
- *Angophora costata – Corymbia gummifera* Woodland (1.19 ha); and
- *Eucalyptus punctata – Acacia parramattensis* Woodland (0.98 ha).

Areas that currently exist as exotic vegetation will be restored to their likely previous native vegetation community. In particular, the area of exotic orchard will be restored to fully structured *Eucalyptus punctata* woodland. The revegetation will be designed to replicate natural vegetation structure. Further analysis of vegetation communities to be restored will be detailed within the Rehabilitation Management Plan.

Local provenance native plant species will be utilised in rehabilitation where possible and seed will be collected from native vegetation in the study area to ensure genetic diversity is maintained. In particular, seed and cuttings will be taken of *Melaleuca deanei* prior to clearing for future propagation and planting in the Proposed Modification area.

The rehabilitation will be undertaken in two stages; replacement of topsoil and natural regeneration of native species, and targeted planting of native species that have not germinated and targeted planting of *Melaleuca deanei*.

Initially, topsoil removed from the proposed mining areas will be stockpiled and then replaced after extraction is complete. It is understood that extraction will be undertaken to an approximate depth of 30 m, and after extraction this will be in-filled to a depth of 5 m below the current land level. The stockpiled topsoil will then be spread onto this surface to provide an appropriate growing medium to regrow native species and also to conserve the native seed bank of local ecological communities. It is expected that significant regrowth will occur from seeds stored within the seed bank of this topsoil which will improve the quality and diversity of native growth in rehabilitation areas and maximise the establishment of a diversity of native species, particularly the understorey species.

The second stage of rehabilitation will involve the targeted planting of particular species that may be missing in the native vegetation community. This will depend on the results of the natural germination of the seed bank, but it may include canopy tree species, understorey shrubs or grasses. In this stage of rehabilitation, efforts will be made to establish a viable population of *Melaleuca deanei* through planting seedlings propagated from cuttings or seed.

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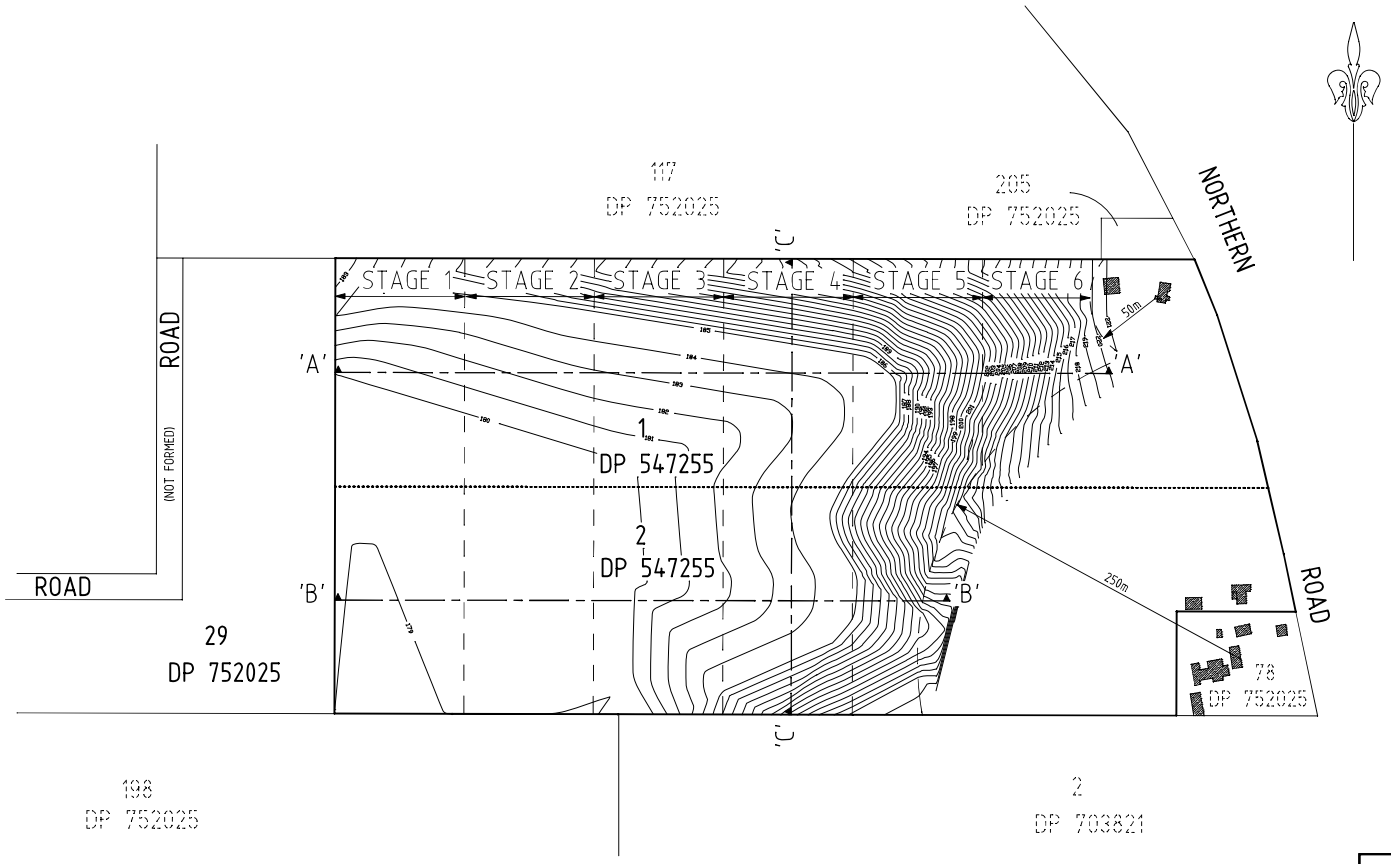

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McKINLAY MORGAN & ASSOCIATES Pty Ltd.
ACN 003 752 525 ABN 23 003 752 525
CONSULTING SURVEYORS – PROJECT MANAGERS
122 Macquarie Street, PO Box 217 Windsor NSW 2756 DX 8615 Windsor
Phone: 4577 6011 Fax: 4577 6918 Email: mail@mckinlaymorgan.com.au www.mckinlaymorgan.com.au

