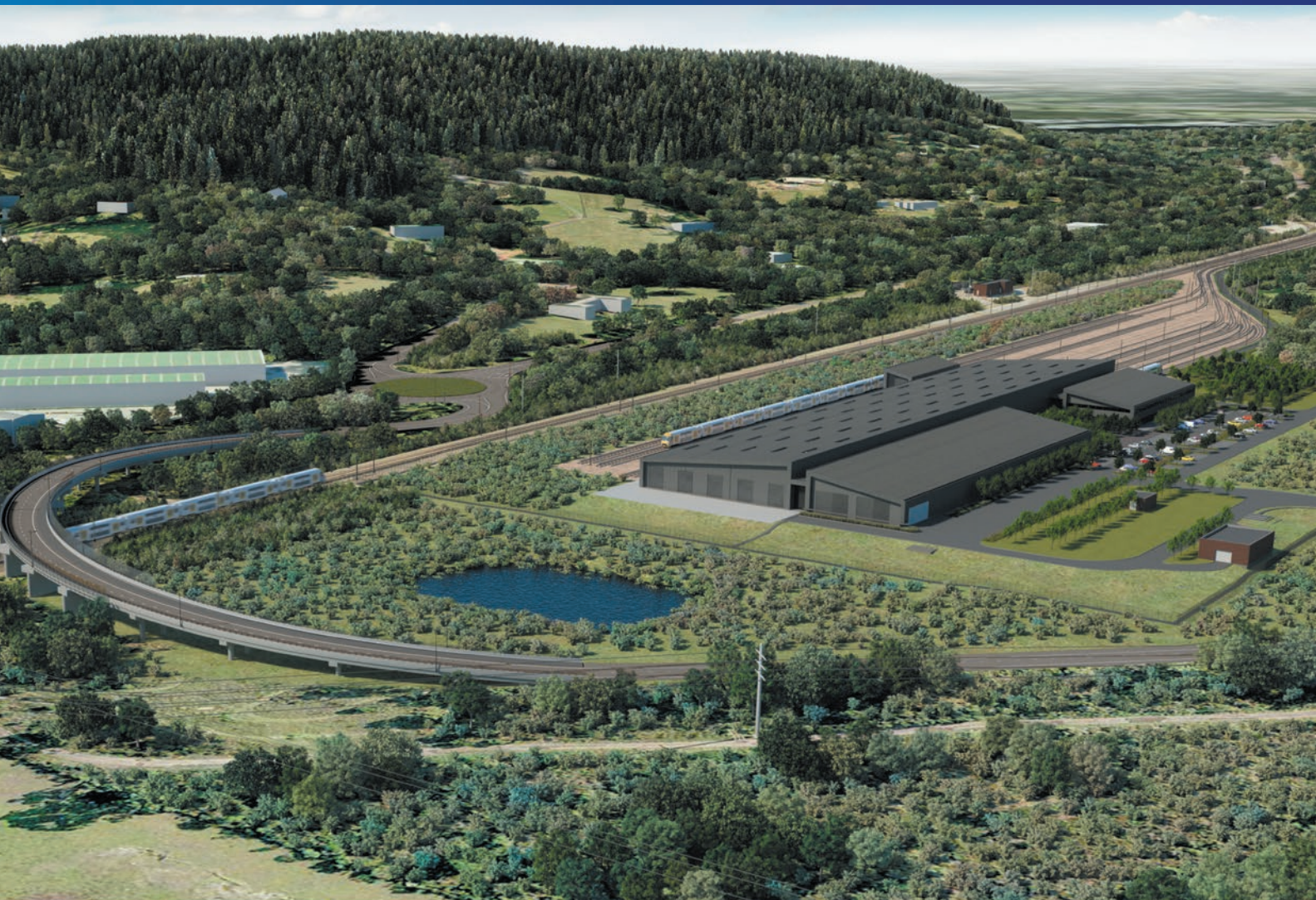




Transport
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New Intercity Fleet Maintenance Facility Project

Species Impact Statement



New Intercity Fleet Maintenance Facility Project

SPECIES IMPACT STATEMENT


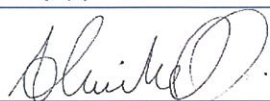
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Appendix B	Species of animal recorded in the study area
Appendix C	Expert report – Threatened frog species habitat assessment

GLOSSARY

Affected species	Subject species likely to be affected by the proposal.
BioBanking Assessment Methodology (BBAM)	Assessment methodology for the NSW BioBanking Scheme – Office of Environment and Heritage 2014, BioBanking Assessment Methodology 2014, Sydney.
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: <ul style="list-style-type: none"> → Genetic diversity — the variety of genes (or units of heredity) in any population. → Species diversity — the variety of species. → Ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. The study area is in the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Biometric vegetation type (BVT)	Provides the occurrence of the PCT within a specific catchment management area. A BVT may be assigned catchment specific attributes such as benchmark data, percent cleared in the catchment area value and associations with threatened species, populations and communities. A PCT may be distributed across one or more major catchment areas and is assigned a BVT with each major catchment area occurrence. BVTs are managed in the VIS Classification Database.
Chief Executive	Chief Executive of the Office of Environment and Heritage
Critical habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered Ecological Community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004b). Critical habitat is listed under either the TSC Act or the EPBC Act and both the state (Department of Environment, Climate Change and Water) and Federal (Department of the Sustainability, Environment, Water, Population and Communities) Directors-General maintain a register of this habitat. Capitalisation of the term ‘Critical Habitat’ in this report refers to the habitat listed specifically under the relevant state and Commonwealth legislation.
Department of the Environment	The department develops and implements national policy, programs and legislation to protect and conserve Australia’s natural environment and cultural heritage and administers the EPBC Act. The Commonwealth Department of Department of the Environment was previously known as: <ul style="list-style-type: none"> → Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) → Department of the Environment, Water, Heritage and the Arts (DEWHA). → Department of Environment and Heritage (DEH). → Department of the Environment and Water Resources (DEWR).

DP	Deposited Plan is a plan number given to a subdivision that is registered by the Land Property Information.
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
Exotic	Introduced from outside the area (Stralberg <i>et al.</i> 2009). Used in the context of this report to refer to species introduced from overseas.
FM Act	NSW <i>Fisheries Management Act 1994</i>
GPS	Global Positioning System – a navigational tool which uses radio receivers to pick up signals from four or more special satellites to provide precise determination of location.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Indigenous	Native to the area: not introduced (Stralberg <i>et al.</i> 2009).
Introduced	Not native to the area: not indigenous (Stralberg <i>et al.</i> 2009). Refers to both exotic and non-indigenous Australian native species of plants and animals.
Key threatening processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004b). Key threatening processes are listed under the TSC Act, the FM Act and the EPBC Act. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004b).
Local occurrence	The ecological community that occurs within the study area. However the local occurrence may include adjacent areas if the ecological community on the study area forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the study area can be clearly demonstrated as defined by Department of Environment and Climate Change (2007e).
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by Department of Environment and Climate Change (2007e).

Locality	The area within a five kilometre radius of the study area.
Migratory species	Species listed as Migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the EPBC Act.
Noxious weed	An introduced species listed under the <i>Noxious Weeds Act 1993</i> . Under the Act, noxious weeds have specific control measures and reporting requirements.
NSW	New South Wales
Office of Environment and Heritage (OEH)	<p>Broadly, the Office of Environment works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making.</p> <p>Previously known as:</p> <ul style="list-style-type: none"> → Department of Environment, Climate Change and Water (DECCW). → Department of Environment and Climate Change (DECC).
Plant community type (PCT)	A NSW plant community type identified using the PCT classification system.
Priorities action statements (PAS)	Priorities action statements outline the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of Threatened species, population and ecological communities and manage key threatening processes (Department of Environment and Climate Change 2007d).
Protected species	Those species defined as protected under the <i>National Parks and Wildlife Act 1974</i> . Includes all native animals, as well as all native plants listed on Schedule 13 of the <i>National Parks and Wildlife Act 1974</i> .
Recovery plan	A plan prepared under the TSC Act, FM Act or the EPBC Act to assist the recovery of a threatened species, population or ecological community.
Risk of extinction	The likelihood that the local population of a threatened species or the local occurrence of an ecological community will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the species or ecological community, and includes changes to ecological function Department of Environment and Climate Change (2007e).
Significant	Important, weighty or more than ordinary.

Significant Impact	<p>A level of impact on threatened species, populations or ecological communities listed under the NSW <i>Threatened Species Conservation</i> (TSC) Act and/or Commonwealth <i>Environment Protection and Biodiversity Conservation</i> (EPBC) Act determined by undertaking an assessment of significance in accordance with:</p> <ul style="list-style-type: none"> → Section 5A of the NSW <i>Environmental Planning & Assessment Act 1979</i> (EP&A Act), triggering the requirement for the preparation of a Species Impact Assessment (SIS). → Matters of National Environmental Significance Impact Guidelines (Department of the Environment 2013), supporting a Referral to the Department of the Environment.
Significant species	Species not listed in the TSC Act but considered to be of regional or local significance.
Species richness	Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species (Matteson & Langellotto 2010).
Study area	Is the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly.
Subject site	The area proposed for development/activity.
Subject species	Those threatened and significant species, populations and ecological communities that are known or considered likely to occur within the study area.
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the TSC Act, FM Act or the EPBC Act.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as threatened) under the TSC Act, FM Act or the EPBC Act. Capitalisation of the terms 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i> .
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007e).
Weed	A plant growing out of place or where it is not wanted: often characterised by high seed production and the ability to colonise disturbed ground quickly (Stralberg <i>et al.</i> 2009). Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

ABBREVIATIONS

AWS	All Weather Station
BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BVT	Biometric Vegetation Type
c.	Circa (about or around)
CER	Chief Executive Requirements
CMA	Catchment Management Authority (now known as Local Land Services)
DA	Development Application
DBH	Diameter at Breast Height
DoE	Department of the Environment
DP	Deposited Plan
DP&I	Department of Planning and Infrastructure
EEC	Endangered Ecological Community
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation of Australia
LEP	Local Environmental Plan
LGA	Local Government Area
OEHS	Office of Environment and Heritage
NSW	New South Wales
PAS	Priority Action Statement
PCT	NSW Plant Community Types
PEA	Preliminary Ecological Assessment
REF	Review of Environmental Factors
SIS	Species Impact Statement

1 FORM OF THIS SPECIES IMPACT STATEMENT

This SIS has been prepared in accordance with the requirements of the Chief Executive of the NSW Office of Environment and Heritage (OEH) issued on the 11 February 2016. Certification of this Species Impact Statement (SIS) is provided below.

1.1 Certification of the SIS by the principal author

This is to certify that this Species Impact Statement (SIS) prepared by WSP | Parsons Brinckerhoff for Transport for NSW, has been prepared in accordance with the requirements of Sections 109 and 110 of the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and in accordance with the requirements of the Chief Executive of the OEH.



2 June 2016

Alex Cockerill
BSc (Hons), Principal Ecologist, WSP | Parsons Brinckerhoff

1.2 Declaration of the SIS by the applicant

'I, Louise Sureda, of Level 5, Tower A, Zenith Centre, 821 Pacific Highway, Chatswood NSW 2067, being the applicant for the proposed New Intercity Fleet Maintenance Facility being assessed under Part 5 of the Environmental Planning and Assessment Act (consisting of the Main North railway corridor and Lot 1 of DP 656505, Lot 82 of DP 737040, Lot 121 of DP 874787, Lot 32 of DP 1033784 and Lots 34 to 41 [inclusive] of DP 2877), north west of Enterprise Drive, Kangy Angy, Central Coast Local Government Area in NSW have read and understood this species impact statement. I understand the implications of the recommendations made in the statement and accept that they may be placed as conditions of consent or concurrence for the proposal.'



2 June 2016

Louise Sureda
A/Director Planning and Environment Services, Transport for NSW

2 CONTEXTUAL INFORMATION

WSP | Parsons Brinckerhoff has been commissioned by Transport for NSW (TfNSW) to prepare a Species Impact Statement (SIS) for the proposed New Intercity Fleet Maintenance Facility project (hereafter, referred to as 'the project'). The SIS provides a detailed technical assessment of the project's impacts on biodiversity and will support a Review of Environmental Factors (REF) for the project. The locality of the project is provided in Figure 2.1. The preparation of an REF for the project has commenced in accordance with the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act). Preliminary investigations for the project identified potential significant impacts to biodiversity, particularly on the threatened ecological community Swamp Sclerophyll Forest and the threatened flora species Biconvex Melaleuca (*Melaleuca biconvexa*), which are both listed under the *Threatened Species Conservation Act 1995* (TSC Act). In light of this and pursuant to Section 111(1) of the *Threatened Species Conservation Act 1995*, Chief Executive Requirements (CER's) were formally requested for the preparation of a Species Impact Statement to support an approval pathway for this project under Part 5 of the *Environmental Planning and Assessment Act 1979*. CERs were issued on 11 February 2016.

For the purposes of the project, the OEH would be a concurrent determining authority for the project (in addition to TfNSW) in accordance with Part 5 of the NSW EP&A Act. In addition to the preparation of an SIS, an *Environment Protection and Biodiversity Conservation (EPBC)* referral has been made due to the likely significant impacts on the vulnerable listed species *Melaleuca biconvexa*. This referral is a separate process to the NSW state assessment process.

2.1 Description of project, subject site and study area

This section provides a description of the proposed works associated with the project as well as a description of the subject site and study area.

2.1.1 Description of the proposal

TfNSW proposes to deliver a new train maintenance facility at a site in Kangy Angy on the Central Coast of NSW to support the procurement of the New Intercity Fleet. The facility would undertake light and heavy train maintenance activities for the New Intercity Fleet, including but not limited to:

- Regular maintenance/servicing
- Repair/replacement of train components
- Interior and Exterior cleaning.

The proposed facility would include about six kilometres of electrified railway (in total), would be seven tracks wide at its widest point, covering an area of approximately 50 hectares, and would be bounded by a perimeter fence (area identified as the 'subject site' in Figure 2.2). The proposed facility would comprise:

Maintenance facility elements:

- Fleet maintenance building
- Four enclosed maintenance roads (tracks for undertaking maintenance on the train sets) and three external standing roads (tracks for holding trains within the maintenance facility) to accommodate the new trains within the site
- Auxiliary workshops
- Electronic clean room

- Material storage, including flammable liquid storage
- Wheel lathe
- Automatic train wash
- Site access roads.

Miscellaneous buildings:

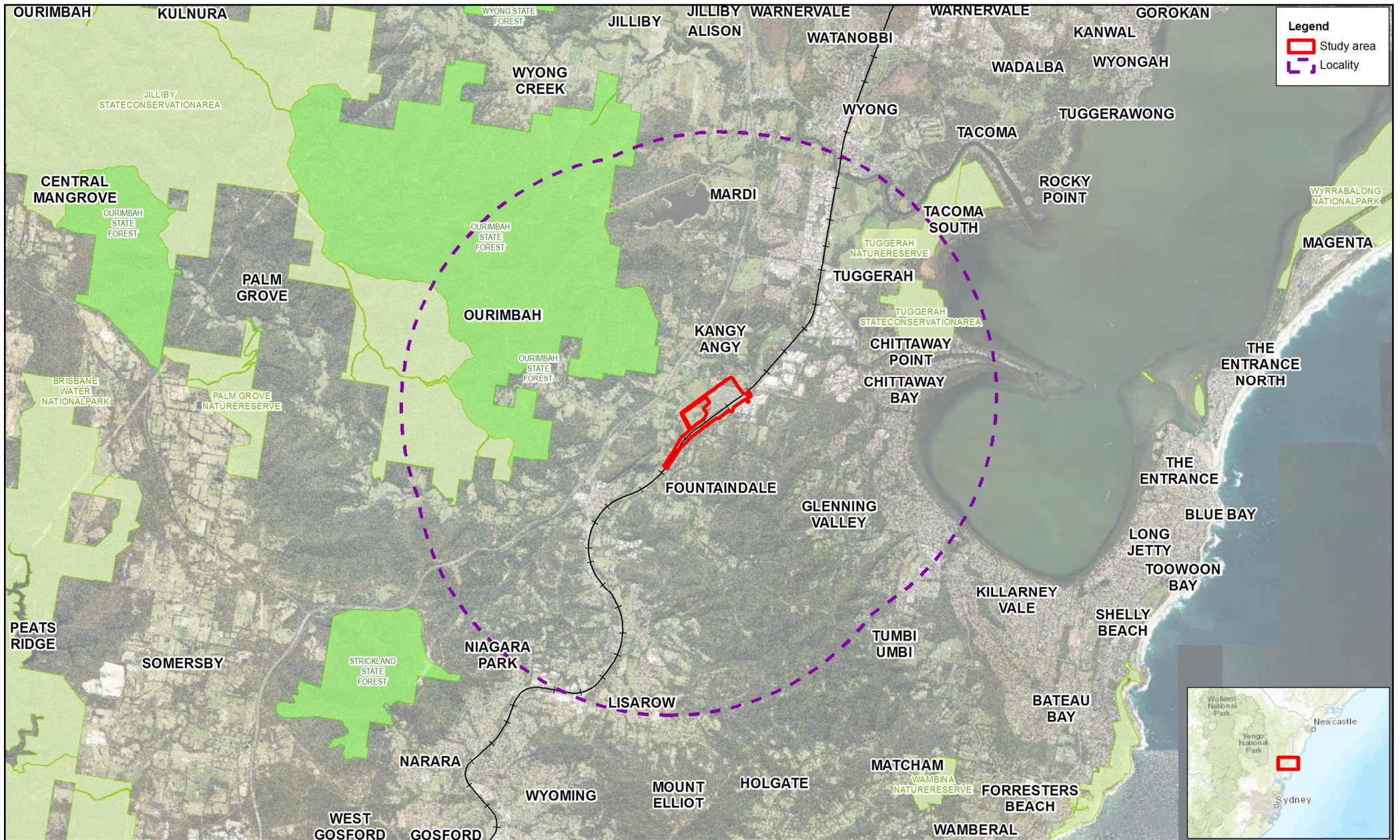
- Administration (including training rooms)
- Facilities for presentation and train maintenance staff
- Signalling building
- Security
- Train simulator
- Substation building
- Power supply (traction power, bulk power, signalling power supply and backup generators).

Other infrastructure including:

- New railway track infrastructure on the western side of the existing rail corridor to allow for trains to enter and exit the maintenance facility site from the Main North railway line
- a new rail bridge (consisting of two separate structures) over Chittaway Creek and Turpentine Road
- A new access roadway and bridge to the maintenance facility site off Enterprise Drive
- A new flood access road between Orchard Road and the proposed new access roadway
- A series of drainage detention ponds
- Staff car park
- Relocation of the existing high voltage power transmission line and Combined Services Route.

Subject to determination and approval, early works associated with the project are expected to commence in early 2017. Full construction of the New Intercity Maintenance Facility is expected to commence in mid-2017. Operation of the maintenance facility, including commissioning is scheduled to commence in 2019. Based on the current construction program and activities, the total construction program for the project would be approximately 33 months.

Further detail regarding the design and different elements of the New Intercity Fleet Maintenance Facility project are provided in Chapter 4 of the REF.



Legend

- Study area
- Locality

Map: 2202522A_GIS_F052_A1
 Date: 11/05/2016
 Author: suansrjr
 Approved by: -

1:100,000
 Coordinate system: GDA 1994 MGA Zone 56
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New Intercity Fleet Maintenance Facility Project
Figure 2.1
 Project locality

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2.1.2 Definitions of SIS study area

2.1.2.1 SUBJECT SITE

The subject site refers to the land which is proposed for development and therefore directly affected by the project. The project's subject site includes all land that will be cleared and/or modified as a result of the proposed works associated with the project, including a nominal six metre wide buffer for construction of the project. Bushfire asset protection zones have not been explicitly considered in the project subject site, with specific requirements to be determined in consultation with the NSW Rural Fire Service during detailed design (WSP | Parsons Brinckerhoff 2016a). The subject site encompasses an area of approximately 50 hectares including 25.5 hectares of Swamp Sclerophyll Forest EEC. The extent of the project's subject site is provided in Figure 2.2.

2.1.2.2 STUDY AREA

The study area refers to the subject site and any additional areas which are likely to be affected by the project either directly or indirectly. The project's study area includes all land that will directly and indirectly impacted as a result of the proposed works associated with the project. The extent of the project's study area is provided in

Figure 2.2.

2.1.3 Description of SIS study area

The study area is located in the suburb of Kangy Angy, within the former Wyong Shire Local Government Area (LGA), now known as the Central Coast Council on the New South Wales (NSW) Central Coast. The study area is generally bordered by the Main North Rail Line rail corridor to the south, and Orchard Road to the north-west. Residential receivers on rural properties generally surround the site to the north, south and west, with industrial precincts to the south east and north-east (on the opposite side of the rail corridor to the study area). The M1 Pacific Motorway is located approximately 0.85 kilometres to the north-west, and Tuggerah Lake is approximately 3.5 kilometres to the east of the study area. Chittaway Creek crosses the project at the southern end and Ourimbah Creek is to the north of the study area. Details of the vegetation communities, fauna habitats are described in detail in section 4 of this report.

2.1.3.1 PREVIOUS ECOLOGICAL STUDIES

CENTRAL COAST TRAIN STABLING AND MAINTENANCE FACILITY COMPARATIVE SITE ANALYSIS

As part of the site selection process, a series of ecological surveys were undertaken at a number of potential locations along the Central Coast to identify potential ecological constraints. The results of those surveys are provided in the *Central Coast Train Stabling and Maintenance Facility Comparative Site Analysis (GHD 2014a)*. The results from the preliminary survey at the Kangy Angy site suggested that two threatened ecological communities listed under the TSC Act occur within the subject site:

- River Flat Eucalypt Forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions; and
- Swamp Sclerophyll Forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.

In addition, one threatened plant species (*Corunastylis* sp. Charmhaven) was predicted to occur at the Kangy Angy site. A targeted survey was undertaken as part of the study during the species flowering period (February 2015), however this species was not detected.

PRELIMINARY ECOLOGICAL ASSESSMENT – NEW INTERCITY MAINTENANCE FACILITY

A Preliminary Ecological Assessment (PEA) was completed by EMM (2015) for the Kangy Angy site to determine the likely significance of the project impacts on biodiversity. The results of this assessment informed the Statement of Impact Assessment Report prepared by TfNSW as part of the preliminary phase of the REF process. Desk-based investigations completed for the PEA indicated that 16 threatened ecological communities are known to occur within 10 kilometres of the study area. The field surveys reported the presence of two threatened ecological communities:

- Swamp Sclerophyll Forest on the coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregion listed as Endangered under the TSC Act
- Lowland Rainforest in the North Coast and the Sydney Basin Bioregion listed as Endangered under the TSC Act.

Desk-based searches and field surveys identified potential habitat for seven threatened flora species to occur within the study area.

The seven species considered likely to occur included:

- Biconvex Paperbark (*Melaleuca biconvexa*)
- Charmhaven Apple (*Angophora inopina*)
- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Tranquillity Mintbush (*Prostanthera askania*)
- Variable Midge Orchid (*Genoplesium insigne*)
- Wyong Sun Orchid (*Thelymitra adorata*)
- Wyong Midge Orchid (*Corunastylis* sp. Charmhaven).

Surveys undertaken to inform the PEA identified several hundred individuals of the threatened plant, *Melaleuca biconvexa* within the subject site which is a threatened species listed as Vulnerable under both the TSC Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Potential habitat for the following species was also considered however none of these species were recorded during the surveys:

- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Tranquillity Mintbush (*Prostanthera askania*)
- Rainforest Cassia (*Senna acclinis*).

Fauna habitat assessments undertaken as part of the survey indicated that potential habitat occurred for the following threatened and migratory species:

- Eleven threatened species of bird; Black-necked Stork, Gang-Gang Cockatoo, Glossy Black-Cockatoo, Little Lorikeet, Little Eagle, Masked Owl, Sooty Owl, Powerful Owl, Wompoo Fruit-Dove, Regent Honeyeater and Swift Parrot
- Three migratory species of bird; Rainbow Bee-eater, Black-faced Monarch and Spectacled Monarch
- Two threatened amphibians; Wallum Froglet and Green-thighed Frog
- Two threatened reptiles; Pale-headed Snake and Stephen's Banded Snake
- Nine threatened mammals; Golden-tipped Bat, Greater Broad-nosed Bat, Eastern Bent-wing Bat, Eastern False Pipistrelle, Grey-headed Flying-fox, Koala, Long-nosed Potoroo, Squirrel Glider and Yellow-bellied Glider.

The assessment undertook preliminary assessments of significance which concluded that the project was likely to have significant impacts on Swamp Sclerophyll Forest threatened ecological community and *Melaleuca biconvexa*. In light of the results of the PEA, it was recommended that additional targeted surveys should be completed to inform the environment impact assessment process moving forward for species considered likely to occur within the study area. Specifically, this would require a SIS under Part 5 of the NSW EP&A Act.

BIODIVERSITY ASSESSMENT REPORT

In light of the results of the PEA, a Biodiversity Assessment Report (BAR) was required to assess potential ecological impacts to support the Review of Environmental Factors (REF) for the project, in addition to informing the preparation of this SIS in accordance with the OEH CER's. The assessment for the BAR included desktop review of available databases and relevant literature as well as targeted field surveys completed over nine days in late February and March 2016 (WSP | Parsons Brinckerhoff 2016b). The results of these surveys are presented in section 4 of this report.

2.1.3.2 PREVIOUS LAND USE

Previous and existing land use in the project study area includes a combination of recreational farming and rural residential properties, vacant (and vegetated) council owned land and various transport related infrastructure land uses including:

- The Main North Rail Line corridor
- Existing roadways including Enterprise Drive, Turpentine Road, Schubolt Lane, Ourimbah Road, Orchard Road and Old Chittaway Road.

Accordingly, the project study area has been subject to previous disturbance inclusive of vegetation clearing for rural residential properties, recreational farming and development of road and rail infrastructure. However recent land use and development within the study area was controlled through zoning provisions of the Wyong Local Environmental Plan (LEP) 2013. Under this LEP, a majority of the project study area is zoned as Environmental Conservation (E2) and Environmental Management (E3) (Figure 2.3), which has restricted further land development in the study area. The remainder of the project site, consisting of the existing rail corridor for the Main North railway, is zoned SP2 Infrastructure.



Legend

- +— Main North railway
- Drainage
- ▨ Subject site
- ▭ Study area
- ▭ Cadastre

Map: 2202522A_GIS_F062_A1	Author: suansrir
Date: 11/05/2016	Approved by: -

0 100 200
m

1:9,500

Coordinate system: GDA 1994 MGA Zone 56
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New Intercity Fleet Maintenance Facility Project
Figure 2.2
Project study area and subject site

2.1.3.3 FIRE HISTORY

The fire history of the study area is unknown although the floristic composition and structure of the vegetation suggests that fire has been generally absent from this landscape within at least the last 10 years.

2.1.3.4 LAND ZONING

The land use and development within the study area is controlled through the zoning provisions of the Wyong LEP. Under this LEP, a majority of the study area is zoned as Environmental Conservation (E2) and Environmental Management (E3) (Figure 2.3). The remainder of the study area, consisting of the existing rail corridor for the Main North railway, is zoned SP2 Infrastructure. A small area of Public Recreation (RE1) and General Industrial (IN1) occur in the south-eastern corner of the study area.

Surrounding the study area, the land is generally zoned as E2 and E3 to the north of Enterprise Drive in addition to a mix of Environmental Living (E4) and E3 zones to the south. There is also General Industrial zone (IN1) in Berkeley Vale, to the east of the Enterprise Drive. The Pacific Highway, Pacific Motorway to the north of the site and Enterprise Drive running along the south of the site are zoned as SP2 Infrastructure.

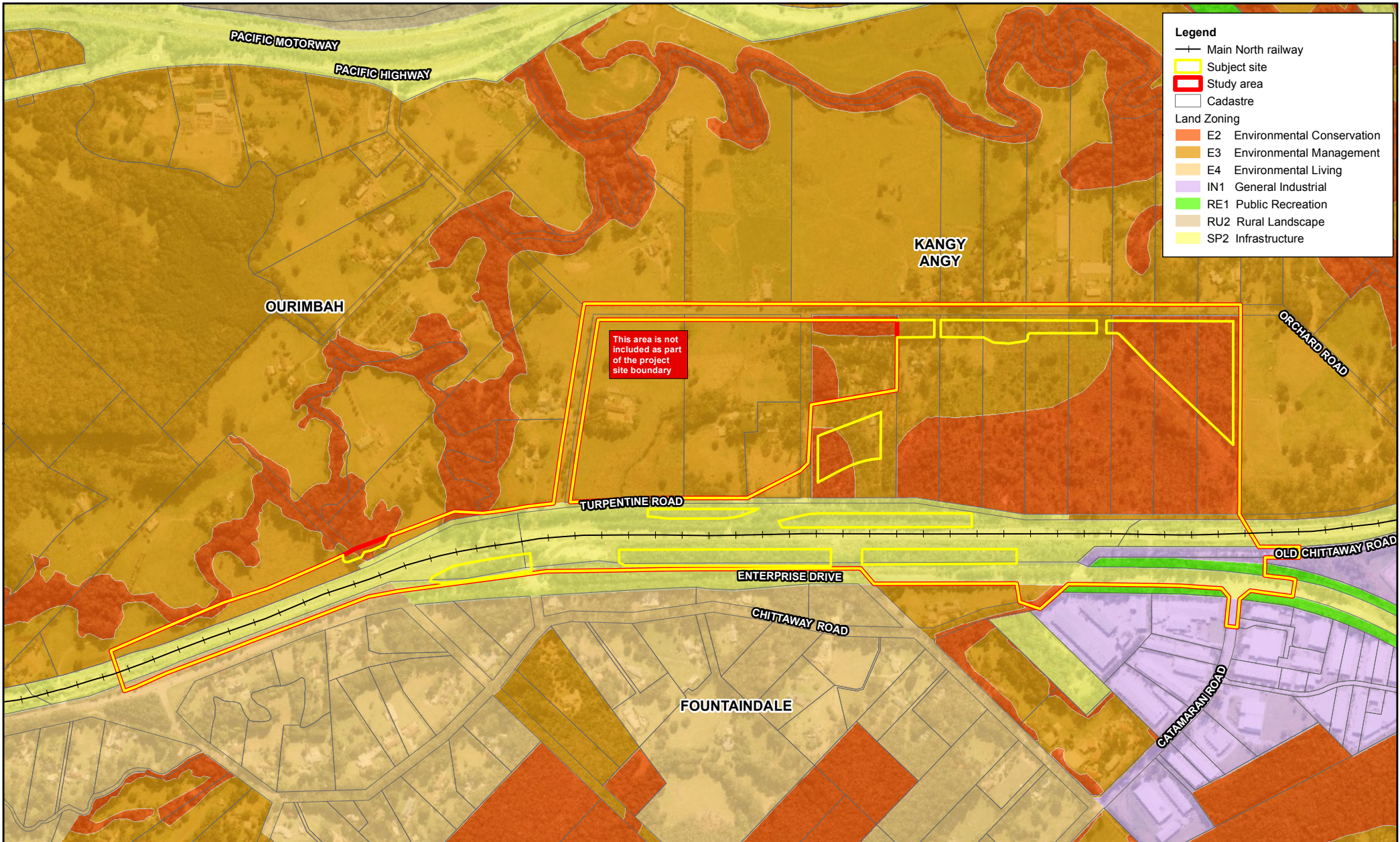
Under the Wyong LEP, zones identified as Environmental Conservation (E2) provide protection for native vegetation and threatened species, populations and ecological communities, as development is not permitted without consent and only if such development is consistent with objectives of such zones. Objectives of Environmental Conservation zones include:

- To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values
- To prevent development that could destroy, damage or otherwise have an adverse effect on those values
- To protect endangered ecological communities, coastal wetlands and littoral rainforests
- To enable development of public works and environmental facilities if such development would not have a detrimental impact on ecological, scientific, cultural or aesthetic values.

However, as the project will be assessed under the *State Environmental Planning Policy (Infrastructure) 2007*, the project is permissible without the need for development consent under Part 4 of the EP&A Act. It follows that development is permissible without the former Wyong Shire Council consent, now known as the Central Coast Council, and areas identified for Environmental Conservation (E2) and Environmental Management (E3) under the Wyong LEP do not infer protection for native vegetation and threatened species, populations and ecological communities within the subject site.

2.1.3.5 LAND TENURE INFORMATION

The study area comprises 12 properties (i.e. lots), of which the majority (seven lots) comprise land currently owned by the former Wyong Shire Council, now known as the Central Coast Council, and consist of vacant, vegetated land zoned for Environmental Protection under the Wyong LEP (Figure 2.3, Figure 2.4). The remaining lots are private rural residential properties that are zoned for Environmental Management.

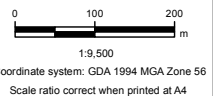


Legend

- Main North railway
- ▭ Subject site
- ▭ Study area
- ▭ Cadastre
- Land Zoning**
- E2 Environmental Conservation
- E3 Environmental Management
- E4 Environmental Living
- IN1 General Industrial
- RE1 Public Recreation
- RU2 Rural Landscape
- SP2 Infrastructure

This area is not included as part of the project site boundary

Map: 2202522A_GIS_F051_A2	Author: suansrir
Date: 2/06/2016	Approved by: -

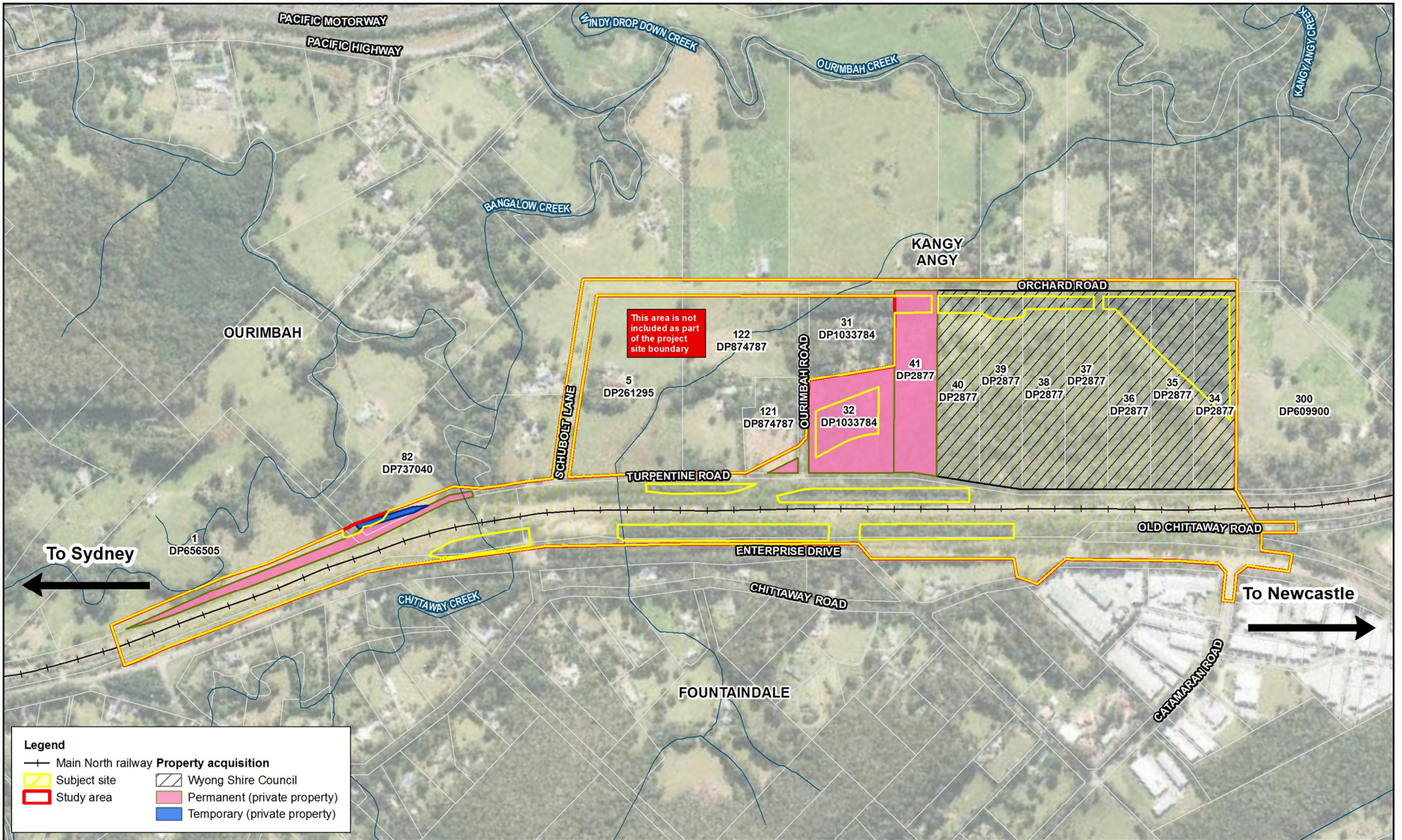


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New Intercity Fleet Maintenance Facility Project
Figure 2.3
Land zoning within the study area and surrounds

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Legend

—+— Main North railway	Property acquisition
Yellow outline Subject site	Hatched box Wyong Shire Council
Red outline Study area	Pink box Permanent (private property)
	Blue box Temporary (private property)

Map: 2202522A_GIS_F061_A1	Author: suansrnr
Date: 11/05/2016	Approved by: -

0 100 200
m
19,500
Coordinate system: GDA 1994 MGA Zone 56
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New Intercity Fleet Maintenance Facility Project
Figure 2.4
Land tenure within the study area

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2.1.3.6 ENVIRONMENTAL PLANNING INSTRUMENTS

STATE ENVIRONMENTAL PLANNING POLICY NO.44 – KOALA HABITAT

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44) aims to encourage the proper conservation and management of natural vegetation areas that provide habitat for koalas to ensure that permanent, free living areas are maintained over their present range. The policy applies to a number of LGAs across NSW, including the Wyong LGA.

As the project is being assessed under Part 5 of the EP&A Act and as is not part of a development application to be assessed by the former Wyong shire Council, now known as the Central Coast Council, SEPP 44 does not apply to the project.

The intent of SEPP 44 was however considered during the preparation of the REF, and as outlined in the *Biodiversity Assessment Report* (WSP | Parsons Brinckerhoff). This assessment identified that the study area was found to contain two Koala feed tree species as listed in Schedule 2 of SEPP 44, being *Eucalyptus robusta* and *E. tereticornis*. *Eucalyptus robusta* was identified to occur within the study area at a density of greater than 15 per cent of the canopy layer and was therefore assessed as containing potential Koala habitat under the conditions contained in SEPP 44. Targeted and opportunistic surveys over the study area found no evidence of Koala habitation.

STATE ENVIRONMENTAL PLANNING POLICY NO.71 – COASTAL PROTECTION

The aim of *State Environmental Planning Policy 71 – Coastal Protection* (SEPP 71) is to ensure:

- Development in the NSW Coastal Zone is appropriate and suitably located
- There is a consistent and strategic approach to coastal planning and management
- There is a clear development assessment framework for the Coastal Zone.

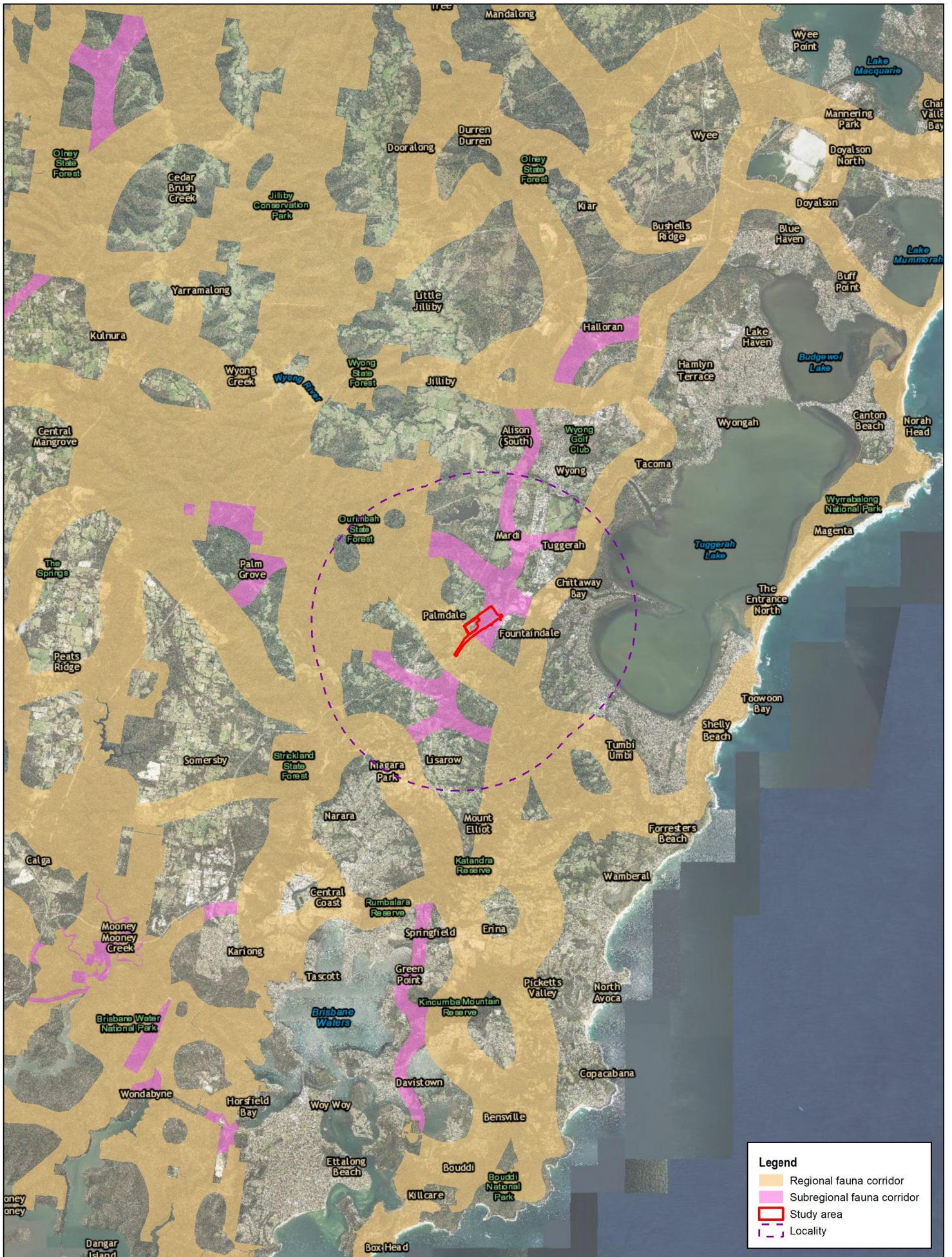
The study area has been partly identified as being within the SEPP 71 'Coastal Zone' (refer to Review of Environmental Factors) (WSP | Parsons Brinckerhoff 2016a) and as such, the SEPP has been considered as part of the project.

As the subject site is located some distance from the coastal foreshore, the project is not expected to have a detrimental impact on the amenity, environmental qualities or water quality of the coastal foreshore or coastal waterbodies. As such, it is not expected that the project would impact on any of the relevant matters for consideration under the SEPP 71. Additional discussion regarding the potential impacts of the project on ecology and heritage are discussed in the REF (WSP | Parsons Brinckerhoff 2016a).

2.1.3.7 WILDLIFE CORRIDORS

Regional wildlife corridors are identified as primary landscape corridors that provide potential residential and dispersal habitat for an assemblage of reference species and are generally in the order of kilometres wide (Bennett 1990; Scotts 2003). The project occurs within a discontinuous regional wildlife corridor, which is commensurate with large contiguous tracts of native vegetation of the coastal ranges, foothills and sheltered gullies that occur to the south-east of the study area and similar habitats within Ourimbah State Forest, extending through to the Watagan Mountains to the north (Figure 2.5).

Sub-regional wildlife corridors are landscape corridors that serve more as routes for dispersal and movement for assemblage reference species and wide-ranging species, rather than habitats in their own right (Scotts 2003). The study area occurs in a sub-regional corridor, albeit with minor localised barriers such as road and rail infrastructure, that passes through the project study area in a north – south alignment, connecting somewhat fragmented habitat patches from Niagara Park north to Halloran (Figure 2.5).



Legend

- Regional fauna corridor
- Subregional fauna corridor
- Study area
- Locality

Map: 2202522A_GIS_F031_A1
 Date: 11/05/2016
 Author: suansir
 Approved by: -


 1:125,000
 Coordinate system: GDA 1984 MGA Zone 56
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New Intercity Fleet Maintenance Facility Project
Figure 2.5
 Wildlife corridors

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3 INITIAL ASSESSMENT

Determining authorities have a statutory obligation under the Part 5 provisions of the EP&A Act to consider whether a project is likely to significantly affect threatened species, populations or ecological communities, or their habitats by applying an Assessment of Significance (the seven-part test). The Preliminary Ecological Assessment (EMM 2015a), concluded that the project is likely to have a significant impact on occurrences of the Endangered Ecological Community (EEC), Swamp Sclerophyll Forest, as well as stands of the Vulnerable plant species, *Melaleuca biconvexa* (Biconvex Paperbark). In light of this and pursuant to Section 111(1) of the TSC Act, CER's were formally requested from OEH for the preparation of a SIS to support an approval pathway of this project under Part 5 of the EP&A Act.

In addition to the likely impact of the project on occurrence of Swamp Sclerophyll Forest EEC and *Melaleuca biconvexa*, OEH provided a list of potential species, populations and ecological communities that require consideration as CER's, which are detailed in section 3.1.1.2.

3.1 Identifying subject species

In preparing the SIS, an initial assessment is required to determine a consolidated list of those threatened species, populations or ecological communities, which are known or are likely to occur in the area and are likely to be affected by the project (henceforth referred to as 'subject species').

3.1.1 Assessment of available information

This assessment included a desktop review of available databases and literature. The methods behind this assessment are provided below.

3.1.1.1 CHIEF EXECUTIVE REQUIREMENT SUBJECT SPECIES

The CERs, which were issued on 11 February 2016 by OEH (OEH Reference number: DOC16/22703-4), included a list of 'subject species' to be included for consideration in this SIS. These were provided as each of the species had been previously recorded within the general area, broad habitat preferences may be present or the subject site is within the species known geographic limits.

Table 3.1 List of subject species provided in the CERs

Scientific name	Common name	TSC Act ¹	EPBC Act ²
Endangered Ecological Communities			
Freshwater Wetlands on the Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		E3	-
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		E3	-
Lowland Rainforest of Subtropical Australia		-	CE
River-Flat Eucalypt Forest on the Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		E3	-
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions		E3	-
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions		E3	-

Scientific name	Common name	TSC Act ¹	EPBC Act ²
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions		E3	-
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		E3	-
Sydney Freshwater Wetlands in the Sydney Basin Bioregion		E3	-
Threatened flora species			
<i>Caladenia tessellata</i>	Thick-lipped Spider Orchid	E1	V
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-	V	-
<i>Maundia triglochinoidea</i>	-	V	-
<i>Melaleuca biconvexa</i>	Bioconvex Melaleuca	V	V
<i>Prostanthera askania</i>	Tranquility Mintbush	E1	E
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V	E
Threatened fauna species – Amphibians			
Wallum Froglet	<i>Crinia tinula</i>	V	-
Giant Burrowing Frog	<i>Heleioporus australiacus</i>	V	V
Green-thighed Frog	<i>Litoria brevipalmata</i>	V	-
Green and Golden Bell Frog	<i>Litoria aurea</i>	E1	V
Stuttering Frog	<i>Mixophyes balbus</i>	E1	V
Giant Barred Frog	<i>Mixophyes iteratus</i>	E1	E
Threatened fauna species – Reptiles			
Stephens Banded Snake	<i>Hoplocephalus stephensii</i>	V	-
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	V	-
Rosenberg's Goanna	<i>Varanus rosenbergi</i>	V	-
Threatened fauna species – Birds			
Regent Honeyeater	<i>Anthochaera phrygia</i>	E4A	CE
Bush Stone-Curlew	<i>Burhinus grallarius</i>	E1	-
Gang-Gang Cockatoo	<i>Callocephalon fimbriatum</i>	V	-
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	V	-
Speckled Warbler	<i>Chthonicola sagittata</i>	V	-
Spotted Harrier	<i>Circus assimilis</i>	V	-
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V	-
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	E1	-

Scientific name	Common name	TSC Act ¹	EPBC Act ²
Black Falcon	<i>Falco subniger</i>	V	-
Little Lorikeet	<i>Glossopsitta pusilla</i>	V	-
Painted Honeyeater	<i>Grantiella picta</i>	V	V
Little Eagle	<i>Hieraaetus morphnoides</i>	V	-
Black Bittern	<i>Ixobrychus flavicollis</i>	V	-
Swift Parrot	<i>Lathamus discolor</i>	E1	CE
Square-tailed Kite	<i>Lophoictinia isura</i>	V	-
Barking Owl	<i>Ninox connivens</i>	V	-
Powerful Owl	<i>Ninox strenua</i>	V	-
Osprey	<i>Pandion haliaetus</i>	V	-
Scarlet Robin	<i>Petroica boodang</i>	V	-
Flame Robin	<i>Petroica phoenicea</i>	V	-
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	V	-
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	V	-
Superb Fruit-Dove	<i>Ptilinopus superbus</i>	V	-
Diamond Firetail	<i>Stagonopleura guttata</i>	V	-
Masked Owl	<i>Tyto novaehollandiae</i>	V	-
Sooty Owl	<i>Tyto tenebricosa</i>	V	-
Threatened fauna species – Mammals			
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V	-
Spotted-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	V	E
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V	-
Southern Brown Bandicoot	<i>Isodon obesulus obesulus</i>	E1	E
Golden-tipped Bat	<i>Kerivoula papuensis</i>	V	-
Little Bentwing-bat	<i>Miniopterus australis</i>	V	-
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>	V	-
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V	-
Southern Myotis	<i>Myotis macropus</i>	V	-
Yellow-bellied Glider	<i>Petaurus australis</i>	V	-
Squirrel Glider	<i>Petaurus norfolcensis</i>	V	-
Koala	<i>Phascolarctos cinereus</i>	V	V

Scientific name	Common name	TSC Act ¹	EPBC Act ²
Long-nosed Potoroo	<i>Potorous tridactylus</i>	V	V
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	V	-
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V
Yellow-bellied Sheathtail-bat	<i>Saccolaimus flaviventris</i>	V	-
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V	-

- (1) Listed as Vulnerable (V), Endangered (E1), Endangered Ecological Community (E3), Critically Endangered (E4A) under the NSW *Threatened Species Conservation Act 1995*.
- (2) Listed as Vulnerable (V), Endangered (E), Critically Endangered (CE) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

3.1.1.2 ADDITIONAL SUBJECT SPECIES

In addition to the 'subject species' provided in the CERs, further investigations are required to identify any additional subject species that may occur. The desktop investigations included a review of existing databases and literature which are summarised below.

DESKTOP REVIEW OF EXISTING DATABASES AND LITERATURE

The aim of this background research was to identify threatened flora and fauna species, populations and ecological communities or their associated habitats that have been recorded previously or predicted to occur in the vicinity of the study area.

This review allowed for known habitat characteristics of potential species to be compared with those present within the study area to determine the likelihood of occurrence of each species, population and community. These results informed the identification of appropriate field survey effort and the groups likely to occur.

Records of threatened species, populations and ecological communities known or predicted to occur in the locality of the project were obtained from a range of databases as detailed in Table 3.2.

Table 3.2 Database searches

Database ¹	Search date	Area searched	References
BioNet Atlas of NSW Wildlife	25 January 2016	10 km x 10 km area centred on subject site	(Office for Environment & Heritage 2016a) (Office of Environment and Heritage 2016b)
OEH Threatened Species CMA search	18 March 2016	Wyong sub-region of the Hunter/Central Rivers Catchment Management Authority	(Office for Environment & Heritage 2016d)
Preliminary Determinations	4 May 2016	10 km x 10 km area centred on subject site	(Office of Environment & Heritage 2016i)
EPBC Protected Matters Search Tool	21 January 2016	5 km buffer around subject site	(Department of the Environment 2016c)
PlantNet	25 January 2016	5 km radius of Kangy Angy	(Royal Botanic Gardens 2016)

Database ¹	Search date	Area searched	References
NSW Department of Primary Industries (Fishing and Aquaculture) threatened Aquatic Fauna Database	18 March 2016	Searches were done of both the former Wyong Local Government Area and Gosford Local Government Area, now collectively known as Central Coast Council.	(Department of Primary industries 2016)
Birdlife Australia (Bird data Atlas)	4 May 2016	2258 postcode	(BirdLife Australia 2016)

- (1) Species of bird returned via the EPBC Protected Matters Search Tool that are only listed under the migratory provisions of the EPBC Act (35 species in total) have been excluded from the likelihood of occurrence assessment in Table 3.5 for threatened fauna species.

In addition to the above database searches other relevant resources were reviewed including:

- Research papers, books and other published data
- Aerial photography
- Broad scale mapping of the region; '*The natural vegetation of the Wyong Local Government Areas, Central Coast, New South Wales*' (Bell, S. 2002)
- Previous ecological assessment of the subject site; '*Preliminary Ecological Assessment: New Intercity Maintenance Facility*' (EMM 2015a).

The desktop investigations identified numerous additional other flora (45) and fauna (59) species as being known or predicted to occur within the study area. The additional subject species are provided in Table 3.4 and Table 3.5 along with the project CERs (refer to data source column for further details).

3.2 Likelihood of occurrence assessment for threatened biodiversity

The likelihood of threatened species and populations occurring within the study area was assessed against the criteria defined in Table 3.3. Species subject to likelihood of occurrence assessments were those identified in section 3.1, inclusive of the CERs and additional species identified during desktop based searches.

Those species that are considered to be 'subject species' for this SIS based on the availability of potential habitat, recent records and known distribution within the locality were those identified as having a moderate or higher likelihood of occurrence based on the professional opinion of contributors to this assessment. The likelihood of occurrence assessment is provided in Table 3.4 and Table 3.5 for threatened flora and fauna respectively.

Table 3.3 Likelihood of occurrence assessment categories

Likelihood of occurrence	Criteria
Low	<p>Species considered to have a low likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> → have not been recorded previously in the survey area and surrounds and for which the survey area is beyond the current distribution range → rely on specific habitat types or resources that are not present in the survey area → are considered locally extinct → are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.

Likelihood of occurrence	Criteria
Moderate	<p>Species considered to have a moderate likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> → have infrequently been recorded previously in the survey area and surrounds → use habitat types or resources that are present in the survey area, although generally in a poor or modified condition → are unlikely to maintain sedentary populations, however, may seasonally use resources within the survey area opportunistically during variable seasons or migration → are cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
High	<p>Species considered to have a high likelihood of occurrence include species not recorded that fit one or more of the following criteria:</p> <ul style="list-style-type: none"> → have frequently been recorded previously in the survey area and surrounds → use habitat types or resources that are present in the survey area, that are abundant and/or in good condition within the survey area → are known or likely to maintain resident populations surrounding the survey area → are known or likely to visit the site during regular seasonal movements or migration.
Recorded	<p>Any threatened species recorded during field surveys undertaken as part of this study or recorded under previous studies of the study area.</p>

3.2.1 Database threatened species not assessed

Due to the proximity of the study area to coastal habitats a number of threatened fauna species, which are dependent on oceanic, estuarine and wetland habitats, and for which no habitat occurs within the study area or its vicinity, have not been assessed, unless the species is listed within the CERs. Such species include but are not limited to:

- Waterfowl and some waterbirds
- Most resident and migratory wading birds
- Terns
- Petrels and albatrosses
- Cetaceans and other marine mammals, and
- Sea turtles.

Table 3.4 Initial likelihood of occurrence assessment for threatened flora species known or with potential to occur within the subject site

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Araliaceae	<i>Astrotricha crassifolia</i>	Thick-leaf Star-hair	V	V	Occurs near Patonga and in the Royal National Park and inland to Glen Davis where it grows in dry sclerophyll woodland on sandstone (Department of Environment and Climate Change 2007a; Harden 1992, 1993).	OEH Profile search – Wyong sub-region	Low – the species is known to occur within dry sclerophyll woodland on sandstone habitats of which no similar habitats were recorded within the study area. In addition the species has not been recorded within the locality (nearest record >15 km from subject study area). Based on a lack of suitable habitat and absence of recent records, it is considered unlikely that the species would occur within the study area.
Asclepiadaceae	<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E1	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden 1992). This species typically occurs at the ecotone between dry subtropical rainforest/woodland communities (James 1997; NSW National Parks and Wildlife Service 2002a).	OEH Profile search – Wyong sub-region	Low – this species is known to occur rainforest gullies, scrub and scree slope habitats at ecotones between sub dry subtropical forest/woodland of which marginal habitat was recorded within the study area. This species has not been recorded within the locality (nearest record >40 km from the study area). Therefore, it is considered unlikely that the species would occur within the study area.
Asteraceae	<i>Rutidosis heterogama</i>	Heath Wrinklewort	V	V	Occurs in coastal districts from Maclean to the Hunter Valley and inland to the Torrington region. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (Harden 1992; Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – this species is known to occur within heath and moist open forest habitats of which no similar habitat was recorded within the study area. No specimens of this species have been previously recorded in the locality with the nearest record being located at Warnervale (approx. 10 km from study area). Given the lack of suitable habitat and absence of records within the locality, it is considered unlikely that the species would occur within the study area.
Asteraceae	<i>Senecio spathulatus</i>	Coast Groundsel		E1	Occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah) where it grows on primary dunes (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – the species is known to occur on frontal sand dunes of which no similar habitat was recorded within the study area. In addition this species has not been recorded in the locality (nearest record approx. 10 km from study area). Therefore, this species is considered unlikely to occur within the study area.
Convolvulaceae	<i>Wilsonia backhousei</i>	Narrow-leafed Wilsonia		V	Occurs chiefly in the Sydney district but also common at Jervis Bay (Harden 2000). A salt tolerant species, it is found in intertidal saltmarshes and sometimes on sea cliffs (NSW Scientific Committee 2000b).	OEH Profile search – Wyong sub-region	Low – this species is known to occur within intertidal saltmarshes and on sea cliffs of which no similar habitats were recorded within the study area. In addition the study area is outside the species known distribution range (i.e. south of Wamberal in northern Sydney). Therefore, it is considered unlikely that the species would occur within the study area.
Dilleniaceae	<i>Hibbertia procumbens</i>	Spreading Guinea Flower		E1	Within NSW, known from several locations only on the Central Coast in the Gosford and Wyong local government areas. These populations are at Bumble Hill near Yarramalong in Wyong LGA; Kulnura, Strickland State Forest, Mangrove Mountain, Somersby, Calga/Mt White and Peats Ridge in the Gosford LGA; and near Mogo Creek to the west of Mangrove Creek Dam. The majority of known populations occur within <i>Banksia ericifolia</i> – <i>Angophora hispida</i> – <i>Allocasuarina distyla</i> scrub/heath on skeletal sandy soils. May also be found associated with 'hanging swamp' vegetation communities on sandy deposits (Office of Environment and Heritage 2014f).	OEH Profile search – Wyong sub-region	Low – this species is known to occur within scrub heath on skeletal soils of which no similar habitat was recorded within the study area. In addition the species has only been recorded in the surrounds (approx. 10 km from study area). Therefore, it is considered unlikely that the species would occur within the study area.
Elaeocarpaceae	<i>Tetratheca glandulosa</i>	Glandular Pink-bell	V	V	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992). Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gynea, Lambert and Faulconbridge. 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. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar). Common woodland tree species include: <i>Corymbia gummifera</i> , <i>C. eximia</i> , <i>Eucalyptus haemastoma</i> , <i>E. punctata</i> , <i>E. racemosa</i> , and/or <i>E. sparsifolia</i> , with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – suitable habitat for this species has not been recorded from the study area. This species has not been recorded from within the locality and is considered unlikely to occur within the study area.

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Elaeocarpaceae	<i>Tetraloche juncea</i>	Black-eyed Susan	V	V	Occurs in coastal districts from Bulahdelah to Port Macquarie where it grows in dry sclerophyll forest and occasionally swampy heath in sandy (Harden 2002). low nutrient soils with a dense understorey of grasses. Specifically it is known to occur within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland (Payne <i>et al.</i> 2002).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Low – the species is known to occur in dry sclerophyll forest with an understorey dense in grasses on well drained soils. Although swampy habitats did occur within the study area the understorey was dense and dominated by sedges which is unlikely to provide habitat for the species. The species has not been previously recorded within the locality (nearest records approx. 7 km from the study area). Given this and the lack of suitable habitat, it is considered unlikely that the species would occur within the study area.
Epacridaceae	<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-		V	Occurs in Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps (Harden 2002). Usually found in sites with a strong shale influence (NSW National Parks and Wildlife Service 2002b).	project CERs, Bionet Search, OEH Profile search - Wyong sub-region	Low – the species is known to occur within sclerophyll forest and swamp habitats which are on soils with a strong shale influence on sandstone. This habitat type does not occur within the study area. Even though the species has been recorded from a single location within the locality (approx. 4 km from the study area (2003) due to the lack of suitable habitat it is considered unlikely that this species would occur within study area. The local record of this species may be of doubtful taxonomic validity as no specimens accompanied the record (Dr Elizabeth Brown pers. comms.) Although this species is considered unlikely to occur it is considered a 'subject species' in this SIS as it is a species of consideration under the CERs for the project.
Euphorbiaceae	<i>Chamaesyce psammogeton</i>	Sand Spurge		E1	Occurs in coastal regions of NSW where it grows on sand dunes near the sea (Harden 2000). Grows on fore-dunes and exposed headlands, often with Spinifex (<i>Spinifex sericeus</i>) (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – the species is known to occur on sand dunes and exposed headlands of which no similar habitat was recorded within the study area. The species has not been recorded from the locality (nearest record approx. 9 km from study area). Based on lack of suitable habitat and absence of records from the locality, this species is considered unlikely to occur within the study area.
Fabaceae (Caesalpinioideae)	<i>Senna acclinis</i>	Rainforest Cassia		E1	Occurs in coastal districts and adjacent tablelands of NSW from the Illawarra to Queensland. It grows in or on the edges of subtropical and dry rainforest (Office of Environment & Heritage 2016n).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – the species is known to occur within rainforest habitats along the coast of which similar habitat occurs within the study area (PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast). The species has also been recorded once in the locality (approx. 5 km to the west (2003). Therefore the species is considered to have potential to occur within the study area. Based on the availability of the potential habitat, records within the locality and the species being provided in the project's CERs by the OEH this species is considered a 'subject species' for the SIS.
Fabaceae (Faboideae)	<i>Pultenaea maritima</i>			V	<i>Pultenaea maritima</i> occurs in New South Wales and Queensland and is restricted to grasslands on exposed coastal headlands. Within NSW, the species has been recorded from Newcastle north to Byron Bay (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – species is known to occur within grassland and exposed heathland on coastal headlands of which no similar habitats were recorded within the study area. In addition the study area is outside the species known distribution range (i.e. Newcastle to Byron Bay). Therefore, it is considered unlikely that the species would occur.
Fabaceae (Mimosoideae)	<i>Acacia bynoeana</i>	Bynoes Wattle	V	E1	Occurs in the Cessnock area within Kurri Sand Swamp Woodland and south of Dora Creek-Morriset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with <i>Corymbia gummifera</i> , <i>Eucalyptus haemastoma</i> , <i>E. gummifera</i> , <i>E. parramattensis</i> , <i>E. sclerophylla</i> , <i>Banksia serrata</i> and <i>Angophora bakeri</i> (NSW National Parks and Wildlife Service 1999a).	EPBC Search, OEH Profile search – Wyong sub-region	Low - species is known to occur within heath or dry sclerophyll forests on sandy soils of which no similar habitats were recorded within the study area. In addition the species has not been recorded within the locality (nearest record >15 km from study area). Therefore, it is considered unlikely that the species would occur.
Geraniaceae	<i>Pelargonium</i> sp. <i>Striatellum</i> (G. W. Carr 10345), syn. <i>Pelargonium</i> sp., <i>Pelargonium</i> sp. 1	Omeo Stork's-bill	E	E1	Known to occur in New South Wales and Victoria in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes and in the transition zone between surrounding grasslands or pasture and the paludal and aquatic communities. During dry periods, the species is known to colonise exposed lake beds (NSW Scientific Committee 2010).	EPBC Search	Low – the species is known to occur in lakes and their transition zones of which no suitable habitat was recorded within the study area. The study area occurs outside the known distribution range of the species (i.e. Monaro and Lake Bathurst). Therefore, it is considered unlikely that the species would occur.
Juncaginaceae	<i>Maundia triglochinosoides</i>	-		V	Occurs north from Sydney. Grows in swamps, creeks or shallow freshwater 30 to 60 cm deep on heavy clay, low nutrients. Associated with wetland species such as <i>Triglochin procerum</i> (Harden 1993).	project CERs, Bionet Search, OEH Profile search – Wyong sub-region, PlantNet	Moderate – the species is known to occur within swamp, wetland and shallow freshwater habitats of which similar habitat occurs within the study area (PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast). The species has also been recorded within the locality (closest record approx. 2 km to the north (1990)). Based on the availability of the potential habitat, records within the locality and the species being provided in the project's CERs by the OEH this species is considered a 'subject species' for the SIS.

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Lamiaceae	<i>Prostanthera askania</i>	Tranquility Mintbush	E	E1	Occurs over a very restricted geographic range (of less than 12 km) in the upper reaches of creeks that flow into Tuggerah Lake or Brisbane Water within the Wyong and Gosford local government areas. Eight populations are known from the catchments of Ourimbah Creek, Narara Creek, Dog Trap Gully, Chittaway Creek and Berkeley Creek. A further two populations are known from the Erina Creek–Fires Creek catchment. Occurs adjacent to, but not immediately in, drainage lines on flat to moderately steep slopes formed on Narrabeen sandstone and alluvial soils derived from it. Occurs in moist sclerophyll forest and warm temperate rainforest communities, and the ecotone between them. These communities are generally tall forests with a mesic understorey; Sydney Blue Gum Eucalyptus saligna and Turpentine Syncarpia glomulifera are usually present, though canopy species present can be highly variable (Office of Environment and Heritage 2014g).	project CERs, Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region, PlantNet	Moderate – this species is known to occur on alluvial soils in rainforest and moist sclerophyll habitats within the catchments of Chittaway Creek and Ourimbah Creek in which the study area resides. Potential habitat for this species may occur within PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast. The species has been recorded frequently within locality (nearest record approx. 1.5 km from study area). Based on the availability of the potential habitat, records within the locality and the species being provided in the project's CERs by the OEH this species is considered a 'subject species' for the SIS.
Lamiaceae	<i>Prostanthera junonis</i>	Somersby Mintbush	E	E1	Grows in sclerophyll forest and woodland, usually near the coast, in sandy loamy soils, overlying sandstone. Occurs in Mangrove Mountain and Sydney districts (Harden 1992).	EPBC Search, OEH Profile search – Wyong sub-region	Low – the species is known to occur in open forest, low woodland and/or open scrub restricted to the Somersby Plateau. The study area does not contain potential habitat for the species and is outside the species known distribution range (approx. 11 km east of the species northern distribution limit). Although the species has been recorded at the periphery of the locality no habitat occurs within the study area therefore, it is considered unlikely that the species would occur.
Lindsaeaceae	<i>Lindsaea fraseri</i>	Frasers Screw Fern		E1	Occurs upon poorly drained, infertile soils in swamp forest or open eucalypt forest, usually as part of a ferny understorey. Confined to the far north coastal areas (Royal Botanic Gardens 2009).	OEH Profile search – Wyong sub-region	Low – this species is known to occur within swamp forest or open eucalypt forest. Although potential habitat may occur, the study area is outside the species known distribution range (i.e. north coast – north of Arrawarra). Therefore, it is considered unlikely that the species would occur.
Myrtaceae	<i>Angophora inopina</i>	Charmhaven Apple	V	V	Restricted to the Charmhaven – Wyee area where it grows in open dry sclerophyll woodland of Eucalyptus haemastoma and Corymbia gummifera with a dense shrub understorey. Occurs on deep white sandy soils over sandstone, often with some gravelly laterite (Harden 2002; NSW Scientific Committee 1998a).	OEH Profile search – Wyong sub-region	Low – the species is known to occur within open dry sclerophyll forest dominated by <i>Eucalyptus haemastoma</i> and <i>Corymbia gummifera</i> of which no suitable habitat was recorded within the study area. In addition the study area is outside the species known distribution range (approx. 8 km south of the southern distribution limit). Therefore, the species is considered unlikely to occur within the study area.
Myrtaceae	<i>Callistemon linearifolius</i>	Netted Bottle Brush		V	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies (Fairley & Moore 2002; Harden 2002; Robinson 1994) Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (NSW Scientific Committee 1999a).	OEH Profile search – Wyong sub-region	Low – the species is known to occur in a variety of dry sclerophyll habitat types of which no similar habitats occur within the study area. In addition the species has not been recorded within the locality (nearest record approx. 11 km north east of the study area). Therefore, the species is considered unlikely to occur.
Myrtaceae	<i>Darwinia glaucophylla</i>	-		V	Restricted to the Gosford LGA where it occurs between Gosford and the Hawkesbury River around Calga, Kariong and Mt Karing. It grows in sandy heath, scrub and woodlands and is often associated with sandstone rock platforms or near hanging swamps and friable sandstone shallow soils. Associated species include: <i>Banksia ericifolia</i> , <i>Acacia terminalis</i> , <i>A. oxycedrus</i> , <i>Angophora hispida</i> , <i>Hakea teretifolia</i> , <i>Bauera rubioides</i> , and in woodland: <i>Corymbia gummifera</i> , <i>C. eximia</i> , <i>Eucalyptus haemastoma</i> and <i>E. punctata</i> (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – the species is known to occur in sandy heath, scrub and woodlands in association with hanging swamps and sandstone rock platforms of which no similar habitats were recorded within the study area. It is considered unlikely that the species would occur.
Myrtaceae	<i>Eucalyptus camfieldii</i>	Heart-leaved Stringybark	V	V	Occurs in scattered locations within a restricted distribution in a narrow band with the most northerly records in the Raymond Terrace area south to Waterfall. Grows in poor coastal country in shallow sandy soils overlying Hawkesbury sandstone, in coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (Office of Environment & Heritage 2016n). Associated species frequently include Brown Stringybark (<i>E. capitellata</i>), Scribbly Gum (<i>E. haemastoma</i>), Narrow-leaved Stringybark (<i>E. oblonga</i>), Silvertop Ash (<i>E. sieberi</i>), Smooth-barked Apple (<i>Angophora costata</i>), Dwarf Apple (<i>A. hispida</i>), Red Bloodwood (<i>Corymbia gummifera</i>), Scrub She-oak (<i>Allocasuarina distyla</i>), Slender Tea Tree (<i>Leptospermum trinervium</i>), and Fern-leaved Banksia (<i>Banksia oblongifolia</i>) (Benson & McDougall 1998; Leigh <i>et al.</i> 1984).	EPBC Search, OEH Profile search – Wyong sub-region	Low – this species is known to occur within coastal heath and low open woodland on exposed sandy ridges of which no similar habitats were recorded within the study area. Although the species has been recorded within the locality, based on lack of suitable habitat it is considered unlikely that the species would occur within the study area.
Myrtaceae	<i>Eucalyptus glaucina</i>	Slaty Red Gum	V	V	Occurs from Taree to Broke where it is locally frequent but very sporadic and grows in grassy woodland on deep, moderately fertile and well-watered soil (Harden 2002). Endemic on low coastal ranges and tablelands of central NSW, Taree to Broke, also near Casino (Brooker & Kleinig 1999).	OEH Profile search – Wyong sub-region	Low – this species is known to occur in grassy woodland and dry eucalypt forest of which no similar habitats were recorded within the study area. In addition this study area is outside the species known distribution range (i.e. north coast west of Maitland between Taree and Broke and also in Casino). Therefore, it is considered unlikely that the species would occur.

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Myrtaceae	<i>Eucalyptus oblonga</i>	Narrow-leaved Stringybark		E2	This species is generally found in dry open forests on dry infertile soils on sandstone. The population at Bateau Bay does however occur on coastal sands (Office of Environment & Heritage 2016n).	Bionet Search, OEH Profile search – Wyong sub-region	Low – the species is known to occur in dry open forests of which no similar habitat was recorded within the study area. Although the species has been recorded infrequently within the locality, based on lack of suitable habitat it is considered unlikely that the species would occur.
Myrtaceae	<i>Eucalyptus parramattensis subsp. decadens</i>		V	V	Locally frequent, grows in dry sclerophyll woodland on sandy soils in low, often wet sites (Harden 2002).	OEH Profile search – Wyong sub-region	Low – the species is known to occur on low-nutrient sands subject to periodic inundation of which similar habitats occur within the study area. Although potential habitat may occur, the study area is outside the species known distribution range (southern distribution limit >30 km from the study area). Therefore, it is considered unlikely that the species would occur.
Myrtaceae	<i>Eucalyptus parramattensis subsp. parramattensis</i>	Parramatta Red Gum		E2	Occurs from the upper Goulburn Valley to Hill Top where it grows in dry sclerophyll woodland on sandy soil (Harden 2002). Endangered population in the Wyong and Lake Macquarie LGAs.	OEH Profile search – Wyong sub-region	Low – the species is known to occur in sandy alluvium substrates that supports <i>Eucalyptus robusta</i> , <i>Corymbia gummifera</i> and <i>Melaleuca</i> species of which similar habitat was recorded within the study area. Although potential habitat may occur, the study area is outside the known distribution limit for the population (southern distribution limit >9 km from the study area) which is centralised around Warnervale north of the Wyong River. Therefore, the species is considered unlikely to occur.
Myrtaceae	<i>Eucalyptus pumila</i>	Pokolbin Mallee	V	V	Now only known from a single stand near Pokolbin where it grows in sclerophyll shrubland on skeletal soil on sloping sandstone (Harden 2002). Previously recorded from Muswellbrook and Wyong (Brooker & Kleinig 1999).	PlantNet	Low – the species is known to occur in dry sclerophyll woodland with a canopy of <i>Eucalyptus fibrosa</i> , <i>Callitris endlicheri</i> and <i>Corymbia maculata</i> of which no similar habitats were recorded within the study area. In addition the study area is outside the species known current distribution range (i.e. Hunter Valley; historic records are known from Wyong area however species has not been recorded recently in these area). Therefore, it is considered unlikely that the species would occur.
Myrtaceae	<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area (NSW Scientific Committee 1998c). Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects (Department of Environment and Climate Change 2008c; Harden 2002).	project CERs, Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region, PlantNet	Recorded – this species has been previously recorded within the study area and has also been frequently recorded in high abundances within the locality. Based on the species being recorded, availability of the known habitat, records within the locality and the species being provided in the project's CERs by the OEH this species is considered a 'subject species' for the SIS.
Myrtaceae	<i>Melaleuca groveana</i>	Groves Paperbark		V	Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands. It grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry shrubby open forest and woodlands (Office of Environment and Heritage 2014e).	OEH Profile search – Wyong sub-region	Low – the species is known to occur in heath and shrubland on outcropping granite, rhyolite and sandstone on cliffs of which no similar habitats were recorded within the study area. In addition the species has not been recorded within the locality (nearest record >20 km from the study area). Therefore, it is considered unlikely that the species would occur.
Myrtaceae	<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V	E1	Occurs between Bulahdelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden 2002). On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (Department of Environment and Climate Change 2008c).	project CERs, Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Moderate – within the locality the species is known to occur in riparian forest along Ourimbah Creek of which similar habitats were recorded within the study area (PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast). This species has also been frequently recorded within the locality including a record approx. 1 km from the study area along Bangalow Creek.
Orchidaceae	<i>Caladenia porphyrea</i>	-		E1	<i>Caladenia porphyrea</i> has a highly restricted geographic distribution. It has been recorded from two localities in the Wyong local government area c. 2 km apart (NSW Department of Environment and Conservation 2006).	OEH Profile search – Wyong sub-region	Low – the species habitat preferences are relatively unknown (recorded from only two locations within the Wyong LGA). This species is not recognised by the National Herbarium of NSW and is included under the taxonomic listing for <i>Caladenia quadrifaria</i> (Royal Botanic Gardens 2016). Habitat for this species is described as slopes and ridges in sclerophyll forest, often under <i>Allocasuarina</i> species in sandy or shallow clay loams. Additionally a preliminary determination to remove the species from the TSC Act was submitted by the Scientific Committee on 4 December 2015. Given the swampy low-lying nature of the site, absence of records in then locality and that the species was not detected during previous orchid surveys conducted during the known flowering period (EMM 2015a), it is considered unlikely that species may occur within the study area.

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Orchidaceae	<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	V	E1	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a heathy or sometimes grassy understorey (Bishop 2000). Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas (NSW Scientific Committee 2002).	project CERs, EPBC Search, OEH Profile search – Wyong sub-region	Low – the species is known to occur within grassy sclerophyll forest of which no similar habitat was recorded within the study area. A population of this species has been previously recorded from Porters Creek Wetland although despite regular searches no specimens have been recorded since 1999 (NSW Scientific Committee 2008). Habitat recorded for this population has been described as heathland with open forest on a hilltop associated with transitional vegetation of Spotted Gum/Smooth-barked Apple/Stringybark Open Forest and Low Swamp Forest Woodland (Wyong Shire Council 2000). Given the swampy low-lying nature of the site, absence of recent records in the locality and that the species was not detected during previous orchid surveys conducted during the known flowering period (EMM 2015a), it is considered unlikely that species may occur within the study area. Notwithstanding the low likelihood of occurrence the species is identified in the project's CERs by the OEH for consideration as a 'subject species' for the SIS. Given this, <i>Caladenia tessellata</i> will be considered as a subject species for further assessment as part of this SIS.
Orchidaceae	<i>Corunastylis sp. Charmhaven</i>	-		CE	Corunastylis sp. Charmhaven (NSW896673) is currently only known from the former the Wyong Shire, now part of the Central Coast Council of NSW where it is restricted to a single location in the Gorokan/Charmhaven area in low woodland to heathland with a shrubby understorey and ground layer. Dominants include <i>Allocasuarina littoralis</i> , <i>Leptospermum juniperinum</i> , <i>Melaleuca nodosa</i> , <i>Callistemon linearis</i> and <i>Schoenus brevifolius</i> . (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – the species is known to occur within in low woodland or heath of which no similar habitat was recorded within the study area. In addition the species has not been recorded within the locality (nearest record approx. 20 km from study area). Based on lack of suitable habitat, the study area being outside the limits of the species known distribution and absence of records in the locality, it is considered unlikely that the species would occur within the study area.
Orchidaceae	<i>Corybas dowlingii</i>	Red Helmet Orchid		E1	<i>Corybas dowlingii</i> is a tuberous orchid, forming clonal colonies. It commonly occurs in gullies of tall open forest, typically between 10 and 200 m elevation and on well-drained gravelly soil (Jones 2006; Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – the species is known to occur on well-drained gravelly soil on south facing slopes of which no similar habitat was recorded within the study area. In addition the study area is located outside the species known distribution range (approx. 30 km south of the southern distribution limit) and has not been recorded within the locality. Therefore, it is considered unlikely that the species would occur within the study area.
Orchidaceae	<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Harden 1993; NSW National Parks and Wildlife Service 1999g).	EPBC Search, OEH Profile search – Wyong sub-region	Low – the species is known to occur in a variety of habitats within the Hunter–Central Rivers although the PCT vegetation associations recorded within the study area are not listed as essential habitat for this species (Office of Environment & Heritage 2016n). Further, this species has not been recorded within the locality, with the nearest record approx. 10km from the study area at Somersby. Specimens at this location were recorded growing in sandstone heath woodland. Therefore, given the lack of records in the locality and the absence of essential PCT habitats, it is considered unlikely that the species may occur within the study area.
Orchidaceae	<i>Cymbidium canaliculatum</i>	Tiger Orchid		E2	In the Hunter Catchment, the endangered population of this species grows singularly or in clumps in tree hollows, commonly between two to six metres above the ground. Found in woodlands and dry sclerophyll forests dominated by <i>Eucalyptus albens</i> , and less commonly found on <i>E. dawsonii</i> , <i>E. crebra</i> , <i>E. moluccana</i> , <i>Angophora floribunda</i> and <i>Acacia salicina</i> . Scattered, non-endangered populations of this species exist across northern Australia, from NSW to Western Australia (NSW Scientific Committee 2006).	OEH Profile search – Wyong sub-region, OEH Profile search – Wyong sub-region	Low – the study area is not located within the Hunter Catchment as defined by Australia's River Basins (1997) as outlined in the scientific determination for the species and therefore this population is not considered further.
Orchidaceae	<i>Dendrobium melaleucaphilum</i>	Spider Orchid		E1	Occurs in coastal districts, north from the lower Blue Mountains. It grows frequently on <i>Melaleuca styphelioides</i> , less commonly on rainforest trees or on rocks (Department of Environment and Conservation 2005d; Royal Botanic Gardens 2005).	OEH Profile search – Wyong sub-region	Moderate - the species is known to occur on <i>Melaleuca styphelioides</i> , rainforest trees and rocks of which marginal habitat occurred within the study area. The study area is outside the species current known distribution (nearest records approx. 200 km from study area with a single historic record within locality (1935)). Although the study area is outside the species known distribution range potential habitat does occur and therefore the species is considered to have potential to occur within the study area.
Orchidaceae	<i>Diuris bracteata</i>	-	X	E1	Previously presumed extinct however in recent years extant populations from north-west of Gosford have been recorded and this area is now the only known area of occurrence of the species. All known plants fall within the Gosford and Wyong Local Government Areas. Occurs in Dry sclerophyll woodland and forest with a predominantly grassy understorey (Office of Environment and Heritage 2014c).	OEH Profile search – Wyong sub-region	Low – this species is known to occur only within with dry sclerophyll forest with predominantly grassy understoreys of which no similar habitat was recorded within the study area. Although the species has been previously recorded within the locality no habitat was recorded within the study area, therefore, the species is considered unlikely to occur within the study area.

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Orchidaceae	<i>Diuris praecox</i>	Rough Double Tail	V	V	Occurs in coastal and near-coastal districts from Ourimbah to Nelson Bay where it grows in sclerophyll forest (Harden 1993) often on hilltops or slopes (Bishop 2000).	OEH Profile search – Wyong sub-region	Low – the species is known to occur on hilltops or slopes within sclerophyll forest in coastal and near-coastal districts of which no similar habitat was recorded within the study area. Although the species may have been recorded at the periphery of the locality no potential habitat for the species was recorded within the study area, therefore, it is considered unlikely that the species would occur.
Orchidaceae	<i>Genoplesium baueri</i>	Bauers Midge Orchid		V	Grows in dry sclerophyll forest and moss gardens over sandstone. The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from northern Sydney suburbs. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments (Office of Environment and Heritage 2014a).	EPBC Search	Low – the species is known to occur within dry sclerophyll forest and moss over sandstone of which no similar habitat was recorded within the study area. In addition the study area is outside the species known distribution range (approx. 30 km north of the northern distribution limit). Therefore the species is considered unlikely to occur.
Orchidaceae	<i>Genoplesium insigne</i>	Variable Midge Orchid	CE	E1	This terrestrial orchid occurs between Chain Valley Bay and Wyong in Wyong local government area. It grows in heathland and forest and is associated with <i>Themeda australis</i> amongst shrubs and sedges. Typically it occurs in dry sclerophyll woodland dominated by <i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i> , <i>Angophora costata</i> and <i>Allocasuarina littoralis</i> (Department of Environment and Climate Change 2009b).	OEH Profile search – Wyong sub-region	Low – the species is known with <i>Themeda triandra</i> (formerly <i>T. australis</i>) amongst shrubs and sedges in heathland and forest of which no similar habitat was recorded within the study area and the species has not been recorded within the locality (nearest record >15 km from the study area). This species is now known from only three extant populations (Charmhaven and Chain Valley Bay), the two populations from Wyong and Toukley are now considered to be extinct. Given the lack of suitable habitat and absence of recent records from the locality, it is considered unlikely that this species would occur within the study area.
Orchidaceae	<i>Rhizanthella slateri</i>	Eastern Australian Underground Orchid	E	V	Highly cryptic as only the flowers may occur above ground. It is more frequent in areas of soil disturbance, but further habitat characteristics or associated vegetation types are poorly known, possibly occurring in sclerophyll forests (Harden 1993).	EPBC Search	Low – within the Hunter–Central Rivers catchment management region essential habitat for this species is unknown however it is known to occur within wet sclerophyll grassy and shrubby forests in the Karuah Manning sub-region (Office of Environment & Heritage 2016n). The species has not been recorded within the locality (nearest record approx. 30 km from the study area) and is not predicted or known from the Wyong sub-region (Office of Environment & Heritage 2016n). The absence of known or predicted habitat and lack of any records from the locality it is considered unlikely that the species may occur within the study area.
Orchidaceae	<i>Thelymitra sp. Adorata</i>	Wyong Sun Orchid		CE	Species known distribution occurs within five local populations within the Wyong Local Government Area. It occurs from 10–40 m elevation in grassy woodland or occasionally in derived native grassland on well-drained clay loam or shale derived soils. The majority of populations have been recorded within Dooralong Spotted Gum – Ironbark Forest with <i>Corymbia maculata</i> and <i>Eucalyptus paniculata</i> with a sparse understory of <i>Melelaueca nodosa</i> . May also be found in Alluvial Redgum Foothills Forest and Alluvial Floodplain Shrub Swamp Forest which adjoin known habitat (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – species is known to occur on clay loam or shale derived soils in grassy woodland or occasionally derived native grassland (predominantly within Spotted Gum – Ironbark Forest) of which no similar habitat was recorded within the study area. Although the species is known to occur within the locality the study area does not contain potential habitat for the species, therefore it is considered unlikely that the species would occur.
Polygonaceae	<i>Muehlenbeckia costata</i>	Scrambling Lignum		V	This climber has sporadic distribution on North Coast and Northern and Central Tablelands, with one record near Newcastle in a SRA. Inhabits rocky sites at higher altitude, specifically coarse sands and peat in heath, mallee or open eucalypt woodland that exist on granite or acid volcanic outcrops. Responds to disturbance especially fire and clearing for powerlines ((Royal Botanic Gardens 2008).	OEH Profile search – Wyong sub-region	Low – the species is known to occur in a range of habitat types at high altitudes of which no similar habitat for the species was recorded within the study area. In addition the study area is outside the species known distribution range (approx. 50 km south of the southern distribution limit (1999)). Therefore, it is considered unlikely that the species would occur.
Polygonaceae	<i>Persicaria elatior</i>	Tall Knotweed	V	V	Occurs infrequently in coastal regions where it grows in damp places especially beside streams and lakes. Also occasionally occurs in swamp forest or associated with disturbance (Department of Environment and Conservation 2005d; Harden 2000).	OEH Profile search – Wyong sub-region	Moderate – the species is known to occur in damp places and occasionally occur in swamp forest of which marginal habitat was recorded within the study area. The species has been recorded within the broader locality (nearest record >25 km from the study area). Although the species has not been recorded within the locality potential habitat was recorded within the study area therefore the species is considered to have potential to occur within the study area.
Proteaceae	<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	V	V	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales (Harden 2002; NSW Scientific Committee 1998b).	EPBC Search, OEH Profile search – Wyong sub-region, PlantNet	Low – species is known to occur within dry sclerophyll woodlands of which no similar habitats were recorded within the subjects site. In addition the species has not been recorded within the locality (nearest record >10 km north of the study area). Therefore, the species is considered unlikely to occur.