DATE 2/3/2012
FILE No. 91930/4
COUNCIL REF

CLIENT NAME DIXON SAND (PENRITH) Pty Ltd
LOCALITY MAROOTA LGA THE HILLS SHIRE
PLAN No. 91930/4E3 C.FILE: 91930403-ALDWG

PLAN SHOWING FINAL LANDFORM OVER LOTS 1 & 2 DP 547255 OLD NORTHERN ROAD, MAROOTA

SHEET No. 3 OF 6 SHEETS

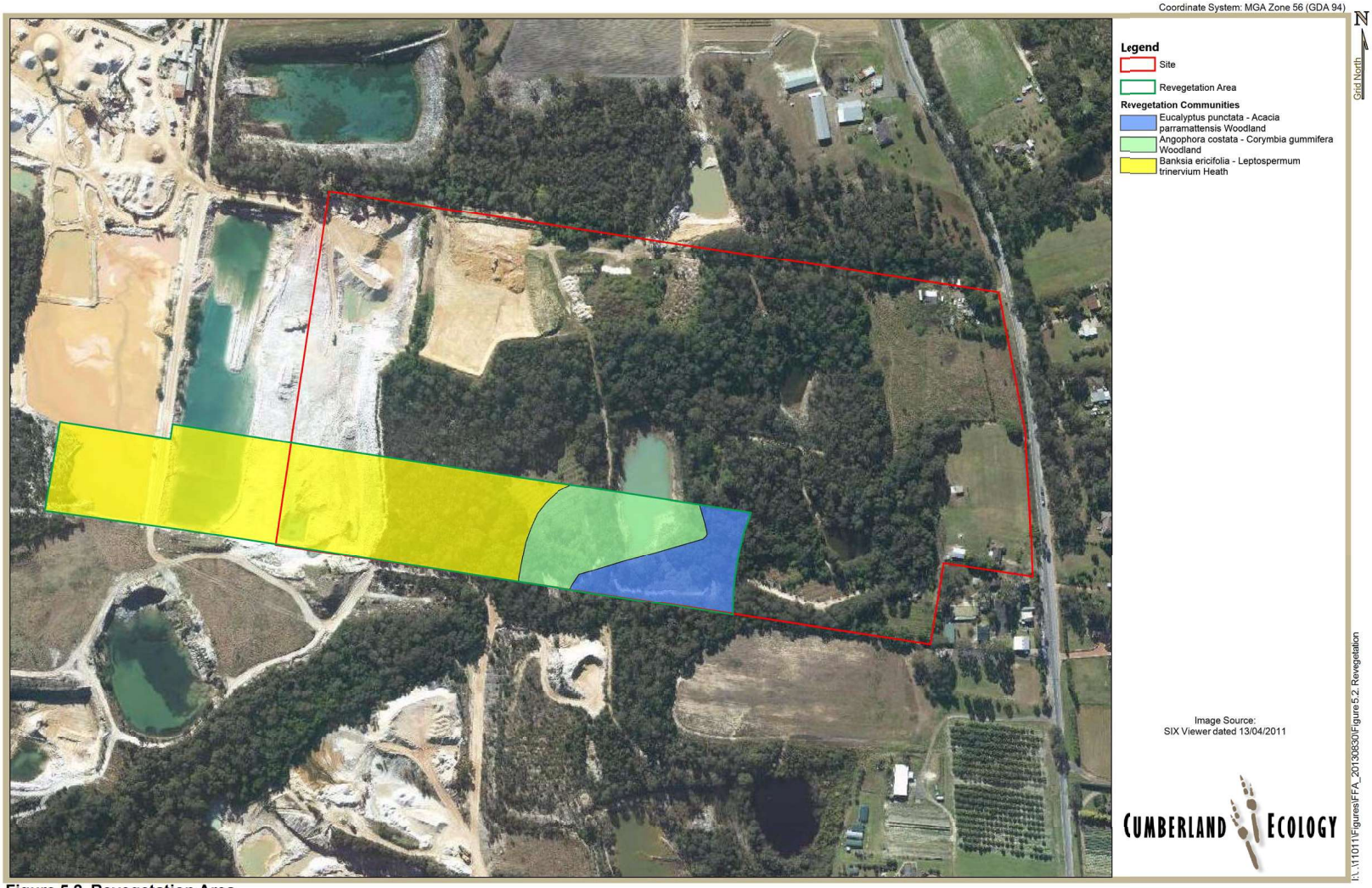

Figure 5.2. Revegetation Area

All rehabilitated areas will be managed for conservation to ensure that the ecological function of native vegetation communities will be recreated and that rehabilitated areas will provide high quality habitat for native flora and fauna. This will include weed and feral animal control, additional planting with native species if required, and other management actions as required. For the recreation of the habitat values of the Proposed Modification area, the following measures will be implemented, if necessary:

- Use of locally occurring native shrubs, trees and groundcover plants for planting;
- Inclusion of logs, dead trees and stumps in strategic locations to enhance fauna habitat;
- Provision of vegetative links to bushland remaining in the study area; and
- Measures to manage weeds and feral animals.

5.1.7 Monitoring

A monitoring program will be developed to monitor the progress of the rehabilitated vegetation in the Proposed Modification area, including both vegetation monitoring and threatened species monitoring. This will provide data to determine the level of success of the rehabilitation measures and to track its progress.

i. Vegetation Monitoring

Vegetation monitoring sites will be established in rehabilitation areas and will be monitored in the long term to allow changes in species composition and structure over time to be quantified. Information will be used in adaptive management, in order to continually improve the outcomes of rehabilitation. Appropriate data management procedures will be implemented to ensure that all data is collected using appropriate techniques and suitably analysed to allow meaningful spatial and temporal comparisons to be made.

ii. Threatened Species Monitoring

Monitoring will also be undertaken on the species of threatened flora that will be established in the rehabilitation area, including *Melaleuca deanei*, in order to determine whether the rehabilitation has been successful in establishing viable populations of these species.

Threatened species monitoring will involve conducting targeted threatened species surveys annually in the rehabilitation areas in order to record the abundance and health of these species. This would focus on *Melaleuca deanei*, which is a priority for introduction. Key indicators for monitoring would be the abundance of individual threatened species.

iii. Weeds and Feral Animal Monitoring

A weed and feral animal monitoring program will also be established as part of the monitoring program. This will include monitoring for the presence and abundance of exotic

species recorded from the Proposed Modification area. The monitoring program will allow for early recognition of increases in the abundance or distribution of weed species and will enable appropriate action to be taken in a timely manner.

5.1.8 Preparation of a Rehabilitation Management Plan

In order to provide a comprehensive framework for the implementation of the proposed biodiversity impact mitigation and offset measures, a Rehabilitation Management Plan (RMP) will be prepared and implemented for the project prior to the commencement of construction. The RMP will ensure that the project's conservation objectives are met and that impacts to biodiversity are adequately managed for the life of the project. The RMP will incorporate all of the impact mitigation measures as described in this chapter that are proposed to be undertaken for the project, and provide detailed specifications for their implementation. The RMP will include the following:

- A description and plan of rehabilitation measures (long and short term);
- Measures to protect local biodiversity values;
- Details of designated areas for rehabilitation and conservation;
- Specifications for pre-clearing surveys and fauna rescue or translocation protocols where practical;
- Vegetation clearing protocols limiting clearance or disturbance of native vegetation;
- Details of revegetation priorities and techniques;
- Control and ongoing management of environmental and noxious weeds;
- Control and ongoing management of feral animals;
- Details of monitoring methodology;
- Description of key performance indicators against which to measure progress; and
- Specification of appropriate review periods where progress is reviewed and the document updated as required.

The RMP will prescribe further information on the staged rehabilitation of the Proposed Modification area and how it will be returned to woodland and/or heath. This will include final landform design, and rehabilitation methodology.

The RMP is intended to be a working document that guides all facets of biodiversity management for the project, and will include clear objectives and actions. The RMP will specify what measures will be undertaken, how they will be undertaken, and will provide a timeline to ensure that all activities are conducted according to the plan. The RMP will include clear objectives, key performance objectives and management actions to ensure biodiversity values are protected and the proposed mitigation measures are implemented.

Chapter 6

Conclusion

The Proposed Modification would have a small impact on the biodiversity values in the locality. Clearing within the Proposed Modification area will result in the loss of 4.30 ha of vegetation, including 1.82 ha of woodland and 1.86 ha of heath.

There are no EECs occurring within the Proposed Modification area. Two threatened flora species and five threatened fauna species were recorded within the Study Area during the current surveys. A small area of vegetation and associated habitat will be removed from the Proposed Modification area, resulting in some limited ecological impact in the locality. However, these impacts would not be significant as there are broad areas of similar biodiversity values in the locality, including within conservation reserves such as Marramarra National Park, Dharug National Park, Parr State Conservation Area and Berowra Valley National Park.

Under the approved DA for the Site, vegetation and associated habitat within the Proposed Modification area will remain isolated and potential impacted by surrounding land uses. Further, the original intent to rehabilitate surrounding lands to farm land will leave habitat within the Proposed Modification area isolated in the long-term.

In recognition of the potential ecological impacts of the Proposed Modification, a package of mitigation and compensatory measures is proposed to be implemented. Mitigation and compensatory measures will focus on the rehabilitation of land within the Proposed Modification area to restore native vegetation communities representative of those to be removed. Further, rehabilitation of woodland and/or heath in other areas of the Site is recommended to compensate for any loss of wildlife corridor values under the Proposed Modification area.

This assessment has found that there are large areas of nearby known habitats for all of the impacted communities, threatened flora and threatened fauna within the locality. It is recognised that the Proposed Modification will have a small impact on the habitat for these communities and species. However, the combined mitigation and compensatory measures to be implemented are likely to sufficiently ameliorate these impacts to the extent that no threatened species are likely to become extinct as a result of the Proposed Modification.

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Appendix A

Cumberland Ecology Letter Regarding Shale Sandstone Transition Forest

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Appendix B

Flora Species Recorded within the Study Area

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Trees										
Myrtaceae		*Angophora bakeri*	Narrow-leaved Apple							X
Myrtaceae		*Angophora costata*	Smooth-barked Apple		5	1				X
Myrtaceae		*Corymbia eximia*	Yellow Bloodwood					X		
Myrtaceae		*Corymbia gummifera*	Red Bloodwood		5			X		
Myrtaceae		*Eucalyptus piperita*	Sydney Peppermint			adj			X	X
Myrtaceae		*Eucalyptus punctata*	Grey Gum		1	5			X	
Myrtaceae		*Eucalyptus resinifera*	Red Mahogany							X
Small Trees										
Casuarinaceae		*Allocasuarina littoralis*	Black She-oak	1	5	1		X	X	
Cunoniaceae		*Ceratopetalum gummiferum*	Christmas Bush		1				X	
Fabaceae (Mimosoideae)		*Acacia parramattensis*	Parramatta Wattle		1	6				X
Myrtaceae		*Angophora bakeri*	Narrow-leaved Apple (small tree)					X	X	

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Myrtaceae		*Angophora costata*	Smooth-barked Apple (small tree)						X	
Myrtaceae		*Angophora hispida*	Dwarf Apple					X		
Myrtaceae		*Corymbia gummifera*	Red Bloodwood (small tree)	2				X	X	
Myrtaceae		*Eucalyptus haemastoma*	Scribbly Gum	adj	adj					
Myrtaceae		*Eucalyptus piperita*	Sydney Peppermint (small tree)					X		
Myrtaceae		*Eucalyptus squamosa*	Scaly Bark					X		
Shrubs										
Apiaceae		*Platysace linearifolia*		1				X	X	
Araliaceae		*Polyscias sambucifolia*	Elderberry Panax			2				
Asteraceae		*Ozothamnus diosmifolius*	Rice Flower							X
Cunoniaceae		*Ceratopetalum gummiferum*	Christmas Bush (shrub)						X	
Dilleniaceae		*Hibbertia ?bracteata/nitida*						X	X	
Dilleniaceae		*Hibbertia diffusa*	Wedge Guinea Flower		4					
Dilleniaceae		*Hibbertia empetrifolia*		2				X		
Dilleniaceae		*Hibbertia fasciculata*		3				X		

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Dilleniaceae		*Hibbertia monogyna*						X		
Ericaceae (Styphelioideae)		*Epacris pulchella*	Wallum Heath	3				X	X	
Ericaceae (Styphelioideae)		*Leucopogon juniperinus*	Prickly Beard-heath	1					X	
Ericaceae (Styphelioideae)		*Leucopogon microphyllus*		2				X		
Ericaceae (Styphelioideae)		*Leucopogon muticus*	Blunt Beard-heath		1				X	
Ericaceae (Styphelioideae)		*Monotoca scoparia*							X	
Ericaceae (Styphelioideae)		*Woollsia pungens*						X		
Euphorbiaceae		*Amperea xiphoclada*	Broom Spurge					X	X	
Fabaceae (Faboideae)		*Bossiaea heterophylla*	Variable Bossiaea						X	
Fabaceae (Faboideae)		*Bossiaea obcordata*	Spiny Bossiaea		2				X	
Fabaceae (Faboideae)		*Bossiaea scolopendria*		2				X		

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Fabaceae (Faboideae)		*Daviesia mimosoides subsp. mimosoides*		1				X		
Fabaceae (Faboideae)		*Dillwynia retorta*							X	
Fabaceae (Faboideae)		*Dillwynia sericea*	Showy Parrot-pea	2						
Fabaceae (Faboideae)		*Gompholobium grandiflorum*	Large Wedge-pea		2			X		
Fabaceae (Faboideae)		*Mirbelia rubiifolia*	Heathy Mirbelia	1						
Fabaceae (Faboideae)		*Phyllota phylicoides*	Heath Phyllota	1						
Fabaceae (Faboideae)		*Pultenaea flexilis*				3				X
Fabaceae (Mimosoideae)		*Acacia linifolia*	White Wattle		2			X	X	
Fabaceae (Mimosoideae)		*Acacia suaveolens*	Sweet Wattle	1					X	
Fabaceae (Mimosoideae)		*Acacia ulicifolia*	Prickly Moses		1			X		
Myrtaceae		*Angophora hispida*	Dwarf Apple (shrub)	2					X	
Myrtaceae		*Calytrix tetragona*	Common Fringe-myrtle	3				X		
Myrtaceae		*Darwinia fascicularis subsp. oligantha*		3				X		
Myrtaceae		*Eucalyptus haemastoma*	Scribbly Gum (shrub)	1						