Family name	Scientific name	Common name	EPBC Act ¹	TSC Act ²	habitat	Data source ³	Likelihood of occurrence ⁴
Proteaceae	<i>Grevillea shiressii</i>		V	V	Known from two populations near Gosford, on tributaries of the lower Hawkesbury River north of Sydney (Mooney Mooney Creek and Mullet Creek). Both populations occur within the Gosford Local Government Area. There is also a naturalised population at Newcastle. Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils (Office of Environment and Heritage 2014d).	OEH Profile search – Wyong sub-region	Low – the species is known to occur along creek banks in wet sclerophyll forest on alluvial sandy or loamy soils of which similar habitat was not recorded within the study area. In addition the species is not known from the Hunter–Central Rivers CMA and is outside of the species known distribution (nearest record approx. 12 km). Therefore, the species is considered unlikely to occur.
Proteaceae	<i>Persoonia hirsuta</i>	Hairy Geebung	E	E1	The species is distributed from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west. It has a large area of occurrence, but occurs in small populations. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone or very rarely on shale (Harden 2002; Office of Environment and Heritage 2015b). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997).	OEH Profile search - Wyong sub-region	Low – species is known to occur within dry sclerophyll open woodlands of which no similar habitats were recorded within the study area. In addition the study area is outside the species known distribution range (approx. 20 km north of the northern distribution limit). Therefore, it is considered unlikely that the species would occur.
Rutaceae	<i>Asterolasia elegans</i>		E	E1	Known from only seven populations, north of Sydney in the Baulkham Hills, Hawkesbury and Hornsby LGAs; also likely to occur in the western part of Gosford LGA. Occurs on Hawkesbury sandstone in sheltered forests on mid-to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>), Smooth-barked Apple (<i>Angophora costata</i>), Sydney Peppermint (<i>Eucalyptus piperita</i>), Forest Oak (<i>Allocasuarina torulosa</i>) and Christmas Bush (<i>Ceratopetalum gummiferum</i>) (Office of Environment and Heritage 2015a).	EPBC Search	Low – this species is known to occur on Hawkesbury Sandstone in sheltered forest of which no suitable habitat was recorded within the study area. In addition the study area is outside the species known distribution range (approx. 30 km north of northern distribution limit). Therefore, it is considered unlikely that this species would occur.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be <i>Themeda australis</i> and <i>Poa</i> spp. (Department of Environment and Climate Change 2008c; Harden 1992).	EPBC Search	Low – the species is known to occur within grassland and grassy woodland on coastal headlands on away from the coast of which no suitable habitat was recorded within the study area. In addition the species has not been recorded within the locality (nearest record >60 m from the study area). Therefore, it is considered unlikely that the species would occur.
Zannichelliaceae	<i>Zannichellia palustris</i>	-		E1	Grows in fresh or slightly saline stationary or slowly flowing water (Royal Botanic Gardens 2005).	OEH Profile search - Wyong sub-region	Low – the species is known to occur in freshwater and slightly saline or slow flowing water (such as saltmarshes and freshwater lagoons) of which no suitable habitat was recorded within the study area. In addition the study area is outside the species known distribution range (nearest records centralised around Newcastle region approx. 40 km from the study area), therefore it is considered unlikely that the species would occur.

(1) Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

(2) Listed as Vulnerable, Endangered or Critically Endangered under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

(3) Data source: project CERs = Kangy Angy Chief Executive Requirement subject species, EPBC Search = DoE's EPBC Protected Matters Search Tool; PlantNet = Royal Botanic Gardens PlantNet spatial database; OEH Profile Search – Wyong sub-region spatial search and BioNat search = OEH's BioNet Atlas of NSW Wildlife.

(4) Likelihood of occurrence as outlined in Table 3.3.

Table 3.5 Initial likelihood of occurrence assessment for threatened fauna species known or with potential to occur within the subject site

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
Invertebrates						
<i>Petalura gigantea</i>	Giant Dragonfly		E1	Found in permanent wetlands, both coastal and upland from Moss Vale northwards to southern Queensland (Department of Environment and Conservation 2005d).	OEH Profile search – Wyong sub-region	Low – The Giant Dragonfly has been recorded from both coastal and upland permanent wetlands. The project study area did not comprise permanent wetland habitat and this species is considered to have a low likelihood of occurrence in the study area.
Fish						
<i>Epinephelus daemeli</i>	Black Cod	V	V	Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries. Black cod are opportunistic carnivores, eating mainly other fish and crustaceans. They can change from one colour pattern to another in just a few seconds. They are usually black in estuaries and banded around clear water reefs. Black cod are apparently slow growing. Smaller fish are mostly females, but they generally change sex to become males at around 100–110 cm in length. (Department of Primary Industries 2005).	EPBC Search	Low – No habitat is available for this species in the project study area.
<i>Macquaria australasica</i>	Macquarie Perch	E		The natural range of Macquarie Perch included the upper and middle reaches of the Murray–Darling basin as well as the Shoalhaven and Hawkesbury Rivers. However, this species has recently been sighted in only a few localities within these river systems. Preferred habitat is deep holes covered with rocks, and spawning occurs above shallow running water. Macquarie Perch is a schooling species (Department of Environment and Climate Change 2007c).	EPBC Search	Low – The study does not occur in the known distribution for this species.
Amphibians						
<i>Litoria aurea</i>	Green and Golden Bell Frog	V	E1	This species occurs in fragment patches near coastal locations from Vic to south of the NSW–QLD border. For breeding it utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral wetlands. It is found in small pockets of habitat in otherwise developed areas and can occur in disturbed sites. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes which include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover used for foraging and shelter. Over-wintering shelter sites may be adjacent to or some distance away from breeding sites but the full range of possible habitat used is not yet well understood (Department of Environment and Conservation 2004a, 2005b).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Low – Expert advice received regarding the Green and Golden Bell Frog found that there was no suitable foraging or shelter habitats within the project area for this species. Assessment of the study area for breeding habitat found that there was a single depression that may be suitable under optimum conditions, but possible utilisation by the frogs is unlikely due to surrounding dense forest habitat that is not suitable for the Green and Golden Bell Frog (refer to Appendix C).
<i>Litoria brevipalmata</i>	Green-thighed Frog		V	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain (Department of Environment and Climate Change 2009b). Breeding occurs following heavy rainfall in late spring and summer, with frogs aggregating around grassy semi-permanent ponds and flood-prone grassy areas. The frogs are thought to forage in leaf-litter. Isolated localities along the coast and ranges from the NSW central coast to south-east Queensland.	Bionet Search, OEH Profile search – Wyong sub-region	Low – Expert advice received regarding the Green-thighed Frog found that foraging habitat within the project area for this species was of low quality, due to the small areas of potential habitat within unsuitable habitat types. Assessment of the study area for breeding habitat found that there were no suitable ephemeral ponds within the project area for Green-thighed Frog (refer to Appendix C).
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog, Heath Frog	V	V	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee 2000a).	EPBC Search, OEH Profile search – Wyong sub-region	Low – Breeding habitat for Littlejohn's Tree Frog is associated with upper reaches of permanent rocky streams with fringing vegetation and perched swamps. Foraging habitat includes shrub and groundcover within 100 m of breeding habitat. The study area does not constitute breeding or foraging habitat and this species is considered to have a low likelihood of occurrence in the project study area.
<i>Crinia tinnula</i>	Wallum Froglet		V	Occurs along coast from south-eastern Queensland to Sydney. Mostly associated with swamps, dams and flooded roadside ditches, usually in heathland, where it is confined to acid, paperbark swamps and sedge swamps of the 'wallum' country. Males call any time of year. Breed in late winter (Anstis 2002; NSW National Parks and Wildlife Service 2002c).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – The Wallum Froglet is typically associated with acidic swamps on coastal sandplains, occurring in sedgeland and wet heathlands. They are also occasionally found in swamp sclerophyll forest. Within the project study area, this species is considered to have a moderate likelihood of occurrence in Swamp Forest habitat.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	V	Exists as two distinct populations: a northern population on the sandstone geology of the Sydney Basin, from Wollemi National Park in the north, south to Jervis Bay; and a southern population in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys where the frog is associated with small headwater and slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from collected water. Also observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised and are surrounded by undisturbed habitat. In the southern population, records appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. It is absent from areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	EPBC Search, OEH Profile search – Wyong sub-region	Low – Giant Burrowing Frog is confined to sandstone ridgetop habitat and upland valleys where it is associated with small headwater and slow flowing/intermittent creek lines. Such habitat does not occur in the project study area and this species is considered to have a low likelihood of occurrence therein.
<i>Mixophyes balbus</i>	Stuttering Frog	V	E1	Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (Cogger 2000; NSW Scientific Committee 2003).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Low – Although the Stuttering Frog occupies streams in rainforest or tall open wet forest in foothills and escarpment on the eastern side of the Great Dividing Range, within the Wyong sub-catchment area, this species is typically associated with relatively wide flat sections of first order (headwater) mountain streams at the top of a catchment, with populations known from higher altitudes in the Watagan Mountains. In the study area, Chittaway Creek and Bangalow Creek, do not occur as first order streams with the project occurring at low elevation, effectively on the floodplain of Chittaway, Bangalow and Ourimbah Creeks. Further, whilst rainforest (riparian) habitat associated with these creeks was in good condition, they lacked the protective buffer of other forest habitat types, which were absent due to land managed for rural residential land holdings; effectively occurring as a thin riparian corridor in an otherwise cleared landscape. Accordingly, this species was considered to have a low likelihood of occurrence in the study area.
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E1	Terrestrial species which occurs in rainforests, Antarctic beech or wet sclerophyll forests. Feeds on insects and smaller frogs (Cogger 2000). The species is associated with permanent flowing drainages, from shallow rocky rainforest streams to slow-moving rivers in lowland open forest. It is not known to utilise still water areas (NSW Scientific Committee 1999b). More prevalent at lower altitudes and in larger streams than its congeners, although has been recorded up to 1000 metres asl. (NSW National Parks and Wildlife Service 1999g).	EPBC Search, OEH Profile search – Wyong sub-region	Moderate – The Giant Barred Frog is associated with permanent flowing drainages, from slow flowing rocky rainforest streams to slow-flowing rivers in lowland open forest. Within proximity to the project study area, five populations of this species is known from the Watagan Mountains area (Department of the Environment 2016d). As this species has been found in disturbed habitats (i.e. vegetated riparian strips in agricultural lands used to run livestock) in the lower reaches of streams, this species was considered to have moderate likelihood of occurrence in the project study area.
<i>Pseudophryne australis</i>	Red-crowned Toadlet		V	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs (Cogger 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Low – The Red-crowned Toadlet is localised species that is largely restricted to the immediate vicinity of ephemeral creeks and gutters below sandstone ridges. Such habitat does not occur in the study area and this species is considered to have low likelihood of occurrence therein.

Reptiles

<i>Caretta caretta</i>	Loggerhead Turtle	EM	E1	Ocean dwellers that generally forage in deep water (NSW National Parks and Wildlife Service 2002c). Females come ashore during summer to lay eggs on beaches, with some nesting sites recorded in northern NSW (Office of Environment & Heritage 2016n).	OEH Profile search – Wyong sub-region	Low – The Loggerhead occur in coral reefs, bays and estuaries in tropical and warm temperate waters. Such habitats do not occur within the study area and the species would not occur therein.
<i>Chelonia mydas</i>	Green Turtle	VM	V	The species has been recorded in coastal waters of all Australian states. Nesting has been recorded in the vicinity of Shark Bay and Lacépède Islands in Western Australia, Cobourg Peninsula in the Northern Territory, and in the Gulf of Carpentaria, Raine Island, and the Capricorn and Bunker Groups of islands on the southern Barrier Reef in Queensland (Cogger <i>et al.</i> 1993).	OEH Profile search – Wyong sub-region	Low – The Green Turtle occur in seaweed rich coral reefs and inshore seagrass pastures in tropical and subtropical areas of the Indo-Pacific region. Such habitats do not occur within the study area and the species would not occur therein.
<i>Dermochelys coriacea</i>	Leatherback Turtle, Leathery Turtle	VM	E1	Marine species that can occur in bays, estuaries and rivers where they feed. Found in all coastal waters of Australia, but more commonly in temperate waters. Known to nest occasionally in Queensland (Cogger 2000).	OEH Profile search – Wyong sub-region	Low – the Leatherback Turtle is a highly pelagic species that ventures close to shore mainly during the nesting season, where they require sandy beaches to nest. Such habitats do not occur within the study area and the species would not occur therein.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake		V	A partly arboreal, nocturnal species found in a range of habitats from rainforest and wet sclerophyll forest to the drier eucalypt forests of the western slopes. Feeds largely on frogs and lizards (Cogger 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – The Pale-headed Snake is a highly cryptic species, which can spend weeks at a time hidden in tree hollows. This species seeks shelter during the day between loose bark and tree trunks, or in hollow trunks and dead limbs of trees. Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a general paucity of tree hollows and understorey debris, potentially suitable habitat for this species occurred in rainforest, swamp forest and wet open forest habitat types in the project study area.
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	V	E1	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb & Shine 1994, 1998).	EPBC Search, OEH Profile search – Wyong sub-region	Low – The Broad-headed Snake is associated with exposed cliff edges and sandstone rock outcropping, where it shelters in rock crevices and under flat sandstone rocks during autumn, winter and spring. During summer, this species seeks shelter in hollows of large trees within 500 m of their escarpment habitat. The project study area did not comprise habitat suitable for habitation by this species and it is considered to have a low likelihood of occurrence therein.
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake		V	Found in coastal areas from Gosford district to southern QLD. Arboreal snake usually encountered in the wetter sclerophyll or rainforests which occur within its range (Cogger 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – In the project study area, potentially suitable habitat for this species comprised rainforest, swamp forest and wet open forest type habitats.
<i>Varanus rosenbergi</i>	Heath Monitor (Rosenberg's Goanna)		V	Found in coastal heaths, humid woodlands, and wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in burrows, hollow logs and rock crevices (Cogger 2000).	OEH Profile search – Wyong sub-region	Low – Within the Hunter Central River Catchment Management Region, the Heath Monitor is associated with Sydney Coastal Dry Sclerophyll Forests, Sydney Hinterland Dry Sclerophyll Forests, Western Slopes Dry Sclerophyll Forests, Coastal Valley Grassy Woodlands and Sydney Coastal Heaths (Office of Environment & Heritage 2016n). Critical habitat components include termite mounds, within which this species nests. The study area did not comprise appropriate habitat types and lacked critical habitat components (termite mounds). Accordingly, this species is considered to have a low likelihood occurrence in the study area.
Birds						
<i>Ptilinopus superbus</i>	Superb Fruit-Dove		V	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lily pillies and blackberries (Pizzey & Knight 2007).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Although the Superb Fruit-dove is rarely seen locally, like other fruit-dove species they are nomadic users of rainforest habitats for fruiting trees. Most records in central NSW are a consequence of window collisions at night, which suggests movements locally may be more regular than sightings suggest. There is suitable habitat within the study area and although likely to be rare it's occurrence within the study area on an intermittent basis cannot be discounted.
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove		V	Occurs in subtropical and dry rainforests and occasionally in moist eucalypt forests and swamp forests where fruit is plentiful. They are thought to move locally as they follow the ripening fruit (NSW National Parks and Wildlife Service 2002c).	OEH Profile search – Wyong sub-region	Moderate – Although the Rose-crowned Fruit-dove is rarely seen locally, like the Wompoo Fruit-dove they are nomadic users of rainforest habitats for fruiting trees. There is suitable habitat within the study area and although likely to be rare it's occurrence within the study area on an intermittent basis cannot be discounted.
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove		V	Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country (Garnett & Crowley 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Although the Wompoo Fruit-dove is rarely seen locally, they are nomadic users of rainforest habitats for fruiting trees. There is suitable habitat within the study area and although likely to be rare it's occurrence within the study area on an intermittent basis cannot be discounted.
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork		E1	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett & Crowley 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Low – The Black-necked Stork forages in freshwater and estuarine wetlands and lakes. They breed in floodplain habitats in northern Australia south to the northern Hunter Region. Suitable breeding and foraging habitats do not occur within the study area. Therefore this species is considered unlikely to occur within the study area.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E1	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002c).	EPBC Search, OEH Profile search – Wyong sub-region	Low – The Australasian Bittern is a wetland bird that frequents freshwater and brackish swamps, in which it forages and breeds. Such habitats do not occur within the vicinity of the study area so it is considered unlikely to occur.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Ixobrychus flavicollis</i>	Black Bittern		V	Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002c).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Locally the Black Bittern uses the lower reaches of coastal creeks and rivers. Bangalow Creek represents suitable habitat for this species and it may occur in the study area on at least an intermittent basis.
<i>Pandion cristatus</i> (syn. <i>P. haliaetus</i>)	Eastern Osprey	M	V	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish (Pizzey & Knight 2007).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Low – The Osprey is a specialised fish hunting species generally using shallow estuary or coastal embayments. They nest in the top of a prominent tree or man-made structure. There are no suitable nesting sites or hunting habitats for this species within the study area, therefore it is not considered likely to occur.
<i>Lophoictinia isura</i>	Square-tailed Kite		V	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes (Garnett & Crowley 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – The Square-tailed Kite occurs locally on a seasonal basis and moves widely within its home range. It forages and breeds in woodland habitats, so much of the study area is suitable for its foraging habits, due to the presence of passerine bird habitat. Although rare locally, the study area is likely to represent part of the foraging range for individuals occurring locally.
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		V	Distributed throughout most of inland Australia and prefers arid scrubland, and open woodlands. Feeds on small mammals and birds (Garnett & Crowley 2000).	OEH Profile search – Wyong sub-region	Low – The Black-breasted Buzzard is an inland species occurring in arid and semi-arid habitats. Movements to coastal areas are likely due to drought driven movements out of their core distribution areas. Local records are accidental and rare and there is no habitat within the study area that it is dependent upon. Therefore it is considered unlikely to occur.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle		*V	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	Bionet Search, OEH Profile search – Wyong sub-region, Bionet Search (species under preliminary determination)	Low – although the White-bellied Sea-Eagle occurs widely in the locality of the site it favours wetland and estuarine habitats for foraging and requires large trees for nest sites. The study area does not contain suitable habitat, which is important for the life-cycles of this species.
<i>Circus assimilis</i>	Spotted Harrier		V	The Spotted Harrier occurs throughout the Australian mainland in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) (Marchant & Higgins 1993). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The diet of the Spotted Harrier includes terrestrial mammals, birds and reptiles, occasionally large insects and rarely carrion (Department of Environment Climate Change and Water 2010a).	OEH Profile search – Wyong sub-region	Low – The Spotted Harrier is a western plains species that sometimes extends its range to near coastal locations, notably to the north in the Lower Hunter Region. Local records for this species in the study area's locality are likely very intermittent and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.
<i>Erythrotriorchis radiatus</i>	Red Goshawk	VM	CE	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 metres which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest (Garnett & Crowley 2000).	OEH Profile search – Wyong sub-region	Low – There are no records for the Red Goshawk locally and this species has been absent from the central NSW coastal area for many years. It's rare in far northern NSW and its stronghold is in northern Australia. Due to its status in the study area region and the lack of local records, this species is considered unlikely to occur.
<i>Hieraaetus morphnoides</i>	Little Eagle		V	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Prey includes birds, reptiles and mammals, with the occasional large insect and carrion. Most of its former native mammalian prey species in inland NSW are extinct and rabbits now form a major part of the diet (Marchant & Higgins 1993).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – The Little Eagle occurs in the study area locality and moves widely within its home range. It forages and breeds in open woodland habitats, so much of the study area is not suited to its foraging habits, due to dense understory strata. Nevertheless, open and managed habitats within the study area may represent part of the foraging habitat of local individuals, so its potential intermittent occurrence within the study area cannot be discounted.
<i>Falco subniger</i>	Black Falcon		V	Widely, but sparsely, distributed in New South Wales, mostly occurring woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. It is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. Habitat selection is generally influenced more by prey densities than by specific aspects of habitat floristics or condition, although in agricultural landscapes it tends to nest in healthy, riparian woodland remnants with a diverse avi-fauna (NSW Scientific Committee 2013).	Bionet Search, OEH Profile search – Wyong sub-region	Low – The Black Falcon generally has a much more westerly distribution than the study area locality. Nevertheless, during certain climatic conditions individuals move into near coastal areas, particularly in the Hunter Region to the north. Although this species is relatively aerial in its habits, the study area does not contain habitat suited to its hunting habits for ground frequenting birds. There are no local records and unsuitable habitat therefore it is considered unlikely that the Black Falcon would occur within the study area.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Burhinus grallarius</i>	Bush Stone-curlew		E1	Inland habitat consists of open forest and woodlands with few, if any, shrubs, and short, sparse grasses of less than 15 cm in height, with scattered fallen timber, leaf litter and bare ground present (Department of Environment and Conservation 2006a). In coastal areas, structurally similar elements of tidal and estuarine communities (Casuarina woodlands, saltmarsh and mangroves) provide suitable habitat (Price 2004). Nesting sites are frequently located in relatively open areas, where ground cover is extremely low and/or sparse including native vegetation and mown lawns, ploughed paddocks and paddocks cut for hay, dirt and gravel roads, seaweed on sand beach, playing fields, vacant lots (Department of Environment and Conservation 2006a).	Bionet Search, OEH Profile search – Wyong sub-region	Low – The Bush Stone-curlew is an open woodland bird found locally in Brisbane Waters National Park and near shoreline and open habitats around Brisbane Waters in the Gosford local government area. The majority of the site does not contain suitable open understorey habitat for this species and there are no known records in the vicinity of the study area. Nevertheless, rare occurrences in the open managed habitats of the study area, but any potential occurrences would likely be as a consequence of accidental movements.
<i>Rostratula australis</i> (syn. <i>R. benghalensis</i>)	Australian Painted Snipe (Painted Snipe)	VM	E1	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as Eucalyptus camaldulensis (River Red Gum), E. populnea (Poplar Box) or shrubs such as Muehlenbeckia florulenta (Lignum) or Sarcocornia quinqueflora (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	EPBC Search, OEH Profile search – Wyong sub-region	Low – The Australian Painted Snipe occurs in freshwater and brackish wetlands throughout Australia, although they appear to be highly nomadic in response to the distribution of water as a consequence of their use of soft substrates for foraging purposes. There is no suitable habitat for this species within the study area.
<i>Turnix maculosus</i>	Red-backed Button-quail		V	The Red-backed Button-quail is a cryptic species and its specific ecology is poorly documented. The species is nocturnal and crepuscular and feeds on insects and seeds. They normally hide and freeze rather than flushing, although individuals will fly for short distances before dropping back to cover. Red-backed Button-quail may be encountered individually, in pairs or in small family groups. Red-backed Button-quail inhabit grasslands, woodlands and cropped lands of warm temperate areas that annually receive 400 mm or more of summer rain. Observations of populations in other parts of its range suggest the species prefers sites near water, including grasslands and sedgeland near creeks, swamps and springs, and wetlands. Red-backed Button-quail usually breed in dense grass near water, and nests are made in a shallow depression sparsely lined with grass and ground litter (Marchant & Higgins 1993).	OEH Profile search – Wyong sub-region	Low – The Red-backed Button-quail frequents coastal grasslands where they feed on grass seeds. There are no known records for the species locally and habitats within the study area are not suitable, therefore it is considered unlikely to occur.
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo		V	Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 1999b).	OEH Profile search – Wyong sub-region	Moderate – Locally the Glossy Black-Cockatoo occurs widely feeding on the nuts of <i>Allocasuarina</i> sp. trees. <i>Allocasuarina torulosa</i> (Forest Oak), which is a feed tree species for Glossy Black-Cockatoos occurs within the study area and they occur locally, so their presence within the study area cannot be discounted on at least an intermittent basis.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo		V	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey & Knight 2007).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Locally the Gang-Gang Cockatoo is generally a montane forest bird primarily feeding on the nuts of eucalypt trees. There is foraging habitat within the study and they occur locally, so their presence within the study area cannot be discounted on at least an intermittent basis.
<i>Glossopsitta pusilla</i>	Little Lorikeet		V	The Little Lorikeet is a small green lorikeet with black bill and red patch on forehead and throat. The underside is yellow-green. Immatures are duller with less red on face and brown bill. Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins, P.J. 1999).	Bionet Search, OEH Profile search – Wyong sub-region	Recorded – The Little Lorikeet was recorded feeding on Swamp Mahogany blossom in the project study area.
<i>Lathamus discolor</i>	Swift Parrot	CE	E1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering <i>Acacia pycnantha</i> , is indicated. Sites used vary from year to year. (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	High – Suitable seasonal foraging habitat occurs throughout the study area for Swift Parrots in the form of winter flowering tree species, notably Swamp Mahogany and Forest Red Gum and the Swift Parrot has been recorded in the subject site in the past. Local occurrences of Swift Parrots are highly dependent upon the distribution of blossom resources and they may not occur in some favourable locations for a number of years.
<i>Neophema pulchella</i>	Turquoise Parrot		V	The Turquoise Parrot inhabits eucalypt and cypress-pine open forests and woodlands (commonly box or box-ironbark) with native grasses, sometimes with a low shrubby understorey, often in undulating or rugged country, or on footslopes. It also lives in open woodland or riparian gum woodland, and often near ecotones between woodland and grassland, or coastal forest and heath. The Turquoise Parrot requires live or dead trees, stumps and logs for nesting, trees and shrubs for shelter, and seeding grasses and forbs (often beneath trees) for food. The Turquoise Parrot's nest is a cavity in a live or dead tree, stump or log, or even fence post often within 1–2 m of the ground. Hollows average about 0.5 m deep, with an entrance hole of 10 x 7 cm, and a nest chamber 12 x 9 cm in diameter (Garnett & Crowley 2000; Higgins, P.J. 1999).	OEH Profile search – Wyong sub-region	Low – The Turquoise Parrot's stronghold is the central western slopes of NSW, but it does approach coastal areas in the Hunter Valley to the north and in the western extremity of the Central Coast region. It is unlikely to occur with the study area due to a lack of local records and suitable habitat.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Ninox strenua</i>	Powerful Owl		V	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, Casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett & Crowley 2000).	Bionet Search, OEH Profile search – Wyong sub-region	High – Although not recorded during onsite surveys Powerful owl records are relatively plentiful in the study area locality. The study area supports habitat suited to their favoured Ringtail Possum prey, which were observed onsite, and therefore the study area likely represents part of the foraging range of Powerful Owl individuals. The study area has a single hollow-bearing tree with hollows of sufficient size to support breeding, but the large open chimney structure of the hollow is not considered suitable for this species. Therefore the study area is considered unlikely to support breeding habitat for a local pair.
<i>Ninox connivens</i>	Barking Owl		V	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett & Crowley 2000).	OEH Profile search – Wyong sub-region	Low – Barking Owl breeding territories occur to the south in the Gosford local government area and there are records to the west of Ourimbah. This species inhabits dry forest types, which are represented in the study area by relatively small patches of Blackbutt forest that are too small to support this species. Therefore it is considered unlikely to occur.
<i>Tyto tenebricosa</i>	Sooty Owl		V	Occurs in wet eucalypt forest and rainforest on fertile soils with tall emergent trees. Typically found in old growth forest with a dense understorey but also occurs in younger forests if nesting trees are present nearby. It nests in large hollows within eucalypts and occasionally caves. It hunts in open and closed forest for a range of arboreal and terrestrial mammals including introduced species and sometimes birds (Garnett & Crowley 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Although there is rainforest habitats within the study area, the Sooty Owl prefers stands of rainforest associated with tall hollow-bearing eucalypt forest, which provide habitat for breeding and their prey species. Although there are records locally, all local Sooty Owl records are associated with the surrounding ranges characterised by continuous forest areas. As such this species is considered unlikely to occur due to the open nature of areas associated with potential riparian habitats. Nevertheless as a precautionary measure, this species has been assessed as an affected species.
<i>Tyto novaehollandiae novaehollandiae</i>	Masked Owl (southern mainland)		V	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett & Crowley 2000).	Bionet Search, OEH Profile search – Wyong sub-region	Low – The Masked Owl's diet consists predominantly of terrestrial mammals, which the study area has in abundance. Nevertheless, the density of understorey strata preclude hunting opportunities for this species within the study area and the site does not contain hollows suited to the breeding requirements of this species. Therefore it is considered unlikely that the study area is important to local Masked Owl individuals.
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)		V	Found in eucalypt woodlands and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly in habits woodlands dominated by stringybarks or other rough-barked eucalypts. Nesting occurs in tree hollows (Department of Environment and Conservation 2005a).	OEH Profile search – Wyong sub-region	Low – The Brown Treecreeper is a western dry woodlands species that only rarely occurs in near coastal locations, notably to the north in the Lower Hunter Region. Local records for this species in the study area's locality are likely accidental and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E1	The habitat of the Eastern Bristlebird is characterised by low dense vegetation. Fire is a feature of all areas where known populations occur. Given the poor flight ability of the species it is thought that few individuals survive the passage of fire, survival is dependant on the availability of fire refuges and recolonisation may be relatively slow. The bird is cryptic and camouflaged and rarely seen but may be detected by its distinctive, loud calls. Confined to NSW/Queensland border region, Illawarra region and NSW/Victorian border region (NSW National Parks and Wildlife Service 1997).	EPBC Search	Low – There are no records for the Eastern Bristlebird locally and this species is known to inhabit coastal and montane heathland habitats. As such habitat does not occur within the study area and there are no local records, this species is considered unlikely to occur.
<i>Chthonicola sagittata</i> (syn. <i>Pyrrholaemus sagittatus</i>)	Speckled Warbler		V	Occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and insects and builds domed nests on the ground (Garnett & Crowley 2000). The species has been shown to decrease in abundance as woodland area decreased, and it appears to be extinct in districts where no fragments larger than 100 hectares remain (Barrett, G.W <i>et al.</i> 1994). Isolation of Speckled Warbler populations in small remnants increases their vulnerability to local extinction as a result of stochastic events and decreases their genetic viability in the long term (NSW Scientific Committee 2001b).	Bionet Search, OEH Profile search – Wyong sub-region	Low – The Speckled Warbler is a western dry woodlands species that only rarely occurs in near coastal locations, notably to the north in the Lower Hunter Region. Local records for this species in the study area's locality are likely accidental and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Anthochaera phrygia</i> (syn. <i>Xanthomyza phrygia</i>)	Regent Honeyeater	EM	CE	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with <i>Casuarina cunninghamiana</i> and <i>Amyema cambagei</i> are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include <i>Eucalyptus sideroxylon</i> (Mugga Ironbark), <i>E. albens</i> (White Box), <i>E. melliodora</i> (Yellow Box) and <i>E. leucoxylon</i> (Yellow Gum) (Garnett & Crowley 2000).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	High – In recent years the Regent Honeyeater has become progressively rarer across its range, including the Central Coast region. The species is not resident in the region, but has in the past migrated to local habitats on an intermittent basis when local blossom resources are abundant. To the north at Morisset it has returned on a 4–5 year cycle and movements coincide with large aggregations of other honeyeaters. However, numbers have been in serious decline since 2002 and it hasn't returned to Morisset since the winter of 2011. Periodical occurrences on the Central Coast coincide primarily with <i>Eucalyptus robusta</i> (Swamp Mahogany) blossoming events. It has not been recorded as breeding in the subject site's locality, with the closest breeding activity recorded at Quorrobolong in the Hunter Valley 42 km to north. Although Regent Honeyeaters are considered unlikely to breed within the study area, there is an abundance of Swamp Mahogany on site, which may be visited intermittently when blossom resource distribution across the Regent Honeyeater's range pushes them into near coastal habitats. Although stands of Swamp Mahogany in the region continue to exist, this community is threatened by development in well populated coastal areas.
<i>Epthianura albigrons</i>	White-fronted Chat		E2	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level (North 1904; Higgins et al. 2001; Barrett et al. 2003). In New South Wales the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins et al. 2001). Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas. (North 1904; Higgins et al. 2001; Barrett et al. 2003). The population in the Sydney Metropolitan Catchment Management Authority region is listed as Endangered (Office of Environment and Heritage 2012).	OEH Profile search – Wyong sub-region, OEH Profile search – Wyong sub-region	Low – In coastal areas the White-fronted Chat occurs within saltmarsh and coastal floodplain habitats. Suitable habitats for this species don't not occur within the study area so it is not considered likely to occur.
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)		V	Occurs within areas of annual rainfall between 400–700 mm. Feed on insects, nectar and lerps (Garnett & Crowley 2000). It occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, Blakely's Red Gum and Forest Red Gum. Also inhabits open forests of smooth-barked gums, stringybarks, river sheoaks (nesting habitat) and tea-trees. Feeding territories are large making the species locally nomadic. It tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least five hectares (Office of Environment and Heritage 2012b).	OEH Profile search – Wyong sub-region	Low – The Black-chinned Honeyeater is a western woodlands species that only rarely occurs in near coastal locations, notably to the north in the Lower Hunter Region. There are no local records for this species in the study area's locality and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.
<i>Grantiella picta</i>	Painted Honeyeater		V	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus <i>Amyema</i> , though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks (Garnett & Crowley 2000).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Low – The Painted Honeyeater is a western dry woodlands species that does not extend its range into in near coastal locations. There are no known records for this species in the study area's locality and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.
<i>Daphoenositta chrysoptera</i>	Varied Sittella		V	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (Department of Environment Climate Change and Water 2010a).	Bionet Search, OEH Profile search – Wyong sub-region	Recorded – The Varied Sittella was observed during on site surveys and the study area's wooded habitats represent suitable habitat for its foraging requirements. Wooded habitat onsite also represents suitable breeding habitat opportunities.
<i>Pomatostomus temporalis temporalis</i>	Grey-Crowned Babbler (Eastern subspecies)		V	The eastern form of the species formerly ranged throughout eastern Australia from South Australia, through Victoria and broadly through NSW and central Queensland but is now extinct in South Australia, coastal Victoria and the ACT. In NSW, it occurs on the western slopes and plains but is less common at the higher altitudes of the tablelands. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (Blakers et al. 1984; Schodde & Mason 1999). Grey-crowned Babbler occupy open woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs. The species builds conspicuous dome-shaped nests and breeds co-operatively in sedentary family groups of 2–13 birds (Davidson & Robinson 1992). Grey-crowned Babbler are insectivorous and forage in leaf litter and on bark of trees (NSW Scientific Committee 2001a).	OEH Profile search – Wyong sub-region	Low – The Grey-crowned Babbler is a western dry woodlands species that only rarely occurs in near coastal locations, notably to the north in the Lower Hunter Region. There are no known records for this species in the study area's locality and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Petroica boodang</i>	Scarlet Robin		V	In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes. Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. It prefers an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris (Department of Environment Climate Change and Water 2010a; Higgins, P.J. & Peter 2002). The species has been found to be absent from remnants surrounded by cereal cropping, less common in isolated patches of 30 hectares or less (where there was no tree cover within 200 m and less than 20% cover within 1 km), less common in sites surrounded by cattle grazing and more common in sites with native versus exotic grasses if ungrazed for more than 10 years (Barrett, G.W. <i>et al.</i> 2003).	OEH Profile search – Wyong sub-region	Low – The Scarlet Robin breeds in elevated woodland habitats of the Great Dividing Range and its foothills. They disperse from breeding habitats during the cooler months to lowland woodland habitats on valley floors below their breeding grounds. The few records occurring in the wider locality are from elevated locations to the west and the study area does not contain the open woodland habitats that suite the breeding or wintering habits of this species. Therefore it is considered unlikely to occur.
<i>Petroica phoenicea</i>	Flame Robin		V	In NSW the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats (Higgins, P.J. & Peter 2002). The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank (NSW Scientific Committee 2010a).	Bionet Search, OEH Profile search – Wyong sub-region	Low – Like the Scarlet Robin the Flame Robin breeds in elevated woodland habitats of the Great Dividing Range and its foothills. They also disperse from breeding habitats during the cooler months to lowland woodland habitats on valley floors below their breeding grounds. The few records occurring in the wider locality are from elevated locations to the south of Broken Bay and the study area does not contain the open woodland habitats that suite the breeding or wintering habits of this species. Therefore it is considered unlikely to occur.
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (South-Eastern)		V	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia (Garnett & Crowley 2000; Traill & Duncan 2000). The species appears unable to survive in remnants smaller than 100–200 hectares (Department of Environment and Conservation 2005c).	OEH Profile search – Wyong sub-region	Low – The Hooded Robin is a western woodlands species that only rarely occurs in near coastal locations, notably to the north in the Lower Hunter Region. There are no local records for this species in the study area's locality and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.
<i>Artamus cyanopterus</i>	Dusky Woodswallow		*V	The Dusky Woodswallow occurs widely in open woodlands and forests in eastern Australia south from the Atherton Tableland to southwestern Australia as far north as the vicinity of Perth (Pizzey & Knight 2012). It is absent from semi-arid and arid inland areas and typically favours open wooded habitats or clearing edges with a grassy understorey, although records occasionally occur in wetter forest contexts (Higgins, P.J. <i>et al.</i> 2006).	Bionet Search (species under preliminary determination)	Low - There is a low number of Dusky Woodswallow records occurring locally and this species was not observed during field surveys. Due to its relatively densely vegetated character the study area is considered unlikely to contain important habitat for locally occurring individuals.
<i>Stagonopleura guttata</i>	Diamond Firetail		V	Distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas (Blakers <i>et al.</i> 1984; Schodde & Mason 1999). Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range (Garnett & Crowley 2000). Firetails nest in trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects (Blakers <i>et al.</i> 1984; Read 1994).	OEH Profile search – Wyong sub-region	Low – The Diamond Firetail is a western woodlands species that only rarely occurs in near coastal locations, notably to the north in the Lower Hunter Region. There are no local records for this species in the study area's locality and habitat within the study area is not suitable. Therefore it is considered unlikely to occur.
Mammals						
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds' nests and shredded bark in the fork of trees (Turner & Ward 1995).	OEH Profile search – Wyong sub-region	Moderate – Eastern Pygmy-possum is found in a broad range of habitat types, but in most areas woodland and heath appear to be preferred. This species feeds largely on nectar and pollen from banksia, eucalypts and bottlebrushes, with soft fruits eaten when flowers unavailable. Although the study area lacked a diverse range of year-round nectar and pollen resources, this species occurrence cannot be discounted. Potentially suitable habitat for this species occurred in rainforest, swamp forest and wet open forest habitat types.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Occurs in moderately wooded habitats, mainly in areas with extensive cliffs and caves and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins (Churchill 1998; Office of Environment and Heritage 2011). Breeding habitat (maternity roosts) is located in roof domes in sandstone caves (Office of Environment and Heritage 2011). Thought to forage below the forest canopy for small flying insects (Churchill 1998).	EPBC Search, OEH Profile search – Wyong sub-region	Moderate – Whilst the study area did not contain roosting or breeding structures for this species, suitable foraging habitat occurred in swamp forest and wet open forest habitat types.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Dasyurus maculatus maculatus</i>	Spotted-Tailed Quoll (Southern Subspecies)	E	V	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999g). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999e, 1999g).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Moderate – The project study area would not support Spotted-tailed Quoll in isolation of larger tracts of surrounding contiguous forests. However, the study area is likely to form part of larger home range for an individual(s) of this species. Potential foraging habitat occurred in the form of rainforest, swamp forest and wet open forest habitat types.
<i>Dasyurus viverrinus</i>	Eastern Quoll		E1	Found in a variety of habitats including dry sclerophyll forest, scrub, heathland and cultivated land. Lives in dens which consist of several chambers including underground burrows, hollow logs, rock piles and hay sheds (Strahan 1995).	OEH Profile search – Wyong sub-region	Low – Apart from being relatively common in Tasmania, this species is now considered extinct over much of its historical range in eastern NSW. This species is considered to have low likelihood of occurrence in the project study area.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle		V	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high (Churchill 2008).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a general paucity of tree hollows and young age cohort of canopy strata, the study area provided suitable habitat in the form of rainforest, swamp forest and wet open forest habitat types.
<i>Isodon obesulus</i>	Southern Brown Bandicoot	E	E1	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire (NSW National Parks and Wildlife Service 1999d).	OEH Profile search – Wyong sub-region	Low – Within NSW the Southern Brown Bandicoot is almost exclusively restricted to the coastal fringe, from the Hawkesbury River in the north to the Victorian border in the south. As the project study area occurs outside (and to the north) the known distribution, the Southern Brown Bandicoot is considered to have a low likelihood of occurrence.
<i>Kerivoula papuensis</i> (syn. <i>Phoniscus papuensis</i>)	Golden-tipped Bat		V	Predominantly distributed throughout Indonesia, New Guinea and the Philippines, the species has been observed on the east coast of NSW and Victoria. Prefers moist dense vegetation in coastal forests, near to where wet and dry forests meet and often in the vicinity of creeks. Possibly prefers ecotonal habitats (such as creek lines) for feeding and passage and an ability to manoeuvre in dense vegetation (Strahan 1995).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Suitable foraging habitat occurred in the study area, inclusive of rainforest, swamp forest and wet open forest habitat types.
<i>Macropus parma</i>	Parma Wallaby		V	Now extinct south of Gosford, and confined to high rainfall areas in the coast and ranges of central and northern NSW; from the Watagan Mountains to the Richmond and Border Ranges area, with the Washpool–Gibraltar Range and Bulga–Dingo Tops areas being areas of greatest importance. Occurs in wet sclerophyll forest and rainforest patches in moist sclerophyll forest, with a moist shrubby understorey, often associated with grassy areas. They are occasionally found in dry sclerophyll forest and rainforest edges are considered important refugia. Ecotones between open and closed forest are favoured, open areas are used for foraging, while areas of dense ground cover provide areas for shelter and protection from predators (NSW National Parks and Wildlife Service 1999g).	OEH Profile search – Wyong sub-region	Moderate – Potential habitat for Parma Wallaby in the study area included rainforest, wet open forest and cleared land with scattered trees.
<i>Miniopterus australis</i>	Little Bentwing-bat		V	Feeds on small insects beneath the canopy of well timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred (Strahan 1995).	Bionet Search, OEH Profile search – Wyong sub-region	Recorded – Suitable foraging habitat for the Little Bentwing-bat occurs within the study area; comprising rainforest, swamp forest and wet open forest habitat types. Potential roosting habitat, in the form of tree hollows were not observed to be abundant, however roosting habitat also potentially occurs under the existing rail bridge spanning Chittaway Creek and Turpentine Road. Five nursery/ maternity colonies are currently known in Australia; none of which occur in project study area.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat		V	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Hunt in rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands (Office of Environment & Heritage 2016n).	Bionet Search	Recorded – The Eastern Bent-wing Bat was recorded via Anabat in wet open forest in the north of the study area. Suitable foraging habitat occurred in the form of rainforest, swamp forest and wet open forest habitat types.
<i>Mormopterus (Micronomus) norfolkensis</i>	Eastern Freetail-bat		V	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a relatively young cohort of canopy strata and general paucity of tree hollows, the study area provided suitable habitat in the form of rainforest, swamp forest and wet open forest habitat types.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Myotis macropus</i>	Southern Myotis		V	Found in most habitat types in association with streams and permanent waterways usually at low elevations in flat or undulating landscapes from northern areas of Western Australia, and the Northern Territory, down the entire east coast and the southern coast of Australia to just west of the Victoria/South Australia border and inland along the Murray River. Roosts in caves, tree hollows, in clumps of dense vegetation (e.g. Pandanus), mines, tunnels, under bridges, road culverts and stormwater drains often in abandoned, intact Fairy Martin nests. Roost sites are strongly associated with bodies of water where this species commonly feeds on aquatic insects, shrimp and small fish at the water surface, however, aerial foraging for other insects is also known (Churchill 2008). Breeding habitat likely to coincide with roosting habitat (Office of Environment and Heritage 2011).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Chittaway Creek and Bangalow Creek and associated fringing rainforest vegetation represent potentially suitable habitat for this species and it may occur in the study area on at least an intermittent basis.
<i>Petaurus australis</i>	Yellow-bellied Glider		V	Restricted to tall, mature eucalypt forest in high rainfall areas of temperate to sub-tropical eastern Australia. Feeds on nectar, pollen, the sap of eucalypts and sometimes insects. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows and year round food resources are available from a mixture of eucalypt species (NSW National Parks and Wildlife Service 1999h, 2003c).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a relatively young cohort of canopy strata and general paucity of tree hollows, the study area provided suitable habitat in the form of swamp forest and wet open forest habitat types.
<i>Petaurus norfolcensis</i>	Squirrel Glider		V	The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland. In NSW it is found in dry sclerophyll forest and woodland but not found in dense coastal ranges, inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. It is associated with mixed tree species stands with a shrub or Acacia midstorey. It requires abundant tree hollows for refuge and nest sites and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999f).	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a relatively young cohort of canopy strata and general paucity of tree hollows, the study area provided suitable habitat in the form of swamp forest and wet open forest habitat types.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	V	E1	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or 'colonies' each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003a).	EPBC Search, OEH Profile search – Wyong sub-region	Low – The Brush-tailed rock Wallaby is found along the Great Dividing Range where they live on rocky escarpments and granite outcrops and cliffs that have caves and ledges for shelter and face north for warmth. Such habitats do not occur in the study area, and this species is considered to have a low likelihood of occurrence.
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale		V	Largely arboreal it occurs in a range of habitats which have reliable rainfall (500–2000 mm), but has preference for open dry sclerophyll forest on ridges (up to 600 m alt) with little/sparse ground cover. It nests in tree hollows and feeds at dusk on arthropods and small vertebrates (Strahan 1995).	OEH Profile search – Wyong sub-region	Low – This species has a preference for open dry sclerophyll forests, particularly on ridges. Such habitats did not occur in the study area and this species is considered to have a low likelihood of occurrence therein.
<i>Phascolarctos cinereus</i>	Koala	V	V	Found in sclerophyll forest. Koalas have been observed to feed on the leaves of in excess of 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species include Forest Red Gum <i>Eucalyptus tereticornis</i> , Grey Gum <i>E. punctata</i> . In coastal areas, Tallowood <i>E. microcorys</i> and Swamp Mahogany <i>E. robusta</i> are important food species, while in inland areas White Box <i>E. albens</i> , Bimble Box <i>E. populnea</i> and River Red Gum <i>E. camaldulensis</i> are favoured (NSW National Parks and Wildlife Service 1999c, 2003b).	OEH Profile search – Wyong sub-region	Moderate – Although records for the Koala in the project locality are few, Swamp forest habitats in the study area consisted of a canopy stratum of <i>Eucalyptus robusta</i> , which is preferred feed tree species for this species.
<i>Planigale maculata</i>	Common Planigale		V	Occurs in a range of habitats from rainforest, sclerophyll forest, grasslands, marshlands and rocky areas, usually where there is ground cover and close to water (NSW National Parks and Wildlife Service 2002c). Builds small saucer-shaped nests of grass and bark (Strahan 1995).	OEH Profile search – Wyong sub-region	Moderate – Potential habitat occurred in rainforest, swamp forest and wet open forest habitat types.
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE mainland)	V	V	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available (Johnston 1995; NSW National Parks and Wildlife Service 1999g).	EPBC Search, OEH Profile search – Wyong sub-region	Moderate – Potential habitat occurred in rainforest, swamp forest and wet open forest habitat types.

Scientific name	Common name	EPBC Act ¹	TSC Act ²	Habitat	Data source ³	Likelihood of occurrence ⁴
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse		V	The species is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps. In the tropics it is more an animal of grassy woodlands. Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously. By the time the heath is mature, the larger Swamp Rat becomes dominant, and Eastern Chestnut Mouse numbers drop again (Strahan 1995).	OEH Profile search – Wyong sub-region	Moderate – Potential habitat occurred in swamp forest and wet open forest habitat types.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	V		The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (<i>Mus musculus</i>), although it can be distinguished by its slightly larger ears and eyes, the absence of a notch on the upper incisors and the absence of a distinctive 'mousy' odour. Known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes (Threatened Species Scientific Committee 2010).	Bionet Search, EPBC Search	Low – Across the species range, the New Holland Mouse is known to inhabit open heathland, open woodland with heathy understorey and vegetated sand dunes (Department of the Environment 2016d). Further, soil type is considered to be an important indicator of habitat (Department of the Environment 2016d), with deeper top soils and soft substrates being preferred. As much of the study area was characterised floodplain topography, perched above Chittaway, Bangalow and Ourimbah Creek's, the underlying substrates are subject to variations in elevation, which formed a mosaic of low areas holding water, as well as more elevated areas less subject to waterlogging. Thus, it is considered that the New Holland Mouse would have a low likelihood of occurrence in the study area.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001b).	Bionet Search, EPBC Search, OEH Profile search – Wyong sub-region	Recorded – The Grey-headed Flying-fox was recorded flying over site during two nocturnal survey events. Although this species was not specifically recorded utilising habitat attributes associated with the study area, the Grey-headed Flying-fox is a blossom nomad known to travel large distances during nightly foraging events. Due the large numbers of <i>Eucalyptus robusta</i> within the study area, it is likely that the study area's swamp forests would be used seasonally during flowering events. No evidence of Grey-headed Flying-fox camps was observed in the study area during field surveys.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat		V	This species is widespread through tropical Australia and migrates to southern Australia in summer. Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts and breeds in tree hollows but has also been recorded roosting under exfoliating bark, in burrows of terrestrial mammals, in soil cracks and under slabs of rock and in the nests of bird and sugar gliders (Churchill 2008).	OEH Profile search – Wyong sub-region	Moderate – Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a general paucity of tree hollows and young age cohort of canopy strata, the study area provided suitable habitat in the form of rainforest, swamp forest and wet open forest habitat types.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat		V	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3–6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 2008)	Bionet Search, OEH Profile search – Wyong sub-region	Moderate – Whilst habitat assessments suggest that the study area is recovering from previous widespread disturbance, including a general paucity of tree hollows and young age cohort of canopy strata, the study area provided suitable habitat in the form of rainforest, swamp forest and wet open forest habitat types.
<i>Thylogale stigmatica</i>	Red-legged Pademelon		V	Distribution: Restricted to the coastal and subcoastal strip of eastern Australia, from the tip of Cape York in north Queensland, south to the Hunter Valley, just north of Newcastle in NSW. Populations are confined mainly to areas of high rainfall. Macrohabitat is coastal and sub-coastal rainforests and wet sclerophyll forest. Dense understorey and ground cover is important. Ecotones between open and closed forest are favoured. Microhabitat is open areas are used for foraging while areas of dense ground cover/understorey provide areas for shelter and protection from predators (NSW National Parks and Wildlife Service 1999g).	OEH Profile search – Wyong sub-region	Low – As the project study area occurs outside the known distribution of this species, the Red-legged Pademelon is considered to have a low likelihood of occurrence in the study area.
<i>Vespadelus troughtoni</i>	Eastern Cave Bat		V	A cave-dwelling species found in eastern Australia from Cape York to NSW. They inhabit tropical mixed woodland and wet sclerophyll forests on the coast and the dividing range, but extend into drier forests on the western slopes (Churchill 1998). Breeding habitat includes caves, rocky outcrops, cliffs, scarps and old mine workings. Roosting habitat includes breeding habitat types and very small crevices in rocky areas or boulder piles or old mine workings and Fairy martin nests. Foraging habitat includes suitable native vegetation within 5 km of breeding habitat (Office of Environment and Heritage 2011).	OEH Profile search – Wyong sub-region	Low – This cave roosting species is usually associated with dry open forest and woodland near cliffs and rocky overhangs and is occasionally found along cliff-lines in wet eucalypt forest and rainforest. However, the Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey. As the study area occurs outside the distribution of this species, the Eastern Cave Bat is considered to have a low likelihood of occurrence in the study area.

(1) Listed as Vulnerable, Endangered or Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Species of bird returned via the EPBC Protected Matters Search Tool that are only listed under the migratory provisions of the EPBC Act (35 species in total) have been excluded from this likelihood of occurrence assessment.

(2) Listed as Vulnerable, Endangered or Critically Endangered under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

(3) Data source: EPBC Search = DoE's EPBC Protected Matters Search Tool; PlantNet = Royal Botanic Gardens PlantNet spatial database; OEH Profile Search – Wyong sub-region spatial search and BioNat search = OEH's BioNet Atlas of NSW Wildlife,

(4) Likelihood of occurrence as outlined in Table 3.3.

* = Both the Dusky Woodswallow and the White-bellied Sea-Eagle are subject to a preliminary determination to be listed as Vulnerable species under the TSC Act and as a consequence have been added to the above table as a precautionary measure subject their potential listing under the TSC Act (Office of Environment & Heritage 2016i).

3.3 Subject species

'Subject species' are those threatened species, populations and ecological communities that may be present or using the project study area. Due to the potential for the project to impact such species, subject species are considered further as part of this SIS. The initial assessment process which identified the subject species for the project is provided in section 3.2 (Table 3.4 and Table 3.5).

Based on the presence of suitable habitat, recent records and known distribution of the subject species identified in the desktop assessment the following subject species have been identified:

- Two threatened ecological communities
- Seven species of flora
- 36 species of fauna.

The subject species identified for the project are outlined in Table 3.6. Field surveys were designed to specifically target these species and communities.

Table 3.6 Subject species identified for further consideration during field surveys

Scientific name	Common name	TSC Act status	EPBC Act status
Endangered Ecological Communities			
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions		E	-
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		E3	CE
Threatened flora species			
<i>Caladenia tessellata</i>	Thick-lipped Spider Orchid	E	V
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	-	V	-
<i>Maundia triglochinosoides</i>	-	V	-
<i>Melaleuca biconvexa</i>	Bioconvex Melaleuca	V	V
<i>Prostanthera askania</i>	Tranquility Mintbush	E	E
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V	E
<i>Senna acclinis</i>	Rainforest Cassia	E	-
<i>Dendrobium melaleucaphilum</i>	Spider Orchid	E	-
<i>Persicaria elatior</i>	Knotweed	V	V
Threatened fauna species – Amphibians			
Wallum Froglet	<i>Crinia tinula</i>	V	-
Giant Barred Frog	<i>Mixophyes iteratus</i>	E	E
Threatened fauna species – Reptiles			
Stephens Banded Snake	<i>Hoplocephalus stephensii</i>	V	-
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	V	-

Scientific name	Common name	TSC Act status	EPBC Act status
Threatened fauna species – Birds			
Regent Honeyeater	<i>Anthochaera phrygia</i>	CE	CE
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	V	-
Glossy Black Cockatoo	<i>Calyptorhynchus lathami</i>	V	-
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V	-
Little Lorikeet	<i>Glossopsitta pusilla</i>	V	-
Little Eagle	<i>Hieraaetus morphnoides</i>	V	-
Black Bittern	<i>Ixobrychus flavicollis</i>	V	-
Swift Parrot	<i>Lathamus discolor</i>	E	CE
Square-tailed Kite	<i>Lophoictinia isura</i>	V	-
Powerful Owl	<i>Ninox strenua</i>	V	-
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	V	-
Rose-crowned Fruit-dove	<i>Ptilinopus regina</i>	V	-
Superb Fruit-Dove	<i>Ptilinopus superbus</i>	V	-
Threatened fauna species – Mammals			
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V	-
Large-eared Pied-bat	<i>Chalinolobus dwyeri</i>	V	V
Spotted-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	V	E
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V	-
Golden-tipped Bat	<i>Kerivoula papuensis</i>	V	-
Parma Wallaby	<i>Macropus parma</i>	V	-
Little Bentwing-bat	<i>Miniopterus australis</i>	V	-
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>	V	-
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V	-
Southern Myotis	<i>Myotis macropus</i>	V	-
Yellow-bellied Glider	<i>Petaurus australis</i>	V	-
Squirrel Glider	<i>Petaurus norfolcensis</i>	V	-
Koala	<i>Phascolarctos cinereus</i>	V	V
Common Planigale	<i>Planigale maculata</i>	V	-
Long-nosed Potoroo	<i>Potorous tridactylus</i>	V	V
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	V	-

Scientific name	Common name	TSC Act status	EPBC Act status
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	V	-
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V	-

- (1) Listed as Vulnerable (V), Endangered (E1), Endangered Ecological Community (E3), Critically Endangered (E4A) under the NSW *Threatened Species Conservation Act 1995*.
- (2) Listed as Vulnerable (V), Endangered (E) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

4 SURVEY

This section provides details regarding the surveys undertaken as part of this SIS, including requirements to survey, survey effort and technique and results of the surveys undertaken.

4.1 Requirement to survey

The survey methodology used to complete the flora and fauna surveys were undertaken in accordance with all relevant detailed survey methodology guidelines for each identified subject species likely to occur within the study area in order to address the CERs. Surveys were conducted in accordance with minimum efforts outlined in the CERs and in consideration of the following survey methodology guidelines:

- Threatened Species Survey and Assessment: Guidelines for Developments and Activities (Department of Environment and Conservation 2004b)
- NSW Guide to Surveying Threatened Plants (Office of Environment and Heritage 2016d)
- Threatened Species Survey and Assessment Guidelines: field survey methods for fauna – Amphibians (Department of Environment and Climate Change 2009a)
- Threatened Species Assessment Guidelines: The Assessment of Significance (Department of Environment and Climate Change 2007e)
- BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014b).

The aim of all surveys completed as part of this SIS was to identify the presence of threatened species, populations and communities listed under the TSC Act and EPBC Act as well as those provided in the CERs. Although comprehensive field surveys have been undertaken within the study area it is acknowledged that no sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. As a result a precautionary approach has been taken when determining whether a threatened species, population or community and/or their associated habitats is potentially present/absent from the study area. In addition, where surveys for subject species could not be undertaken due to seasonal or climatic requirements, an expert report has been prepared to assess the potential for those species to be affected species. An expert report was prepared for the threatened amphibian species Green-thighed Frog (*Litoria brevipalmata*) and Green and Golden Bell Frog (*Litoria aurea*).

4.2 Documentation of survey effort and technique

4.2.1 Description of survey techniques and survey sites

Prior to designing the survey effort a site inspection was undertaken to identify the vegetation communities and their associated habitat types. The initial site inspection allowed for the stratification of the study area into vegetation communities and corresponding habitat types that informed the survey effort that would be required in order to comply with the CERs and relevant survey guidelines.

The study area was initially surveyed by GHD (2014) and in further detail by EMM (2015). Surveys conducted by EMM were carried out over three days on 10, 16 and 17 September 2015. As part of the SIS, the study area was inspected over nine days and four nights between 22 February 2016 and 29 April 2016 by a team of experienced ecologists. Weather conditions experienced during surveys is provided in (Table 4.1).

Table 4.1 Field survey dates and weather conditions

Date	Temp °c (min)	Temp °c (max)	Rain (mm)	Wind (max speed (km/ph)/direction)
22 February 2016	18.5	28.8	0.8	30/ENE
23 February 2016	17.0	30.0	0.2	30/NE
26 February 2016	22.8	26.7	0	48/S
29 February 2016	16.9	27.9	0	24/SE
17 March 2016	18.9	25.2	10.2	20/ENE
21 March 2016	15.8	21.4	38.4	31/SSW
22 March 2016	15.7	23.0	14.8	39/S
23 March 2016	15.2	24.6	0	13/WNW
24 March 2016	13.6	27.6	0	26/NE
29 April 2016	13.1	25.2	0	15/E
20 May 2016	9.0	23.0	0	30/NW

Note: Data obtained from Bureau of Meteorology Gosford AWS (Station 061425).

4.2.1.1 FLORA

The floristic diversity and possible presence of threatened species was assessed using a combination of random meander, plot-based (quadrat/transect) and rapid data point surveys and generally in accordance with the resources outlined in section 4.1 and below.

NOMENCLATURE

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with updates from PlantNet (Royal Botanic Gardens 2016). Scientific names are used in this report for species of plant. Scientific and common names of plants are listed in Appendix A. Introduced species are identified within the text with an asterisk following the name, for example *Lantana camara**

Vegetation community names have followed that of the NSW Plant Community Types (PCT) & Biometric Vegetation Type (BVT) (Office of Environment & Heritage 2016c). Corresponding vegetation community names from the local broad scale vegetation mapping project and corresponding threatened ecological communities have been also provided in section 4.3.

DESKTOP ANALYSIS OF VEGETATION

Preliminary mapping of vegetation community boundaries was undertaken through analysis of existing vegetation mapping and aerial photograph interpretation. Analysis of the aerial photographs was used to identify areas of disturbance (e.g. buildings, vehicle tracks, dams and power lines), vegetation structure and likely native versus exotic species composition throughout the site. This provided an initial definition of vegetation communities into simple structural and disturbance classifications for verification during field surveys.

Where access to vegetation was not available during the survey period vegetation community distribution was extrapolated by visual comparison of vegetation apparent in aerial photography with vegetation in areas which were subject to field survey and through consideration of landscape position and existing vegetation mapping.

FIELD VERIFICATION OF EXISTING VEGETATION

Vegetation within the subject site and locality has been previously mapped at the regional scale in *'The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales'* (Bell, S. 2002). Additionally the subject site was previously mapped in a site-specific ecological report *'Preliminary Ecological Assessment: New Intercity Maintenance Facility'* prepared by EMM (2015b).

Field validation (ground-truthing) of the initial vegetation classifications identified from aerial photograph interpretation existing vegetation mapping (Bell, S. 2002; EMM 2015b) and associated PCTs was undertaken to determine the vegetation types present, their condition and their relationship to threatened ecological community listings under NSW and Commonwealth legislation.

QUADRATS

Fourteen quantitative (quadrat/transect) site surveys (Figure 4.1, Figure 4.4 and Table 4.2) were completed as outlined in the procedure contained in the BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014b) and described below.

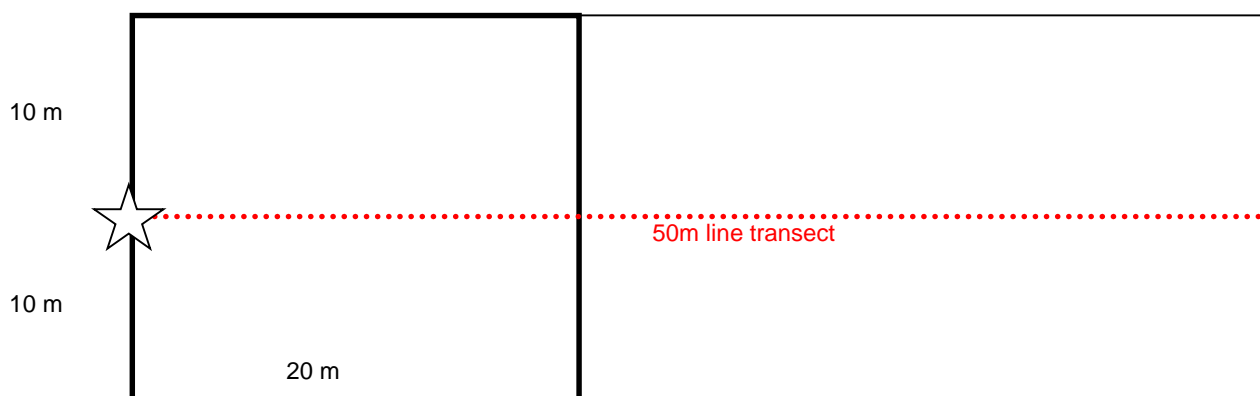


Figure 4.1 Schematic diagram illustrating the layout of the nested 20 metres x 50 metres and 20 metres x 20 metres quadrats used for the assessment of condition attributes at each site

The following site attributes were recorded at each site:

- Location (easting – northing grid type MGA 94, Zone 56).
- Vegetation structure and dominant species and vegetation condition.
- Native and exotic species richness (within a 400 square metre quadrat): this consisted of recording all species by systematically walking through each 20 metre x 20 metre quadrat. The cover abundance of each species was estimated.
- Number of trees with hollows (1,000 square metre quadrat): this was the frequency of hollows within living and dead trees within each 50 metre x 20 metre quadrat. A hollow was only recorded if:
 - The entrance could be seen
 - The estimated entrance width was at least five centimetres across
 - The hollow appeared to have depth

- The hollow was at least one metre above the ground
 - The centre of the tree was located within the sampled quadrat.
- Total length of fallen logs (1,000 square metre quadrat): this was the cumulative total of logs within each 50 metre x 20 metre quadrat with a diameter of at least 10 centimetres and a length of at least 0.5 metres.
- Native over-storey cover: this consisted of estimating the percentage cover of the tallest woody stratum present (>one metre and including emergents). The woody stratum included species that were native to NSW and not necessarily those that were locally endemic.
- Native mid-storey cover: this involved estimating the cover of vegetation between the over-storey stratum and a height of one metre (i.e. tall shrubs, under-storey trees and tree regeneration).
- Ground cover: this comprised estimating the cover of plants below one metre in height. The following categories of plants were recorded:
- Native ground cover (grasses): native grasses (Poaceae family native to NSW)
 - Native ground cover (shrubs): all woody vegetation below one metre in height and native to NSW
 - Native ground cover (other): non-woody vegetation (i.e. vascular plants–ferns and herbs) below one metre in height and native to NSW
 - Exotic plant cover: vascular plants not native to Australia.
- Evaluation of regeneration: this was estimated as the proportion of over-storey species present at the site that were regenerating (i.e. saplings with a diameter at breast height ≤five centimetres). The maximum value for this measure was one.

Table 4.2 Location of BBAM quadrats/transects

Quadrat/ Transect ID	Vegetation community	Easting ¹	Northing ¹	Transect orientation
BB1	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – High Quality)	351283	6310983	235°
BB2	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – High Quality)	350701	6310663	190°
BB3	Jackwood – Lilly Pilly – Sassafras Riparian Warm Temperate Rainforest (Moderate to Good – Medium Quality)	350221	6310157	210°
BB4	Jackwood – Lilly Pilly – Sassafras Riparian Warm Temperate Rainforest (Moderate to Good – Medium Quality)	340057	6309963	0°
BB5	Jackwood – Lilly Pilly – Sassafras Riparian Warm Temperate Rainforest (Moderate to Good – Medium Quality)	349990	6309966	335°
BB6	Jackwood – Lilly Pilly – Sassafras Riparian Warm Temperate Rainforest (Moderate to Good – Medium Quality)	349888	6309708	250°
BB7	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest (Moderate to Good – High Quality)	350789	6310807	180°

Quadrat/ Transect ID	Vegetation community	Easting ¹	Northing ¹	Transect orientation
BB8	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – High Quality)	350854	6310704	145°
BB9	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest (Moderate to Good – High Quality)	351112	6310833	270°
BB10	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – High Quality)	350647	6310445	215°
BB11	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – Medium Quality)	350869	6310825	350°
BB12	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Low Condition)	351264	6311054	15333°
BB13	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – Medium Quality)	350950	6311093	10°
BB14	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – Medium Quality)	350841	6310929	195°

(1) GDS 94: Zone 56.

VEGETATION CONDITION

The condition of vegetation was assessed firstly against the BBAM definitions of ‘low’ and ‘moderate to good’ broad conditions and secondly against the BioBanking condition benchmark data for the relevant vegetation type and other parameters such as intactness, diversity, history of disturbance, weed invasion and health.

Under BBAM, vegetation in ‘low’ broad condition is:

a) woody native vegetation with native over-storey percent foliage cover less than 25 per cent of the lower value of the over-storey percent foliage cover benchmark for that vegetation type, and where either: – less than 50 per cent of ground cover vegetation is indigenous species, or greater than 90 per cent of ground cover vegetation is cleared

OR

b) native grassland, wetland or herbfield where either: – less than 50 per cent of ground cover vegetation is indigenous species, or more than 90 per cent of ground cover vegetation is cleared.

‘Moderate to good’ broad condition is native vegetation that is not in ‘low’ broad condition.

Three condition sub-categories within the 'moderate to good' broad BBAM condition class were used to further define the condition of the vegetation using factors such as levels of disturbance, weed invasion, resilience and comparison with BioBanking benchmark data:

- **Condition sub-category 'High quality' condition:** Vegetation that still retains the species complement and structural characteristics of the vegetation community. The vegetation displays resilience to weed invasion due to intact groundcover, shrub and canopy layers (greater than 25 per cent of the lower benchmark). Native species diversity is relatively high. Weeds may exist in this vegetation type but exhibit less than 10 per cent foliage cover.
- **Condition sub-category 'Medium quality' condition:** Vegetation generally retains most of the species complement and structural characteristics however may no longer contain one or more of the strata layers due to land use disturbances. This vegetation generally displays resilience to weed invasion and has regeneration potential. Weeds may exist in this vegetation type but exhibit 10 to 60 per cent foliage cover.
- **Condition sub-category 'Low quality' condition:** Vegetation generally no longer contains a native canopy but the understorey and groundcover layers are generally dominated or co-dominated by exotic species that exhibit between 61 to 70 per cent foliage cover. Native species diversity is generally relatively low and the mid and low strata have been structurally modified due to weed incursions.

These sub-categories are based on a modified version of the Weed Invasion Mapping method developed by the Hawkesbury-Nepean Catchment Management Trust (2000).

RANDOM MEANDERS

Random meander surveys (a technique developed by Cropper (1993) are a variation of the transect type survey, whereby the recorder walks in a random meander throughout the site recording all species observed (including threatened species), boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

MELALEUCA BOCONVEXA

TARGETED SURVEYS

Biconvex Melaleuca (*Melaleuca biconvexa*) individuals have been previously recorded by EMM (2015b) and by the OEH BioNet Atlas of NSW Wildlife (Office of Environment and Heritage 2016b) within the subject site and greater locality.

A random meander survey following Cropper (1993) was initially completed across the entire subject site to identify the species presence/absence. In areas where the species was detected, a more intensive survey in the form of parallel transects was carried out to determine the extent of the population and the abundance of individuals present.

It is widely accepted that *Melaleuca biconvexa* reproduces from seedlings and multiple stems may arise from a single rootstock. Subsequently, it is difficult to estimate the population size from visual inspection (Office of Environment and Heritage 2016a; Threatened Species Scientific Committee 2008). To estimate the population size and abundance of *Melaleuca biconvexa* within the subject site two methods incorporating a broad visual abundance assessment and stem count were completed.

The visual abundance method was principally based on Duncan's (2001b) conservation assessment of abundance of each stand of *Melaleuca biconvexa* as High, Medium and Low and based on the following criteria:

- High: greater than 50 per cent cover abundance of *Melaleuca biconvexa*

- Medium: five to 50 per cent cover abundance of *Melaleuca biconvexa*
- Low: less than 5 per cent cover abundance of *Melaleuca biconvexa*.

To provide a more quantifiable estimate to the population size, a total stem count or estimate based on species density per hectare of *Melaleuca biconvexa* were completed for each age class classification. The three age classifications of *Melaleuca biconvexa* included:

- Mature/Intermediate: stem Diameter at Breast Height (DBH) at chest height greater than 200 millimetres and individual greater than six metres in height
- Immature: stem DBH at chest height less than 200 millimetres and individual less than six metres in height
- Saplings: stem DBH at chest height less than 200 millimetres and individual less than one metre in height.

The method used to determine the abundance of *Melaleuca biconvexa* was based upon the size of the population and density of individuals present. The two methods employed are described below.

1. Small population with low densities *Melaleuca biconvexa* (total stem count): performed parallel transects 20 metres apart counting all above ground stems of all age classes that had potential to be impacted upon by the project. Where possible each individual was marked using a GPS point with a five metre accuracy. Where dense thickets occurred a five metre radius counting all above stems were recorded and classified into the age class criteria.
2. Large populations with high numbers of *Melaleuca biconvexa* plant stems (estimate of stem count based on average densities): boundary of each large population was delineated and a total stem count of individuals of each age class were recorded from within a 20 metre x 20 metre quadrat. The number and position of quadrats completed varied dependent on the size and location of the population. The total stem count of individuals present was then calculated based on the average density of *Melaleuca biconvexa* and the area that it occupied within the subject site.

LOCAL POPULATION SURVEY

In addition to targeted *Melaleuca biconvexa* surveys completed within the study area, a population survey was undertaken to gain an approximate understanding of the local population distribution, abundance and age class.

In defining the local population of *Melaleuca biconvexa* the following definition has been considered:

'The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area (Department of Environment and Climate Change 2007e).'

In light of the above, a review of existing literature on the known biology and ecology of *Melaleuca biconvexa* was undertaken to understand potential pollination vectors and the species specific requirements to allow cross-pollination and genetic dispersal.

In addition, a desktop review of existing records of the species within the locality was undertaken using the following sources:

- BioNet Atlas of NSW Wildlife (Office for Environment & Heritage 2016a) including point locations of where the species has been previously recorded
- Atlas of Living Australia records (Atlas of Living Australia 2016)

- The Conservation of *Melaleuca biconvexa* Byrnes (Myrtaceae) within the Wyong Shire (Duncan 2001a) including maps detailing the species distribution, age class and abundance.

The data collected from these sources were overlaid on aerials and analysed in terms of habitat connectivity and the potential for species patch areas (subpopulations) to reasonably enable cross-pollination. These patch areas were then subject to field validation.

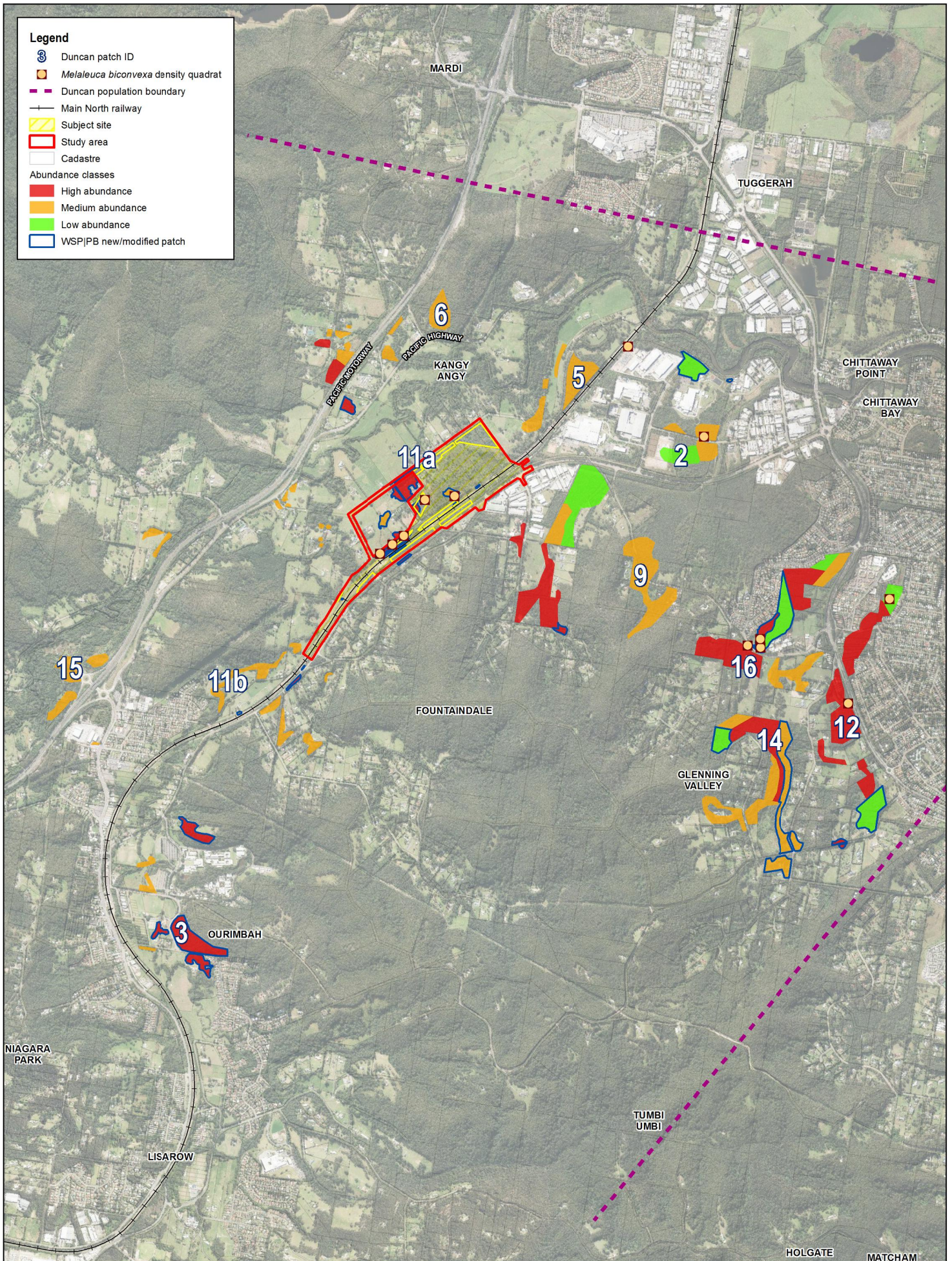
Field survey of the local population was undertaken by two ecologists on 29 April 2016. Field surveys involved inspecting known subpopulations of the species previously identified based on desktop analysis and visual inspections of low lying swampy vegetation within the vicinity of these records.

Based on limited site access (i.e. public reserves, parks, crown land) a total of eight 20 X 20 metre quadrats were undertaken. These quadrats sampled all abundance categories described by Duncan (2001a) and were compiled in accordance with the targeted survey methodology.












Where access was not available the species presence was confirmed from the nearest public access point, often with the aid of binoculars. Where applicable, the existing records and mapping were updated and any previously unmapped patches were recorded and assigned abundance and age class estimates based on the method utilised in the targeted survey.



Due to the number of other similar *Melaleuca* species recorded growing with *Melaleuca biconvexa*, particularly *M. sieberi* & *M. styphelioides*, care was taken to ensure those species were not included in the density counts.

An estimate of the total population of *Melaleuca biconvexa* was extrapolated using the averaged density of each abundance category (i.e. High, Medium and Low) and this was applied to all existing mapped abundance/age call patches and newly identified patch areas.



Legend

-  Duncan patch ID
-  *Melaleuca biconvexa* density quadrat
-  Duncan population boundary
-  Main North railway
-  Subject site
-  Study area
-  Cadastre
- Abundance classes**
-  High abundance
-  Medium abundance
-  Low abundance
-  WSP/IPB new/modified patch

Map: 2202522A_GIS_F060_A1	Author: Suansrir		 1:26,003	Note: Design is indicative only. Subject to detailed design.	New Intercity Fleet Maintenance Facility Project Figure 4.2 <i>Melaleuca biconvexa</i> local population distribution and survey effort
Date: 11/05/2016	Approved by: -		Coordinate system: GDA 1984 MGA Zone 56 Scale ratio correct when printed at A3		
Data source: - © Land and Property Information 2015					
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4.2.1.2 FAUNA

NOMENCLATURE

Names of vertebrates follow the Australian Faunal Directory (Department of the Environment 2016a), maintained by the Commonwealth Department of the Environment (DoE). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendix B.

Terrestrial vertebrate surveys completed within the study area were carried out as described below and where applicable, considering the methodology detailed in the *NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation 2004b), the Survey Guidelines for Australia's Threatened Birds (Department of Environment Water Heritage and the Arts 2010), the *Threatened Species survey and assessment guidelines: field survey and methods for fauna-Amphibians* (NSW Department of Environment 2009) and the *Survey guidelines for Australia's threatened frogs* (Department of the Environment Water Heritage and the Arts 2010).

The fauna survey methodology involved surveys at 'standard fauna survey sites' and supplementary sites. Standard trapping sites were established to survey broad habitat types within the study area and consisted of standard fauna survey sites (S1, S2 and S3). At each standard fauna survey site the following methodologies were used:

- Terrestrial mammal trapping
- Arboreal mammal trapping
- Arboreal hair-tubes
- Diurnal bird survey
- Ultrasonic echolocation detection (Anabat survey)
- Spotlighting
- Nocturnal call playback (nocturnal birds, mammals and amphibians)
- Herpetofauna active search
- Targeted Koala habitat and scat search
- Fauna habitat assessment.

Supplementary sites (Figure 4.3) were selected to target specific habitat features likely to be used by threatened species of fauna. Supplementary surveys included:

- Harp trapping
- Ultrasonic echolocation detection (Anabat survey)
- Nest box trapping
- Remote camera trapping
- Diurnal bird survey
- Targeted Koala habitat and scat search
- Herpetofauna active search
- Spotlighting
- Call playback (amphibians).

A summary of the total fauna survey effort for threatened species is provided in Table 4.4 (Figure 4.3). All fauna species observed during field surveys were documented and combined into a total species list (Appendix B).

In addition to targeted fauna surveys completed by WSP | Parsons Brinckerhoff in the study area, an additional 15 days of opportunistic sightings were recorded by EMM informing the Preliminary Ecological Assessment (EMM 2015a), ecological assessment for geotechnical and contamination investigations (EMM 2015a) and onsite ecological advice for boundary maintenance and installations (EMM 2015a).

MICROCHIROPTERAN BAT SURVEY

Ultrasonic Anabat bat detection (Anabat SD1 CF Bat Detector – Titley Electronics, Ballina) was used to record and identify the echolocation calls of microchiropterans foraging across six locations in the study area (Figure 4.3). Passive monitoring of these survey sites was achieved by setting Anabat bat detectors to record throughout the night. Bat call analysis was completed by Nathan Cooper of WSP | Parsons Brinckerhoff, with the presentation of data (refer Appendix C) considering the guidelines of the Australasian Bat Society. Bat call of New South Wales Sydney Basin region (Pennay *et al.* 2004) was used as a reference collection for bat call identification.

Harp traps were used to trap foraging microchiropterans, with traps located at sites within the study area that had potential to be used as fly-ways. Four locations were targeted therein with harp traps set in two locations for two consecutive nights, and the another two locations for one night each (Figure 4.3). Harp traps were checked every evening following spotlighting events and again the following day during morning hours. Microchiropteran species caught by harp traps were identified to species level, sexed and forearm measurement recorded. Microchiropterans caught before evening harp trap checks were released the same night.

DIURNAL BIRD SURVEY

Eighteen formal 20 minute diurnal bird searches were completed within the study area (Figure 4.3). Bird surveys were completed by actively walking through the nominated site (transect) over a period of 20 minutes. All birds were identified to the species level, either through direct observation or identification of calls. Bird surveys were completed during different times of the day, but generally occurred during morning hours. Birds were also recorded opportunistically during all other surveys.

THREATENED BIRD SURVEYS

In addition to standard diurnal bird surveys, targeted surveys were conducted for threatened birds. Wherever threatened bird species were absent from the site, habitat assessments were conducted to determine the likelihood that study area might support those species that are known to occur in the region. Targeted seasonal surveys were completed for blossom nomads, including Swift Parrot, Regent Honeyeater and Little Lorikeet in late May 2016. These species were surveyed by actively targeting patches of Swamp Mahogany in blossom.

TARGETED KOALA SURVEYS – SEPP 44

Targeted searches for the Koala were completed at three locations in the study area (Figure 4.3), where stands of Koala feed trees were observed and consisted of inspecting feed trees for signs of usage, including Koala pellets and scratches. Koala feed tree species identified in the study area that are consistent with State Environmental Planning Policy 44 – Koala habitat protection (SEPP 44) and the Approved Recovery Plan for the Koala (Central Coast management area) (Department of Environment and Climate Change 2008) included, *Eucalyptus robusta* and *E. tereticornis*. At each survey location the Spot Assessment Technique (SAT) methodology was employed, which involved actively searching the ground between the drip-line of the canopy and the trunk of 30 trees for Koala pellets; specifically targeting feed tree species where possible.

SPOTLIGHTING

Spotlighting was used to target arboreal, flying and ground-dwelling mammals, as well as, nocturnal birds, reptiles and amphibians. Spotlighting was completed after dusk for four nights (17, 21–23 March) generally following the targeted nocturnal search transects, as shown in Figure 4.3. Surveys were completed on foot using high-powered headlamps and hand torches. Sighted animals were identified to the species level. Fourteen person hours of spotlighting were conducted within the study area.

CALL PLAYBACK

Call playback was used to survey for nocturnal birds (Powerful Owl, Barking Owl, Masked Owl, and Sooty Owl), nocturnal mammals (Koala, Yellow bellied Glider, and Squirrel Glider) and frogs (Wallum Froglet, Green-thighed Frog, Giant Barred Frog and Stuttering Frog), using standard methods (Debus 1995; Kavanagh & Debus 1994). Call playback was completed after dusk on four separate nights at four locations, in the study area (Figure 4.3). A total of two person hours of call play-back were conducted within the study area.

For each survey, an initial listening period of 10 to 15 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animals in the immediate vicinity. The calls of the target species were then played intermittently for five minutes followed by a 10 minute listening period. After the calls were played, another 10 minutes of spotlighting was done in the vicinity to check for animals attracted by the calls, but not vocalising. Calls from Stewart and Pennay (Pennay *et al.* 2004; Stewart 1998) were broadcast using a portable media player and megaphone.

Call playback was also used to survey for the Wallum Froglet, Green-thighed Frog and Giant Barred Frog, the methodology described above was used for each species at appropriate locations within the project study area.

HERPETOFAUNA ACTIVE SEARCH

Herpetofauna active searches during the day and at night, involved looking for active specimens and eye shine, turning over suitable ground shelter, such as fallen timber, sheets of iron and exposed rocks, raking debris, and peeling decortivating bark. Specimens were either identified visually, by aural recognition of call (frogs only) or were collected and identified using nomenclature outlined in *A Field Guide to Reptiles of New South Wales* (Swan *et al.* 2004).

Herpetofauna surveys were completed by one or two persons over a 30 minute period with all ground shelter returned to their original position. A total of three person hours were conducted throughout the project study area. Herpetofauna active searches were completed in conjunction with diurnal and nocturnal surveys. Frogs and reptiles were also surveyed opportunistically during all other surveys in the study area over a five day period. Reptiles were surveyed in reference to *Threatened species survey and assessment guidelines: field survey methods for fauna (reptiles)* (Department of Environment and Climate Change 2009a).

ARBOREAL TRAPPING

Medium to large sized arboreal mammals were surveyed using arboreal set Elliott Type B trapping methods. Live capture/release Elliott Type B traps were set in three transects of eight traps for three nights per transect to target Squirrel Gliders and Eastern Pygmy-possum. Each trap was baited with a suitable food source containing honey, and each trap and immediate location was sprayed with an attractant of honey/vanilla essence water mix. Traps were checked at dawn each morning with captured animals identified to species level and released. All live trapping followed guidelines and policies for wildlife research in accordance with animal ethics protocols.

TERRESTRIAL TRAPPING

Small to medium sized terrestrial mammals were surveyed using Elliott Type A trapping methods. Live capture/release Elliott Type A traps were set in three transects of 25 traps for three nights per transect to target Eastern Chestnut Mouse and New Holland Mouse. Each trap was baited with a suitable food source containing honey. Traps were checked at dawn each morning with captured animals identified to species level and released. All live trapping followed guidelines and policies for wildlife research in accordance with animal ethics protocols.