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Myrtaceae		*Eucalyptus piperita*	Sydney Peppermint (shrub)	1					X	
Myrtaceae		*Kunzea ambigua*	Tick Bush							X
Myrtaceae		*Leptospermum arachnoides*						X		
Myrtaceae		*Leptospermum polygalifolium*	Tantoon			1				
Myrtaceae		*Leptospermum trinervium*	Flaky-barked Tea-tree	5	1			X	X	
Myrtaceae		***Melaleuca deanei***	**Deane's Melaleuca**						**X**	
Myrtaceae		*Micromyrtus ciliata*	Fringed Heath-myrtle	2						
Phyllanthaceae		*Phyllanthus hirtellus*	Thyme Spurge		2				X	
Proteaceae		*Banksia ericifolia*	Heath-leaved Banksia	6				X	X	
Proteaceae		*Banksia serrata*	Old Man Banksia					X	X	
Proteaceae		*Banksia spinulosa*	Hairpin Banksia			1			X	
Proteaceae		*Grevillea buxifolia*	Grey Spider Flower	3				X	X	
Proteaceae		*Grevillea sericea*	Pink Spider Flower						X	
Proteaceae		*Hakea laevipes*		1				X		
Proteaceae		*Hakea sericea*	Needlebush	1				X	X	
Proteaceae		*Isopogon anemonifolius*	Broad-leaf Drumsticks	1				X	X	

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Proteaceae		*Lambertia formosa*	Mountain Devil	2						
Proteaceae		*Lomatia silaifolia*	Crinkle Bush		2	2		X		X
Proteaceae		*Persoonia lanceolata*	White Dogwood					X		
Proteaceae		*Persoonia levis*	Broad-leaved Geebung		1			X	X	
Proteaceae		*Persoonia linearis*	Narrow-leaved Geebung		2	2			X	X
Proteaceae		*Petrophile pulchella*	Conesticks	2				X		
Proteaceae		*Xylomelum pyriforme*	Woody Pear		2	1				
Rosaceae	*	*Prunus sp.*					1			
Rutaceae		*Boronia floribunda*		2						
Rutaceae		*Boronia ledifolia*	Showy Beronia					X		
Santalaceae		*Exocarpos strictus*	Dwarf Cherry						X	
Sapindaceae		*Dodonaea triquetra*	Large-leaf Hop-bush			2				
Solanaceae	*	*Solanum chenopodioides*	Whitetip Nightshade							X
Ulmaceae		*Trema tomentosa var. aspera*	Native Peach			1				
Verbenaceae	*	*Lantana camara*	Lantana		2	5	5	X	X	X

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Xanthorrhoaceae		*Xanthorrhoea media*	Grass Tree	1	1				X	
Herbs - Ferns and Allies										
Adiantaceae		*Adiantum aethiopicum*	Common Maidenhair			1				
Dennstaedtiaceae		*Hypolepis muelleri*	Harsh Ground Fern			2				X
Dennstaedtiaceae		*Pteridium esculentum*	Bracken		3	3			X	X
Lindsaeaceae		*Lindsaea linearis*	Screw Fern	2	2				X	
Herbs - Dicots										
Apiaceae		*Actinotus minor*	Lesser Flannel Flower	4				X	X	
Apiaceae		*Hydrocotyle peduncularis*				1	1			
Apiaceae		*Hydrocotyle sp.*								X
Asteraceae	*	*Bidens pilosa*	Cobbler's Pegs							X
Asteraceae	*	*Conyza bonariensis*	Flax-leaf Fleabane			2	2	X		X
Asteraceae	*	*Gamochaeta sp.*								X
Asteraceae	*	*Hypochaeris radicata*	Catsear				2			

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Asteraceae		*Senecio hispidulus*	Hill Fireweed							X
Asteraceae		*Senecio sp.*				2				
Caryophyllaceae	*	*Paronychia brasiliana*	Chilean Whitlow Wort				1			
Elaeocarpaceae		*Tetratheca thymifolia*	Thyme Pink-bells						X	
Fabaceae (Faboideae)	*	*Trifolium repens*	White Clover				1			
Gentianaceae	*	*Centaurium tenuiflorum*					1			
Goodeniaceae		*Dampiera stricta*						X	X	
Goodeniaceae		*Scaevola ramosissima*	Purple Fan-flower					X		
Lobeliaceae		*Lobelia sp.*							X	
Lobeliaceae		*Pratia purpurascens*	Whiteroot		1	2				X
Malvaceae	*	*Sida rhombifolia*	Paddy's Lucerne			2	2			X
Oxalidaceae		*Oxalis perennans*				1				X
Oxalidaceae	*	*Oxalis sp.*					2			
Plantaginaceae	*	*Plantago lanceolata*	Lamb's Tongues				3			
Polygonaceae	*	*Acetosella vulgaris*	Sheep Sorrel				1			
Rubiaceae		*Pomax umbellata*	Pomax						X	

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Scrophulariaceae		*Veronica plebeia*	Trailing Speedwell			2	1	X		X
Solanaceae	*	*Solanum nigrum*	Black-berry Nightshade			1	1			X
Solanaceae		*Solanum prinophyllum*	Forest Nightshade							X
Verbenaceae	*	*Verbena officinalis*	Common Verbena				2			
Herbs - Monocots (grasses)										
Poaceae	*	*Andropogon virginicus*	Whisky Grass				2			
Poaceae		*Anisopogon avenaceus*	Oat Speargrass		1			X		
Poaceae		*Aristida vagans*	Threeawn Speargrass		1					
Poaceae		*Austrostipa pubescens*		1	1				X	
Poaceae	*	*Axonopus fissifolius*	Narrow-leaved Carpet Grass				2			
Poaceae		*Cynodon dactylon*	Couch				8			
Poaceae		*Echinopogon ovatus*	Forest Hedgehog Grass			2				
Poaceae		*Entolasia marginata*	Bordered Panic							X
Poaceae		*Entolasia stricta*	Wiry Panic		3	5			X	X

Table 6.1 Flora species recorded within the Study Area

Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Poaceae		*Imperata cylindrica var. major*	Blady Grass		3					X
Poaceae		*Microlaena stipoides*	Weeping Grass		3	5	1	X		X
Poaceae		*Oplismenus aemulus*								X
Poaceae		*Paspalidium distans*			1	1				
Poaceae	*	*Paspalum dilatatum*	Paspalum				2			
Poaceae	*	*Paspalum urvillei*	Vasey Grass				2			
Poaceae	*	*Setaria parviflora*					4			
Poaceae		*Themeda australis*	Kangaroo Grass		2					
Herbs - Monocots (other)										
Anthericaceae		*Laxmannia gracilis*	Slender Wire Lily					X		
Cyperaceae		*Caustis flexuosa*	Curly Wig					X	X	
Cyperaceae		*Caustis pentandra*	Thick Twist Rush					X		
Cyperaceae		*Cyathochaeta diandra*		4	2			X	X	

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Cyperaceae	*	*Cyperus aggregatus*					2			
Cyperaceae	*	*Cyperus brevifolius*	Mullumbimby Couch				2			
Cyperaceae		*Schoenus ericetorum*	Heath Bog-rush					X	X	
Cyperaceae		*Schoenus melanostachys*	Black Bog Rush			3				X
Juncaceae	*	*Juncus cognatus*					2			
Lomandraceae		*Lomandra glauca*	Pale Mat-rush	2				X	X	
Lomandraceae		*Lomandra longifolia*	Spiny-headed Mat-rush			2		X	X	X
Lomandraceae		*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush	1	1			X		X
Lomandraceae		*Lomandra obliqua*			1					
Orchidaceae		*Cryptostylis sp.*				1				
Phormiaceae		*Dianella caerulea var. assera*						X	X	
Phormiaceae		*Dianella caerulea var. producta*			1	1				X
Restionaceae		*Lepyrodia scariosa*		6				X	X	