NEST BOXES

Nest boxes were used to survey for small to medium sized arboreal mammals, specifically targeting Eastern Pygmy-possum. Twelve nest boxes were set in appropriate habitat throughout the study area (Figure 4.3). Nest boxes were set over a period of 14 nights. In total, 168 trap nights were recorded in the study area.

HAIR TUBES

Small (50 millimetres) and medium (90 millimetres) hair tubes were used to target Eastern Pygmy-possum and Squirrel Gliders. Each trap was baited with a suitable food source containing honey, and each trap and immediate location was sprayed with an attractant of honey/vanilla essence water mix. Twenty 90 millimetres and twenty-five 50 millimetres hair tubes were set in the field for over 15 nights. A total of 675 trap nights were recorded in the study area.

REMOTE CAMERA

Six remote motion sensing infra-red cameras were positioned in the study area to target Spotted-tailed Quoll, Long-nosed potoroo, Squirrel Glider and Eastern Pygmy-possum. Five remote cameras were used to target Spotted-tailed Quoll and Long-nosed Potoroo in appropriate microhabitats in the study area. One other camera trap was set with a suitable food source containing honey and sprayed with the attractant of honey/vanilla essence water mix to target Squirrel Glider and Eastern Pygmy-possum in the appropriate microhabitat (inclusive of proteaceous shrubs). Cameras were also used to target other animals occurring within survey locations including introduced species. In total, 15 trap nights were recorded for arboreal mammals and 75 trap nights for terrestrial mammals.

FAUNA HABITAT ASSESSMENT

Fauna habitat assessments were completed to assess the likelihood of threatened species of animal occurring in the study area. Habitat assessments included the assessment and identification of habitat features through targeted meander surveys.

During habitat assessments and targeted meander surveys, opportunistic recordings of species were made through incidental sightings, aural recognition of calls and observations of indirect evidence of species' presence (such as Glossy-black Cockatoo chewed cones, nests/dreys, whitewash, burrows and scats). This provided supplementary information on faunal species presence.

Fauna habitats were assessed generally by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, shelter roosting and breeding. The following criteria were used to evaluate habitat values:

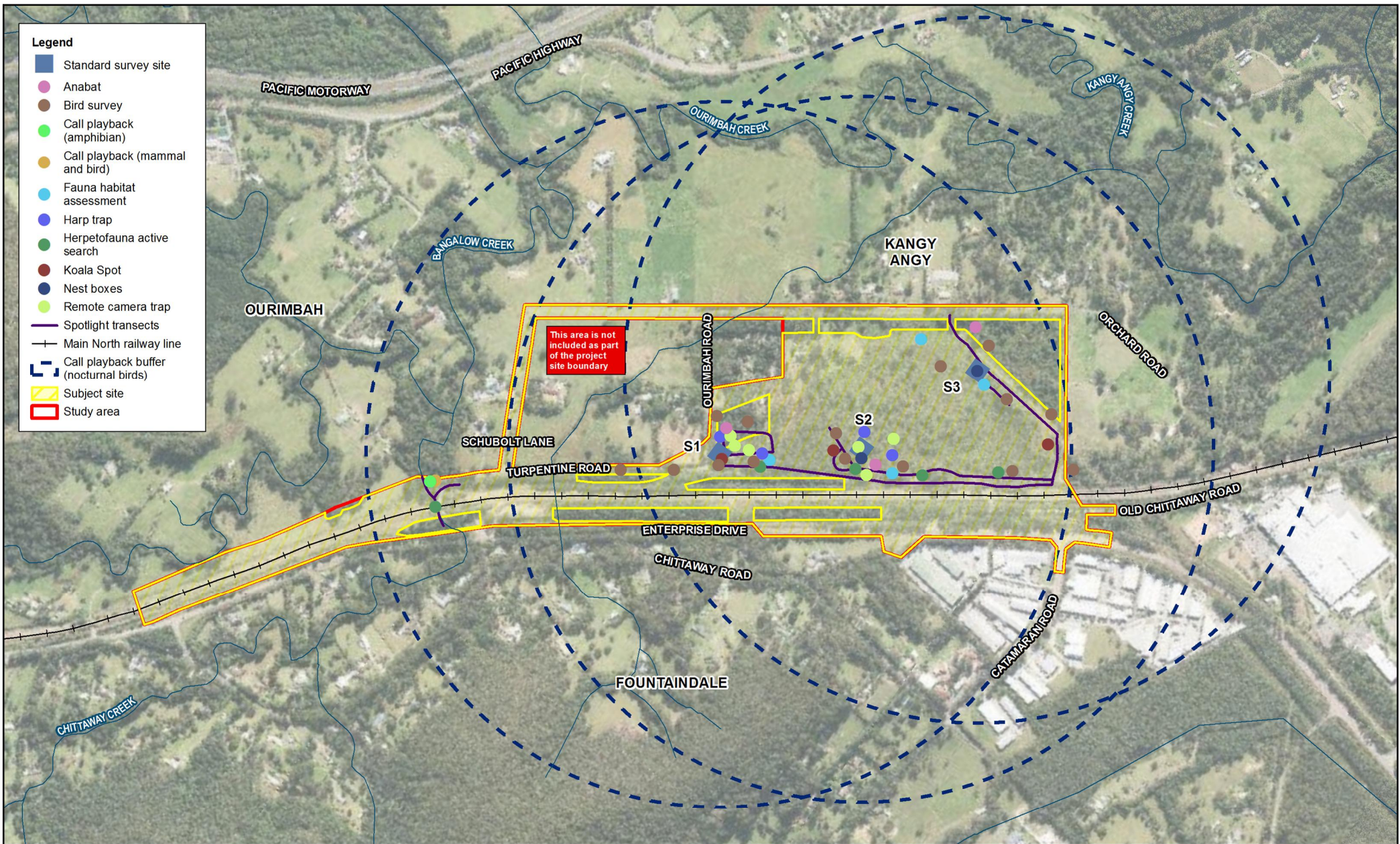
- **Good:** A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate:** Some fauna habitat components are missing (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
- **Poor:** Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

Specific fauna habitat features were assessed at each standard fauna survey site (Figure 4.3) in the study area and an additional four locations in the study area.

OPPORTUNISITC SIGHTINGS

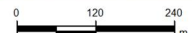
In total 25 days of opportunistic sightings have been recorded in the study area:

- 10 days targeted surveys for BAR and SIS (WSP | Parsons Brinckerhoff)
- Onsite ecological advice for boundary maintenance and installations (14 March 2016) (EMM 2016)
- 11 days onsite ecological services during geotechnical and contamination investigations (7–17 December 2015) (EMM 2016)
- Three days during surveys informing Preliminary Ecological Assessment (10, 16 and 17 September 2015) (EMM 2015a).



Map: 2202522A_GIS_F054_A1

Author: suansrir



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Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 4.3

Fauna survey effort

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4.2.2 Documenting survey effort

4.2.2.1 FLORA

A summary of targeted flora survey effort is provided in Table 4.3. For more detail regarding survey methodology refer to section 4.2.1.

Table 4.3 Summary of targeted flora survey effort

Target species	Optimal survey period (OEH 2016D)	Dates surveyed	Survey type	Survey effort (person hours)	Habitat searched
<i>Melaleuca biconvexa</i>	Survey all year round	10, 16 and 17 September 2015 7–17 December 2015 1, 22, 23, 26 and 29 February 2016 14, 17, 21, 22, 23, 24 and 29 March 2016	Random meanders, visual abundance (Duncan) and stem counts (total counts and stem density quadrats (20 x 20 m). Opportunistic surveys i.e. vegetation mapping, BioBanking quadrats and fauna survey.	300 hours	PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast
<i>Syzygium paniculatum</i>	Survey all year round	10, 16 and 17 September 2015 7–17 December 2015 1, 22, 23, 26 and 29 February 2016 14, 17, 21, 22, 23, 24 and 29 March 2016	Random meander. Opportunistic surveys.	60 hours	PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast
<i>Maundia triglochinosides</i>	Survey all year round	10, 16 and 17 September 2015 7–17 December 2015 1, 22, 23, 26 and 29 February 2016 14, 17, 21, 22, 23, 24 and 29 March 2016	Random meander. Opportunistic surveys.	300 hours	PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast
<i>Prostanthera askania</i>	September to December	10, 16 and 17 September 2015 7–17 December 2015	Random meander. Opportunistic surveys.	60 hours	PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast
<i>Senna acclinis</i>	February to March	1, 22, 23, 26 and 29 February 2016 14, 17, 21, 22, 23, 24 and 29 March 2016	Random meander. Opportunistic surveys.	45 hours	PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast

Target species	Optimal survey period (OEH 2016D)	Dates surveyed	Survey type	Survey effort (person hours)	Habitat searched
<i>Caladenia tessellata</i>	September to October	10, 16 and 17 September 2015	Random meander. Opportunistic surveys.	45 hours	Entire study area.
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	Survey all year round	10, 16 and 17 September 2015 7–17 December 2015 1, 22, 23, 26 and 29 February 2016 14, 17, 21, 22, 23, 24 and 29 March 2016	Random meander. Opportunistic surveys.	360 hours	Entire study area.
<i>Dendrobium melaleucaphilum</i>	July to October	10, 16 and 17 September 2015	Random meander. Opportunistic surveys.	15 hours	PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast
<i>Persicaria elatior</i>	Summer and/or Autumn	7–17 December 2015 1, 22, 23, 26 and 29 February 2016 14, 17, 21, 22, 23, 24 and 29 March 2016	Random meander. Opportunistic surveys.	250 hours	PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast

4.2.2.2 FAUNA

A summary of targeted flora survey effort is provided in Table 4.4. For more detail regarding survey methodology refer to section 4.2.1.

Table 4.4 Summary of targeted fauna survey effort

Subject species	Survey type	Survey effort	Dates surveyed	Habitat searched
Arboreal mammals	Arboreal mammal trapping	72 trap nights	17, 21–23 March 2016	Swamp Forest (32.4 ha)
→ Eastern Pygmy-possum	Hair tubes	675 trap nights	22 March–5 April 2016	Wet Open Forest (4.5 ha)
→ Yellow-bellied Glider	Nest boxes	168 trap nights	23 March–5 April 2016	
→ Squirrel Glider	Spotlight surveys	14 person hours	17, 21–23 March 2016	
	Call playback	2 hours	17, 21–23 March 2016	
	Camera traps	15 trap nights	22 March–5 April 2016	
Terrestrial mammals	Terrestrial mammal trapping	225 trap nights	17, 21–23 March 2016	Swamp Forest (32.4 ha)
→ Eastern Chestnut Mouse	Spotlight surveys	14 person hours	17, 21–23 March 2016	Wet Open Forest (4.5 ha)
→ Common Planigale	Camera traps	75 trap nights	22 March–5 April 2016	
→ Spotted-tailed quoll				
→ Long-nosed Potoroo				
Large forest owls	Call playback	2 hours	17, 21–23 March 2016	Swamp Forest (32.4 ha)
→ Powerful owl	Spotlight surveys	14 person hours		Rainforest (1.6 ha)
→ Sooty Owl				Wet Open Forest (4.5 ha)

Subject species	Survey type	Survey effort	Dates surveyed	Habitat searched
Diurnal birds → Regent Honeyeater → Gang-gang Cockatoo → Glossy Black Cockatoo → Varied Sittella → Little Lorikeet → Little eagle → Black Bittern → Swift parrot → Square-tailed Kite → Wompoo Fruit-dove → Rose-crowned Fruit-dove → Superb Fruit-dove	Standard 20 minute area search	6 person hours	17, 21–24 March 2016	Swamp Forest (32.4 ha) Wet Open Forest (4.5 ha)
Diurnal blossom nomads → Regent Honeyeater → Little Lorikeet → Swift Parrot	Active search of study area, targeting patches of Swamp Mahogany in blossom	6.5 person hours	20 May 2016	Swamp Forest (32.4) Wet Open Forest (3.8)
Microchiropteran bats → Large-eared Pied-bat → Eastern False Pipistrelle → Golden-tipped Bat → Little Bentwing-bat → Eastern Bent-wing Bat → Eastern Freetail-bat → Southern Myotis → Yellow-bellied Sheath-tail-bat → Greater Broad-nosed Bat	Active ultrasonic bat detection Passive ultrasonic bat detection	1 hr active during spotlight event 6 nights full recording	21–23 March 2016	Swamp Forest (32.4 ha) Rainforest (1.6 ha) Wet Open Forest (4.5 ha)
	Harp trapping	6 trap nights	21–23 March 2016	Swamp Forest (32.4 ha) Rainforest (1.6 ha) Wet Open Forest (4.5 ha)

Subject species	Survey type	Survey effort	Dates surveyed	Habitat searched
Amphibians	Spotlight surveys	14 person hours	17, 21–24 March 2016	Swamp Forest (32.4 ha)
→ Wallum Froglet	Call playback	2 hours	17, 21–24 March 2016	Rainforest (1.6 ha)
→ Green-thighed Frog	Herpetofauna active searches	3 person hours	17, 21–24 March 2016	Wet Open Forest (4.5 ha)
→ Giant Barred Frog	Opportunistic sightings	25 days	Please refer to opportunistic surveys below	Within entirety of the study area
Reptiles	Spotlight surveys	14 person hours	17, 21–24 March 2016	Swamp Forest (32.4 ha)
→ Stephen's Banded Snake	Herpetofauna active searches	3 person hours	17, 21–24 March 2016	Rainforest (1.6 ha)
→ Pale-headed Snake	Opportunistic sightings	5 days	Please refer to opportunistic surveys below	Wet Open Forest (4.5 ha) Within entirety of the study area
Koala	(SPOT assessment technique)	2 person hours	21–24 March 2016	Habitat containing Koala feed tree species
	Spotlight survey	14 person hours		Swamp Forest (32.4 ha)
	Call playback			
All threatened species	Opportunistic sightings	25 days	29 April 2016 14, 17, 21–24 March 2016 22, 23, 26 and 29 February 2016 7–17 December 2015 10, 16 and 17 September 2015	Within entirety of the study area

4.3 Survey results

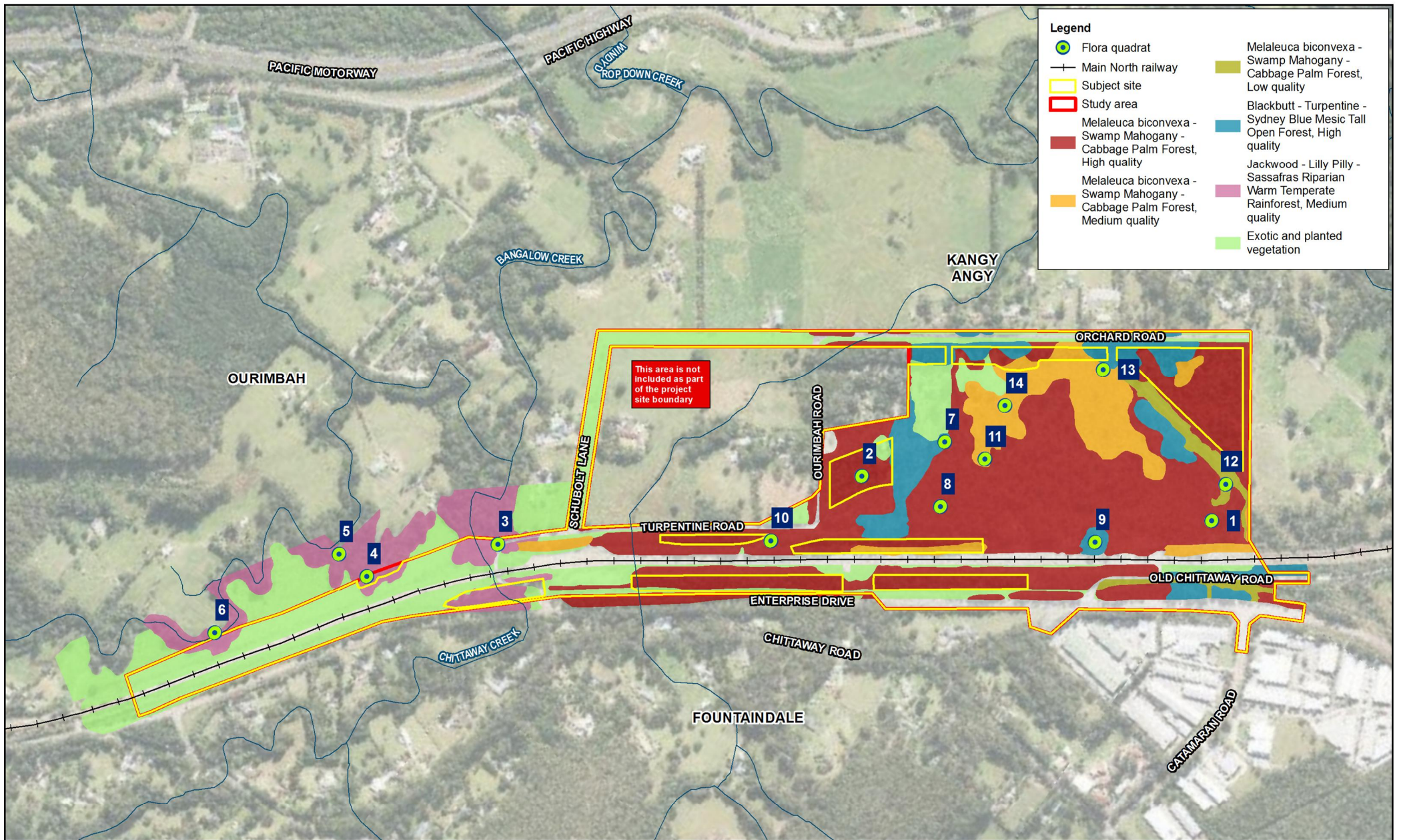
This section provides the results of the flora and fauna survey conducted within the study area.

4.3.1 General survey results

4.3.1.1 DESCRIPTION OF VEGETATION COMMUNITIES

The desktop analysis of existing vegetation mapping and field validation surveys identified that the vegetation within the subject site was comprised of four vegetation communities, the distribution of which are related to geological, topographical and geomorphological characteristics as well as previous and current land uses. The vegetation communities mapped within the subject site are provided in Table 4.5 and illustrated in Figure 4.4.

Detailed descriptions of each vegetation community are provided below.



Legend

- Flora quadrat
- Main North railway
- Subject site
- Study area
- Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm Forest, High quality
- Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm Forest, Medium quality
- Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm Forest, Low quality
- Blackbutt - Turpentine - Sydney Blue Mesic Tall Open Forest, High quality
- Jackwood - Lilly Pilly - Sassafras Riparian
- Warm Temperate Rainforest, Medium quality
- Exotic and planted vegetation

Map: 2202522A_GIS_F053_A1
 Author: suansrir
 Date: 11/05/2016
 Approved by: -

0 100 200 m
 1:9,500
 Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A4

Note: Design is indicative only.
 Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 4.4
 Vegetation communities and flora survey effort

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Table 4.5 Vegetation communities identified within the study area

WSP PB 2016	Plant community type/Biometric vegetation type ¹	Existing broad-scale mapping ²	EMM 2015 ³	TSC Act status	EPBC Act status	Extant within subject site (ha)	Extant within study area (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest	PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast	MU17: Alluvial Robusta – Paperbark Sedge Palm Forest	Swamp Mahogany Forest	Endangered – Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	Not listed	25.5	32.4
Jackwood – Lilly Pilly – Sassafras Rainforest	PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast	MU40: Riverine Alluvial Gallery Rainforest – Moist Forest	Jackwood – Lilly Pilly	Not listed	Not listed	1.1	1.6
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	PCT1568/HU782: Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the central coast	MU27: Narrabeen Coastal Blackbutt Scrubby Forest	Not mapped	Not listed	Not listed	3.6	4.5
Exotic and planted vegetation	N/A	Not mapped	Not mapped	Not listed	Not listed	12.1	12.6

- (1) Plant Community Type (PCT)/Biometric Vegetation Type (BVT) derived from 'Vegetation Information Systems (VIS) Classification 2.1' (Office of Environment and Heritage 2016f)
- (2) Existing broad-scale mapping derived from 'The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales' (Bell, S. 2002).
- (3) Previous vegetation mapping undertaken as part of the *Preliminary Ecological Assessment: New Intercity Maintenance Facility* (EMM 2015a).

MELALEUCA BICONVEXA – SWAMP MAHOGANY – CABBAGE PALM FOREST

This was the dominant vegetation community within the subject site occurring predominantly within the northern portion of the subject site. This community was also recorded as the dominant vegetation type in the previous ecological study (EMM 2015b) and within the existing broad-scale vegetation mapping (Bell, S. 2002). The vegetation type was in Moderate to Good condition (High and Medium Quality) and in Low condition (dependent upon its location within the landscape and subsequently the level of disturbance the community is or has been subjected to). Some areas of this community, particularly along the railway line, roads and access tracks experienced sparse to dense weed infestations.

A summary description of this community is provided in Table 4.6 and shown in Photo 4.1, Photo 4.2 and Photo 4.3.

Table 4.6 Summary characteristics of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest within the subject site

Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	5–20	0–40	<i>Eucalyptus robusta</i> , <i>Syncarpia glomulifera</i> , <i>Livistona australis</i> , <i>Glochidion ferdinandi</i> and the occasional <i>Eucalyptus pilularis</i> and <i>Archontophoenix cunninghamiana</i> in transitional areas.
Sub-canopy	3–8	0–30	<i>Acacia longifolia</i> , <i>Glochidion ferdinandi</i> , <i>Melaleuca biconvexa</i> , <i>Elaeocarpus reticulatus</i> , <i>Melaleuca linariifolia</i> and <i>Melaleuca ericifolia</i> . In some locations the sub-canopy was dominated by exotic species i.e. <i>Ligustrum sinense</i> *.
Shrub stratum	0.4–4	0–90	<i>Acacia longifolia</i> , <i>Persoonia linearis</i> , <i>Leptospermum polygalifolium</i> , <i>Elaeocarpus reticulatus</i> , <i>Melaleuca linariifolia</i> and <i>Melaleuca ericifolia</i> . In some locations the shrub stratum was dominated by exotic species i.e. <i>Lantana camara</i> * as well as <i>Ligustrum sinense</i> * and <i>Lantana camara</i> * juveniles.
Groundcover	0.1–2	0–100	<i>Gahnia</i> spp., <i>Baloskion tetraphyllum</i> , <i>Baumea acuta</i> , <i>Pteridium esculentum</i> , <i>Gleichenia dicarpa</i> , <i>Calochlaena dubia</i> , <i>Cyperus</i> spp. and <i>Entolasia stricta</i> . In some locations the groundcover did experience high levels of weeds species including <i>Ehrharta erecta</i> *, <i>Ligustrum sinense</i> * saplings and <i>Rubus fruticosus</i> *.
NSW PCT/BVT	PCT1723/HU937: <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast		
Conservational significance	High: This community forms part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions threatened ecological community listed as Endangered under the TSC ACT. This community provides habitat for a variety of threatened flora and fauna species including <i>Melaleuca biconvexa</i> which was recorded within this vegetation type.		

Strata	Height range (m)	Foliage cover (%)	Dominant species
Condition	<p>Moderate to Good (High Quality): Areas of good quality Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest predominantly within areas which retained a canopy and contained a high abundance and diversity of native species. These areas generally showed resilience to weed infestations as a result of an intact groundcover, shrub and canopy layers. These areas generally occurred in areas of lower disturbance and where vegetation was more intact i.e. few clearings, access tracks etc.</p> <p>Moderate to Good (Medium Quality): Areas of medium quality Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest predominantly occurred along the peripheries of the community or in areas where the canopy was absent. Within these areas the community lacked one or more strata and experienced low to moderate densities of exotic species, native species diversity did remain high.</p> <p>Low: Areas of low condition Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest occurred along the access track to the north of the subject site. Within this area the vegetation lacked one or more strata layers and was generally dominated by exotic groundcover species (native species <50 per cent).</p>		
Extent and distribution within the site	<p>This community covered the majority of the northern portion of the subject site covering an extent of 32.4 hectares or 62 per cent of the subject site. The community was situated on sandy alluvial soils with poor drainage with large stands of water observed in some locations. This community integrated with the Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest and Jackwood – Lilly Pilly – Sassafras Rainforest community preferring soils with lower drainage potential and at slightly lowered elevations.</p>		



Photo 4.1 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest Moderate to High (High Quality)



Photo 4.2 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest Moderate to Good (Medium Quality)



Photo 4.3 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest Low Condition

JACKWOOD – LILLY PILLY – SASSAFRAS RAINFOREST

This vegetation community dominated the southern portion of the subject site occurring along Bangalow Creek and Chittaway Creek which are tributaries of Ourimbah Creek. This community was also recorded in the previous ecological study (EMM 2015b) and in the existing broad-scale vegetation mapping (Bell, S. 2002). The vegetation type was in Moderate to Good (Medium Quality) condition with high native species richness and low to moderate weed infestations. Some areas of this community experienced sparse to dense woody weed infestations.

A summary description of this community is provided in Table 4.7 and shown in Photo 4.4 and Photo 4.5.

Table 4.7 Summary characteristics of Jackwood – Lilly Pilly – Sassafras Rainforest within the subject site

Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	8–30	30–70	<i>Eucalyptus saligna</i> , <i>Doryphora sassafras</i> , <i>Syncarpia glomulifera</i> , <i>Eucalyptus tereticornis</i> , <i>Livistona australis</i> and <i>Archontophoenix cunninghamiana</i> .
Sub-canopy	4–12	30–80	<i>Cryptocarya glaucescens</i> , <i>Cryptocarya microneura</i> , <i>Neolitsea australiensis</i> , <i>Synoum glandulosum</i> subsp. <i>glandulosum</i> , <i>Acmena smithii</i> , <i>Ripogonum album</i> , <i>Alphitonia excels</i> , <i>Diploglottis australis</i> , <i>Glochidion ferdinandi</i> , <i>Elaeocarpus reticulatus</i> and <i>Acacia parramattensis</i> . In some locations the sub-canopy was dominated by exotic species i.e. <i>Ligustrum lucidum</i> * and <i>Ligustrum sinense</i> *.
Shrub stratum (incl. vines and scramblers)	0.4–5	0–80	<i>Breynia oblongifolia</i> , <i>Ficus coronata</i> , <i>Rapanea howittiana</i> , <i>Rapanea variabilis</i> , <i>Acmena smithii</i> , <i>Backhousia myrtifolia</i> , <i>Syzygium austral</i> , <i>Syzygium oleosum</i> , <i>Melicope micrococci</i> , <i>Zieria smithii</i> and <i>Acacia prominens</i> . This community also included a series of vines and scramblers including <i>Pandorea pandorana</i> , <i>Dioscorea transversa</i> , <i>Glycine clandestine</i> , <i>Eustrephus latifolius</i> , <i>Geitonoplesium cymosum</i> , <i>Sarcopetalum harveyanum</i> , <i>Trophis scandens</i> and <i>Smilax australis</i> .
Groundcover	0.1–3	0–100	<i>Blechnum indicum</i> , <i>Oplismenus aemulus</i> , <i>Dichondra repens</i> , <i>Commelina cyanea</i> , <i>Carex appressa</i> , <i>Livistona australis</i> . In some locations the groundcover did experience high levels of weeds species including <i>Axonopus fissifolius</i> *, <i>Ligustrum sinense</i> *, <i>Ehrharta erecta</i> *, <i>Sida rhombifolia</i> * and <i>Tradescantia fluminensis</i> *.
NSW PCT/BVT	PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast		
Conservational significance	Moderate: This community does not form part of any listed threatened ecological community under the TSC ACT or the EPBC Act. This community does however provide habitat for a variety of threatened flora and fauna species. The community also creates a narrow wildlife corridors in some areas of the subject site linking vegetation to remnants of vegetation within the locality.		
Condition	Moderate to Good (Medium Quality): Areas of medium quality Jackwood – Lilly Pilly – Sassafras Rainforest occurred within the southern portion of the subject site along Bangalow Creek and Chittaway Creek. Within these areas the community generally lacked an intact native groundcover layer, instead dominated it was dominated by exotic species. This is likely to be attributed to a high edge ratio. All other strata layers generally had a high diversity of native species.		

Strata	Height range (m)	Foliage cover (%)	Dominant species
Extent and distribution within the site	This community was the dominant vegetation type within the southern portion of the subject site covering an extent of 1.6 hectares or three per cent of the subject site. The community occurred along Bangalow Creek which flows into Chittaway Creek and ultimately Ourimbah Creek. This community integrated with the Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest and exotic and planted vegetation.		



Photo 4.4 Jackwood – Lilly Pilly – Sassafras Rainforest Moderate to Good (Medium Quality)



Photo 4.5 Jackwood – Lilly Pilly – Sassafras Rainforest Moderate to Good (Medium Quality) grazed understorey

BLACKBUTT – TURPENTINE – SYDNEY BLUE GUM MESIC TALL OPEN FOREST

This community occurred as patches within the subject site; integrating with the *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation type. This community generally occurred on alluvial sandy soils which had higher drainage potential and were at slightly higher elevations than the surrounding vegetation. This community was not recorded within the subject site in the previous ecological study (EMM 2015b) however has been recorded in the locality by existing broad-scale mapping (Bell, S. 2002). This community occurred in good condition with high native species diversity.

A summary description of this community is provided in Table 4.8 and shown in Photo 4.6 and Photo 4.7.

Table 4.8 Summary characteristics of Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest within the subject site

Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	10–26	0–40	<i>Eucalyptus pilularis</i> , <i>Syncarpia glomulifera</i> and <i>Corymbia gummifera</i> within the occasional <i>Eucalyptus robusta</i> and <i>Angophora floribunda</i> .
Sub-canopy	0–10	0–60	Immature <i>Syncarpia glomulifera</i> and <i>Melaleuca linariifolia</i> .

Strata	Height range (m)	Foliage cover (%)	Dominant species
Shrub stratum	0.4–2.2	0–50	<i>Ozothamnus diosmifolius</i> , <i>Leptospermum polygalifolium</i> , <i>Leucopogon lanceolatus</i> , <i>Zieria smithii</i> , <i>Epacris pulchella</i> , <i>Cassinia uncata</i> , <i>Leucopogon margarodes</i> , <i>Acacia longissimi</i> , <i>Livistona australis</i> and <i>Polyscias sambucifolia</i> .
Groundcover	0.1–1.8	0–60	<i>Baloskion tetraphyllum</i> , <i>Entolasia stricta</i> , <i>Pteridium esculentum</i> , <i>Hibbertia dentata</i> , <i>Pomax umbellata</i> , <i>Gahnia</i> spp., <i>Xanthosia pilosa</i> , <i>Dianella caerulea</i> , <i>Microlaena stipoides</i> and the occasional exotic species such as <i>Hypochoeris radicata</i> *
NSW PCT/BVT	PCT1568/HU782: Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the central coast.		
Conservational significance	Moderate: This community does not form part of any listed threatened ecological community under the TSC ACT or the EPBC Act. This community does however provide habitat for a variety of threatened flora and fauna species. The community also creates a narrow wildlife corridors in some areas of the subject site linking vegetation to remnants of vegetation within the locality.		
Condition	Moderate to Good (High Quality): Areas of good quality Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest retained an intact canopy and contained a high abundance and diversity of native species. These areas generally showed resilience to weed infestations as a result of an intact groundcover, shrub and canopy layers. Some areas of this community has been exposed to understorey clearing however retains a high diversity of native groundcover species which had good regeneration potential.		
Extent and distribution within the site	This community occurred as scattered patches within the north western portion of the subject site covering an extent of 4.5 hectares or nine per cent of the subject site. This community integrated with <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest preferring slightly perched sandier alluvial soils which had higher drainage potential.		



Photo 4.6 Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest Moderate to Good (High Quality)



Photo 4.7 Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest Moderate to Good (High Quality)

EXOTIC AND PLANTED VEGETATION

This vegetation type occurs across the subject site in areas subjected to past and current land uses such as residential properties, access tracks, infrastructure associated with the railway line and hobby farms. As a result of this vegetation types poor condition it is not consistent with any native vegetation community.

A summary description of this community is provided in Table 4.9 and shown in Photo 4.8.

Table 4.9 Summary characteristics of exotic and planted vegetation within the subject site

Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	5–25	0–30	Generally absent. If present consists of planted exotic tree species.
Shrub stratum	0.4–2	0–100	Generally absent. If present consists of planted exotic species.
Groundcover	0.1–1.8	0–100	Generally dominated by exotic species such as <i>Axonopus fissifolius</i> *, <i>Ehrharta erecta</i> *, <i>Pennisetum clandestinum</i> *, <i>Tradescantia fluminensis</i> *, <i>Paspalum dilatatum</i> *, <i>Paspalum urvillei</i> * and <i>Senecio madagascariensis</i> *.
NSW PCT/BVT	Not consistent with any NSW PSCT/BVT.		
Conservational significance	Low: These areas generally contained planted or exotic vegetation with no or limited native vegetation. These areas provide limited habitat for threatened species and generally create small to large gaps between remnant vegetation reducing connectivity within the subject site.		
Condition	Poor: This community is in low condition as it is dominated by planted and exotic species. The structural integrity of this vegetation type generally lacks one more stratum and low regeneration potential.		
Extent and distribution within the site	This community occurred throughout the subject site covering an extant of 12.6 hectares or 25 per cent of the subject site. The community was not associated with soil or geology occurring on a variety of soil and geology types instead was associated with previous and current disturbances such as clearing for residential properties, access tracks, infrastructure associated with the railway line and hobby farms. This community bordered all other native vegetation communities recorded.		



Photo 4.8 Exotic and planted vegetation

4.3.1.2 FLORA SPECIES RECORDED

A total of 173 species of plant were recorded within the subject site, of which 132 species (76 per cent) were native. The most diverse family was the Poaceae with 20 species, the Myrtaceae with 16 species and the Fabaceae with 12 species.

Of the 41 exotic species recorded, three are declared as noxious weeds under the *Noxious Weeds Act 1993* (NW Act) for the former Wyong Shire Council Local Control Authority, now part of the Central Coast Council Local Control Authority (Table 4.10). These are all classified as Class 4 Locally Controlled Weeds which means that '*The plant must not be sold, propagated or knowingly distributed*'. In addition two of these noxious species and one additional exotic species recorded within the subject site are listed as Weeds of National Significance (Fireweed, Blackberry and Lantana) (Australian Weeds Committee 2016). Although they are not listed as noxious weeds under the *Noxious Weed Act* within the former Wyong Shire Local Control area (now part of the Central Coast Council) additional exotic plant species which have potential to spread rapidly were recorded within the study area. These species included *Lonicera japonica** (Japanese Honeysuckle), *Ligustrum lucidum** (Large-leaved Privet), *Ligustrum sinense** (Small-leaved Privet) and *Chloris gayana** (Rhodes Grass).

Table 4.10 Noxious weeds recorded within the study area

Scientific name	Common name	Class 4 Under NW Act	Wons
<i>Senecio madagascariensis</i> *	Fireweed	4	Yes
<i>Ageratina adenophora</i> *	Crofton Weed	4	No
<i>Rubus fruticosus</i> *	Blackberry complex	4	Yes
<i>Lantana camara</i> *	Lantana	-	Yes

4.3.1.3 DESCRIPTION OF FAUNA HABITATS

The suitability, size and configuration of the fauna habitats correlated broadly with the vegetation communities, as summarised in Table 4.11. These areas provided habitat for a range of birds, herpetofauna and mammals, and vegetation communities within the study area and were observed to vary in suitability for native fauna from good to poor.

Habitat features recorded in the study area generally included those associated with swamp forest types occurring on flood plains in the Central Coast and wet sclerophyll forests occurring in sheltered gullies and drainage lines in the foot hills of near coastal ranges.

Table 4.11 Fauna habitat corresponding to vegetation communities

Fauna habitat description	Corresponding vegetation community (refer to Section 3.2)
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High
Cleared land with scattered trees	Exotic and planted vegetation

While the majority of vegetation within the study area is dominated by native species, it is evident by the general paucity of understorey debris, the relatively young age cohort of canopy trees, the lack of canopy strata in some areas and the dense understorey strata, suggested that the vegetation communities are recovering from previous widespread disturbance. As a consequence the vegetation communities do not occur as old-growth forms and important fauna habitat attributes such as hollows, fallen timber, connectivity and large patch size are lacking. The general lack of these important habitat attributes reduce the study area's capacity for supporting a wide diversity of local native species, including threatened species, in isolation from other higher quality habitats in the locality.



Map: 2202522A_GIS_F055_A1 Author: suansrir

Date: 11/05/2016 Approved by: -



Data source: - © Land and Property Information 2015

Coordinate system: GDA 1994 MGA Zone 56
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New Intercity Fleet Maintenance Facility Project

Figure 4.5

Fauna habitats and features



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RAINFOREST

Rainforest habitats within the study area occurred as isolated patches of vegetation associated with Chittaway Creek (Photo 4.4). Although much of this habitat was relatively intact, protective buffers of other forest types were generally absent due to adjacent land managed for rural residential land holdings.

Rainforest habitats within the study area contained a variety of native broad-leaved trees providing seasonal fruits for frugivorous animals, such as fruit eating birds, flying foxes and possums. The understorey and canopy provides foraging habitats for insectivorous birds and bats and potential roosting sites for forest owls. Trees within onsite rainforest habitats were generally of an insufficient age-class to develop hollows for animals dependent on these resources for shelter and nesting purposes. The substrates associated with Chittaway Creek and the flowing nature of the water column is suited to the breeding cycles of rainforest frog species, such as the Barred Frogs (*Mixophyes* sp.), but does not suit the ephemeral pond breeding preferences of other species such as Green-thighed Frog (*Litoria brevipalmata*). Some patches of this forest type have emergent *Eucalyptus saligna* in the upper canopy, which would provide seasonal nectar foraging resources for nectarivorous birds and bats, including threatened species.

SWAMP FOREST

Much of the study area was characterised by floodplain topography perched above Chittaway, Bangalow and Ourimbah Creeks. The underlying substrates are subject to variations in elevation, which form a mosaic of low areas holding water, as well as more elevated substrates less subject to waterlogging. Throughout the swampy sections of the study area *Eucalyptus robusta* (Swamp Mahogany) is the dominant canopy tree, sometimes associated with ferns and mesic mid-storey trees (Photo 4.1), while other wetter areas with *Gahnia* sp. (Saw Sedge) and *Baloskion* sp. (Tassel Rush) species, with melaleucas dominating the mid-storey. Swamp Mahogany is a winter-flowering eucalypt with strong flowering events every three years or so. Due to the relatively large numbers of Swamp Mahogany within the study area, it is likely that the study area's swamp forests would be used seasonally by nectarivorous birds and bats, including threatened species, during Swamp Mahogany flowering events.

The structural complexity of swamp forest community habitats within the study area was relatively diverse with a variety of canopy, mid-storey and understorey plants. Such habitats are well suited to the foraging and nesting requirements of many common forest birds, although the diversity of such species was limited in this and adjacent forest habitats by the domination of Bell Miners in the canopy and mid-storey strata. In those sections where mesic mid-storey trees occur, the presence of fruit-bearing trees, shrubs and vines provide fruit for local frugivorous birds, such as Satin Bowerbird (*Ptilonorhynchus violaceus*), Australian King-Parrot (*Alisterus scapularis*), Lewin's Honeyeater (*Meliphaga lewinii*) and White-headed Pigeon (*Columba leucomela*). The dense understorey of ferns with vine masses extending into the mid-storey provided shelter and excellent foraging opportunities for wet forest understorey animals as well as nesting opportunities for these species and arboreal mammals such as Common Ringtail Possum.

Where swamp forest community occurred in lower areas Photo 4.9 the canopy was dominated by Swamp Mahogany, the mid-storey strata by melaleucas and the understorey by *Gahnia sieberana*. This habitat provided cover and foraging microhabitats for smaller forest animals, with seasonal blossom from Swamp Mahogany and melaleucas likely to attract a range of nectarivorous animals including threatened nomadic species when they occur locally.

In the northern sections of the study area swamp forest habitats are reduced to understorey strata, with only occasional emergent trees, largely *Syncarpia glomulifera* (Turpentine) and melaleucas (Photo 4.10). This habitat is suitable to understorey frequenting animals for shelter and foraging opportunities, but, for many native animals, its habitat value is compromised by large areas without mid-storey and canopy strata.



Photo 4.9 Swamp forest with *Melaleuca biconvexa* and *Gahnia sieberana*



Photo 4.10 Swamp forest reduced to understorey strata

WET OPEN FOREST

Wet open forest canopy-strata were dominated by *Eucalyptus pilularis* (Blackbutt) with some areas also *Corymbia gummifera* (Red Bloodwood), *Eucalyptus saligna* (Sydney Blue Gum) or *Syncarpia gummifera* (Turpentine). Understorey strata was usually dominated by ferns and *Leptospermum* sp. (Tea Tree) (Photo 4.6), but other areas were more open and grassy in the lower strata (Photo 4.11). The canopy stratum of this forest type provides summer seasonal nectar foraging resources for nectarivorous birds, bats and arboreal mammals. This community contains the largest and most mature trees in the study area which are most likely to contain hollows, however very few hollows were observed within the study area, with total numbers appearing consistent with the 12 recorded in the EMM report (EMM 2015a). As such, although the study area is likely to represent part of the home range for large forest owls occurring locally, the canopy trees within the study are not of sufficient age-class to develop hollows of the dimensions required for nesting forest owls or cockatoos; especially the larger species.

Understorey shrubs in areas of wet open forest (Photo 4.6) provide good cover for smaller forest birds and both nesting and foraging opportunities for common arboreal mammals, such as Common Ringtail Possum and Sugar Glider.

Photo 4.11 shows wet open forest habitat occurring on more elevated substrates, hence the dryer understorey plants dominated by grasses with bracken fern. This section of the community contained Red Bloodwood amongst the dominant Blackbutts, which would provide nectar and pollen during late summer for canopy nectarivorous fauna, including birds, bats and arboreal mammals. The under-storey stratum in this section of habitat was open with little structural diversity, so fauna habitat opportunities in this stratum were relatively poor.

In the northeast of the study area an isolated patch of this community is surrounded by swamp forest reduced to the understorey layer. This patch of wet open forest is subject to incursions of *Lantana camara** (Lantana), which provides sufficient shelter for small animals, but displaces the natural structure provided by native vegetation. This northeast wet open forest patch was the only forest habitat where hollows were observed and occurred in a single dead stag reduced to a free-standing bole. The size and shape of the hollows in this old stag are unlikely to provide habitat opportunities for fauna apart from small animals.



Photo 4.11 Wet open forest with a grassy understorey

CLEARED LAND WITH SCATTERED TREES

Relatively large areas of land within and surrounding the study area have been managed for residential and rural land-uses, largely horse husbandry. While these areas are dotted with scattered trees suited to larger canopy animals understorey strata are highly managed and do not offer any cover for small animal species. As a consequence these areas are suited to common open country birds and introduced mammals.

4.3.1.4 FAUNA MICROHABITATS

Table 4.12 describes the details of microhabitats recorded during habitat assessments in each fauna stratification unit.

Table 4.12 Fauna microhabitats

Microhabitat attribute	Fauna habitat stratification			
	Rainforest	Swamp forest	Wet open forest	Cleared land
Upper canopy	<i>Eucalyptus saligna</i> , <i>Doryphora sassafras</i> , <i>Syncarpia glomulifera</i> , <i>Eucalyptus tereticornis</i> , <i>Livistona australis</i> and <i>Archontophoenix cunninghamiana</i> .	<i>Eucalyptus robusta</i> , <i>Syncarpia glomulifera</i> , <i>Glochidion ferdinandi</i> , (occasional <i>E. pilularis</i> and <i>Archontophoenix cunninghamiana</i> in ecotonal areas)	<i>Eucalyptus pilularis</i> , <i>Syncarpia glomulifera</i> and <i>Corymbia gummifera</i> within the occasional <i>Eucalyptus robusta</i> and <i>Angophora floribunda</i>	Generally absent. If present consists of planted exotic tree species.
Sub-canopy	<i>Cryptocarya glaucescens</i> , <i>Cryptocarya microneura</i> , <i>Neolitsea australiensis</i> , <i>Synoum glandulosum</i> subsp. <i>glandulosum</i> , <i>Acmena smithii</i> , <i>Ripogonum album</i> , <i>Alphitonia excels</i> , <i>Diploglottis australis</i> , <i>Glochidion ferdinandi</i> , <i>Elaeocarpus reticulatus</i> and <i>Acacia parramattensis</i> . Occasional exotic species i.e. <i>Ligustrum lucidum</i> * and <i>Ligustrum sinense</i> *.	<i>Acacia longifolia</i> , <i>Glochidion ferdinandi</i> , <i>Elaeocarpus reticulatus</i> , <i>Melaleuca linariifolia</i> and <i>Melaleuca ericifolia</i>	Immature <i>Syncarpia glomulifera</i> and <i>Melaleuca linariifolia</i>	Absent
Shrub layer	<i>Breynia oblongifolia</i> , <i>Ficus coronata</i> , <i>Rapanea howittiana</i> , <i>Rapanea variabilis</i> , <i>Acmena smithii</i> , <i>Backhousia myrtifolia</i> , <i>Syzygium austral</i> , <i>Syzygium oleosum</i> , <i>Melicope micrococci</i> , <i>Zieria smithii</i> and <i>Acacia prominens</i> . This community also included a series of vines and scramblers including <i>Pandorea pandorana</i> , <i>Dioscorea transversa</i> , <i>Glycine clandestine</i> , <i>Eustrephus latifolius</i> , <i>Geitonoplesium cymosum</i> , <i>Sarcopetalum harveyanum</i> , <i>Trophis scandens</i> and <i>Smilax australis</i> .	<i>Acacia longifolia</i> , <i>Glochidion ferdinandi</i> , <i>Elaeocarpus reticulatus</i> , <i>Melaleuca linariifolia</i> and <i>Melaleuca ericifolia</i>	<i>Ozothamnus diosmifolius</i> , <i>Leptospermum polygalifolium</i> , <i>Leucopogon lanceolatus</i> , <i>Zieria smithii</i> , <i>Epacris pulchella</i> , <i>Cassinia uncata</i> , <i>Lissanthe strigosa</i> , <i>Acacia longissimi</i> , <i>Livistona australis</i> and <i>Polyscias sambucifolia</i>	Generally absent. If present consists of planted exotic species.

Microhabitat attribute	Fauna habitat stratification			
	Rainforest	Swamp forest	Wet open forest	Cleared land
Grasses, herbs, forbs, sedges, and rushes	<i>Blechnum indicum</i> , <i>Oplismenus aemulus</i> , <i>Dichondra repens</i> , <i>Commelina cyanea</i> , <i>Carex appressa</i> , <i>Livistona australis</i> . In some locations the groundcover did experience high levels of weeds species including <i>Axonopus fissifolius</i> *, <i>Ligustrum sinense</i> *, <i>Ehrhata erecta</i> *, <i>Sida rhombifolia</i> * and <i>Tradescantia fluminensis</i> *	<i>Gahnia</i> spp., <i>Baloskion tetraphyllum</i> , <i>Baumea acuta</i> , <i>Pteridium esculentum</i> , <i>Gleichenia dicarpa</i> , <i>Calochlaena dubia</i> , <i>Cyperus</i> spp. and <i>Entolasia stricta</i> . In some locations the groundcover did experience high levels of weeds species including <i>Ehrhata erecta</i> *, <i>Ligustrum sinense</i> * saplings and <i>Rubus fruticosus</i> *	<i>Baloskion tetraphyllum</i> , <i>Entolasia stricta</i> , <i>Pteridium esculentum</i> , <i>Hibbertia dentata</i> , <i>Pomax umbellata</i> , <i>Gahnia</i> spp., <i>Xanthosia pilosa</i> , <i>Dianella caerulea</i> , <i>Microlaena stipoides</i> and the occasional exotic species such as <i>Hypochaeris radicata</i> *	Generally dominated by exotic species such as <i>Axonopus fissifolius</i> *, <i>Ehrhata erecta</i> *, <i>Pennisetum clandestinum</i> *, <i>Tradescantia fluminensis</i> *, <i>Paspalum dilatatum</i> *, <i>Paspalum urvillei</i> * and <i>Senecio madagascariensis</i> *
Leaf litter	60–80 per cent	20–30 per cent	20–30 per cent	Absent
Fallen timber	Present	Absent	Present	Absent
Tree hollows and stags	Generally absent	Generally absent	Present in low abundance	Present
Rocks and rock shelves	Absent	Absent	Absent	Absent
Drainage lines and water bodies	Bangalow and Chittaway Creeks	Occurred as ephemeral ponds	Occurred as ephemeral ponds	Absent
Overall condition	Moderate	Poor to Moderate	Poor to moderate	Poor

4.3.1.5 FAUNA SPECIES RECORDED

A total of 95 native species of animal were recorded during field surveys (Table 4.13, Appendix A), including five threatened species; Varied Sittella, Little Lorikeet, Little Bentwing-bat, Eastern Bent-wing Bat and Grey-headed Flying-fox. Two introduced species, Spotted Turtle-dove and Rabbit, were recorded during field surveys.

Table 4.13 species of animal recorded

Group	Native	Introduced	Threatened	Total
Frogs	7	–	-	7
Reptiles	6	–	-	6
Birds	63	1	2	66
Mammals	14	1	3	18
Total	90	2	5	97

FROGS

Frog surveys were conducted under showery conditions during nocturnal hours. Although frog surveys were conducted during March, conditions were still warm enough to illicit frog calling activity throughout the study area. Three common frog species were calling on the survey nights, including Common Eastern Froglet (*Crinia signifera*), Brown-striped Frog (*Limnodynastes peronii*) and Dusky Gungan (*Uperoleia fusca*). One common species occurring at the southern end of its range, the Dainty Green Tree Frog (*Litoria gracilentia*) was observed calling in numbers during the survey. Two other common frogs the Eastern Dwarf Tree Frog (*Litoria fallax*) and Bleating Tree Frog (*Litoria dentata*) were observed during the day as young frogs from recent breeding events.

REPTILES

Only a small number of common reptiles were observed within the study area; three skinks, one dragon and two snakes. The study area was characterised by dense understorey vegetation, which would provide a diversity of micro-habitats for the prey species reptiles, so it is likely that the study area supports a diversity of common reptile species beyond those species that were observed.

BIRDS

Although the study area was generally well vegetated, not all areas were structurally complex in relation to a full complement of different strata. Large areas were devoid of mid-storey and canopy layers. As a consequence largely understorey aerial birds frequented these areas. In most other areas where canopy and midstorey strata represented good habitat for forest passerines, the upper forest layers were dominated by Bell Miners (*Manorina melanophrys*), which suppressed the potential for a higher diversity of small to medium sized passerines in these habitats.

The ferny understorey was found to support a good dense occurrence of ground dwelling birds, a relatively high density of Yellow-throated Scrubwren (*Sericornis citreogularis*) being of note.

A moderately diverse list of common forest and open country birds were observed, with only two threatened species recorded, the Varied Sittella (*Daphoenositta chrysoptera*) and Little Lorikeet (*Glossopsitta pusilla*).

MIGRATORY SPECIES

Two migratory species listed under the provisions of the EPBC Act were observed during field survey, they are, Rufous Fantail and Black-faced Monarch. After onsite habitat assessments a further four EPBC Act listed Migratory species were considered to have a moderate or greater likelihood of occurring within the study area.

MAMMALS

A number of common native terrestrial mammal species were observed within the study area, including, in order of density, Brown Antechinus (*Antechinus stuartii*), Bush Rat (*Rattus fuscipes*), Swamp Rat (*Rattus lutreolus*), and Dusky Antechinus (*Antechinus swainsonii*). The cover provided by the dense understorey across the study area was well suited to the habitat requirements of these species. Two arboreal mammals were observed, a Common Ringtail Possum (*Pseudocheirus peregrinus*) and Sugar Glider (*Petaurus breviceps*). The viny mid-storey of the swamp forest habitats were well suited to the habitat requirements of the possum and the Sugar Glider (*Petaurus breviceps*) was observed feeding on the sap of acacias within the same habitat type.

Grey-headed Flying-foxes (*Pteropus poliocephalus*) were observed flying over the study area during nocturnal surveys and would likely make use of seasonal blossom within the study area when available. The Grey-headed Flying-fox (*Pteropus poliocephalus*) is listed as Vulnerable under both the TSC Act and the EPBC Act and the study area showed no evidence that this species might set up camps within it.

A relatively diverse number of common microchiropteran bat species were observed throughout the study area including Ride's Free-tailed Bat, Eastern Broad-nosed Bat (*Scotorepens orion*), Chocolate Wattled Bat (*Chalinolobus morio*), Gould's Wattled Bat (*Chalinolobus gouldii*), Little Forest Bat (*Vespadelus vulturnus*), Eastern Forest Bat (*Vespadelus pumilus*), Gould's Long-eared Bat (*Nyctophilus gouldi*) and White-striped Freetail-bat (*Austronomus australis*).

The, Little Bent-wing Bat (*Miniopterus australis*) and Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*), which are listed as Vulnerable under the TSC Act, were also recorded within the study area. The Little Bent-wing Bat (*Miniopterus australis*) at site 1 and 2 and the Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) at site 3. Due to their nomadic habits, it is likely that a number of other microchiropteran bats, which occur in the wider locality would occur within the study area on at least an intermittent basis. The study area does not provide any roosting opportunities for cave-dwelling microchiropteran bats, and there is a paucity of small hollows throughout the study area, which might provide roosting sites for hollow-dwelling species.

KOALA HABITAT ASSESSMENT

The study area was found to contain two Koala feed tree species as listed in Schedule 2 of SEPP 44, being *Eucalyptus robusta* (Swamp Mahogany) and *E. tereticornis* (Forest Red Gum). *Eucalyptus robusta* (Swamp Mahogany) occurred within the study area at a density of greater than 15 per cent of the canopy layer therefore the study area was assessed as potential Koala habitat under the conditions contained in SEPP 44.

SAT methodology was employed at three locations within Swamp Mahogany stands with no sign of Koala activity with these stands. Opportunistic surveys over the study area found no evidence of Koala habitation with the study area.

4.3.2 Subject species survey results

4.3.2.1 FLORA SUBJECT SPECIES RECORDED

MELALEUCA BICONVEXA

TARGETED SURVEY

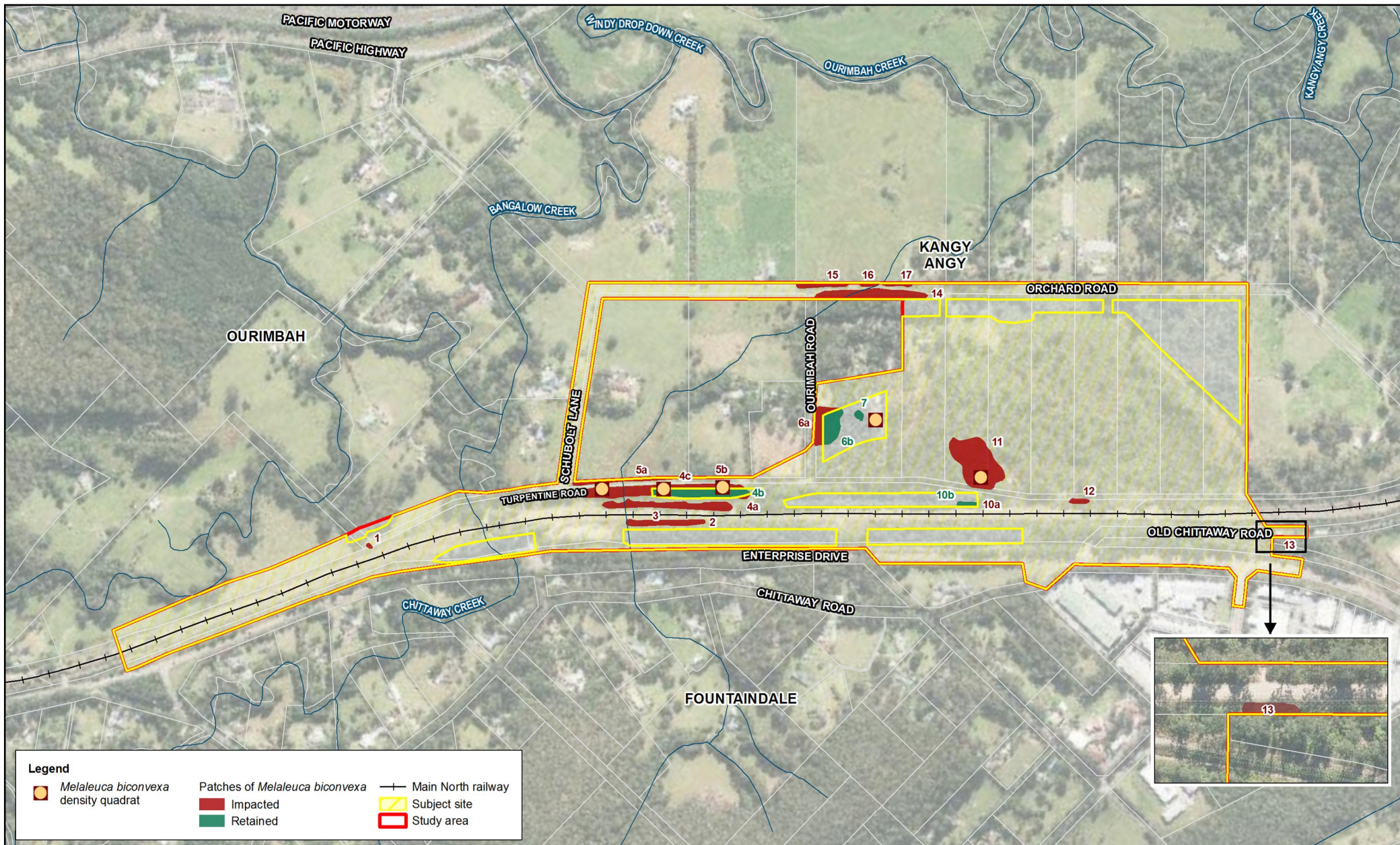
One targeted threatened flora subject species was recorded during previous and current surveys completed for the project; *Melaleuca biconvexa* (Figure 4.6).

Melaleuca biconvexa grows as shrub to small tree usually to 10 metres in height (but is known to reach 20 metres). The species has typical paperbark bark with small leaves to 18 millimetres in length and two millimetres in width. Each of the leaves has a characteristic centre-vein groove from which the leaf blade curves upright on either side (Office of Environment and Heritage 2016a) (Photo 4.12). This species is listed as Vulnerable under both the TSC Act and EPBC Act.



Photo 4.12 *Melaleuca biconvexa* recorded within the subject site

The distribution of *Melaleuca biconvexa* was associated with the Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest vegetation type. Within these areas the species occurred in high, medium and low abundances forming small to large populations across the subject site (Figure 4.6).



Legend

<i>Melaleuca biconvexa</i> density quadrat	Patches of <i>Melaleuca biconvexa</i> Impacted	Main North railway
Patches of <i>Melaleuca biconvexa</i> Retained	Subject site	Study area

Map: 2202522A_GIS_F056_A1
 Author: suansrir
 Date: 11/05/2016
 Approved by: -

Scale ratio correct when printed at A4

Coordinate system: GDA 1994 MGA Zone 56
 Note: Design is indicative only.
 Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 4.6
 Location of *Melaleuca biconvexa*

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Melaleuca biconvexa occurred in all three age class categories the dominant being the immature cohort (i.e. stem DBH at breast height less than 200 millimetres and less than six metres in height) whilst the abundance of saplings and mature specimens were considerably less Photo 4.13. The juvenile individuals generally occurred at the peripheries of the population along access tracks and roads. In one location the species was recorded only as juveniles and no immature or mature specimens were recorded (Photo 4.14).

The population recorded within the subject site forms part of local population (population two) within the Wyong Shire as described by Duncan (Duncan 2001a). Duncan (Duncan 2001a) maps the distribution of this local population as occurring approximately four kilometres south of the subject site and north to Tuggerah. This local population contains numerous subpopulations such as that recorded within the subject site of varying sizes and abundances. The subject site is also mapped as a priority area for conservation reserves and habitat protection in accordance with Duncan's (Duncan 2001a) conservation strategy for the species within the Wyong LGA.



Photo 4.13 High density immature *Melaleuca biconvexa* within the subject site



Photo 4.14 Juvenile *Melaleuca biconvexa* within subject site

Melaleuca biconvexa recorded within the subject site were subjected to population counts and age class estimates to identify the number of plant stems likely to be impacted upon by the project. Given that determining the population size of *Melaleuca biconvexa* through visual inspections is difficult (i.e. reproduced from seedlings and rhizome growth) the population size and abundance within the subject site were estimated via total counts or density average quadrats which included stem counts and a broad visual abundance assessment. In order to gain a more accurate extent and population estimate, the distribution of *Melaleuca biconvexa* within the subject site was split into 20 areas as shown in Table 4.14. A summary of this assessment is provided below in Table 4.14 and illustrated in Figure 4.6.

Table 4.14 Summary of *Melaleuca biconvexa* within the proposed study area

Impacted area	Age classification			Total	Visual abundance assessment (DUNCAN 2001B)	Count method ¹
	Mature	Immature	Saplings			
Inside area of impact						
Area 1	0	0	30	30	Low	Total count
Area 2	1	57	0	58	Medium	Density average
Area 3	154	167	247	568	High	Total count
Area 4a	1	28	5	34	High	Density average
Area 4c	34	938	176	1,148	High	Density average
Area 5a	9	243	44	296	High	Density average
Area 5b	0	8	2	10	High	Density average
Area 6a	26	49	72	147	High	Total count
Area 10a	0	1	1	2	High	Total count
Area 11	32	227	32	291	Medium	Density average
Area 12	0	12	6	18	Medium	Total Count
Area 13	1	23	4	28	High	Density average
Area 14	29	816	153	998	High	Density average
Area 15	6	174	33	213	High	Density average
Area 16	2	44	8	54	High	Density average
Area 17	3	72	14	89	High	Density average
Total inside area of impact				3,984		
<i>Melaleuca biconvexa</i> to be retained within the study area boundary						
Area 4b	23	634	119	776	High	Density count
Area 6b	32	62	92	186	High	Total count
Area 7	2	9	4	15	Medium	Density average
Area 10b	3	40	10	53	High	Total count
Total be retained within the project site boundary				1,030		

Note: 1) High density abundance stem counts based on 83 mature plant stems, 2,317 immature plant stems and 433 sapling plant stems per hectare; Medium density abundance stem counts based on 100 mature plant stems, 350 immature plant stems and 150 sapling plant stems per hectare; Low density abundance stem counts based on 50 mature plant stems, 350 immature plant stems and 50 sapling plant stems per hectare.

Results of the population estimate surveys identified that 5,014 *Melaleuca biconvexa* plant stems occur within the study area. Of these, 3,984 will be removed by the project whilst the remaining 1,030 will be retained. The majority of *Melaleuca biconvexa* plants likely to be impacted occur as immature to sapling age class.

Based on these survey results and given the project will result in both direct and indirect impacts on this species, *Melaleuca biconvexa* is considered as an 'affected species'. A detailed assessment of likely impacts of the project on *Melaleuca biconvexa* and its habitat is provided under section 5 of this report.

LOCAL POPULATION STUDY

In defining the local population of *Melaleuca biconvexa* the following definition has been considered:

The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area (Department of Environment and Climate Change 2007e).

The Duncan (2001a) study identifies a total of five populations of *Melaleuca biconvexa* within the Wyong LGA and these comprise of:

- Population 1 – Tumby Umbi
- Population 2 – Ourimbah/Fountaindale/Berkeley Vale
- Population 3 – Wyong/Porters Creek Wetland
- Population 4 – Jilliby/Dooralong
- Population 5 – Buttonderry Creek.

These populations were defined based on habitat discontinuity of no more than one kilometre from discrete groupings of plants that were deemed likely to be reasonable for maintain cross-pollination processes Duncan (2001a). This population framework was derived from a geographic discontinuity rule of thumb definition as outlined in Keith *et al* (1997).

It is considered that cross-pollination between *Melaleuca biconvexa* specimens within these patch areas are likely due to relatively contiguous vegetation (separation <one kilometer) that could be utilised by relatively mobile pollination species. The extent of the local population in which the study area occurs is considered generally consistent with Wyong LGA – Population 2 – Ourimbah/Fountaindale/Berkeley Vale (Duncan 2001a) and is shown in Figure 4.2.

The local population study utilised existing extent mapping of the local population undertaken by Duncan (2001). Field verification of the *Melaleuca biconvexa* mapping of the local population was relatively accurate. Where appropriate, updates to the existing mapping was completed which included the addition of new areas where the species was not previously recorded or modifications to the abundance categories.

An estimate of the total population of *Melaleuca biconvexa* was extrapolated using the averaged density of each abundance category (i.e. High, Medium and Low) and this was applied to all existing mapped abundance/age call patches and newly identified patch areas. A total of seven density quadrats within the local population and five density plots completed in the study area were averaged to estimate the total local population.

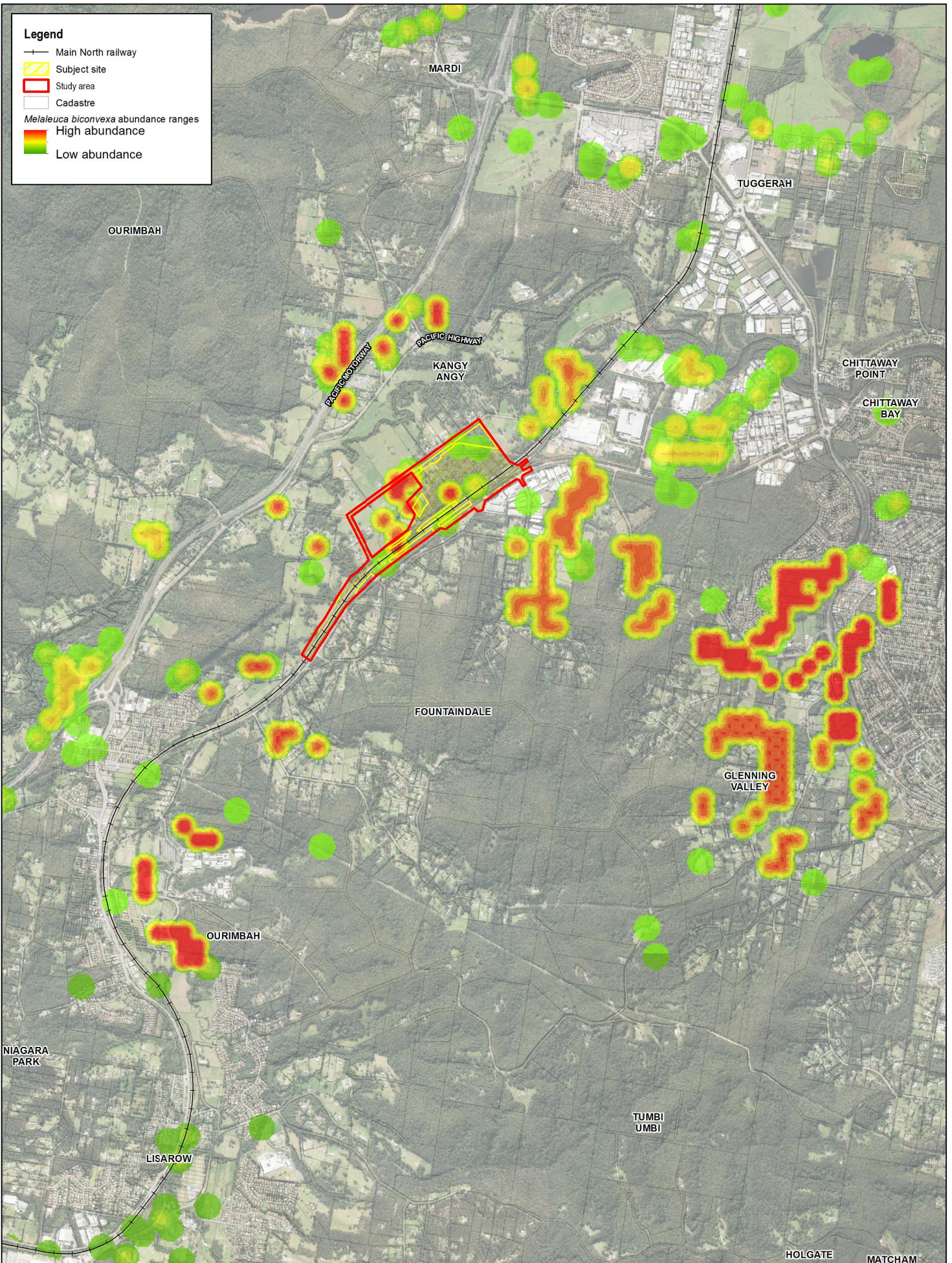
The local population study estimates that the local population of mature and immature *Melaleuca biconvexa* plant stems consist of approximately 72,275 and 167,612 respectively. Therefore, the 3,984 plant stems recorded within the subject site constitute approximately 1.6 per cent of the total population of mature and immature plant stems within the local population.

The records and abundances obtained from OEH's BioNet Atlas of NSW Wildlife, Duncan (2001) and field validation surveys were collectively mapped to generate a heat map of the local population (Figure 4.7). The heat map indicates that the *Melaleuca biconvexa* within the study area is one of numerous densely populated areas within the local population.

Table 4.15 Local population abundance and distribution estimate

Patch area	Age class	Average plant stems per visual abundance category (DUNCAN 2001B) ¹			Total
		Low	Medium	High	
Area 2	Mature	676	1,335	-	2,011
	Immature	1,201	2,518	-	3,719
Area 3	Mature	-	6,717	510	7,227
	Immature	-	17,310	961	18,271
Area 5	Mature	-	2,428	-	2,428
	Immature	-	4,578	-	4,578
Area 6	Mature	-	2,151	2,276	4,427
	Immature	-	5,544	4,292	9,836
Area 9	Mature	1,084	4,334	7,371	12,789
	Immature	1,928	8,172	18,997	29,097
Area 11b	Mature	-	2,538	2,126	4,664
	Immature	-	4,787	5,480	10,267
Area 12	Mature	229	1,381	24,812	11,237
	Immature	408	2,604	9,627	27,824
Area 14	Mature	710	5,443	7,515	13,668
	Immature	1,262	10,265	19,368	30,895
Area 15	Mature	-	2,082	-	2,082
	Immature	-	3,926	-	3,926
Area 16	Mature	720	704	10,318	11,742
	Immature	1,280	1,328	26,591	29,199
Total plant stems to be removed (all age classes within subject site)					3,984
Total mature plant stems within local population					72,275
Total immature plant stems within local population					167,612
Total plant stems within local population (including those within the subject site)					243,874

Note: 1) High density abundance stem counts based on 702 mature plant stems and 1,808 immature plant stems per ha; Medium density abundance stem counts based on 292 mature plant stems and 550 immature plant stems per hectare; Low density abundance stem counts based on 113 mature plant stems, 200 immature plant stems per hectare.



Map: 2202522A_GIS_F059_A1	Author: Suansrir		 1:26,003 Coordinate system: GDA 1984 MGA Zone 56 Scale ratio correct when printed at A3	Note: Design is indicative only. Subject to detailed design.	New Intercity Fleet Maintenance Facility Project Figure 4.7 Heat map of <i>Melaleuca biconvexa</i> abundances
Date: 11/05/2016	Approved by: -				
Data source: - © Land and Property Information 2015					

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4.3.2.2 FAUNA SUBJECT SPECIES RECORDED

Five threatened species of animal were recorded in the project study area during targeted field surveys (Table 4.16).

Table 4.16 Threatened species of animal recorded during targeted field surveys

Common name	Scientific name	TSC Act	EPBC Act
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V	
Little Lorikeet	<i>Glossopsitta pusilla</i>	V	
Little Bentwing-bat	<i>Miniopterus australis</i>	V	
Eastern Bent-wing Bat	<i>Miniopterus schreibersii oceanensis</i>	V	
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V

VARIED SITTELLA

The Varied Sittella was observed in the study area within swamp forest habitat beside Turpentine Road. Wooded areas of swamp forest and wet open forest habitats within the study area provide high quality foraging and breeding habitat for this species. The Varied Sittella prefers rough-barked trees for foraging and nest site locations, choosing nest locations in the upper branches of rough-barked trees and often foraging in the canopy strata. They sometimes descend to mid-storey shrubby trees and the individual observed within the study area was observed foraging on acacia bark in a mid-storey stratum. Swamp forest habitat in the study area contains large stands of Swamp Mahogany, which is often used by this species for foraging and nesting purposes. Wet open forest habitats contain Red Bloodwood, which is a rough-barked tree species, also suitable for both foraging and nesting purposes for the Varied Sittella. Half-barked trees such as Blackbutt and smooth-barks such as Sydney Blue Gum provide supplementary foraging habitats particularly when decorticating bark. The Varied Sittella is a sedentary species although they move widely within a moderate sized territory and due to relatively high quality of habitat within the study area it likely represents part of the home range of one or more local family groups.

LITTLE LORIKEET

A group of 12 Little Lorikeets were observed feeding on Swamp Mahogany blossom in the study area to the south of the rail corridor and immediately adjacent to the electrical easement. Wet open forest which contained a canopy stratum dominated by *Eucalyptus pilularis* with some areas also containing *Corymbia gummifera*, *Eucalyptus saligna*, would also provide summer seasonal nectar foraging resources for the Little Lorikeet.

LITTLE BENTWING-BAT

Foraging habitat for the Little Bentwing-bat encompassed the majority of the study area, including rainforest, swamp forest and wet open forest habitats. The study area did not contain any breeding or maternity structures (i.e. caves). Whilst it is not known to what extent this species uses tree hollows for roosting, canopy strata over much of the study area was of generally of an insufficient age-class to develop hollows, and these important habitat structures were not abundant in the study area. Nevertheless, the Little Bentwing-bat is known to use a variety of structures to roost, and a lack of caves does not preclude the presence of other potential roosting structures. The existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow.

EASTERN BENT-WING BAT

Foraging habitat for the Eastern Bent-wing Bat includes all fauna habitat types in the study area, including rainforest, swamp forest, wet open forest and cleared land with scattered trees. Importantly, no critical habitat structures, such as maternity caves were recorded in the study area, although potential overwintering habitat was identified in expansion joints between concrete cast sections of the rail bridge over Chittaway Creek and Turpentine Road. A small private bridge structure over Chittaway Creek could also potentially provide refuge for this species during periods of low flow.

GREY-HEADED FLYING-FOX

The Grey-headed Flying-fox, which is listed as Vulnerable under the TSC Act and EPBC Act was observed flying over the project study area during two separate nocturnal survey events (Figure 4.8). Although this species was not specifically observed using habitat within the study area, this species is a blossom nomad that is known to commute long distances as food availability varies over time

Potential habitat for Grey-headed Flying-fox in the project study area included swamp forest, rainforest and wet open forest type habitats. In the study area swamp forest was dominated by *Eucalyptus robusta*, which is a winter-flowering eucalypt with strong and profuse flowering events every three years or so. No evidence of Grey-headed Flying-fox camps was observed in the study area during field surveys.

Due to the relatively large numbers of *Eucalyptus robusta* within the study area, it is likely that the study area's swamp forests would be used seasonally by the Grey-headed Flying-fox, during Swamp Mahogany flowering events. Rainforest habitat associated with Chittaway Creek contained a variety of native broad-leaved trees providing seasonal fruits for frugivorous animals, including the Grey-headed Flying-fox. Wet open forest were dominated by *Eucalyptus pilularis* with some areas also containing *Corymbia gummifera*, *Eucalyptus saligna*. This canopy stratum would provide summer seasonal nectar foraging resources for the Grey-headed Flying-fox.

4.3.2.3 SUBJECT SPECIES HABITAT MAPPING

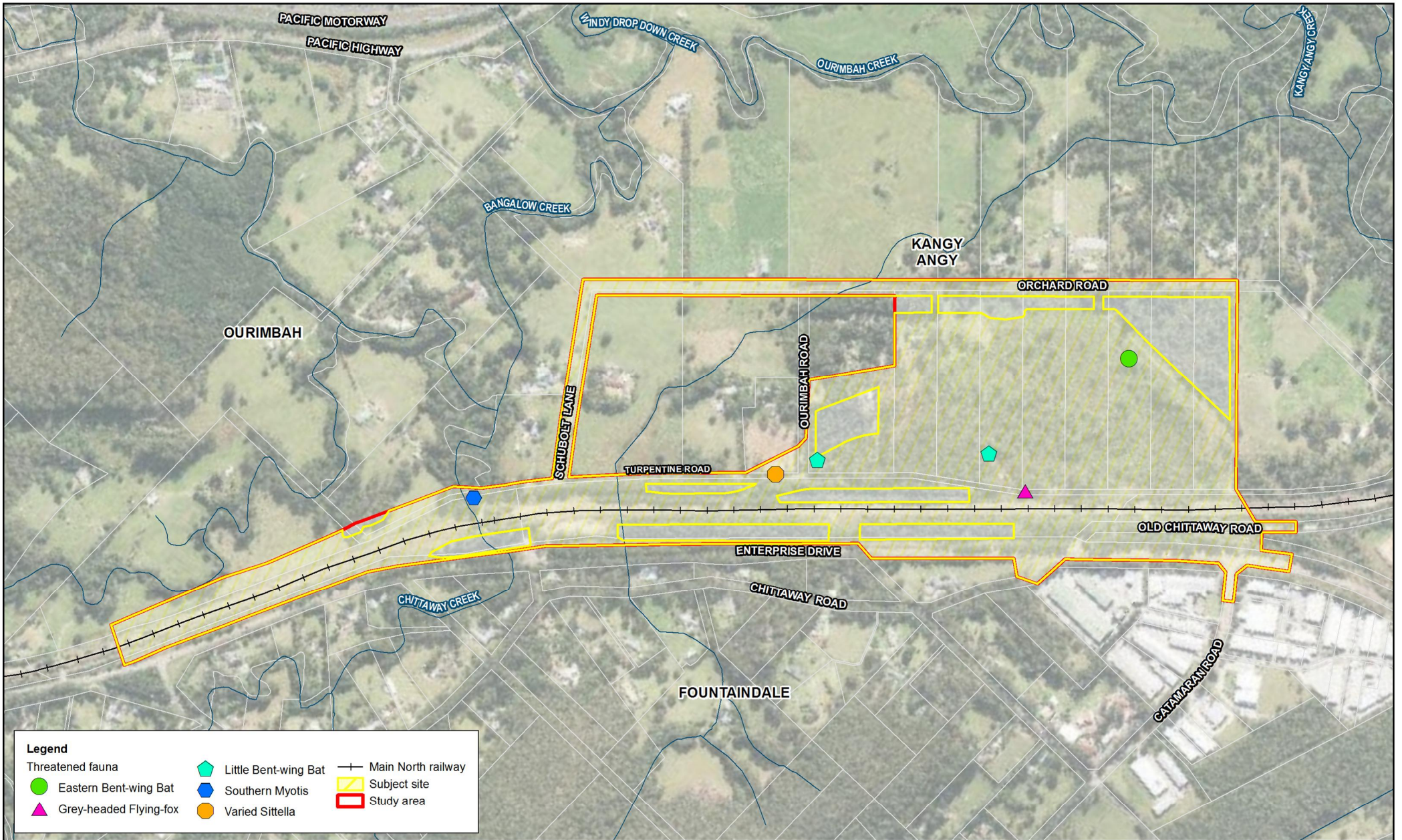
Fauna habitats described in the study area are mapped in Figure 4.5. Specific habitat mapping for species considered likely to be affected by the project (affected species) are provided in section 5 of this report.

4.3.2.4 FIELD SURVEY LIMITATIONS

Even when field surveys are undertaken, no sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental conditions of the site at the time field surveys are undertaken, including the presence or absence of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.

Access to some locations were restricted as a result of dense undergrowth particularly associated with the *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation type. Where access on foot was restricted or limited, but adjacent areas were accessible, vegetation community boundaries, condition and threatened flora and fauna habitat attributes were extrapolated from a distance with the aid of binoculars.

Fauna surveys were conducted during early autumn during a wet period, although rainfall was likely insufficient to promote activity in some amphibian species, which require high rainfall events to trigger breeding cycle responses.



Legend

Threatened fauna		Little Bent-wing Bat		Main North railway
		Eastern Bent-wing Bat		Subject site
		Southern Myotis		Study area
		Grey-headed Flying-fox		
		Varied Sittella		

Map: 2202522A_GIS_F057_A1
 Date: 11/05/2016
 Author: suansrir
 Approved by: -

19,500
 Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A4

Note: Design is indicative only.
 Subject to detailed design

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New Intercity Fleet Maintenance Facility Project
Figure 4.8
 Threatened fauna locations within the study area

5 ASSESSMENT OF LIKELY IMPACTS ON THREATENED SPECIES AND POPULATIONS

5.1 Assessment of species likely to be affected

This section provides an overview of potential impacts associated with the project and an assessment of these impacts on subject species in order to determine affected species.

5.1.1 Potential impacts associated with the project

Potential direct and indirect impacts to biodiversity are likely to result from the construction and operational phases of the project. The key impacts associated with the project will include:

- Clearing of 25.5 hectares of Swamp Sclerophyll Forest listed as Endangered under the TSC Act
- Clearing of approximately 3,984 *Melaleuca biconvexa* from within the study area
- Clearing of 30.1 hectares of native vegetation (inclusive of 25.5 hectares of Swamp Sclerophyll Forest) and fauna habitats that provides known and potential habitat for threatened species of plant and animal.

A summary of impacts likely to occur as a result of the project area provided below in Table 5.1.

Table 5.1 Potential impacts associated with the project

Potential impact	Potential phase of the project	
	Construction	operation
Direct impacts		
Removal of native vegetation (including Swamp Sclerophyll Forest EEC)	•	
Removal of threatened plant species (<i>Melaleuca biconvexa</i>)	•	
Removal of threatened fauna species habitat	•	
Indirect impacts		
Alteration of natural hydrology regimes	•	•
Sediment, pollutant or nutrient runoff into adjacent vegetation	•	•
Wildlife connectivity and fragmentation (including edge effects)	•	•
Potential environmental impact of increased noise, light and vibration on wildlife	•	•
Increase in fauna injury and/or mortality	•	•
Weed invasion and feral animal incursion	•	•
Introduction and spread of pathogens and disease	•	•

5.1.2 Assessment of subject species likely to be affected

With consideration of targeted field surveys completed in the project study area, vegetation and habitat mapping, threatened species habitat assessments, a review of available literature, analysis of NSW BioNet (Atlas of NSW Wildlife), and consideration of likely impacts, the list of subject species identified in Table 3.6 has been refined to a list of affected species below (Table 5.2).

Table 5.2 Refinement of subject species to affected species

Species	Potential to be affected by the project	Affected species?
Flora		
<i>Caladenia tessellata</i> (Thick-lipped Spider Orchid)	<p><i>Caladenia tessellata</i> (Thick Lip Spider Orchid) is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. This species is known to occur within the Wyong CMA sub-region of the Hunter Central Rivers Catchment Management Region (Office of Environment & Heritage 2016l) and comprises of three separate populations with each estimated to contain less than 50 individuals (Office of Environment & Heritage 2016d). The nearest NSW BioNET record of this species in relation to the study area is approximately two kilometres to the north and was recorded in 1953. The two additional records are located along the coast, to the east of Tuggerah Lakes, and were both recorded in 1996.</p> <p>Since the listing of this species in 2002 under the TSC Act, the NSW Scientific Committee consider two of the three Wyong populations as possibly extinct due to habitat degradation and changes in natural vegetation structure (NSW Scientific Committee 2008). Despite regular searches by a number of botanists and orchid enthusiasts no specimens of this species have been recorded from these populations since the 1990's. These three populations include:</p> <ul style="list-style-type: none"> → Munmorah State Recreation Area – contains approx. 20 plants within Spotted Gum Forest plants scattered along banks and walking tracks to the headland (not seen since 1999). → Porters Creek – contains less than 10 plants within heathland with open forest on a hilltop associated with transitional vegetation of Spotted Gum/Smooth-barked Apple/Stringybark Open Forest and Low Swamp Forest Woodland (not seen since 1999) → Wyrribalong National Park – contains less than 10 plants within Coastal Heathland/Low Woodland with Heathland (not seen since 1997). <p><i>Caladenia tessellata</i> is known to occur in grassy sclerophyll woodland on clay loam or sandy soils (Office of Environment & Heritage 2016m). Within the Central Hunter Rivers Catchment Management Region the species is known to be associated with the following four PCT/BVT communities:</p> <ul style="list-style-type: none"> → Red Bloodwood – Scribbly Gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion → Smooth-barked Apple – Sydney Peppermint – Turpentine heathy open forest on plateaux areas of the Sydney Basin Bioregion → Yellow Bloodwood – Ironbark shrubby woodland of the dry hinterland of the Central Coast, Sydney Basin Bioregion → Yellow Bloodwood – Narrow-leaved Apple heathy woodland on hinterland plateaux of the Central Coast, Sydney Basin Bioregion <p>None of these vegetation types were recorded within the study area.</p> <p>Additional habitat analysis within the Wyong LGA for this species identifies the following vegetation types as providing known habitat:</p> <ul style="list-style-type: none"> → MU13 – Coastal Headland Complex (Bell, S. 2002) → Qs2 – Closed Heathland/Low Woodland (Payne & Duncan 1999) → Qhd5 – Low Open Forest (Payne & Duncan 1999) 	No

Species	Potential to be affected by the project	Affected species?
	<p>→ Rnm3 – Forest (Wyong Shire Council 2000)</p> <p>→ Qs3 – Low Woodland with Heathland (Wyong Shire Council 2000)</p> <p>→ Qa4 – Low Swamp Forest Woodland (Treed Floodplain and Drainage Lines) (Wyong Shire Council 2000).</p> <p>None of these vegetation types have been recorded from the study area.</p> <p>In respect to the species record from Porters Creek wetland, the habitat was recorded as heathland with open forest on a hilltop associated with transitional vegetation of Spotted Gum/Smooth-barked Apple/Stringybark Open Forest and Low Swamp Forest Woodland. Whilst swamp forest is recorded within the study area, this vegetation assemblage is distinctively different to the transitional area of Low Swamp Forest Woodland (Qa4) referred to at Porters Creek that is generally dominated by <i>Angophora costata</i>, <i>Angophora floribunda</i>, <i>Eucalyptus tereticornis</i> and <i>Eucalyptus longifolia</i> with only occasional occurrences of <i>Eucalyptus robusta</i> (Payne & Duncan 1999). Swamp forest within the study area more closely resembles map unit Qa5 – Swamp Woodland Forest (Payne & Duncan 1999), is dominated by <i>Eucalyptus robusta</i> and is not known as habitat for <i>Caledenia tessellata</i>.</p> <p>Based on a review of known habitat types, it is considered unlikely that the study area provides any suitable habitat for this species.</p> <p>In terms of targeted surveys, <i>Caledenia tessellata</i> is a small terrestrial orchid that requires flowering plants to enable positive identification. The flowering period for this species is generally considered to occur between September and November although within the Wyong CMA sub-region, the important time of year for species identification is considered to be about three weeks in September–October (Office of Environment & Heritage 2016l).</p> <p>Surveys conducted by WSP Parsons Brinckerhoff as part of this SIS were undertaken during late February 2016, outside the recognised flowering period for this species, and are not considered reliable for the positive identification. Previous targeted orchid surveys however, conducted over the entire study area as part of the Preliminary Ecological Assessment (EMM 2015a), were undertaken during the recognised flowering period for <i>Caledenia tessellata</i> on 10, 16 and 17 September 2015. Whilst these field surveys did not specifically target this species, they were conducted for a number of other threatened orchid species, namely <i>Corunastlis</i> sp. Charmhaven, <i>Genoplesium insigne</i> (Variable Midge Orchid) and <i>Thelymitra adorata</i> (Wyong Sun Orchid) and as such the methodology employed for these targeted surveys would have enabled detection of <i>Caledenia tessellata</i> within the study area if the species was flowering. No <i>Caladenia tessellata</i> specimens were recorded during these surveys.</p> <p>Notwithstanding surveys have been conducted within the last 12 months during the recognised flowering period for this species of which no individuals were recorded, detailed analysis of habitat requirements for <i>Caladenia tessellata</i> has also been considered. This assessment has identified that the species and its habitat are unlikely to occur within the study area or be impacted upon by the project. Consequently, <i>Caladenia tessellata</i> is considered not to be an ‘affected species’ and is not subject to further detailed assessment in Section 5 of this report.</p>	
<i>Dendrobium melaleucaphilum</i>	<p><i>Dendrobium melaleucaphilum</i> is listed as Endangered under the TSC Act. This species is known to occur within the Wyong sub-region of the Hunter–Central Rivers CMA (Office of Environment & Heritage 2016n). The study area is outside the species current known distribution (nearest records approx. 200 km from study area with a single historic record within locality (1935).</p> <p>The species is known to occur frequently on <i>Melaleuca styphelioides</i> (of which none were recorded on site) and less commonly on rainforest trees or on rocks (Department of Environment and Conservation 2005d; Royal Botanic Gardens 2005). Potential habitat was recorded within the study area; PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the</p>	No

Species	Potential to be affected by the project	Affected species?
	<p>Central Coast. This vegetation type however is not one of the eight vegetation types within the Wyong sub-region of the Hunter–Central Rivers CMA that the species is associated. Therefore the potential habitat within the study area is only considered likely to provide marginal habitat for the species.</p> <p>OEH (Office of Environment & Heritage 2016n) recognise that the species is identifiable between July and October. Subsequently, surveys targeting the species were undertaken in September 2015 (EMM 2015a). These surveys involved a series of random meanders through potential habitat available within the study area. No <i>Dendrobium melaleucaphilum</i> individuals were recorded within the study area during these surveys.</p> <p>Although marginal habitat occurs within the study area for <i>Dendrobium melaleucaphilum</i> the species is not considered to occur within the study area. This is based on the species not being recorded during targeted surveys undertaken during the species fruiting period, that none of the vegetation within the study area align with any of the species associated vegetation types within the Wyong sub-region of the Hunter–Central Rivers CMA and therefore unlikely to be significant for the species in the locality. Consequently, <i>Dendrobium melaleucaphilum</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in Section 5 of this report.</p> <p><i>Dendrobium melaleucaphilum</i> is not considered likely to occur within the study area due to lack of suitable habitat, paucity of recent records within the locality and given the species was not recorded during targeted surveys. Consequently, <i>Dendrobium melaleucaphilum</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in section 5 of this report.</p>	
<i>Epacris purpurascens</i> var. <i>purpurascens</i>	<p><i>Epacris purpurascens</i> var. <i>purpurascens</i> is listed as Vulnerable under the TSC Act. This species is known to occur within the Wyong sub-region of the Hunter–Central Rivers CMA (Office of Environment & Heritage 2016f) and comprises of a single population near Gosford. The nearest NSW BioNET record of this species in relation to the study area is approximately 1.5 kilometres to the west near Ourimbah exit of the M1 Motorway recorded in 2003 whilst the remaining records of this population occurs to the south near Gosford.</p> <p><i>Epacris purpurascens</i> var. <i>purpurascens</i> is known to occur within a range of habitats associated with strong shale soil influences including sclerophyll forest, scrub and swamps. No habitat matching the species habitat preferences were identified within the study area. In addition within the Hunter–Central Rivers CMA the species is not recognised as being associated with any vegetation type (Office of Environment & Heritage 2016f).</p> <p>OEH (Office of Environment & Heritage 2016f) recognise that although the flowering period for <i>Epacris purpurascens</i> var. <i>purpurascens</i> is between July and September the species can be detected year round during targeted surveys. Surveys targeting the species were undertaken during September 2015 (EMM 2015a) and February and March 2016 (WSP Parsons Brinckerhoff 2016a). The surveys involved random meanders throughout the study area to identify the presence of threatened flora species that may occur. No <i>Epacris purpurascens</i> var. <i>purpurascens</i> were recorded during the targeted surveys.</p> <p><i>Epacris purpurascens</i> var. <i>purpurascens</i> is not considered likely to occur within the study area due to lack of suitable habitat, paucity of recent records within the locality and given the species was not recorded during targeted surveys. Consequently, <i>Epacris purpurascens</i> var. <i>purpurascens</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in section 5 of this report.</p>	No

Species	Potential to be affected by the project	Affected species?
<i>Maundia triglochinooides</i>	<p><i>Maundia triglochinooides</i> is listed as under the Vulnerable under the TSC Act. This species is known to occur within the Wyong sub-region of the Hunter–Central Rivers CMA (Office for Environment & Heritage 2016b). A review of NSW BioNet identified that the species has been recorded at six locations in the locality (nearest record two kilometres north of the study area from 1990). These records form the southern boundary of the species current known distribution (records to the south of Wyong LGA are now considered to be extinct) (Office for Environment & Heritage 2016a, 2016b).</p> <p><i>Maundia triglochinooides</i> is known to occur in swamp, wetlands and shallow freshwater environments (Harden 2002). Within these environments populations of the species is known to expand during flood events and contract to more permanent wetlands during times of low rainfall (Office for Environment & Heritage 2016b). Habitat similar to these environments was recorded within the study area (PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast vegetation type). The potential habitat identified contains ephemeral pools that contain water during times of heavy rainfall however dry up during drier periods. Subsequently the habitat within the study area is considered sub-optimal for the species.</p> <p>OEH (2016b) recognise that although <i>Maundia triglochinooides</i> flowering period is between November and January the species can be detected year round during targeted surveys. Surveys targeting the species were undertaken by Parsons Brinckerhoff in February and March 2016 after a period of heavy rainfall (large ponds of water present). The surveys involved random meanders through potential habitat available within the study area. No <i>Maundia triglochinooides</i> individuals were recorded during the targeted surveys.</p> <p>Although the study area provides sub-optimal habitat for <i>Maundia triglochinooides</i> the species is considered unlikely to occur within the study area. This is based on the assumption that the species was not recorded during targeted surveys (not a cryptic species surveyed during period of rainfall when potential habitat was available), is approximately two kilometres south of the southern distribution limit for the species, potential habitat for the species within the study area is marginal (i.e. does not contain permanent ponds of water likely to sustain a population during periods of low rainfall) and therefore the study area is unlikely to play an important role for the species in the locality. Consequently, <i>Maundia triglochinooides</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in Section 5 of this report.</p>	No
<i>Melaleuca biconvexa</i> (Bioconvex Melaleuca)	<p><i>Melaleuca biconvexa</i> is listed as Vulnerable under the TSC Act and EPBC Act. This species is known to occur within the Wyong sub-region of the Hunter–Central Rivers CMA and has been recorded by previous studies within or adjacent to the study area (Duncan 2001a; EMM 2015a). A review of the NSW BioNet and Duncan’s study of the species within the Wyong Shire Duncan (2001a) has also identified the species as occurring frequently throughout the locality.</p> <p>OEH (Office of Environment & Heritage 2016a) identify that <i>Melaleuca biconvexa</i> flowering period is between September and October however can be detected year round during targeted surveys. Surveys targeting the species were undertaken by EMM (September 2015) and Parsons Brinckerhoff (February and March 2016) which involved stem counts and visual abundance estimates of cover. The survey identified 5014 <i>Melaleuca biconvexa</i> plant stems as occurring within the study area from a single vegetation type; PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast.</p> <p>The Project will require the removal of 3,984 <i>Melaleuca biconvexa</i> plant stems and the removal of 25.5 hectares of PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast which constitutes known habitat for the species. Consequently, <i>Melaleuca biconvexa</i> is considered an ‘affected species’ and is subject to further detailed assessment in section 5 of this report.</p>	Yes. Detailed assessment provided in section 5.2.

Species	Potential to be affected by the project	Affected species?
<p><i>Prostanthera askania</i> (Tranquility Mintbush)</p>	<p><i>Prostanthera askania</i> is listed as Endangered under the TSC Act and EPBC Act. This species is known to occur within the Wyong sub-region of the Hunter Central Rivers CMA. A review of the NSW BioNet has identified that the species has been recorded within the locality from four locations (nearest record approx. 1.5 kilometres south of the study area).</p> <p>The species is known to occur on alluvial soils derived from Narrabeen sandstone adjacent to drainage lines on flat to moderately steep slopes (Office of Environment & Heritage 2016o). Vegetation matching the species known habitat was recorded within the study area; PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast.</p> <p>OEH (Office of Environment & Heritage 2016o) recognise that although <i>Prostanthera askania</i> flowering period is September to December when the species is more easily identified the species can be detected year round during targeted surveys. Surveys targeting the species were undertaken by Parsons Brinckerhoff (February and March 2016) and EMM (September 2015). These surveys involved a series of random meanders through potential habitat available within the study area. No <i>Prostanthera askania</i> individuals were recorded within the study area during targeted survey.</p> <p>As the species is not cryptic and no individuals were recorded within the study area it is considered unlikely that <i>Prostanthera askania</i> individuals occur within the study area. Although not recorded within the study area there is potential for the species to occur within the soil seed bank.</p> <p>The reproductive ecology of <i>Prostanthera askania</i> is relatively unknown however the species is considered to reproduce both asexually (vegetative growth) and sexually (production of seed). The viability of seeds and seeds within the soil seed bank is also unknown however the species has been suggested to be a colonising species which utilises gaps in the canopy (i.e. along tracks, post fire and in canopy gaps). It is also considered likely that they species may require cues to break seed coat dormancy such as disturbances caused by increased light intensity or fire (heat and/or smoke) (Department of the Environment and Conservation 2006). The potential habitat within the study area contained a canopy cover (30–70 per cent) which may prevent the recruitment and establishment of <i>Prostanthera askania</i> individuals and was dominated by exotic species therefore the species is considered unlikely to contain a persistent soil seed bank within the study area.</p> <p>Although the study area provides potential habitat for <i>Prostanthera askania</i> the species is not considered to occur within the study area. This is based on the assumption that the species was not recorded during targeted surveys for the species, that the vegetation is likely to provide marginal habitat for the species and therefore unlikely to be important for the species in the locality. Consequently, <i>Prostanthera askania</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in section 5 of this report.</p>	No
<p><i>Syzygium paniculatum</i> (Magenta Lilly Pilly)</p>	<p><i>Syzygium paniculatum</i> is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. This species is known to occur within the Wyong sub-region of the Hunter Central Rivers CMA (Office of Environment & Heritage 2016g). A review of the NSW BioNet has identified that the species has been recorded frequently within the locality; particularly along Ourimbah Creek and Bangalow Creek.</p> <p><i>Syzygium paniculatum</i> is recognised to be separated geographically into five meta-populations across the coast of NSW between Upper Lansdowne in the north to Conjola National Park in the South including:</p> <ul style="list-style-type: none"> → Karuah-Manning → Central Coast 	No

Species	Potential to be affected by the project	Affected species?
	<p>→ Botany Bay → Coalcliff → Jervis Bay.</p> <p>The study area forms part of the Central Coast meta-population which is comprised of 22 subpopulations. This meta-population is considered by the OEH to contain up to two thirds of all individuals of the species within three subpopulations (located at Wyrribalong National Park, Ourimbah Creek and Martinsville).</p> <p><i>Syzygium paniculatum</i> is known to utilise a range of habitats including areas which have been previously cleared or modified including subtropical, lowland and littoral rainforest as well as riparian forests on sandy soils or stabilised dunes in proximity to the sea (Harden 2002; Office of Environment & Heritage 2011, 2012). Within the Central Coast <i>Syzygium paniculatum</i> is known to occur within riparian forest; especially along Ourimbah Creek (600 metres from study area). This riparian forest habitat is generally characterised by <i>Cryptocarya glaucescens</i> (Jackwood), <i>Acmena smithii</i> (Lilly Pilly), <i>Doryphora sassafras</i> (Sassafras) and <i>Diploglottis cunninghamii</i> (Native Tamarind) and the occasional <i>Eucalyptus saligna</i> (Sydney Blue Gum) as an emergent canopy species (Office of Environment & Heritage 2012). Vegetation within the study area aligning to PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast is consistent with this description of riparian forest which is known to be suitable habitat for the species. Additionally, the suitable habitat recorded within the study area occurs along Bangalow Creek and Chittaway Creek which are tributaries of Ourimbah Creek from where the species is known to occur.</p> <p>OEH (Office of Environment & Heritage 2016g) recognise that although the species flowering time is between December and March the species can be detected year round during targeted surveys. Surveys targeting the species were undertaken by EMM (September 2015) and Parsons Brinckerhoff (February and March 2016). These surveys involved a series of random meanders through potential habitat available within the study area. No <i>Syzygium paniculatum</i> individuals were recorded within the study area during these surveys.</p> <p>Although potential habitat occurs within the study area for <i>Syzygium paniculatum</i> the species is not considered to occur within the study area. This is based on the assumption that the species was not recorded during targeted surveys, that the vegetation is likely to provide marginal habitat for the species and therefore unlikely to be significant for the species in the locality. Consequently, <i>Syzygium paniculatum</i> is not considered an 'affected species' and is not subject to further detailed assessment in section 5 of this report.</p>	
<i>Senna acclinis</i>	<p><i>Senna acclinis</i> is listed as Endangered under the TSC Act. The species is known to occur within the known to occur within the Wyong sub-region of the Hunter–Central Rivers CMA (Office of Environment & Heritage 2016j). The nearest NSW BioNET record of this species in relation to the study area is approximately four kilometres to the north west and was recorded in 2003. The next nearest record is over 25 kilometres to the north in Olney State Forest.</p> <p>The species is known to occur on the margins of subtropical, littoral and dry rainforests. Potential habitat was recorded within the study area; PCT1528/HU742: Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest on the Central Coast. This vegetation type however is not one of the eight vegetation types within the Wyong sub-region of the Hunter–Central Rivers CMA that the species is associated. Therefore the potential habitat within the study area is only considered likely to provide marginal habitat for the species.</p>	No

Species	Potential to be affected by the project	Affected species?
	<p>OEH (Office of Environment & Heritage 2016j) recognise that species is identifiable only during the species fruiting period between February and March and where disturbance is less than 15 years previous. Subsequently, surveys targeting the species were undertaken in February and March 2016 (WSP Parsons Brinckerhoff 2016b). These surveys involved a series of random meanders through potential habitat available within the study area. No <i>Senna acclinis</i> individuals were recorded within the study area during these surveys.</p> <p>Although marginal habitat occurs within the study area for <i>Senna acclinis</i> the species is not considered to occur within the study area. This is based on the species not being recorded during targeted surveys undertaken during the species fruiting period, that none of the vegetation within the study area align with any of the species associated vegetation types within the Wyong sub-region of the Hunter–Central Rivers CMA and therefore unlikely to be significant for the species in the locality. Consequently, <i>Senna acclinis</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in section 5 of this report.</p>	
<i>Persicaria elatior</i>	<p><i>Persicaria elatior</i> is listed as Vulnerable under the TSC Act and the EPBC act. The species is predicted to occur within the Wyong sub-region of the Hunter – Central Rivers CMA (Office of Environment and Heritage 2016e). The nearest NSW BioNet record of this species in relation to the study area is approximately 20 km to the north and was recorded in 2010. There is only one other record within the broader locality recorded from 1999 to the north west adjacent the Great North Road near Yallambie. All other records of the species are over 70 km from the study area.</p> <p>The species is known to occur in damp places especially beside streams, lakes and occasionally in swamp forest or associated with disturbance. Potential habitat for the species was recorded within the study area; Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast. This vegetation type however is not one of the eight vegetation types within the Wyong sub-region of the Hunter–Central Rivers CMA that the species is associated. Therefore the potential habitat within the study area is only considered likely to provide marginal habitat for the species.</p> <p>OEH (Office of Environment and Heritage 2016e) recognise that the species is identifiable only in flower which occurs in summer and autumn. Subsequently, surveys targeting the species were undertaken in December 2015 (EMM 2015a) and February and March 2016 (WSP Parsons Brinckerhoff 2016b). These surveys involved a series of random meanders through potential habitat available within the study area. No <i>Persicaria elatior</i> individuals were recorded within the study area during these surveys.</p> <p>Although marginal habitat occurs within the study area for <i>Persicaria elatior</i> the species is not considered to occur within the study area. This is based on the species not being recorded during targeted surveys undertaken during the species fruiting period, that none of the vegetation within the study area align with any of the species associated vegetation types within the Wyong sub-region of the Hunter–Central Rivers CMA and therefore unlikely to be significant for the species in the locality. Consequently, <i>Persicaria elatior</i> is not considered an ‘affected species’ and is not subject to further detailed assessment in section 5 of this report.</p>	No
Fauna		
Wallum Froglet (<i>Crinia tinula</i>)	<p>The Wallum Froglet is known to occur within the Wyong CMA sub-region of Hunter Central River Catchment Management Region (Office of Environment & Heritage 2016n), with a distribution that extends along the east-coast of Australia from south-east Queensland to Sydney, NSW (Anstis 2002). The nearest NSW BioNet (Office for Environment & Heritage 2016a) record occurs approximately 1.5 kilometres to the north-east of the project study area. One other record for this species occurs in the southern</p>	No

Species	Potential to be affected by the project	Affected species?
	<p>extremities of Tuggerah Lake, whilst the majority of the records in the project locality occur approximately seven kilometres to the north of the study area, north of the Wyong River.</p> <p>Wallum Froglet survey effort typically includes a combination of call surveys and nocturnal searches in suitable weather conditions around swamps, dams and flooded roadside ditches (Department of Environment and Climate Change 2009a). Suitable survey periods are considered to occur from November to May, with weather conditions likely more important, with males calling anytime of the year, but especially after heavy rainfall (Department of Environment and Climate Change 2009a).</p> <p>Surveys undertaken as part of this SIS were completed in mid to late March 2016, during and following rainfall events and incorporated a combination of aural recognition of calls, call playback, spotlight transects and habitat assessments. Targeted surveys were completed in the study area as follows:</p> <ul style="list-style-type: none"> → On 17 March 2016 → From 21 March to 24 March 2016 with 53.2 millimetres recorded over this survey period. 88.4 millimetres was recorded in the week preceding these surveys (Bureau of Meteorology 2016). <p>Targeted surveys for Wallum Froglet are considered to have met survey guidelines during suitable weather conditions to have had a reasonable expectation of recording this species. Furthermore, although not specifically targeting Wallum Froglet, previous ecological field surveys (totalling 16 days) were completed in the study area for:</p> <ul style="list-style-type: none"> → Preliminary Ecological Assessment (10, 16 and 17 September 2015) (EMM 2015a) → Ecological services during geotechnical investigations (7–17 December and 1 February 2016) (EMM 2015a) → Ecological advice for boundary maintenance and installations (14 March 2016) (EMM 2015a) <p>During these 16 days of onsite works in the study area, three species of frog were recorded, including <i>L. fallax</i>, <i>L. dentata</i> and <i>C. signifera</i>. It is likely that site-based surveys would have enabled the detection of Wallum Froglet in areas of suitable habitat if this species was calling.</p> <p>The Wallum Froglet is found amongst fringing vegetation in wallum wetlands, where it is associated with swamps, dams, and flooded roadside ditches. Wallum wetlands are characterised by low nutrients, highly acidic, tannin stained waters that are typically dominated by paperbark and tea tress as well as sedgeland and wet heathland (Anstis 2002).</p> <p>In the study area potentially suitable habitat for the Wallum Froglet largely comprised swamp forest type habitat that was characterised by floodplain topography perched above Chittaway, Bangalow and Ourimbah Creeks. The underlying substrates are subject to variations in elevation, which form a mosaic of low areas holding water, as well as more elevated substrates less subject to waterlogging. Throughout the swampy sections of the study area, <i>Eucalyptus robusta</i> (Swamp Mahogany) is the dominant canopy tree, sometimes associated with ferns and mesic mid-storey trees (Photo 4.1), while other wetter areas with <i>Gahnia</i> sp. (Saw Sedge) and <i>Baloskion</i> sp. (Tassel Rush) species, with melaleucas dominating the mid-storey.</p> <p>Although the study area was not typical of acidic paperbark swamp fringing wallum wetlands where Wallum Froglet is commonly recorded, where swamp forest habitat occurred in lower waterlogged areas of the study area (Photo 4.9), the canopy was dominated by <i>E. robusta</i>, mid-storey strata by melaleucas and the understorey by <i>Gahnia sieberana</i>. Thus, the study area was considered to provide potentially suitable habitat for this species. Notwithstanding this, due to the paucity of Wallum Froglet records in the project</p>	

Species	Potential to be affected by the project	Affected species?
	locality, that the species was not accounted for during targeted surveys during ideal seasonal/weather conditions, together with the majority of evidence for this species occurring north of the Wyong River, it is considered that potential habitat in the project study area is not likely to be important the Wallum Froglet in the locality. Consequently, Wallum Froglet is not considered an 'affected species' and is not subject to further detailed assessment in this report.	
Giant Barred Frog (<i>Mixophyes iteratus</i>)	<p>The Giant Barred Frog is listed as Endangered under the TSC Act and EPBC Act. This species is known to occur within the Wyong CMA sub-region of the Hunter–Central River Catchment Management Region (Office for Environment & Heritage 2016a), with a distribution along the coast and ranges from Eumundi in south-east Queensland to Warrimoo in the Blue Mountains (Office for Environment & Heritage 2016a). The nearest NSW BioNet (Office for Environment & Heritage 2016a) record occurs approximately three kilometres to the north near Mardi Dam. No other records for this species exist within the project locality. Moreover, whilst in some parts of this species range they are coastal and lowland, in the Wyong CMA sub-region this does not necessarily hold. Indeed, a review of NSW BioNet indicate this species association with higher order streams in the Watagan Mountains (Office for Environment & Heritage 2016a).</p> <p>Giant Barred Frog survey effort typically includes a combination of aural recognition of calls, call playback and nocturnal streamside searches during suitable weather conditions (Department of Environment and Climate Change 2009a). Suitable survey periods are considered to occur from September to March, when air temperature is above 18°C (Department of Environment and Climate Change 2009a).</p> <p>Surveys undertaken as part of this SIS were completed in mid to late March 2016, during and following rainfall events and incorporated a combination of aural recognition of calls, call playback, spotlight transects and habitat assessments. Targeted surveys were completed in the study area as follows:</p> <p>→ From 21 and 23 March 2016 with 88.4 millimetres recorded in the week preceding survey period (Bureau of Meteorology 2016).</p> <p>Targeted surveys for Giant Barred Frog during suitable weather conditions are considered to have had a reasonable expectation of recording this species. During the survey period, <i>Mixophyes</i> sp. were recorded calling in known stream side habitat in the Watagan Mountains to the north-west of the project study area (Richardson 2016).</p> <p>The Giant Barred frog is associated with permanent flowing drainages, from slow flowing rocky rainforest streams to slow-flowing rivers in lowland open forest. In mid-eastern NSW (i.e. in proximity to the project study area), five populations of this species is known from the Watagan Mountains area (Department of Primary Industries 2016). As this species has been found in disturbed habitats (i.e. vegetated riparian strips in agricultural lands used to run livestock) in the lower reaches of streams, this species was considered to have moderate – low likelihood of occurrence in the project study area in rainforest habitat in association with Chittaway Creek. However, due to the paucity of Giant Barred Frogs in the project locality, that the species was not accounted for during targeted surveys during reasonable weather conditions (88.4 millimetres in the week preceding survey), together with majority of evidence for this species occurring to the north-west of study area in association with Watagan Mountain area, it is considered that potential habitat in the project study area is not considered important for this species in the locality. A corollary includes Giant Barred frog not being considered an 'affected species' and is not subject to further detailed assessment in section 5 of this report.</p>	No
Stephens Banded Snake	The Stephens' Banded Snake has a distribution that encompasses the coast and ranges from southern Queensland to Gosford in NSW, where it inhabits rainforest, moist forest, heaths, vine thickets and rocky areas (Office of Environment & Heritage 2016n) (Museum 2016). Stephens' Banded Snake is largely nocturnal, where it hunts for frogs, lizards, birds and small mammals. In the	No

Species	Potential to be affected by the project	Affected species?
<i>(Hoplocephalus stephensii)</i>	<p>Hunter–Central Rivers CMR Stephens’ Banded Snake is known from 80 records, of which one occurred in the project locality in Ourimbah State Forest to the north-west of the study area (Office for Environment & Heritage 2016a). One other record occurs in proximity to the study area, occurring approximately 10 kilometres to the study area’s south near Erina Heights.</p> <p>In the study area, potentially suitable habitat for Stephens’ Banded Snake comprised rainforest, swamp forest and wet open forest type habitats. Surveys undertaken as part of this SIS were completed in mid to late March 2016 and incorporated a combination of spotlight transects and herpetofauna active searches, with approximately 17 person hours of survey effort completed. Furthermore, although not specifically targeting Stephens Banded Snake, previous ecological field surveys (totalling 14 days) were completed in the study area for:</p> <ul style="list-style-type: none"> → Preliminary Ecological Assessment (10, 16 and 17 September 2015) (EMM 2015a) → Ecological services during geotechnical investigations (7–17 December and 1 February 2016) (EMM 2015a). <p>Although intermittent occurrences of Stephens Banded Snake in the study area cannot be discounted, due to the lack of records in the project locality, the paucity of important microhabitat elements (tree hollows), that this species was not accounted for during searches over different seasonal contexts, and given the abundance of similar or higher quality habitat in the locality, it is not considered likely that impacts associated with the project would not have a significant adverse impact on local populations. Accordingly, Stephens Banded Snake is not considered an ‘affected species’ and is not considered further in this report.</p>	
Pale-headed Snake <i>(Hoplocephalus bitorquatus)</i>	<p>Over much of its distribution, the Pale-headed Snake is mainly associated with dry eucalypt forests and woodlands, cypress forests and occasionally rainforests or moist eucalypt forests. Although this species is known from the Wyong CMA sub-region of the Hunter–Central Rivers Catchment Management Region (Office of Environment & Heritage 2016n), only one record exists therein, occurring approximately five kilometres to the south-west of the project study area. Within the extent of the project region (i.e. Sydney Basin bioregion), only one other record exists, occurring approximately 25 kilometres to the project’s north-west near Olney State Forest. However the Pale-headed Snake is a cryptic species that can at times spend weeks on end hidden in tree hollows, making survey efficacy difficult. Notwithstanding this, due to the general lack of preferred coastal habitat (i.e. dry eucalypt forest and woodland), a paucity of important microhabitat elements (tree hollows), and a lack of records for this species in Sydney Basin bioregion, the Pale-headed Snake is not considered to be an ‘affected species’.</p>	No
Regent Honeyeater <i>(Anthochaera phrygia)</i>	<p>The Regent Honeyeater is listed as Critically Endangered under both the NSW TSC Act and the federal EPBC Act. This species was not recorded within the study area during onsite surveys and there are no previous records known for the site (Office of Environment & Heritage 2016n).</p> <p>The Regent Honeyeater is a blossom nomad within NSW, with its range extending across a range of areas from the western slopes to near coastal localities (Pizzey & Knight 2012). Individual birds, or groups of birds, follow the changing distribution of blossom resources as governed by seasonal blossom timings and discontinuous flowering frequencies (Saunders, D. L. & Heinsohn 2008). Tree species’ flowering events are often characterised by return rates spanning several years which in turn are influenced by rainfall reliability. Consequently the distribution of Regent Honeyeaters follows the patchy matrix of blossom resources over scales much greater than what can be measured at the local level. As a consequence of blossom event variability Regent Honeyeater return rates to a given patch of suitable blossom is spasmodic and may span a number of years, such as the 4–5 year return frequency noted at Morisset to the study area’s north (Richardson A. 2016a).</p>	Yes. Detailed assessment provided in section 5.3

Species	Potential to be affected by the project	Affected species?
	<p>In recent years the Regent Honeyeater has become progressively rarer across its range, including the Central Coast region (Pizze & Knight 2012). The species is not resident in the region, but has in the past migrated to local habitats on an intermittent basis when local blossom resources are abundant (Higgins, P.J. <i>et al.</i> 2001). Periodical occurrences on the Central Coast coincide primarily with <i>Eucalyptus robusta</i> (Swamp Mahogany) blossoming events. To the north at Morisset, between 2002 and 2011, it has returned on a 4-5 year cycle with local occurrences coinciding with large aggregations of other honeyeaters. However, numbers have been in serious decline since 2002 (100+, 2002: 50, 2007: 13, 2011) and it hasn't been recorded in Morisset since the winter of 2011.</p> <p>The Regent Honeyeater has not been recorded as breeding in the study area's locality, with the closest breeding activity recorded at Quorrobolong in the Hunter Valley 42 kilometres to north (Roderick, M. 2015). Although Regent Honeyeaters are considered unlikely to breed within the study area, there is an abundance of Swamp Mahogany on site, which may be visited intermittently when blossom resource distribution across the Regent Honeyeater's range pushes them into near coastal habitats. Although stands of Swamp Mahogany in the region continue to exist, this community is increasingly threatened by development in well populated coastal areas (Office of Environment & Heritage 2016n).</p> <p>Winter-flowering tree species within the study, Swamp Mahogany in particular, represent a relatively large patch of blossom resources, which may be of significance to the Regent Honeyeater locally during times when winter blossom is scarce elsewhere in its range. Therefore the Regent Honeyeater is considered to be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Regent Honeyeater is provided in section 5.3 of this report.</p>	
<p>Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>)</p>	<p>The Gang-Gang Cockatoo is listed as Vulnerable under the NSW TSC Act. The Glossy Black-Cockatoo was not recorded in the study area during onsite surveys and there are no previous records known for the site.</p> <p>Within its range the Gang-Gang Cockatoo generally prefers tall montane eucalypt forests during the summer months, ranging into surrounding lowlands during the winter months (Higgins, P.J. <i>et al.</i> 2001). It forages in forest canopies for the seeds of eucalypt fruits. It has been recorded as foraging on the fruits of two <i>Eucalyptus</i> spp. that occur on site, <i>E. pilularis</i> (Blackbutt) and <i>E. saligna</i> (Sydney Blue Gum) (Higgins, P.J. <i>et al.</i> 2001).</p> <p>Gang-Gang Cockatoos occur regionally in the mountains to the west of the study area and elevated locations to the south in the Gosford LGA (BirdLife Australia 2016). They may occasionally use the study area's habitats for foraging purposes during seasonal movements away from habitats at higher elevations. There is no Gang-Gang Cockatoo breeding habitat within the study area.</p> <p>Although intermittent occurrences of Gang-Gang Cockatoos in the study area cannot be discounted, due to the abundance of similar and much higher quality foraging habitat elsewhere in the locality it is considered very unlikely that impacts on potential Gang-Gang Cockatoo foraging habitat onsite would have a significant adverse impact upon local populations. Accordingly, the Gang-Gang Cockatoo is not considered an 'affected species' and is not considered further in this report.</p>	No
<p>Glossy Black Cockatoo (<i>Calyptorhynchus lathamii</i>)</p>	<p>The Glossy Black-Cockatoo is listed as Vulnerable under the NSW TSC Act. The Glossy Black-Cockatoo was not recorded in the study area during onsite surveys and there are no previous records known for the site. However, there are a number of records for this species within the locality of the site.</p> <p>Within its range the Glossy Black-Cockatoo prefers woodlands and forests that contain trees of the <i>Casuarinaceae</i> family, upon the fruits of certain species it feeds (Higgins, P.J. <i>et al.</i> 2001). Locally it mostly forages on the seeds of <i>Allocasuarina littoralis</i> (Black She-</p>	No

Species	Potential to be affected by the project	Affected species?
	<p>oak) and <i>A. torulosa</i> (Forest Oak) (Higgins, P.J. <i>et al.</i> 2001). Whilst Forest Oak was recorded within the study area, it only occurs in relatively low densities</p> <p>Glossy Black-Cockatoo occur locally where <i>Allocasuarina</i> spp. occur, including the nearby ranges to near coastal habitats (BirdLife Australia 2016). They may occasionally use the study area for foraging purposes when Forest Oak fruit is available. There is no Glossy Black-Cockatoo breeding habitat within the study area.</p> <p>Although intermittent occurrences of Glossy Black-Cockatoos in the study area cannot be discounted, there is a low density of feed trees although the study area is considered unlikely to provide important habitat for the species. Due to the abundance of similar and much higher quality foraging habitat elsewhere in the locality it is considered very unlikely that impacts on potential Glossy Black-Cockatoo habitat onsite would have a significant adverse impact upon local populations. Accordingly, the Glossy Black-Cockatoos is not considered an 'affected species' and is not considered further in this report.</p>	
<p>Varied Sittella (<i>Daphoenositta chrysoptera</i>)</p>	<p>The Varied Sittella, which is listed as Vulnerable under the TSC Act, was recorded in the project study area in association with swamp forest (Figure 5.6).</p> <p>The Varied Sittella is a sedentary species that inhabits the majority of mainland Australia, except treeless deserts and open grasslands. In NSW this species is nearly continuous from coastal regions to the far west (Office of Environment & Heritage 2016n). Locally there is a number records.</p> <p>The Varied Sittella inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead limbs, mallee and <i>Acacia</i> woodland (Office of Environment & Heritage 2016n). This species forages on arthropods that are gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (Office of Environment & Heritage 2016n). The Varied Sittella builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork, often high in the living tree canopy. The same fork or tree is often re-used in successive years (Office of Environment & Heritage 2016n).</p> <p>The site encompasses some of the typical habitat types frequented by the Varied Sittella. An arboreal species foraging over the bole and branches of forest trees it is regularly observed in the types of dry woodland and swamp forest habitats that occur within the study area. The study area has an abundance of suitable habitats for foraging and breeding requirements of the Varied Sittella. It is a sedentary species living in relatively small territories of 13–20 hectares, so may be at risk due to the removal of habitat in their home range.</p> <p>Based on favourable habitat occurring within the study area and the onsite observation of this species it is likely that the study area represents part of the home range of one or more local family groups. As such the Varied Sittella is considered to be an 'affected species'. A detailed assessment of likely impacts of the project on Varied Sittella is provided in section 5.4 of this report.</p>	<p>Yes. Detailed assessment provided in section 5.4</p>
<p>Little Lorikeet (<i>Glossopsitta pusilla</i>)</p>	<p>The Little Lorikeet, which is listed as Vulnerable under the TSC Act, was recorded in the project study area in association with swamp forest habitat (Figure 5.7).</p> <p>The Little Lorikeet is a locally nomadic species that inhabits the coast and ranges of eastern Australia from about Cairns Queensland to Adelaide in South Australia (Pizzey & Knight 2012). In NSW this species' range extends from the coastal strip to the western slopes' woodlands of the Great Dividing Range and the riverina district in the State's central south (Pizzey & Knight 2012). Locally it is relatively frequent with many records in the locality (BirdLife Australia 2016).</p>	<p>Yes. Detailed assessment provided in section 5.5</p>

Species	Potential to be affected by the project	Affected species?
	<p>Little Lorikeets inhabit eucalypt forests and woodlands, from wet sclerophyllous forests of the coast and ranges to open woodland and riverine habitats on the western slopes and riverina. They are highly dependent on blossom resources and although their movements are not completely clear, a wide range of movement observations suggests that their movements are likely relatively local in response to season blossom distribution with birds remaining relatively sedentary while foraging resources continue (Higgins, P.J. <i>et al.</i> 2001). To the north in the Morisset area Little Lorikeets are more common in the ranges when <i>Eucalyptus saligna</i> is in flower, but they are found variably across lowland habitats when other tree species, such as Swamp Mahogany, Bloodwood, Blackbutt and Forest Red Gum are in flower (Richardson A. 2016a).</p> <p>The study area contains a number of tree species that have been previously recorded as being used by Little Lorikeets, including <i>Eucalyptus robusta</i> (Swamp Mahogany), <i>E. pilularis</i> (Blackbutt), <i>E. tereticornis</i> (Forest Red Gum) and <i>Corymbia gummifera</i> (Red Bloodwood) (Higgins, P.J. <i>et al.</i> 2001). Although there is an abundance of foraging habitat within the study area few trees were of sufficient age to develop breeding hollows suited to this species.</p> <p>The study area included some of the typical habitats frequented seasonally by the Little Lorikeet, particularly Swamp Mahogany habitat in winter. Therefore the Little Lorikeet is considered to be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Little Lorikeet is provided in section 5.5 of this report.</p>	
Little Eagle (<i>Hieraaetus morphnoides</i>)	<p>The Little Eagle is listed as Vulnerable under the TSC Act. Although it was not recorded in the project study area, due to local records (BirdLife Australia 2016) and foraging habitat in the study area it is considered likely that the study area would represent part of the range of local individuals (Figure 5.8).</p> <p>The Little Eagle has a widespread distribution throughout mainland Australia (Pizzey & Knight 2012). Pairs in established territories are generally sedentary, while in some areas other individuals appear to be migratory on a seasonal basis (Marchant & Higgins 1993).</p> <p>Little Eagles inhabit a range of habitat types from eucalypt forests and woodlands to open inland habitats, preferring a mosaic of open and wooded habitats (Marchant & Higgins 1993). Their diet is variable, with rabbits dominating when present, but in areas where rabbits are absent, birds, and to a lesser extent reptiles, make up the bulk of their diet (Marchant & Higgins 1993).</p> <p>Although the study area contains a paucity of open habitats for hunting ground dependent prey animals, birds are abundant, particularly Bell Miners, which are likely to be attractive to foraging Little Eagles locally. Although there is an abundance of trees within the study area, no nesting activity was observed and many of the trees on the site are considered too young to suit the Little Eagle's bulky nest building habits.</p> <p>Based on favourable foraging habitat occurring within the study area and local records the study area may be part of the territory of one or more Little Eagle individuals. Therefore the Little Eagle may be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Little Eagle is provided in section 5.6 of this report.</p>	Yes. Detailed assessment provided in section 5.6
Black Bittern (<i>Ixobrychus flavicollis</i>)	<p>The Black Bittern is listed as Vulnerable under the TSC Act. Although it was not recorded in the project study area, due to local records (BirdLife Australia 2016) and potential foraging habitat in the study area it is considered that the study area may represent part of the range of local individuals (Figure 5.9).</p> <p>The Black Bittern has a widespread distribution around coastal mainland Australia, being only absent from the southern and central western coasts of the continent (Pizzey & Knight 2012). They appear to be generally sedentary, while there may be some local movements depending on seasonal differences in behaviour (Marchant & Higgins 2004).</p>	Yes. Detailed assessment provided in section 5.7

Species	Potential to be affected by the project	Affected species?
	<p>Black Bitterns inhabit a range of wetland habitat types from tidal estuaries, creek and river edges and vegetated wetlands (Marchant & Higgins 2004). Their diet is likely dominated by fish and crustaceans taken in a stealthy manner similar to cryptic heron-like species (Marchant & Higgins 2004).</p> <p>There a number of local Black Bittern records downstream of the study area in Ourimbah Creek and to north along the Wyong River (BirdLife Australia 2016). Chittaway Creek, which traverses the study area, runs into Ourimbah Creek and so is continuous with known habitat of local Black Bitterns. Therefore the study area may represent part of the home range of one or more individuals.</p> <p>Based on favourable foraging habitat occurring within the study area and local records the study area may be part of the territory of one or more Black Bittern individuals. Therefore the Black Bittern may be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Black Bittern is provided in section 5.7 of this report.</p>	
Swift Parrot (<i>Lathamus discolor</i>)	<p>The Swift Parrot is listed as Endangered under the NSW TSC Act and Critically Endangered under the federal EPBC Act. This species was not recorded within the study area during onsite surveys, but there is a previous record known for the site (Office of Environment & Heritage 2016n).</p> <p>The Swift Parrot is largely a blossom nomad within NSW, with its distribution extending across a range of areas from the south-western slopes to coastal localities (Higgins, P.J. 1999; Pizzey & Knight 2012). Individual birds, or groups of birds, follow the changing distributions of blossom resources as governed by seasonal blossom timings and discontinuous flowering frequencies (Higgins, P.J. 1999; Saunders, D. L. & Heinsohn 2008). They use nectar from blossom widely, but in many areas they seek out lerp often avoiding large honeyeaters such as Noisy Friarbirds and Red Wattlebirds (Higgins, P.J. 1999).</p> <p>In recent years the Swift Parrot has declined across its range, including the Central Coast region (Higgins, P.J. 1999; Pizzey & Knight 2012). The species is not resident in the region, due migration to Tasmania during the summer months but has in the past migrated to local habitats on an intermittent basis when local blossom resources are abundant (Higgins, P.J. 1999). Around Lake Macquarie to the north of the study area they have been observed to take nectar from <i>Eucalyptus robustus</i> (Swamp Mahogany) and <i>E. tereticornis</i> (Forest Red Gum) and lerps from <i>E. pilularis</i> (Blackbutt) (Author pers. obs.). In the Central to Lower Hunter Swift Parrots have been observed to take nectar from <i>Corymbia maculata</i> (Spotted Gum) and <i>E. fergusonii</i>, and taking lerps from <i>E. crebra</i> (Narrow-leaved Red Ironbark), <i>E. punctata</i> (Grey Gum), Forest Red Gum and Spotted Gum (Richardson A. 2016a).</p> <p>The study area has a resident Bill Miner colony, which have been observed to protect areas of forest habitat supporting lerp colonies from other species of bird (Higgins, P.J. 1999). Such infestations of lerps have been observed to attract Swift Parrots (Department of the Environment 2016a) and therefore the study area may continue to attract Swift Parrots during years when winter-flowering trees are not flowering.</p> <p>Dominant vegetation communities within the study area are listed as Swift Parrot habitat in the National Recovery Plan for the Swift Parrot (Saunders, D. A. & Tzaros 2011). Winter-flowering tree species within the study, Swamp Mahogany in particular, represent a relatively large patch of blossom resources, which may be of significance to the Swift Parrot locally during times when winter blossom is scarce elsewhere in its range. Therefore, due to the occurrence of known habitat and a previous onsite observation, the Swift Parrot is considered to be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Swift Parrot is provided in section 5.8 of this report.</p>	Yes. Detailed assessment provided in section 5.8

Species	Potential to be affected by the project	Affected species?
<p>Square-tailed Kite <i>Lophoictinia isura</i></p>	<p>The Square-tailed Kite is listed as Vulnerable under the TSC Act. Although it was not recorded in the project study area, due to local records (BirdLife Australia 2016) and foraging habitat in the study area it is considered likely that the study area would represent part of the range of local individuals (Figure 5.11).</p> <p>The Square-tailed Kite has a widespread distribution throughout mainland Australia, apart from the arid zone, with densities lessening away from the coast into semi-arid districts (Pizzey & Knight 2012). A breeding migrant into south-eastern Australia for the breeding season during spring and summer, with birds moving north during autumn and winter (Marchant & Higgins 1993). Northern NSW birds appear to be sedentary, while southern NSW birds are absent during the cooler months apparently due to a lack food (Marchant & Higgins 1993). There is generally a spate of records in the Lower Hunter Region during autumn, which may be due to birds dispersing after the breeding season or migrating through.</p> <p>Square-tailed Kites inhabit a range of wooded habitat types from tall eucalypt forests and dry woodlands to wooded habitats interspersed with clearing, they prefer habitats supporting high passerine activity (Marchant & Higgins 1993). The Square-tailed Kite's diet is dominated by birds and foliage insects, taken while foraging in a harrier-like manner over the canopy. They are also known to take small mammals and reptiles (Marchant & Higgins 1993).</p> <p>Although some areas of the study area are open, due to a lack of mid-storey and canopy strata, birds are abundant, particularly Bell Miners, which are likely to be attractive to foraging Square-tailed Kites locally. Although there is an abundance of trees within the study area, no nesting activity was observed and many of the trees on the site are considered too young to suit the Square-tailed Kite's bulky and lofty nest building habits.</p> <p>Based on favourable foraging habitat occurring within the study area and local records, the study area may represent part of the breeding territory of one or more Square-tailed Kite individuals. Therefore the Square-tailed Kite may be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Square-tailed Kite is provided in section 5.9 of this report.</p>	<p>Yes. Detailed assessment provided in section 5.9</p>
<p>Powerful Owl <i>Ninox strenua</i></p>	<p>The Powerful Owl is listed as Vulnerable under the TSC Act. Although the Powerful Owl was not recorded in the project study area, due to local records (BirdLife Australia 2016) and foraging habitat in the study area it is considered likely that the study area may lie in the range of one or more local individuals (Figure 5.12).</p> <p>The Powerful Owl's range is limited to the coast and ranges of eastern Australia from central Queensland to far south-eastern South Australia where suitable habitat exists (Pizzey & Knight 2012). Its range extends into more inland locations in some areas, including dispersive movements, but for the most part it is limited to 200 kilometres of the coast (Pizzey & Knight 2012).</p> <p>The Powerful Owl is generally sedentary with good patches of habitat occupied by resident pairs (Higgins, P.J. 1999). While most movements are limited to the nest site vicinity (300 metres) during the breeding season, home range estimates range from 300 to 1500 hectares, and foraging movements between August and March outside of the breeding period have been reported to 4.1 kilometre. Distances between roost sites outside the breeding season in the same studies were around 3 kilometre (Higgins, P.J. 1999).</p> <p>Powerful Owls inhabit a range of wooded habitat types from tall eucalypt forests to dry woodlands where their favoured arboreal mammal prey is abundant (Higgins, P.J. 1999). The Powerful Owl's diet is dominated by arboreal mammals, particularly Ringtail Possums, but they supplement it with roosting birds (Higgins, P.J. 1999).</p>	<p>Yes. Detailed assessment provided in section 5.10</p>

Species	Potential to be affected by the project	Affected species?
	<p>Although some sections of the study area are open, due to a lack of mid-storey and canopy strata, wooded areas are well suited to smaller arboreal mammals, including Ringtail Possums, and both the Ringtail Possum and Sugar Glider were observed on site. Although there is an abundance of trees within the study area, no nesting activity was observed and many of the trees on the site are considered too young to suit the Powerful Owl's large hollow nesting habits. Powerful Owls are known to inhabit fragmented habitats and there are good roosting and foraging habitats along Ourimbah and Bangalow Creeks within and in the vicinity of the study area.</p> <p>Based on favourable foraging habitat occurring within the study area and local records, the study area may lie within the home of one or more Powerful Owl individuals. Therefore the Powerful Owl may be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Powerful Owl is provided in section 5.10 of this report.</p>	
<p>Sooty Owl (<i>Tyto tenebricosa</i>)</p>	<p>The Sooty Owl is listed as Vulnerable under the TSC Act. The Sooty Owl was not recorded in the project study area, although records occur in the wider locality (BirdLife Australia 2016) and rainforest habitat within the study area may represent roosting habitats for dispersing immature birds (Figure 5.13).</p> <p>The Sooty Owl's range is limited to the coast and ranges of eastern Australia from central Queensland to the Dandenong Ranges east of Melbourne, where suitable habitat exists (Pizzey & Knight 2012). Its range does not extend beyond the ranges into more inland locations in some areas (Pizzey & Knight 2012).</p> <p>The Sooty Owl is sedentary throughout its range, but the dispersal movements of young birds is poorly known (Higgins, P.J. 1999).</p> <p>Sooty Owls prefer rainforested gullies and escarpments in coastal ranges where tall eucalypt forests provide nesting sites for them and arboreal mammals that are part of their diet (Higgins, P.J. 1999). They prefer gullies associated with wet sclerophyll forests and generally avoid dry ridges, will use rainforest adjacent to dry forests and are sometimes recorded using the ecotone between dense forests and clearings (Higgins, P.J. 1999). In contrast to other large forest owls they forage throughout the all strata, taking both arboreal and terrestrial mammals and sometimes supplementing their diet with birds (Higgins, P.J. 1999).</p> <p>Relatively large areas of the study area and surrounding habitats are open and managed in nature and there is a paucity of mature sclerophyll forest of sufficient age class to provide nesting/roosting hollows for Sooty Owls. Local records occur in the surrounding ranges or in riparian mesic forests adjacent to them at the foot of the ranges (Office for Environment & Heritage 2016c).</p> <p>Sooty Owls are known to roost in mesic vegetation along drainage lines, and the rainforest habitats associated with Bangalow Creek may provide temporary lodgings for dispersing young birds. Nevertheless, the fragmented nature of such habitat in relation to a lack of buffering tall eucalypt forests containing hollows preclude them from supporting established Sooty Owl pairs.</p> <p>Based on the presence of potential roosting/foraging habitat for dispersing young Sooty Owls it is considered that rainforest habitats associated with Bangalow Creek in the study area, may represent habitat intermittently used by Sooty Owls. Therefore the Sooty Owl may be an 'Affected Species' in relation to the project and a detailed assessment of likely impacts of the project on Sooty Owl is provided in section 8.10 of this report.</p>	<p>Yes. Detailed assessment provided in section 5.11</p>
<p>Wompoo Fruit-Dove (<i>Ptilinopus magnificus</i>)</p>	<p>The Wompoo Fruit-dove is listed as Vulnerable under the TSC Act and was not recorded in the project study area (BirdLife Australia 2016). Birddata (BirdLife Australia) has a single record for this species locally, although their inconspicuous habits suggest that they may be under-recorded in the very south of their range. Nevertheless, this species is very rare south of the large rainforest tracts of the northern Hunter Region and local occurrences may be attributable to vagrant movements (Pizzey & Knight 2012).</p>	<p>No</p>

Species	Potential to be affected by the project	Affected species?
	<p>The Wompoo Fruit-dove's range is limited to the coast and ranges of eastern Australia from Northern Queensland to c. the Manning River with seasonal and vagrant movements further south to the Hunter and Sydney respectively (Pizzey & Knight 2012). Higgins (Higgins, P.J. & Davies), reports it as rare south of Coffs Harbour and the Dorrigo Plateau, however it can generally be found in the large rainforest tracts of the northern Hunter Region and is recorded as resident in the Annual Bird Report produced by the Hunter Bird Observers Club (Stuart, A 2015). South of the northern Hunter it becomes rare and vagrant as far south as Sydney and there have been no recent records from the southern limit of its range in the Illawarra region (Higgins, P.J. & Davies 1996; Pizzey & Knight 2012).</p> <p>The Wompoo Fruit-dove is variously considered as resident and locally nomadic by different authors (Higgins, P.J. & Davies 1996), but reading HANZAB reports in sum suggests that variation in movement status reported is probably a function of habitat patch size and the availability of fruiting trees throughout different parts of the year (Higgins, P.J. & Davies 1996).</p> <p>Wompoo Fruit-doves prefer tall undisturbed stands of tropical and sub-tropical rainforest at all altitudes with an abundance of fruiting trees (Higgins, P.J. & Davies 1996). Their diet is composed wholly of fruit of which they consume a wide variety from trees, palms vines and epiphytes (Higgins, P.J. & Davies 1996).</p> <p>Although small patches (1.5 hectares) of rainforest-type habitats occur in the study area's south, associated with Bangalow and Chittaway Creeks, the limited extent and fruiting plant species diversity offered is unlikely to be an important resource for supporting Wompoo Fruit-doves locally.</p> <p>Based on the vagrant status of Wompoo Fruit-doves in the locality, evidenced by a very low number of records, and the relatively poor quality of potential habitat within the study area it is considered unlikely that the Wompoo Fruit-dove will be an 'Affected Species' as a consequence of the project.</p>	
Rose-crowned Fruit-dove (<i>Ptilinopus regina</i>)	<p>The Rose-crowned Fruit-Dove is listed as Vulnerable under the TSC Act and was not recorded in the project study area (BirdLife Australia 2016). Birddata (BirdLife Australia), has a single record for this species locally, although their inconspicuous habits suggest that they be under-recorded in the study area locality when present. Nevertheless, this species is uncommon south of the rainforest tracts of Northern NSW, with occurrences south of Port Stephens occasional (Higgins, P.J. & Davies 1996; Pizzey & Knight 2012).</p> <p>The Rose-crowned Fruit-dove ranges across tropical northern Australia from the Kimberley coast to Cape York Peninsular, down the east coast to central NSW (Pizzey & Knight 2012). They are relatively common where fruiting habitat occurs in Queensland and northern NSW rainforests, with relatively smaller numbers making seasonal and somewhat regular movements further south to the Northern Hunter Region as far as Port Stephens (Higgins, P.J. & Davies 1996; Pizzey & Knight 2012). Movements further south in NSW are rarer and may be partly a function of reduced habitat availability, due to the more urbanised coastal strip from Newcastle south. There are confirmed breeding reports in the north of its NSW range (Higgins, P.J. & Davies 1996). Rose-crowned Fruit-doves appear to be regular in the littoral rainforest patches north of Port Stephens at Mungo Brush (Stuart, A 2015). South of the Port Stephens records are much rarer as the number of records in the study area's locality suggest (Higgins, P.J. & Davies 1996; Pizzey & Knight 2012).</p> <p>The Rose-crowned Fruit-dove is described as highly mobile although its movements are not completely understood (Higgins, P.J. & Davies 1996). In the southern areas of its range the greatest proportion of records made during the warmer (Higgins, P.J. & Davies 1996).</p>	No

Species	Potential to be affected by the project	Affected species?
	<p>Rose-crowned Fruit-doves occur in a wide range of closed forest types throughout their range (Higgins, P.J. & Davies 1996). Although there are no records detailing the types of habitats they might use in the study area's locality, it is likely that they would seek out closed-forest patches where fruit is available during autumn and winter and the location of window-strike birds in near coastal areas, such as Merewether Newcastle (Stuart, A. 2010), suggest that the coastal strip is preferred during southward movements. Their diet is composed wholly of fruit of which they consume a wide variety from trees, palms vines and epiphytes (Higgins, P.J. & Davies 1996).</p> <p>Although small patches (1.5 hectares) of rainforest-type habitats occur in the study area's south, associated with Bangalow and Chittaway Creeks, the limited extent and fruiting plant species diversity offered is considered unlikely to be an important resource for supporting Rose-crowned Fruit-doves locally.</p> <p>Based on the relatively rare status of Rose-crowned Fruit-doves in the locality, evidenced by a incidence of records, and the relatively poor quality of potential habitat within the study area, it is considered unlikely that the Rose-crowned Fruit-dove will be an 'Affected Species' as a consequence of the project.</p>	
<p>Superb Fruit-Dove (<i>Ptilinopus superbus</i>)</p>	<p>The Superb Fruit-Dove is listed as Vulnerable under the TSC Act and was not recorded in the project study area (BirdLife Australia 2016). Birddata (BirdLife Australia), has a single record for this species locally, although their inconspicuous habits and occasional window-strike records suggest that they are likely under-recorded in the south of their range. Nevertheless, this species is rare south of the large rainforest tracts of the south-east Queensland and Northern NSW, and local occurrences may be due to regular seasonal movements (Pizzey & Knight 2012).</p> <p>The Superb Fruit-dove's range is most commonly limited to the coast and ranges of eastern Australia from Northern Queensland to the northern NSW rainforests, with relatively small numbers making somewhat seasonal and irregular movements further south to the Hunter, Sydney, NSW south coast and historically as far south as Tasmania (Pizzey & Knight 2012). There are no confirmed breeding reports in NSW (Higgins, P.J. & Davies 1996). Although there have at times been a spate of southern records from window-strike individuals, it is not readily observable south of Queensland and is recorded as accidental in the Annual Bird Report produced by the Hunter Bird Observers Club (Stuart, A 2015). South of the northern NSW it becomes rare although occasional records continue on an intermittent basis (Higgins, P.J. & Davies 1996; Pizzey & Knight 2012).</p> <p>The Superb Fruit-dove is described as highly mobile although its movements are not well understood (Higgins, P.J. & Davies 1996). There is generally a greater proportion of records made during the warmer months in the north with most southerly records occurring during autumn and winter (Higgins, P.J. & Davies 1996).</p> <p>Superb Fruit-doves occur in a wide range of closed forest types throughout their range (Higgins, P.J. & Davies 1996). Although there are no records detailing the types of habitats they might use in the study area's locality, it is likely that they would seek out closed-forest patches where fruit is available during autumn and winter and the location of window-strike birds in near coastal areas, such as Merewether Newcastle (Stuart, A. 2010), suggest that the coastal strip is preferred during southward movements. Their diet is composed wholly of fruit of which they consume a wide variety from trees, palms vines and epiphytes (Higgins, P.J. & Davies 1996).</p> <p>Although small patches (1.5 hectares) of rainforest-type habitats occur in the study area's south, associated with Bangalow and Chittaway Creeks, the limited extent and fruiting plant species diversity offered is unlikely to be an important resource for supporting Superb Fruit-doves locally.</p>	<p>No</p>

Species	Potential to be affected by the project	Affected species?
	Based on the rare status of Superb Fruit-doves in the locality, evidenced by a incidence of records, and the relatively poor quality of potential habitat within the study area, it is considered unlikely that the Superb Fruit-dove will be an 'Affected Species' as a consequence of the project.	
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)	<p>The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. In most areas in this species range woodlands and heath appear to be preferred, but in northern NSW they are most frequently recorded in rainforest (Office of Environment & Heritage 2016n; Strahan 1995). They feed largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes but insects are also taken. Tree hollows, rotten stumps, holes in the ground, abandoned bird-nests and Ringtail Possum dreys (Office of Environment & Heritage 2016n) are variously used for shelter, whilst tree hollows area used preferentially for nesting purposes (Office of Environment & Heritage 2016n). In the Hunter–Central Rivers CMA there are 51 records for the Eastern Pygmy-possum, of which none occur in the project locality. However, marginal habitat for this species was recorded in the study area, including rainforest, swamp forest and wet open forest type habitats.</p> <p>Surveys undertaken as part of this SIS were completed in mid to late March 2016. Targeted survey effort for the Eastern Pygmy-possum involved a combination of camera trapping, arboreal trapping, hair tubes, nest boxes, and spotlighting transects across potentially suitable habitat.</p> <p>Although the study area contained marginal habitat for the Eastern Pygmy-possum, such habitat is not considered important due to:</p> <ul style="list-style-type: none"> → The lack of preferred woodland and heath type habitats in the study area → No observations in the study area during surveys using multiple survey techniques (camera trapping, arboreal trapping, hair tubes, nest box trapping and spotlight transects) → The lack of records in the locality (Office for Environment & Heritage 2016a) → The general paucity of hollow-bearing trees in the study area → The abundance of similar or higher quality habitats in the locality and region. <p>Therefore, the Eastern Pygmy-possum is not considered an 'affected species' and is not subject to further detailed assessment in this report.</p>	No
Large-eared Pied-bat (<i>Chalinolobus dwyeri</i>)	<p>The Large-eared Pied Bat is mainly found in areas with extensive cliffs and caves, from Rockhampton in Queensland, south to Bungonia in the Southern Highlands of NSW, with scattered records from the north west slopes of NSW and New England Tableland (Office of Environment & Heritage 2016n). This species is known to roost in caves, crevices in cliffs, old mine workings and in disused Fairy Martin nests, from which they frequent low to mid-elevation dry open forest and woodland close to these features, as well as well-timbered areas containing gullies.</p> <p>Targeted surveys for microchiropteran bats were completed in the study area in late March 2016, with a combination of harp trapping (six trap nights) and passive ultrasonic bat detection (six nights full recording) completed in suitable habitat. The Large-eared Pied Bat was not recorded in the study area during targeted surveys. A review of records for the Large-eared Pied Bat in the Hunter–Central River CMA indicate that the species is known from 266 records, none of which occur within the project locality (Office for Environment</p>	No

Species	Potential to be affected by the project	Affected species?
	<p>& Heritage 2016a). The nearest record occurs approximately nine kilometres to the north of the project, adjacent to Jilliby State Conservation Area (Office for Environment & Heritage 2016a).</p> <p>Although caves may occur in the project locality (i.e. Ourimbah State Forest), the study area did not contain critical roost structures for the Large-eared Pied Bat. Whilst occasional foraging events cannot be discounted in the study area, based on the rare status of the species in the locality, evidenced by a low incidence of records, it is not likely that the Large-eared Pied Bat would be an 'affected species' as a consequence of the project and is not considered further.</p>	
<p>Spotted-tailed Quoll (<i>Dasyurus maculatus maculatus</i>)</p>	<p>The Spotted-tailed Quoll is found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Spotted-tailed Quoll occur in a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline (Belcher 2003; Office of Environment & Heritage 2016n). Preferred habitat for Spotted-tailed Quoll includes dry and moist sclerophyll forests, suitable den sites include hollow-bearing trees, fallen logs, burrows, small caves, rock crevices, boulder-fields and rocky-cliff faces and will feed in nearby cleared areas (Office of Environment & Heritage 2016n; Strahan 1995). Spotted-tailed quolls have large home ranges (up to 3,500 hectares for males), and these predominately solitary and are known to travel up to six kilometres at night to forage (Office of Environment & Heritage 2016n). Potential habitat for the Spotted-tailed Quoll in the study area included rainforest, swamp forest and wet open forest type habitats.</p> <p>Targeted surveys for the Spotted-tailed Quoll were completed in the study area in late March 2016, with a combination of remote camera traps, hair tubes and spotlight transects completed in suitable habitat (WSP Parsons Brinckerhoff 2016b). The Spotted-tailed Quoll was not recorded in the study area during targeted surveys. A review of records for the Spotted-tailed Quoll in indicates that in the Hunter–Central Rivers CMA, this species known from 2,489 records, of which 10 occur in the project locality.</p> <p>Whilst the study area may to be visited by Spotted-tailed Quoll on at least an intermittent basis, potential habitat therein would not be utilised in isolation of other areas and largely lacked an abundance of hollow-bearing trees and ground debris due to the disturbed nature of much of the study area. Due to the extensive and contiguous nature of similar or higher quality habitat available in the adjacent foothills and ranges, it is not likely that project related impacts would have an adverse effect on local populations of Spotted-tailed Quoll. Therefore, the Spotted-tailed Quoll is not considered an 'affected species' as a consequence of the project and it is not considered further.</p>	No
<p>Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>)</p>	<p>The Eastern False Pipistrelle is a hollow-dwelling microchiropteran bat that is found along the south-east coast and ranges of Australia from southern Queensland to Victoria and Tasmania (Office of Environment & Heritage 2016n). This species prefers moist habitats with trees taller than 20 metres, where it forages for beetles, moths and other flying insects above or just below the tree canopy (Office of Environment & Heritage 2016n). In the Hunter–Central Rivers CMA the Eastern False Pipistrelle is known from 421 records, of which 15 occur in the project locality (Office for Environment & Heritage 2016a).</p> <p>Targeted surveys for microchiropteran bats were completed in the study area in late March 2016, with a combination of harp trapping (six trap nights) and passive ultrasonic bat detection (six nights full recording) completed in suitable habitat (WSP Parsons Brinckerhoff 2016b). The Eastern False Pipistrelle was not recorded in the study area during targeted surveys. The study area largely provided marginal and supplementary foraging habitat for this species, with preferred habitat likely occurring in areas of extensive and contiguous tall forests associated with the foothills and ranges adjacent to the project. Whilst intermittent foraging events cannot be discounted in the study area, it is not likely that the Eastern False Pipistrelle would be an 'affected species' as a consequence of the project due to:</p>	No

Species	Potential to be affected by the project	Affected species?
	<ul style="list-style-type: none"> → The lack of preferred habitat within the study area (extensive areas of tall forest with trees >20 metres in height) → No records for the species in the study area during targeted surveys → The general paucity of hollow-bearing trees in the study area. <p>The extensive and contiguous nature of high quality tall forests in the foothills and ranges in the project locality and region.</p>	
Golden-tipped Bat (<i>Kerivoula papuensis</i>)	<p>The Golden-tipped Bat is a specialist feeder on small web-building spiders that distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland, south to Eden in Southern NSW (Office of Environment & Heritage 2016n). They are primarily found in rainforest habitat where they usually roost along creek lines in abandoned nests of Yellow-throated Scrubwren and Brown Gerygone (Van Dyck & Strahan 2008); although they are also known to use hollows, dense foliage moss on tree trunks and epiphytes (Office of Environment & Heritage 2016n). The Golden-tipped Bat is known to forage up to 2 kilometres from roost sites, regularly on mid to upper slopes away from rainforest (Law & Chidel 2004).</p> <p>In the study area potential foraging habitat for this species included rainforest and swamp forest type habitats, whilst roosting habitat was confined to rainforest habitat in association with the Chittaway Creek. Yellow-throated Scrubwren and Brown Gerygone were also recorded in the study area.</p> <p>Targeted surveys for microchiropteran bats were completed in the study area in late March 2016, with a combination of harp trapping (six trap nights) and passive ultrasonic bat detection (six nights full recording) completed in the study area (WSP Parsons Brinckerhoff 2016b). The Golden-tipped Bat was not recorded in the study area during surveys. A review of records for the Golden-tipped Bat in the Hunter–Central Rivers CMA indicate that the species is known from 242 records of which six occur in the project locality (Office for Environment & Heritage 2016a). However, all records for the Golden-tipped Bat occur to the west and north-west of the project in association with higher altitude ranges of Ourimbah State Forest and the Watagan range.</p> <p>Although the occurrence of the Golden-tipped Bat in the study area cannot be ruled out, it is considered unlikely that the species would be an ‘affected species’ as a consequence of the project, due to:</p> <ul style="list-style-type: none"> → The relatively small area (1.1 hectares) of preferred rainforest roosting habitat likely to be affected. This may further be reduced during detailed design phases of the project. → The lack of mid and upper slope rainforest and sclerophyll forest foraging habitat → Extensive and contiguous nature of higher quality habitat associated with coastal foothills and ranges, including Ourimbah State Forest and the Watagan range → The occurrence of all existing records in the locality (and region) to the west and north-west of the project in Ourimbah State Forest and the Watagan range. 	No

Species	Potential to be affected by the project	Affected species?
Parma Wallaby (<i>Macropus parma</i>)	<p>The Parma Wallaby is known to occur within the Wyong CMA sub-region of the Hunter – Central River Catchment Management Region (Office of Environment & Heritage 2016n). The Parma Wallaby is now confined to the coast and ranges of central and northern NSW from Gosford to the Queensland border. Preferred habitat is wet sclerophyll forest with dense understory, occasionally also in rainforest and dry sclerophyll forest. Typically feeding at night in cleared – open forest areas on grasses and herbs (Office of Environment & Heritage 2016n).</p> <p>In the study area potential habitat for the Parma Wallaby was restricted to small areas of marginal rainforest and wet open forest type habitats. In the Hunter–Central Rivers CMA the Parma Wallaby is known from 544 records, of which none occur in the project locality. In proximity to the study area, records for the Parma Wallaby are largely restricted to the Ourimbah and Olney State Forests to the project’s west and north-west respectively that contain more desirable habitat (Office for Environment & Heritage 2016a). However, one record occurs to the south of the study area near Erina.</p> <p>Targeted surveys for the Parma Wallaby included remote camera traps, spotlight transects and opportunistic surveys whilst traversing through areas of suitable habitat (WSP Parsons Brinckerhoff 2016b). No individuals were recorded within the survey period.</p> <p>Although intermittent occurrences of Parma Wallaby in the locality cannot be discounted, due to the small extent of marginal rainforest and wet open forest type habitats available in the study area, together with the extensive and contiguous nature of higher quality habitat in the adjacent foothills and ranges, the Parma Wallaby is not considered an ‘affected species’ as a consequence of the project.</p>	No
Little Bentwing-bat (<i>Miniopterus australis</i>)	<p>The Little Bentwing-bat was recorded via passive Anabat surveys in swamp forest type habitat in the study area (Figure 5.14). Foraging habitat for the Little Bentwing-bat encompassed the majority of the study area, including rainforest, swamp forest and wet open forest habitats. Whilst the study area did not contain any breeding or maternity structures (i.e. caves), the Little Bentwing-bat is known to use a variety of structures to roost, and a lack of caves does not preclude the presence of other potential roosting structures. The existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow.</p> <p>Based on these results and given that the project will result in direct impacts on known foraging habitat and potential roost structures, the Little Bentwing-bat is considered an ‘affected species’. A detailed assessment of likely impacts of the project on Little Bentwing-bat is provided in section 5.11 of this report.</p>	Yes. Detailed assessment provided in section 5.12
Eastern Bentwing Bat (<i>Miniopterus schreibersii oceanensis</i>)	<p>The Eastern Bent-wing Bat was recorded via passive Anabat surveys in wet open forest type habitat in the project study area (Figure 5.15). Foraging habitat for the Eastern Bent-wing Bat includes all fauna habitat types in the study area, including rainforest, swamp forest, wet open forest and cleared land with scattered trees. Importantly, no critical habitat structures, such as maternity caves were recorded in the study area, although potential overwintering habitat was identified in expansion joints between concrete cast sections of the rail bridge over Chittaway Creek and Turpentine Road. A small private bridge structure over Chittaway Creek could also potentially provide refuge for this species during periods of low flow.</p> <p>Based on these results and given that the project will result in direct impacts on known foraging habitat and potential overwinter roost structures, the Eastern Bent-wing Bat is considered an ‘affected species’. A detailed assessment of likely impacts of the project on Eastern Bent-wing Bat is provided in section 5.12 of this report.</p>	Yes. Detailed assessment provided in section 5.13

Species	Potential to be affected by the project	Affected species?
Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>)	<p>The Eastern Freetail-bat is a hollow-dwelling insectivorous bat of which little is known (McConville & Law 2013). It occurs along the east coast of Australia from southern Queensland to southern NSW, where they occupy dry sclerophyll forest, woodland, swamp forests and mangrove forests (Office of Environment & Heritage 2016n). Anecdotal evidence and morphological characteristics of this species suggest that it is an open-adapted species (Churchill 2008; Hoye 2008).</p> <p>Targeted surveys for microchiropteran bats were completed in the study area in late March 2016, with a combination of harp trapping (six trap nights) and passive ultrasonic bat detection (six nights full recording) completed in the study area (WSP Parsons Brinckerhoff 2016b). The Eastern Freetail-bat was not recorded in the study area during surveys. A review of records for this species in the Hunter–Central Rivers CMA indicate that this species is known from 694 records, of which 11 occur in the project locality (Office for Environment & Heritage 2016a).</p> <p>Although the occurrence of Eastern Freetail-bat within the study area cannot be discounted, it is considered that potential habitat in the study area may not constitute important habitat to this species due to:</p> <p>It is considered unlikely that the species would be an ‘affected species’ as a consequence of the project, due to:</p> <ul style="list-style-type: none"> → No records for the species from six harp trap nights and six full night Anabat recordings (echolocation call is distinctive) → Potential habitat in the study area is not likely to constitute preferred habitat of an open-adapted species → Canopy strata over much of study area was generally of an insufficient age class to provide an abundance of hollow-bearing trees → Extensive and contiguous nature of higher quality habitat associated with coastal foothills and ranges, including Ourimbah State Forest and the Watagan range. <p>Therefore, the Eastern Freetail-bat is considered unlikely to be an ‘affected species’ as a consequence of the project and it is not considered further.</p>	No
Southern Myotis (<i>Myotis macropus</i>)	<p>Foraging habitat for the Southern Myotis was largely restricted to Chittaway Creek and Bangalow Creek and associated fringing rainforest habitat. Roosting structures such as caves did not occur in the study area and trees within onsite rainforest habitat were generally of an insufficient age-class to develop hollows for animals dependent on these resources. In fact, due to the relatively young age cohort of canopy strata over much of the study area, there was generally a paucity of hollow-bearing trees observed throughout. Nevertheless, the Southern Myotis is known to use a variety of structures to roost, and general lack of caves and tree hollows does not preclude the presence of other potential roosting structures. The existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow.</p> <p>Given that the Southern Myotis was recorded in preferred rainforest/riparian habitat and that the project will result in direct impacts therein, the Southern Myotis is considered an ‘affected species’. A detailed assessment of likely impacts of the project on Southern Myotis is provided in section 5.12 of this report.</p>	Yes. Detailed assessment provided in section 5.14

Species	Potential to be affected by the project	Affected species?
<p>Yellow-bellied Glider (<i>Petaurus australis</i>)</p>	<p>The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria (Office of Environment & Heritage 2016n). Preferred habitat is tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils; typically being found in wet sclerophyll gullies. Live in small family groups of two–six individuals and are nocturnal. Very mobile and occupy large home ranges between 20 to 85 hectares. In the Hunter–Central Rivers CMA the Yellow-bellied Glider is known from 1,451 records, with numerous records occurring in the foothills, forested gullies and ranges adjacent to the project (Office of Environment & Heritage 2016n).</p> <p>Surveys undertaken as part of the SIS were completed in mid to late March 2016 (WSP Parsons Brinckerhoff 2016b), with survey effort comprising a combination of spotlight transects, call playback, camera trapping and hair tubes. The yellow-bellied Glider was not recorded in the study area during targeted surveys. Concurrently with targeted surveys informing this SIS, the Yellow-bellied Glider was heard/observed numerous in habitat more typical of this species in the southern extent of Olney State Forest (Richardson A. 2016b).</p> <p>Potential habitat (swamp forest and wet open forest) in the study area did not constitute habitat typically preferred by the Yellow-bellied Glider; being tall mature wet sclerophyll gullies. Furthermore, the study area did not comprise high quality habitat that would be used in isolation of adjacent stands of habitat and canopy strata over much of the site was generally of an age-class insufficient for the development of numerous hollow-bearing trees.</p> <p>Although the study area may be used intermittently for foraging purposes or movement through the landscape, the Yellow-bellied Glider is not considered an 'affected species' due to:</p> <ul style="list-style-type: none"> → The study area not constituting preferred habitat → The species not being recorded in the study area during targeted surveys when this species was known to be active in the region (recorded both aurally and visually in mature gully forest in the southern extremities of Olney State Forest) → The general paucity of hollow-bearing trees over much of the study area largely precludes habitats in the study area constituting important habitat, although occasional movements and/foraging events are always possible → Extensive and contiguous nature of higher quality habitat associated with the foothills and sheltered gullies of the adjacent coastal ranges, where the majority of records in the locality occur (i.e. Ourimbah State Forest). <p>Accordingly, project related impacts on the Yellow-bellied Glider are considered unlikely to have an adverse impact on populations in the locality.</p>	<p>No</p>
<p>Squirrel Glider (<i>Petaurus norfolcensis</i>)</p>	<p>The Squirrel Glider is sparsely distributed in eastern Australia, from northern Queensland to western Victoria, where it inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt–Bloodwood forest with shrub or Acacia midstorey, and heath understorey in coastal areas (Office of Environment & Heritage 2016n). Squirrel Gliders live in family groups and require abundant tree hollows. In the Hunter–Central Rivers CMA the Squirrel Glider is known from 1,032 records, of which approximately 11 in the project locality (Office for Environment & Heritage 2016a). Records for the Squirrel Glider occur particularly to the north of the project locality, whilst the foothills, sheltered gullies and ranges immediately adjacent to the study area retain no records (Office for Environment & Heritage 2016a).</p>	<p>No</p>

Species	Potential to be affected by the project	Affected species?
	<p>Survey undertaken in the study area as part of this SIS were completed in mid to late March 2016, with targeted survey effort involving a combination of arboreal set Elliott type B trapping, spotlight transects, hair tubes, remote camera trapping and call playback (WSP Parsons Brinckerhoff 2016b). The Squirrel Glider was not recorded in the study area during targeted searches.</p> <p>Although potential habitat for the Squirrel Glider was recorded in the study area (swamp forest and wet open forest), it is unlikely that impacts on this species would have an adverse impact on local populations due to:</p> <ul style="list-style-type: none"> → The species not being recorded in the study area during targeted surveys using multiple survey methodologies → Records for Sugar Glider (heard/observed) in the study area during targeted surveys → Canopy strata over much of the study area generally being of an age-class insufficient for the development of hollows. Hollow-bearing trees were not abundant in the study area → The lack of previous records for this species in the study area and adjacent foothills and ranges. <p>Although intermittent occurrences of Squirrel Glider cannot be discounted, due to the above reasons, the Squirrel Glider is not considered an 'affected species'.</p>	
Koala (<i>Phascolarctos cinereus</i>)	<p>The Koala has a fragmented distribution in eastern Australia from north-east Queensland to South Australia, where they inhabit eucalypt woodlands and forests and feed on more than 70 eucalypt species and 30 non-eucalypt species (Office of Environment & Heritage 2016n). In the study area swamp forest type habitat was dominated in the canopy strata by <i>Eucalyptus robusta</i> (Swamp Mahogany), which is listed as a primary food trees species for the Koala in the Central Coast Koala Management Area (Department of Environment and Climate Change 2008b). One other primary food tree species, <i>Eucalyptus tereticornis</i> (Forest Red Gum) was recorded in the study area but it occurred as a solitary specimen.</p> <p>In the Hunter–Central Rivers CMA the Koala is known from 10,555 records, of which four occur in the project locality. Of those, two are records from 1949 and 1968 to the north of the study area near Tuggerah and Wyong. The remaining two records are more recent from Berkeley Vale and Chittaway in 2006 and 2007 respectively (Office for Environment & Heritage 2016a).</p> <p>Targeted surveys undertaken as part of this SIS were completed in mid to late March 2016, with targeted survey effort involving a combination of spotlight transects, call playback and scat searches in accordance with SAT methodology. The Koala was not recorded in the study area during targeted searches.</p> <p>The relatively rare status of Koala in the locality, as evidenced by a low incidence of records, and the lack of records in the study area during targeted searches and 25 days of opportunistic sightings over different seasonal contexts, suggest that the study area may not be important for the Koala. Whilst intermittent occurrences of the Koala in the study area cannot be discounted, it is considered unlikely that the Koala will be an 'affected species' as a consequence of the project.</p>	No

Species	Potential to be affected by the project	Affected species?
Common Planigale (<i>Planigale maculata</i>)	<p>The Common Planigale is known to occur within the Wyong CMA sub-region of the Hunter–Central River Catchment Management Region. In NSW, this species is found along the east coast from Queensland as far south as Gosford (Office of Environment & Heritage 2016n). Occurring in nearly all terrestrial environments including rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas with surface cover. Carnivorous forager at night amongst leaf litter, in dense grass and in low vegetation. Shelters during the day under rocks timber, bar, human debris, and in termite mounds.</p> <p>Surveys undertaken as part of this SIS were completed in mid to late March 2016, with survey effort involving a combination of terrestrial mammal trapping and remote camera traps. The Common Planigale was not recorded in the study area and the nearest record occurs in the Barrington Tops region. For this reason, the Common Planigale is not considered an 'affected species'.</p>	No
Long-nosed Potoroo (<i>Potorous tridactylus</i>)	<p>The Long-nosed Potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. In NSW it is generally restricted to coastal heaths and dry and wet sclerophyll forests east of the Great Dividing Range, with an annual rainfall exceeding 760 millimetres. Dense understorey with occasional open areas is an essential part of habitat. The fruit-bodies of hypogeous (underground-fruited) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae. The species is mainly nocturnal, solitary, and non-territorial and have home range sizes ranging between 2–5 hectares.</p> <p>Within the Hunter–Central Rivers CMA the Long-nosed Potoroo is known from 1,206 records, of which none occur in the project locality Gosford (Office of Environment & Heritage 2016n). The nearest record for this species occurs to the south of the project site near Holgate, NSW. Furthermore, five management sites for the Long-nosed Potoroo have been identified in NSW; the nearest being Mount Royal near Barrington Tops.</p> <p>Surveys undertaken as part of this SIS were completed in mid to late March 2016. Survey effort involved a combination of remote camera trapping, spotlight transects and opportunistic sighting over 25 days during different seasonal contexts. The Long-nosed Potoroo was not recorded in the study area during the survey period.</p> <p>Although intermittent occurrences of Long-nosed Potoroo locality cannot be discounted, the rare status in the locality, as evidenced by no previous records, together with the extensive and contiguous nature of habitat available in the locality and region, the Long-nosed Potoroo is not considered an 'affected species' as a result of the project.</p>	No
Eastern Chestnut Mouse (<i>Pseudomys gracilicaudatus</i>)	<p>In NSW the Eastern Chestnut Mouse distribution is patchy occurring to the east of the great diving range from the Hawkesbury River area extending north into Queensland. There are isolated records in the Jervis bay area (Office of Environment & Heritage 2016n). The Eastern Chestnut Mouse is found in low numbers in heathland, preferring dense wet heath and swamps. Optimal habitat appears to be regenerating heathland 2–4 years after fire, by the time heath is mature the Swamp Rat becomes dominant. This largely nocturnal, generalist granivore, nests in constructed grass nests or in shallow burrows during the day (Strahan 1995).</p> <p>In the Hunter–Central Rivers CMA the Chestnut Mouse is known from 25 records, none of which are known to occur in the project locality (Office of Environment & Heritage 2016n). Two management sites for the Eastern Chestnut Mouse have been identified under the <i>Saving our Species</i> program, the nearest of which occurs near Myall Lakes, NSW.</p> <p>Targeted surveys undertaken as part of this SIS were completed in mid to late March 2016, with 225 Elliott type A trap nights completed in suitable habitat. Elliott trapping returned a high rate of returns for Bush Rat (<i>Rattus fuscipes</i>) (26 captures), Swamp Rat (<i>Rattus lutreolus</i>) (seven captures) and Brown Antechinus (<i>Antechinus stuartii</i>) (24 captures).</p>	No

Species	Potential to be affected by the project	Affected species?
	Based on targeted trapping survey results and the rarity of this species in the project locality, it is considered unlikely that project related impacts would have an adverse impact on this species. Accordingly, the Eastern Chestnut Mouse is not considered an 'affected species' and is not considered further in this report.	
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	<p>The Grey-headed Flying-fox was observed flying over the project study area during two separate nocturnal survey events (Figure 5.17). Although this species was not specifically observed using habitat within the study area, this species is a blossom nomad that is known to commute long distances as food availability varies over time. Rainforest, swamp forest (particularly <i>E. robusta</i>) and wet open forest provide potential seasonal foraging resources for this species.</p> <p>Given that Grey-headed Flying-fox was recorded during field surveys and the project will impact potential important seasonal foraging resources, this species is considered an 'affected species'. A detailed assessment of likely impacts of the project on Grey-headed Flying-fox is provided in section 5.13 of this report.</p>	Yes. Detailed assessment provided in section 5.15
Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>)	<p>The Yellow-bellied Sheathtail-bat is a wide-ranging, hollow-dwelling, insectivorous, species found across northern and eastern Australia, foraging in most habitats across its wide range. The propensity for this species to forage at high-speed dictates that it mostly a high flier, foraging for insects above canopy strata; however in more open environments it is known to come lower to the ground. Habitat for this species in the locality was largely restricted to foraging opportunities over the canopy of eucalypt forest. The somewhat cluttered environments below the canopy strata in swamp forest and rainforest type habitats in the study area are not conducive to the Yellow-bellied Sheathtail-bat's foraging ecology. And, the age-class of canopy structure over much of the study area was generally insufficient for the development of numerous hollow-bearing trees.</p> <p>Targeted surveys for microchiropteran bats were completed in the study area in late March 2016, with a combination of harp trapping (six trap nights) and passive ultrasonic bat detection (six nights full recording) completed in the study area (WSP Parsons Brinckerhoff 2016b). The Yellow-bellied Sheathtail-bat was not recorded in the study area during surveys. In the Hunter–Central Rivers CMA, the Yellow-bellied Sheathtail-bat is known from 95, with one record occurring in the project locality (Office for Environment & Heritage 2016a).</p> <p>Although intermittent occurrences of Yellow-bellied Sheathtail-bat in the study area are possible, it is not considered an 'affected species' as a consequence of the project due to:</p> <ul style="list-style-type: none"> → No records for the species from six harp trap nights and six full night Anabat recordings (echolocation call is distinctive) → Canopy strata over much of study area was generally of an insufficient age class to provide an abundance of hollow-bearing trees → The propensity for this species to forage at high-speed largely precludes this species from foraging below the canopy strata in available habitats in the study area → Foraging opportunities largely occurring above the canopy strata of available habitats in the study area → Extensive and contiguous nature of higher quality habitat associated with coastal foothills and ranges, including Ourimbah State Forest and the Watagan range. 	No

Species	Potential to be affected by the project	Affected species?
Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>)	<p>The Greater Broad-nosed Bat is found from north-east Victoria to the Atherton Tableland in Queensland, where it occupies gullies and river systems that drain the Great Dividing Range, extending to the coast over much of this range (Office of Environment & Heritage 2016n). The Greater Broad-nosed Bat is a hollow-dwelling insectivorous bat that is known to use a variety of habitats from woodland through to dry and moist eucalypt forest and rainforest. They forage for beetles and other large slow-flying insects by flying slowly and directly along creek and river corridors (Office of Environment & Heritage 2016n). In the Hunter–Central Rivers CMA the Greater Broad-nosed Bat is known from 463 records, of which 16 occur in the project locality.</p> <p>Although intermittent occurrences of Greater Broad-nosed Bat in the study area cannot be discounted, it is not considered an ‘affected species’ as a consequence of the project due to:</p> <ul style="list-style-type: none"> → No records for the species from six harp trap nights and six full night Anabat recordings → The small area of potential foraging habitat likely to be impacted along Chittaway Creek by extending the width of the existing rail corridor → Canopy strata over much of study area was generally of an insufficient age class to provide an abundance of hollow-bearing trees → The lack of preferred habitat types, being woodland and dry forest that suit their direct flight, were not available in the study area → The propensity of this species to forage slowly and directly largely precludes this species from foraging below the canopy strata of swamp forest type habitats in the study area → Extensive and contiguous nature of higher quality habitat associated with coastal foothills, sheltered gullies and ranges, including Ourimbah State Forest and the Watagan range. 	No

5.2 *Melaleuca biconvexa* – Biconvex Paperbark

5.2.1 Discussion of conservation status

Melaleuca biconvexa is a native tree species that is listed as Vulnerable under both the TSC Act and EPBC Act. Within in the Hunter–Central Rivers CMA, OEH has recorded that the species can sustain up to a 10 per cent loss for populations greater than 100 mature individuals (Office of Environment & Heritage 2016b).

DISTRIBUTION

Melaleuca biconvexa is restricted in its distribution, limited to coastal regions between Port Macquarie in the north to Jervis Bay in the south within NSW. The species occurs in scattered and disjunct populations within the Hawkesbury–Nepean, Northern Rivers, Hunter–Central Rivers and Southern Rivers CMAs (NSW Scientific Committee 2008).

Melaleuca biconvexa recorded within the study area does not form part of the species known distribution limits. At a regional scale the study area falls within the centre of the species known distribution and at a local scale the study area is located within the central portion of the Gosford–Wyong meta-population.

Results of the population estimate surveys undertaken to inform this SIS identify 5,014 *Melaleuca biconvexa* plant stems as occurring within the study area, the majority of which are within the immature and sapling age class. Of the 5,014 *Melaleuca biconvexa* plant stems recorded approximately 3,984 stems occur within the subject site and therefore will require removal, whilst the remaining 1,030 stems in the study area will be retained in situ. Of the 5,014 plant stems recorded from the study area a total of 359 have been identified as of mature age class in which a total of 298 are identified for removal within the subject site and 61 to be retained in the study area.