Table 6.1 Flora species recorded within the Study Area

Family	*	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Banksia ericifolia – Leptospermum trinervium Heath	Angophora costata – Corymbia gummifera Woodland	Eucalyptus punctata – Acacia parramattensis Woodland
Herbs - Vines and Climbers										
Apocynaceae	*	*Araujia sericifera*	Moth Vine			3				X
Apocynaceae		*Parsonsia straminea*	Common Silkpod			adj				X
Asparagaceae	*	*Asparagus asparagoides*	Bridal Creeper			1	1			X
Fabaceae (Faboideae)		*Glycine microphylla*	Small-leaf Glycine			2				X
Fabaceae (Faboideae)		*Hardenbergia violacea*	False Sarsparilla		1					
Lauraceae		*Cassytha glabella*						X		
Lauraceae		*Cassytha pubescens*		2	2			X	X	
Loranthaceae		*Amyema sp.*			1					
Menispermiaceae		*Stephania japonica var. discolor*	Snake Vine			2				X
Passifloraceae	*	*Passiflora edulis*	Common Passionfruit		1					
Pittosporaceae		*Billardiera scandens*	Hairy Apple Berry		2	1			X	X
Ranunculaceae		*Clematis glycinoides*	Headache Vine		1	3				X
Smilacaceae		*Smilax glyciphylla*	Sweet Sarsaparilla					X		

KEY

* denotes exotic species

Bold denotes threatened species

Form: 1 = Trees; 2 = Small Trees; 3 = Shrubs; 4 = Herbs - Ferns and Allies; 5 = Herbs - Dicots; 6 = Herbs - Monocots (grasses); 7 = Herbs - Monocots (other); 8 = Herbs - Vines and Climbers

Cover-Abundance: 1 = <5%, rare; 2 = <5%, occasional; 3 = <5%, common; 4 = <5%, very common; 5 = 5-25%; 6 = 26-50%; 7 = 51-75%; 8 = 76-100%

Appendix C

Assessment of Likelihood of Occurrence of Threatened Flora Species

Table 6.2 Likelihood of occurrence of threatened flora within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Records within 10km of the Study Area	Likelihood of Occurrence within the Study Area
Olearia cordata		V,P	V	1	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Tetratheca glandulosa		V,P	V	120	Present
Amperea xiphoclada var. pedicellata		E4,P	X	1	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Dillwynia tenuifolia	Dillwynia tenuifolia Sieber ex D.C. in the Baulkham Hills local government area	E2,V,P		5	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Acacia bynoeana	Bynoe's Wattle	E1,P	V	37	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Pilularia novae-hollandiae	Austral Pillwort	E1,P,3		1	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Darwinia biflora		V,P	V	2	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated,

Table 6.2 Likelihood of occurrence of threatened flora within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Records within 10km of the Study Area	Likelihood of Occurrence within the Study Area
					heavily altered and low quality
Darwinia fascicularis subsp. oligantha	Darwinia fascicularis subsp. oligantha population in the Baulkham Hills and Hornsby Local Government Areas	E2		5	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Darwinia peduncularis		V,P		1	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Kunzea rupestris		V,P	V	29	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Melaleuca deanei	Deane's Paperbark	V,P	V	1	Present
Micromyrtus blakelyi		V,P	V	3	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Ancistrachne maidenii		V,P		2	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated,

Table 6.2 Likelihood of occurrence of threatened flora within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Records within 10km of the Study Area	Likelihood of Occurrence within the Study Area
					heavily altered and low quality
Grevillea parviflora subsp. supplicans		E1,P		23	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Persoonia hirsuta	Hairy Geebung	E1,P,3	E	3	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Pomaderris brunnea	Brown Pomaderris	V,P	V	1	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Asterolasia elegans		E1,P	E	30	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Zieria involucrata		E1,P	V	25	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Lasiopetalum joyceae		V,P	V	5	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality
Pimelea curviflora var. curviflora		V,P	V	14	Unlikely. Not recorded within the Study Area despite extensive surveys. Habitat present but isolated, heavily altered and low quality

Appendix D

Fauna Species Recorded within the Study Area

Table 6.3 Fauna recorded within the Study Area

	Scientific Name	Common Name	EPBC Act	TSC Act
Amphibians	*Limnodynastes dumerilii*	Eastern Banjo Frog		
	Limnodynastes peronii	Striped Marsh Frog		
	Platyplectrum ornatum	Ornate Burrowing Frog		
	Crinia signifera	Common Froglet		
	Uperoleia laevigata	Smooth Toadlet		
Reptiles	*Physignathus lesueurii*	Eastern Water Dragon		
	Varanus varius	Lace Monitor		
	Ctenotus taeniolatus	Copper-tailed Skink		
Birds	*Ocyphaps lophotes*	Crested Pigeon		
	Calyptorhynchus lathami	Glossy Black-Cockatoo		V
	Platycercus elegans	Crimson Rosella		
	Dacelo novaeguineae	Laughing Kookaburra		
	Cormobates leucophaea	White-throated Treecreeper		
	Ptilonorhynchus violaceus	Satin Bowerbird		
	Malurus cyaneus	Superb Fairy-wren		
	Malurus lamberti	Variegated Fairy-wren		
	Acanthiza pusilla	Brown Thornbill		
	Acanthorhynchus tenuirostris	Eastern Spinebill		
	Meliphaga lewinii	Lewin's Honeyeater		
	Lichenostomus chrysops	Yellow-faced Honeyeater		
	Lichenostomus leucotis	White-eared Honeyeater		
	Anthochaera chrysoptera	Little Wattlebird		
	Phylidonyris novaehollandiae	New Holland Honeyeater		
	Psophodes olivaceus	Eastern Whipbird		
	Pachycephala pectoralis	Golden Whistler		
	Cracticus torquatus	Grey Butcherbird		
	Rhipidura albiscapa	Grey Fantail		
	Eopsaltria australis	Eastern Yellow Robin		
	Zosterops lateralis	Silvereye		
	Taeniopygia bichenovii	Double-barred Finch		
	Neochmia temporalis	Red-browed Finch		
Mammals				

Table 6.3 Fauna recorded within the Study Area

Scientific Name	Common Name	EPBC Act	TSC Act
Perameles nasuta	Long-nosed Bandicoot		
Wallabia bicolor	Swamp Wallaby		
Rhinolophus megaphyllus	Eastern Horseshoe Bat		
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Chalinolobus gouldii	Gould's Wattled Bat		
Chalinolobus morio	Chocolate Wattled Bat		
Vespadelus vulturnus	Little Forest Bat		
Miniopterus australis	Little Bent-wing Bat		V
Miniopterus orianae (formerly schreibersii) oceanensis	Eastern Bent-wing Bat		V
Tadarida australis	White-striped Freetail-bat		
Mormopterus norfolkensis	East Coast Freetail-bat		V
Mormopterus ridei	Eastern Freetail-bat		
Oryctolagus cuniculus	European Rabbit		