In addition to these plant stems estimates, private lands directly adjoining the study area (within patch 11 in Figure 4.2) have also been previously mapped as containing a high abundance mature to intermediate stand age class of *Melaleuca biconvexa* (Duncan 2001a). Due to site access restrictions, it was not possible to undertake field verification of these patches. Given this, density estimate extrapolation over these areas indicate that an additional 14,932 *Melaleuca biconvexa* plant stems are likely occur.

HABITAT

The species is known to occur in damp areas which are often associated with streams or low lying areas on alluvial soils. Within these areas the species is known to favour lower slopes and/or sheltered aspects (Office of Environment & Heritage 2016a). Within the Wyong sub-region of the Hunter–Central Rivers CMA the species is known to occur in association with the following PCTs:

- Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion
- Paperbarks - Woollybutt swamp forest on coastal lowlands of the Central Coast
- Swamp Mahogany swamp forest on coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion
- Tallowwood – Narrow-leaved White Mahogany open forest of the hinterland ranges of the North Coast
- Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion.

Within the study area the species was recorded from within PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast. Within this habitat *Melaleuca biconvexa* was identified to occur in association with other *Melaleuca* and *Callistemon* species such as *Melaleuca nodosa*, *Melaleuca ericifolia*, *Melaleuca linearifolia*, *Melaleuca sieberi*, *Melaleuca styphelioides* and *Callistemon salignus* which favour similar habitat.

ECOLOGY

Melaleuca biconvexa grows as shrub to small tree usually to 10 metres in height (but is known to reach 20 metres). The species has typical paperbark bark with small leaves to 18 millimetres in length and two millimetres in width. Each of the leaves have a characteristic centre-vein groove from which the leaf blade curves upright on either side (Office of Environment and Heritage 2016a).

Similar to Eucalypt, *Callistemon* and other *Melaleuca* species, *Melaleuca biconvexa* contains woody fruit with numerous fine seeds that are often retained in the canopy. The species is recorded as flowering for approximately 3–4 weeks during September and October (Office of Environment & Heritage 2016a). Reproduction is known to occur both sexually (seed germination) and asexually (root suckering) with the latter leading to dense stands of clonal plants that cause difficulties for understanding population densities and individual genetic specimens (Duncan 2001a; NSW Scientific Committee 2011a).

RECOVERY PLAN

To date, a recovery plan for *Melaleuca biconvexa* has not been prepared. The OEH has however assigned *Melaleuca biconvexa* to the site-managed species management stream under the *Saving our Species* conservation program (Office of Environment & Heritage 2016a). Site-managed species are species that have been considered to require management activities to ensure security of the species in the wild for the next 100 years. Under this program the NSW OEH have established three management sites for *Melaleuca biconvexa* which include:

- Porters Creek management site within the Wyong LGA
- Ourimbah management site within the Gosford LGA
- St Georges Basin management site within the Shoalhaven LGA.

The study area does not form part of any management site in which the species is conserved under the *Saving our Species* conservation program.

Although the species is conserved in a number of OEH estates, it was estimated by Duncan in 2001 that over 70 per cent of all mapped *Melaleuca biconvexa* within the Wyong Shire (now part of Central Coast Council) occurred on lands with private tenure. Many of these privately owned lands are currently under zones that permit a wide range of land uses that conflict with many of the activities identified to assist this species recovery.

The local population study undertaken as part of this SIS estimate that in 2016 approximately 87 per cent of the mapped *Melaleuca biconvexa* occurs on land of private tenure. Subsequently, *Melaleuca biconvexa* is considered to be not adequately conserved within the locality and the region.

KEY THREATS

The OEH have identified the following processes that may threaten the survival of *Melaleuca biconvexa* (Office of Environment & Heritage 2016a):

- It is likely Biconvex Paperbark has evolved to cope with infrequent fires. Burning for hazard reduction and other unnatural ignitions have increased fire frequency and may threaten the species' survival
- Clearing for residential development

- Most populations are on private land and there is poor threats knowledge about the species and its requirements by land managers
- Alterations to the drainage hydrology of low-lying floodplains and swamps including swamp reclamation
- Increased pollution and nutrients through adjoining developments and rubbish dumping
- Grazing and trampling by stock causing root damage, prevention of seedling establishment and erosion
- Potentially affected by Myrtle Rust
- Increased pollution and nutrients through adjoining developments and rubbish dumping
- Competition from noxious aquatic weeds particular *Sagittaria platyphylla* along with woody weeds such as Privet.

The project will add incrementally to the loss known habitat for the species and alter the drainage hydrology of the floodplain. In addition the project has potential to increase pollution, alter fire regimes, introduce Myrtle Rust and weed species if the appropriate mitigation measures are not implemented.

With regard to *Melaleuca biconvexa*, KTPs that the project is likely to be commensurate with, include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands – *Melaleuca biconvexa* is known to prefer damp places near streams or low lying areas on alluvial soils. The study area is located on a coastal floodplain which contains known habitat for the species and is groundwater dependent. The proposed works are likely to modify the natural hydrology of this habitat within the study area which has potential to impact the population of *Melaleuca biconvexa* on site.
- Clearing of native vegetation – the proposed activities would require the removal of 25.5 hectares of known habitat for the species; *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation community. The species occupies 2.2 hectares of this vegetation which will result in the direct removal of approximately 3,984 *Melaleuca biconvexa* plant stems.
- Infection of native plants by *Phytophthora cinnamomi* – proposed activities (i.e. vegetation clearing and earthworks) has potential to introduce pathogens if appropriate mitigation measures are not implemented.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae – see above.
- Invasion and establishment of exotic vines and scramblers – proposed activities have potential to result in invasion and/or spread of exotic species during the construction phase (i.e. vegetation clearing and earthworks activities) and operation phase of the project (movement, storage and maintenance of trains).
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata* – see above.
- Invasion, establishment and spread of *Lantana camara* – see above.
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed) – see above.
- Invasion of native plant communities by exotic perennial grasses – see above.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants – see above.

Under the 'Saving our Species' conservation program the OEH have also established seven activities as a targeted approach to managing *Melaleuca biconvexa* (Office of Environment & Heritage 2016a). The proposed works have the potential to impact on three of these activities being:

- Ensure run-off into swamps is controlled
- Retain or reintroduce ecologically sustainable water flows to swampland habitat

- Survey thoroughly for the presence of Biconvex Paperbark before the approval of development applications.

5.2.2 Discussion of local and regional abundance

5.2.2.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

At a regional scale, the distribution of *Melaleuca biconvex* is known from the North Coast and Sydney Basin Bioregions. A review of species records from the Atlas of NSW Wildlife (Office of Environment & Heritage 2016b) and Atlas of Living Australia (Atlas of Living Australia 2016) indicate there are four core meta-populations distributed from Port Macquarie in the north to Jervis Bay in the south.

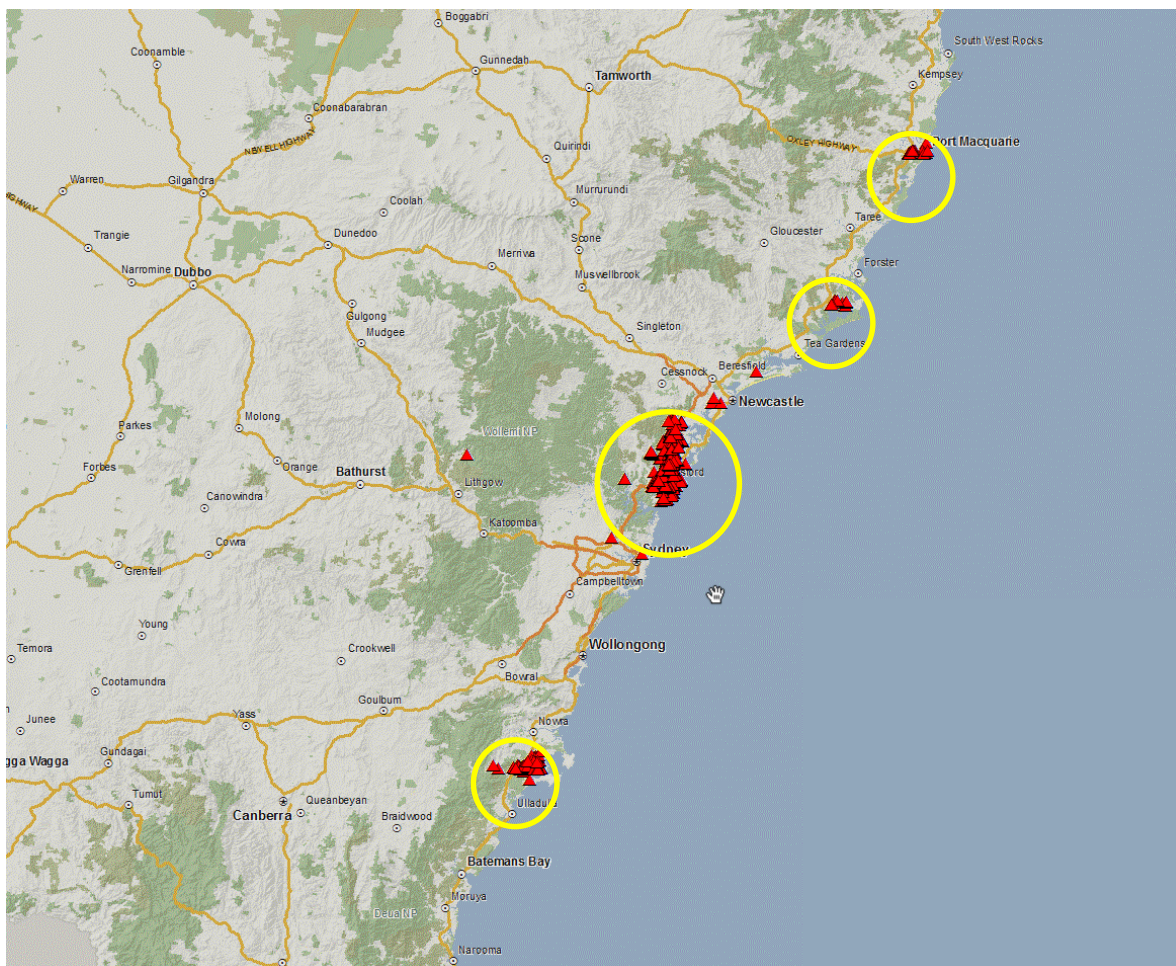
Within the North Coast Bioregion this species is restricted to areas south of Kempsey within the Macleay–Hastings sub-region of the Northern Rivers CMA and Karuah Manning sub-region of the Hunter–Central Rivers CMA (Office of Environment & Heritage 2016a) principally in the Port Macquarie and Bulahdelah areas.

The main concentration of records for this species are within the Sydney Basin Bioregion where the largest meta-population occurs within both the Wyong and Pittwater sub-regions of the Central–Hunter Rivers and Hawkesbury–Nepean CMAs in the Gosford–Wyong area (Office of Environment & Heritage 2016a). The southern extent of the species distribution is within the Jervis Bay area that is located in the Jervis sub-region of the Southern Rivers CMA. An overview of *Melaleuca biconvex* meta-population distribution is provided in Table 5.3 and Figure 5.1.

Table 5.3 Regional distribution of *Melaleuca biconvex*

Bioregion	CMA	CMA sub-region	META population
North Coast	Northern Rivers	Macleay-Hastings	Port Macquarie
North Coast	Hunter–Central Rivers	Karuah Manning	Bulahdelah
Sydney Basin	Hunter–Central Rivers	Wyong	Gosford-Wyong
	Hawkesbury–Nepean	Pittwater	
Sydney Basin	Southern Rivers	Jervis	Jervis Bay

The study area forms part of the Gosford–Wyong meta-population which comprises of a number a scattered disjunct populations that vary in age class and abundance. No concise population data has been recorded for the Gosford–Wyong meta-population although mapping of age class and abundance of populations within the Wyong LGA have been previously recorded (Duncan 2001a).



Note: adapted from OEH's BioNet Atlas of NSW Wildlife records for *Melaleuca biconvexa* (Office for Environment & Heritage 2016a).

Figure 5.1 Regional distribution of four meta-populations of *Melaleuca biconvexa*

DISCUSSION OF LOCAL POPULATION

In defining the local population of *Melaleuca biconvexa* the following definition has been considered:

The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area (Department of Environment and Climate Change 2007f).

In light of this, an overview of existing knowledge and understanding of the species reproductive biology and ecology is provided.

The reproductive biology of *Melaleuca biconvexa* is considered to generally comprise of asexual clonal suckering and sexual reproduction by seed (Duncan 2001a). The current understand of the ecology of *Melaleuca biconvexa* is relatively limited although it has been recorded that seed is locally dispersed and that a possible dormancy inhibitor may lead to low germination rates (Benson & McDougall 1998). Germination experiments conducted by Duncan (2001a) confirmed low germination rates although it was concluded that seed germination is readily achievable. The ability of this species to be readily germinated, albeit at low

rates, was also confirmed by Gosford City Council plant nursery that readily propagate *Melaleuca biconvexa* under licence for conservation projects (pers. Com Peter Lambert 2013).

Floral pollination vectors for this species are relatively unknown although European honeybees, native bees, beetles, flies, ants and moths have been observed visiting flowering specimens (Duncan 2001a). These species are considered probably the main pollinators for similar melaleuca species such as *M. styphelioides* (Benson & McDougall 1998). In addition, the highly mobile Grey-headed Flying Fox has been recorded as an important pollinator for melaleucas (Department of Environment Climate Change and Water NSW 2009) and may contribute to the cross pollination of small disjunct habitat patches within a local population.

In terms of seed dispersal it is considered that wind and water may play an important role (Benson & McDougall 1998). The very small and fine nature of the seed and position of seed capsules in the upper canopy generally indicate that wind dispersal would be an important mechanism for this species. In addition, many stands of *Melaleuca biconvexa* follow water courses or extend over floodplains that most likely indicate water could also play an important role in the dispersal of seed for this species.

Habitat within the study area adjoins low-lying swamp vegetation to the north associated with Ourimbah Creek and riparian vegetation to the south fringing Chittaway and Bangalow creeks and their tributaries. To the southeast of the study area, *Melaleuca biconvexa* habitat extends to low-lying swampy areas and small drainage channels around Fountaindale near Manns Road and Pleasant Valley Drive, along Berkeley Road and vegetated areas north of Enterprise Drive. Known habitat that is vegetatively linked also occurs along Berkeley Creek, Berkeley Park, Myrtle Brush Park, Glenning Valley and Quondong Gully (Duncan 2001a; Office for Environment & Heritage 2016a).

The Duncan (2001a) study identifies a total of five populations of *Melaleuca biconvexa* within the Wyong LGA and these comprise of:

- Population 1 – Tumbi Umbi
- Population 2 – Ourimbah/Fountaindale/Berkeley Vale
- Population 3 – Wyong/Porters Creek Wetland
- Population 4 – Jilliby/Dooralong
- Population 5 – Buttonderry Creek.

These populations were defined based on habitat discontinuity of no more than one kilometre from discrete groupings of plants that were deemed likely to be reasonable for maintain cross-pollination processes (Duncan 2001). This population framework was derived from a geographic discontinuity rule of thumb definition as outlined in Keith *et al* (1997).

Of these five populations, Population 2 is the largest in terms of patch area, abundance and maturity of age class (Duncan 2001a). The local population generally comprises of a number of core patch areas of *Melaleuca biconvexa* that have been identified to contain high to medium abundance of intermediate to mature age class (Figure 4.7).

It is considered that cross-pollination between *Melaleuca biconvexa* specimens within these patch areas are likely due to relatively contiguous vegetation (separation <one kilometre) that could be utilised by relatively mobile pollination species. The extent of the local population in which the study area occurs is considered generally consistent with Wyong LGA – Population 2 – Ourimbah/Fountaindale/Berkeley Vale (Duncan 2001a) and is shown in Figure 4.7.

In terms of the estimated local population of *Melaleuca biconvexa* it is considered that the species occupies approximately 2.2 hectares of habitat (Figure 5.4). Population density extrapolation indicates that approximately 243,874 number of *Melaleuca biconvexa* plant stems are likely to occur within the local population. In terms of the project impact on the local population it is considered that the removal of 3,984 plants stems constitutes approximately 1.6 per cent of the local population.

Based on these estimates it is considered that the project impact on the local population is within the sustain loss threshold of 10 per cent for populations > 100 mature individuals outlined within the Hunter–Central Rivers CMA (Office Of Environment & Heritage 2016e).

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

The regional significance of the Central Coast meta-population and Local Population 2 (Ourimbah/ Fountaindale/Berkeley Vale) is likely to be high, due to the small extent of potential habitat that remains for the species at a regional scale and the large abundance of *Melaleuca biconvexa* present within the locality (i.e. strong hold population). The regional significance of Swamp Sclerophyll Forest to *Melaleuca biconvexa* is likely to be high, due to their shared habitat characteristics i.e. damp areas, coastal floodplains and alluvial soils (Office of Environment & Heritage 2016a).

The current extent of Swamp Sclerophyll Forest at a regional scale was estimated at representing less than 30 per cent of its original extent in the early 1990's (up to 7000 hectares in the Hunter–Central Coast region) (NSW Scientific Committee 2011b). It is highly likely that the community's extent has been reduced further in the past 20 years as a result of coastal development. Subsequently, although the species does not always occur within Swamp Sclerophyll Forest the removal of 25.5 hectares required for the project is likely to constitute the removal of approximately 4.2 per cent of similar habitat within the locality.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

Within the Gosford–Wyong meta-population area know and suitable habitat for the species are conserved in a number of OEH estates and Council Reserves including:

- Tuggerah Nature Reserve
- Tuggerah State Conservation Area
- Jilliby State Conservation Area
- Wyrribalong National Park
- Bouddi National Park
- Myrtle Brush Park
- Berkeley Park
- Greenbank Road Council Conservation Area
- Gosford City Council Coastal Open Space System (COSS).

In addition, OEH have established two *Saving our Species* management sites within the locality. These sites have been established as it is recognised that management activities are required to ensure the conservation of *Melaleuca biconvexa* into perpetuity. The two management sites for *Melaleuca biconvexa* include:

- Porters Creek management site within the Wyong LGA
- Ourimbah management site within the Gosford LGA.

The Porters Creek management site is 3,921.75 hectares in area and is located approximately 3 kilometres north of the study area on wetlands west of Tuggerah on targeted areas of land on council property (Figure 5.2). Within this management site the species fringes wetland habitats however the population size is unknown (Office of Environment & Heritage 2016a). The local population to which the study area occurs does not form part of this site management site.

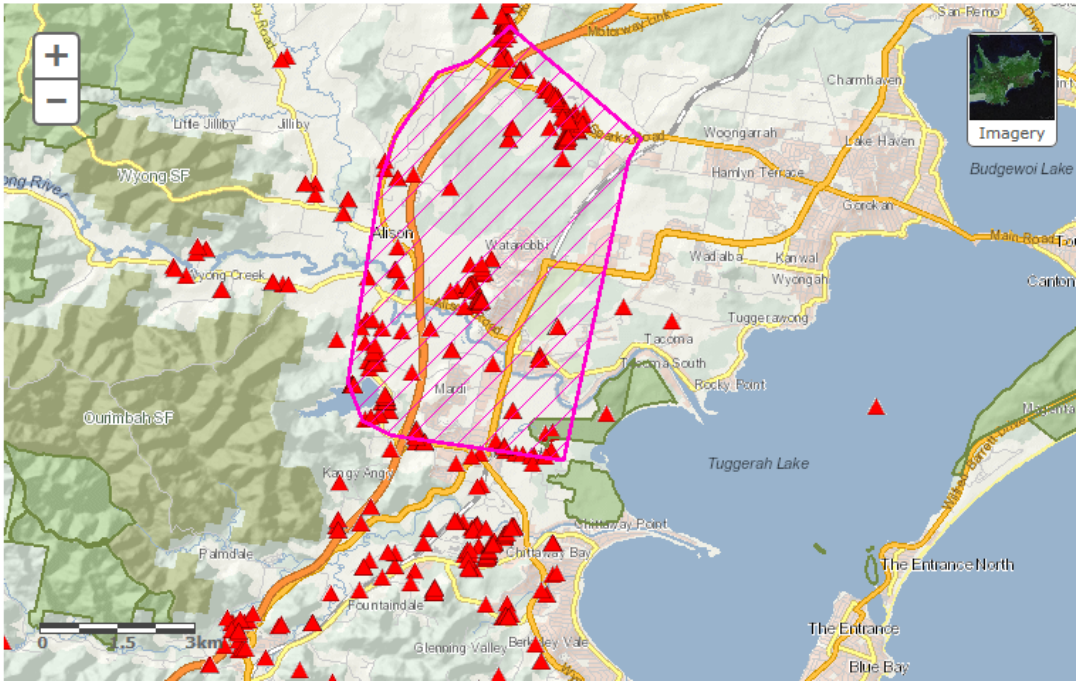


Figure 5.2 Porters Creek Saving our Species management site

The Ourimbah management site is 8.41 hectares in total site area and is located approximately five kilometres to the south-southwest of the study area (Figure 5.3). The site is located at Lisarow on multi use land that includes Lisarow wetlands, Lisarow High School, grazing lands, vegetated lands and power utility. A management plan has been prepared by Gosford City Council for part the management site (Office of Environment & Heritage 2016a). The local population to which the study area occurs does not form part of this site management site.

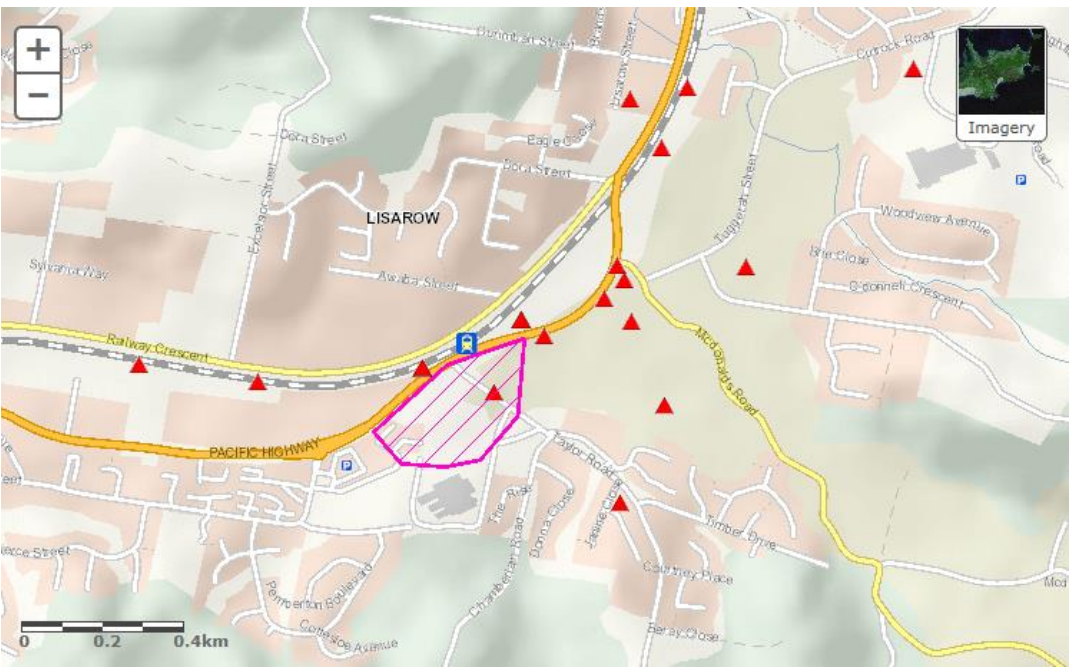


Figure 5.3 Ourimbah Saving our Species management site

Although the species is conserved in a number of OEH estates, management site and Council reserves, it has been estimated that over 70 per cent of all known *Melaleuca biconvexa* records within the Wyong Shire (now part of Central Coast Council) occur on privately owned lands (Duncan 2001a).

Habitat for *Melaleuca biconvexa*, is considered at risk and overall given development pressures that characterise coastal landscapes on the Central Coast and elsewhere in the bioregion, the long term security of habitat for *Melaleuca biconvexa* at both the local or regional scale is considered not adequately reserved.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Swamp Sclerophyll Forest and other similar vegetation types that provide suitable habitat for *Melaleuca biconvexa* such as riparian and/or moist Blue Gum Palm Forest associations, continue to be under threat due to development pressures in the landscape contexts where they occur. In 2011 the final determination for Swamp Sclerophyll Forest as an EEC estimated that less than 30 per cent of the original extent of this community continued to exist (NSW Scientific Committee 2011b). Additionally it was estimated by National Parks and Wildlife Service (1999) that European Settlement had resulted in the removal of around 82 per cent of Alluvial Tall Moist Forest and 68 per cent of Swamp Mahogany Paperbark Forest within the region.

Locally stands of Swamp Mahogany and other similar communities continue to persist, but they are becoming increasingly fragmented due to developmental pressures. *Melaleuca biconvexa*'s Vulnerable status is due to the loss and fragmentation of its habitats and alterations to water tables (Office of Environment & Heritage 2016a), therefore stands of Swamp Sclerophyll forest the size of that occurring within the site are uncommon locally. Although large patches of Swamp Sclerophyll Forest are uncommon, large patches of *Melaleuca biconvexa* do frequently occur within the locality. Nevertheless large patches of Swamp Sclerophyll Forest have high significance in the locality.

5.2.2.2 DISCUSSION OF HABITAT UTILISATION

Approximately 5,014 *Melaleuca biconvexa* were identified as occurring within the study area. Of the 5,014 recorded, the project will require removal of 3,984. Within the subject site the species utilises 2.2 hectares of PCT1723 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest (9 per cent of available habitat within the subject site) which is associated with low lying areas on alluvial soils. Within these areas the species forms low to high abundance densities forming monoculture stands in some locations.

Habitat within the study area is connected to other remnants within the locality including:

- Adjoins low-lying swamp vegetation to the north associated with Ourimbah Creek and riparian vegetation to the south fringing Chittaway and Bangalow creeks and their tributaries.
- To the southeast of the study area *Melaleuca biconvexa* habitat extends to low-lying swampy areas and small drainage channels around Fountaindale near Manns Road and Pleasant Valley Drive, along Berkeley Road and vegetated areas north of Enterprise Drive.
- Known habitat that is vegetatively linked also occurs along Berkeley Creek, Berkeley Park, Myrtle Brush Park, Glenning Valley and Quondong Gully (Duncan 2001a; Office for Environment & Heritage 2016a).

The local population is estimated to contain over 243,874 mature and immature *Melaleuca biconvexa* plant stems. The 3,984 *Melaleuca biconvexa* recorded within the subject site would represent the loss of approximately 1.6 per cent of the total local population and 4.2 per cent of total similar habitats within the population's distribution.

Within in the Hunter–Central Rivers CMA, OEH identify that the species can sustain up to a 10 per cent loss for populations greater than 100 mature individuals (Office of Environment & Heritage 2016b). As the project would ultimately remove 1.6 per cent of the total local population this would suggest that the species can sustain such a loss within the Hunter–Central Rivers CMA.

5.2.2.3 DESCRIPTION OF VEGETATION

Melaleuca biconvexa was recorded from one vegetation community within the study area; PCT1723 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest. This vegetation type varies in its condition (High, Medium and Low quality) of which all provide habitat for the species (Figure 4.4). A discussion of the vegetation composition and condition are provided in Table 4.6. No other vegetation communities recorded within the study area provide suitable habitat for this species.

5.2.3 Assessment of habitat

5.2.3.1 DESCRIPTION OF HABITAT VALUES

A single vegetation type recorded within the study area has been identified as providing occupied and potential habitat for *Melaleuca biconvexa*; PCT1723 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest. During targeted surveys for the species approximately 5,014 *Melaleuca biconvexa* were recorded from within this vegetation type.

Although PCT1723 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest is not a vegetation type associated with the species in the Wyong sub-region of the Hunter–Central Rivers it does contain known habitat characteristics. Specifically, the vegetation occurred on a coastal floodplain on alluvial soils which are subjected to inundation as they occur on low lying areas.

PCT1723 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest varied in its species composition and condition the distribution of which is related to geological, topographical and geomorphological characteristics as well as previous and current land uses. *Melaleuca biconvexa* occurred within two of the three condition types identified including:

- Moderate to Good (High quality) – contained intact species compliment and structural characteristics typical of the vegetation community. The vegetation displayed a resilience to weed invasion due to intact groundcover, shrub and canopy layers. Weed invasion was limited to the periphery of the community and/or along access tracks (0–5 per cent weed cover). Native species diversity was relatively high.
- Moderate to Good (Medium Quality) – contained most of the species compliment and structural characteristics typical of the vegetation community however no longer contained some aspects due to land use disturbances. This vegetation generally displays resilience to weed invasion and has regeneration potential (<five per cent weed cover). Some weed species did occur such as *Rubus fruticosus**, *Ligustrum spp** and *Lantana camara**.

Disturbances to potential habitat was associated with past clearing for transport and power infrastructure, residential properties and hobby farms and access tracks.

For more details regarding the vegetation composition and condition refer to Table 4.6.

5.2.3.2 EXTENT OF HABITAT REMOVAL

The proposed project construction works will require the removal of approximately 25.5 hectares of PCT1723 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest which constitutes potential habitat for *Melaleuca biconvexa* (Figure 4.4). Of this, approximately 2.2 hectares contains an estimated 3,984 *Melaleuca biconvexa* plant stems that would be removed by the project.

Table 5.4 Potential habitat for *Melaleuca biconvexa* with potential to be impacted upon by the proposed works

Plant community type (Biometric vegetation type)	Extent within the study area (ha)	Extent within the subject site (ha) (area to be directly impacted)	Extent within locality (HA)
PCT1723 <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest (HU937)	32.4	25.5	609.3

5.2.3.3 KNOWN CUMULATIVE IMPACTS ON OTHER POPULATIONS OF MELALEUCA BICONVEXA IN THE LOCALITY

In terms of cumulative impacts, the current extent of development proposals that impact on *Melaleuca biconvexa* and its habitat is unknown. Notwithstanding, two Roads and Maritime Service projects that are currently either under construction or considered for planning approval are identified to impact on *Melaleuca biconvexa*. These projects are the Wyong Road intersection upgrade at Tuggerah and the Lisarow–Ourimbah Street and Parsons Road upgrade. The proposed project is located within a separate population to these road upgrades.

The Wyong Road upgrade has been approved and is currently in the construction phase. This project resulted in the direct removal of 297 stems of *Melaleuca biconvexa* that was estimated to constitute approximately five per cent of the local population and one per cent in the locality (Roads & Maritime Services 2013).

This project is located within the locality although its occurrence is within a separate disjunct population (Population 3 – Wyong/Porters Creek Wetland (Duncan 2001a)). The current project will not result in cumulative impacts to the local population of *Melaleuca biconvexa* that was the subject to impacts under the Wyong Road upgrade project.

The Lisarow–Ourimbah Street and Parsons Road upgrade is currently still in the planning approval phase. This project has been identified to potentially directly impact on 2.13 hectares of *Melaleuca biconvexa* that is estimated to exhibit an approximately 2396 stems (Jacobs 2015).

This project is located within the locality although its occurrence is within a separate disjunct population (Lisarow–Narara population). The current project will not result in cumulative impacts to the local population of *Melaleuca biconvexa* that is the subject to proposed impacts under the Lisarow–Ourimbah Street and Parsons Road upgrade.

Whilst the proposed project impacts will not lead to cumulative impacts on these other populations, it is acknowledged that current or future impacts from other developments on the local population is unknown.

5.2.3.4 CONSIDERATIONS OF CORRIDORS

Regional wildlife corridors are identified as primary landscape corridors that provide potential residential and dispersal habitat for an assemblage of reference species and are generally in the order of kilometres wide (Scotts 2003). The study area occurs as part of a regional wildlife corridor, which is commensurate with large contiguous tracts of native vegetation of the coastal ranges, foothills and sheltered gullies that occur to the south-east of the project and similar habitats within Ourimbah State Forest, extending through to the Watagan Mountains to the north (Figure 2.5).

As much of the study area and associated lands are characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north – south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Whilst the removal of this vegetation will increase fragmentation in the study area, it is unlikely to exacerbate fragmentation at the regional scale. Additionally, given the species is capable of a 10 per cent loss in the local population, capable of both sexual and asexual reproduction and has dispersive agents with a 30 kilometres effective foraging range (for example Grey-headed Flying-fox) the capability of the local population to reproduce is unlikely to be significantly impacted upon by the disruption to existing corridors.

5.2.3.5 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Melaleuca biconvexa is conserved in a number of OEH estates including:

- Tuggerah Nature Reserve
- Tuggerah State Conservation Area
- Jiliby State Conservation Area
- Wyrabalong National Park
- Bouddi National Park.

In addition to these OEH estates the NSW OEH have established two management sites for *Melaleuca biconvexa* which include:

- Porters Creek management site within the Wyong LGA
- Ourimbah management site within the Gosford LGA.

The study area does not form part of or adjoin any OEH estates. Whilst the proposed project will impact on known habitat and actual specimens of *Melaleuca biconvexa* it is unlikely to alter pollination vectors within the local population to the extent that adverse impacts would be wrought on specimens conserved in any OEH estate.

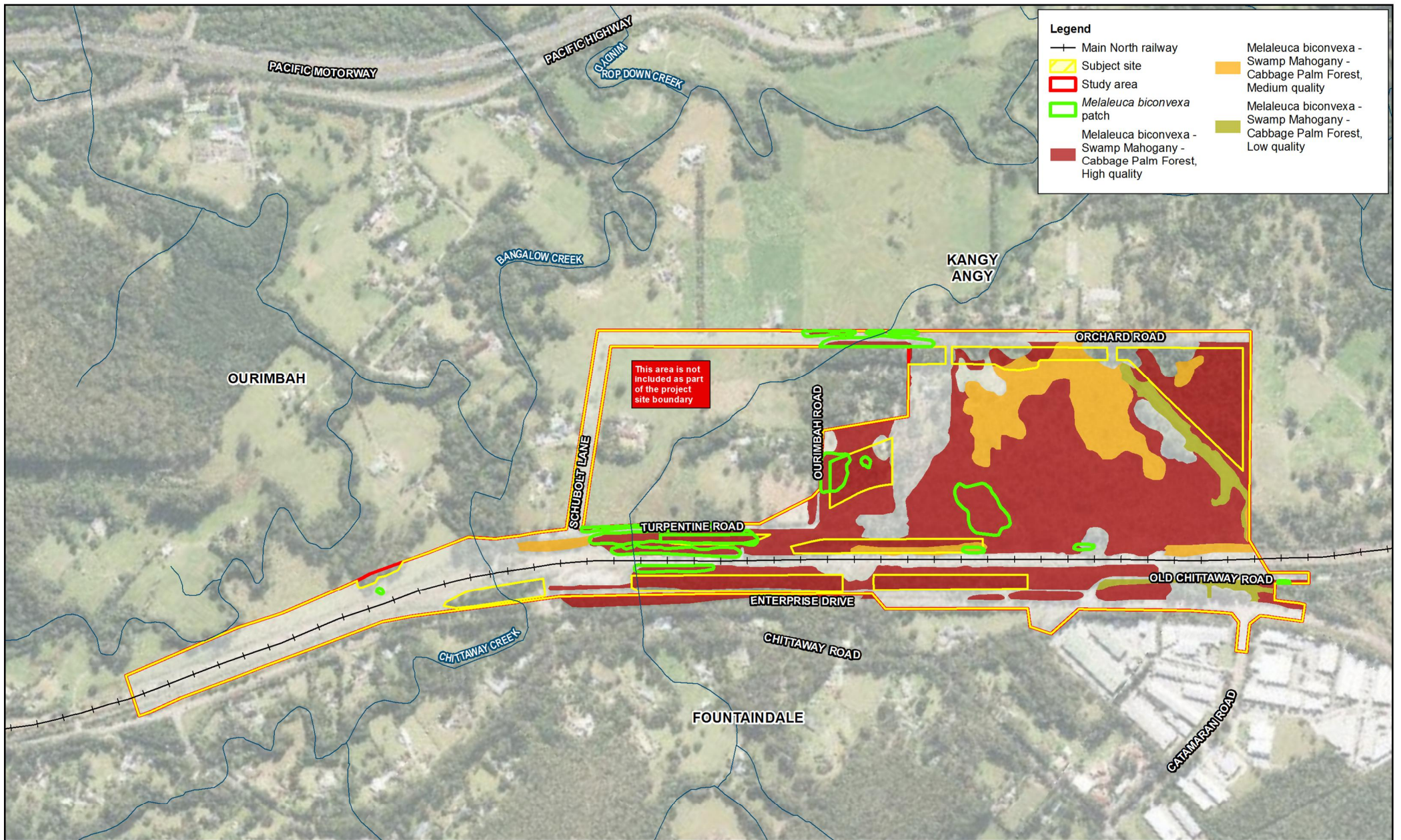
5.2.4 Feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.8.

Table 5.5 The reduction of impacts to vegetation communities by amending the subject site during detailed design


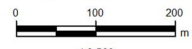
Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Legend

- +— Main North railway
- ▭ Subject site
- ▭ Study area
- ▭ *Melaleuca biconvexa* patch
- ▭ Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm Forest, High quality
- ▭ Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm Forest, Medium quality
- ▭ Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm Forest, Low quality

Map: 2202522A_GIS_F058_A1	Author: suansrir
Date: 11/05/2016	Approved by: -

 19,500

 Coordinate system: GDA 1994 MGA Zone 58

 Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.4

Melaleuca biconvexa habitats



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5.3 Regent Honeyeater

5.3.1 Conservation status

The Regent Honeyeater is listed as Critically Endangered under both the NSW TSC Act and the Federal EPBC Act.

DISTRIBUTION

The Regent Honeyeater distribution extends generally from Brisbane in the north to Melbourne in the south. They are largely a western slopes species (Higgins, P.J. *et al.* 2001) extending to near coastal areas during periods when blossom is scarce west of the divide (Higgins, P.J. *et al.* 2001). In the past two known key breeding areas have been recognised in NSW — the Capertee Valley and Bundarra–Barraba regions (Geering & French 1998). More recent breeding event observations have shown that woodlands in the Lower Hunter Region near Cessnock are also important as breeding and winter foraging habitat for this species (M. Roderick *et al.* 2014). As well as the Lower Hunter Region the Regent Honeyeater periodically moves into more coastal swamp forest habitats, including the Central Coast, for winter-flowering tree species, particularly Swamp Mahogany (Roderick, M *et al.* 2014).

In recent years the Regent Honeyeater has become progressively rarer across its range, including the Central Coast region (Pizzey & Knight 2012). The species is not resident on the Central Coast, but has in the past migrated to local habitats (Office of Environment & Heritage 2016n) on an intermittent basis when local winter blossom resources are abundant (Higgins, P.J. *et al.* 2001). Periodical occurrences on the Central Coast region coincide primarily with Swamp Mahogany blossoming events (Roderick, M *et al.* 2014). To the north at Morisset, between 2002 and 2011, it has returned on a 4–5 year cycle with local occurrences usually coinciding with large aggregations of other honeyeaters. However, numbers have been in decline since 2002 (c. 100+ in 2002: c. 50 in 2007: c. 13 in 2011: 1 in 2013) and it hasn't been recorded in Morisset since December 2013 (Roderick, M *et al.* 2014).

HABITAT

Throughout much of their known range Regent Honeyeaters inhabit dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak (Department of Environment and Conservation 2006c). The woodlands they inhabit support a significantly high abundance and richness of bird species. Where they persist in good condition these western woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes (Higgins, P.J. *et al.* 2001).

In addition to the use of western slopes habitat types, movements to coastal areas, including the Central Coast, occur intermittently due to drought and the changing distribution of blossom resources as governed by seasonal blossom timings and discontinuous flowering frequencies (Saunders, D. L. & Heinsohn 2008).

ECOLOGY

The Regent Honeyeater is a generalist forager, which mainly feeds on nectar from a wide range of eucalypts and mistletoes. Key eucalypt species on the western slopes include Mugga Ironbark, Yellow Box, Blakely's Red Gum and White Box with Spotted Gum, Stringybark (Roderick M. 2015) and Swamp Mahogany important nectar resources in the Lower Hunter and Central Coast. Nectar and fruit from the mistletoes *Amyema miquelii*, *A. pendula* and *A. cambagei* are also eaten during the breeding season (Oliver 2000). When nectar is scarce, lerp and honeydew comprise a large proportion of the diet. Insects make up about 15 per cent of the total diet and are important components of the diet of nestlings (Higgins, P.J. *et al.* 2001). A shrubby understorey is an important source of insects and nesting material (Oliver *et al.* 1998).

Twenty-five kilometres to the north, in Morisset, Swamp Mahogany stands along drainage lines in similar topography to the study area are used for foraging, with proximate coinciding blossom of *Eucalyptus saligna* (Sydney Blue Gum) and *E. capitellata* (Brown Stringybark) sometimes used (Richardson A. 2016a). Where competition with largely honeyeaters from blossom occurred Regent Honeyeaters were forced to perch in adjacent Scribbly Gum woodland. In Morisset Regent Honeyeaters preparing to roost have been observed to stage together in large loose groupings within dry open woodland associated with riparian habitats, with birds sparsely roosting singularly or in pairs in riparian or near-riparian trees (Richardson A. 2016a).

Colour-banding of Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres (Higgins, P.J. *et al.* 2001). However, the exact nature of these movements is still poorly understood. It is likely that movements are dependent on spatial and temporal flowering and other resource patterns. To successfully manage the recovery of this species a full understanding of the habitats used in the non-breeding season is critical (Department of Environment and Conservation 2006c).

The Regent Honeyeater has not been recorded as breeding in the study area's locality, with the closest breeding activity recorded at Quorrobolong in the Hunter Valley 42 kilometres to north (Roderick, M. 2015).

RECOVERY PLAN

A Draft National Recovery Plan for the Regent Honeyeater *Anthochaera phrygia* was prepared in 2015 (Department of the Environment 2015). The NSW OEH has assigned the Regent Honeyeater to the 'site-managed species' management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Site-managed species are those NSW threatened species that are best managed by carrying targeted conservation projects on specific sites. Due to the Regent Honeyeater's Critically Endangered status, *Saving our Species* projects involve the management of all known populations (Office for Environment & Heritage 2016c). The Regent Honeyeater is determined to require site-managed management stream to secure it from extinction in NSW for 100 years.

THREATS AND KEY THREATENING PROCESSES

Key threats detailed in the National Recovery Plan for the Regent Honeyeater (Department of the Environment 2015) in order of importance include:

- Small population size
- Habitat loss and fragmentation
- Habitat degradation
- Competition.

The project will incrementally reduce the amount of seasonal foraging resources available to the Regent Honeyeater locally and will increase the fragmentation and degradation of Regent Honeyeater habitat in the study area. With regard to the Regent Honeyeater, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.3.2 Discussion of local and regional abundance

5.3.2.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Regent Honeyeater is believed to consist of a single population with some interchange of individuals between the most frequently used locations (Department of the Environment 2015). Due to their nectarivorous habits they are not strictly resident in any region, but their stronghold is generally recognised as occurring to the west of and on the slopes of the Great Dividing Range (Higgins, P.J. *et al.* 2001). Movements to near coastal areas, such as the Central Coast of NSW where the study area occurs, appear to be in response to limits on nectar resources in their usual more westerly habitats as a consequence of drought or other cause of blossom failure (Saunders, D. L. & Heinsohn 2008).

There are eight records comprising seventeen birds in the locality of the study area, all dated between January 1 and August 6 1991; six of which generally occur at Tuggerah 2.6 kilometres to the northeast of the study area and two at Berkeley Vale 3.8 kilometres to the study area's east (Office for Environment & Heritage 2016a). Both of these two general locations are subject to various urbanisation pressures; the Berkeley Vale sites within a residential area, the Tuggerah Locations in fragmented habitats characterised by infrastructure and tracts of natural bushland.

As a consequence of regular use by both Swift Parrots and Regent Honeyeaters of coastal catchments, two publications have been produced by Birdlife Australia in relation to the importance of coastal habitats for both Swift Parrots and Regent Honeyeaters; in the Lower Hunter Region (Roderick, M *et al.* 2013) and Lake Macquarie City Council area (Roderick, M & Ingwersen 2014) Records for the Regent Honeyeater that are local to the study area are probably part of broad easterly movements by nomadic groups which also reach the Swamp Mahogany forests of southern Lake Macquarie, which is only some twenty-five kilometres to the north of the study area.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

The regional significance of coastal Swamp Mahogany stands to the Regent Honeyeater is likely to be high, due to regular movements recorded (Roderick, M & Ingwersen 2014) and the lengths Regent Honeyeaters go to reach them from their usual western habitats, such as appears to occur in times of drought (Saunders, D. L. & Heinsohn 2008). The significance of single Swamp Mahogany stands may be greater than a measurement of the whole population extent regionally when it is considered that Swamp Mahogany does not blossom every year, due to fruiting cycles, and that all Swamp Mahogany patches are not synchronised in their flowering events (Richardson A. 2016a). In some climatic timings, this may substantially reduce the availability of Swamp Mahogany blossom to Regent Honeyeaters when drought conditions occur in their core westerly range.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality falls within the hinterland strip between coastal estuarine lakes and adjacent foothills in a very similar topographic context to those areas visited by Regent Honeyeaters in the southern Lake Macquarie area. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood plains and depressions providing landscape conditions suited to swamp sclerophyll communities where Swamp Mahogany thrives. Such locations are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments which are attracted to the same near coastal locations. Due primarily to the development pressures that characterise coastal landscapes on the Central Coast and elsewhere in the bioregion Swamp Sclerophyll Forests are listed as an Endangered Ecological Community (EEC) under the TSC Act (NSW Scientific Committee 2011b).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

SFoCF EEC habitats containing winter-flowering stands of Swamp Mahogany continue to be under threat due to development pressures in the landscape contexts where they occur. At the time of the final determination to list these communities as an EEC less than 30 per cent of the original extent of these communities continued to exist (NSW Scientific Committee 2011b). Locally stands of Swamp Mahogany continue to persist, but they are becoming increasingly fragmented due to developmental pressures. The Regent Honeyeater's Critically Endangered status is due to the loss and fragmentation of its habitats (Roderick, M *et al.* 2013), therefore stands of Swamp Sclerophyll forest the size of that occurring within the site are uncommon locally and due to possible variations in flowering intervals of local patches may be very important to Regent Honeyeaters during those time when climactic conditions push the birds into these coastal forests.

5.3.2.2 HABITAT UTILISATION

The Regent Honeyeater has declined in numbers moving into Swamp Sclerophyll forests within the region over the past 14 years (Roderick, M & Ingwersen 2014). Over 100 individuals were observed in Morisset during the winter of 2002 and these numbers have not been repeated during the intervening period (Roderick, M & Ingwersen 2014). During the same period there are no records for Regent Honeyeater in the study area locality. However, (Saunders, D. A. & Tzaros 2011) report that large movements of Swift Parrots into coastal areas during 2002 were a function of drought conditions in western habitats, which is likely the driver for large numbers of Regent Honeyeaters and Noisy Friarbirds observed in Morisset during the same period. Although the drop in Regent Honeyeater utilisation of the Morisset habitats since 2002 may be in part attributable to falling population numbers, the very large 2002 numbers of non-declining species, such as Noisy Friarbirds, also have never be repeated in the Morisset context since 2002 (Richardson A. 2016a). The peak 2002 Regent Honeyeater numbers and their subsequent decline correlating with declining Noisy Friarbird observations history at Morisset during the same period suggests that a number of resource limitation factors elsewhere in the Regent Honeyeater range coincided to push large numbers of nectarivorous bird species east to a strong Swamp Mahogany blossoming event. Therefore, apparent low utilisation of Swamp Mahogany in the study area locality may also be attributable to the same blossom distribution limiting factors.

5.3.2.3 DESCRIPTION OF VEGETATION

Vegetation within the study area varies in its suitability for Regent Honeyeaters. Swamp forest habitat (mapped as *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest) within the study area occurs in three different condition classes High, Medium and Low quality (see section 4.3.1.1). Areas of low and medium quality did not have a canopy layer or suitable foraging habitat in the understorey strata for Regent Honeyeaters. Only high quality swamp forest habitats have Swamp Mahogany trees, which are suited to the foraging habits of Regent Honeyeater as mapped in this habitat type in Figure 5.5.

Wet open forest habitats (mapped as Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest, see section 4.3.1.1) contain Blackbutt, Red Bloodwood and Sydney Blue Gum in the canopy. This habitat may be used by Regent Honeyeaters for supplementary resources during periods when they move to the coast for Swamp Mahogany.

Table 5.6 Regent Honeyeater habitat in the project study area and corresponding vegetation community

Fauna habitat description	Corresponding vegetation community
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.3.3 Assessment of habitat

5.3.3.1 DESCRIPTION OF HABITAT VALUES

Much of the vegetation within the study area shows evidences of previous management practices. A relatively young and similar age-cohort of canopy trees, suggest clearing within the study area in the past as well as large patches of habitat reduced to understorey strata with occasional trees, which in a natural setting should contain a canopy layer. Nevertheless, coastal occurrences of Regent Honeyeaters are due to the distribution of blossom and maturing age-cohort trees as occur within the study area produce blossom well.

Two habitat types within the study area provide seasonal foraging resources for Regent Honeyeaters; swamp forest and wet open forest habitats.

Swamp forest habitats provide Swamp Mahogany stands, which is a prolific winter flowering species and an important provider of winter food resources for nectarivorous fauna during those years when it flowers. Swamp Mahogany stands as occur within the study area have been observed to be important to Regent Honeyeaters during times when other regions in their range are experiencing low incidences of blossom (Roderick, M & Ingwersen 2014; Saunders, D. A. & Tzaros 2011). Although the Regent Honeyeater has not been observed within the study area, there is a Swift Parrot record for the study area and this species' movements often coincide with the movements of Regent Honeyeaters and other nectarivorous birds.

Wet open forest habitats within the study area contain Red Bloodwood *Corymbia gummifera*, Blackbutt *Eucalyptus pilularis* and Sydney Blue Gum *Eucalyptus saligna*. Each of these tree species are not recognised as important for Regent Honeyeater winter resources, but both Red Bloodwood Roderick, 2014 #7170} and Sydney Blue Gum (Richardson A. 2016a) have been used by Regent Honeyeaters prior to and after Swamp Mahogany flowering events respectively in the Lake Macquarie area to the north of the study area.

Under the EPBC Act 1999 important habitat for migratory species includes areas where the species is declining. Given that this species is Critically Endangered, it can be considered to be declining within the study area and the wider locality. Therefore under Come wealth legislation Regent Honeyeater habitat within the study area is considered to be important.

5.3.3.2 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 23.2 hectares of potential foraging habitat for the Regent Honeyeater, which represents approximately 77 per cent of the study area (Table 5.7).

Table 5.7 Extent of Regent Honeyeater habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	19.6	25.7	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.3.3.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Nonetheless, the Regent Honeyeater is a very mobile and nomadic species that would not be impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.3.3.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrribalong National Park. The project is not likely to directly or indirectly impact Regent Honeyeaters in these reserves.

5.3.4 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.8.

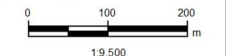
Table 5.8 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F039_A1 Author: suansrir

Date: 11/05/2016 Approved by: -



Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.5

Regent Honeyeater habitat

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5.4 Varied Sittella

The Varied Sittella, is listed as Vulnerable under the TSC Act. Although there are five recognised subspecies of Varied Sittella in Australia, no distinction between subspecies is observed in the final determination to list this species as Vulnerable under the TSC Act.

DISTRIBUTION

The Varied Sittella is a sedentary species that inhabits the majority of mainland Australia, except treeless deserts and open grasslands. In NSW this species is nearly continuous from coastal regions to the far west (Office of Environment & Heritage 2016n), although it is rarely recorded west of the Darling River. In eastern NSW subspecies *Daphoenositta chrysoptera chrysoptera* occurs and is replaced in far western NSW by *D. c. pileata* (Higgins, P.J. & Peter 2002).

HABITAT

The Varied Sittella occurs in forests and woodland across all climatic zones throughout mainland Australia (Higgins, P.J. & Peter 2002). The Varied Sittella inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead limbs, mallee and *Acacia* woodland (Office of Environment & Heritage 2016n). This species forages on arthropods that are gleaned from crevices in rough or decortivating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (Office of Environment & Heritage 2016n).

ECOLOGY

Varied Sittella are highly social, with groups foraging together, whereby they fly into the heads of trees and generally make their way down limbs and the trunk of the tree. They feed on arthropods, which are gleaned from dead branches, small branches in the canopy and crevices from rough or decortivating bark (NSW Scientific Committee 2009b).

Varied Sittellas breed from August–October and February–March. Average clutch size is 2–3, with young fledge aged 18–20 days (Morcombe 2003). The Varied Sittella typically breeds in groups of five to seven individuals during spring and summer, with nests well camouflaged and situated in a fork, high in the living tree canopy. The same fork or tree is often used in successive years. During winter this species forms larger companies (NSW Scientific Committee 2009b).

RECOVERY PLAN

No recovery plan or priority action statements have been prepared for the Varied Sittella under the TSC Act. Nevertheless a targeted strategy for the management of the Varied Sittella has been developed within the *Saving our Species* program (Office for Environment & Heritage 2016c). The Varied Sittella has been assigned to the 'Landscape species' management stream under the *Saving our Species* program. Management objectives aim to ensure that wild Varied Sittellas remain secure in NSW and that its geographic range in NSW is maintained or extended (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

Threats to the Varied Sittella are detailed in the Varied Sittella profile (Office of Environment & Heritage 2016n) and include:

- Habitat fragmentation from habitat loss
- Habitat degradation from small-scale clearing
- Habitat infestation by invasive weeds
- Inappropriate fire regimes

- Aggressive exclusion from wooded habitats by an overabundance of Noisy Miners
- Climate Change
- Degradation of woodland habitat and vegetation structure from overgrazing.

The Project will incrementally reduce the amount of foraging resources available to the Varied Sittella locally and will increase the fragmentation and degradation of Varied Sittella habitat in the study area. With regard to the Varied Sittella, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.4.1 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Varied Sittella's geographical variation is extensive and complex with no less than five subspecies recognised in Australia with some authors recognising a further five subspecies, which have been shown to be intergrades of the five established subspecies (Higgins, P.J. & Peter 2002). In the study area's locality the south-eastern subspecies *Daphoenositta chrysoptera chrysoptera* occurs. In its western extremity the range of *D. c. chrysoptera* extends roughly from a point west of Melbourne to central-western Queensland where it abuts the range of *D. c. pileata* and is replaced in coastal Queensland north of the NSW border by *D. c. leucocephala* (Higgins, P.J. & Peter 2002; Simpson & Day 1996).

There are five records of Varied Sittella in the study area locality representing 16 individuals observed between December 1995 and March 22 2004 (Office for Environment & Heritage 2016a). The five records are spread out locally with one at Ourimbah to the south of the study area, two in Ourimbah State Forest to the study area's west and two to the north in Tuggerah, one of which was located in Lees Reserve (Office for Environment & Heritage 2016a).

Each of the local observations occur in bushland settings with semi-rural urban habitats occurring in the vicinity of two locations. This species was also observed in the study area during bird surveys conducted by Parsons Brinckerhoff ecologists.

The number of records in the study area's locality is relatively small considering the period the records encompass. However, this species is very mobile, often foraging relatively quietly high in the forest canopy and may be somewhat difficult to pick up, for those unfamiliar with their calls. Therefore the relatively low number of records locally may not be a true representation of their true local presence as local individuals are likely to occur within the study area locality all year round.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

The regional significance of the Varied Sittella is likely to be relatively high, due to their vulnerable status in NSW and despite the widespread occurrence of suitable forested habitat throughout the study area's region and habitat context. The species' Vulnerable listing is due to a reduction in population size based on comparative analysis of atlas records over past decades (NSW Scientific Committee 2010c; Office of Environment & Heritage 2016n). Vegetation communities that Varied Sittellas frequent regionally have been subject to significant developmental pressure over the period of the species' decline (NSW Scientific Committee 2010c) Key threats continue to be responsible for loss of habitat and degradation of remaining habitats (Office of Environment & Heritage 2016n).

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality occurs in lakeside hinterland between coastal estuarine lakes and adjacent foothills in a topographic context similar to many near coastal floodplains in the region. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood depressions and plains build landscape conditions suited to a variety of wetland, riparian, swamp sclerophyll and sclerophyllous vegetation communities. In coastal contexts higher ground that supports the general types of forests and woodlands that support the Varied Sittella have been largely removed for anthropogenic land-uses. Therefore intact regional native vegetation patches are relatively sparse in this landscape context due in part to the relatively small area of landscape context they occupy and the overlaying of anthropogenic developments which characterise the same near coastal locations. Such habitat contexts for the Varied Sittella continue to be under great pressure from human population increases and the housing and infrastructure developments that necessarily follows such growth. Forested foothills and ranges occurring to the west of such habitats have generally avoided the high impact developments of the coastal strip and currently offer more continuous habitat resources for the Varied Sittella. Due primarily to the development pressures that characterise coastal landscapes in the bioregion, Swamp Sclerophyll forests on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (SFoCF) are listed as an Endangered Ecological Community (EEC) under the TSC Act (NSW Scientific Committee 2011b). As the developmental pressures that have led to the threat-listed status of Varied Sittella habitat in the study area continue to increase in the study area's locality and similar areas across NSW, the long term security of similar habitats in NSW may be difficult to assure. Nevertheless, habitats frequented by the Varied Sittella in the ranges adjacent to habitat contexts in which the study area occurs likely provide greater medium to long term security for this species.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Varied Sittellas are generally sedentary in their habits and observed to occur in home ranges of 13–20 hectares (Higgins, P.J. & Peter 2002). Although they are reported to be somewhat nomadic during some season contexts, the literature describes their movements as limited and not migratory (Higgins, P.J. & Peter 2002). Although there are large tracts of suitable habitat in the foothills and ranges in the region and locality, floodplain habitats are relatively sparsely distributed with many of the closed forest types associated with local creeks not suitable as habitat for Varied Sittellas. The study area contains a relatively large area of floodplain habitat in an already fragmented landscape, which is suitable for the Varied Sittella and as such contributes to the continuity of occupied habitat in the study area's vicinity. Nevertheless, habitat impacts locally are unlikely to cause this species to become extinct in the locality, although it may represent significant habitat loss to family groups whose home ranges encompass all or part of the study habitats.

HABITAT UTILISATION

A single Varied Sittella was observed within the study area during onsite bird surveys. It is unusual to observe a solitary individual of this species during the season when surveys were conducted as during the post-breeding period after summer they are usually observed in extended family groups (Higgins, P.J. & Peter 2002). This species is reported as occupying home ranges of 13–20 hectares (Higgins, P.J. & Peter 2002) and so local individuals may be dependent upon part or the majority of suitable habitat in the study area.

DESCRIPTION OF VEGETATION

Vegetation within the study area varies in its suitability for Varied Sittellas. Swamp forest habitat (mapped as *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest) within the study area occurs in three different condition classes High, Medium and Low quality (see section 4.3.1.1). Areas of low and medium quality did not have a canopy layer or suitable foraging habitat in the understorey strata for Varied Sittellas. Only high quality swamp forest habitats have Swamp Mahogany trees, which are suited to the foraging habits of Varied Sittella as mapped in this habitat type in Figure 5.6.

Wet open forest habitats (mapped as Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest, see section 4.3.1.1) contain Blackbutt, Red Bloodwood, Sydney Blue Gum and low numbers of Forest Red Gum in the canopy and these canopy species offer suitable foraging and nesting habitats for Varied Sittellas using the study area.

Table 5.9 Varied Sittella habitat in the Project study area and corresponding vegetation community

Fauna habitat description	Corresponding vegetation community
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.4.2 Assessment of habitat in subject site

Much of the vegetation within the study area shows evidences of previous management practices. There is a relatively young similar age-cohort of canopy trees, suggesting past clearing within the study area, which is also evidenced by large patches of habitat without canopy strata. Nevertheless, habitat use by Varied Sittellas locally is associated with the surfaces of trunks and branches of woodland trees, and maturing age-cohort trees where they occur within the study area provide excellent foraging and nesting habitats for them.

Two habitat types within the study area provide foraging and nesting habitats for Varied Sittellas; swamp forest and wet open forest habitats.

Swamp forest habitats provide stands of Swamp Mahogany, which is a rough-barked tree species and often used by Varied Sittellas where it occurs in the home ranges. Swamp forest habitats also contain a diversity of mesic ecotone trees as well as paperbark trees, which also provide foraging habitats for Varied Sittellas.

Wet open forest habitats within the study area contain Blackbutt, Red Bloodwood, Sydney Blue Gum and to a lesser extent Forest Red Gum. Due to their rough bark Blackbutt and Red Bloodwood are very suitable as foraging trees for Varied Sittella and both Forest Red Gum and Sydney Blue Gum would provide supplementary foraging habitat especially when these species have decorticated bark. A moderate number of individual trees in this habitat type represent excellent nesting opportunities for this species due to rough bark in the upper branches.

5.4.2.1 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 23.2 hectares of potential foraging habitat for the Varied Sittella, which represents approximately 77 per cent of the study area (Table 5.10).

Table 5.10 Extent of Varied Sittella habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	19.6	25.7	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.4.2.2 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the Project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape Figure 2.5.

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Although the Varied Sittella is a sedentary species they are relatively mobile as long as breaks in vegetation are not excessive in extent and may not be seriously impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.4.2.3 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the Project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrabalong National Park. The Project is not likely to directly or indirectly impact Varied Sittellas in these reserves.

5.4.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.11.

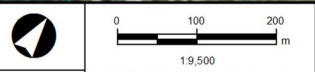
Table 5.11 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F040_A1 Author: suansrir

Date: 11/05/2016 Approved by: -



Data source: - © Land and Property Information 2015

Coordinate system: GDA 1994 MGA Zone 56

Note: Design is indicative only. Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.6
 Varied Sittella habitat

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5.5 Little Lorikeet

5.5.1 Conservation status

The Little Lorikeet, which is listed as Vulnerable under the NSW TSC Act, was recorded during targeted seasonal surveys in swamp forest type habitat in the study area (Figure 5.7).

DISTRIBUTION

The Little Lorikeet's range extends along coastal eastern Australia from Cooktown to south-east South Australia. In NSW its range extends from the coast to the western slopes of the Great Dividing Range, with a western limit considered in the vicinity of Parkes, Dubbo and Narrabri (Pizzey & Knight 2007). Nomadic movements are common, influenced by seasonal and food availability, although some areas retain residents for much of the year (NSW Scientific Committee 2009a).

In the study area locality and region records are relatively numerous (Office for Environment & Heritage 2016a). Only 36 per cent of the Little Lorikeet's distribution overlays reserves held within the NSW National Parks and Wildlife Service estate (Office of Environment & Heritage 2016n), although the portion of the reserve system that provides suitable habitat for this species is not known.

HABITAT

The Little Lorikeet inhabits forests and woodlands, with most suitable vegetation associations occurring in dry, open eucalypt forest and woodlands (Higgins, P.J. 1999). They have a general preference for dry open forest and woodland dominated by *Eucalyptus* spp., but they are also known to use *Melaleuca* spp. and *Angophora* spp. forests as well as tall wet sclerophyll forest in some areas (Higgins, P.J. 1999).

Breeding habitat is in hollow branches or other holes in trees, usually live eucalypts with some preference for trees associated with water (Higgins, P.J. 1999). Breeding sites are usually selected in woodland but they have been recorded in *Allocasuarina* spp. and in partly cleared forest (Higgins, P.J. 1999).

ECOLOGY

Little Lorikeets are gregarious, foraging in small flocks and usually with other species of lorikeet, whereby they feed primarily on nectar and pollen in the tree canopy (NSW Scientific Committee 2009a). On the Western slopes of NSW, White Box and Yellow Box are considered to be important food resources for pollen and nectar respectively (Courtney J. 2006). Most breeding records come from the western slopes of NSW (where there has been extensive loss of habitat from historic clearing), with the southern Australia breeding season extending from June-December and sometimes January (Higgins, P.J. 1999). Nest hollows are located at heights of two metres to 15 metres (Courtney J. 2006) in smooth-barked eucalypts including Blakely's Red Gum. Long term studies of this species on the north-west slopes of NSW (Courtney J. 2006) indicate that nest hollows are used traditionally, whereby the same hollow is known to be occupied for at least 29 years, although, not necessarily by the same individuals.

While this species is not considered to be migratory, it is generally recognised to be nomadic (Higgins, P.J. 1999), particularly concerning food availability, with irregular influxes occurring at any time. Long-term investigation of the breeding population on the north-western slopes indicates that breeding birds are resident from April to December, and even during their non-resident period, they may return to the nest area for short periods if there is some tree-flowering in the vicinity (Courtney J. 2006).

Locally they are likely to use different foraging resources as they become available throughout the year, which would prevent site use continuity with different blossom occurring in different areas. In Morisset to the north, amongst the wide variety of blossom producing trees they might use, they have been observed to move into the Watagan Mountains in autumn for Sydney Blue Gum blossom; Swamp Mahogany, and

Forest Red Gum associated with drainage lines and lake margins through winter and spring; and then Blackbutt through spring and summer (Richardson A. 2016a).

RECOVERY PLAN

No recovery plan or priority action statements have been prepared for the Little Lorikeet under the TSC Act.

Nevertheless a targeted strategy for the management of the Little Lorikeet has been developed within the *Saving our Species* program (Office for Environment & Heritage 2016c). The Little Lorikeet has been assigned to the 'Landscape species' management stream under the *Saving our Species* program. Management objectives aim to ensure that wild Little Lorikeets remain secure in NSW and that its geographic range in NSW is maintained or extended (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

Threats to the Little Lorikeet are detailed in the Little Lorikeet profile (Office of Environment & Heritage 2016n) and include:

- Habitat loss, fragmentation and degradation
- Loss of old hollow-bearing trees
- Competition with the Honeybee
- Habitat infestation by invasive weeds
- Inappropriate fire regimes
- Aggressive exclusion from wooded habitats by an overabundance of Noisy Miners
- Climate change
- Degradation of woodland habitat and vegetation structure from overgrazing.

The Project will incrementally reduce the amount of seasonal foraging resources available to the Little Lorikeet locally and will increase the fragmentation and degradation of Little Lorikeet habitat in the study area. With respect to the Little Lorikeet, the project is likely to be commensurate with two KTPs, being clearing of native vegetation and loss of hollow-bearing trees. This KTP is not likely to significantly affect this species in the locality.

5.5.2 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

In the available literature the Little Lorikeet appears to consist of a single unbroken population (Higgins, P.J. 1999). Due to their nectarivorous habits they may not be strictly resident in any region, but there is evidence to suggest that movements are induced by variations in the distribution of nectar resources even if it is only at the local level (Higgins, P.J. 1999). There are no distinctive breaks known across their range which might isolate regional groupings from the greater population and the species exhibits no genetic variation across its geographical range (Higgins, P.J. 1999).

There are three records of Little Lorikeet in the study area locality representing 29 individuals from March 1 1995 till September 24 2007 (Office for Environment & Heritage 2016a). The three records occur at Ourimbah to the south of the study area, Fountaindale to the study area's east and at Lees Reserve Tuggerah to the north (Office for Environment & Heritage 2016a).

Each of the local observations occur in bushland settings with semi-rural urban habitats occurring in the vicinity.

The number of records in the study area's locality is relatively small considering the period the records encompass. However, this species is very mobile, often flying high and fast and are often somewhat difficult to pick up, for those unfamiliar with them. Therefore the low number of records locally are unlikely to be a true representation of their local presence as they occur within the study area on an intermittent basis, particularly during those times when blossom is present on site.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

The regional significance of the Little Lorikeet is likely to be moderately high, as their Vulnerable status in NSW is due to declines in reporting rate over several decades (NSW Scientific Committee 2009a) and has occurred despite the widespread occurrence of suitable forested habitat throughout the study area's region. Natural vegetation communities that the Little Lorikeet frequent in the region have been under significant developmental pressure over the period of the species' decline (NSW Scientific Committee 2009a), with key threats continuing to be the loss of habitat and various degradation to remaining habitats (Office of Environment & Heritage 2016n).

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality falls within the lakeside hinterland strip between coastal estuarine lakes and adjacent foothills in a very similar topographic context to many near coastal floodplains in the region. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood depressions and plains providing landscape conditions suited to swamp sclerophyll communities where Swamp Mahogany thrives. Such locations are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments which are attracted to the same near coastal locations. Due primarily to the development pressures that characterise coastal landscapes on the Central Coast, and elsewhere in the bioregion, Swamp Sclerophyll forests on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (SFoCF) are listed as an Endangered Ecological Community (EEC) under the TSC Act (NSW Scientific Committee 2011b).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Although Little Lorikeets are somewhat transitory and intermittent in relation to the study area, this species was observed utilising seasonal resources within the study area, most significant of which are the winter flowering Swamp Mahogany stands.

SFoCF EEC habitats containing winter-flowering stands of Swamp Mahogany continue to be under threat due to development pressures in the landscape contexts where they occur. At the time of the final determination to list these communities as an EEC less than 30 per cent of their original extent continued to exist. (NSW Scientific Committee 2011b). Locally stands of Swamp Mahogany *E. robusta* continue to persist, but they are becoming increasingly fragmented due to developmental pressures. The Little Lorikeet's Vulnerable status is in part due to the loss and fragmentation of its habitats (NSW Scientific Committee 2009a) therefore stands of Swamp Sclerophyll forest the size of that occurring within the site are uncommon locally and due to possible variations in flowering intervals of local patches may be very important to Little Lorikeets during those times when Swamp Mahogany blossom is present.

HABITAT UTILISATION

During targeted seasonal surveys for diurnal blossom nomads, patches of Swamp Mahogany were producing blossom. However, Little Lorikeets are known to use the blossom of at least another four species of tree occurring within the study area, being; Blackbutt *E. pilularis*, Sydney Blue Gum *E. saligna*, Red Bloodwood *Corymbia gummifera* and Forest Red Gum *E. tereticornis* (Higgins, P.J. 1999) (Richardson A. 2016a). Red Bloodwood, Sydney Blue Gum and Forest Red Gum occur within the study area in relatively low numbers, so may not be important to Little Lorikeets locally, however Blackbutt to some extent and Swamp Mahogany especially are in sufficient numbers to be of significance to them.

DESCRIPTION OF VEGETATION

Vegetation within the study area varies in its suitability for Little Lorikeets. Swamp forest habitat (mapped as *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest) within the study area occurs in three different condition classes High, Medium and Low quality (see section 4.3.1.1). Areas of low and medium quality did not have a canopy layer or suitable foraging habitat in the understorey strata for Little Lorikeets. Only high quality swamp forest habitats have Swamp Mahogany trees, which are suited to the foraging habits of Little Lorikeet as mapped in this habitat type in Figure 5.7.

Wet open forest habitats (mapped as Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest, see section 4.3.1.1) contain Blackbutt, Red Bloodwood, Sydney Blue Gum and low numbers of Forest Red Gum in the canopy and these tree species would offer nectar resources during different seasons for Little Lorikeets in the locality.

Table 5.12 Little Lorikeet habitat in the project study area and corresponding vegetation community

Fauna habitat description	Corresponding vegetation community
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.5.3 Assessment of habitat in subject site

Much of the vegetation within the study area shows evidences of previous management practices. There is a relatively young similar age-cohort of canopy trees, suggesting past clearing within the study area, which is also evidenced by large patches of habitat without canopy strata. Nevertheless, occurrences of Little Lorikeets locally are due to the distribution of blossom and maturing age-cohort trees where they occur within the study area should produce blossom well.

Two habitat types within the study area provide seasonal foraging resources for Little Lorikeets; swamp forest and wet open forest habitats.

Swamp forest habitats provide stands of Swamp Mahogany, which is a prolific winter flowering species and an important provider of winter food resources for nectarivorous fauna during those years when it flowers. Swamp Mahogany stands as occur within the study area are likely to be important to local Little Lorikeets and may be more important to Little Lorikeets during times when other regions in their range are experiencing low incidences of blossom as is the case with other nectarivorous birds (Roderick, M & Ingwersen 2014; Saunders, D. L. & Heinsohn 2008).

Wet open forest habitats within the study area contain Blackbutt, Red Bloodwood, Sydney Blue Gum and to a lesser extent Forest Red Gum. Each of these tree species are recorded as foraging trees for Little Lorikeet (Higgins, P.J. 1999) (Richardson A. 2016a).

Due to the relatively low age-cohort of trees within the study area there is a paucity of hollow-bearing trees which might provide nest sites for the Little Lorikeet. Therefore it is considered unlikely that the project study area represents breeding habitat for the Little Lorikeet.

5.5.3.1 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 23.2 hectares of potential foraging habitat for the Little Lorikeet, which represents approximately 77 per cent of the study area (Table 5.13).

Table 5.13 Extent of Little Lorikeet habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	19.6	25.7	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.5.3.2 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Nonetheless, the Little Lorikeet is a very mobile and nomadic species that would not be impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.5.3.3 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrabalong National Park. The project is not likely to directly or indirectly impact Little Lorikeets in these reserves.

5.5.4 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.14.

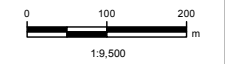
Table 5.14 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F041_A1 Author: suansrir

Date: 27/05/2016 Approved by: -



Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.7

Little Lorikeet habitat



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5.6 Little Eagle

The Little Eagle is listed as Vulnerable under the NSW TSC Act.

DISTRIBUTION

The Little Eagle has a widespread distribution throughout mainland Australia, excepting the most densely forested parts of the Dividing Range escarpment, and generally less common near the coast (Pizzey & Knight 2012). This species is known to occur within the Wyong CMA sub-region of the Hunter – Central River Catchment Management Region (Office of Environment & Heritage 2016n).

HABITAT

Little Eagles inhabit a range of habitat types from eucalypt forests and woodlands to open inland habitats, preferring a mosaic of open and wooded habitats (Marchant & Higgins 1993). They are also known to use she-oak or acacia woodland, riparian woodlands, and mallee in the interior of NSW (Marchant & Higgins 1993; Office of Environment & Heritage 2016n). Nests in mature living trees in open forest, woodland, or remnant woodland, and also along tree-lined watercourses.

ECOLOGY

Pairs in established territories are generally sedentary, while in some areas other individuals appear to be migratory on a seasonal basis (Marchant & Higgins 1993). Little Eagle nesting territories are defended by either of the following; soaring, undulating flight display, conspicuous perching and/or calling. Pairs build a large stick nest in winter. Little Eagles only reproduce once a year, they lay one-three eggs during early spring, and young fledge in early summer.

They forage widely, often many kilometres from their nest. Hunting methods involve soaring above woodland or from lookout perch where they dive quickly to retrieve prey from woodland floor, trees or shrubs. Their diet is variable, with rabbits dominating when present, but also birds, mammals and to a lesser extent reptiles making up their diet, and occasionally large insects and carrion (Marchant & Higgins 1993).

RECOVERY PLAN

The TSC Act provides for the preparation of recovery plan. No such plan has been prepared for the Little Eagle. The NSW OEH has assigned the Little Eagle to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

Key threats detailed by OEH include:

- Clearing and degradation of foraging and breeding habitat
- Secondary poisoning from rabbit baiting.

Little Eagle has experienced a long term decline in reporting rate in the vicinity of 50 per cent since the 1970's in south-eastern NSW. This downward trend has increased since the 1990s (NSW Scientific Committee 2010b). In the 1990's the Little Eagle was recorded common in the Blue Mountains, but by the mid 2000's its status had eroded to 'very uncommon' (NSW Scientific Committee 2010b). The relatively long-lived, territorial and sedentary nature of the Little Eagle, while exhibiting low breeding productivity and a stable population density, suggests its decline may represent a long term process linked to habitat quality and availability of prey (NSW Scientific Committee 2010b).

As over 50 per cent of the forest and woodland habitats favoured by the Little Eagle for foraging and breeding have been cleared in NSW, contributing to its decline (NSW Scientific Committee 2010b). This key threat to habitat is most evident around expanding provincial cities, where urbanisation and rural-residential expansion are displacing breeding pairs (NSW Scientific Committee 2010b). Which is likely a contributing factor to declines in the locality.

The Project will incrementally reduce the amount of potential foraging and breeding habitat to the Little Eagle locally, and will increase the fragmentation and degradation of Little Eagle habitat in the study area.

5.6.1 Discussion of local and regional abundance

5.6.1.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Little Eagle is endemic to Australia and is distributed throughout the mainland. In south eastern Australia there has been a general and continuing decline in its abundance over the last 30 years based on indices established by national and regional censuses (NSW Scientific Committee 2010b). Typical habitat includes woodland and open forest, higher abundance is associated with hillsides where there is mosaic of wooded and open areas such as riparian woodlands, forest margins and wooded farmland which are preferable for hunting (Marchant & Higgins 1993), which is consistent with habitats within the study area and its vicinity.

There are just two records within the locality of the study area dated; 30 June 1996 and the 5 October 1989 (Office for Environment & Heritage 2016a). These two records are subject to various urbanisation pressures, but their very mobile foraging habits do not preclude them from reaching isolated patches of habitat in semi-rural areas subject to urban encroachment.

The number of records in the study area's locality is relatively small considering the period the records encompass. However, this species like all raptors encompasses large home ranges reducing their detectability in well wooded areas and are somewhat difficult to separate from more common medium sized raptors, such as the Whistling Kite for those unfamiliar with them. Little Eagles are likely to be in relatively low densities in coastal areas (Marchant & Higgins 1993), but the very low number of records locally may not be a true representation of their local presence.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

A comprehensive literature review for the Little Eagle in the early 90's noted that this species is less common in coastal areas (Marchant & Higgins 1993), In the more westerly influenced Hunter Region to the north, this species was still relatively regularly recorded during 2014 with records from 31 per cent of cells throughout the region, an overall recording rate of 1.5 per cent and a recording rate of 7.9 per cent in the cell with the highest number of records (Stuart, A 2015). As a comparison the overall recording rate of a much more common eagle during the same period, the Wedge-tailed Eagle, was 9.3 per cent (Stuart, A 2015). A wider review of Little Eagle records from Broken Bay to Lake Macquarie returned only 13 records since the mid 80's till now, the latest more local record being from 1996 (Office for Environment & Heritage 2016a).

As the final determination to list the Little Eagle as Vulnerable (NSW Scientific Committee 2010b) lists land-use changes as key contributing factors to the decline in Little Eagle numbers throughout its range the species may continue to decline as greater pressure is brought to bear on its existing habitats in bioregions where they occur in close proximity to the expansion of human development. Despite its long history of anthropogenic land-use the Sydney Basin bioregion contains many more records (325) than the significantly less developed South Coast Corner (53) and North Coast (73) bioregions (Office for Environment & Heritage 2016a). The much greater number of Sydney Basin Bioregion records is no doubt partly a function of greater inputs from formal fauna surveys associated with development and a greater reporting rate by bird groups, as well as the larger area it encompasses. Nevertheless, in near-coastal areas subject to development, such as the locality of the subject site, the paucity of more recent records despite active bird interest groups

locally, suggests that the species is in decline locally. There are no studies suggesting that the locality was ever a stronghold for this species, in fact the contrary appears to be the case due to their recognised sparseness in coastal areas (Marchant & Higgins 1993). As such the regional significance of the study area's locality for Little Eagle is unlikely to be high in relation to its support of the greater population elsewhere in the bioregion, but local declines are at the edge of the species' range and impacts on local vegetation may contribute incrementally to reduce habitat suitability for the Little Eagle where it appears to be already in decline.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

Elsewhere in the bioregion, such as the Hunter Region to the north, the Little Eagle is still observed relatively regularly (Stuart, A 2015), although there is no evidence to suggest that those areas of the Little Eagle population are stable. Open forest and woodland habitat of similar value to the Little Eagle continues to exist locally, but may not offer medium to long term security, due to land tenure and growing development projections locally (Wyong Shire Council 2016).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

In terms of suitable habitat locally in a similar floodplain context the study area has a relatively large footprint in area, however the habitat value in terms of productivity for prey species may be greater than surrounding managed habitats due to a greater diversity of structural complexity for bird species upon which the Little Eagle may prey. The Little Eagle prefers a mosaic of open and woodland habitats to hunt and nest in (Marchant & Higgins 1993) and as the study area contains one of the largest patches of woodland remaining on the floodplain in the study area's locality it may contribute much in terms of maintaining the mosaic of open and wooded habitats on a local scale. As such the study area may be of some significance to supporting local occurrences of the Little Eagle.

5.6.1.2 DESCRIPTION OF VEGETATION

Vegetation within the study area varies in the structural forms present. Swamp forest habitat (mapped as *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest) within the study area occurs in three different condition classes High, Medium and Low quality (see section 4.3.1.1). Areas of low and medium quality did not have a canopy layer and only high quality swamp forest habitat had Swamp Mahogany trees, in the canopy layer (Figure 5.8).

Wet open forest habitats (mapped as Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest, see section 4.3.1.1) contain a variety of tall *Eucalyptus* spp. including Blackbutt, Red Bloodwood and Sydney Blue Gum. This community along with Swamp forest habitats are part of the area utilised by Bell Miners in defence of lerp concentrations and Bell Miners may be suitable as prey species for Little Eagle locally.

The variety of vegetation structural forms within the study area enhance the complexity of habitat for local animals, which is likely to be attractive to birds of prey, such as the Little Eagle, which include birds and other small animals in their diet (Marchant & Higgins 1993).

Table 5.15 Little Eagle habitat in the Project study area

Fauna habitat description	Corresponding vegetation community
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.6.2 Assessment of habitat in subject site

Much of the vegetation within the study area shows evidences of previous management practices. There is a relatively young and similar age-cohort of canopy trees, suggesting past clearing within the study area, which is also evidenced by large patches of habitat without canopy strata, in which a canopy layer should otherwise be present.

Two habitat types within the study area provide suitable habitat for Little Eagle prey species; swamp forest and wet open forest habitats (Table 5.15).

The structural diversity represented by different quality vegetation communities within the study area contribute importantly to the mosaic of wooded and open habitats in the locality, which are suited to the foraging habits of the Little Eagle (Marchant & Higgins 1993). As such habitats in the subject site may promote the likelihood of Little Eagles persisting in the locality.

5.6.2.1 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 29.1 hectares of potential foraging habitat for the Little Eagle, which represents approximately 79 per cent of the study area (Table 5.16).

Table 5.16 Extent of Little Eagle habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest	25.5	32.4	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.6.2.2 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Nonetheless, the Little Eagle is a relatively large and mobile bird of prey that is not impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.6.2.3 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrabalong National Park. The project is not likely to directly or indirectly impact Little Eagle in these reserves.

5.6.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.17.

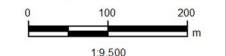
Table 5.17 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F042_A1 Author: suansrir

Date: 11/05/2016 Approved by: -



Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

Data source: - © Land and Property Information 2015

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New Intercity Fleet Maintenance Facility Project
Figure 5.8
Little Eagle habitat

5.7 Black Bittern

5.7.1 Conservation status

The Black Bittern is listed as Vulnerable under the NSW TSC Act.

DISTRIBUTION

The Black Bittern has a widespread coastal distribution throughout mainland Australia from far eastern Victoria north to Cape York and then across northern Australia to c. Derby. It also occurs in two isolated sections of the Western Australian coast; one encompassing the southwest corner, the other extending east and west of Port Headland (Marchant & Higgins 2004). This species is known to occur within the Wyong CMA sub-region of the Hunter–Central River Catchment Management Region (Office for Environment & Heritage 2016e) and there are a number of records within the study area locality (Office for Environment & Heritage 2016a).

HABITAT

Black Bitterns inhabit a range of wetland habitats from estuarine flats and creek-lines to freshwater wetlands and inland river systems (Marchant & Higgins 2004). In the study area locality there are records along creek-lines on the western edges of Tuggerah Lake (Office for Environment & Heritage 2016a), within a variety of vegetation types, including forest, woodlands, mangroves and rainforest (Office of Environment & Heritage 2016n). Nests in leafy horizontal braches over-hanging water.

ECOLOGY

The Black Bittern is generally considered sedentary (Marchant & Higgins 2004), but due to their dependence on water edge foraging habitats, they may make small or wider movements due to the effects of water quality changes on their prey species. Reptiles, fish, invertebrates and crustaceans make up the bulk of the Black Bittern's diet (Office for Environment & Heritage 2016a).

The Black Bittern builds a nest of sticks placed in a leafy location on a horizontal branch over-hanging water (Marchant & Higgins 2004). They breed from September to April, laying three to five eggs, although little is known about the frequency of their breeding events (Marchant & Higgins 2004; Pizzey & Knight 2007).

RECOVERY PLAN

The TSC Act provides for the preparation of recovery plan. No such plan has been prepared for the Black Bittern. The NSW OEH has assigned the Black Bittern to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

Key threats detailed by OEH include:

- Clearing of riparian vegetation
- Predation by foxes and cats on eggs and juveniles
- Grazing and trampling of riparian vegetation by stock
- Lack of knowledge about habitat use and the distribution of breeding activity.

The Project may incrementally reduce the amount of potential foraging and breeding habitat to the Black Bittern locally, and will increase the fragmentation and degradation of Black Bittern habitat in the study area. Nevertheless, potential riparian edge habitats, within the subject site represent only a very small proportion of suitable habitat for the Black Bittern locally (Table 5.19).

5.7.2 Discussion of local and regional abundance

5.7.2.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

There are number of records for this species within the locality of the study area along the lower reaches of Ourimbah Creek (nine), Tumbi Creek (one), Wyong Racecourse (one) and the Wyong River (two) further to the north (Office for Environment & Heritage 2016a). In a 2010 review of the status of threatened bird species in the Hunter Region, conducted by Roderick and Stuart (Stuart, A. 2010), the authors note that although the recording rate of Black Bitterns is relatively low, a 2005 study of drainage lines to the west of Lake Macquarie found a number of birds to be present, suggesting that the cryptic nature of this species may be partly responsible for its low recording rate.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

From within the Sydney Basin bioregion there is a total of forty-three records for the Black Bittern (Office for Environment & Heritage 2016a). There are relatively few records from south of Sydney with a number of records from the north and mid north coast of NSW outside of the bioregion. Birds occurring locally may have tentative links with other areas where habitat allows, although no studies have been undertaken to determine their movements (Marchant & Higgins 2004).

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

Elsewhere in the bioregion, such as the Hunter Region to the north, the Black Bittern is observed intermittently although it is reported as rare in that part of the bioregion (Stuart, A 2015). Although there is no evidence to suggest that one section of the Black Bittern population is more stable than another, but it is likely that the species does best where human encroachment upon its habitat is minimal. The Black Bittern continues to exist locally, but the Wyong LGA may not offer medium or long term security, due to land tenure and growing development projections locally (Wyong Shire Council 2016).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Locally Black Bittern records occur downstream of the study area and Chittaway Creek in Ourimbah Creek closer to the tidal influence of Tuggerah Lake (Office for Environment & Heritage 2016a). Although there are likely times when water columns within study area creeks are suitable as part of local Black Bittern foraging range, the site is unlikely to be usable for this species during times of high rainfall when water columns are turbid and of high velocity or when water columns may become somewhat stagnant during extended dry periods. Furthermore, the subject site represents only a very small portion of potential foraging habitat for the Black Bittern locally and water edged foraging habitat is likely to continue to exist post-development. Therefore, the relative significance of habitat within the subject site to that occurring locally is considered to be low.