Appendix E

Assessment of Likelihood of Occurrence of Threatened Fauna Species

Table 6.4 Likelihood of occurrence of threatened fauna within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Records within 10km of the Study Area	Likelihood of Occurrence within the Study Area
Heleioporus australiacus	Giant Burrowing Frog	V,P	V	1	Unlikely. Habitat present but isolated, heavily altered and low quality
Pseudophryne australis	Red-crowned Toadlet	V,P		1	Unlikely. Habitat present but isolated, heavily altered and low quality
Varanus rosenbergi	Rosenberg's Goanna	V,P		1	Unlikely. Habitat present but isolated, heavily altered and low quality
Hieraaetus morphnoides	Little Eagle	V,P		1	Unlikely. Small habitat patch present.
Falco subniger	Black Falcon	V,P		1	Unlikely. No suitable habitat.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V,P,2		10	Present
Neophema pulchella	Turquoise Parrot	V,P,3		1	Unlikely. No suitable habitat.
Ninox strenua	Powerful Owl	V,P,3		2	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Tyto novaehollandiae	Masked Owl	V,P,3		2	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Tyto tenebricosa	Sooty Owl	V,P,3		1	Unlikely. No suitable habitat.
Climacteris picumnus victoriae	Brown Treecreeper (eastern	V,P		1	Unlikely. No suitable habitat.

Table 6.4 Likelihood of occurrence of threatened fauna within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Records within 10km of the Study Area	Likelihood of Occurrence within the Study Area
	subspecies)				
Anthochaera phrygia	Regent Honeyeater	E4A,P	E	1	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Daphoenositta chrysoptera	Varied Sittella	V,P		1	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Petroica phoenicea	Flame Robin	V,P		1	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Dasyurus maculatus	Spotted-tailed Quoll	V,P	E	2	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Phascolarctos cinereus	Koala	V,P	V	4	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Cercartetus nanus	Eastern Pygmy-possum	V,P		1	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Petaurus australis	Yellow-bellied Glider	V,P		2	Unlikely. Small habitat patch present but isolated, heavily altered and low quality
Mormopterus norfolkensis	Eastern Freetail-bat	V,P		K	Present
Chalinolobus dwyeri	Large-eared Pied Bat	V,P	V	2	Present
Miniopterus australis	Little Bentwing-bat	V,P		K	Present

Table 6.4 Likelihood of occurrence of threatened fauna within the Study Area

Scientific Name	Common Name	TSC Act	EPBC Act	Records within 10km of the Study Area	Likelihood of Occurrence within the Study Area
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V,P		K	Present

Appendix F

Assessments of Significance

F.1 Background

This appendix contains a number of Assessments of Significance (also known as and hereafter referred to as the Seven-part Test), which are typically used to assess the impact of development on threatened species under Section 5A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Seven-part Test provides a means by which a qualitative risk analysis can be conducted to determine the magnitude and significance of impacts on threatened flora and fauna species, populations and ecological communities as listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act). Threatened species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EBPC Act) are not required to be assessed.

i. Species to be Assessed

A Seven-part Test has been prepared for each threatened species that is known to occur within or in close proximity to the Project, or which is considered highly likely to occur based on suitable habitat availability and distribution (as indicated in Appendices C and E of the Dixon Sands Maroota Flora and Fauna Impact Assessment (Cumberland Ecology 2013). Each Seven-part Test comprises a series of questions (presented in italics) for which a response is supplied below it (in plain text). Please note that 'local population' refers to the population that occurs within the study area, including the area to be affected by the Project (the subject site) and surrounding lands.

ii. Consideration of Ameliorative and Compensation Measures

Each Seven-part Test has been prepared without considering the ameliorative and compensatory measures proposed for the Project as instructed under the Assessment of Significance guidelines (DECC (NSW) 2007):

> *"Proposed measures that mitigate, improve or compensate for the action, development or activity should not be considered in determining the degree of the effect on threatened species, populations or ecological communities, unless the measure has been used successfully for that species in a similar situation".*

The following species presented in Table 1 have been assessed:

Table F.1 Likelihood of Occurrence of Threatened Species in the Subject Site

Scientific Name	Common Name	TSC Act	EPBC Act	Locality (10km) Records	Likelihood of Occurrence
Threatened Flora					
Tetratheca glandulosa		V	V	120	Present – individuals recorded from

Table F.1 Likelihood of Occurrence of Threatened Species in the Subject Site

Scientific Name	Common Name	TSC Act	EPBC Act	Locality (10km) Records	Likelihood of Occurrence
					previous surveys
Melaleuca deanei	Deane's Paperbark	V	V	1	Present – individuals recorded
Threatened Fauna					
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		10	Present – evidence of chewed cones
Mormopterus norfolkensis	Eastern Freetail-bat	V		K	Present – recorded on echolocation devices
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	2	Present– recorded on echolocation devices
Miniopterus australis	Little Bentwing-bat	V		K	Present– recorded on echolocation devices
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		K	Present– recorded on echolocation devices

Note: V = Vulnerable; K = Known

F.2 Seven-part Tests

F.2.1 Tetratheca glandulosa

Tetratheca glandulosa is listed as Vulnerable under the TSC Act and EPBC Act. There are 130 records for this species within the locality (OEH 2013). This species was not recorded within the subject site during current surveys; however, individuals have been recorded from two previous surveys of the subject site by Gunninah Environmental Consultants (Fanning, Hayes et al. 1998) and Hawkeswood (2010).

Tetratheca glandulosa is strongly associated with areas of shale-sandstone transition habitat. In particular, remnant local occurrences of shale-cappings over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge, are a broad habitat indicator of the majority of populations. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. The larger populations occur in woodland/open woodland vegetation communities that provide semi-shade. Vegetation communities that it occurs in correspond broadly to Sydney Sandstone Ridgetop Woodland. Common dominant woodland tree species where it occurs include: *Corymbia gummifera, C. eximia, Eucalyptus haemastoma, E. punctata, E. racemosa,* and/or *E. sparsifolia*, with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae. (NSW NPWS, 2000b)

(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

No individuals were recorded during recent surveys of the subject site. However, approximately 40 to 50 plants were detected in 1998 (Fanning et al. 1998) and five plants were recorded in 2010 (Hawkeswood 2010). It was suggested by Hawkswood that this decline may be a result of changes in condition of vegetation, resulting in competition with other species.

Despite the absence of recent records, it is likely that *Tetratheca glandulosa* persists within the subject site, albeit at significantly reduced abundance. The Project will remove the known local population of the species.

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

Not applicable to threatened species.

(c) 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, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable to threatened species.

(d) 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, and

(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, and

(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, and

The Project will clear approximately 1.15 ha of suitable habitat for this species, comprising *Angophora costata – Corymbia gummifera* Woodland.

The loss of this vegetation would result in a very small decrease in the overall area of suitable habitat available to *Tetratheca glandulosa* in the locality. *Tetratheca glandulosa* populations in the locality south of the Hawkesbury are considered to be adequately conserved in Berowra Valley National Park, Marramarra National Park and Kuring- gai Chase National Park (NSW NPWS 2000).

As such, the habitat to be removed within the subject site is not considered critical to the long term survival of the species and is unlikely to endanger the viability of the species in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for *Tetratheca glandulosa* has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery or abatement plans have been prepared for this species.