5.7.2.2 DESCRIPTION OF VEGETATION

Vegetation within the study area's potential Black Bittern habitat is represented by rainforest vegetation. This habitat provides suitable cover for Black Bitterns locally as they prefer reaches of drainage lines with denser riparian habitats (Marchant & Higgins 2004), although they appear to prefer water columns closer to tidal influence (Stuart, A. 2010) than occur within the study area.

Table 5.18 Black Bittern habitat in the Project study area

Fauna habitat description	Corresponding vegetation community
Rainforest (and associated creek lines)	Jackwood – Lilly Pilly – Sassafras Rainforest High

5.7.3 Assessment of habitat in subject site

Habitat within the subject site for the Black Bittern occurs well upstream from all records occurring along drainage lines in the locality (Office for Environment & Heritage 2016a). Although associated rainforest vegetation would likely provide suitable cover for Black Bitterns this species appears to prefer riparian habitats closer to tidal influences in the wider region (Office for Environment & Heritage 2016a; Stuart, A. 2010). Therefore potential onsite habitat for the Black Bittern may only be used during periods when other sections of Chittaway and Ourimbah Creeks are not suitable.

5.7.3.1 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 1.1 hectares of rainforest vegetation through which potential foraging habitat for the Black Bittern occurs along the edges of Chittaway Creek. This represents approximately 69 per cent of the study area's rainforest habitat (Table 5.19). The removal of 1.1 hectares of rainforest habitat within the subject site represents 0.65 per cent of 169.9 hectares of riparian habitats within the study area locality (Table 5.19).

Table 5.19 Extent of Black Bittern habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	169.9

- (1) As the Black Bittern is strongly associated with streams, permanent waterways and wetlands, and roosting habitat is often nearby preferred foraging habitats, potentially suitable habitat in the locality for this species was estimated by applying a 10 metre buffer to water courses in the locality that corresponded with mapped vegetation (i.e. Wyong and Gosford vegetation mapping).

5.7.3.2 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. However, the Black Bittern is considered most likely to use drainage lines for movements locally and the project is considered unlikely to significantly increase barriers to movements along locally drainage lines by this species in the project locality.

5.7.3.3 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrribalong National Park. The project is not likely to directly or indirectly impact Black Bittern in these reserves.

5.7.4 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.20.

Table 5.20 The reduction of impacts to vegetation communities by amending the subject site during detailed design

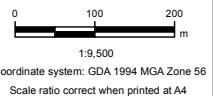
Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



- Legend**
- +— Main North railway
 - Drainage
 - ▭ Subject site
 - ▭ Study area
 - ▭ Potential habitat
 - ▭ Rainforest

This area is not included as part of the project site boundary

Map: 2202522A_GIS_F043_A1	Author: suansrir
Date: 2/06/2016	Approved by: -



Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.9
Black Bittern habitat

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5.8 Swift Parrot

5.8.1 Conservation status

The Swift Parrot is listed as Endangered under the NSW TSC Act and Critically Endangered under the Federal EPBC Act.

DISTRIBUTION

The Swift Parrot distribution extends generally from Brisbane in the north to Tasmania in the south and across to Adelaide in the west (Higgins, P.J. 1999). They become scarcer north of the Hunter Region (Higgins, P.J. 1999) and records north of Brisbane are rare. The entire population resides in Tasmania from September to April during the breeding season (Higgins, P.J. 1999), and no Swift Parrots breed on the Mainland. On the mainland during the winter months they are widely nomadic in response to the varying distribution of blossom (Higgins, P.J. 1999). Swift Parrot movements locally vary from year to year in response to resources within their range, and the presence of good resources locally is not an indicator that they will necessarily be present at a given location. Although blossom is used by Swift Parrots, they also frequently take lerps and may be found using lerps even when blossom is present to avoid conflict with large honeyeaters, such as Noisy Friarbirds and Red Wattlebirds (Saunders, D. A. & Tzaros 2011).

In recent years like the Regent Honeyeater the Swift Parrot has become progressively rarer across its range, including occurrences in the Central NSW Coast region (Roderick, M *et al.* 2013). Their migration to the mainland sometimes includes habitats in the project locality when winter-blossom resources are available (Roderick, M *et al.* 2013). Periodical occurrences in the Central NSW area coincide with Swamp Mahogany *Eucalyptus robusta* blossoming events and Forest Red Gum *E. tereticornis* (Roderick, M *et al.* 2014).

HABITAT

Throughout much of their known range Swift Parrots inhabit forest and woodland habitats, particularly Box-Ironbark woodland in inland habitats, including the Lower Hunter Region, with riparian forests and coastal heathland used in more coastal locations (Higgins, P.J. 1999). Habitat use is not predictable on the occurrence of blossom alone as blossom distributions may encompass many regions at the same time preventing Swift Parrots from visiting some areas even when blossom is present in good quantities.

As Swift Parrots use western slopes habitat types, movements to coastal areas, including the Central Coast, sometimes occur as a consequence of drought conditions and the changing distribution of blossom resources as governed by seasonal blossom timings and discontinuous flowering frequencies (Saunders, D. A. & Tzaros 2011). Local habitat preferences of Swift Parrots include habitats that are listed as Endangered in NSW, including River-Flat Eucalypt Forest on Coastal Floodplains and Swamp Sclerophyll Forest on Coastal Floodplains (Saunders, D. A. & Tzaros 2011).

ECOLOGY

The Swift Parrot is a generalist forager, which mainly feeds on nectar, psyllids and lerps from a wide range of eucalypts (Higgins, P.J. 1999). Key eucalypt species in the Central Coast area include Swamp Mahogany and Forest Red Gum as providing important nectar resources with Blackbutt and Sydney Blue Gum sometimes providing lerp resources (Roderick, M *et al.* 2014). Often blossom resources are so dominated by larger honeyeater species that Swift Parrots are forced away from key blossom, using lerps instead (Saunders, D. A. & Tzaros 2011). Furthermore, Bell Miner colonies are resident in areas of lerp occurrences and defend these sites from other bird species, (Higgins, P.J. 1999), which often attracts Swift Parrots to these colonies for the lerps (Richardson A. 2016a). In the south of Lake Macquarie to north of the project area Bell Miners establish colonies in a range of different eucalypt dominated communities including Forest Red Gum, Sydney Blue Gum, Blackbutt and Swamp Mahogany (Richardson A. 2016a).

Although Swift Parrots are often associated with Regent Honeyeaters, due to a crossover in resource use, the two species use markedly different pathways to reach Central Coast locations; Regent Honeyeaters essentially moving east from westerly locations Swift Parrots travelling north from Tasmania (Higgins, P.J. 1999; Higgins, P.J. *et al.* 2001). Swift Parrots are very fast fliers and are well equipped to cross breaks in vegetation continuity, as their traverse of Bass Strait twice each year suggests (Higgins, P.J. 1999).

Swift Parrots breed in Tasmania during the austral summer generally in areas dominated by Blue Gum *E. globulus*. Although they do use Swamp Gum *E. ovata* patches these areas often contain some Blue Gums (Higgins, P.J. 1999). Breeding is in a tree hollow most often in large Blue Gums, Messmate *E. obliqua* or White Peppermint *E. pulchella* with a diameter at breast height > 0.7 metres (Higgins, P.J. 1999). In recent years studies of Swift Parrot nesting events have found that Swift Parrot nests are predated upon by the Sugar Glider (*Petaurus breviceps*), which was introduced to Tasmania from the mainland in the past (Stojanovic 2014). The study found that females were almost always lost as a consequence of Sugar Glider predation and that survival rates for Swift Parrot nests in Sugar Glider areas was only 0.17 per cent over a 60-day nesting period (Stojanovic 2014). [RECOVERY PLAN](#)

A National Recovery Plan for the Swift Parrot *Lathamus discolor* was prepared in 2011 (Saunders, D. A. & Tzaros 2011). The NSW OEH has assigned the Swift Parrot to the 'landscape species' management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape species are those NSW threatened species that are best managed by a landscape-scale approach to conservation due to the wide and mobile distribution of such species. Due to the Swift Parrot's Endangered status, *Saving our Species* projects involve the identification of priority sites for the Swift Parrot, although as yet, no priority management sites have been identified (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

Key threats detailed in the National Recovery Plan for the Swift Parrot (Saunders, D. A. & Tzaros 2011) in order of importance include:

- Habitat loss and alteration
- Climate Change
- Collision mortality
- Competition
- Psittacine Beak and Feather Disease
- Illegal wildlife capture and trading
- Listed threatening processes
- Cumulative impacts.

The project will incrementally reduce the amount of seasonal foraging resources available to the Swift Parrot locally and will increase the fragmentation and degradation of Swift Parrot habitat in the study area. With respect to the Swift Parrot, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.8.2 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Swift Parrot consists of a single population (Higgins, P.J. 1999). Due to their nectarivorous habits they are not strictly resident in any region, but the whole population migrates to Tasmania for the breeding season leaving Tasmania around April and returning around September each year (Higgins, P.J. 1999). During the non-breeding season the population migrates to mainland Australia with the bulk of the population using Victoria and south-eastern NSW with some birds reaching south-eastern South Australia and South-east Queensland (Saunders, D. A. & Tzaros 2011). They roam widely in response to the distribution of blossom resources using western slopes box-ironbark communities, Spotted Gum-Ironbark communities in the Hunter Valley and both Swamp Sclerophyll and River Flat Eucalypt Forest associations on coastal floodplains (Saunders, D. A. & Tzaros 2011).

There are just three records comprising thirty-four birds in the locality of the study area. The details of the three records are: Chittaway Bay, dated August 6 1995 (two birds), Tuggerah May 24 2002 (two birds), and the study area June 28 2002 (30 birds) (Office for Environment & Heritage 2016a). Outside of the study area locality there are 158 records from Broken Bay to central Lake Macquarie encompassing 7,381 birds (Office for Environment & Heritage 2016a), however 136 of those records are from 2002 alone and there are likely some duplicate counts of the same birds as the same birds are counted over multiple days by multiple observers.

The two record locations at Tuggerah and Chittaway Bay are subject to various urbanisation pressures; the Chittaway Bay site is within a residential area, the Tuggerah location in fragmented habitats characterised by infrastructure and tracts of natural bushland. The very mobile and canopy foraging habits of Swift Parrots do not preclude them from reaching isolated patches in such urban settings.

As a consequence of regular use of coastal catchments by both Swift Parrots and Regent Honeyeaters, two publications have been produced by Birdlife Australia in relation to the importance of coastal habitats for both Swift Parrots and Regent Honeyeaters; in the Lower Hunter Region (Roderick, M *et al.* 2013) and Lake Macquarie City Council area (Roderick, M & Ingwersen 2014). As regional records suggest records for the Swift Parrot in the study area locality in 2003 are almost certainly part of broad movements by a significant portion of the Swift Parrot population into the coastal habitats of the region.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

The regional significance of coastal Swamp Mahogany stands to the Swift Parrot is likely to be high, due to regular movements recorded in coastal areas (Office for Environment & Heritage 2016a; Roderick, M & Ingwersen 2014) and the range of habitats available to Swift Parrots in relation to their ability to easily overcome large distances to reach suitable foraging resources, such as appears to occur in times of drought (Saunders, D. A. & Tzaros 2011). The significance of single Swamp Mahogany stands may be greater than a measurement of the sum of stand extent regionally when it is considered that Swamp Mahogany does not blossom every year, due to fruiting cycles and bud setting cycles, and that all Swamp Mahogany patches are not synchronised in their flowering events (Richardson A. 2016a). In some climatic timings, this may substantially reduce the availability of Swamp Mahogany blossom to Swift Parrots when drought conditions occur in other parts of their wintering range.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality falls within the lakeside hinterland strip between coastal estuarine lakes and adjacent foothills in a very similar topographic context to those areas visited by Swift Parrots in the southern Lake Macquarie area in the north. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood plains and depressions providing landscape conditions suited to swamp sclerophyll communities where Swamp Mahogany thrives. Such locations are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments which are attracted to the same near coastal locations. Due primarily to the development pressures that characterise coastal landscapes on the Central Coast, and elsewhere in the bioregion, Swamp Sclerophyll forests on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (SFoCF) are listed as an Endangered Ecological Community (EEC) under the TSC Act (NSW Scientific Committee 2011b).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Although, Swift Parrots are transitory and intermittent in relation to the locality of the study area, the key aspect of the 2002 records is that 2002 was clearly a year that was important for Swift Parrots to use habitats in the wider regional coastal context, including the study area itself.

SFoCF EEC habitats containing winter-flowering stands of Swamp Mahogany continue to be under threat due to development pressures in the landscape contexts where they occur. At the time of the final determination to list these communities as an EEC less than 30 per cent of the original extent of these communities continued to exist (NSW Scientific Committee 2011b). Locally stands of Swamp Mahogany continue to persist, but they are becoming increasingly fragmented due to developmental pressures. The Swift Parrot's Endangered status is in part due to the loss and fragmentation of its habitats (Roderick, M *et al.* 2013), therefore stands of Swamp Sclerophyll forest the size of that occurring within the site are uncommon locally and due to possible variations in flowering intervals of local patches may be very important to Swift Parrots during those time when climactic conditions push the birds into these coastal forests.

HABITAT UTILISATION

There has been general decline in Swift Parrot numbers moving into Swamp Sclerophyll forests locally within the past 14 years (Roderick, M & Ingwersen 2014). Over 158 Swift Parrot records were made regionally during the winter of 2002 and these numbers have not been repeated during the intervening period till now (Roderick, M & Ingwersen 2014; Saunders, D. A. & Tzaros 2011) report that large movements of Swift Parrots into coastal areas during 2002 were a function of drought conditions in western habitats. Although the drop in Swift Parrot utilisation of the habitats in the study area's locality since 2002 may be in part attributable to falling population numbers, the very large 2002 numbers of non-declining species, such as Noisy Friarbirds, have also never be repeated in the Regional context since 2002 (Richardson A. 2016a). Therefore the correlation of falling numbers for both Swift Parrot and Noisy Friarbird locally since the 2002 peak and the findings of Saunders *et al* (Saunders, D. A. & Tzaros 2011) suggests that 2002 was an exceptional coincidence of blossom distribution and climatic pressure. Therefore, apparent low utilisation of Swamp Mahogany by Swift Parrots locally in more recent times should not be interpreted as a lack of habitat utilisation, but to the contrary, the 2002 event suggests that habitats in the study area's locality are an important part of the Swift Parrot's broader niche, which allows them to survive periodic climatic stochastic events. As such intermittent utilisation of habitat in the study area and its locality should be viewed as nectarivorous birds depending upon and utilising all sections of their niche as the distribution of resources dictate in the boom and bust setting of Australia's climatic landscape.

DESCRIPTION OF VEGETATION

Vegetation within the study area varies in its suitability for Swift Parrots. Swamp forest habitat (mapped as *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest) within the study area occurs in three different condition classes High, Medium and Low quality (see section 4.3.1.1). Areas of low and medium quality did not have a canopy layer or suitable foraging habitat in the understorey strata for Swift Parrots. Only high quality swamp forest habitats have Swamp Mahogany trees, which are suited to the foraging habits of Swift Parrot as mapped in this habitat type in Figure 5.10.

Wet open forest habitats (mapped as Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest, see section 4.3.1.1) contain Blackbutt, Red Bloodwood and Sydney Blue Gum in the canopy and although these tree species do not provide nectar resource during the winter period when Swift Parrots may be present, this community along with Swamp forest habitats are part of the area utilised by Bell Miners in defence of lerp concentrations which are suited to the foraging habitat requirements of Swift Parrots. Lerp habitats are important to Swift Parrots for supplementary resources during periods when blossom on species like Swamp Mahogany is dominated by large honeyeaters such as Noisy Friarbirds and red Wattlebirds (Saunders, D. A. & Tzaros 2011).

Table 5.21 Swift Parrot habitat in the project study area and corresponding vegetation community

Fauna habitat description	Corresponding vegetation community
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.8.3 Assessment of habitat in subject site

Much of the vegetation within the study area shows evidences of previous management practices. There is a relatively young and similar age-cohort of canopy trees, suggesting past clearing within the study area, which is also evidenced by large patches of habitat without canopy strata, in which a canopy layer should be present. Nevertheless, coastal occurrences of Swift Parrots are due to the distribution of blossom and maturing age-cohort trees where they occur within the study area should produce blossom well.

Two habitat types within the study area provide seasonal foraging resources for Swift Parrots; swamp forest and wet open forest habitats.

Swamp forest habitats provide Swamp Mahogany stands, which is a prolific winter flowering species and an important provider of winter food resources for nectarivorous fauna during those years when it flowers. Swamp Mahogany stands as occur within the study area have been observed to be important to Swift Parrots during times when other regions in their range are experiencing low incidences of blossom (Roderick, M & Ingwersen 2014; Saunders, D. A. & Tzaros 2011). Although the Swift Parrot has not been observed within the study area recently, an onsite 2002 Swift Parrot record of 30 birds coincides with the movements of other nectarivorous birds during that year. As such swamp forest habitat in the study area appears to be a relatively large stand of utilised habitat in a locality, which is relied upon by nectarivorous birds, including the Swift Parrot, during times of drought and blossom scarcity elsewhere in their niche.

Wet open forest habitats within the study area contain Red Bloodwood *Corymbia gummifera*, Blackbutt *Eucalyptus pilularis* and Sydney Blue Gum *Eucalyptus saligna*. Each of these tree species are not recognised as important for Swift Parrot winter resources, but Blackbutt, Red Bloodwood and Sydney Blue Gum (Richardson A. 2016a) stands have been used by Swift Parrots for lerp foraging particularly in areas where Bell Miners occur, as is the case with the project study area.

5.8.3.1 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 23.2 hectares of potential foraging habitat for the Swift Parrot, which represents approximately 77 per cent of the study area (Table 5.22).

Table 5.22 Extent of Swift Parrot habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	19.6	25.7	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.8.3.2 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Nonetheless, the Swift Parrot is a very mobile and nomadic species that would not be impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.8.3.3 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jiliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrabalong National Park. The project is not likely to directly or indirectly impact Swift Parrots in these reserves.

5.8.4 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

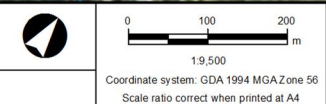
Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.23.

Table 5.23 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F044_A1
 Author: suansrir
 Date: 11/05/2016
 Approved by: -



Note: Design is indicative only.
 Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.10
 Swift Parrot habitat

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5.9 Square-tailed Kite

The Square-tailed Kite is listed vulnerable under TSC Act.

DISTRIBUTION

The Square-tailed Kite is sparsely distributed throughout most of Australia, except inland treeless areas and the highest alpine regions (Office of Environment & Heritage 2016n). It is represented by a single population although slight plumage variation has been noted between western and eastern birds (Marchant & Higgins 1993). It mainly frequents coastal and subcoastal areas from south western and northern Australia, through Queensland, NSW, and Victoria to far south-eastern South Australia (Pizzey & Knight 2012). In NSW, scattered records indicate the species is more common in the north, north-east and along the major west-flowing river systems. It commonly migrates to the south-east, including the NSW south coast, during the spring-summer breeding season (Marchant & Higgins 1993).

HABITAT

Typically found in forested and wooded lands of tropical and temperate Australia seeking habitats where its favoured passerine prey are abundant (Marchant & Higgins 1993). Such habitats are mostly in coastal and subcoastal areas, but their range does extend into more arid areas along timbered water courses where bird prey remains abundant, but it is absent in waterless desert (Marchant & Higgins 1993). Its range also occasionally extends into stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Square-tailed Kites mainly forage in eucalypt-dominated open forests and woodlands, favouring those habitats which occur on fertile soils which support an abundance of passerines (Marchant & Higgins 1993).

ECOLOGY

The Square-tailed kite is a specialist hunter of passerines, especially honeyeaters, most commonly nestlings taken from the canopy (Marchant & Higgins 1993). This species also feeds on large insects, reptiles and occasionally small mammals and forages in a floating manner somewhat similar to the harriers but at the canopy level whether in forest, heathland or grassland (Marchant & Higgins 1993).

Breeding occurs variably from July to February across its range (Marchant & Higgins 1993). This species builds a large stick platform nest in a living tree in open forest or woodland, nesting sites are typically located along or near watercourses (Office of Environment & Heritage 2016n). Nesting occurs once a year, laying one and sometimes two eggs each season (Marchant & Higgins 1993). Resident breeding pairs defend territories ranging from 100–170 square metres in size (Office of Environment & Heritage 2016n).

RECOVERY PLANS

The TSC Act provides for the preparation of a recovery plan, but to date no such plan has been prepared for the Square-tailed Kite (Office of Environment & Heritage 2016n). The NSW OEH has assigned the Square-tailed Kite to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

Key threats detailed by OEH include:

- Clearing, logging, burning, and grazing of habitats resulting in a reduction in nesting and feeding resources
- Disturbance to or removal of potential nest trees near watercourses

→ Illegal egg collection and shooting.

The project will incrementally reduce the amount of foraging habitat available locally, remove potential nest trees, and will increase the fragmentation and degradation of Square-tailed Kite habitat in the study area. With respect to the Square-tailed Kite, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.9.1 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

There is one record within the locality of the study area dated 29 October 2007 (Office for Environment & Heritage 2016a). This record is subject to urbanisation pressures, but the sighting's vicinity occurs in a mosaic of open and cleared habitats suited to the foraging habits of this species. Furthermore, the Square-tailed Kite is very mobile and open country does not preclude them from reaching isolated patches of habitat in such semi-urban settings (Marchant & Higgins 1993). Although there is only a single record in the study area's locality, this is not unusual as the literature reports this species as rare across its range (Pizzey & Knight 2012) and there are a further four records to the south in the Gosford LGA, the latest of which is from 2014 (Office for Environment & Heritage 2016a).

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

Records for this species in the Bionet database generally coincide with areas of human habitation, suggesting that the distribution of sightings is tied closely to the distribution of survey effort and not the bird's true range throughout the Sydney Basin Bioregion (Office for Environment & Heritage 2016a). Therefore large tracts of forested habitat, which might otherwise provide excellent and secure habitat for this species, such as the Wollemi and Yengo National Parks appear to be under-surveyed (Office for Environment & Heritage 2016a).

Due to their migratory habits, continuous population dynamics and apparent use of large hunting ranges exceeding 100 square kilometres (Office for Environment & Heritage 2016a) the significance of individuals occurring in the study area's locality may be difficult to assess apart from records proving that the locality continues to be capable of supporting part of the Square-tailed Kite's life cycle. The significance of local occurrences to the population as a whole may be maintenance of genetic diversity or population security if other areas in the distribution become unsuitable for sustaining individuals. Due to their relatively sparse status in the landscape it may be difficult to identify patterns about habitat usage particularly during declines as development encroaches on habitats currently used. The study area itself represents a diverse range of habitat structural types, which is highly suitable for promoting and sustaining a diversity of bird species. Such places represent the types of habitats in which Square-tailed Kites prefer to hunt for small birds and other animals (Office for Environment & Heritage 2016a) and as such may be of some significance to the Sydney Basin Bioregion population as whole as it currently contributes to a location that was recently known (Office for Environment & Heritage 2016a) to support this species.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality falls within the hinterland strip between coastal estuarine lakes and adjacent foothills. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood down-slope plains and depressions providing landscape conditions suited to a range of both tall and wet forests and dry woodland communities. Such floodplain locations are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments which are attracted to the same near coastal locations.

Due to the general availability of water, periodic inundations of nutrients from floodwaters and often deep alluvial sediments, floodplain contexts are productive in supporting a high diversity of vegetation structure and species. Due to their productivity such topographical contexts are important for promoting faunal diversity, which makes them desirable to birds of prey like the Square-tailed Kite as hunting habitats.

Open forest and woodland habitat of similar value for the Square-tailed Kite continues to exist locally, but may not offer medium to long term security, due to land tenure and growing development projections locally (Wyong Shire Council 2016).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Due to the general availability of water, periodic inundations of nutrients from floodwaters and often deep alluvial sediments, floodplain contexts are productive in supporting a high diversity of vegetation structure and species. Due to their productivity such topographical contexts are important for promoting faunal diversity, which makes them desirable to birds of prey like the Square-tailed Kite as hunting habitats (Marchant & Higgins 1993).

Examinations of the subject site locality show the floodplain landscape generally dominated by managed lands and traversed by drainage lines dominated by rainforest vegetation. Although such habitats may compliment habitats of higher foraging quality for the Square-tailed Kite, habitats of higher structural diversity, such as the study area, are important for providing sufficient hunting habitats for this species, due to the higher diversity and density of bird species they attract (Marchant & Higgins 1993). As such habitat like that occurring within the study area, particularly in light of its size, is likely to be important for supporting Square-tailed Kites in the locality.

HABITAT UTILISATION

There are no records for this species within the study area, but it is a sparsely distributed species utilising foraging ranges exceeding 100 square kilometres (Office for Environment & Heritage 2016a). Considering their propensity to move widely during hunting forays and five records within 12 kilometres of the study area, one <five kilometres, it is likely that the study area occurs within the foraging range of one or more individuals locally. There are no breeding records known from the locality.

5.9.1.1 DESCRIPTION OF VEGETATION

The Square-tailed Kite forages across two habitat types found within the project study area, including swamp forest and wet open forest (Table 5.24, Figure 5.11).

Table 5.24 Square-tailed Kite habitat in the Project study area

Fauna habitat description	Corresponding vegetation community
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.9.2 Assessment of habitat

5.9.2.1 DESCRIPTION OF HABITAT VALUES

Foraging habitat for the Square-tailed Kite includes most of the study area, including swamp forest and wet open forest type habitats (Table 5.24, Figure 5.11).

5.9.2.2 EXTENT OF HABITAT REMOVAL

Within the subject site the Project is likely to affect approximately 29.1 hectares of foraging habitat for the Square-tailed Kite, which represents approximately 79 per cent of the study area (Table 5.25).

Table 5.25 Extent of Square-tailed Kite habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	25.5	32.4	609.3
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate			
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low			
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.9.2.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the Project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential properties, construction and operation of the Project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah creek in the north. Whilst the Project will contribute to and add incrementally to existing fragmentation within the locality, it is not likely to exacerbate the general effects of fragmentation at the landscape scale. Nonetheless, potential impacts of the incremental addition to fragmentation on the Square-tailed Kite are not likely to be significant given the mobile nature of this species and its foraging ecology.

5.9.2.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the Project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrribalong National Park. The Project is not likely to directly or indirectly impact Square-tailed Kite are in these reserves.

5.9.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.26.

Table 5.26 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F045_A1	Author: suansrir
Date: 11/05/2016	Approved by: -

0 100 200 m

19,500

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.11
Square-tailed Kite habitat

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5.10 Powerful Owl

The Powerful Owl is listed vulnerable under TSC Act.

DISTRIBUTION

The Powerful Owl inhabits a range of different vegetation types, from woodland and open sclerophyll forest (on productive sites) to tall wet open forests and rainforest, with mesic gullies and permanent streams (Debus & Chafer 1994).

HABITAT

This species prefers large tracts of forest or woodland habitat but can also occur in fragmented landscapes. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation often in riparian contexts (Higgins, P.J. 1999).

ECOLOGY

Powerful Owls nest in large tree hollows (at least 0.5 metres deep), in large eucalypts (diameter at breast height of 80–240 centimetres) that are at least 150 years old. (Kavanagh & Debus 1994). During the breeding season, the male Powerful Owl roosts in a 'grove' of up to 20–30 trees, situated within 100–200 metres of the nest tree where the female shelters (NSW National Parks and Wildlife Service 1998).

The main prey items are medium-sized arboreal marsupials, particularly the slow-moving Greater Glider, as well as Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls (Kavanagh *et al.* 1995).

Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400–1450 hectares (Debus 1995).

RECOVERY PLANS

Recently the NSW OEH has assigned the Powerful Owl to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

Furthermore, a recovery plan has been prepared for the Threatened large forest owls of NSW which includes the Powerful Owl (Department of Environment Climate Change and Water 2010b).

THREATS AND KEY THREATENING PROCESSES

Key threats detailed by OEH include:

- Historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. Also affecting prey species such as the Greater Glider.
- Inappropriate forest harvesting practices that have changed forest structure and removed old-growth hollow-bearing trees. Hollow loss results in a reduction of nest sites for the owl and its prey species.
- Disturbances during the breeding period may affect breeding success.
- High frequency hazard reduction burning may also reduce the longevity of individuals by affect in prey availability.
- Secondary poisoning.
- Predation of fledglings by foxes, dogs and cats.

The project will incrementally reduce the amount of foraging habitat available locally and will increase the fragmentation and degradation of Powerful Owl habitat in the study area. With respect to the Powerful Owl, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.10.1 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

There are thirty-six Powerful Owl records within the locality of the study area dated between August 14 1988 and September 1 2013 (Office for Environment & Heritage 2016a), the closest record occurring within 0.5 kilometres of the study area. The locality records occur across a mosaic of open and forested habitats, traversed by drainage lines lined with rainforest vegetation.

Across their range local Powerful Owl populations show no geographic variation and are regarded as belonging to a single population (Higgins, P.J. 1999). Due to the relatively high number of local records it is considered likely that the study area represents part of the home range of local individuals. Although the study area occurs in a somewhat fragmented landscape, the separation of suitable habitats is considered unlikely to represent significant barriers to Powerful Owls locally.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

Records for this species in the Bionet database occur widely across the Powerful Owl's range with most generally coinciding with areas of human habitation. The distribution pattern suggests that the distribution of sightings is tied closely to the distribution of survey effort and not the bird's true range throughout the Sydney Basin Bioregion (Office for Environment & Heritage 2016a). Therefore large tracts of forested habitat, which might otherwise provide excellent and secure habitat for this species, such as the Wollemi and Yengo National Parks appear to be under-surveyed (Office for Environment & Heritage 2016a).

Nevertheless, the records show a relatively continuous spread throughout coastal areas, including the Central Coast area (Office for Environment & Heritage 2016a). Due to their sedentary habits it is perhaps unlikely that there are significant interactive movements between local individuals and other populations in other regions. The most likely movements may those of dispersing off-spring from existing pairs.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality falls within the hinterland strip between coastal estuarine lakes and adjacent foothills. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood down-slope plains and depressions providing landscape conditions suited to a range of both tall and wet forests and dry woodland communities. Such floodplain locations are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments which are attracted to the same near coastal locations.

Due to the general availability of water, periodic inundations of nutrients from floodwaters and often deep alluvial sediments, floodplain contexts are productive in supporting a high diversity of vegetation structure and species. Due to their productivity such topographical contexts are important for promoting faunal diversity, which makes them desirable to birds of prey like the Powerful Owl as hunting habitats.

Open forest and woodland habitat of similar value for the Powerful Owl continues to exist locally, but may not offer medium to long term security, due to land tenure and growing development projections locally (Wyong Shire Council 2016). Nevertheless, where vegetation continues to support arboreal mammals. Powerful Owls appear to remain extant, even in somewhat urban settings.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Due to the general availability of water, periodic inundations of nutrients from floodwaters and often deep alluvial sediments, floodplain contexts are productive in supporting a high diversity of vegetation structure and species. Due to their productivity such topographical contexts are important for promoting faunal diversity, which makes them desirable to birds of prey like the Powerful Owl as hunting habitats (Higgins, P.J. 1999).

Examinations of the subject site locality show the floodplain landscape generally dominated by managed lands and traversed by drainage lines dominated by rainforest vegetation. Although such habitats may compliment habitats of higher foraging quality for the Powerful Owl, habitats of higher structural diversity, such as the study area, are important for providing sufficient hunting habitats for this species, due to the higher diversity and density of arboreal mammal species they attract (Higgins, P.J. 1999). As such habitat like that occurring within the study area, particularly in light of its size, is likely to contribute to supporting Powerful Owls in the locality.

Although there is suitable roosting habitat in onsite rainforest and swamp forest and foraging habitats within all wooded onsite habitats, the study area has no hollows suitable for the nesting purposes of the Powerful Owl.

HABITAT UTILISATION

There are a relatively consistent number of records for this species within the study area locality, despite their relatively large territories and nocturnal habitats (Office for Environment & Heritage 2016a). Due to the occurrence of records in relatively close proximity of the study area is considered likely that the study may be used occasionally for foraging and roosting if only for dispersing offspring. There are no breeding records known from the study area's general vicinity.

5.10.1.1 DESCRIPTION OF VEGETATION

The Powerful Owl forages across three habitat types found within the project study area, including rainforest, swamp forest and wet open forest (Table 5.27, Figure 5.12).

Table 5.27 Powerful Owl habitat in the Project study area

Fauna habitat description	Corresponding vegetation community
Rainforest (and associated creek lines)	Jackwood – Lilly Pilly – Sassafras Rainforest High
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.10.2 Assessment of habitat

5.10.2.1 DESCRIPTION OF HABITAT VALUES

Foraging habitat for the Powerful Owl includes most of the study area, including swamp forest, wet open forest and rainforest habitats. Rainforest habitat and dense areas of vegetation in swamp forest and wet open forest represent potential roosting habitat (Table 5.27, Figure 5.12).

5.10.2.2 EXTENT OF HABITAT REMOVAL

Within the subject site the Project is likely to affect approximately 30.2 hectares of foraging habitat for the Powerful Owl, which represents approximately 78 per cent of the study area (Table 5.28).

Table 5.28 Extent of Powerful Owl habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	937.4
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low	25.5	32.4	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.10.2.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the Project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential properties, construction and operation of the Project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah creek in the north. Whilst the Project will contribute to and add incrementally to existing fragmentation within the locality, it is not likely to exacerbate the general effects of fragmentation at the landscape scale. Therefore, potential impacts of the incremental addition to fragmentation on the Powerful Owl are not likely to be significant given their ability to occupy territories containing open areas (Pizzey & Knight 2012).

5.10.2.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the Project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrribalong National Park. The Project is not likely to directly or indirectly impact Powerful Owl are in these reserves.

5.10.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.29.

Table 5.29 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



- Legend**
- +— Main North railway
 - Drainage
 - ▭ Subject site
 - ▭ Study area
 - Potential habitat
 - ▭ Rainforest
 - ▭ Swamp forest
 - ▭ Wet open forest

This area is not included as part of the project site boundary

Map: 2202522A_GIS_F046_A1	Author: suansrir
Date: 11/05/2016	Approved by: -

0 100 200 m
19,500
Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.12
Powerful Owl habitat

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5.11 Sooty Owl

The Sooty Owl is listed vulnerable under TSC Act.

DISTRIBUTION

The Sooty Owl occurs within the ranges and coastal strip of south-eastern Australia from Melbourne Victoria to The Eungella National Park in Queensland (Pizzey & Knight 2012).

HABITAT

This species prefers rainforested gullies of the ranges that are surrounded by tall, usually wet, eucalypt forests, but it occasionally occurs in rainforest patches associated with dry forest and rarely open habitats (Higgins, P.J. 1999).

ECOLOGY

Sooty Owls nest in large tree hollows, mostly in large smooth-barked eucalypts, but also in large rainforest trees species, such as Stinging Trees and Figs (Higgins, P.J. 1999). During the breeding season, the male Sooty Owl assumes hunting duties, which targets a range of both arboreal and terrestrial mammal prey species (Higgins, P.J. 1999).

Higgins (1999) record that the majority of studies recorded amongst other prey species the same four native mammals, being Brown Antechinus, Bush Rat, Common Ringtail Possum and Sugar Glider.

Said to vary in the onset of the breeding season, but mostly recorded as breeding through winter with pairs courting in March-April, incubating through June–July with young appearing in October (Higgins, P.J. 1999).

RECOVERY PLANS

Recently the NSW OEH has assigned the Sooty Owl to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

Furthermore, a recovery plan has been prepared for the Threatened large forest owls of NSW which includes the Sooty Owl (Department of Environment Climate Change and Water 2010b).

THREATS AND KEY THREATENING PROCESSES

Key threats detailed by OEH include:

- Historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. Also affecting prey species such as the Greater Glider.
- Inappropriate forest harvesting practices that have changed forest structure and removed old-growth hollow-bearing trees. Hollow loss results in a reduction of nest sites for the owl and its prey species.
- Disturbances during the breeding period may affect breeding success.
- High frequency hazard reduction burning may also reduce the longevity of individuals by affect in prey availability.
- Secondary poisoning.
- Predation of fledglings by foxes, dogs and cats.

The project will incrementally reduce the amount of foraging habitat available locally and will increase the fragmentation and degradation of Sooty Owl habitat in the study area. With respect to the Sooty Owl, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.11.1 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

There are thirty-three Sooty Owl records within the locality of the study area dated between December 31 1973 and September 11 2009 (Office for Environment & Heritage 2016a), the closest record occurring 1 kilometre away from the study area in 2007 (Office for Environment & Heritage 2016a). Records in the locality occur in association with surrounding ranges in continuous forested habitats. Although there are records along rainforested creeklines locally, these records are in close proximity to continuous forest in adjacent ranges (Office for Environment & Heritage 2016a).

Across their range in NSW Sooty Owl populations show no geographic variation and are regarded as belonging to a single population (Higgins, P.J. 1999). Due to the moderate number of local records it is considered likely that Sooty Owls occur in resident home ranges locally. As the study area occurs in a somewhat fragmented landscape, the separation of suitable habitats is considered likely to represent barriers to Sooty Owls locally. Movements by dispersing young birds into floodplain rainforests associated with the study area are possible, but it is considered unlikely that potential habitats associated with the study represent part of the territories of local pairs.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

Records for this species in the Bionet database occur widely across the Sooty Owl's range with the greatest majority of record coinciding with coastal ranges and escarpment topography (Office for Environment & Heritage 2016a). In some respects the distribution pattern suggests that sightings are tied closely to the distribution of survey effort and not the bird's true range throughout the Sydney Basin Bioregion (Office for Environment & Heritage 2016a). Therefore large tracts of forested habitat, which might otherwise provide excellent and secure habitat for this species, such as the Wollemi and Yengo National Parks appear to be under-surveyed (Office for Environment & Heritage 2016a).

Nevertheless, the records show a relatively continuous spread throughout coastal uplands, including the Central Coast area (Office for Environment & Heritage 2016a). Due to their sedentary habits it is perhaps unlikely that there are significant interactive movements between local individuals and other populations in other regions. The most likely movements may be those of dispersing off-spring from existing pairs.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The study area locality falls within the hinterland strip between coastal estuarine lakes and adjacent foothills. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood down-slope plains and depressions providing landscape conditions suited to a range of both tall and wet forests and dry woodland communities. Such floodplain locations are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments which are attracted to the same near coastal locations.

Due to the general availability of water, periodic inundations of nutrients from floodwaters and often deep alluvial sediments, floodplain contexts are productive in supporting a high diversity of vegetation structure and species. Due to their productivity such topographical contexts are important for promoting faunal diversity, which makes them generally desirable to birds of prey. Nevertheless, such habitats are not usually

inhabited by Sooty Owls, their preference being for rainforest gullies of the ranges that are continuous with surrounding forests (Higgins, P.J. 1999).

Rainforest and tall forest habitat of greater value and suitability for the Sooty Owl continues to exist locally, and should offer at least medium-term security, due to land tenure of local ranges and State Forests locally (Wyong Shire Council 2016). Nevertheless, where vegetation is continuous with wet gullies containing large trees in local ranges, Sooty Owls are likely to remain extant.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Due to the general availability of water, periodic inundations of nutrients from floodwaters and often deep alluvial sediments, floodplain contexts are productive in supporting a high diversity of vegetation structure and species. Due to their productivity such topographical contexts are important for promoting faunal diversity, which usually makes them desirable to birds of prey like the Sooty Owl as hunting habitats (Higgins, P.J. 1999).

Examinations of the subject site locality show the floodplain landscape generally dominated by managed lands and traversed by drainage lines dominated by rainforest vegetation. Such habitats may represent areas where young birds disperse to from established breeding territories, but is considered unlikely to represent part of the territories of local breeding Sooty Owl pairs. As such rainforest habitat occurring within the topographic context of the study area, particularly in light of its very small size, is considered unlikely to contribute to supporting Sooty Owls in the locality.

Although there is potential roosting habitat in onsite rainforest habitats, the study area occurs away from rainforested gullies containing large trees providing potential nesting hollows suitable for the breeding purposes of the Sooty Owl.

HABITAT UTILISATION

Although there is a relatively consistent number of records for this species within the ranges of the study area locality (Office for Environment & Heritage 2016a), there are no habitats considered likely to support Sooty Owls in the study area, apart perhaps from intermittent roost sites for dispersing young birds. There are no breeding records known from the study area's general vicinity.

5.11.1.1 DESCRIPTION OF VEGETATION

Dispersing Sooty Owls may roost on rare occasions in rainforest habitat found within the project study area, (Table 5.30, Figure 5.13).

Table 5.30 Sooty Owl habitat in the Project study area

Fauna habitat description	Corresponding vegetation community
Rainforest (and associated creek lines)	Jackwood – Lilly Pilly – Sassafras Rainforest High

5.11.2 Assessment of habitat

5.11.2.1 DESCRIPTION OF HABITAT VALUES

Although the study area contains mammal species that are recorded as prey for the Sooty Owl the study area is considered unlikely to be utilised by individuals in the locality due to the much higher quality and suitability of surrounding habitats (Table 5.31, Figure 5.13).

5.11.2.2 EXTENT OF HABITAT REMOVAL

Within the subject site the Project is likely to affect approximately 1.1 hectares of potential roosting habitat for the Sooty Owl, which represents approximately 0.001 per cent of such habitat in the locality (Table 5.31).

Table 5.31 Extent of Sooty Owl habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	937.4

5.11.2.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of tall wet forest habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the Project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential properties, construction and operation of the Project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah creek in the north. Whilst the Project will contribute to and add incrementally to existing fragmentation within the locality, it is not likely to exacerbate the general effects of fragmentation at the landscape scale. Therefore, potential impacts of the incremental addition to fragmentation on the Sooty Owl are not likely to be significant given the high likelihood of occupied territories being limited to surrounding ranges containing continuous forests interspersed with rainforest gullies (Higgins, P.J. 1999).

5.11.2.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the Project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrribalong National Park. The Project is not likely to directly or indirectly impact Sooty Owl are in these reserves.

5.11.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

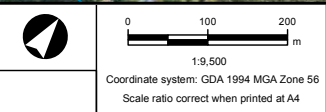
Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.32.

Table 5.32 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F087_A1
 Author: suansrir
 Date: 2/06/2016
 Approved by: -



Note: Design is indicative only.
 Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.13
 Sooty Owl habitat

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5.12 Little Bentwing-bat

The Little Bentwing-bat, which is listed as Vulnerable under the TSC Act, was recorded via passive Anabat surveys in swamp forest type habitat in the study area (Figure 5.14).

DISTRIBUTION

The Little Bentwing-bat occurs along the eastern coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW (Office of Environment & Heritage 2016n). The project study area does not occur at the limit of distribution of the Little Bentwing-bat.

HABITAT AND ECOLOGY

The Little Bentwing-bat is generally found in well-timbered areas where they hunt beneath the canopy of densely vegetated habitats for small insects, including moist eucalypt forest, rainforest, wet and dry sclerophyll forests, vine thickets, Melaleuca swamps, dense coastal forests and banksia scrub (Office of Environment & Heritage 2016n). Little Bentwing-bats are cave-dwelling bats that are known to roost in a variety of structures encompassing caves, tunnels, mines, stormwater rains, culverts and bridges (Office of Environment & Heritage 2016n). This species has also been recorded roosting within tree hollows, however it is unclear whether this is a regular occurrence (Office of Environment & Heritage 2016n; Van Dyck & Strahan 2008). Caves (mainly limestone) constitute breeding (maternity/nursery) habitat. Currently, only five maternity sites are known in Australia, three of which occur south of the tropics (Office of Environment & Heritage 2016n; Van Dyck & Strahan 2008). In NSW, the largest maternity colony occurs in close association with the Eastern Bent-wing Bat and is likely dependent on the large colony for provision of high temperatures required to rear young (Office of Environment & Heritage 2016n).

RECOVERY PLAN

The TSC Act provides for the preparation of recovery plan. No such plan has been prepared for the Little Bentwing-bat. The NSW OEH has assigned the Eastern Bent-wing Bat to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office of Environment & Heritage 2016n).

THREATS AND KEY THREATENING PROCESSES

The NSW OEH have detailed the following threats to the Little Bent-wing Bat (Office of Environment & Heritage 2016n):

- Disturbance of colonies, especially in nursery or hibernating caves, may be catastrophic
- Destruction of caves that provide seasonal or potential roosting sites
- Changes to habitat, especially surrounding maternity/nursery caves and winter roosts
- Pesticides on insects and in water consumed by bats bio accumulates, resulting in poisoning of individuals
- Predation from foxes, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges
- Predation from feral cats, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges
- Introduction of exotic pathogens such as the White-nosed fungus
- Hazard reduction and wildfire fires during the breeding season

- Large scale wildfire or hazard reduction can impact on foraging resources
- Poor knowledge of reproductive success and population dynamics.

The project will add incrementally to the loss of foraging habitat for this species and potential over-wintering roosts in man-made structures spanning Chittaway Creek. With regard to the Little Bentwing-bat, KTPs that the project is likely to be commensurate with, include:

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

5.12.1 Discussion of local and regional abundance

5.12.1.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Little Bentwing-bat occurs along the eastern coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW (Office of Environment & Heritage 2016n). Within its range, the Little Bentwing-bat is known from five maternity sites (limestone caves), of which three occur south of the tropics. In the southern portion of its range the Little Bentwing-bat becomes increasingly coastal with females moving distances up to 200 kilometres to reach a maternity cave that they shares with the Eastern Bent-wing Bat; although most other movements are substantially less (Office of Environment & Heritage 2016n; Van Dyck & Strahan 2008).

The Little Bentwing-bat was recorded via Anabat detector at two locations in swamp forest habitat in the study area during field surveys informing this report (Figure 5.14). In the project locality the Little Bentwing-bat is known from 24 records (Office for Environment & Heritage 2016a).

Breeding and primary roosting habitat (caves) for the Little Bentwing-bat is not available in the study area, as determined through the lack of caves. However, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potentially suitable roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow. Man-made structures such as these are likely to be abundant in the locality and region. Although it is unclear to what extent the Little Bentwing-bat uses hollow tree resources for roosting (Van Dyck & Strahan 2008) habitat types in the study area were generally of an insufficient ag-class to for the provision abundant hollows, as depicted in the general paucity of hollow-bearing trees observed over much of the study area.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

In the Hunter–Central Rivers CMR the Little Bentwing-bat is known from 1,032 records, of which 24 occur in the project locality (Office for Environment & Heritage 2016a). The Little Bentwing-bat is also known from the Hawkesbury-Nepean CMR, Northern Rivers CMR, Southern Rivers CMR and Sydney Metro CMR (Office of Environment & Heritage 2016n). Although primary roost structures (caves) cannot be discounted as potentially occurring in ranges adjacent to the study area (e.g. Ourimbah State Forest), no such structure or maternity cave occurred in the subject site (or study area). Notwithstanding this, potential roost sites were identified in existing bridge structures spanning Chittaway Creek in the south of the study area; although the relative importance of these structures is not known as man-made structures are widespread throughout the locality and region. A corollary is that individuals occurring in the locality are likely to be of moderate significance in the region.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

Within NSW, approximately 44 per cent of the species' range occurs on NSW National Parks and Wildlife estate (Office of Environment & Heritage 2016n). Although this species is reliant on critically limiting resources (maternity and roosting caves) in the landscape, no priority sites have been identified for appropriate management under the *Saving our Species* program (Office for Environment & Heritage 2016c). Accordingly, potential habitat for this species is not considered to be secure in the long term. In the project locality however, several conservation estates that may provide habitat for this species include, Jiliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrribalong National Park.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

The Little Bentwing-bat was recorded via Anabat detector at two locations in swamp forest type habitat in the study area (Figure 5.14). Maternity sites and primary roosting habitat (natural caves) did not occur in the subject site (or study area), however, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide refuge during periods of low flow. Although, similar man-made structures are likely to occur widely in the locality.

Therefore, the subject provides known foraging habitat for the Little Bentwing-bat in rainforest, swamp forest, wet open forest and potentially suitable man-made roost structures over Chittaway Creek. As the study area is associated with relatively fertile soils and riparian/swampy habitat of Chittaway Creek, Bangalow Creek and Ourimbah Creek floodplain, the subject site could be considered of moderate significance in the project locality.

5.12.1.2 HABITAT UTILISATION

The Little Bentwing-bat is an insectivorous cave-dwelling bat that relies on naturally occurring caves for breeding, whereby only five nursery sites/maternity colonies are known in Australia (Office of Environment & Heritage 2016n). Little Bentwing-bats inhabit moist eucalypt forest, rainforest, vine thickets, wet and dry sclerophyll forests, melaleuca swamps, dense coastal forests and banksia scrub where they forage for small insects beneath the canopy of densely vegetated habitats (Office of Environment & Heritage 2016n).

In the Hunter–Central Rivers CMR the Little Bentwing-bat is known from 1,032 records, of which 24 occur in the project locality (Office for Environment & Heritage 2016a). Whilst man-made structures such as bridges in the study area may provide supplementary roosting structures, such structures are likely to be widespread in the locality and region. Further, as the Little Bentwing-bat is known to travel up to 200 kilometres or more to reach a maternity site in the southern portion of their range, individuals occurring in the study area may occur as breeding or over-wintering individuals. A corollary is that individuals occurring in the subject site are likely to be of moderate significance to the viability of this species in the project locality.

5.12.1.3 DESCRIPTION OF VEGETATION

As the Little Bentwing-bat forages for insects below the canopy of densely vegetated habitats, habitat for this species in the project study area encompassed rainforest, swamp forest and wet open forest (Table 5.33, Figure 5.14).

Table 5.33 Little Bentwing-bat habitat in the project study area

Fauna habitat description	Corresponding vegetation community
Rainforest (and associated creeklines)	Jackwood – Lilly Pilly – Sassafras Rainforest High
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.12.2 Assessment of habitat

5.12.2.1 DESCRIPTION OF HABITAT VALUES

Foraging habitat for the Little Bentwing-bat included the majority of the study area, including rainforest, swamp forest and wet open forest type habitats (Figure 5.14, Table 5.37, Table 5.33). The study area did not contain any breeding or maternity structures (i.e. caves). Whilst it is not known to what extent this species uses tree hollows for roosting, canopy strata over much of the study area was of generally of an insufficient age-class to develop hollows, and these important habitat structures were not abundant in the study area. Nevertheless, the Little Bentwing-bat is known to use a variety of structures to roost, and a lack of caves does not preclude the presence of other potential roosting structures. The existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow. However, similar man-made structures are likely to occur widely in the locality and region.

5.12.2.2 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 30.2 hectares of foraging habitat for the Little Bentwing-bat, which represents approximately 78 per cent of the study area (Table 5.34).

Table 5.34 Extent of Little Bent-wing Bat habitat removal

Fauna habitat description	Corresponding vegetation community	extent within subject site	Extent within study area	Extent within locality (5 km) ¹
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	937.4
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low	25.5	32.4	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

(1) Note: 1: Extent within locality estimated from similar habitat type in Wyong LGA vegetation mapping and Gosford LGA vegetation mapping.

5.12.2.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential properties, construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah creek in the north. Whilst the project will contribute to and add incrementally to existing fragmentation within the locality, it is not likely to exacerbate the general effects of fragmentation at the landscape scale. Nonetheless, potential impacts of the incremental addition to fragmentation on the Little Bentwing-bat are not likely to be significant given the mobile nature of this species and its foraging ecology.

5.12.2.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrabalong National Park. The project is not likely to directly or indirectly impact Eastern Bentwing-bat in these reserves.

5.12.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.38.

Table 5.35 The reduction of impacts to vegetation communities by amending the subject site during detailed design

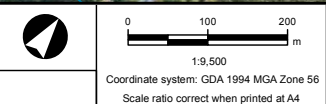
Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F047_A1 Author: suansrir

Date: 2/06/2016 Approved by: -

Data source: - © Land and Property Information 2015



Note: Design is indicative only.
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New Intercity Fleet Maintenance Facility Project
Figure 5.14
Little Bentwing-bat habitat

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5.13 Eastern Bent-wing Bat

The Eastern Bent-wing Bat, which is listed as Vulnerable under the TSC Act, was recorded via passive Anabat surveys in wet open forest type habitat in the project study area (Figure 5.15).

DISTRIBUTION

The Eastern Bent-wing Bat is distributed along the eastern coast of Australia, from Cape York in Queensland to Victoria (Van Dyck & Strahan 2008). The project study area does not occur at the limit of distribution of the Eastern Bent-wing Bat.

HABITAT AND ECOLOGY

Eastern Bent-wing Bats are cave-dwelling bats that form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young (Office of Environment & Heritage 2016n). Very specific temperature and humidity regimes are required for maternity caves, of which 12 are currently known throughout the range of this species, all of which are located in limestone and sandstone caves, abandoned gold mines, lava tubes and concrete bunkers (Van Dyck & Strahan 2008). Outside the breeding period, populations disperse considerable distances (within about a 300 kilometre range of maternity caves) to overwintering roosts, which variously include cool areas located in caves, storm water tunnels, culverts, bridges and mines (Office of Environment & Heritage 2016n; Van Dyck & Strahan 2008).

The Eastern Bent-wing Bat has a fast and direct pattern of flight. Consequently they forage for moths and flying insects above the tree canopy in forested areas, open areas, along waterways and tracks (Office of Environment & Heritage 2016n; Van Dyck & Strahan 2008).

RECOVERY PLAN

The TSC Act provides for the preparation of recovery plan. No such plan has been prepared for the Eastern Bent-wing Bat. The NSW OEH has assigned the Eastern Bent-wing Bat to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

The NSW OEH have detailed the following threats to the Eastern Bent-wing Bat (Office of Environment & Heritage 2016n):

- Disturbance by recreational cavers and general public accessing caves an adjacent areas particularly during winter or breeding
- Loss of high productivity foraging habitat
- Introduction of exotic pathogens, particularly white-nose fungus
- Cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances
- Hazard reduction and wildfire fires during the breeding season.

The project will add incrementally to the loss of foraging habitat for this species and potential over-wintering roosts in man-made structures spanning Chittaway Creek. With regard to the Eastern Bent-wing Bat, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.13.1 Discussion of local and regional abundance

5.13.1.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Eastern Bent-wing Bat is distributed along the eastern coast of Australia, from Cape York in Queensland to Victoria (Van Dyck & Strahan 2008). Within its range, limestone caves with very specific temperature and humidity regimes are used as maternity sites. In NSW, known maternity colonies for the Eastern Bent-wing Bat occur in three Catchment Management Regions, however none are known to occur within the Hunter–Central Rivers CMR. Outside of the breeding period, Eastern Bent-wing Bats are known to disperse up to 300 kilometres from maternity sites to over-wintering roosts, with primary roosting habitat occurring as limestone/sandstone caves (Office of Environment & Heritage 2016n; Van Dyck & Strahan 2008).

Furthermore, whilst dispersal movements between breeding colonies are not uncommon events, the majority of individuals remain within their natal population range (Wilson 2003). The Eastern Bent-wing Bat was recorded via Anabat detector (one pass) at the ecotone of swamp forest and wet open forest habitats in the north of the study area during field surveys informing this report (Figure 5.15). In the project locality the Eastern Bent-wing Bat is known from 35 records (Office for Environment & Heritage 2016a).

Primary roosting habitat for the Eastern Bent-wing Bat is not present in the study area, as determined through the lack of caves. However, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potentially suitable roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

Due to the very specific temperature and humidity regimes required for maternity caves, the Eastern Bent-wing Bat is only known from 12 maternity sites across its distribution (Van Dyck & Strahan 2008). In NSW, maternity colonies are currently known from three Catchment Management Regions, of which the Hunter–Central Rivers CMR is not one (Office of Environment & Heritage 2016n). However, due to the underlying geological formations associated with the Hawkesbury–Nepean CMR (that abuts the Hunter–Central Rivers CMR), maternity colonies are likely to occur therein. Therefore, within the locality, individuals of the Eastern Bent-wing Bat are likely to occur as over-wintering or dispersing individuals, as they are known to over-winter up to 300 kilometres from maternity sites. Further, whilst primary roosting habitat in the form of natural limestone/sandstone caves cannot be discounted as potentially occurring in ranges adjacent to the study area (e.g. Ourimbah State Forest), no such structure occurred in the subject site. Notwithstanding this, potential roost sites were identified in existing bridge structures spanning Chittaway Creek in the south of the study area; although the relative importance of these structures is not known as man-made structures are widespread throughout the locality and region. A corollary is that individuals occurring in the locality are likely to be of moderate significance in the Sydney Basin bioregion.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

Within NSW, approximately 19 per cent of this species range occurs on NSW National Parks and Wildlife estate (Office for Environment & Heritage 2016c). Although this species has specific requirements from critically limiting resources (maternity and roosting caves) in the landscape, no priority sites have been identified for appropriate management under the *Saving our Species* program (Office for Environment & Heritage 2016c). Accordingly, potential habitat for this species is not considered to be secure in the long term. In the project locality however, several conservation estates that may provide habitat for this species include, Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrabalong National Park.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

The Eastern Bent-wing Bat was recorded via Anabat detector along an ecotone of swamp forest and wet open forest in the north of the study area (Figure 5.15). Maternity sites and primary roosting habitat (natural caves) did not occur in the subject site (or study area). However, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow. Although, similar man-made structures occur widely in the locality.

Therefore, the subject site provides known foraging habitat for the Eastern Bent-wing Bat in rainforest, swamp forest, wet open forest and cleared land with scattered trees habitats and potentially suitable over-wintering roosts in man-made structures over Chittaway Creek. As the study area is associated with relatively fertile soils and riparian/swampy habitat of Chittaway Creek, Bangalow Creek and Ourimbah Creek floodplain, the subject site could be considered of moderate significance in the project locality.

5.13.1.2 HABITAT UTILISATION

The Eastern Bent-wing Bat is an insectivorous cave-dwelling bat that largely relies on naturally occurring caves for breeding and roosting purposes. Across their range, maternity sites are known from 12 locations, of which none occur in the Hunter–Central Rivers CMR (Office of Environment & Heritage 2016n). Analysis of banding data suggest that movements are typically within 100 kilometres of maternity or non-maternity sites, giving an effective range from maternity sites of up to 200 kilometres (Wilson 2003); however populations are known to disperse within about 300 kilometres of maternity caves (Office of Environment & Heritage 2016n). The Eastern Bent-wing Bat hunts over forested areas, catching moths and other flying insects above the canopy (Office of Environment & Heritage 2016n).

In the Hunter–Central Rivers CMR the Eastern Bent-wing Bat is known from 1,114 records, of which 35 occur in the project locality (Office for Environment & Heritage 2016a). As no maternity caves or naturally occurring roosting structures occur in the study area, individuals of the Eastern Bent-wing Bat are likely to occur as over-wintering or dispersing individuals, as they are known to over-winter up to 300 kilometres from maternity sites. Whilst man-made structures such as bridges in the study area may provide supplementary over-winter roost sites, such structures are likely to be widespread in the locality and region. A corollary is that individuals occurring in the subject site are likely to be of low to moderate significance to the viability of this species in the project locality.

5.13.1.3 DESCRIPTION OF VEGETATION

As the Eastern Bent-wing Bat forages for insects above the canopy of forested areas, habitat for this species in the project study area incorporated rainforest, swamp forest, wet open forest and cleared land with scattered trees (Table 5.36, Figure 5.15). As cleared land type habitat will effectively still be available post construction of the project, it is not considered further.

Table 5.36 Eastern Bent-wing Bat habitat in the project study area

Fauna habitat description	Corresponding vegetation community
Rainforest (and associated creeklines)	Jackwood – Lilly Pilly – Sassafras Rainforest High
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.13.2 Assessment of habitat

5.13.2.1 DESCRIPTION OF HABITAT VALUES

Foraging habitat for the Eastern Bent-wing Bat included rainforest, swamp forest and wet open forest (Figure 5.15, Table 5.36). Importantly, no critical habitat structures, such as maternity caves or primary roosting sites (natural caves separate to maternity caves) were recorded in the study area. However, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow. Although, similar man-made structures are likely to occur widely in the locality.

5.13.2.2 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 30.2 hectares of foraging habitat for the Eastern Bent-wing Bat, which represents approximately 78 per cent of the study area (Table 5.37).

Table 5.37 Extent of Eastern Bent-wing Bat habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within Subject site	extent within study area	Extent within locality (5 km)
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	937.4
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	25.5	32.4	609.3
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Moderate			
	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest Low			
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

(1) Note: 1: Extent within locality estimated from similar habitat type in Wyong LGA vegetation mapping and Gosford LGA vegetation mapping.

5.13.2.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential properties, construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah creek in the north. Whilst the project will contribute to and add incrementally to existing fragmentation within the locality, it is not likely to exacerbate the general effects of fragmentation at the landscape scale. Nonetheless, potential impacts of the incremental addition to fragmentation on the Eastern Bent-wing Bat are not likely to be significant given the mobile nature of this species and its foraging ecology.

5.13.2.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrribalong National Park. The project is not likely to directly or indirectly impact Eastern Bentwing-bat in these reserves.

5.13.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

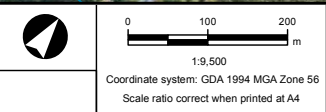
Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.38.

Table 5.38 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



Map: 2202522A_GIS_F048_A1	Author: suansrir
Date: 2/06/2016	Approved by: -



Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.15
Eastern Bent-wing Bat habitat

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5.14 Southern Myotis

The Southern Myotis is listed as Vulnerable under the TSC Act.

DISTRIBUTION

The Southern Myotis is found in a coastal band from western Victoria, north across the top-end to the north-west of Australia. Although it can be found inland along major rivers, the Southern Myotis is rarely found more than 100 kilometres inland (Office of Environment & Heritage 2016n). The project study area does not occur at the limit of distribution of the Southern Myotis.

HABITAT AND ECOLOGY

The Southern Myotis forages over streams and pools where it catches invertebrates and small fish by raking their feet across the water surface (Office of Environment & Heritage 2016n). The foraging strategy of the Southern Myotis generally influences their propensity to roost close to water in a variety of structures, inclusive of caves, mine shafts, hollow-bearing trees, storm water culverts, under bridges, in dense foliage and buildings (Office of Environment & Heritage 2016n). Breeding habitat for the Southern Myotis is also thought to coincide with roosting habitat (Office of Environment & Heritage 2016n).

RECOVERY PLAN

The TSC Act provides for the preparation of recovery plan. No such plan has been prepared for the Southern Myotis. The NSW OEH has assigned the Southern Myotis to the landscape species management stream under the *Saving our Species* (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESSES

The NSW OEH and Heritage have detailed the following threats to the Southern Myotis (Office of Environment & Heritage 2016n):

- Loss or disturbance of roosting sites
- Clearing adjacent to foraging areas
- Application of pesticides in or adjacent to foraging areas
- Reduction in stream water quality affecting food resources.

The project will add incrementally to the loss of riparian type habitats along Bangalow Creek and Chittaway Creek, including potential foraging habitat along Chittaway creek line for the expansion of the existing rail corridor.

With regard to the Southern Myotis, KTPs that the project is likely to be commensurate with, include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains
- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees.

5.14.1 Discussion of local and regional abundance

5.14.1.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The Southern Myotis is found primarily in coastal environments from the Kimberley region in Western Australia, through coastal Northern Territory, Queensland, New South Wales and Victoria, with some inland populations following major rivers (e.g. Murray and Murrumbidgee River). In NSW, it is likely that the Southern Myotis is sparsely dispersed and that they are most likely to be recorded on large streams in the lower end of catchments (Anderson *et al.* 2006).

In the project locality the Southern Myotis is known from 12 records, 10 of which occurred to the north of the study area in association with large bodies of water, including Mardi Dam, Wyong River, Ourimbah Creek and Wyong South Sewage Works (Office for Environment & Heritage 2016a). This pattern of records, while not discounting such records are dependent on ecological survey data, correlates with research undertaken by Anderson *et al.* (Anderson *et al.* 2006) in northern NSW that suggested that records of the Southern Myotis are significantly associated with larger, more permanent waterways.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

Research by Anderson *et al.* (Anderson *et al.* 2006) suggest that in northern NSW the Southern Myotis is sparsely dispersed across streams in forests and that they are most likely to be recorded on large streams in the lower end of catchments. In the region (Sydney Basin bioregion), the Southern Myotis is known from 1,504 records (Office for Environment & Heritage 2016a), of which 974 occur within the Hunter–Central Rivers CMR. The species' is also known from the Border Rivers–Gwydir, Hawkesbury–Nepean, Hunter–Central Rivers, Lachlan, Murray, Murrumbidgee, Northern Rivers, Southern Rivers and Sydney Metro Catchment Management Regions (Office of Environment & Heritage 2016n). As this species is sparsely dispersed across suitable streams within its distribution, individuals in the locality could be considered moderately significant.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

In NSW, approximately 45 per cent of this species' range occurs on NSW National Parks and Wildlife estate, however, no priority sites have been identified for appropriate management (Office for Environment & Heritage 2016c). Furthermore, as this species' distribution is largely confined to the coastal belt, sparsely occurring in larger streams in the lower end of catchments, its habitat is likely to be burdened due to the overlaying of urbanisation, which is attracted by the same coastal locations. Accordingly, potential habitat for this species in not considered to be secure in the long term. In the project locality however, several conservation estates that may provide habitat for this species include, Jiliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrabalong National Park.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Potential foraging habitat for the Southern Myotis was largely restricted to Chittaway Creek and Bangalow Creek and associated riparian vegetation (Figure 5.16). Roosting structures such as caves did not occur in the subject site (or study area), whilst rainforest and swamp forest type habitats were generally of an insufficient age-class to develop hollows. Nevertheless, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow.

Therefore the subject site provides potential foraging habitat for the Southern Myotis, in the form of Bangalow Creek and Chittaway Creek and potential roost structures across Chittaway Creek. Whilst the

majority of records for this species' in the locality are associated with larger bodies of water to the north of the study area, the subject site could be considered of moderate significance in the project locality.

5.14.1.2 HABITAT UTILISATION

The Southern Myotis is strongly associated with streams, permanent waterways and wetlands, being recorded most frequently in these habitats at low elevations in the lower reaches of catchments (Churchill 2008). In northern NSW, records for Southern Myotis suggest that they are significantly associated with larger, more permanent waterways (Anderson *et al.* 2006). Southern Myotis generally roost in small groups of 10 to 15 individuals in caves, mine shafts, culverts, under bridges, tree hollows and dense foliage, and are known to forage over streams and pools catching insects and small fish by raking their feet across the water surface (Office of Environment & Heritage 2016n).

In the Hunter–Central River CMR the Southern Myotis is known from 974 records, of which 12 occur in the project locality (Office for Environment & Heritage 2016a). In the project locality, 10 of these records occur to the north of the study area in association with large bodies of water including, Mardi Dam, Wyong River, Ourimbah Creek and Wyong South Sewage Works (Office for Environment & Heritage 2016a). Although the Southern Myotis would use appropriate habitat along most creek lines and rivers in the locality the most significant habitats would likely include those large waterbodies described above. Nonetheless, as this species' is sparsely dispersed across suitable streams, available waterbodies with adjacent riparian vegetation, as occurring in the subject site, could be considered significant.

5.14.1.3 DESCRIPTION OF VEGETATION

In the project study area, habitat for the Southern Myotis was limited to rainforest type habitat in association with Chittaway Creek and Bangalow Creek (Table 5.39, Figure 5.16). Although the Southern Myotis is known from swamp forest type habitats, within the study area such habitat was not observed to contain open water bodies suitable for the foraging strategies employed by this species. In addition, the relatively young age cohort of canopy strata was insufficient for the development of numerous hollow-bearing trees; thus reducing the potential for this species to use such resources in this habitat adjacent to favoured foraging environments.

Table 5.39 Southern Myotis habitat in the project study area

Fauna habitat description	Corresponding vegetation community
Rainforest (and associated creek lines)	Jackwood – Lilly Pilly – Sassafras Rainforest High

5.14.2 Assessment of habitat

5.14.2.1 DESCRIPTION OF HABITAT VALUES

Foraging habitat for the Southern Myotis was largely restricted to Chittaway Creek and Bangalow Creek and associated fringing rainforest habitat. Roosting structures such as caves did not occur in the study area and trees within onsite rainforest habitat were generally of an insufficient age-class for development of hollows. Due to the relatively young age cohort of canopy strata over much of the study area, there was generally a paucity of hollow-bearing trees observed throughout. Nevertheless, the Southern Myotis is known to use a variety of structures to roost, and general lack of caves and tree hollows does not preclude the presence of other potential roosting structures. The existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow.

5.14.2.2 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 1.1 hectares of potential foraging habitat for the Southern Myotis, which represents approximately 69 per cent of the study area (Table 5.40). Due to their highly specialised foraging ecology the Southern Myotis is strongly associated with streams, permanent waterways and wetlands. Their foraging mode also appears to influence roost selection behaviour, with roosts typically occurring in riparian vegetation within 100 metres of favoured foraging grounds. Estimates of the extent of potentially suitable habitat in the locality was calculated by applying a 10 metre buffer to water courses in the locality that corresponded with mapped vegetation layers. Alluvial riparian vegetation communities together with freshwater wetlands and rainforest were then selected to represent potential habitat for Southern Myotis in the locality.

Table 5.40 Extent of Southern Myotis habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km) ¹
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	261.4

- (1) Potentially suitable habitat in the locality for this species was estimated by applying a 10 m buffer to water courses in the locality that corresponded with mapped vegetation (i.e. Wyong and Gosford vegetation mapping). Alluvial riparian vegetation communities together with freshwater wetlands and rainforest were selected to represent potential habitat for Southern Myotis in the locality.

5.14.2.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of rainforest and foraging habitat along Chittaway Creek, in association with the existing rail corridor. Nonetheless, the Southern Myotis is a mobile species that would not be impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.14.2.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrribalong National Park. The project is not likely to directly or indirectly impact Southern Myotis in these reserves.

5.14.3 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

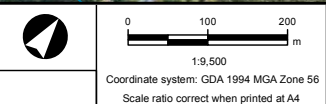
Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.41.

Table 5.41 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



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 Author: suansrir
 Date: 2/06/2016
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New Intercity Fleet Maintenance Facility Project
Figure 5.16
 Southern Myotis habitat

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5.15 Grey-headed Flying-fox

5.15.1 Conservation status

The Grey-headed Flying-fox is listed as Vulnerable under the TSC Act and EPBC Act.

The Grey-headed Flying-fox was observed flying over the project study area during two separate nocturnal survey events (Figure 5.17). Although this species was not specifically observed using habitat within the study area, this species is a blossom nomad that is known to commute long distances as food availability varies over time.

DISTRIBUTION

This species is generally found within 200 kilometres of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia (Department of the Environment 2016d). At any one time, the majority of animals only occupy a small proportion of this entire range (NSW National Parks and Wildlife Service 2001b), as the species selectively forages where food is available. Consequently, patterns of occurrence and relative abundance within its distribution varies between seasons and between years (Department of the Environment 2016d). The project study area does not occur at the limit of the known distribution of the Grey-headed Flying-fox.

HABITAT

The Grey-headed Flying-fox typically occur in subtropical and temperate rainforests, tall sclerophyll forests, woodlands, heaths, swamps and mangroves, as well as urban gardens and fruit crops (Churchill 2008; NSW National Parks and Wildlife Service 2001b). Approximately 15 per cent of the species' distribution occurs on reserves within NSW National Parks and Wildlife Service estate (Office for Environment & Heritage 2016c; Office of Environment & Heritage 2016n). Accordingly, the Grey-headed Flying-fox is not considered to be adequately represented in conservation reserves.

ECOLOGY

This species is considered an important pollinator and seed disperser of native trees, as they forage on the nectar and pollen of *Eucalyptus*, *Angophora*, *Melaleuca* and *Banksia*, as well as fruit of rainforest trees and vines (NSW National Parks and Wildlife Service 2001b; Van Dyck & Strahan 2008). While the majority of foraging events occur within 20 kilometres of their day roost, some individuals will disperse and commute up to 50 kilometres (Van Dyck & Strahan 2008).

Grey-headed Flying-foxes are highly mobile and as the availability of native fruits, nectar and pollen varies over time and throughout their range, they respond to this by migrating between camps up and down the east coast, sometimes travelling hundreds of kilometres (NSW National Parks and Wildlife Service 2001b). The population concentrates in May and June in northern NSW and Queensland where animals exploit winter-flowering trees such as Swamp Mahogany, Forest Red Gum and Paperbark, dispersing south during the summer (Department of the Environment and Heritage 2003).

Grey-headed Flying-fox roost in large colonies of up to tens of thousands and may be shared with Little Red Flying-fox and Black Flying-fox (Churchill 2008). Camps are generally located in gullies with dense vegetation (such as mangrove, rainforest, *Melaleuca* and *Casuarina*), close to water and generally located within 20 kilometres of a regular food source (NSW National Parks and Wildlife Service 2001b). Site fidelity to camps is high with some camps in NSW used for over a century (NSW National Parks and Wildlife Service 2001b). These bats usually return annually to particular camps for rearing young (NSW National Parks and Wildlife Service 2001b).

RECOVERY PLAN

A Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* was prepared in 2009 (Department of Environment Climate Change and Water NSW 2009). The NSW OEH has assigned the Grey-headed Flying-fox to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by habitat loss and degradation. Examples of how they could be managed include control of vegetation clearing and management of national parks and reserves (Office for Environment & Heritage 2016c).

THREATS AND KEY THREATENING PROCESS

The NSW OEH and Heritage have detailed the following threats to the Grey-headed Flying-fox (Office of Environment & Heritage 2016n):

- Loss of roosting and foraging sites
- Electrocutation on powerline, entanglement in netting and barbed-wire
- Heat stress
- Conflict with humans
- Incomplete knowledge of abundance and distribution across the species' range.

The project will add incrementally to the loss of seasonal/intermittent foraging resources for the Grey-headed Flying-fox during. With regard to the Grey-headed flying-fox, the project is likely to be commensurate with one KTP, being clearing of native vegetation. This KTP is not likely to significantly affect this species in the locality.

5.15.2 Discussion of local and regional abundance

5.15.2.1 DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

DISCUSSION OF KNOWN POPULATIONS IN THE LOCALITY

The national population of the Grey-headed Flying-fox is structured spatially into colonies. However there are no distinct or separate populations due to constant genetic exchange and movement between camps throughout the entirety of the species' geographic range (Department of the Environment 2016d).

The Grey-headed Flying-fox is a highly mobile and nomadic species that relies on food sources that largely have irregular patterns of production. Consequently, patterns of occurrence and abundance within its distribution can vary between seasons and years (Department of Environment Climate Change and Water NSW 2009). When considering this species in context of the project locality (five kilometre radius of the project study area), this species is usually present intermittently and irregularly (Department of Environment Climate Change and Water NSW 2009; Eby, P & Lunney 2002). A review of the National Flying-fox Monitor Reviewer (Department of the Environment 2016b) indicates that no Flying-fox camp occurs in the project locality. The nearest nationally important Flying-fox camp occurs some 52 kilometres to the project's north-east in Blackbutt Reserve (Newcastle), NSW (Department of the Environment 2016b). However, four other Flying-fox camps are known in proximity to the project study area:

- Jiliby, which occurs approximately 9 kilometres to the north of the project
- Watanobbi, which occurs approximately 7 kilometres to the north north-east of the project
- Wingello Creek (Gosford), which occurs approximately 8.5 kilometres to the south of the project
- Matcham, which occurs approximately 8.5 kilometres to the south-east of the project.

Between 1986 and 1990, the movements and numbers of Grey-headed Flying-fox were recorded at the Matcham colony, near Gosford, NSW (Parry-Jones 1992). Over the four year survey period, it was found that population numbers were high during the March to May period that corresponds with the mating period (McGuckin 1987). Dependent on the year, there was a gradual or rapid abandonment of the Matcham site, as individuals dispersed to scattered sites in the surrounding area (Parry-Jones 1992). More recent surveys as part of the National Flying-fox Monitoring Program (Department of the Environment 2016b) did not record Grey-headed Flying-fox at the Matcham or Jiliby camp on survey dates between February 2013 and August 2015 (Department of the Environment 2016b). Grey-headed Flying-fox was recorded at the Watanobbi camp in May and November of 2015 and in November 2014 at Wingello Creek.

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

Grey-headed Flying-foxes are partial migrants whereby some individuals migrate and others are considered sedentary (Fleming 2003; Tidemann, C. R., Nelson, J. 2004). A small number of local areas support continuous presence and others are associated with regular, annual patterns of use (Department of Environment Climate Change and Water NSW 2009). At a regional scale, the metropolitan areas of Newcastle and Sydney are occupied continuously due to a diverse garden and street scape that provide continuous food sources together with suitable vegetation for roosting. Similarly, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration (Department of Environment Climate Change and Water NSW 2009; Department of the Environment 2016d; Eby, P & Lunney 2002). Camps with annual patterns of occupation are known to occur in coastal areas and are common north of Batemans Bay, NSW (Department of Environment Climate Change and Water NSW 2009). Four Flying-fox camps are known in proximity to the project study area, which are used intermittently (Department of the Environment 2016b). In the Sydney Basin bioregion there were approximately 7,108 records for the Grey-headed Flying-fox (Office for Environment & Heritage 2016a), of which 27 occur within project locality (Office for Environment & Heritage 2016a). Accordingly, the local individuals of the Grey-headed Flying-fox could be considered of moderate significance within the region.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

In NSW, approximately 15 per cent of the Grey-headed Flying-fox distribution occurs on reserves within NSW National Parks and Wildlife Service estate (Office for Environment & Heritage 2016c). Accordingly, potential habitat for this species is not considered to be secure in the long term. In the project locality however, several conservation estates that are likely to provide seasonal foraging resources for this species include, Jiliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina nature Reserve and Wyrribalong National Park.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

Two individual Grey-headed Flying-foxes were observed flying over the project study area during two separate nocturnal survey events (Figure 5.17); however no Grey-headed Flying-fox camp was observed therein and none are known to occur in the project locality (Department of the Environment 2016b). The subject site is likely to provide intermittent foraging resources from habitats including rainforest, swamp forest and wet open forest. However, due to the relatively large number of *Eucalyptus robusta* within swamp forest type habitats, it is considered that any Grey-headed Flying-fox foraging events within the subject site would correspond with the intermittent flowering events of this species. *Eucalyptus robusta* is a winter-flowering eucalypt with strong and profuse flowering events every three years or so. In the project locality, the subject site contained approximately 25.5 hectares of swamp forest habitat, which is 4.2 per cent occurring in the locality. Therefore, the subject site could be considered of moderate to high importance during years when *E. robusta* is flowering substantially.

5.15.2.2 HABITAT UTILISATION

The Grey-headed Flying-fox is known from a variety of habitats where they primarily feed on blossom and fruit in canopy vegetation, with the majority of animals foraging on nectar and pollen from *Eucalyptus*, *Corymbia*, *Angophora*, *Melaleuca* and *Banksia* (Department of Environment Climate Change and Water NSW 2009). Grey-headed Flying-foxes forage over extensive areas, typically commuting distances <20 kilometres during nightly foraging events (Tidemann, C. R. 1999). However one-way commutes of up to 50 kilometres have been recorded between camps and foraging areas (Eby, P. 1991).

In the Wyong LGA there are 97 records for the Grey-headed Flying-fox (Office for Environment & Heritage 2016a), of which 27 occurred in the project locality. A review of the National Flying-fox Monitor Reviewer (Department of the Environment 2016b), indicates that the nearest nationally important Flying-fox camp occurs some 52 kilometres to the project's north-east in Blackbutt Reserve (Newcastle), NSW (Department of the Environment 2016b). Whilst no Flying-fox camp is known to occur within the subject site or project locality (Department of the Environment 2016b), four camps are known in proximity to the study area, including Jiliby, Watanobbi, Wingello Creek and Matcham. The Grey-headed Flying-fox is likely to occur in the project locality intermittently to exploit seasonal foraging resources, however, such resources may not be available every year. Indeed, while the majority of eucalypts have regular seasonal flowering schedules they do not necessarily flower every year (Department of Environment Climate Change and Water NSW 2009).

5.15.2.3 DESCRIPTION OF VEGETATION

Vegetation in the study area varies in its suitability for Grey-headed Flying-fox. Swamp forest habitat (mapped as *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest) within the study area occurs in three different condition classes High, Medium and Low quality (see section 4.3.1.1). Areas of low and medium quality did not have a canopy layer or suitable foraging habitat in the understorey strata for Grey-headed Flying-fox. Only high quality swamp forest habitats have Swamp Mahogany trees, which are suited to the foraging habits of Grey-headed Flying-fox as mapped in this habitat type in Figure 5.17. Rainforest and wet open forest habitat types also provide potential foraging habitat for the Grey-headed Flying-fox in the study area.

Table 5.42 Grey-headed Flying-fox habitat in the project study area

Fauna habitat description	Corresponding vegetation community
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High

5.15.3 Assessment of habitat

5.15.3.1 DESCRIPTION OF HABITAT VALUES

Regarding the Grey-headed Flying-fox, the project study area largely comprised foraging resources that would likely be available on an intermittent and seasonal basis. Although Grey-headed flying-fox camps are commonly located in close forest habitats, including *Melaleuca* swamps or stands of *Casuarina* in close proximity to creek and rivers (Hall 2000), no evidence of a camp was observed in the study area during field surveys and none are known to occur within the project locality (Department of the Environment 2016b).

Potential foraging habitat for Grey-headed Flying-fox in the project study area included swamp forest, rainforest and wet open forest type habitats (Table 5.42, Figure 5.17). Due to the relatively large numbers of *Eucalyptus robusta* within the study area, it is likely that the study area's swamp forests would be used seasonally by the Grey-headed Flying-fox, during *E. robusta* flowering events. *Eucalyptus robusta* is a winter-flowering eucalypt with strong and profuse flowering events every three years or so. Rainforest habitat

associated with Chittaway Creek contained a variety of native broad-leaved trees that would provide seasonal fruits, while the canopy stratum of wet open forest (*E. pilularis* with some areas also containing *Corymbia gummifera* and *E. saligna*), would provide summer seasonal nectar foraging resources for this species.

5.15.3.2 EXTENT OF HABITAT REMOVAL

Within the subject site the project is likely to affect approximately 24.3 hectares of potential foraging habitat for the Grey-headed Flying-fox, which represents approximately 76 per cent of the study area (Table 5.43).

Table 5.43 Extent of Grey-headed Flying-fox habitat removal

Fauna habitat description	Corresponding vegetation community	Extent within subject site	extent within study area	Extent within locality (5 km)
Rainforest	Jackwood – Lilly Pilly – Sassafras Rainforest High	1.1	1.6	937.4
Swamp Forest	<i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm Forest High	19.6	25.7	609.3
Wet Open Forest	Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest High	3.6	4.5	3,369.8

5.15.3.3 CONSIDERATION OF CORRIDORS

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity for less mobile species of animal in an otherwise managed landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Nonetheless, the Grey-headed Flying-fox is a highly mobile and nomadic species that would not be impacted by marginal increases to existing barriers and fragmentation in the project locality.

5.15.3.4 IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the project locality, including Jilliby State Conservation Area, Palm Grove Nature Reserve, Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and Wyrabalong National Park. The project is not likely to directly or indirectly impact Grey-headed Flying-fox in these reserves.

5.15.4 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the ‘do nothing option’ are provided in section 3.1 of Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a). The subject site was selected as the preferred location from 24 site options giving consideration to environmental, heritage, ecological and engineering values.

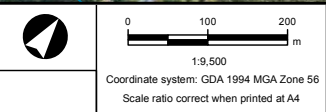
Opportunities to reduce the clearing of native vegetation were investigated during detailed design. The consideration of ecological constraints resulted in the reduction of Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20%. See reductions across all vegetation communities after ecological input at the detailed design phase in Table 5.44.

Table 5.44 The reduction of impacts to vegetation communities by amending the subject site during detailed design

Vegetation community	Fauna habitat	Previous extant within subject site (ha)	Revised extant within subject site (ha)	Vegetation saved by amending the subject site (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest ¹	Swamp Forest	31.8	25.5	6.3
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.1	0.4
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.6	0.3
Cleared and disturbed land	Cleared land	13.4	12.1	1.3



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Date: 2/06/2016	Approved by: -



Note: Design is indicative only.
Subject to detailed design

New Intercity Fleet Maintenance Facility Project
Figure 5.17
Grey-headed Flying-fox habitat

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6 ASSESSMENT OF LIKELY IMPACTS ON THREATENED ECOLOGICAL COMMUNITIES

6.1 Assessment of likely impacts on threatened ecological communities (Endangered or Critically Endangered)

Impacts associated with the project likely to have detrimental effects on threatened ecological communities (both Endangered and Critically Endangered) will be similar to those of threatened species and/or populations as discussed in section 5.1.1.

This section provides an assessment of these impacts on threatened ecological communities targeted in this SIS to determine which will be affected by the project and subsequently require further assessment in section 6.2.

6.1.1 Assessment of subject species likely to be affected

With consideration of targeted field surveys completed in the study area, vegetation and habitat mapping, a review of available literature and consideration of likely impacts, the list of threatened ecological communities identified as being subject species for the SIS were refined to a list of threatened ecological communities affected by the project below (Table 6.1).

Table 6.1 Refinement of affected threatened ecological communities

Threatened ecological community	Potential to be affected by the project	Affected species?
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	<p>Swamp Sclerophyll Forest on the Coastal Floodplains on the NSW North Coast, Sydney Basin and South-East Corner Bioregion is listed as Endangered under the TSC Act.</p> <p>One vegetation community within the study area (PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast) is considered consistent with the Swamp Sclerophyll Forest threatened ecological community and has been previously recorded during previous surveys (EMM 2015b; GHD 2014b).</p> <p>Swamp Sclerophyll Forest occupied 32.4 hectares within the study area. The project will require the removal of approximately 25.5 hectares from within the subject site whilst the remaining 6.9 hectares will be retained. Subsequently, the PEA indicated that the project would likely have a significant impact upon this community (EMM 2015b).</p> <p>The project will require the removal of 25.5 hectares of PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast which is consistent with the Swamp Sclerophyll threatened ecological community. Consequently, Swamp Sclerophyll Forest is considered an affected threatened ecological community and is subject to further detailed assessment in section 6 of this report.</p>	Yes. Detailed assessment provided in section 6.1.
Lowland Rainforest in the NSW North Coast	Lowland Rainforest in the NSW North Coast and Sydney Basin bioregion is listed as Endangered under the TSC Act. To be listed as	No

**Threatened
ecological
community**
Potential to be affected by the project
Affected species?

and Sydney Basin
Bioregions

Endangered under the TSC Act vegetation must be consistent with the criteria outlined in the Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion NSW Scientific Committee final determination (Office of Environment and Heritage 2016c).

As outlined in the final determination, in order to form part of the Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion – endangered ecological community listing, the vegetation must form part of the Subtropical Rainforests class described by Keith (2004) or form part of a related structurally complex form of Dry Rainforests class. Whilst the final determination generally excludes warm temperate rainforest from the listing, three Floyd (1990) suballiances of this rainforest subformation in NSW are included if they occur in conjunction with any of the subtropical Floyd (1990) suballiances listed in paragraph 4 of the determination. The three warm temperate rainforest (Floyd 1990) suballiances that are included if they occur in conjunction with those suballiances in paragraph four include:

- 33. *Ceratopetalum apetalum* – *Schizomeria* – *Argyrodendron* spp – *Sloanea* suballiance
- 34. *Ceratopetalum* – *Diploglottis australis* – *Acmena smithii* suballiance
- 35. *Ceratopetalum* – *Schizomeria* – *Caldcluvia* suballiance.

Consideration of this community against the above criteria identified that the PCT 1528/BVT HU742 Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest of the Central Coast within the study area:

- Forms part of the Northern Warm Temperate Rainforests **NOT** the Subtropical Rainforests class described by Keith (2004)
- Floristic characteristics of the vegetation recorded within the Project site align to suballiance 37 **NOT** to any of the subtropical suballiances detailed in paragraph four of the final determination based on the following:
 - Examination of VIS Classification 2.1 (Office of Environment and Heritage 2016f) identifies the reference community for this PCT as MU 9 Jackwood/Lilly Pilly riparian rainforest of the Central Coast (Somerville 2009). This community has also been aligned to the Northern Warm Temperate Rainforests class and identified as having a relationship to PCT 768 Coachwood – Crabapple warm temperate rainforest of the NSW North Coast Bioregion and northern Sydney Basin Bioregion. The reference communities for PCT 768 are Floyd (1990) suballiances 35 *Ceratopetalum* – *Schizomeria* – *Caldcluvia* suballiance and 37 *Ceratopetalum/Schizomeria* – *Acmena* – *Doryphora*.
 - NSW suballiance 35 generally occurs north of Barrington Tops to the Queensland Border. In areas to the south of the Hunter River, *Caldcluvia* is replaced by *Acmena* and *Doryphora* and are associated with suballiance 37 Floyd (1990).
 - Characteristics of the vegetation within the study area that align with suballiance 37 (Floyd 1990) include:
 - South of the Hunter River

Threatened ecological community	Potential to be affected by the project	Affected species?
	<ul style="list-style-type: none"> – Below 750 metres above sea level (generally below 20 metres above sea level within the Project site) – High abundances of <i>Acmena</i> and presence of <i>Doryphora</i> – Scattered <i>Eucalyptus saligna</i> and <i>Syncarpia glomulifera</i> – Sandstone, alluvium, gravel, sand, silt and clay soils derived from Quaternary and Triassic geologies. <p>In conclusion, PCT 1528/BVT HU742 Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest of the Central Coast within the study area does not form part of the Subtropical Rainforests class as described by Keith (2004) and does not align with the three warm temperate rainforest Floyd (1990) suballiances listed in paragraph 4 of the determination. Therefore this vegetation within the study area is not considered to form part of the threatened ecological community listed as Endangered under the TSC Act; Lowland Rainforest in the North Coast and Sydney Basin Bioregion.</p> <p>Consequently, Lowland Rainforest is not considered an affected threatened ecological community and is not subject to further detailed assessment in section 6 of this report.</p>	

6.2 Swamp Sclerophyll Forest on Coastal Floodplain of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Swamp Sclerophyll Forest on the Coastal Floodplains on the NSW North Coast, Sydney Basin and South-East Corner Bioregion (Swamp Sclerophyll Forest) is listed as Endangered under the TSC Act. To be listed as Endangered under the TSC Act vegetation must be consistent with the criteria outlined in the Swamp Sclerophyll community NSW Scientific Committee Final Determination (NSW Scientific Committee 2011b).

One vegetation community within the study area (PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast) is considered consistent with the Swamp Sclerophyll Forest threatened ecological community based on the following characteristics which align with the criteria outlined in the NSW Scientific Committee Determination for the community:

- Study area is located within the Sydney Basin Bioregion and Wyong LGA
- Associated with humic clay and sandy loams on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains
- Occurred at elevations approximately 10–20 metres above sea level
- Occurred as open forest and as partially cleared areas with scattered canopy trees
- Floristic composition characteristic of the threatened ecological community i.e. canopy, sub-canopy, shrub and groundcover species.

The location of Swamp Sclerophyll Forest within the study area and subject site are provided in Figure 4.4.

6.2.1 Discussion of conservation status

Swamp Sclerophyll Forest is listed as endangered under the TSC Act although this community is not listed under the Commonwealth EPBC Act.

6.2.1.1 DISTRIBUTION

The original extent of Swamp Sclerophyll Forest is unknown however it is estimated that the current extent is less than 30 per cent of the original. The community is now restricted to coastal regions within the Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven LGAs. The community may also occur within other areas of the NSW North Coast, Sydney Basin and South East Corner Bioregions (Office of Environment & Heritage 2016k).

6.2.1.2 HABITAT

Swamp Sclerophyll Forest is associated with humic clay soils and sandy loams on waterlogged or periodically inundated alluvial flats and drainage lines along coastal floodplains. The community is generally restricted to 20 elevation however is known on occasion to occur at elevations up to 50 metres (Office of Environment & Heritage 2016k).

In the context of the study area, the site is bounded by Ourimbah Creek and its floodplains to the north and east and by Bangalow Creek and Chittaway Creek in the west. The study area also forms part of the larger estuarine Tuggerah Lake coastal floodplain. The underlying soils are derived from Quaternary alluvium and comprise of sands, silts and clays (Coffey 2016).

6.2.1.3 ECOLOGY

Swamp Sclerophyll Forest typically occurs as an open forest however it is also recorded as scrub, fernland, tall reedland or sedgeland, particularly where vegetation clearing or disturbance has occurred. The floristic and structural composition of the community is thus highly variable and determined by the following attributes (NSW Scientific Committee 2011b; Office of Environment & Heritage 2016k):

- Frequency and duration of waterlogging
- Texture, salinity, nutrient and moisture content of the soil
- Latitude
- Land use disturbances such as vegetation clearing, invasion of weeds, grazing and cropping.

6.2.1.4 RECOVERY PLAN

To date, no recovery plan has been prepared for Swamp Sclerophyll Forest. The OEH are currently developing a targeted approach to managing threatened ecological communities. In the interim they have provided a set of 12 management actions that have been identified for the community's protection. The interim management actions developed by the OEH focus predominantly on research required to fill gaps in knowledge to allow for targeted management moving forward. The interim management actions include (Office of Environment & Heritage 2016k):

- Undertake research to determine minimum fire frequency
- Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants
- Prepare identification and impact assessment guidelines and distribute to consent and determining authorities
- Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land

- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance
- Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made
- Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan and associated PAS actions
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required
- Investigate the ecology of Swamp sclerophyll forest species with particular emphasis on the importance of drying and wetting cycles in maintaining ecosystem health
- Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works
- Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT – all known provenances (conservation collection)
- Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).

6.2.1.5 THREATS AND KEY THREATENING PROCESSES

The OEH have identified the following processes that may threaten the survival of Swamp Sclerophyll Forest (Office of Environment & Heritage 2016k):

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation
- Flood mitigation and drainage works
- Management of water and tidal flows
- Landfilling and earthworks associated with urban and industrial development
- Grazing and trampling by stock and feral animals (particularly pigs)
- Changes in water quality, particularly increased nutrients and sedimentation
- Weed invasion
- Climate change
- Activation of acid sulfate soils
- Removal of dead wood
- Rubbish dumping
- Frequent burning which reduces the diversity of woody plant species.

The project will add incrementally to the loss of known habitat for this community and alter local surface drainage hydrology within the subject site. In addition the project has potential to increase pollution, alter fire regimes and introduce weed species if the appropriate mitigation measures are not implemented.

With regard to Swamp Sclerophyll Forest, KTPs that the project is likely to be commensurate with, include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands – Swamp Sclerophyll Forest occurs within the study area and is associated waterlogged or periodically inundated alluvial flats and drainage lines on coastal floodplains. The proposed works are likely to modify the natural hydrology of the study area and therefore may affect this community.

- Clearing of native vegetation – the proposed activities would require the removal of 25.5 hectares of Swamp Sclerophyll Forest. This would include the removal of dead trees, fallen timber and hollow bearing trees.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition – dependent upon APZs and management.
- Infection of native plants by *Phytophthora cinnamomi* - proposed activities (i.e. vegetation clearing and earthworks) has potential to introduce pathogens if appropriate mitigation measures are not implemented.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae – see above.
- Invasion and establishment of exotic vines and scramblers – proposed activities have potential to result in invasion and/or spread of exotic species during the construction phase (i.e. vegetation clearing and earthworks activities) and operation phase of the project (movement, storage and maintenance of trains).
- Invasion and establishment of Scotch broom (*Cytisus scoparius*) – see above.
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata* – see above.
- Invasion, establishment and spread of *Lantana camara* – see above.
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed) – see above.
- Invasion of native plant communities by exotic perennial grasses – see above.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants – see above.
- Loss of hollow-bearing trees – see above.
- Removal of dead wood and dead trees – see above.

Under the *Saving our Species* conservation program, OEH have also established seven activities as a targeted approach to managing Swamp Sclerophyll Forest (Office of Environment & Heritage 2016k). The proposed works have the potential to impact on one of these activities being 'Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning processes.

6.2.1.6 SIGNIFICANCE WITHIN A LOCAL CONTEXT

Swamp Sclerophyll Forest currently occupies approximately 25.5 hectares within the subject site (Figure 4.4). Within the study area the project will retain approximately 6.9 hectares of Swamp Sclerophyll Forest in similar condition to that being removed. The current tenure of the study area is comprised of private residences and land owned by the former Wyong Shire Council (now part of Central Coast Council) both of which are zoned as either E2 (Environmental Conservation), E3 (Environmental Management) or Infrastructure (SP2) under the provisions of the Wyong Local Environment Plan.

The local occurrence of Swamp Sclerophyll Forest is considered to occur as a patchwork of swampy vegetation associated with the lower Ourimbah Creek catchment. Specifically:

- Within the study area adjoins low-lying swamp vegetation to the north associated with Ourimbah Creek and riparian vegetation to the south fringing Chittaway and Bangalow creeks and their tributaries.
- To the southeast of the study area, Swamp Sclerophyll Forest extends to low-lying swampy areas and small drainage channels around Fountaindale near Manns Road and Pleasant Valley Drive, along Berkeley Road and vegetated areas north and south of Enterprise Drive.

- Swamp Sclerophyll Forest also extends along Berkeley Creek, Berkeley Park, Myrtle Brush Park, Glenning Valley and Quondong Gully and includes smaller tributaries and drainage channels Figure 6.2.

The total extent of the local occurrence is estimated to be 295.9 hectares of which the project will remove 25.5 hectares or 8.6 per cent of the extent of the local occurrence.

Swamp Sclerophyll Forest occupies low lying land in the locality (5 kilometre radius from study area) covering approximately 609.3 hectares (Bell 2008; Bell 2009) as illustrated in Figure 6.1 and Figure 6.2.

This is based broadly off the eight map units considered likely to be consistent with the threatened ecological community under both the Gosford and Wyong LGA vegetation mapping and include:

- E37a – Alluvial Paperbark Sedge Forest – 7.05 hectares (Bell, S. 2009)
- MU16 – Alluvial Bluegum-Paperbark Mesic Palm Forest – 153.33 hectares (Bell, S. A. J. 2008)
- MU17 – Alluvial Robusta-Paperbark Sedge Palm Forest – 105.18 hectares (Bell, S. A. J. 2008)
- MU18 – Alluvial Floodplain Swamp Paperbark Thicket – 98.46 hectares (Bell, S. A. J. 2008)
- MU19 – Alluvial Woollybutt-Melaleuca Sedge Forest – 44.15 hectares (Bell, S. A. J. 2008)
- MU20 – Alluvial Floodplain Shrub Swamp Forest – 201.11 hectares (Bell, S. A. J. 2008).

Within the locality the floristic composition, structural characteristics and condition of the threatened community are highly variable, the distribution of which are related to geological, topographical and geomorphological characteristics as well as previous and current land uses. The community within the locality is conserved in a number of OEH Estates and Wyong Council Reserves however is inadequately conserved within the locality as most land occurs on private tenure much of which are under zones that permit a wide range of land uses that conflict with the species conservation efforts.

Swamp Sclerophyll Forest continues to be under threat due to development pressures in the landscape contexts where they occur. In 2011 the final determination for Swamp Sclerophyll Forest as an EEC estimated that less than 30 per cent of the original extent of this community continued to exist (NSW Scientific Committee 2011b). Additionally it was estimated by National Parks and Wildlife Service (1999) that European Settlement had resulted in the removal of around 82 per cent of Alluvial Tall Moist Forest and 68 per cent of Swamp Mahogany Paperbark Forest within the region which form part of the threatened ecological community.

Within the locality, stands of Swamp Mahogany and other similar communities continue to persist, but they are becoming increasingly fragmented due to developmental pressures. Swamp Sclerophyll Forest's status as an endangered ecological community is due to the loss and fragmentation of its habitats and alterations to water tables (NSW Scientific Committee 2011b). The current project will result in the loss of 25.5 hectares of Swamp Sclerophyll Forest and this equates to an approximate loss of 4.2 per cent within the locality and 8.6 per cent within the local occurrence.

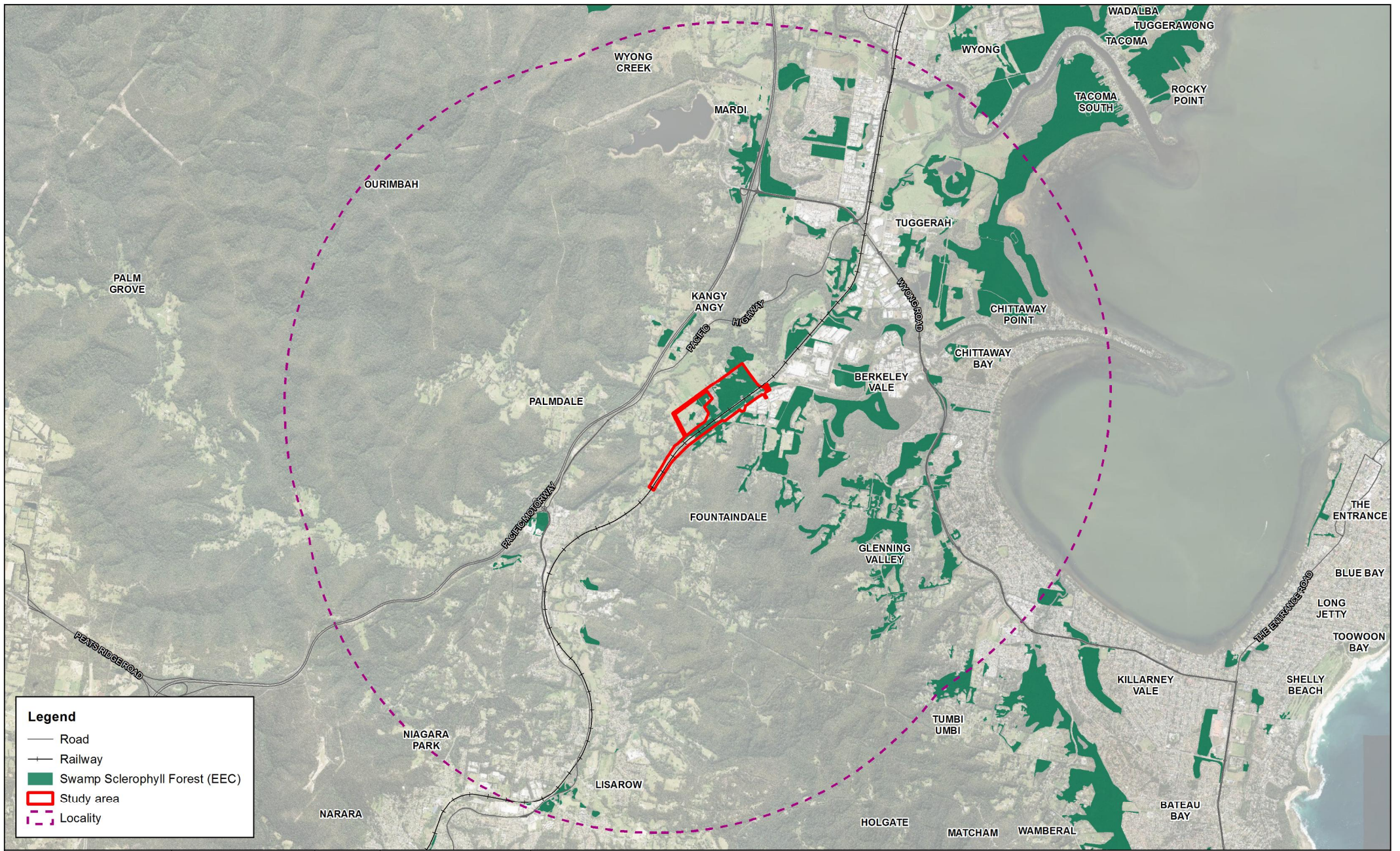
6.2.1.7 DISCUSSION OF CORRIDOR VALUES

Regional wildlife corridors are identified as primary landscape corridors that provide potential residential and dispersal habitat for an assemblage of reference species and are generally in the order of kilometres wide (Scotts 2003). The study area occurs as part of a regional wildlife corridor, which is commensurate with large contiguous tracts of native vegetation of the coastal ranges, foothills and sheltered gullies that occur to the south-east of the project and similar habitats within Ourimbah State Forest, extending through to the Watagan Mountains to the north (Figure 2.5).

As much of the study area and associated lands are characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural and rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity in an otherwise patchy fragmented landscape (Figure 2.5).

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of Swamp Sclerophyll Forest in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north.

In addition, the construction and operation of the project would add incrementally to the existing fragmentation of Swamp Sclerophyll Forest within the locality. Whilst the removal of this vegetation would increase the fragmentation in the locality, it is unlikely to exacerbate fragmentation at the regional scale.



Legend

- Road
- +— Railway
- Swamp Sclerophyll Forest (EEC)
- ▭ Study area
- - - Locality

Map: 2202522A_GIS_F032_A1	Author: suansrir
Date: 11/05/2016	Approved by: -

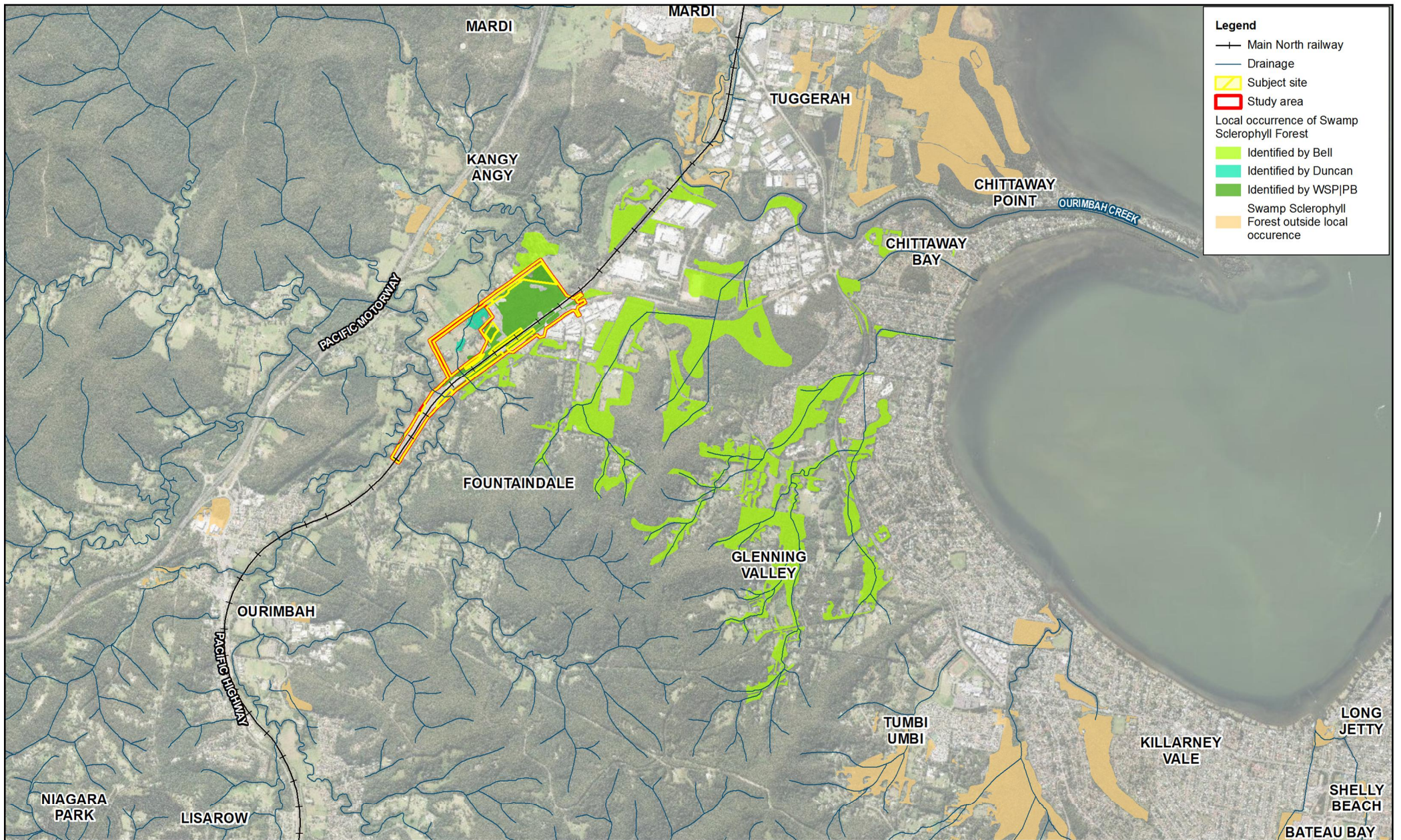


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Coordinate system: GDA 1994 MGA Zone 56
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New Intercity Fleet Maintenance Facility Project
Figure 6.1
 Swamp Sclerophyll Forest in the locality



Map: 2202522A_GIS_F038_A1 Author: suansr/r

Date: 11/05/2016 Approved by: -



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New Intercity Fleet Maintenance Facility Project
Figure 6.2
 Local occurrence of Swamp Sclerophyll Forest

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6.2.1.8 DISCUSSION OF REGIONAL SIGNIFICANCE

The study area is located within the Sydney Basin Bioregion and forms part of Hunter–Central Rivers CMA. Within the Hunter–Central Rivers CMA Swamp Sclerophyll Forest occupies approximately 24,642.2 hectares (Figure 6.3) according to the *'Greater Hunter Native Vegetation Mapping'* (Office of Environment & Heritage 2014). The use of this vegetation mapping classification project for regional analysis purpose has been adopted due to this being the VIS classification 2.1 PCT reference mapping for PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast. The regional extent of Swamp Sclerophyll Forest is based broadly off the four map units considered likely to be consistent with the threatened ecological community including:

- E5a – Alluvial Bluegum-Paperbark Forest
- E37a-e all veg comms
- E42 – Narrabeen Alluvial Sedge Woodland
- E43a – Estuarine Paperbark Scrub Forest.

At a regional scale (Figure 6.3) the extent of Swamp Sclerophyll Forest appears to dominate coastal floodplains between Laurieton in the north and south to the Gosford area. Within this regional extent, the community appears to be more abundant (larger and more numerous intact remnants) in the north and scarcer in the south (more small and disjunct remnants) which are most likely attributed to higher coastal development pressures (Figure 6.3). Swamp Sclerophyll Forest in the locality is therefore subjected to increased development and population expansion pressures and subsequently at higher risk of becoming extinct compared to other areas within the region.

The current extent of Swamp Sclerophyll Forest at a regional scale was estimated at representing less than 30 per cent of its original extent in the early 1990's (up to 7000 hectares in the Hunter–Central Coast region) (NSW Scientific Committee 2011b). It is highly likely that the community's extent has been reduced further in the past 20 years as a result of coastal development.

Based on analysis of the (Office of Environment & Heritage 2014) mapping the extent of Swamp Sclerophyll Forest at a regional scale is approximately 24,642.2 hectares. Subsequently, the removal of 25.5 hectares required for the project is likely to constitute the removal of approximately 0.01 per cent of Swamp Sclerophyll Forest within the Hunter–Central Rivers CMA region, although the extent of this impact within the broader Sydney Basin Bioregion is unknown.

6.2.1.9 IMPACTS ON ECOLOGICAL COMMUNITIES IN OEH ESTATES

Other areas of Swamp Sclerophyll Forest occur within the locality of which some are located within OEH Estates (National Parks, OEH management sites) and Wyong Council Reserves including:

- Tuggerah Nature Reserve
- Tuggerah State Conservation Area
- Jiliby State Conservation Area
- Wyrabalong National Park.

The study area does not occur on or directly adjoin any OEH Estate land that contains Swamp Sclerophyll Forest. It is considered unlikely that the project will have significant impacts in terms of reducing ecological function of Swamp Sclerophyll Forest on any of the OEH Estates listed above.

6.2.2 Assessment of habitat

A full description of Swamp Sclerophyll Forest characteristics within the study area is provided in section 4 of this report. The distribution of the community within the study area, locality and Hunter–Central Rivers CMA region is provided in Figure 4.4, Figure 6.1, Figure 6.2 and Figure 6.3 respectively.

6.2.2.1 DESCRIPTION OF DISTURBANCE HISTORY

The existing land use on the study area is generally vacant, and rural-residential land which contains a mixture of vegetation including generally forested areas, lower-lying scrub and some areas of regrowth forest. One existing residential dwelling is located within the study area (53 Orchard Road) which is proposed to be acquired as part of the project. The remaining land uses within the study area consist of various transport and power land uses and their associated infrastructure including:

- Powerlines
- Access tracks
- The Main North railway
- Existing roadways including Enterprise Drive, Turpentine Road, Schubolt Lane, Ourimbah Road, Orchard Road and Old Chittaway Road.

Disturbances associated with these land uses have led to the modification of native vegetation ultimately leading to fragmentation and edge effects. Factors such as weed incursions and removal of canopy trees in some locations lowered the condition of Swamp Sclerophyll Forest in some areas as illustrated in Figure 4.4. The three condition categories mapped on site:

- PCT1723/HU937 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – High Quality)
- PCT1723/HU937 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – Medium Quality)
- PCT1723/HU937 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest (Low Condition).

Although the different conditions of Swamp Sclerophyll Forest showered varying degrees of resilience to weeds, all condition types are considered to have the potential to be recovered to a pre-disturbance condition. This is based on the assumption that the community occurs as a large patch and that active management of the vegetation occurs. To date, no funding or plan of management is associated with the land and as such it is unlikely that low condition vegetation will recover to pre-disturbance condition levels. Vegetation management is recommended as part of mitigation measures outlined under section 7 of this report.

6.2.2.2 EXTENT OF HABITAT REMOVAL

The project will require the removal of 25.5 hectares of PCT1723 *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest which is consistent with the Swamp Sclerophyll threatened ecological community (Table 6.2 and Figure 4.4). The removal of this vegetation represents 79 per cent of potential habitat within the study area and 4.2 per cent within the locality. The occurrence of Swamp Sclerophyll Forest within the locality and the Hunter–Central Rivers CMA region is illustrated in Figure 6.1, Figure 6.2 and Figure 6.3 respectively.

Given this community is under threat from incremental loss due to other development activities it is considered that this estimate of loss within the locality is likely to be slightly greater.

The NSW Scientific Committee (2011b) estimate that Coastal Floodplain Wetlands (which includes Swamp Sclerophyll Forest) currently occupied only 800–1400 square kilometres which is considered to be

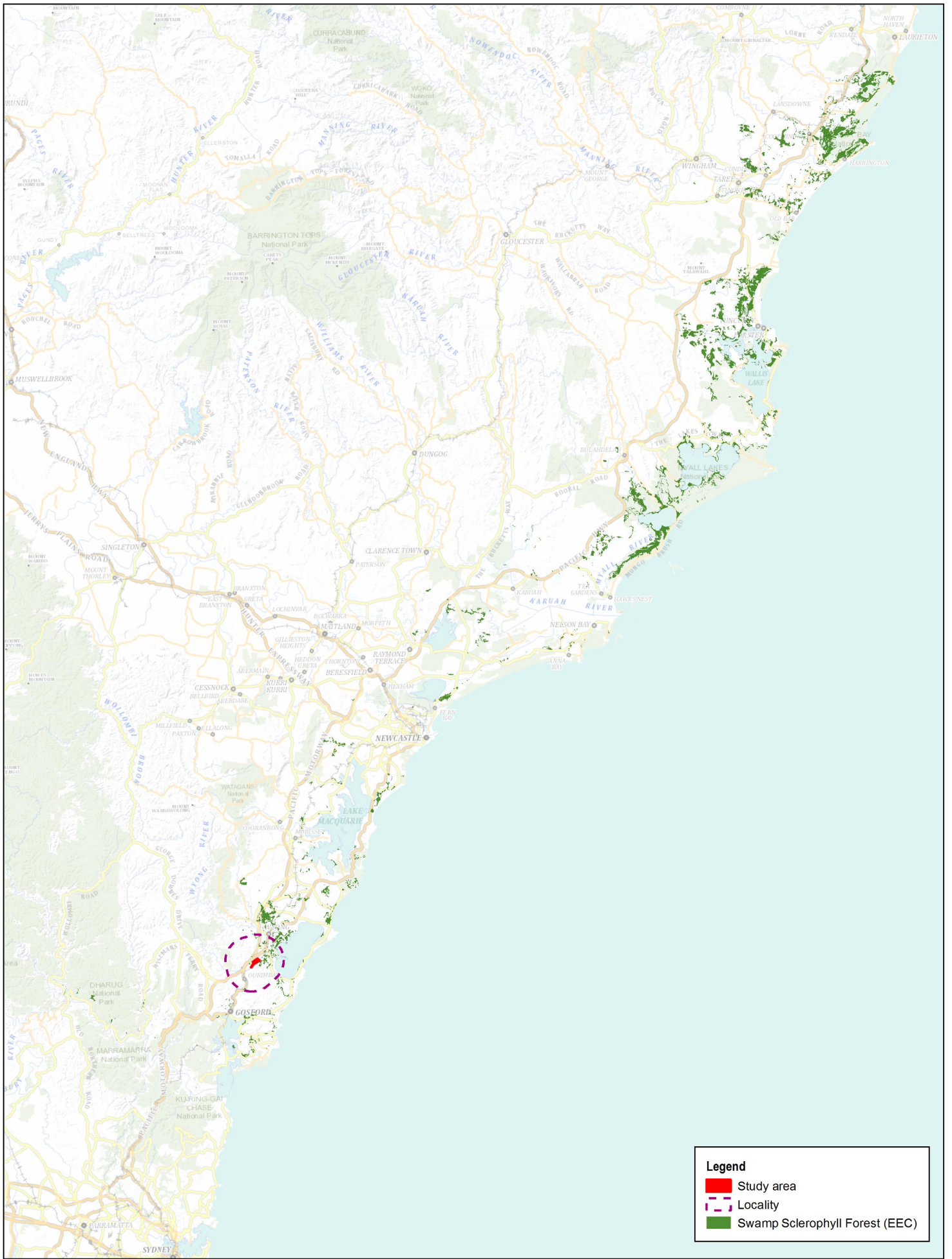
less than 30 per cent of the communities original extent. Subsequently, the removal of 25.5 hectares of Swamp Sclerophyll Forest would constitute an additional reduction of 0.1 per cent of the community's current known regional extent.

Table 6.2 Swamp Sclerophyll Forest to be removed by the proposed works

Plant community type (biometric vegetation type)	Extent within the study area (ha)	Extent within the subject site (ha) (area to be directly impacted)	Total extent within locality (ha)
PCT1723/HU937 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – High Quality)	25.7	19.6	609.3
PCT1723/HU937 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest (Moderate to Good – Medium Quality)	5.3	4.5	
PCT1723/HU937 Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest (Low Condition)	1.4	1.4	

6.2.3 Description of feasible alternatives

Please refer to the Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff 2016a).



Legend

- Study area
- Locality
- Swamp Sclerophyll Forest (EEC)

Map: 2202522A_GIS_F033_A1	Author: suansir	
Date: 11/05/2016	Approved by: -	

1:700,000
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New Intercity Fleet Maintenance Facility Project
Figure 6.3
 Swamp Sclerophyll Forest extent within
 the Hunter-Central Rivers CMA

Data source: - Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Swire, NITN, GEBCO, Esri, Japan, METI, Esri, China (Hong Kong), Swire, Mitsuboshi, © OpenStreetMap contributors, and the GIS User Community
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7 AMELIORATIVE MEASURES

7.1 Description of ameliorative measures

The general principle to minimise impacts to biodiversity, should in order of consideration, endeavour to:

- avoid impacts on habitat, through the planning process
- minimise impacts on habitat, through the planning process
- Mitigate impacts on habitat, though the use of a range of mitigation measures.

The avoidance of impacts can be achieved through the planning process. This process involves a preliminary examination of a number of possible site options and their potential impacts on the environment and other factors (for example, economic and social considerations). Those potential sites that best fit the environmental, social and economic criteria are then short-listed. This was completed as part of the site selection process for the project. The results of this selection process is provided in the *Central Coast Train Stabling and Maintenance Facility Comparative Site Analysis* (GHD 2014a).

Minimising impacts involves reducing the loss of habitat or significant species as far as practicable. Through detailed surveys, it is usually possible to fine-tune the subject site (alignment and width of project footprint) to minimise loss of important vegetation communities or habitats and avoid significant plant species or habitat features. The final subject site is also subject to engineering constraints and safety standards.

The project has undertaken this process through suitable siting of work compounds and drainage detention basins, which has minimised impacts to native vegetation, including *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC (high quality), patches of *Melaleuca biconvexa* and habitat for threatened species of animal. The area of direct impact will also be reviewed throughout the detailed design stage and where possible further reductions may be achievable.

Residual impacts that cannot be avoided or minimised are mitigated wherever possible. Depending on vegetation and project type, mitigation measures generally employed during construction can include the following:

- landscaping and revegetation
- site rehabilitation.

In order to address the potential impacts of the proposed project on biodiversity, the following mitigation measures are recommended.

Table 7.1 Proposed mitigation measures

Impact	Mitigation measure
Removal of native vegetation and fauna habitats	<ul style="list-style-type: none"> → clearing of vegetation should be minimised, to only vegetation that is absolutely required to be removed in order to undertake work. → Implement clearing protocols, including: <ul style="list-style-type: none"> ▪ Environmental manager or ecologist to undertake a pre-clearance survey to identify any habitat that may be present on limbs or in tree to be removed such as bird nests or fauna roosting. ▪ Removal of any hollow bearing trees or limbs to be supervised by an ecologist in order to facilitate the relocation of any injured or displaced native fauna. ▪ Check trees for the presence of bird nests and potentially arboreal mammals, prior to felling. ▪ As far as practicable, animals found to be occupying trees would be allowed to leave before clearing. ▪ Use a licensed fauna ecologist or wildlife carer with specific animal handling experience to carry out any fauna handling. ▪ Establish exclusion zones to protect vegetation and fauna habitat outside of the assessed and approved clearing limits, including the threatened ecological communities recorded within the study area (including Swamp Sclerophyll Forest, Lowland Rainforest and Biconvex Melaleuca). ▪ the limits of clearing would be clearly demarcated on-site prior to construction to avoid unnecessary vegetation and habitat removal. → Restrict equipment placement, storage and stockpiling of removed branches and trees to designated areas in cleared land.
Removal of <i>Melaleuca biconvexa</i>	<ul style="list-style-type: none"> → Removal of threatened plants should be minimised, to only vegetation that is absolutely required to be removed in order to undertake work. → Exclusion zones should be established around areas containing threatened plant species. → All construction staff working in the vicinity of these threatened species should be informed of the location of these threatened flora species.
Aquatic impacts	<ul style="list-style-type: none"> → Minimise the clearing of aquatic habitats to that which is absolutely necessary for the safe construction and operation of the proposed Project. → Incorporate existing drainage channels into design of proposed Project drainage channels where practicable. → Protect aquatic habitats and riparian zones where works are not required with exclusion zones. → Control and manage potential contaminants (fuels, oils, lubricants) from construction activities. → Install high visibility signs at freshwater aquatic sites occurring outside the proposal area, to inform workers of no go areas and that these areas are environmentally sensitive. This is particularly important during spring and summer when migratory shorebirds and waders use such habitats. → Design and construct waterway crossings in accordance with the DPI's fish passage requirements (Fairfull <i>et al.</i> 2003). → Riparian and fringing aquatic vegetation would be replanted in disturbed areas immediately after construction to stabilise creek banks.

Impact	Mitigation measure
Direct mortality	<ul style="list-style-type: none"> → Implementation of clearing protocols as per removal of native vegetation and fauna habitats. → Where practicable and feasible, one wall of proposed drainage detention basins could be graded or trimmed to provide a gradient that is amenable for fauna to escape on their own accord.
Impacts to groundwater dependent ecosystems (swamp forest)	<ul style="list-style-type: none"> → A groundwater management plan and monitoring program would be developed and implemented to address potential impacts to groundwater, if encountered. → Revegetate disturbed areas with native vegetation where appropriate.
Erosion and sedimentation	<ul style="list-style-type: none"> → Erosion and sediment controls should be implemented in accordance with the Blue Book (Department of Environment and Climate Change 2008a). → Ensure that when trees are removed the stump and roots of the tree are retained to minimise ground disturbance and retain soil stability. → Ensure that bushrock is not disturbed when conducting vegetation removal. → Revegetate disturbed areas with native vegetation groundcover where appropriate. → Avoid excessive soil disturbance. → When accessing construction sites, contractors should only use designated access tracks.
Weed invasion	<ul style="list-style-type: none"> → Noxious weeds within the study area will be managed in accordance with the <i>Noxious Weeds Act 1993</i>. → Management techniques may include immediate weed removal and disposal without stockpiling, disposal of weed-contaminated soils at appropriate weed disposal facilities and to ensure that all equipment is cleaned prior to and on completion of works to ensure weeds are not introduced or spread to other locations.
Invasion and spread of pathogens and disease	<ul style="list-style-type: none"> → Protocols to prevent the introduction and/or spread of Chytrid fungus would be implemented. These protocols would be based on OEH Hygiene Protocol for the Control of Disease in Frogs. → Protocols and site hygiene to prevent the introduction and/or spread Myrtle rust would be implemented (i.e. vehicle and equipment wash down facilities).
General	<ul style="list-style-type: none"> → Ensure all workers are provided an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches. → Prepare a flora and fauna management plan as part of the CEMP.
Residual impacts	<ul style="list-style-type: none"> → Develop an offset strategy to mitigate the impact of clearing native vegetation. This will fulfil the need to improve or maintain as required in the <i>Principles for the use of biodiversity offsets in NSW</i>.

7.1.1 Long-term management strategies

7.1.1.1 REVEGETATION OF TEMPORARILY DISTURBED GROUND

It is proposed that all areas of temporarily disturbed ground, such as construction compound or stockpile areas, would be revegetated in accordance with a Vegetation Management Plan (VMP). Replanting of affected vegetation is to use locally occurring native species. The VMP would:

- Identify specific areas in the study area for rehabilitation
- Detail revegetation plan for identified areas

- Specify use of locally occurring native species with reference to designated vegetation community type
- Identify appropriate timing for rehabilitation works
- Detail relevant inspections during rehabilitation works
- Corrective actions and adaptive management
- Describe monitoring procedure to quantify success of rehabilitation works.

7.1.1.2 THREATENED FLORA MANAGEMENT PLAN

A threatened flora management plan is to be prepared for *Melaleuca biconvexa* and Swamp Sclerophyll Forest. This plan will provide a framework for the management of the species and community from pre-clearing, construction and operation phases of the project.

This threatened flora management plan will be appended to the CEMP document and will be required to be implemented throughout the life of the project and continue into the operational phase until aims of the plans have been achieved.

The aims of the plan are:

- To provide a framework to enable further opportunities to avoid and minimise impacts on *Melaleuca biconvexa* and Swamp Sclerophyll Forest during detailed design phase
- To provide pre-clearing management controls to ensure retained *in situ* plants and vegetation are adequately protected during clearing and construction
- To identify weed management procedure for protection of retained *in situ* plants and vegetation
- To identify targeted revegetation of disturbed areas adjoining retained *in situ* patch areas
- To provide a translocation strategy that focuses on seed collection and soil biomass translocation and ensures loss of genetic material is limited
- To establish a Before After Control Impact (BACI) monitoring program to evaluate the effectiveness and success of mitigation measures, including protection of *in situ* plants and vegetation, success of translocation and habitat revegetation.

The plan should include an adaptive management approach that allows for corrective actions to be applied to improve mitigation where required.

The plan shall be prepared by a suitable qualified ecologist (with a minimum tertiary degree in Science/ Environmental Science/ Ecology or equivalent) with a minimum five years demonstrated experience in preparing threatened flora management plans.

7.1.2 Compensatory strategies

7.1.2.1 IS AN OFFSET REQUIRED?

The need for biodiversity offsets is founded in the theory of 'avoid, minimise and mitigate' the impacts of projects. The accepted approach to environmental assessment requires that, in the first instance, environmental impacts are avoided or minimised as far as possible and subsequently reduced to acceptable levels through appropriate mitigation techniques. Where measures to avoid and mitigate impacts are not feasible or cost effective, then offset strategies can be used to compensate the residual impacts of the development on biodiversity.

Transport for NSW has followed the 'avoid, minimise and mitigate' theory by firstly avoiding impacts to approximately 8.3 hectares of native vegetation and 1,030 *Melaleuca biconvexa* plant stems within the study area via modifications in preliminary design. Further avoidance of native vegetation clearing has the potential to occur during the detailed design phase of the project.

Although the project will avoid and minimise impacts it could still remove up to 30.2 hectares of native vegetation, including 25.5 hectares of Swamp Sclerophyll Forest which is listed as a threatened ecological community, 3,984 *Melaleuca biconvexa* plant stems and habitat for other threatened species. Subsequently, it would be necessary to provide biodiversity offsets to fulfil the CERs and OEHs requirements for the SIS.

7.1.2.2 BIODIVERSITY OFFSET POLICY AND GUIDELINES

In order to address the SIS CERs for the project, this biodiversity offset strategy has been developed with reference to:

- The OEH Principles for the use of biodiversity offsets in NSW (Office of Environment & Heritage 2016h)
- The BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014b).

The relevant NSW and Commonwealth biodiversity offsetting principles and guidelines are summarised below.

PRINCIPLES FOR THE USE OF BIODIVERSITY OFFSETS IN NSW

The OEH have provided guidelines for developing biodiversity offsets to achieve conservation outcomes, particularly for projects where there will be an unavoidable loss of biodiversity (Office of Environment & Heritage 2016h). Although not a defined requirement under legislation, these guidelines provide a list of 13 principles to be followed when developing biodiversity offsets:

1. Impacts must be avoided first by using prevention and mitigation measures
2. All regulatory requirements must be met
3. Offsets must never reward ongoing poor performance
4. Offsets will complement other government programs
5. Offsets must be underpinned by sound ecological principles
6. Offsets should aim to result in a net improvement in biodiversity over time
7. Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs
8. Offsets should be agreed prior to the impact occurring
9. Offsets must be quantifiable (the impacts and benefits must be reliably estimated)
10. Offsets must be targeted
11. Offsets must be located appropriately
12. Offsets must be supplementary
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contracts.

BIOBANKING SCHEME

The NSW government has developed the Biodiversity Banking and Offsets Scheme (BioBanking) to help address the loss of biodiversity values, including threatened species. This scheme was established under Part 7A of the TSC Act and uses offsets (where appropriate) to assist in addressing the cumulative effects of development in NSW and in particular, to help meet the goal of maintaining or improving biodiversity. This approach is intended to allow development to occur in a sustainable way without placing extra stress on the environment (Department of Environment and Climate Change 2007b).

BioBanking consists of the following main components:

- Establishment of BioBank sites on private land through 'BioBanking agreements' with the Minister for the Environment. A BioBanking agreement is similar to a covenant and is attached to the land title. It stays with the land, and lasts in perpetuity to ensure that the BioBank site is managed for biodiversity conservation.
- Calculation of biodiversity credits through either:
 - Creation of biodiversity credits for the gain in biodiversity values from taking management actions on a BioBank site
 - Measuring the biodiversity credits required to offset the loss of biodiversity values due to the impacts of a development.
- The trading of biodiversity credits between development sites and BioBank sites to offset the impact of development on biodiversity.

The BBAM establishes two classes of biodiversity credits that may be created:

- Ecosystem credits – these are created or required for all impacts on biodiversity values (including threatened species that can be reliably predicted by habitat surrogates), except the threatened species or populations that require species credits.
- Species credits – these are created or required for impacts on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Species Profile Database.

The OEH maintains the BioBanking public register which lists biodiversity credits generated at BioBank sites for sale, BioBank site expressions of interest (EOI) register and lists of biodiversity credits which are required to offset development impacts.

While the BBAM represents an alternative pathway to that of the SIS for Part 4 matters, it also provides a currently recognised methodology to quantify the offset requirements for a project's residual impacts. OEH have requested that biodiversity offset requirements for the project are quantified using the BioBanking Assessment Methodology 2014.

7.1.2.3 ESTIMATING THE PROJECTS OFFSET REQUIREMENTS

To estimate the biodiversity offset requirements for the project, an assessment using the BioBanking credit calculator (tool version 4.1) has been completed.

The BioBanking credit calculator estimated that approximately 1,837 ecosystem credits would be required to offset the impacts of native vegetation removal required by the project. An overview of the ecosystems required is provided in Table 7.2.

Table 7.2 Summary of vegetation to be impacted and ecosystem credits required to offset impacts

Biometric Vegetation type	Plant community type	Threatened Ecological Community	Area to be impacted (HA)	Red flag	Estimated credit required
HU937	Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Moderate to Good – High Quality)	Yes	19.6	Yes	1,597.44
	Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Moderate to Good – Medium Quality)	Yes	4.5	Yes	
	Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Low Condition)	Yes	1.4	Yes	
HU782	Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (Moderate to Good – High Quality)	No	3.6	Yes	187
HU742	Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest of the Central Coast (Moderate to Good – Medium Quality)	No	1.1	Yes	52.66
Total			30.2		1,837

In addition to the ecosystem credits required above the project will also be required to offset the removal of 3,984 *Melaleuca biconvexa* from within the subject site. An estimate of the species credit required for the project is provided in Table 7.3.

Table 7.3 Species credit required by the project

Scientific name	Common name	Number of individuals to be removed	Number of credits required
<i>Melaleuca biconvexa</i>	Biconvex Melaleuca	3,984	52,000

7.1.2.4 POTENTIAL OFFSET OPTIONS

The biodiversity offset strategy for the project would be developed with reference to the principals for the use of biodiversity offsets in NSW (refer to section 7.1.2.2). In accordance with these principals, the feasibility of potential offset options will be assessed using the following criteria:

- Duration – measures must offset the impact of the development for the period that the impact occurs
- Accuracy – the impacts and benefits must be reliably estimated

- Suitability – measures must offset the impact in the same region
- Effort – measures must be undertaken beyond existing requirements and not already be funded by another scheme
- Enforcement – measures must be enforceable through development consent conditions, license conditions, covenants or a contract.

Offset strategies may include both on and offsite or local area proposals that contribute to the long term conservation of threatened species and ecological communities. The offset strategies which are considered for the project will include a combination of the following in order of preference:

- Onsite offsets – securely conserve and improve the condition of existing habitat or providing a buffer to an area of existing habitat within the study area
- Purchase of biodiversity credits under the NSW BioBanking Scheme
- Offsite offsets – securing and improving the condition of existing habitats at another site.

Given that similar habitats will be retained within the study area the preferred option would be to securely conserve and improve these areas as onsite offset areas (Figure 2.2). In addition the participation in BioBanking, involving the purchase of biodiversity credit from a BioBank, would aid in fulfilling the remaining offset requirements.

Transport for NSW is committed to delivering an offset package that will appropriately offset the impacts of the project. In the event that the preferred offsetting approach is unsuccessful, Transport for NSW will consider the other alternative offset options in consultation with DP&I and OEH. It is acknowledged that the biodiversity offset package may incorporate one or more of these options to deliver an offset package for the project that satisfies the CERs and agency requirements.

ONSITE OFFSET AREAS

The onsite areas within the study area to be retained which include 8.3 hectares of native vegetation and 1,030 *Melaleuca biconvexa* would be managed appropriately via the 'Threatened flora management plan' that will be developed for the project. The management plan would be developed to clearly document areas of retained vegetation and/or habitat features to ensure their long-term conservation and viability. Refer to section 7.1.1.2 for more details.

PURCHASE OF BIODIVERSITY CREDITS

BioBanking enables a proponent to offset the biodiversity impacts of a proposed development by buying and retiring biodiversity credits. Often, the BBAM requires offsets to include the same vegetation type or formation and to occur within the same IBRA Subregion. For the purposes of BioBanking, the characteristics of the study area are summarised in Table 7.4.

Table 7.4 Criteria of the study area relevant to BioBanking

Criteria	Location
Council	The former Wyong Shire Council, now known as the Central Coast Council
Bioregion	Sydney Basin
Catchment Management Area	Hunter–Central Rivers CMA Wyong sub-catchment
Vegetation community type to be cleared	HU937 – <i>Melaleuca biconvexa</i> – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Swamp Sclerophyll Forest)

Criteria	Location
	HU782- Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast
	HU742- Jackwood – Lilly Pilly – Sassafras riparian warm temperate rainforest of the Central Coast

CONSIDERATION OF OTHER OFFSET OPTIONS

CONTRIBUTIONS TO LAND MANAGEMENT FOR CONSERVATION

The project is located within the former Wyong Shire Local Government Area (LGA), which is now part of the Central Coast Council and therefore the development of the offset package should consider local requirements. This could include financial (or other) contributions to the *Saving our Species* sites for *Melaleuca biconvexa*, including Porters Creek Management site.

As part of the development of the offset package for the project, Transport for NSW are investigating the possibility of contributions that can be used to facilitate such restoration of wetlands within the Wyong and/or Gosford LGA. In particular, contributions would be targeted at wetlands in the Porters Creek area.

Any contributions would be seen as discounting the quantum of the offset requirements for the project determined using the BBAM. In particular, contributions to land management would target the offset requirements for Swamp Sclerophyll Forest vegetation types, which are not identified within BioBanking sites.

PROPERTY ACQUISITION

Property acquisition may form part of the final offset package if property owners are not willing to participate in BioBanking. Transport for NSW would seek to eventually transfer acquired properties into the NSW conservation reserve estate or local council reserve system as appropriate.

Transport for NSW is currently investigating the viability of acquiring private properties, near the Project, which contain high quality native vegetation suitable for offsetting the vegetation to be cleared.

Acquired offset land would need to be actively managed in order to maintain or improve the condition of the vegetation and habitats. Property acquisition could be used to improve connectivity in wildlife corridors and/or consolidation of high conservation areas/reserves.

Property acquisition is not the Transport for NSW preferred offset strategy given the limited availability of privately owned suitable offset sites, the potential requirements for negotiation with multiple land owners and potentially additional costs.

7.1.2.5 SECURITY OF OFFSET SITES

Transport for NSW is committed to delivering an offset that will provide ongoing conservation of land in perpetuity for the benefit of future generations. Offset sites must be enduring and must offset the impact of the development for at least the period that the impact occurs. The security of land tenure and ongoing management of offset site(s) is critical to the long-term viability of offsets and must be carefully considered.

To ensure the conservation of lands in-perpetuity, the offset strategy will require the dedication of the identified offset sites under a secure conservation arrangement. There are a number of options available to secure land under permanent conservation agreements. Transport for NSW is committed to exploring and identifying the most suitable conservation arrangement for land in consultation with the relevant stakeholders. Potential options in order of preference may include:

- obtaining a BioBanking agreement
- voluntary Conservation Agreements under the NPW Act
- trust Agreements under the *Nature Conservation Trust Act 2001* (NCT Act)
- transfer of lands to National Park Estate.

7.1.2.6 SUMMARY AND WAY FORWARD

The project will require the removal of 30.2 hectares of native vegetation or 1,837 ecosystem credits and 52,000 species credits using the BioBanking credit calculator (BBAM tool Version 4.1).

The preferred options for offsetting include onsite offsets and purchase of biodiversity credits under the NSW BioBanking Scheme.

Transport for NSW and Parsons Brinckerhoff are currently identifying a range of potential offset sites. These sites will contain large areas of the wetland communities, or similar wetland communities that are required to be offset. Given the limited available and/or suitable offsets containing suitable wetland environments, the Project will offset its impacts in accordance with the OEH principles for the use of biodiversity offsets in NSW (Office of Environment & Heritage 2016h).

Transport for NSW is committed to delivering an offset package that will appropriately offset the impacts of the Project. In the event that the preferred offsetting approach is unsuccessful, Transport for NSW will consider other alternative offset options in consultation with DP&I and OEH, to deliver an offset package for the Project that satisfies the CERs and agency requirements.

7.1.3 Ongoing monitoring

Monitoring of vegetation within the study area would be required to ensure the long term success of the protection and amelioration measures implemented by the project. The monitoring program would be developed in accordance with the project's conditions of approval and in consideration of the project BAR and this SIS. The monitoring should be undertaken on an annual basis, begin prior to construction and include transect, quadrat and photo monitoring techniques.

The main objective of the monitoring program is to determine changes in ecological function and the integrity of biodiversity values such as floristic composition and condition. This will ensure that the offset areas and retained and revegetated areas within the study area are maintained or improved as a result of the amelioration measures implemented.

Specifically, the monitoring program should aim to focus upon:

- Monitoring the condition of retained, conserved and/or translocated *Melaleuca biconvexa* stands within the study area and offset areas
- Monitoring the condition retained, conserved or revegetated Swamp Sclerophyll Forest within the study area and offsets areas
- Collecting and assessing data required to identify significant changes in biodiversity attributes
- Compare results against performance criteria to assist the effectiveness of the amelioration measures

- Propose additional contingency measures for circumstances where impacts to biodiversity are detected that are directly attributed to the project.

7.1.3.1 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

Ongoing monitoring for the effectiveness of mitigation measures would be detailed in the project Construction Environmental Management Plan (CEMP) and/or Construction Flora and Fauna Management Plan (CFFMP) (or similar document). The purpose of this document is to outline key actions for environmental (and ecological) management and to monitor the effectiveness of the biodiversity mitigation measures that were recommended in the Biodiversity Assessment Report (as appended to the project REF). The monitoring relates to the general impacts of construction activities on ecological characteristics, such as native vegetation (including EECs), fauna habitats, aquatic habitats and general ecological values in the immediate vicinity of the project.

The CEMP/CFFMP or similar document would detail the following proposed mitigation measures, including timing, monitoring procedure, responsibilities and performance measures:

- Environmental induction for site personnel
- Delineation of no-go zones
- Weed monitoring and treatment:
 - Heavy machinery inspections
 - Hygiene protocols
 - Chemical and physical control methods
- Vegetation clearing:
 - Demarcation of vegetation in the construction footprint (subject site)
 - Pre-clearing surveys and inspections
 - Pre-clearing surveys for amphibians
 - Removal of vegetation
 - Fauna handling and relocation
- Pathogens and disease:
 - Protocols to prevent the introduction or spread of Chytrid Fungus
- Aquatic disturbance:
 - Control and management of potential contaminants (i.e. fuels and lubricants)
 - Water sampling of Chittaway Creek (chemical/physical analysis)
- Implementation of environmental controls:
 - Erosion and sediment control
 - Minimising incidence of fauna being trapped in drainage detention basins
 - Revegetation of temporarily disturbed grounds (referencing site specific VMP).

8 ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION

The project will be assessed under Part 5 of the Environmental Planning & Assessment Act 1979 (EP&A Act). Section 5A of the EP&A Act requires that a seven part test is undertaken to assess the likelihood of significant impact upon threatened species, populations or ecological communities listed under the Threatened Species Conservation Act 1995 (TSC Act) (Department of Environment and Climate Change 2007e).

Assessment of significance was completed in accordance with the TSC Act for the following:

- Swamp Sclerophyll Forest on Coastal Floodplain of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- *Melaleuca biconvexa*
- Regent honeyeater
- Varied Sittella
- Little lorikeet
- Little Eagle
- Black Bittern
- Swift Parrot
- Square-tailed Kite
- Little Bentwing
- Eastern Bentwing
- Southern Myotis
- Grey-headed Flying-fox.

8.1 Swamp Sclerophyll Forest on Coastal Floodplain of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Swamp Sclerophyll Forest is listed as Endangered under the TSC Act. The PCT 1723/BVT HU937 *Melaleuca biconvex* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast vegetation type recorded within the study area is consistent with the listing for the Swamp Sclerophyll Forest threatened ecological community.

Approximately 32.4 hectares of Swamp Sclerophyll Forest was recorded within the study area. Of this, the project will require the removal of 25.5 hectares within the subject site whilst the remaining 6.9 hectares would be retained within the study area.

The local occurrence of Swamp Sclerophyll Forest is considered to occur as a patchwork of swampy vegetation associated with the lower Ourimbah Creek catchment. Specifically:

- Within the study area adjoins low-lying swamp vegetation to the north associated with Ourimbah Creek and riparian vegetation to the south fringing Chittaway and Bangalow creeks and their tributaries.

- To the southeast of the study area, Swamp Sclerophyll Forest extends to low-lying swampy areas and small drainage channels around Fountaindale near Manns Road and Pleasant Valley Drive, along Berkeley Road and vegetated areas north and south of Enterprise Drive.
- Swamp Sclerophyll Forest also extends along Berkeley Creek, Berkeley Park, Myrtle Brush Park, Glenning Valley and Quondong Gully and includes smaller tributaries and drainage channels.

The total extent of the local occurrence is estimated to be 295.9 hectares.

8.1.1 TSC Act assessment

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

Not applicable.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**

The extent of the local occurrence of this community is considered to cover approximately 295.9 hectares of which the project will lead to a reduction of 25.5 hectares or 8.6 per cent. Within the study area approximately 6.9 hectares of Swamp Sclerophyll Forest will be retained and actively management under a threatened flora management plan.

The local occurrence of Swamp Sclerophyll Forest is currently considered to not be adequately conserved in conservation reserves and much of its extent occurs on private land holdings. The action proposed will lead to a further net reduction of this community in the locality.

Whilst the proposed action will result in the reduction in the extent of this community within its local occurrence by 8.6 per cent, the local occurrence of this community still occupy approximately 270.4 hectares. Much of this local occurrence was observed during local *Melaleuca biconvexa* population surveys as being relatively floristically complex and structurally intact. Many patches only exhibited minor weed infestations although patches adjoining residential developments appeared to exhibit higher levels of weed incursion due to edge effects. Subsequently, areas of equal or higher quality and structural complexity will remain within the community's local occurrence. Additionally, the retained 6.9 hectares of this community within the study area will be subject to ongoing intensive vegetation management and as such is unlikely to further reduce the extent of the community over its local occurrence after construction.

The proposed action is considered unlikely to adversely affect the extent of Swamp Sclerophyll Forest such that it places the local occurrence of this community at risk of extinction.

- **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.**

Swamp Sclerophyll Forest typically occurs as an open forest however may occur as scrub, fernland, tall reedland or sedgeland where the canopy is absent or scattered, particularly where vegetation clearing and disturbances have occurred. The floristic and structural composition of the community is thus highly variable and determined by the following attributes (NSW Scientific Committee 2011b; Office of Environment & Heritage 2016k):

- Frequency and duration of waterlogging
- Texture, salinity, nutrient and moisture content of the soil
- Latitude
- Land use disturbances such as vegetation clearing, invasion of weeds, grazing and cropping.

The floristic composition, structural characteristics and condition of the threatened community within the study area and within the local occurrence are highly variable although many of the patches appear floristically complex and structurally intact. Whilst the proposed action will result in the loss of 25.5 hectares of this community it is not considered likely to substantially and adversely modify the composition of the community such that its local occurrence is likely to be placed at risk of extinction.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will result in removal of 25.5 hectares of Swamp Sclerophyll Forest from within the subject site. This impact equates to a reduction of approximately 8.6 per cent of the local occurrence of this community.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

As much of the study area and associated lands are characterised by floodplain topography associated with Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural and rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient riparian habitat that provide connectivity in an otherwise patchy fragmented landscape.

The proposed action will add incrementally to existing fragmentation to the local occurrence of Swamp Sclerophyll Forest in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek and its tributaries.

Whilst the proposed action will add to an increase the fragmentation of this community, it is unlikely to significantly fragmentation or isolate habitat within the local occurrence that would result in it being placed at the risk of extinction.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The importance of the habitat being removed to the long term survival of the ecological community is unclear. The project however will result in the removal of 25.5 hectares of Swamp Sclerophyll Forest from the subject site which constitutes 8.6 per cent of the community's local occurrence (considered to be locality in terms of Section 5A) or 0.1 per cent within the Hunter–Central Rivers CMA region.

Although considered unlikely to place the community at risk of extinction in the near future, the community is becoming increasingly fragmented due to developmental pressures. Into the future, the community will continue to increasingly be under threat due to development pressures in the landscape contexts where it occurs. Furthermore, it has been estimated that less than 30 per cent of the community's original extent continues to exist (NSW Scientific Committee 2011b). Subsequently, if Swamp Sclerophyll Forest continues to be cleared within the local occurrence it could be placed at risk of extinction over the longer term.

Given, the community's current extent is less than 30 per cent of its original extent, is under continual threat from further development activities, not adequately conserved within the locality the proposed action to remove a patch of the community totalling 25.5 hectares in extent is considered likely to be of importance to the long-term survival of Swamp Sclerophyll Forest within the locality.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Chief Executive of Office of Environment and Heritage. No critical habitat has been listed for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

To date, no recovery plan has been prepared for Swamp Sclerophyll Forest although OEH are currently developing a targeted approach to managing threatened ecological communities. In the interim they have provided a set of 12 management actions that have been identified for the community's protection. The interim management actions developed by OEH focus predominantly on research required to fill gaps in knowledge to allow for targeted management moving forward. The interim management actions include (Office of Environment & Heritage 2016k):

- Undertake research to determine minimum fire frequency
- Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants
- Prepare identification and impact assessment guidelines and distribute to consent and determining authorities
- Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land
- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance
- Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made
- Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan and associated PAS actions
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required
- Investigate the ecology of Swamp sclerophyll forest species with particular emphasis on the importance of drying and wetting cycles in maintaining ecosystem health
- Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works
- Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT – all known provenances (conservation collection)

- Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).

The action proposed will result in the removal of 25.5 hectares of Swamp Sclerophyll Forest and is not considered consistent with recovery objectives or actions for this community.

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.

With regard to Swamp Sclerophyll Forest, KTPs that the project is likely to be commensurate with, include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands – Swamp Sclerophyll Forest occurs within the study area and is associated waterlogged or periodically inundated alluvial flats and drainage lines on coastal floodplains. The proposed works are likely to modify the natural hydrology of the study area and therefore may affect this community.
- Clearing of native vegetation – the proposed activities would require the removal of 25.5 hectares of Swamp Sclerophyll Forest. This would include the removal of dead trees, fallen timber and hollow bearing trees.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition – dependent upon APZs and management.
- Infection of native plants by *Phytophthora cinnamomi* – proposed activities (i.e. vegetation clearing and earthworks) has potential to introduce pathogens if appropriate mitigation measures are not implemented.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae – see above.
- Invasion and establishment of exotic vines and scramblers – proposed activities have potential to result in invasion and/or spread of exotic species during the construction phase (i.e. vegetation clearing and earthworks activities) and operation phase of the project (movement, storage and maintenance of trains).
- Invasion and establishment of Scotch broom (*Cytisus scoparius*) – see above.
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata* – see above.
- Invasion, establishment and spread of *Lantana camara* – see above.
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed) – see above.
- Invasion of native plant communities by exotic perennial grasses – see above.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants – see above.
- Loss of hollow-bearing trees – see above.
- Removal of dead wood and dead trees – see above.

In respect to weed and pathogen key threatening processes the action proposed will incorporate ameliorative measures that will mitigate such processes.

The action proposed will however result in the clearing of native vegetation, loss of hollow-bearing trees, the removal of dead wood and dead trees, and the alteration of natural flow regimes that constitute key threatening processes to this community. As such, the action proposed is considered likely to result in the operation of a key threatening processes to Swamp Sclerophyll Forest.

CONCLUSION

Approximately 32.4 hectares of Swamp Sclerophyll Forest was recorded within the study area. Of this, the project will require the removal of 25.5 hectares whilst the remaining 6.9 hectares would be retained. This is estimated to constitute a reduction of 8.6 per cent of the local occurrence of Swamp Sclerophyll Forest.

Although the project is considered unlikely to have an adverse effect on the composition or extent of the community within the local occurrence in the short to medium term, the project would add incrementally to fragmentation within the locality and would remove up to 25.5 hectares of Swamp Sclerophyll Forest that is considered to constitute important habitat to the long-term survival of Swamp Sclerophyll Forest within the locality.

Consequently, a significant impact to Swamp Sclerophyll Forest is considered likely to occur as a result of the project. Whilst a significant impact is considered likely based on potential long-term impacts, the project is committed to the delivery of a comprehensive biodiversity offset package that will include in perpetuity conservation and management of Swamp Sclerophyll Forest much of which is looking to be sourced from the local occurrence.

8.2 *Melaleuca biconvexa*

Melaleuca biconvexa is listed as Vulnerable under the TSC Act and EPBC Act.

Approximately 3,984 plant stems of *Melaleuca biconvexa* or 2.2 hectares will be removed by the project. The species was recorded from within a single vegetation type within the study area (PCT 1723/BVT HU937 *Melaleuca biconvex* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast) of which 25.5 hectares will be removed by the project. An additional, 1,030 plant stems were recorded from within the study area which will be retained.

The local population of *Melaleuca biconvexa* has been defined as being comprised of more than 240,000 plant stems of mature to intermediate age class that extend over low-lying swamp vegetation associated with the Ourimbah Creek floodplain and associated tributaries. Given this, the action proposed is considered to result in a loss of the estimated local population by approximately 1.6 per cent.

8.2.1 TSC Act assessment

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

Targeted surveys identified 5,014 *Melaleuca biconvexa* as occurring within the study area for the project from a single vegetation type; PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast.

The project will require the removal of 3,984 *Melaleuca biconvexa* plant stems or 2.2 hectares recorded within the subject site and the removal of 25.5 hectares of Swamp PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast which constitutes potential habitat for the species. The removal of 3,984 plant stems of *Melaleuca biconvexa* would represent a loss of 1.6 per cent of the local population.

Reproduction is known to occur both sexually (seed germination) and asexually (root suckering) with the latter leading to dense stands of clonal plants that cause difficulties for understanding population densities and individual genetic specimens (Duncan 2001a; NSW Scientific Committee 2011a).

Within the Hunter–Central Rivers CMA, OEH identify that the species can sustain up to a 10 per cent loss for populations greater than 100 mature individuals (Office of Environment & Heritage 2016b). As the project would ultimately remove 1.6 per cent of the total local population this would suggest that the species can sustain such a loss within the Hunter–Central Rivers CMA.

Therefore, the removal of 3,984 *Melaleuca biconvexa* plant stems is considered unlikely to adversely affect the life cycle of the species such that the local population is placed at risk of extinction.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

Approximately 3,984 plant stems of *Melaleuca biconvexa* which were recorded within the subject site would be removed by the project. The project will also require the removal of 25.5 hectares of PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast which constitutes potential habitat for the species. This will result in a loss of approximately 1.6 per cent of the estimated local population.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Although the study area is surrounded by cleared and managed rural residential tenures; construction and operation of the project would add incrementally to existing fragmentation of habitat in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north.

Whilst the removal of this vegetation will increase fragmentation in the study area, it is unlikely to exacerbate fragmentation at the regional scale. Additionally, given the species is considered capable of a 10 per cent loss in the local population, able to both sexual and asexual reproduce and has pollination agents with effective foraging range (for example Grey-headed Flying-fox) the capability of the local population to reproduce is unlikely to be significantly impacted upon by the disruption to existing corridors.

Given this, habitat is unlikely to become significantly fragmented or isolated from other areas of habitat as a result of the proposed action.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The subject site is unlikely to be of critical importance to the long term survival of *Melaleuca biconvexa*. Although the project would require the removal of 3,984 plant stems and 25.5 hectares of potential habitat for the species the OEH accept that within the Hunter–Central Rivers CMA the species can sustain up to a 10 per cent loss for populations greater than 100 mature individuals (Office of Environment & Heritage

2016b). As the project would ultimately remove 1.6 per cent of the total local population this would suggest that the species can sustain such a loss within the Hunter–Central Rivers CMA.

Within the study area *Melaleuca biconvexa* was recorded from within PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast. Within this habitat *Melaleuca biconvexa* was identified to occur in association with other *Melaleuca* and *Callistemon* species such as *Melaleuca nodosa*, *Melaleuca ericifolia*, *Melaleuca linearifolia*, *Melaleuca sieberi*, *Melaleuca styphelioides* and *Callistemon salignus* which favour similar habitat. The importance of this habitat in the locality is generally unknown although 295.9 hectares of Swamp Sclerophyll Forest has been estimated within the local occurrence.

The action proposed will result in the removal of 3,984 plant stems and 25.5 hectares of potential habitat within the subject site. In terms of the impact on the local population, this equates to a loss of 1.6 per cent.

Within the Gosford–Wyong meta-population known and suitable habitat for the species are conserved in a number of OEH estates and Council Reserves although the species is considered not to be adequately reserved.

The habitat within the study area does not form part of any *Saving our Species* management site and has not been identified as important to the long term survival of the species.

Given that a population of the species is recognised being able to sustain up to a 10 per cent loss (project to remove approximately 1.6 per cent of the local population) and that no conserved areas of the species will be impacted upon by the project, it is unlikely that the removal of 3,984 *Melaleuca biconvexa* plant stems and the removal of 25.5 hectares of potential habitat will significantly impact the long term survival of the species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Chief Executive of Office of Environment and Heritage. No critical habitat has been listed for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

To date, a recovery plan for *Melaleuca biconvexa* has not been prepared. The OEH has however assigned *Melaleuca biconvexa* to the site-managed species management stream under the *Saving our Species* conservation program (Office of Environment & Heritage 2016a). Site-managed species are species that have been considered to require management activities to ensure security of the species in the wild for the next 100 years. Under this program the NSW OEH have established three management sites for *Melaleuca biconvexa* which include:

- Porters Creek management site within the Wyong LGA
- Ourimbah management site within the Gosford LGA
- St Georges Basin management site within the Shoalhaven LGA.

The study area does not form part of any management site in which the species is conserved under the *Saving our Species* conservation program.

Whilst the action proposed will not impact any *Melaleuca biconvexa* management site it will result in the loss of 3,984 *Melaleuca biconvexa* plant stems and the removal of 25.5 hectares of potential habitat and is not considered consistent with recovery objectives or actions for this community.

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.

With regard to *Melaleuca biconvexa*, KTPs that the project is likely to be commensurate with, include:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands – *Melaleuca biconvexa* is known to prefer damp places near streams or low lying areas on alluvial soils. The study area is located on a coastal floodplain which contains known habitat for the species and is groundwater dependent. The proposed works are likely to modify the natural hydrology of this habitat within the study area which has potential to impact the population of *Melaleuca biconvexa* on site.
- Clearing of native vegetation – the proposed activities would require the removal of 25.5 hectares of known habitat for the species; *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation community. The species occupies 2.2 hectares of this vegetation which will result in the direct removal of approximately 3,984 *Melaleuca biconvexa* plant stems.
- Infection of native plants by *Phytophthora cinnamomi* - proposed activities (i.e. vegetation clearing and earthworks) has potential to introduce pathogens if appropriate mitigation measures are not implemented.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae – see above.
- Invasion and establishment of exotic vines and scramblers – proposed activities have potential to result in invasion and/or spread of exotic species during the construction phase (i.e. vegetation clearing and earthworks activities) and operation phase of the project (movement, storage and maintenance of trains).
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata* – see above.
- Invasion, establishment and spread of *Lantana camara* – see above.
- Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed) – see above.
- Invasion of native plant communities by exotic perennial grasses – see above.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants – see above.

In respect to weed and pathogen key threatening processes the action proposed will incorporate ameliorative measures that will mitigate such processes.

The action proposed will however result in the clearing of native vegetation and the alteration of natural flow regimes that constitute key threatening processes to this community. As such, the action proposed is considered likely to result in the operation of a key threatening processes to *Melaleuca biconvexa*.

CONCLUSION

A total of 5,014 *Melaleuca biconvexa* plant stems were recorded within the study area. Of these, 3,984 will be removed by the project and the remaining 1,030 will be retained. Vegetation within the study area identified as providing potential habitat included the PCT1723/HU937: *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast of which 25.5 hectares will be removed by the project.

The project is considered unlikely to have an adverse effect on the life cycle of a viable local population so that *Melaleuca biconvexa* is placed at risk of extinction. Although the project action proposed will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scale that would prevent cross-pollination or seed dispersal mechanisms within the local population. In addition, the subject site is unlikely to be of critical importance to the long term survival of *Melaleuca biconvexa*. Consequently, a significant impact to *Melaleuca biconvexa* is considered unlikely to occur as a result of the project.

Whilst it is considered that a significant impact is unlikely, the project is committed to the delivery of a comprehensive biodiversity offset package that will include in perpetuity conservation and management of in excess of 50,000 *Melaleuca biconvexa* species credits and 170 hectares of Swamp Sclerophyll Forest habitat, much of which is looking to be sourced from the local population.

8.3 Regent Honeyeater

8.3.1 TSC Act assessment

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

This species was not recorded within the study area during onsite surveys and there are no previous records known for the site. There are eight records comprising seventeen birds in the locality of the study area, all dated between January 1 and August 6 1991 (Office for Environment & Heritage 2016a).

In examining the life cycle of the Regent Honeyeaters, it is considered unlikely that this species would breed within the study area. However there is an abundance of Swamp Mahogany on site, a winter flowering species which may be of significance to the Regent Honeyeater when blossom resource distribution is scarce elsewhere in its range. Potential foraging habitat found within the study area spans the two broad habitat types; swamp forest and wet open forest.

The study area provides approximately 30.2 hectares of foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Regent Honeyeater.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. The loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

→ **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality.

→ **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental addition to fragmentation on the Regent Honeyeater, through the removal of 23.2 hectares of potential foraging habitat is not likely to be significant given the mobile nature of this species.

→ **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scale that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the mobile nature of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable foraging habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Chief Executive of Office of Environment and Heritage. No critical habitat has been listed for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

A Draft National Recovery Plan for the Regent Honeyeater *Anthochaera phrygia* was prepared in 2015 (Department of the Environment 2015). Regent Honeyeater has been assigned as a site-managed species under the *Saving our Species* program, in which the Office of Environment and Heritage has established four management sites where conservation activities need to take place to ensure the conservation of this species (Office for Environment & Heritage 2016c). The subject site does not impact any of these sites or the management objectives assigned to each site, which include:

- Negotiate in land management agreements to minimise the impacts of clearing of key habitat
- Monitoring disturbance impacts
- Track species abundance
- Land management consultation to ensure appropriate grazing regime
- Restore and rehabilitate native vegetation
- Reduce impacts of noisy miners.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Regent Honeyeater, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

The Regent Honeyeater has not been recorded within the study area. The study area provides approximately 30.2 hectares of potential foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 16.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable foraging habitat for the Regent Honeyeater.

Whilst the project will add incrementally to the loss of foraging habitat in the locality, in particular reducing the amount of seasonal foraging resources available (i.e. Swamp Forest), the loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse effect on this species' life cycle or long term survival.

8.4 Varied Sittella

8.4.1 TSC Act assessment

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 Varied Sittella was recorded in the project study area in association with swamp forest. There are also past records of this species occurring within the study area locality (Office for Environment & Heritage 2016a).

The study area has an abundance of suitable habitat for foraging and breeding requirements of the Varied Sittella. Potential foraging and breeding habitat found within the study area spans across the habitat types; swamp forest and wet open forest.

The study area provides approximately 30.2 hectares of foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Varied Sittella.

It is a sedentary species living in relatively small territories of 13–20 hectares, therefore the removal of 23.2 hectares of breeding and foraging habitat may impact availability of resources for a selected number of local individuals. However due to the abundance of similar habitat adjacent to the site and small proportion of habitat (0.6 per cent) to be removed within the locality, the action is unlikely to have an adverse effect on the life cycle of the species that will place the species at risk of extinction.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. The loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similar available habitat in the locality.

→ **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental addition to fragmentation of Varied Sittella habitat, through the removal of 23.2 hectares of potential foraging habitat, is not likely to be significant given the mobile nature of this species.

→ **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scale that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, and the extensive and contiguous nature of suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Chief Executive of Office of Environment and Heritage. No critical habitat has been listed for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the Landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). The Office of Environment and Heritage has identified a number of management actions for the recovery of this species, which include:

- Raising public awareness and education
- Encouraging landowners to protect floristically and structurally diverse ground layer and mid-storey vegetation by implementing sensitive grazing practices, and avoiding slashing or under scrubbing.
- Targeted removal of weeds and restoring native vegetation
- Monitoring the impact of noisy miners on the species
- Targeted research to inform protection methods
- Promoting revegetation and connecting isolated habitat patches.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Varied Sittella, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

The Varied Sittella was recorded within the study area during surveys. The study area provides approximately 30.2 hectares of potential foraging and breeding habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Varied Sittella.

Whilst the project will add incrementally to the loss of foraging habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable habitat in the locality is not likely to have a significantly adverse effect on this species' life cycle or their long term survival in the locality.

8.5 Little Lorikeet

8.5.1 TSC Act assessment

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

A group of 12 Little Lorikeet's were recorded feeding on Swamp Mahogany blossom in the study area during targeted seasonal surveys. There are also past records of this species occurring within the study area locality (Office for Environment & Heritage 2016a). In particular the blossom resources associated with swamp forest and dry forest habitats, are considered suitable habitat on a seasonal basis for this species.

In examining the life cycle of the Little Lorikeet, it is considered unlikely that this species would breed within the study area. However there is an abundance of potential foraging resources onsite which include both swamp forest and wet open forest. In particular the blossom resources associated with swamp forest and dry forest habitats, are considered suitable foraging habitat on a seasonal basis for this species.

The study area provides approximately 30.2 hectares of foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 percent of potentially suitable foraging habitat for the Little Lorikeet.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. The loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental addition to fragmentation on the Little Lorikeet, through the removal of 23.2 hectares of potential foraging habitat, is not likely to be significant given the mobile nature of this species.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the mobile nature of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable foraging habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities.

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Chief Executive of Office of Environment and Heritage. No critical habitat has been listed for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the Landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no priority sites have been identified for Little Lorikeet. The Office of Environment and Heritage has identified a number of management actions for the recovery of this species, which include:

- Raising public awareness and education
- Encouraging landowners to protect floristically and structurally diverse ground layer and mid-storey vegetation by implementing sensitive grazing practices, and avoiding slashing or under scrubbing
- Targeted removal of weeds and restoring native vegetation
- Monitoring the impact of noisy miners on the species
- Targeted research to inform protection methods
- Identify sites where tree hollows are limiting and develop and implement a nest box strategy
- Undertake native revegetation works and connecting isolated habitat patches
- Promoting revegetation and connecting isolated habitat patches.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Little Lorikeet, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

A group of 12 Little Lorikeet's were recorded feeding on Swamp Mahogany blossom in the study area during targeted seasonal surveys. The study area provides approximately 30.2 hectares of potential foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable foraging habitat for the Little Lorikeet.

Whilst the project will add incrementally to the loss of foraging habitat in the locality, in particular reducing the amount of seasonal foraging resources available (i.e. swamp forest), the loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse effect on this species' life cycle or long term survival.

8.6 Little Eagle

8.6.1 TSC Act assessment

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 Little Eagle has not been recorded in the project study area, however there is favourable foraging habitat in the study area that is considered to potentially form part of the range of local individuals.

In considering the life cycle of this species, the study area contains open habitats for hunting ground dependent prey animals, and an abundance of birds which are likely to be attractive to foraging Little Eagles locally. However, no nesting activity was observed and many of the trees on the site are considered too young to suit the Little Eagle's bulky nest building habits. Foraging habitats for this species within the study area are considered to include both swamp forest and wet open forest.

The study area provides approximately 36.9 hectares of foraging habitat for this species, of which 29.1 hectares is likely to be impacted, including 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.7 per cent of potentially suitable foraging habitat for the Little Eagle.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. Given the large home ranges, mobile foraging habits, and availability of suitable habitat adjacent to the site, the loss of approximately 0.7 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 29.1 hectares of potential foraging habitat for this species, including 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase to fragmentation of Little Eagle habitat, through the removal of 29.1 hectares of potential foraging habitat, is not likely to be significant given the mobile nature of this species.

→ **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 29.1 hectares of potential foraging habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the larger home ranges and mobile foraging habits of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable foraging habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities.

Critical habitat refers to those areas of land listed in the Register of Critical Habitat kept by the Chief Executive of Office of Environment and Heritage. No critical habitat has been listed for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the Landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no priority sites identified have been identified for Little Eagle. The Office of Environment and Heritage has identified a number of management actions for the recovery of this species, which include:

- Protect and maintain high quality habitat
- Improve prey availability through restoration of degraded remnants
- Undertake native revegetation works and connecting isolated habitat patches
- Increase the abundance of large paddock trees
- Raise awareness amongst land managers of the risks of secondary poisoning.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threaten, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Little Eagle, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

The Little Eagle was not recorded within the study area. The study area provides approximately 36.9 hectares of potential foraging habitat for this species, of which 29.1 hectares is likely to be impacted, including 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.7 per cent of potentially suitable foraging habitat for the Little Eagle.

Although the project will incrementally reduce the amount of potential foraging habitat in the locality. Given the already fragmented state of the study area and project locality, the larger home ranges and mobile foraging habits of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.7 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse effect on this species life cycle or its long term survival.

8.7 Black Bittern

8.7.1 TSC Act assessment

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 Black Bittern was not recorded in the project study area. The study area is considered to contain favourable habitat for the Black Bittern, specifically creek line habitat in the rainforest sections of the study area.

The study area provides 1.6 hectares of rainforest habitat, which is considered potential Black Bittern habitat. Of this, 1.1 hectares is likely to be impacted and/or removed by this project. In the locality this equates to approximately 0.65 per cent of the 169.9 hectare of potentially suitable habitat for the Black Bittern in the locality. Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, the loss of approximately 0.65 per cent of potentially suitable habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will involve the removal of 1.1 hectares of potential foraging rainforest habitat. In the locality this equates to approximately 0.65 per cent of potentially suitable habitat for the Black Bittern.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase to fragmentation of Black Bittern habitat, through the removal of 1.1 hectares of potential rainforest habitat, is not likely to be significant given the availability of suitable habitat adjacent to the site and within the wider locality for this species.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 1.1 hectares of potential habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the foraging habits of this species, and the availability of suitable habitat in the locality and wider region, the loss of approximately 0.65 per cent of potentially suitable habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the Landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no priority sites identified have been identified. The Office of Environment and Heritage has identified a number of management actions for the recovery of this species, which include:

- Survey for enhanced understanding of breeding activity and habitat use in key locations
- Encourage land owners to enter land management agreements that promote maintenance of riparian habitat
- Implement riparian restoration activities
- Encourage land managers to implement sensitive land grazing practises.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threaten, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Black Bittern, the project is commensurate with two KTPs:

- Alteration of the natural flow regimes of rivers and streams and their floodplains
- Clearing of native vegetation.

The project will add incrementally to these KTPs, however they are not likely to significantly affect the Black Bittern in the project locality.

CONCLUSION

The study area provides 1.6 hectares of rainforest habitat, which is considered potential Black Bittern habitat. Of this, 1.1 hectares is likely to be impacted and/or removed by this project. In the locality this equates to approximately 0.65 per cent of potentially suitable habitat for the Black Bittern. This project will add incrementally to the loss of foraging habitat in the locality, but given the already fragmented state of the study area and project locality, the foraging habits of this species, and the availability of suitable habitat in the locality and wider region, the loss of approximately 0.65 per cent of potentially suitable habitat in the locality is not likely to have an adverse effect on the life cycle or the long term survival of this species.

8.8 Swift Parrot

8.8.1 TSC Act assessment

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 Swift Parrot was not recorded within the study area during onsite surveys, but there is a previous record known for the site (Office for Environment & Heritage 2016a). Dominant vegetation communities within the study area are listed as Swift Parrot habitat in the National Recovery Plan for the Swift Parrot. Swamp Mahogany in particular, represent a relatively large patch of blossom resources, which may be of significance to the Swift Parrot locally during times when winter blossom is scarce elsewhere in its range.

In examining the life cycle of the Swift Parrot, it is considered unlikely that this species would breed within the study area. However there is an abundance of potential seasonal foraging resources onsite which include both swamp forest and wet open forest.

The study area provides approximately 30.2 hectares of foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Swift Parrot.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. The loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species, including 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase to fragmentation of Swift Parrot habitat, through the removal of 23.2 hectares of potential foraging habitat, is not likely to be significant given the mobile nature of this species.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 23.2 hectares of potential foraging habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the mobile nature of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable foraging habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

A National recovery Plan for the Swift Parrot has been developed and recovery actions associated with this plan include:

- Identify the extent and quality of habitat
- Manage and protect swift parrot habitat at the landscape scale
- Monitor and manage the impact of collisions, competition and disease
- Monitor population and habitat.

The Office of Environment and Heritage has assigned this species to the Landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no priority sites identified have been identified for this species. The Office of Environment and Heritage has identified a number of management actions for the recovery of this species, which include:

- Raise public awareness of the importance of swift parrot habitat and food resources
- Increase the extent and quality of foraging habitat
- Engage the community in the enhancement of priority sites
- With the assistance the community monitor the Swift Parrot's distribution and abundance
- Raise awareness amongst the public of collision risks and how these can be minimised
- Establish appropriate Beak and Feather disease Virus management, test and quarantine.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Swift Parrot, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

The Swift Parrot was not recorded within the study area, but there are past records of the species occurring within the subject site. The study area provides approximately 30.2 hectares of potential foraging habitat for this species, of which 23.2 hectares is likely to be impacted, including 19.6 hectares of swamp forest and

3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable foraging habitat for the Swift Parrot.

Whilst the project will add incrementally to the loss of foraging habitat in the locality, in particular reducing the amount of seasonal foraging resources available (i.e. swamp forest), the loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse effect on this species life cycle or long term survival.

8.9 Square-tailed Kite

8.9.1 TSC Act assessment

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 Square-tailed Kite was not recorded in the project study area, but is considered to have foraging habitat in the study area that may form part of the range of local individuals.

In considering the life cycle of this species, the study area contains structurally complex habitats for attracting a diversity of small birds, which are likely to be attractive to foraging Square-tailed Kite's locally. However, no nesting activity was observed and many of the trees on the site are considered too young to suit their bulky and lofty nest building habits. Foraging habitats for this species within the study area are considered to include both swamp forest and wet open forest.