No priority actions have been identified for this species.

(g) 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

The Project constitutes the KTP 'clearing of native vegetation' as 1.15 ha of habitat will be removed as well as several individuals.

Conclusion

The Project will remove several individuals of *Tetratheca glandulosa* that occur on the subject site, and is expected to impact on approximately 1.15 ha of habitat for this species through direct removal. However, the species is well conserved within the locality and the loss of a small population in the subject site is unlikely to significantly impact the viability of the species elsewhere in the locality. No significant impact is considered likely to occur to this species as a result of the Project.

F.2.2 Melaleuca deanei (Deane's Paperbark)

Melaleuca deanei (Deane's Paperbark) is listed as Vulnerable under the TSC Act and EPBC Act. There is one record for this species within the locality and five from the Hills Shire LGA (OEH 2013). A total of 18 individuals were recorded from one location during recent surveys of the subject site.

Melaleuca deanei is a shrub to 5m high (DECCW 2010) endemic to the Sydney Basin Bioregion (DEC (NSW) 2005). The species is known from 94 populations and is distributed from St. Albans in the north, to Nowra in the south and west to Faulconbridge (DECCW 2010). Within its extent, *Melaleuca deanei* is known from broad flat ridgetops, dry ridges and slopes and is strongly associated with sandy loam soils that are low in nutrients and sometimes containing ironstone (DECCW 2010). As *Melaleuca deanei* is a clonal species, it has the ability to re-sprout from a swollen rootstock to produce coppiced growth and can also sucker from its rootstock (DECCW 2010). Due to the suckering nature of this species, individuals are recorded based on clumps of stems (ramets).

(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 Project will remove 18 *Melaleuca deanei* individuals that have been recorded from one location in the subject site. The Project will result in the extinction of the local population as no other individuals have been recorded within a 500m radius of the subject site, which is considered the maximum distance by which the species can disperse and still constitute the same population (Felton 1993, in (DECCW 2010)).

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

Not applicable to threatened species.

(c) 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, or*
>
> *(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) 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, and*

(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, and

(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, and

The Project will clear approximately 1.15 ha of suitable habitat for this species, comprising *Angophora costata – Corymbia gummifera* Woodland. The species is known to occur in a wide range of vegetation associations and communities and the removal of habitat for the Project would result in a very small decrease in the overall area of habitat present in the locality.

While the Project will remove some individuals, other known occurrences of *Melaleuca deanei* are conserved within the nearby Marramarra National Park and Dharug National Park, and the species occurs in other bushland areas in the locality (e.g. near Wiseman's Ferry). These populations will not be impacted by the Project; the removal of 1.15 ha will not further isolate or fragment other *Melaleuca deanei* populations or impact the long-term survival of the species in the locality. Other populations in the locality are not dependent on the survival of the local population given that dispersal of the species is unlikely to exceed more than 500m (Felton 1993, in (DECCW 2010).

It is acknowledged that only a few of the known populations are secure and reproductively viable (DECCW 2010) and that the species is vulnerable to habitat clearance and development activities. However, given the current condition and landscape context of the subject site, including the isolation of the local population, existing approval for surrounding areas to be mined, alteration of natural fire regimes and lack of management, it is considered that the local population is unlikely to be viable in the long term regardless of the outcome of the Project.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for *Melaleuca deanei* has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A National Recovery Plan exists for *Melaleuca deanei* (DECCW 2010). The Project is not consistent with its objectives as it will result in the removal of a small population of this species.

(g) 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

The Project constitutes the KTP 'clearing of native vegetation' as 1.15 ha of habitat will be removed as well as several individuals.

Conclusion

The Project is expected to impact on approximately 1.15 ha of habitat for *Melaleuca deanei*, including the removal of 18 individuals. These individuals are likely to comprise a local population as no other individuals have been recorded within 500m. That notwithstanding, other known occurrences of *Melaleuca deanei* are conserved within the nearby Marramarra National Park and Dharug National Park, and the species occurs in other bushland areas in the locality (e.g. near Wiseman's Ferry). These populations will remain viable, and the removal of 1.15 ha of relatively degraded habitat will not impact on these populations. Accordingly, no significant impact is predicted to occur to *Melaleuca deanei* as a result of the Project.

F.2.3 Glossy Black-Cockatoo (Calyptorhynchus lathami)

The Glossy Black-Cockatoo (*Calyptorhynchus lathami*) is listed as Vulnerable under the TSC Act. There are 10 records of the species within the locality (OEH 2013). The species has not been observed in the subject site; however, evidence of feeding was recorded during current surveys.

The Glossy Black-Cockatoo was previously widely distributed across most of south eastern Australia. In NSW the species now has patchy distribution along the coast and tablelands in eucalypt open forest and woodland with hollow-bearing trees and stands of she-oak species. The species tends not to live in country where extensive clearing has taken place, and they prefer to fly over intact habitat rather than open country. The species feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species). It generally nests in tree hollows of approximately 26cm wide by 1.4cm deep in live trees or stags. Pairs defend the immediate area surrounding the nest hollow and have extensive forage ranges (NSW NPWS 1999; NSW Scientific Committee 2004).

(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 Project will remove approximately 3.7 ha of known and potential forage habitat for the Glossy Black-Cockatoo in the form of *Allocasuarina littoralis* (Black Sheoak), which are preferred feed trees for the species. Habitat assessments concluded that the subject site does not provide suitable breeding habitat for the species due to a lack of substantial hollows.

The removal of approximately 3.7 ha of forage habitat is not considered likely to place a viable local population at risk of extinction. This species has a large range and the local population is likely to utilise a far wider area than the subject site, particularly since no breeding habitat is present. The subject site is not considered to be important for the long-term survival of the species given the extent of high quality forage and breeding habitat located elsewhere in the locality and the high mobility of the species. Glossy Black-Cockatoos are known from Marramarra National Park, Dharug National Park, Parr State Conservation Area and Berowra Valley National Park, where high quality forage and breeding habitat is well conserved.

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

Not applicable to threatened species.

(c) 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, or*

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable to threatened species.

(d) 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, and

(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, and

(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, and

Approximately 3.7 ha of heath and woodland habitat that provides forage habitat for the Glossy Black-Cockatoo will be removed as part of the Project.

The Glossy Black-Cockatoo is highly mobile and the removal of this vegetation will not affect habitat connectivity or inhibit the species' movement and dispersal within the locality. This species is able to fly over disturbed areas and no habitat will be isolated or fragmented as a result of the Project.

This is not considered to constitute core habitat for a local population and its removal will not affect the long-term viability of the species in the locality. Large tracts of suitable forage habitat, as well as hollows for breeding and nesting habitat, are known to occur elsewhere in the locality, including the conservation areas Marramarra National Park, Dharug National Park, Parr State Conservation Area and Berowra Valley National Park.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for the Glossy Black-Cockatoo has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The "Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species" is relevant to the Glossy Black-Cockatoo. The Project is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

(g) 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

The Project constitutes or has the potential to exacerbate the following KTPs:

- 'Clearing of native vegetation' as this reduces the area of forage habitat available for this species;

- 'Invasion of native plant communities by exotic perennial grasses' as this results in the loss of key food plants and habitat and encourages flock-foraging species; and
- 'Infection by Psittacine Circoviral (beak and feather) Disease' affecting endangered psittacine species and populations as this can lead to a severe reduction in populations; and habitat degradation by feral animals.

Conclusion

The Project is expected to impact on approximately 3.7 ha of heath and woodland that includes forage habitat for the Glossy Black-Cockatoo. Evidence of feeding has been recorded in the subject site; however no breeding habitat is present due to the lack of large tree hollows. Extensive areas of high quality forage and breeding habitat are available throughout the locality, including in protected areas.

The Project is considered unlikely to have a significant impact on the Glossy Black-Cockatoo.

F.2.4 Microbats

The following Seven-part Test has been prepared as a composite test for four species of microchiropteran bats (microbats) known to occur in the subject site, three of which are cave-dependent and one that is hollow-roosting.

i. Eastern Bentwing-bat (Miniopterus orianae oceanensis)

The Eastern Bentwing-bat (*Miniopterus orianae oceanensis*) is listed as Vulnerable under the TSC Act. The species is known to occur in the locality (OEH 2013). This species was recorded by echolocation devices from multiple locations in the subject site.

The Eastern Bentwing-bat is an insectivorous species that almost exclusively roost in caves and artificial constructions such as mines along the east coast of Australia (Churchill, 2008). The species occurs in large colonies of up to 150,000 individuals and forages above the canopy over forested areas for insects. In south eastern Australia the species hibernates in underground sites, usually large caves with a constant microclimate, during winter. It requires very specific conditions in terms of temperature and humidity for maternity sites (Van Dyck and Strahan 2008). The species changes roosts in response to seasonal needs, and in turn long-distance movements occur occasionally (DECC (NSW) 2005).

ii. Large-eared Pied Bat (Chalinolobus dwyeri)

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under both the EPBC and TSC Acts. There are two records of the species within the locality (OEH 2013). This species was recorded by echolocation devices from multiple locations in the subject site.

The Large-eared Pied Bat is an insectivorous species with poorly known population densities and distribution. It is considered to be patchily distributed from mid-Queensland to southern NSW (DEC (NSW) 2005). Little is known about the habitat requirements of the species, but natural roosts are typically dependent on extensive sandstone outcrops, cliffs and caves, and old mine workings. The species appears to prefer low to mid-elevation dry open forest and woodland close to these roost features, particularly areas containing gullies. They typically exist in small colonies consisting of less than 50 individuals and use the same cave over many years (SEWPaC 2011).

iii. Miniopterus australis (Little Bentwing-bat)

The Little Bentwing-bat (*Miniopterus australis*) is listed as Vulnerable under the TSC Act. The species is known to occur in the locality (OEH 2013). This species was recorded by echolocation devices from multiple locations in the subject site.

The Little Bent-wing Bat is an insectivorous species that roosts in caves, tunnels, tree hollows, abandoned mines, culverts and other man-made infrastructure (Churchill 2008). The species is distributed along the east coast and ranges of Australia from northern QLD to Wollongong, NSW. It prefers well timbered moist eucalypt forest, rainforest, vine thicket and sclerophyll forest where it can forage beneath the dense canopy for small insects. Maternity colonies, of which only five are known in Australia, form in spring and are often associated

with those of Common Bent-wing Bats, where larger colonies provide the high temperatures required to rear young. Males and juveniles generally disperse in summer (DEC (NSW) 2005).

iv. East-coast Freetail-bat (Mormopterus norfolkensis)

The East-coast Freetail-bat (*Mormopterus norfolkensis* syn. *Micronomus norfolkensis*) is listed as Vulnerable under the TSC Act. The species is known to occur in the locality (OEH 2013). This species was recorded by echolocation devices from multiple locations in the subject site.

The Eastern Freetail-bat is a solitary, insectivorous bat most commonly found in open spaces in dry sclerophyll forests, woodland and swamp forests in eastern NSW (Churchill 2008). The species mainly roost in spout hollows of large mature trees and sometimes under bark or in man-made structures (NSW NPWS 2004). They tend to forage in gaps in upper-slope vegetation and over larger waterways.

(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 Eastern Bentwing-bat, Large-eared Pied Bat and Little Bentwing-bat are predominantly cave-roosting species, although bentwing-bat species have also been known to roost in mine shafts, culverts, roof cavities and other artificial structures. The subject site does not provide suitable roosting habitat for these species as no rock outcrops or caves are present. It is likely that these species roost elsewhere in the locality and travel to the subject site and surrounds to forage.

The East-coast Freetail-bat is a hollow-roosting species. While it is considered likely that any hollow, no matter how small, may provide habitat for this species (Menkhorst and Knight 2001; DEC (NSW) 2005), hollows are relatively scarce in the subject site and extensive areas of multi-age woodland with more abundant hollow resources occur elsewhere in the locality.

These species are unlikely to be restricted or adversely impacted by the removal of a small area of vegetation as they frequently travel across large distances to find suitable forage habitat and there are extensive areas of suitable habitat elsewhere in the locality. The lifecycles of the cave-dependent species are unlikely to be adversely affected as no caves or artificial roost sites are to be impacted by the Project.

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

Not applicable to threatened species.

(c) 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, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable to threatened species.

(d) 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, and

(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, and

(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, and

Approximately 4.3 ha of suitable forage habitat for microbats will be removed as part of the Project. Of this, approximately 1.8 ha of woodland potentially provides some roost habitat for the East-coast Freetail-bat. No roost habitat for the cave-dependent species will be impacted.

The removal of vegetation will not fragment or isolate habitat for these species. They are highly mobile species that are able to fly over disturbed areas and are unlikely to be restricted or adversely impacted by the loss of a small area of habitat. .

The habitat to be removed is not considered to be important to the long term survival of these species. All four of the threatened microbats are known to occur in conservation areas of the locality, including Marramarra National Park, Dharug National Park, Parr State Conservation Area, Berowra Valley National Park and Cattai National Park. These conservation areas will continue to provide large areas of intact forage and breeding habitat for both cave-dependent and hollow-roosting threatened microbat species in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for these microbat species has been identified by the Director-General of OEH under the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Action Plan for Australian Bats (Duncan, Baker et al. 1999) is applicable to these species and outlines actions to promote the recovery of these species and the abatement of KTP affecting their occurrence. The project is considered to be consistent with this Action Plan. Only a small area of habitat will be removed, and large areas of suitable habitat in the locality will remain.

(g) 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

The Project constitutes the following KTP 'Clearing of native vegetation' as this reduces the area of forage and potential roosting habitat available for these species.

Conclusion

The Project is expected to impact on approximately 4.3 ha of forage habitat for these species, including 1.8 ha of potential roosting habitat for the East-coast Freetail-bat.

These microbat species are highly mobile and have large forage ranges. Given their roosting preferences and the availability of good quality forage and roost habitat elsewhere in the locality, none of the species are considered unlikely to rely on habitat in the subject site. As such, the Project is not considered likely to have a significant impact on the Eastern Bentwing-bat, Large-eared Pied Bat, Little Bentwing-bat and East-coast Freetail-bat.

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