The study area provides approximately 36.9 hectares of foraging habitat for this species, of which 29.1 hectares is likely to be impacted, including 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.7 per cent of potentially suitable foraging habitat for the Square-tailed Kite.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. Given the large home ranges, mobile foraging habits, and availability of suitable habitat adjacent to the site, the loss of approximately 0.7 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

→ **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 29.1 hectares of potential foraging habitat for this species, including 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.7 per cent) part of similarly available habitat in the locality.

→ **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental addition to fragmentation of Square-tailed Kite habitat, through the removal of 29.1 hectares of potential foraging habitat, is not likely to be significant given the mobile nature of this species.

→ **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 29.1 hectares of potential foraging habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the larger home ranges and mobile foraging habits of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.7 per cent of potentially suitable foraging habitat within the locality is unlikely to affect the long term survival of this species.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the Landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no priority sites identified have been identified. The Office of Environment and Heritage has identified a number of management actions for the recovery of this species, which include:

- Encourage landholders to adopt agreements to promote the retention of large trees in riparian areas and connectivity of remnant woodland patches
- Identify active nest sites and ensure these sites are not disturbed during breeding season
- Conduct targeted surveys of breeding pairs and nest trees to track reproductive success and population viability
- Undertake restoration and revegetation of remnant woodland patches within 20 kilometres of known nest sites
- Promote awareness of the consequences of nest robbing, trapping and shooting of this species.

The project will not interfere significantly with any of these management objectives.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Square-tailed Kite, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

The Square-tailed Kite was not recorded within the study area. The study area provides approximately 36.9 hectares of potential foraging habitat for this species, of which 29.1 hectares is likely to be impacted, including 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.7 per cent of potentially suitable foraging habitat for the Square-tailed Kite.

Although the project will incrementally reduce the amount of potential foraging habitat in the locality. Given the already fragmented state of the study area and project locality, the larger home ranges and mobile foraging habits of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.7 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse effect on this species life cycle or its long term survival.

8.10 Powerful Owl

8.10.1 TSC Act assessment

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

This species was not recorded within the study area during onsite surveys. However the study area is considered to contain potential roosting and foraging habitat for the Powerful Owl. In examining the life cycle of the Powerful Owl, potential roosting habitat could comprise of the dense patches of rainforest occurring on site. Sugar Gliders and Ring-tailed Possums were observed within the subject site which are attractive prey to foraging Powerful Owls. It is considered unlikely that this species would breed within the study area as there is an absence of large hollows.

Potential foraging and roosting habitat found within the study area spans across the habitat types; rainforest, swamp forest and wet open forest. The study area provides approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Powerful Owl.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality. The loss of approximately 0.6 per cent of potentially suitable habitat in the locality is not likely to have an adverse effect on the life cycle of this species

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 30.2 hectares of potential foraging habitat for this species, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase to fragmentation of Powerful Owl habitat, through the removal of 30.2 hectares of potential habitat, is not likely to be significant.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 30.2 hectares of potential habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, the larger home ranges and mobile foraging habits of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable foraging habitat within the locality is unlikely to affect the long term survival of this species in the locality or region.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

An Approved Recovery Plan for the Large Forest Owls (Department of Environment and Conservation 2006b), which includes the Powerful Owl, was prepared in 2006. This recovery plan details recovery actions to help recovery this species (Table 8.1).

Table 8.1 Recovery actions for the Powerful Owl

Description of recovery action ¹	Does action relate to the proposal?
Update and refine existing owl habitat models using the best available information.	Not applicable
Map the amount of modelled habitat across forested land in NSW.	Not applicable
Design a sampling strategy to test the modelled habitat for the presence of owls and locate identified sites.	Not applicable
Field validation of modelled habitat for the presence of owls.	Not applicable
Estimate the areal amount of mapped modelled habitat for each owl species that is occupied (based on the proportion of sample sites with owls in them) and use this estimate to further estimate the number of owl territories present within different land tenures (based on home range data).	Not applicable
Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.	Not applicable
Seek cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.	Not applicable
Implement a regional monitoring program.	Not applicable
Investigate the implementation by DPI (Forests NSW) of the forestry TSL owl prescriptions by carrying out proactive audits targeting these prescriptions (DEC) and through IFOA monitoring and reporting DPI (Forests NSW).	Not applicable
Carry out post-harvest surveys in locations where owls were detected prior to logging to determine if they are continuing to occupy the habitat.	Not applicable
Encourage post-graduate student radio tracking proposals examining the use of logged and unlogged forest by the three owl species.	Not applicable
Make an assessment of the implementation and effectiveness of forestry owl prescriptions using data collected in this action and if necessary refine the prescriptions and negotiate changes to the forestry TSLs.	Not applicable
Prepare and disseminate environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess and mitigate the impacts of developments on the large forest owls and their habitats.	Not applicable

Description of recovery action ¹	Does action relate to the proposal?
Monitor and report on the effectiveness of concurrence and licence conditions that have previously been applied to reduce the impacts of developments on the three large forest owl species or their habitats. This will involve keeping a record of such conditions, selecting case studies and then checking for the presence of owls at long intervals post development.	Not applicable
Use this information to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the three large forest owls.	Not applicable
Provide up-to-date and accurate large forest owl and habitat information in the 'PVP Developer – Threatened Species Tool'. This will ensure that broadscale clearing is only approved under the NV Act if the 'improve or maintain' test is met.	Not applicable
Facilitate the adequate consideration of large forest owls during biodiversity certification of environmental planning instruments. This may include ensuring that correct survey methods are used, informed habitat assessments are undertaken and adequate conservation measures are included in EPIs to assist the recovery of the owls.	Not applicable
Provide up to date information and data for the BioBanking assessment methodology.	Not applicable
Prepare guidelines addressing issues associated with habitat protection and management, and survey and assessment. The guidelines are to provide detailed information on the identification of significant habitat for owls, appropriate strategies for its protection, and for habitat creation as part of revegetation programs. The guidelines will be published on the DEC threatened species website and link to species profile information.	Not applicable
Encourage CMAs to invest in actions that actively manage and/or conserve large forest owl habitat as part of their Catchment Action Plans. In addition, seek other funding opportunities in partnership with community groups, to promote owl conservation on private lands.	Not applicable
Encourage private landholders to undertake management options to conserve and/or actively manage large forest owl habitat (and particularly nest sites) through incentive Property Vegetation Plans, Voluntary Conservation Agreements or other management initiatives.	Not applicable
Seek an Australian Research Council (ARC) Linkage grant or other joint funding opportunity to initiate research into identified key areas of the biology and ecology of the large forest owls.	Not applicable
Promote awareness and involvement of the research and management needs of the three large forest owls among the scientific and academic community.	Not applicable
Seek scholarship funds for an aboriginal student to investigate the cultural and historic significance of the three species.	Not applicable
Encourage and coordinate the involvement of community-based groups (e.g. the Australian Bird and Bat Study Association) and animal care groups (e.g. WIRES) in the implementation of recovery actions.	Not applicable
Ensure the DEC threatened species website provides current information on owl identification (including photographs and samples of calls), habitat identification and protection, any current activities the community can be involved in, as well as information on how and where to report sightings and other relevant information. Ensure the site has links to other key internet sites such as the Australasian Raptor Association.	Not applicable
Coordinate implementation of actions.	Not applicable
Review plan and rewrite in final year.	Not applicable

Description of recovery action ¹	Does action relate to the proposal?
Convene a threatened owl workshop with relevant experts and stakeholders to reassess the NSW conservation status of the three large forest owls. This action will be undertaken upon conclusion of the implementation of all of the above actions.	Not applicable

The project will not interfere with any of these recovery actions.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Powerful Owl, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality.

CONCLUSION

The Powerful Owl was not recorded within the study area. The study area provides approximately 38.5 hectares of potential foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Powerful Owl.

Although the project will incrementally reduce the amount of potential foraging habitat in the locality, given the already fragmented state of the study area and project locality, the larger home ranges and mobile foraging habits of this species, and the extensive and contiguous nature of potentially suitable habitat in the locality, the loss of approximately 0.6 per cent of potentially suitable habitat in the locality is not likely to have a significantly adverse effect on this species.

8.11 Sooty Owl

8.11.1 TSC Act assessment

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

This species was not recorded within the study area during onsite surveys. In examining the habitat preferences of the Sooty Owls, preferred habitats in the locality for the establishment of breeding territories occur in the rainforested gullies of surrounding ranges, as suggested by the distribution of local records. Nevertheless, the study area contains rainforest habitat areas, which may represent potential roosting habitat for dispersing immature Sooty Owls. It is considered unlikely that this species would breed within the study area as there is an absence of large hollows and rainforest habitats are not buffered by tall eucalypt forests as favoured by this species.

Dispersing immature Sooty Owls may roost on rare occasions in rainforest habitat found within the project study area. Within the subject site the Project is likely to affect approximately 1.1 hectares of potential roosting habitat for the Sooty Owl. In the locality this equates to approximately 0.001 per cent of potentially suitable habitat.

Therefore, whilst the project will add incrementally to the loss of roosting habitat in the locality. The loss of approximately 0.001 per cent of potentially suitable habitat in the locality is not likely to have an adverse effect on the life cycle of this species

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will require the removal of approximately 1.1 hectares of rainforest considered to be potential roosting habitat for dispersing individuals of this species. This represents only a small (0.001 per cent) part of similarly available habitat in the locality.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase to fragmentation of potential Sooty Owl habitat, through the removal of 1.1 hectares of potential habitat, is not likely to be significant.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The project will require the removal of approximately 1.1 hectares of potential habitat for this species. Although the project will add incrementally to fragmentation within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent the species from foraging within the project locality. Given the already fragmented state of the study area and project locality, and the unlikelihood that the study area is part of the territory of established pairs, the loss of approximately 0.001 per cent of potential roosting habitat within the locality is unlikely to affect the long term survival of this species in the locality or region.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

An Approved Recovery Plan for the Large Forest Owls (Department of Environment and Conservation 2006b), which includes the Sooty Owl, was prepared in 2006. This recovery plan details recovery actions to help recovery this species (Table 8.1).

Table 8.2 Recovery actions for the Sooty Owl

Description of recovery action ¹	Does action relate to the proposal?
Update and refine existing owl habitat models using the best available information.	Not applicable
Map the amount of modelled habitat across forested land in NSW.	Not applicable
Design a sampling strategy to test the modelled habitat for the presence of owls and locate identified sites.	Not applicable
Field validation of modelled habitat for the presence of owls.	Not applicable
Estimate the areal amount of mapped modelled habitat for each owl species that is occupied (based on the proportion of sample sites with owls in them) and use this estimate to further estimate the number of owl territories present within different land tenures (based on home range data).	Not applicable
Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.	Not applicable
Seek cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.	Not applicable
Implement a regional monitoring program.	Not applicable
Investigate the implementation by DPI (Forests NSW) of the forestry TSL owl prescriptions by carrying out proactive audits targeting these prescriptions (DEC) and through IFOA monitoring and reporting DPI (Forests NSW).	Not applicable
Carry out post-harvest surveys in locations where owls were detected prior to logging to determine if they are continuing to occupy the habitat.	Not applicable
Encourage post-graduate student radio tracking proposals examining the use of logged and unlogged forest by the three owl species.	Not applicable
Make an assessment of the implementation and effectiveness of forestry owl prescriptions using data collected in this action and if necessary refine the prescriptions and negotiate changes to the forestry TSLs.	Not applicable
Prepare and disseminate environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess and mitigate the impacts of developments on the large forest owls and their habitats.	Not applicable
Monitor and report on the effectiveness of concurrence and licence conditions that have previously been applied to reduce the impacts of developments on the three large forest owl species or their habitats. This will involve keeping a record of such conditions, selecting case studies and then checking for the presence of owls at long intervals post development.	Not applicable

Description of recovery action ¹	Does action relate to the proposal?
Use this information to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the three large forest owls.	Not applicable
Provide up-to-date and accurate large forest owl and habitat information in the 'PVP Developer – Threatened Species Tool'. This will ensure that broadscale clearing is only approved under the NV Act if the 'improve or maintain' test is met.	Not applicable
Facilitate the adequate consideration of large forest owls during biodiversity certification of environmental planning instruments. This may include ensuring that correct survey methods are used, informed habitat assessments are undertaken and adequate conservation measures are included in EPIs to assist the recovery of the owls.	Not applicable
Provide up to date information and data for the BioBanking assessment methodology.	Not applicable
Prepare guidelines addressing issues associated with habitat protection and management, and survey and assessment. The guidelines are to provide detailed information on the identification of significant habitat for owls, appropriate strategies for its protection, and for habitat creation as part of revegetation programs. The guidelines will be published on the DEC threatened species website and link to species profile information.	Not applicable
Encourage CMAs to invest in actions that actively manage and/or conserve large forest owl habitat as part of their Catchment Action Plans. In addition, seek other funding opportunities in partnership with community groups, to promote owl conservation on private lands.	Not applicable
Encourage private landholders to undertake management options to conserve and/or actively manage large forest owl habitat (and particularly nest sites) through incentive Property Vegetation Plans, Voluntary Conservation Agreements or other management initiatives.	Not applicable
Seek an Australian Research Council (ARC) Linkage grant or other joint funding opportunity to initiate research into identified key areas of the biology and ecology of the large forest owls.	Not applicable
Promote awareness and involvement of the research and management needs of the three large forest owls among the scientific and academic community.	Not applicable
Seek scholarship funds for an aboriginal student to investigate the cultural and historic significance of the three species.	Not applicable
Encourage and coordinate the involvement of community-based groups (e.g. the Australian Bird and Bat Study Association) and animal care groups (e.g. WIRES) in the implementation of recovery actions.	Not applicable
Ensure the DEC threatened species website provides current information on owl identification (including photographs and samples of calls), habitat identification and protection, any current activities the community can be involved in, as well as information on how and where to report sightings and other relevant information. Ensure the site has links to other key internet sites such as the Australasian Raptor Association.	Not applicable
Coordinate implementation of actions.	Not applicable
Review plan and rewrite in final year.	Not applicable
Convene a threatened owl workshop with relevant experts and stakeholders to reassess the NSW conservation status of the three large forest owls. This action will be undertaken upon conclusion of the implementation of all of the above actions.	Not applicable

The project will not interfere with any of these recovery actions.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Sooty Owl, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however it is not likely to affect this species in the project locality due to the likely low usage of habitats away from the surrounding ranges.

CONCLUSION

The Sooty Owl was not recorded within the study area. The study area provides approximately 1.1 hectares of potential rainforest roosting habitat for dispersing immature individuals of this species as habitat attributes are not of sufficient quality to support the territories of established pairs. In the locality this equates to approximately 0.001 per cent of similar habitat occurring in the locality.

Although the project will incrementally reduce the amount of potential dispersal habitat for immature Sooty Owls in the locality, given the fragmented state of the study area and its locality, and the very small amount (0.001 per cent) of similar habitat in the locality is considered unlikely that the project will have a significantly adverse effect on this species.

8.12 Little Bentwing-bat

8.12.1 TSC Act assessment

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 Little Bentwing-bat was recorded via passive Anabat surveys in swamp forest type habitat in the project study area.

The study area essentially provided foraging habitat for the Little Bentwing-bat as breeding and primary roosting habitat (caves) were not available in the project subject site. The study area provided approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Little Bentwing-bat. Although the study area lacked important cave structures for this species, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potentially suitable roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow. However, man-made structures such as these are likely to be abundant in the locality.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, no primary breeding or roost structures (caves) will be impacted. The loss of approximately 0.6 per cent of similar habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will impact approximately 30.2 hectares of foraging habitat, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality. Although no primary breeding or roosting habitat will be affected by the project, potential roost habitat associated with the existing rail bridge spanning Chittaway Creek and Turpentine Road, and a private bridge over Chittaway Creek may be disturbed.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase of fragmentation on Little Bentwing-bat habitat is not likely to be significant given the mobile nature of this species.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The study area essentially provided foraging habitat for the Little Bentwing-bat as breeding and primary roosting habitat (caves) were not available in the project subject site. The study area provided approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Little Bentwing-bat. Given the mobile nature of this species, the lack of primary breeding and roosting habitat (caves) in the study area, and the extensive and contiguous nature of potentially suitable habitat in the locality, the project would not impact habitat considered critical to the long term survival of populations in the locality or region.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no specific management sites have been developed for this species.

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

Threatening process means a process that threaten, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Little Bentwing-bat, the project is commensurate with three KTPs:

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

The project will add incrementally to these KTPs, however they are not likely to significantly affect the Little Bentwing-bat in the project locality.

CONCLUSION

The Little Bentwing-bat was recorded via passive Anabat surveys in swamp forest type habitat in the project study area. The study area essentially provided foraging habitat for the Little Bentwing-bat as breeding and primary roosting habitat (caves) were not available therein. The study area provided approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Little Bentwing-bat. Although the study area lacked important cave structures for this species, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potentially suitable roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek could provide potential refuge during periods of low flow. However, man-made structures such as these are likely to be abundant in the locality.

Whilst the project will add incrementally to the loss of foraging habitat in the locality, no primary breeding or roost structures (caves) will be impacted. Therefore, the loss of approximately 0.6 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse effect on this species.

8.13 Eastern Bent-wing Bat

8.13.1 TSC Act assessment

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 Bent-wing Bat was recorded via passive Anabat surveys in wet open forest type habitat in the project study area.

The study area essentially provided foraging habitat for the Eastern Bent-wing Bat as breeding and primary roosting habitat (caves) were not available in the project subject site. The study area provided approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including

1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Eastern Bent-wing Bat. Although the study area lacked important cave structures for this species, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potentially suitable roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow. However, man-made structures such as these are likely to be abundant in the locality.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, no primary breeding or roost structures (caves) will be impacted. The loss of approximately 0.6 per cent similar habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will impact approximately 30.2 hectares of foraging habitat, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.6 per cent) part of similarly available habitat in the locality. Although no primary breeding or roosting habitat will be affected by the project, potential roost habitat associated with the existing rail bridge spanning Chittaway Creek and Turpentine Road, and a private bridge over Chittaway Creek may be disturbed.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental addition to fragmentation of Eastern Bent-wing Bat habitat is not likely to be significant given the mobile nature of this species.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The study area essentially provided foraging habitat for the Eastern Bent-wing Bat as breeding and primary roosting habitat (caves) were not available in the subject site. The study area provided approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of similar habitat for the Eastern Bent-wing Bat. Given the mobile nature of this species, the lack of primary breeding and roosting habitat (caves) in the study area, and the extensive and contiguous nature of similar and potentially suitable habitat in the locality, the project would not impact habitat considered critical to the long term survival of populations in the locality or region.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no specific management sites have been developed for this species.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Eastern Bent-wing Bat, the project is commensurate with one KTP; being clearing of native vegetation. The project will add incrementally to this KTP, however, this is not likely to significantly affect the Eastern Bent-wing Bat in the project locality.

CONCLUSION

The Eastern Bent-wing Bat was recorded via passive Anabat surveys in wet open forest type habitat in the project study area. The study area essentially provided foraging habitat for the Eastern Bent-wing Bat as breeding and primary roosting habitat (caves) were not available in the subject site. The study area provided approximately 38.5 hectares of foraging habitat for this species, of which 30.2 hectares is likely to be impacted, including 1.1 hectares of rainforest, 25.5 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.6 per cent of potentially suitable habitat for the Eastern Bent-wing Bat. Although the study area lacked important cave structures for this species, the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potentially suitable roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow. However, man-made structures such as these are likely to be abundant in the locality.

Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, no primary breeding or roost structures (caves) will be impacted. The loss of approximately 0.6 per cent of similar habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

8.14 Southern Myotis

8.14.1 TSC Act assessment

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

In the study area, potential habitat for the Southern Myotis was largely restricted to Chittaway Creek and Bangalow Creek and associated fringing rainforest habitat. Roosting structures such as caves did not occur in the study area and trees within onsite rainforest habitat were generally of an insufficient age-class to develop hollows for animals dependent on these resources. However a lack of caves and hollows does not preclude the presence of other roosting structures. The existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow. However, man-made structures such as these are likely to be abundant in the locality.

Research on Southern Myotis (Anderson *et al.* 2006) suggest that this species is sparsely dispersed across streams in forests and that they are more likely to be recorded on large streams in the lower end of catchments. Indeed, 10 (of 12) known records in the locality for the Southern Myotis occur north of the study area in association with large bodies of water, including Mardi Dam, Wyong River and Ourimbah Creek.

The project will impact approximately 1.1 hectares of rainforest (riparian) habitat in association with Chittaway Creek. In the locality, 261.4 hectares of similar riparian habitat occurs. Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, no breeding or primary roost structures will be impacted. The loss of approximately 0.4 per cent similar habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The Southern Myotis is strongly associated with streams, permanent waterways and wetlands, being recorded most frequently in these areas at low elevations, where they forage for insects and small fish by raking their feet across the water surface. Although the Southern Myotis is known from swamp forest type habitats, within the study area such habitat was not observed to contain open water bodies suitable for the foraging strategies employed by this species. In addition, the relatively young age cohort of canopy strata was generally insufficient for the development of numerous hollow; thus reducing the potential for this species to use such resources in vegetation adjacent to favoured foraging environments.

Therefore, approximately 1.1 hectares of rainforest habitat in association with Chittaway Creek will be affected by the project, representing 0.4 per cent of similar riparian habitat in the locality. Although no primary breeding or roosting habitat will be affected by the project, potential roost habitat associated with the existing rail bridge spanning Chittaway Creek and Turpentine Road, and a private bridge over Chittaway Creek may be disturbed.

- **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. Construction and operation of the project would also add incrementally to existing fragmentation of rainforest habitat and Southern Myotis foraging habitat along Chittaway Creek, in association with the existing rail corridor. Nonetheless, the Southern Myotis is a mobile species that would not be impacted by marginal increases to existing barriers and fragmentation in the project locality.

- **The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.**

The Southern Myotis is strongly associated with streams, permanent waterways and wetlands, being recorded most frequently in these areas at low elevations, where they forage for insects and small fish by raking their feet across the water surface. Although the Southern Myotis is known from swamp forest type habitats, within the study area such habitat was not observed to contain open water bodies suitable for the foraging strategies employed by this species. In addition, the relatively young age cohort of canopy strata was generally insufficient for the development of numerous hollow; thus reducing the potential for this species to use such resources in this vegetation adjacent to favoured foraging environments.

Therefore, approximately 1.1 hectares of rainforest habitat in association with Chittaway Creek will be affected by the project, representing 0.4 per cent of similar riparian habitat in the locality. Although no primary breeding or roosting habitat (caves) will be affected by the project, potential roost habitat associated with the existing rail bridge spanning Chittaway Creek and Turpentine Road, and a private bridge over Chittaway Creek may be disturbed. Such man-made structures are likely to be widespread in the locality.

Given the mobile nature of this species, the lack of primary breeding and roosting habitat in the study area, and potentially more important larger order streams in the locality (Wyong River, Ourimbah Cree and Mardi Dam), the project is not likely to impact habitat considered critical to the long term survival of Southern Myotis in the locality or region.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery or threat abatement plans have been prepared for this species. The Office of Environment and Heritage has assigned this species to the landscape species management stream under the *Saving our Species* program (Office for Environment & Heritage 2016c). Currently no specific management sites have been developed for this species. Landscape-managed species are species that are distributed across large areas, or they are highly mobile and threatened across the landscape by the loss, fragmentation and degradation of habitat. Many of these threats are addressed by NSW planning, native vegetation, and biodiversity legislation, policy and programs including the BioBanking offsets program, Biodiversity Certification and management of environmental water and reservation under the *National Parks and Wildlife Act 1974*. Notwithstanding this, OEH has identified a number of management actions to guide management at a site. Those most pertinent to the project include:

- Retain and protect live and standing dead trees likely to contain suitably sized hollows, or that have the potential to develop hollows, particularly in riparian zones.
- Identify sites, particularly in riparian zones, where hollows are limiting and facilitate regeneration that will recruit hollows in the future.
- Protect and monitor bridges, tunnels and other structures acting as bat habitat. And ensure major works on these structures are done outside the breeding (October-February) and overwintering period. Where bats are known to roost, a compensatory structure should be placed under new infrastructure.
- Encourage land owners to protect and restore riparian areas.
- Check cave utilisation and ensure access.
- Discourage/prevent human access and disturbance to roosting areas.
- Promote artificial roosting habitat.
- Promote land management that minimises disturbance to waterways likely to be foraging habitat.
- Restoration of riparian zones.

Potential habitat for the Southern Myotis was largely restricted to foraging habitat associated with Chittaway Creek and its fringing riparian rainforest habitat. Through the design process, impacts to rainforest habitat was reduced as far as practicable, with potential for further savings during the detailed design phase. The project may not be consistent the timing of construction works to occur outside the breeding and overwintering.

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Southern Myotis, the project is commensurate with four KTPs:

- Alteration of the natural flow regimes of rivers and streams and their floodplains
- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees.

The project will add incrementally to these KTPs, however they are not likely to significantly affect the Southern Myotis in the project locality.

CONCLUSION

In the study area, habitat for the Southern Myotis was largely restricted to Chittaway Creek and Bangalow Creek and associated fringing rainforest habitat. Roosting structures such as caves did not occur in the study area and trees within onsite rainforest habitat were generally of an insufficient age-class to develop hollows for animals dependent on these resources. However the existing rail bridge spanning Chittaway Creek and Turpentine Road provided potential roosting habitat in expansion joints between concrete cast sections of the bridge, whilst a small private bridge over Chittaway Creek may provide potential refuge during periods of low flow. However, man-made structures such as these are likely to be abundant in the locality.

The project will impact approximately 1.1 hectares of rainforest riparian habitat in association with Chittaway Creek. In the locality, approximately 261.4 hectares of similar riparian habitat occurs. Therefore, whilst the project will add incrementally to the loss of potential foraging habitat in the locality, no breeding or primary roost structures will be impacted. The loss of approximately 0.4 per cent similar riparian habitat in the locality is not likely to have a significantly adverse effect on the Southern Myotis. Furthermore, research and the distribution of known records suggest that this species is associated with larger bodies of water, such as Mardi Dam, Wyong River and Ourimbah Creek.

8.15 Grey-headed Flying-fox

8.15.1 TSC Act assessment

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 Grey-headed Flying-fox was observed flying over the project study area during two separate nocturnal survey events. Although this species was not specifically observed using habitat within the study area, this species is a blossom nomad that is known to commute long distances as food availability varies over time. Accordingly, this species is likely to be present intermittently and irregularly. No Grey-headed Flying-fox camps were observed in the study area and none are known to occur in the locality. However, four Grey-headed flying-fox camps are known of in proximity to the project including, Jilliby, Watanobbi, Wingello Creek and Matcham. A review of the National Flying-fox Monitor Reviewer indicate that the Grey-headed Flying-fox has not been recorded at the Matcham or Jilliby camps on survey dates between February 2013 and August 2015. Grey-headed Flying-fox was recorded at the Watanobbi camp in May and November of 2015 and November 2014 at Wingello Creek. The nearest nationally important Flying-fox camp occurs some 52 kilometres to the project's north-east in Blackbutt Reserve, Newcastle.

The study area provided approximately 31.8 hectares of foraging habitat for the Grey-headed Flying-fox, of which 24.3 hectares is likely to be impacted, including 1.1 hectares of rainforest, 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.5 per cent of similarly suitable habitat for the Grey-headed Flying-fox. Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, no camps will be impacted. The loss of approximately 0.5 per cent of potentially suitable foraging habitat in the locality is not likely to have an adverse effect on the life cycle of this species.

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.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

- **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.**
- **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.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

- **The extent to which habitat is likely to be removed or modified as a result of the action proposed.**

The project will impact approximately 24.3 hectares of foraging habitat, including 1.1 hectares of rainforest, 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. Foraging habitat in the study area represents only a small (0.5 per cent) part of similarly available habitat in the locality. No Grey-headed Flying-fox camps will be directly affected as a result of the project.

→ **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.**

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor and managed rural residential lands. Construction of the project would add incrementally to existing fragmentation of habitat in an approximate north-south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north. The incremental increase to fragmentation of Grey-headed Flying-fox habitat would not be significant given the nomadic nature and wide ranging movements undertaken by this species.

→ **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.**

Roost/maternity camps were not observed in the study area and none are known in the project locality. The study area provided approximately 31.8 hectares of foraging habitat for this species, of which 24.3 hectares is likely to be impacted, including 1.1 hectares of rainforest, 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.5 per cent of similar suitable habitat for the Grey-headed Flying-fox. The Grey-headed Flying-fox is a wide ranging nomadic species that relies on food sources that largely have irregular patterns of production, with nightly foraging events typically occurring within 20 kilometres of camps, but some commutes can be up to 50 kilometres.

Given the mobile nature of this species, the lack of camps in the study area and locality, the irregular pattern of available foraging resource in the study area, and the extensive and contiguous nature of similarly suitable habitat in the locality, habitat within the study area would not be considered important to the survival of Grey-headed Flying-fox in the locality or region.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery plan has been prepared for the Grey-headed Flying-fox under the TSC Act. However, a Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* was prepared in 2009 (Department of Environment Climate Change and Water NSW 2009), which details 12 objectives to help recover this species (Table 8.3).

Table 8.3 Recovery objectives for the Grey-headed Flying-fox

Objective	Likely to be affected by the project?
Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range.	Not applicable
Protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes.	Not applicable
Identify roosting habitat critical to the survival of Grey-headed Flying-foxes.	Not applicable
Protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes.	Not applicable
Substantially reduce deliberate destruction of Grey-headed Flying-foxes in fruit crops.	Not applicable

Objective	Likely to be affected by the project?
Reduce negative public attitudes toward Grey-headed Flying-foxes and reduce conflict with humans.	Not applicable
Increase public awareness and understanding of Grey-headed Flying-foxes and the recovery program, and to involve the community in recovery actions.	Not applicable
Monitor population trends in Grey-headed Flying-foxes so as to monitor the species' national distribution and status.	Not applicable
Assess and reduce the impact on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and on barbed-wire.	Not applicable
Improve knowledge of the demographics and population structure of Grey-headed Flying-foxes in order to increase understanding of the ecological requirements of the species.	Not applicable
Increase the effectiveness and efficiency of recovery initiatives for Grey-headed Flying-foxes by working cooperatively with conservation and management programs.	Not applicable
Maintain an effective Grey-headed Flying-fox National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan.	Not applicable

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

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities. Key threatening processes are listed under the TSC Act and at present there are 38 listed KTPs.

With respect to the Grey-headed Flying-fox, the project is commensurate with one KTP, being clearing of native vegetation. The project will add incrementally to this KTP, however, this is not likely to significantly affect the Grey-headed Flying-fox in the project locality.

CONCLUSION

The Grey-headed Flying-fox was observed flying over the project study area during two separate nocturnal survey events. Although this species was not specifically observed using habitat within the study area, this species is a blossom nomad that is known to commute long distances as food availability varies over time. Accordingly, this species is likely to be present intermittently and irregularly. No Grey-headed Flying-fox camps were observed in the study area and none are known to occur in the locality. However, four Grey-headed flying-fox camps are known of in proximity to the project including, Jilliby, Watanobbi, Wingello Creek and Matcham. A review of the National Flying-fox Monitor Reviewer indicate that the Grey-headed Flying-fox has not been recorded at the Matcham or Jilliby camps on survey dates between February 2013 and August 2015. Grey-headed Flying-fox was recorded at the Watanobbi camp in May and November of 2015 and November 2014 at Wingello Creek. The nearest nationally important Flying-fox camp occurs some 52 kilometres to the project's north-east in Blackbutt Reserve, Newcastle.

The study area provided approximately 31.8 hectares of foraging habitat for the Grey-headed Flying-fox, of which 24.3 hectares is likely to be impacted, including 1.1 hectares of rainforest, 19.6 hectares of swamp forest and 3.6 hectares of wet open forest. In the locality this equates to approximately 0.5 per cent of similarly suitable habitat for the Grey-headed Flying-fox. Therefore, whilst the project will add incrementally to the loss of foraging habitat in the locality, no camps will be impacted. The loss of approximately 0.5 per cent of potentially suitable foraging habitat in the locality is not likely to have a significantly adverse impact on Grey-headed Flying-fox in the locality.

9 ADDITIONAL INFORMATION

9.1 Qualification and experience

The contributors to the preparation of this report, their qualifications and their role is provided in Table 9.1.

Table 9.1 Contributors and their qualifications

Name	Qualification	Role
Alex Cockerill	BSc (Hons)	Lead Ecologist – project manager and technical review
Mark Stables	BSc (Hons)	Senior Ecologist – Flora survey and reporting
Debbie Landenberger	BSc (Hons)	Senior Ecologist – Flora survey
Tanya Bangel	BSc (Hons), Dip ConsLdMgt	Ecologist – Flora survey and reporting
Nathan Cooper	BEnvSc, Grad Dip Ornith	Senior ecologist – Fauna survey, Anabat analysis and reporting
Allan Richardson	BEnvSc (Hons)	Senior ecologist – Fauna survey and reporting
Clementine Watson	BEnvSc	Graduate Ecologist – Fauna survey and reporting
Rob Suansri	BSc, BEc	Mapping and data management – GIS operator
Matt Goganovski	BSc(Geosciences)	Mapping and data management – GIS operator
Elizabeth Asby	BSc, MScPrel	Senior Ecologist – Expert review
Arthur White	PhD	Expert Amphibian Report

9.2 Other approvals required for the development activity

Other approvals may be required under NSW legislation for the project. Additional approvals may include Part 5 approval under the NSW EP&A Act. Before the project can proceed this SIS will require concurrency from OEH as the determining authority for the project.

In addition to the preparation of an SIS, an EPBC referral has been made due to the likely significant impacts on the vulnerable listed species *Melaleuca biconvexa*. This referral is a separate process to the NSW state assessment process.

Additional approval requirements for the proposed works are provided in the relevant sections of the project's REF.

9.3 Licensing matters relating to the survey

All work was carried out under the appropriate licences which included:

- Scientific Licence: SL100630 issued by OEH as required under Clause 22 of the *National Parks and Wildlife Regulations 2002* and Section 132C of the *National Parks and Wildlife Act 1974*
- Animal Research Authority: Trim 15/74 issued by the Department of Industries and Investment NSW (Agriculture) as required under the *Animal Research Act 1985*.

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Appendix A

SPECIES OF PLANT RECORDED IN THE STUDY AREA

Appendix A – Flora species recorded

Table A.1 Plant species recorded from within the subject site/study area

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Acanthaceae	<i>Pseuderanthemum variabile</i>	Pastel Flower			Native
Apiaceae	<i>Centella asiatica</i>	Pennywort			Native
Apiaceae	<i>Cyclospermum leptophyllum</i>	Slender Celery			Exotic
Apiaceae	<i>Hydrocotyle bonariensis</i>	American Pennywort			Exotic
Apiaceae	<i>Hydrocotyle peduncularis</i>				Native
Apiaceae	<i>Xanthosia pilosa</i>	Woolly Xanthosia			Native
Apocynaceae	<i>Parsonsia straminea</i>	Common Silkpod			Native
Araliaceae	<i>Hedera helix</i>	English Ivy			Exotic
Araliaceae	<i>Polyscias sambucifolia</i>	Elderberry Panax			Native
Araliaceae	<i>Schefflera actinophylla</i>	Umbrella Tree			Exotic
Arecaceae	<i>Archontophoenix cunninghamiana</i>	Bangalow Palm		P13	Native
Arecaceae	<i>Livistona australis</i>	Cabbage Palm		P13	Native
Asteraceae	<i>Ageratina adenophora</i>	Crofton Weed			Exotic
Asteraceae	<i>Bidens pilosa</i>	Cobblers Pegs			Exotic
Asteraceae	<i>Cassinia uncata</i>	Sticky Cassinia			Native
Asteraceae	<i>Cirsium vulgare</i>	Spear Thistle			Exotic
Asteraceae	<i>Conyza albida</i>	Tall Fleabane			Exotic
Asteraceae	<i>Hypochaeris radicata</i>	Catsear			Exotic
Asteraceae	<i>Ozothamnus diosmifolius</i>	White Dogwood			Native
Asteraceae	<i>Senecio madagascariensis</i>	Fireweed			Exotic
Asteraceae	<i>Sigesbeckia orientalis</i>				Native
Asteraceae	<i>Tagetes minuta</i>	Stinking Roger			Exotic
Bignoniaceae	<i>Pandorea pandorana</i>	Wonga Wonga Vine			Native
Blechnaceae	<i>Blechnum cartilagineum</i>	Gristle Fern			Native
Blechnaceae	<i>Blechnum indicum</i>	Swamp Water Fern			Native

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Caprifoliaceae	<i>Lonicera japonica</i>	Japanese Honeysuckle			Exotic
Casuarinaceae	<i>Allocasuarina torulosa</i>	Forest Oak			Native
Celastraceae	<i>Maytenus silvestris</i>	Narrow-leaved Orangebark			Native
Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew			Native
Commelinaceae	<i>Tradescantia fluminensis</i>	Wandering Jew			Exotic
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed			Native
Cyperaceae	<i>Baumea acuta</i>	Pale Twig-sedge			Native
Cyperaceae	<i>Carex appressa</i>	Tussock Sedge			Native
Cyperaceae	<i>Carex inversa</i>	Knob Sedge			Native
Cyperaceae	<i>Carex sp.</i>				Native
Cyperaceae	<i>Cyperus brevifolius</i>	Mullumbimby Couch			Exotic
Cyperaceae	<i>Cyperus congestus</i>	Dense Flat-sedge			Exotic
Cyperaceae	<i>Cyperus polystachyos</i>	Bunchy Flat-sedge			Native
Cyperaceae	<i>Cyperus sphaeroideus</i>	Globe Kyllinga			Native
Cyperaceae	<i>Fimbristylis dichotoma</i>	Common Fringe-sedge			Native
Cyperaceae	<i>Gahnia erythrocarpa</i>				Native
Cyperaceae	<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge		P13	Native
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken			Native
Dicksoniaceae	<i>Calochlaena dubia</i>	Common Ground Fern			Native
Dilleniaceae	<i>Hibbertia dentata</i>	Twining Guinea Flower			Native
Dilleniaceae	<i>Hibbertia scandens</i>	Climbing Guinea Flower			Native
Dioscoreaceae	<i>Dioscorea transversa</i>	Native Yam			Native
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash			Native
Epacridaceae	<i>Epacris pulchella</i>	NSW Coral Heath			Native
Epacridaceae	<i>Leucopogon juniperinus</i>	Long-flower Beard-heath			Native
Epacridaceae	<i>Leucopogon lanceolatus</i>	Lance Beard Heath			Native
Epacridaceae	<i>Leucopogon margarodes</i>				Native

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Euphorbiaceae	<i>Breynia oblongifolia</i>	Coffee Bush			Native
Euphorbiaceae	<i>Glochidion ferdinandi</i>	Cheese Tree			Native
Euphorbiaceae	<i>Ricinus communis</i>	Castor Oil Plant			Exotic
Fabaceae (Faboideae)	<i>Glycine clandestina</i>	Twining Glycine			Native
Fabaceae (Faboideae)	<i>Kennedia rubicunda</i>	Red Kennedy Pea			Native
Fabaceae (Faboideae)	<i>Lotus sp.</i>				Native
Fabaceae (Faboideae)	<i>Trifolium repens</i>	White Clover			Exotic
Fabaceae (Faboideae)	<i>Vicia sp.</i>				Exotic
Fabaceae (Mimosoideae)	<i>Acacia irrorata</i>	Green Wattle			Exotic
Fabaceae (Mimosoideae)	<i>Acacia longifolia</i>	Sydney Golden Wattle			Native
Fabaceae (Mimosoideae)	<i>Acacia longissima</i>	Narrow-leaved Wattle			Native
Fabaceae (Mimosoideae)	<i>Acacia maidenii</i>	Maidens Wattle			Native
Fabaceae (Mimosoideae)	<i>Acacia parramattensis</i>	Parramatta Wattle			Native
Fabaceae (Mimosoideae)	<i>Acacia podalyriifolia</i>	Queensland Silver Wattle			Native
Fabaceae (Mimosoideae)	<i>Acacia prominens</i>	Gosford Wattle			Native
Flacourtiaceae	<i>Scolopia braunii</i>	Flintwood			Native
Geraniaceae	<i>Geranium sp.</i>				Native
Gleicheniaceae	<i>Gleichenia dicarpa</i>	Pouched Coral-fern			Native
Goodeniaceae	<i>Dampiera stricta</i>	Blue Dampiera			Native
Goodeniaceae	<i>Goodenia paniculata</i>	Branched Goodenia			Native
Haloragaceae	<i>Gonocarpus micranthus</i>	Creeping Raspwort			Native
Haloragaceae	<i>Gonocarpus tetragynus</i>	Common Raspwort			Native

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Juncaceae	<i>Juncus australis</i>	Austral Rush			Native
Juncaceae	<i>Juncus cognatus</i>				Exotic
Juncaceae	<i>Juncus planifolius</i>	Broad-leaf Rush			Native
Juncaceae	<i>Juncus sp.</i>				Native
Juncaceae	<i>Juncus sp. I</i>				Native
Juncaceae	<i>Juncus sp. M</i>				Native
Lauraceae	<i>Cassytha sp.</i>				Native
Lauraceae	<i>Cinnamomum camphora</i>	Camphor Laurel			Exotic
Lauraceae	<i>Cryptocarya glaucescens</i>	Jackwood			Native
Lauraceae	<i>Cryptocarya microneura</i>	Murrogun			Native
Lauraceae	<i>Neolitsea australiensis</i>	Green Bolly Gum			Native
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot			Native
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			Native
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry			Native
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily			Native
Malvaceae	<i>Sida rhombifolia</i>	Paddys Lucerne			Exotic
Meliaceae	<i>Synoum glandulosum subsp. glandulosum</i>	Scentless Rosewood			Native
Menispermaceae	<i>Sarcopetalum harveyanum</i>	Pearl Vine			Native
Menyanthaceae	<i>Villarsia exaltata</i>	Erect Marsh-flower			Native
Monimiaceae	<i>Doryphora sassafras</i>	Sassafras			Native
Moraceae	<i>Ficus coronata</i>	Creek Sandpaper Fig			Native
Moraceae	<i>Trophis scandens</i>				Native
Myrsinaceae	<i>Rapanea howittiana</i>	Brush Muttonwood			Native
Myrsinaceae	<i>Rapanea variabilis</i>	Muttonwood			Native
Myrtaceae	<i>Acmena smithii</i>	Lilly Pilly			Native
Myrtaceae	<i>Angophora floribunda</i>	Rough-barked Apple			Native
Myrtaceae	<i>Backhousia myrtifolia</i>	Grey Myrtle			Native

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Myrtaceae	<i>Callistemon salignus</i>	Willow Bottlebrush			Native
Myrtaceae	<i>Corymbia gummifera</i>	Red Bloodwood			Native
Myrtaceae	<i>Eucalyptus pilularis</i>	Blackbutt			Native
Myrtaceae	<i>Eucalyptus robusta</i>	Swamp Mahogany			Native
Myrtaceae	<i>Eucalyptus saligna</i>	Sydney Blue Gum			Native
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum			Native
Myrtaceae	<i>Leptospermum polygalifolium</i>				Native
Myrtaceae	<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V	Native
Myrtaceae	<i>Melaleuca ericifolia</i>	Swamp Paperbark			Native
Myrtaceae	<i>Melaleuca linariifolia</i>				Native
Myrtaceae	<i>Syncarpia glomulifera</i>	Turpentine			Native
Myrtaceae	<i>Syzygium australe</i>	Brush Cherry			Native
Myrtaceae	<i>Syzygium oleosum</i>	Blue Lilly Pilly			Native
Oleaceae	<i>Ligustrum lucidum</i>	Large-leaved Privet			Exotic
Oleaceae	<i>Ligustrum sinense</i>	Small-leaved Privet			Exotic
Onagraceae	<i>Ludwigia sp.</i>				Native
Oxalidaceae	<i>Oxalis perennans</i>	Grassland Wood-sorrel			Native
Passifloraceae	<i>Passiflora edulis</i>	Common Passionfruit			Exotic
Philydraceae	<i>Philydrum lanuginosum</i>	Frogsmouth			Native
Phormiaceae	<i>Dianella caerulea</i>				Native
Phormiaceae	<i>Dianella sp.</i>				Native
Phytolaccaceae	<i>Phytolacca octandra</i>	Inkweed			Exotic
Pinaceae	<i>Pinus sp.</i>				Exotic
Pittosporaceae	<i>Billardiera scandens</i>	Appleberry			Native
Pittosporaceae	<i>Hymenosporum flavum</i>	Native Frangipani			Native
Pittosporaceae	<i>Pittosporum multiflorum</i>	Orange Thorn			Native
Plantaginaceae	<i>Plantago lanceolata</i>	Lambs Tongues			Exotic
Poaceae	<i>Andropogon virginicus</i>	Whisky Grass			Exotic

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Poaceae	<i>Axonopus fissifolius</i>	Narrow-leafed Carpet Grass			Exotic
Poaceae	<i>Briza subaristata</i>				Exotic
Poaceae	<i>Chloris gayana</i>	Rhodes Grass			Exotic
Poaceae	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass			Native
Poaceae	<i>Ehrharta erecta</i>	Panic Veldtgrass			Exotic
Poaceae	<i>Eleusine tristachya</i>	Goose Grass			Exotic
Poaceae	<i>Entolasia marginata</i>	Bordered Panic			Native
Poaceae	<i>Entolasia stricta</i>	Wiry Panic			Native
Poaceae	<i>Eragrostis leptostachya</i>	Paddock Lovegrass			Native
Poaceae	<i>Imperata cylindrica</i>	Bladey Grass			Native
Poaceae	<i>Microlaena stipoides</i>				Native
Poaceae	<i>Oplismenus aemulus</i>				Native
Poaceae	<i>Oplismenus imbecillis</i>	Creeping Beard Grass			Native
Poaceae	<i>Panicum maximum var. maximum</i>	Guinea Grass			Exotic
Poaceae	<i>Paspalum dilatatum</i>	Paspalum			Exotic
Poaceae	<i>Paspalum distichum</i>	Water Couch			Native
Poaceae	<i>Paspalum urvillei</i>	Vasey Grass			Exotic
Poaceae	<i>Phragmites australis</i>	Common Reed			Native
Poaceae	<i>Setaria gracilis</i>	Slender Pigeon Grass			Exotic
Polygonaceae	<i>Persicaria lapathifolia</i>	Pale Knotweed			Native
Polygonaceae	<i>Persicaria orientalis</i>	Princes Feathers			Native
Polygonaceae	<i>Rumex brownii</i>	Swamp Dock			Native
Proteaceae	<i>Banksia collina</i>				Native
Proteaceae	<i>Banksia spinulosa</i>	Hairpin Banksia		P13	Native
Proteaceae	<i>Persoonia linearis</i>	Narrow-leafed Geebung		P13	Native
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup			Native
Ranunculaceae	<i>Ranunculus sp.</i>				Native

FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	EPBC ACT STATUS ¹	TSC ACT STATUS ²	NATIVE
Restionaceae	<i>Baloskion tetraphyllum</i>				Native
Restionaceae	<i>Empodisma minus</i>	Spreading Rope-rush			Native
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash			Native
Ripogonaceae	<i>Ripogonum album</i>	White Supplejack			Native
Rosaceae	<i>Rubus fruticosus</i>	Blackberry complex			Exotic
Rosaceae	<i>Rubus rosifolius</i>	Rose-leaf Bramble			Native
Rubiaceae	<i>Pomax umbellata</i>	Pomax			Native
Rutaceae	<i>Melicope micrococca</i>	Hairy-leaved Doughwood			Native
Rutaceae	<i>Zieria smithii</i>	Sandfly Zieria			Native
Sapindaceae	<i>Diploglottis australis</i>	Native Tamarind			Native
Scrophulariaceae	<i>Veronica plebeia</i>	Trailing Speedwell			Native
Smilacaceae	<i>Smilax australis</i>	Sarsaparilla			Native
Solanaceae	<i>Solanum mauritianum</i>	Wild Tobacco Bush			Exotic
Typhaceae	<i>Typha orientalis</i>	Broad-leaved Cumbungi			Native
Verbenaceae	<i>Lantana camara</i>	Lantana			Exotic
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop			Exotic
Violaceae	<i>Viola hederacea</i>	Ivy-leaved Violet			Native

1) Listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2) Listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and/or listed as protected under Schedule 13 Protected native plants of the NSW *National Parks and Wildlife Act 1974*.

Appendix B

SPECIES OF ANIMAL RECORDED IN THE STUDY AREA

Appendix B – Fauna species recorded

Table B.1 Fauna species recorded from within the subject site/study area

SCIENTIFIC NAME	COMMON NAME	NATIVE	EPBC ACT ¹	TSC ACT ²	OBSERVATION TYPE ³
Amphibians					
<i>Crinia signifera</i>	Common Eastern Froglet	Native			O
<i>Limnodynastes peronii</i>	Brown-striped Frog	Native			O
<i>Litoria dentata</i>	Bleating Tree Frog	Native			O
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	Native			O
<i>Litoria gracilentata</i>	Dainty Green Tree Frog	Native			O
<i>Uperoleia fusca</i>	Dusky Gungan	Native			O
<i>Uperoleia</i> sp.	Undescribed <i>Uperoleia</i>	Native			T
Reptiles					
<i>Amphibolurus muricatus</i>	Jacky Lizard	Native			O
<i>Demansia psammophis</i>	Yellow-faced Whip Snake	Native			O
<i>Egernia major</i>	Land Mullet	Native			T
<i>Eulamprus quoyii</i>	Eastern Water Skink	Native			O
<i>Hemiaspis signata</i>	Black-bellied Swamp Snake	Native			O
<i>Lampropholis delicata</i>	Grass Skink	Native			O
Birds					
<i>Acanthiza lineata</i>	Striated Thornbill	Native			O
<i>Acanthiza nana</i>	Yellow Thornbill	Native			O
<i>Acanthiza pusilla</i>	Brown Thornbill	Native			O
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	Native			O
<i>Accipiter cirricephalus</i>	Collared Sparrowhawk	Native			O
<i>Alisterus scapularis</i>	Australian King-Parrot	Native			O
<i>Anhinga novaehollandiae</i>	Australasian Darter	Native			O
<i>Anthochaera carunculata</i>	Red Wattlebird	Native			O
<i>Anthochaera chrysoptera</i>	Little Wattlebird	Native			O
<i>Ardea ibis</i>	Cattle Egret	Native	M		O
<i>Ardea pacifica</i>	White-necked Heron	Native			O
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	Native			O
<i>Cacatua tenuirostris</i>	Long-billed Corella	Native			O
<i>Caligavis chrysops</i>	Yellow-faced Honeyeater	Native			O

SCIENTIFIC NAME	COMMON NAME	NATIVE	EPBC ACT ¹	TSC ACT ²	OBSERVATION TYPE ³
<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo	Native			0
<i>Columba leucomela</i>	White-headed Pigeon	Native			0
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	Native			0
<i>Corvus coronoides</i>	Australian Raven	Native			0
<i>Coturnix ypsilophora australis</i>	Brown Quail	Native			0
<i>Cracticus nigrogularis</i>	Pied Butcherbird	Native			0
<i>Cracticus tibicen</i>	Australian Magpie	Native			0
<i>Cracticus torquatus</i>	Grey Butcherbird	Native			0
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	Native			0
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Native		V	0
<i>Dicaeum hirundinaceum</i>	Mistletoebird	Native			0
<i>Eopsaltria australis</i>	Eastern Yellow Robin	Native			0
<i>Eudynamys scolopacea</i>	Common Koel	Native			0
<i>Geopelia humeralis</i>	Bar-shouldered Dove	Native			0
<i>Gerygone mouki</i>	Brown Gerygone	Native			0
<i>Glossopsitta pusilla</i>	Little Lorikeet	Native		V	0
<i>Grallina cyanoleuca</i>	Magpie-lark	Native			0
<i>Haliastur sphenurus</i>	Whistling Kite	Native			0
<i>Hirundo neoxena</i>	Welcome Swallow	Native			0
<i>Lopholaimus antarcticus</i>	Topknot Pigeon	Native			0
<i>Malurus cyaneus</i>	Superb Fairy-wren	Native			0
<i>Malurus lamberti</i>	Variegated Fairy-wren	Native			0
<i>Manorina melanocephala</i>	Noisy Miner	Native			0
<i>Manorina melanophrys</i>	Bell Miner	Native			0
<i>Meliphaga lewinii</i>	Lewin's Honeyeater	Native			0
<i>Melithreptus lunatus</i>	White-naped Honeyeater	Native			0
<i>Monarcha melanopsis</i>	Black-faced Monarch	Native	M		0
<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	Native			0
<i>Neochmia temporalis</i>	Red-browed Finch	Native			0
<i>Ocyphaps lophotes</i>	Crested Pigeon	Native			0

SCIENTIFIC NAME	COMMON NAME	NATIVE	EPBC ACT ¹	TSC ACT ²	OBSERVATION TYPE ³
<i>Oriolus sagittatus</i>	Olive-backed Oriole	Native			O
<i>Pachycephala pectoralis</i>	Golden Whistler	Native			O
<i>Pachycephala rufiventris</i>	Rufous Whistler	Native			O
<i>Pardalotus punctatus</i>	Spotted Pardalote	Native			O
<i>Pelecanus conspicillatus</i>	Australian Pelican	Native			O
<i>Philemon corniculatus</i>	Noisy Friarbird	Native			O
<i>Phylidonyris nigra</i>	White-cheeked Honeyeater	Native			O
<i>Platycercus eximius</i>	Eastern Rosella	Native			O
<i>Psophodes olivaceus</i>	Eastern Whipbird	Native			O
<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird	Native			O
<i>Rhipidura fuliginosa</i>	Grey Fantail	Native			O
<i>Rhipidura leucophrys</i>	Willie Wagtail	Native			O
<i>Rhipidura rufifrons</i>	Rufous Fantail	Native	M		O
<i>Sericornis citreogularis</i>	Yellow-throated Scrubwren	Native			O
<i>Sericornis frontalis</i>	White-browed Scrubwren	Native			O
<i>Sericornis magnirostris</i>	Large-billed Scrubwren	Native			O
<i>Strepera graculina</i>	Pied Currawong	Native			O
<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	Exotic		U	O
<i>Threskiornis spinicollis</i>	Straw-necked Ibis	Native			O
<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	Native			O
<i>Vanellus miles</i>	Masked Lapwing	Native			O
<i>Zosterops lateralis</i>	Silvereye	Native			O
Mammals					
<i>Antechinus stuartii</i>	Brown Antechinus	Native			T
<i>Antechinus swainsonii</i>	Dusky Antechinus	Native			T
<i>Austronomus australis</i>	White-striped Freetail-bat	Native			D
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	Native			D
<i>Miniopterus australis</i>	Little Bent-wing Bat	Native		V	D
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	Native		V	D
<i>Mormopterus ridei</i>	Ride's Free-tailed Bat	Native			D

SCIENTIFIC NAME	COMMON NAME	NATIVE	EPBC ACT ¹	TSC ACT ²	OBSERVATION TYPE ³
<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat	Native			T
<i>Nyctophilus sp.</i>	Long-eared Bat	Native			D
<i>Oryctolagus cuniculus</i>	Rabbit	Exotic		U	O
<i>Petaurus breviceps</i>	Sugar Glider	Native			O
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	Native			O
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Native	V	V	O
<i>Rattus fuscipes</i>	Bush Rat	Native			T
<i>Rattus lutreolus</i>	Swamp Rat	Native			T
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	Native			D
<i>Vespadelus pumilus</i>	Eastern Forest Bat	Native			D
<i>Wallabia bicolor</i>	Swamp Wallaby	Native			CT

- 1) Listed as Vulnerable, Endangered or Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- 2) Listed as Vulnerable, Endangered or Critically Endangered under the NSW *Threatened Species Conservation Act 1999* (TSC Act).
- 3) Observation type = O = observed, T= trapped, D = detected by Anabat survey, CT= camera Trap.

Appendix C

**EXPERT REPORT – THREATENED FROG SPECIES HABITAT
ASSESSMENT**



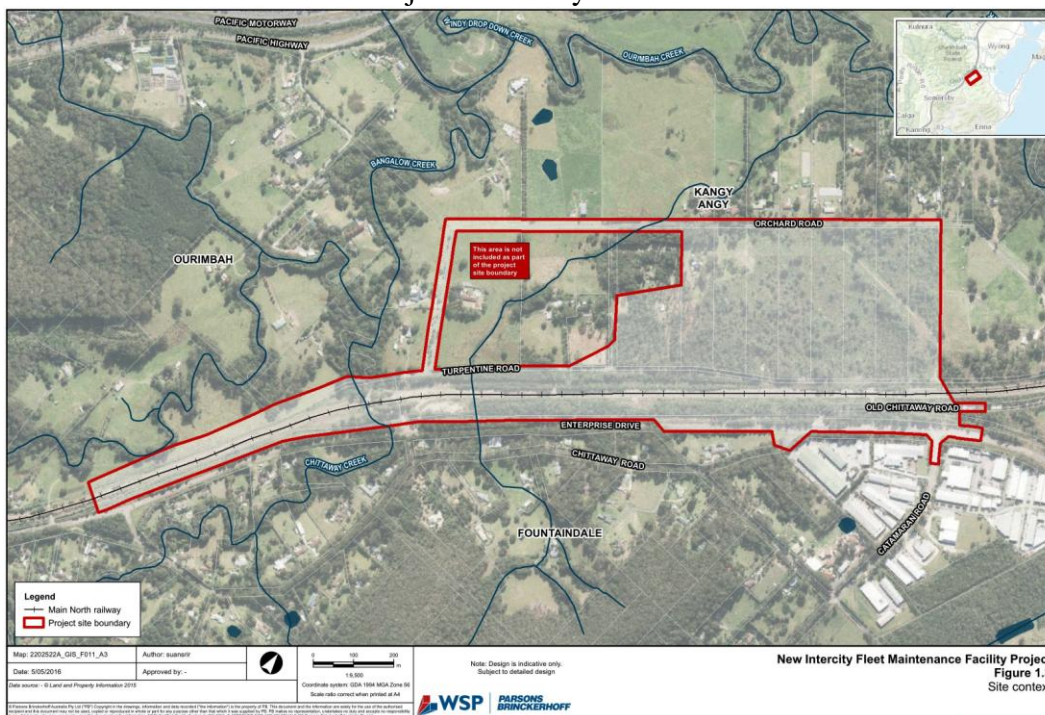
Mail Address: 69 Bestic St. Rockdale NSW 2216 A.C.N. 065 241 732
e-mail: 1arthur@tpg.com.au A.B.N. 32 065 241 732

Expert Report
Likelihood of Occurrence of Threatened Frog Species
New Intercity Fleet Maintenance Facility Project (Transport for NSW).
Kangy Angy, Central Coast of NSW

Introduction

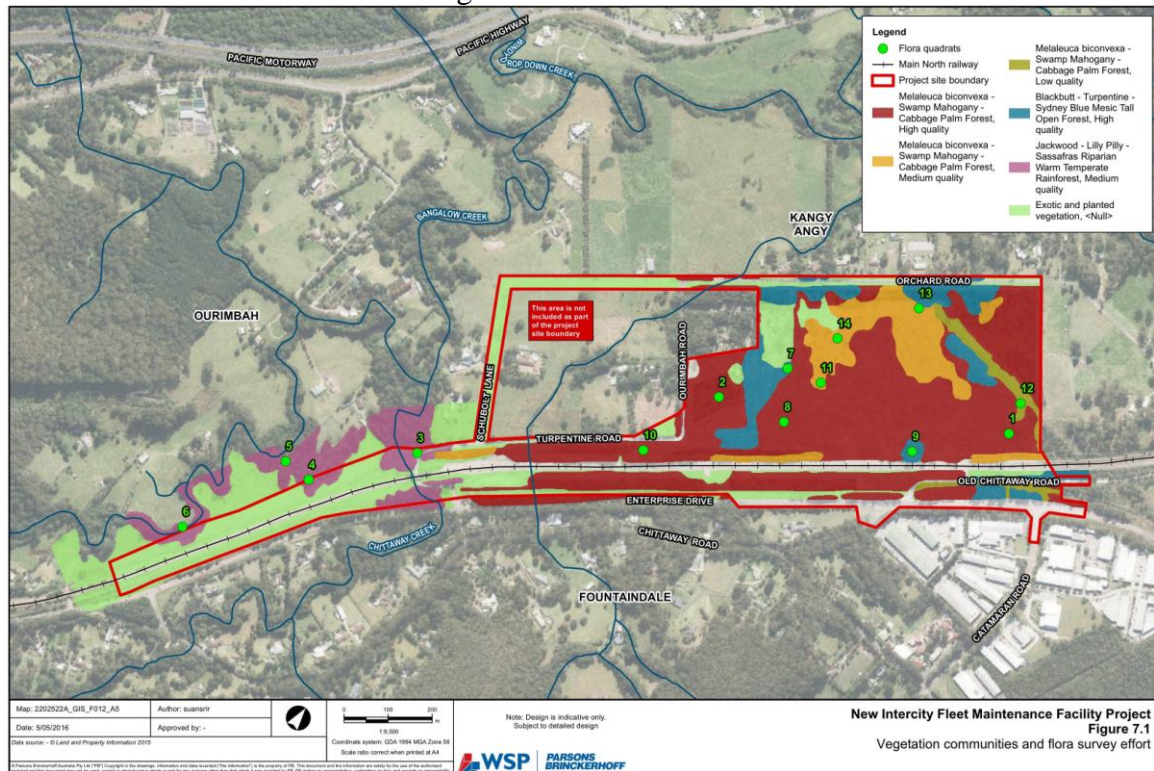
Transport of NSW is proposing to construct a new fleet maintenance facility at Kangy Angy on the Central Coast of NSW. The facility would be located adjoining the existing North Coast railway line and would require the acquisition of almost 70 ha of land. The site for the facility has been chosen and the outline of the project boundary is depicted in Figure 1.

Figure 1
Project Boundary Outlines



The land consists of a mixture of cleared pasture land, highly disturbed re-growth areas and lightly disturbed warm tropical rainforest and wet sclerophyll forest. Vegetation surveys have been completed on the site and the vegetation communities have been mapped (Figure 2).

Figure 2
Vegetation Communities



In early May 2016 I was contacted by Parson Brinkerhoff and asked to inspect the site with the aim of determining if there was any likelihood of threatened frog species being there. The species of immediate interest were:

Green Thighed Frog *Litoria brevipalmata*
Green and Golden Bell frog *Litoria aurea*.

The survey was not to be limited to these two species but to consider any threatened frog species that could occur on this site.

Method

As the site inspection and surveys were to be done in May, it would not be possible to rely on the direct detection of these frogs as they were unlikely to be active or easily detectable at this time of year. Instead, habitat assessments were made to determine if potential habitat for any of the likely threatened species was present in the project area.

An initial inspection of the site was made on the 12th of May 2016. All water bodies including creeks and dams were visited. The entire area was traversed on foot to determine where core habitat areas for threatened frogs might exist.

As the evening of the 12th of May was mild (air temperatures 20.6° at 7.00 pm and 18.7° at 10.00 pm) frog surveys were conducted at sites 3,5,6 and 9 (Figure 2) and at a further two locations in the south-western portion of the project area. In these sites the mating calls of Green-thighed Frogs, or Green and Golden Bell frogs or Wallum Froglets were played using a small portable amplifier. After a two minute listening period the sites were surveyed for non-calling frogs using a head-lamp. It should be noted that conditions were quite dry as no appreciable rain had fallen on the site in the last three weeks. Despite this the creeks were still flowing and some of the larger depressions still retained surface water.

The project area was again traversed on the 13th of May 2016. This time the intention was to quantify the extent of habitat of threatened frogs. Point GPS locations were taken at the margins of frog habitat areas and these were transposed to a site map so that the entire habitat area could be marked out.

The criteria for defining the habitat of the three threatened frog species surveyed (Note: habitat for the Wallum Froglet *Crinia tinnula*) was deemed to be potentially present in the project area and so the criteria for this species is also included below:

Green-thighed Frog:

Vegetation Associations: Warm temperate rainforest or wet sclerophyll forest.

Foraging Habitat: Fallen bark and leaf-rich leaf litter that is high in invertebrate life.

Breeding Habitat: Creek overflows or side channels that only fill after heavy local rain.

Shelter Habitat: Peeling bark on tall and medium height trees, small hollows or knot holes on taller trees.

Source References: Ehmann (1997), Lemckert and Slatycher (2002), Hines *et al.* (2004), BAMM (2005), Anstis (2013).

Green and Golden Bell Frog:

Vegetation Associations: Open woodland, grasslands.

Foraging Habitat: Grassy margins or pond/dam margins.

Breeding Habitat: Ephemeral or non-static small open water bodies such as farm dams, pools in paddocks or on the edges of woodland.

Shelter Habitat: Tussock bushes, rock or refuse piles.

Source References: Pyke and White (2001), Pyke *et al.* (2002), White and Pyke (2008).

Wallum Froglet:

Vegetation Associations: Paperbark wetlands, sedgeland or fernlands on acid-rich ground water.

Foraging Habitat: Margins of wet heath or fernlands.

Breeding Habitat: Ephemeral shallow depressions in paperbark areas, wet heath or fernlands.

Shelter Habitat: Low ground cover vegetation such as sedges, ferns, sphagnum or other wallum herbs and grasses.

Source References: Ehmann (2007b), Meyer *et al.* 2006, Anstis (2013).

In addition to the three threatened species listed above, another frog species was detected during the night survey that is currently undescribed. This frog (Figures 3 and 4) belongs to the genus *Uperoleia* and is currently being studied in preparation for description by the University of Newcastle. This is not the first record of the species in the Wyong Shire, other locations where this species occurs include Norah Head and Wyrabalong National Park, but to my knowledge it is the first time that the species has been found on the western side of Tuggerah Lake.

Figure 3: Undescribed *Uperoleia*, Dorsal View.



Figure 4: Undescribed *Uperoleia* ventral view

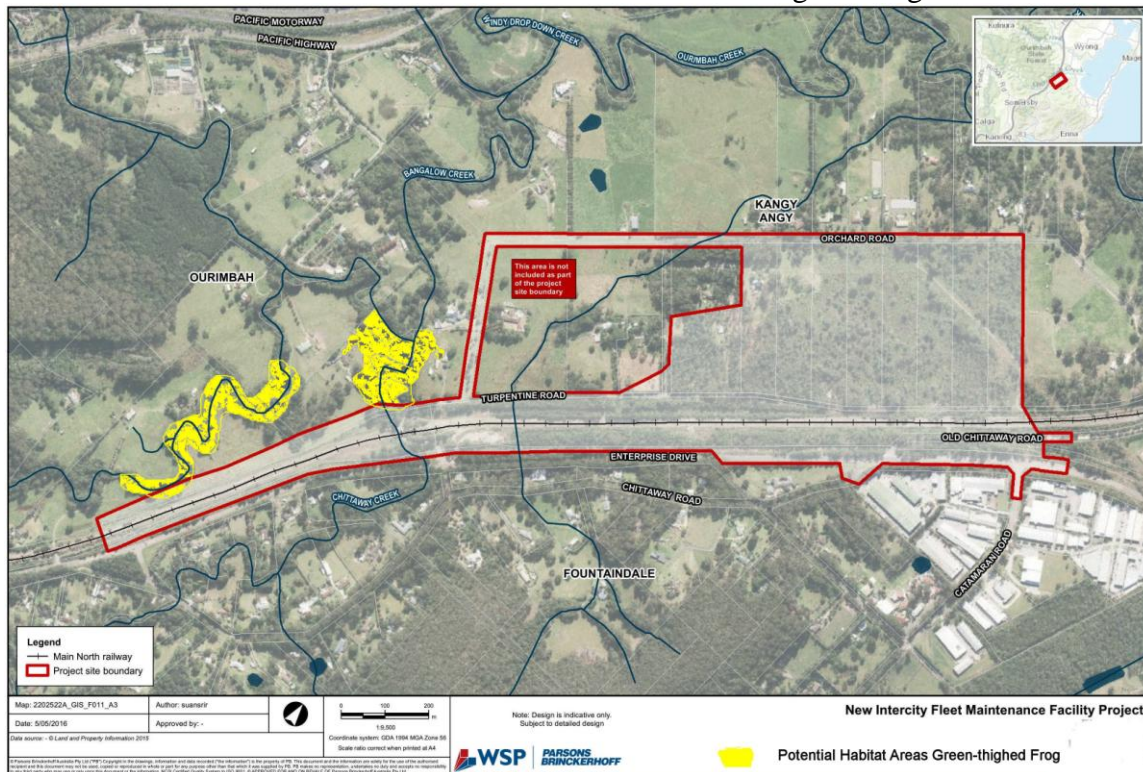


Results

Potential habitat for the three threatened frog species listed above is depicted on Figure 5, 6 and 7.

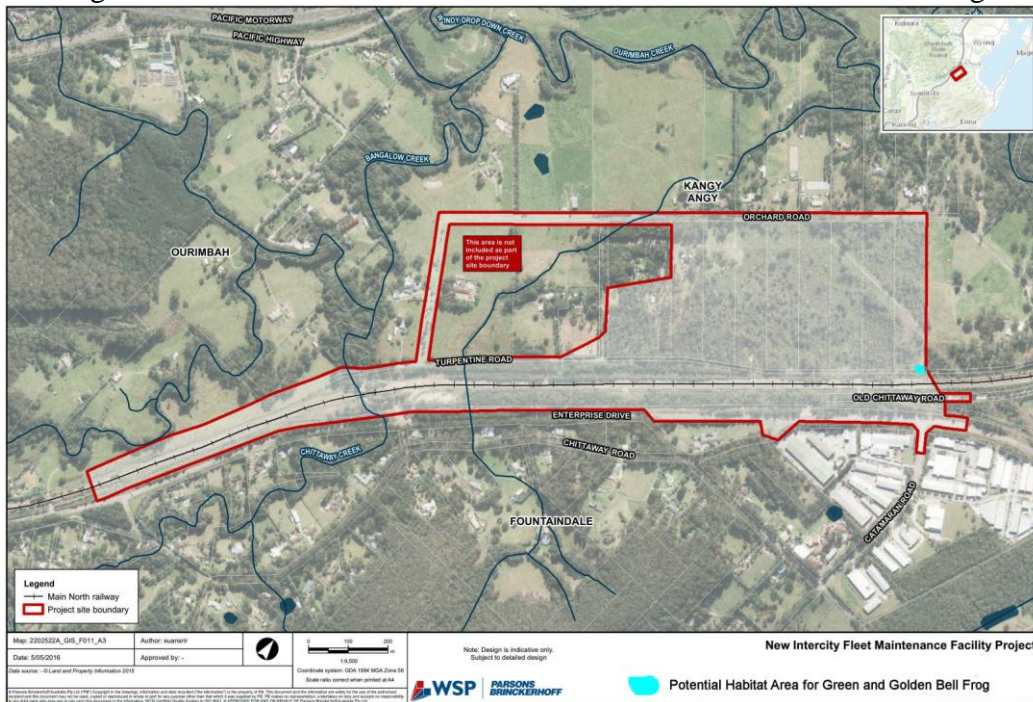
Potential Habitat for the Green-thighed Frog is located at the extreme eastern end of the project area. Most of the habitat is outside of the project boundary but some habitat extends inside of the boundary, particularly alongside Chittaway Creek and the un-named tributary of Bangalow Creek. (Figure 5).

Figure 5
Areas of Potential Habitat for the Green-thighed Frog



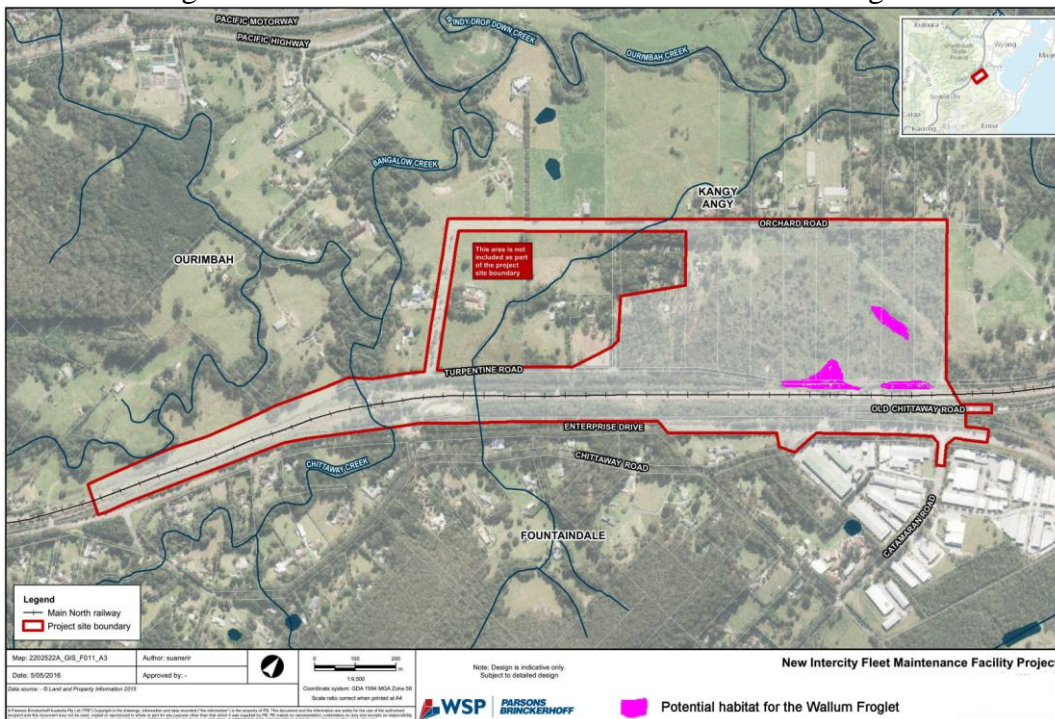
Potential habitat for the Green and Golden Bell Frog is confined to a single location in the extreme south-western corner of the project area (Figure 6). This site comprises a depression alongside the access track. Emergent plants such as Spike rushes (*Eleocharis* sp) are present in the depression and smaller sedges are also present around the margins of the site. To the west of this site are open pastureland and farm dams that could also constitute habitat (these were not included in survey area and so whether habitat for the Green and Golden Bell frogs exists on those lands is unsubstantiated).

Figure 6: Areas of Potential Habitat for the Green and Golden Bell Frog



Potential habitat for the Wallum Froglet is present in the south-eastern portion of the project area (Figure 7). The habitat is confined to shallow depressions and channels that runs through dense paperbark-dominated areas. The channels and depressions are only lined with sedges or ferns.

Figure 7: Areas of Potential Habitat for the Wallum Froglet



Other Frogs recorded on site:

Five frog species were detected during the day and night surveys of the site; they are listed in Table 1 below:

Table 1
Frog Species Detected in Project Area May 2016

Common Name	Scientific Name	Status	Where Found
Perons Tree Frog	<i>Litoria peronii</i>	Common	Tributary of Bangalow Creek
Bleating Tree frog	<i>Litoria dentata</i>	Common	Three locations in Swamp Mahogany Forest, eastern area.
Common Eastern Froglet	<i>Crinia signifera</i>	Common	All parts of the site.
Striped Marsh Frog	<i>Limnodynastes peronii</i>	Common	Tributary of Bangalow Creek,
Undescribed Red-groined Toadlet	<i>Uperoleia sp.</i>	Unknown	Sedgelands in eastern area of project area.

Discussion

These surveys have identified the potential habitat areas for three threatened frog species. Having identified these habitat areas, it now remains to consider the likelihood that any of these areas are occupied by the threatened frogs. For example, if the habitat areas are considered to be of poor quality or missing a major component (such as breeding sites) the likelihood of the threatened species being present would be low. Conversely, if the habitat is deemed to be of good quality and containing all of the requirements for survival, the likelihood of the frogs being present would be high.

Likelihood of Green-thighed Frogs being present:

The Green-thighed frog habitat at Kangy Angy is of low quality. Its quality is diminished because of the removal of so much vegetation away from the riparian edges. This means that Green-thighed frogs would be highly constrained to reduced foraging areas only.

In addition, the potential habitat areas in the western end of the project area lack overflow sites that could act as breeding areas. It is possible that breeding sites occur on private land nearby that were not surveyed. Based on the results of this survey, I have to conclude that the likelihood of Green-thighed frogs being present in the project area is low.

Likelihood of Green and Golden Bell frogs being present:

The only Green and Golden Bell Frog habitat that was found consisted of a small depression that could act as a breeding site under optimal conditions. There is no foraging or shelter habitat for this frog species in the project area, however both foraging and shelter habitat is present on private lands nearby (these lands were not included in the survey and so the presence of the frog there was not ascertained).

Given the scarcity of habitat and that the potential breeding site is surrounded by unfavourable habitat (ie dense forest), there is little likelihood that Green and Golden Bell frogs are present in the project area.

Likelihood of Wallum Froglets being present:

Wallum Froglet habitat is scattered about the eastern portion of the site. Most of the habitat areas are confined to small channels or depressions that periodically fill with water (this observation is based on the presence of emergent sedges and residual algal scum in the depression indicating that they periodically hold open water). While the areas of habitat are small they are reasonably close together and are surrounded by favourable intervening habitat (namely Paperbark and Swamp Mahogany dominated forests).

At the time of the survey most of the depressions were dry. Some had soft,damp soil in their bases but only had had any open water. It is unknown how often these depressions fill with water and how long they hold water. Based on the density of sedges in the depressions and the presence of sphagnum in some of them, it seems likely that water is present fairly regularly. The habitat areas contains shelter, foraging and potential breeding sites and so there is reasonably high likelihood that Wallum Froglets are present in the project area.

Wallum Froglets have been detected in other locations in the Wyong Shire: the largest aggregation of Wallum Froglets is in the Porters Creek wetland but they are also present in small wet heath areas such as near Wyong racecourse and Blue Haven on the western side of Tuggerah Lake.

Conclusion

Potential habitat for three threatened frog species was found to be present on the project site at Kangy Angy. Habitat for the Green-thighed Frog and the Green and Golden Bell frog was limited and the probability of these frogs actually being in the project area was low. On the other hand, habitat areas for the Wallum Froglet were more substantial and contained all of the essential elements for viable habitat: the probability of Wallum Froglets being in the project area is high. A targeted search for Wallum Froglets should be carried out to determine if these small frogs are present in the area.

Dr Arthur White
21 May 2016.

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- Hines HB, Mahony MJ, and McDonald KR. (1999). An assessment of frog declines in wet subtropical Australia. In Campbell, A [ed.] *Declines and Disappearances of Australian Frogs*, Environment Australia, Canberra.
- Meyer E, Hero JM, Shoo L and Lewis B.(2006). National recovery plan for the wallum sedgefrog and other wallum-dependent frog species. Report to Department of the Environment and Water Resources, Canberra. Queensland Parks and Wildlife Service, Brisbane.
- Pyke, G.H. and A.W. White (2001). A Review of the Biology of the Green and Golden Bell Frog *Litoria aurea*. *Aust. Zool.* 31(4): 563-598.
- Pyke, G.H., White, A.W., Bishop, P.J., and Waldman, B. (2002). Habitat-use by Green and Golden Bell frog *Litoria aurea* in Australia and New Zealand. *Australian Zoologist* 32(1): 12-31.
- White, A.W., and G.H. Pyke. (2008). Green and Golden Bell frogs in New South Wales: current status and future prospects. *Australian Zoologist* 34(3): 319-333.

Expert Credentials

Although I am acting as an ecological consultants for this project, my main background is in frog ecology and taxonomy. I have been studying frogs for over forty years and have published a range of papers dealings with taxonomic difficulties, population studies and population dynamics as well as other aspects of the ecology of frogs. As an example. I include a range of selected citations below (for a full list of publications see the publication list in attached CV).

- White, A.W., Whitford, D. and G. Watson (1980). A redescription of the Jervis Bay tree Frog *Litoria jervisiensis* (Anura: Hylidae), with notes on Krefft's Frog (*Litoria kreffti*). *Aust. Zool.* **20**: 375-390.
- White, A. W. (1980a). Zoogeography of the Amphibia, in "Aspects of Australian Vertebrate Zoogeography". M. Archer (ed).
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University of New South Wales Press, Sydney.
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- White, A.W. (1993) Ecological and behavioural observations on the toadlets *Pseudophryne coriacea* and *Pseudophryne bibronii* on the central coast of New South Wales. In "*Herpetology in Australia, a diverse discipline*", eds D. Lunney and D. Ayers. Trans. of the Royal Zoological Society of New South Wales. Pp139-149.
- White. A.W. 1999. Frogs as Bio-indicators. In “ Blue Mountain Bio-indicators Project”. Urban Run-off Control Program/ NSW National Parks and Wildlife Service. Chapter 5.
- White, A,W, and G.H.Pyke (1999) Past distribution of *Litoria aurea* and *Litoria castanea* in the Bathurst-Orange District of New South Wales. *Herpetofauna* **29** (1): 2-9.
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- Pyke, G.H. and A.W. White (2001). A Review of the Biology of the Green and Golden Bell Frog *Litoria aurea*. *Aust. Zool.* **31**(4): 563-598.

- White, A.W. (2001). Editor. *Frog Diseases and Frog Hygiene*. Special Publication of the NSW Frog and Tadpole Study Group Inc. Pp 1- 127.
- White, A. W., and R. Shine. 2009. The extra-limital spread of an invasive species via "stowaway" dispersal: toad to nowhere? *Animal Conservation* 12:38-45.
- White, A.W. 2008. Predation of frogs in northern Australia by pigs. *Herpetofauna* 38(1): 35-38.
- White, A.W., Magarey, E., Barker, C., and N. Williams. 2008. The distribution and conservation status of Barred frogs in the Sydney Basin. Part 2: Stuttering Frog *Mixophyes balbus*. *Herpetofauna* 38(2): 84-95.
- White, A.W. 2008. The distribution and conservation status of Barred frogs in the Sydney Basin. Part 1: Giant Barred Frog *Mixophyes iteratus*. *Herpetofauna* 38(1): 24-34.
- White, A.W. 2010. The distribution and conservation status of Barred frogs in the Sydney Basin. Part 3: Great Barred Frog *Mixophyes fasciolatus*. *Herpetofauna* 40(2): 76-87.
- White, A.W. 2013. "Frogs and Wetlands", in *Workbook for Managing Urban Wetlands in Australia*, E-book ed. S. Paul. Ch. 2.7. Sydney Olympic Parklands Authority. Ppp122-142.
- White, A.W. and G.H. Pyke. 2015. Vegetation mounds as over-winter habitat for the Green and Golden Bell Frog *Litoria aurea*. *Australian Zoologist* 37(4): 510-516.

Because I have been studying frogs for so long I have been asked by industry to undertake a number of frog management and frog habitat creation projects. Some of the larger ones have included:

Sydney Olympic Park: Monitoring and Management of Green and Golden Bell frogs. December 1992 to August 2010.

Australand Holdings Pty Ltd. Habitat Creation and Management of Green and Golden Bell frog, Kurnell. May 2005 to July 2012.

Hannas Construction. Habitat Creation and Management of Green and Golden Bell frog, Greenacre. February 1999 to May 2008.

Roads and Maritimes Services. Habitat Creation and Management of Green and Golden Bell frog, Arncliffe October 1999 to present.

Sydney Motorway Corporation (Westconnect): Monitoring and Management of Threatened Frogs. June 2015 to present.

See CV for additional management reports.

Apart from the various reports and research publications above I was also a contributor to the Threatened Frogs of New South Wales (Endfrogs) conducted between 2004 and 2006. This field work produced the first detailed account of the distribution and abundance of threatened frogs in this state.

I am also an advisor on the NSW Government advisory panel for the Control of Cane Toads in New South Wales, and a member of the "Keeping of Native Animals" Committee.

I was until recently a Research Associate at the Australian Museum but am now an Adjunct Senior Lecturer at the University of New South Wales.

Abbreviated Curriculum Vitae

Name: Dr. Arthur William White
Home Address: 69 Bestic Street, Rockdale, N.S.W. Australia 2216
Home Phone Number (and Fax No.): (02) 9599-1161
Date of Birth: 22 . 2 . 51
Marital Status: Married , two children.
Occupation: Director, Biosphere Environmental Consultants Pty. Ltd.

Degrees/Diplomas/Fellowships:

1973 B.Sc (Hons)	University of New South Wales
1982 Ph. D (Biological Sciences)	University of New South Wales
1984 Dip. Ed. (Science)	University of New England
2001.	Fellow of the Royal Zoological Society of NSW

Scientific Societies/Honoraria:

Honorary Batrachologist	Taronga Zoo, Sydney (since 1981).
Council Member	Royal Zoological Society of New South Wales (since 1978)
Council member / President	Riversleigh Society (since 1987)
Member	Australian Society of Herpetologists (since 1978)
Scientific Adviser	Frog and Tadpole Study Group (1992-97)
President	Frog and Tadpole Study Group of NSW (since 1998)
Research Associate	School of Biological Sciences, University of NSW (1989-1998; 2004-present)
Honorary Research Fellow	Australian Museum (1999-2014)
Fellow of the Royal Zoological Society of New South Wales	(2001)
Adjunct Senior Lecturer	University of NSW (2014- present)

Brief Resume of Activities:

- Director of Biosphere Environmental Consultants Pty Ltd, a company that specialises in fauna-related projects
- Dr White has been involved in field surveys and studies on native fauna since 1978. These have included all vertebrate groups but special expertise has been developed in the area of threatened and endangered herpetofauna (frogs and reptiles).
- Dr White has been involved in various aspects of frog research in Australia since 1979. This research has included studies of the natural history, distribution,

- conservation status and ecology of a range of species (see publication list).
- Other major research areas include the taxonomy of fossil and modern turtles, and the ecology of Australasian bats.
(see publication list).
 - Biosphere Environmental Consultants have undertaken various major and minor faunal studies on behalf of both private and government agencies. These include general fauna surveys, targeted surveys for threatened and endangered species, Species Impact Statement, Plans of Management and habitat management and creation programs.
 - Dr White is an adviser to the NSW Scientific Committee (National Parks and Wildlife Service, a member of the Departments of Environment, Climate Change and Water (DECCW) Native Animal Keepers Consultative Committee, a member of the Declining Frogs Task Force and an advisor to the State Govt on Cane Toad control.

Selected Recent Faunal Statements, Major Surveys and Management Plans

2016. Plan of Management. Green and Golden Bell frog. New M5 East. Arncliffe.
Prepared for Sydney Motorway Corporation.
- 2013-2014 POM *Litoria aurea*. Clyde Refinery. Shell Australia.
- 2013 Design Compensatory Habitat. Green and Golden Bell frog Kooragang Island.
NCIG.
- 2012-2013 Survey and Monitoring, POM. *Aprasia parapulchella*. Dubbo Zirconium
Project Alkane Resources.
- 2011-2012 Monitoring surveys Giant Barred Frogs. Gloucester Coal.
- 2010 Pre-mining Impact Assessment, Fauna Survey, Abel Coal Mine. Donaldson Coal
Pty Ltd.
2010. Fauna survey (with URS) Holsworthy Military Area. Dept. of Defence.
- 2008-09 Pre-mining Impact Assessment, Fauna Survey, Illawarra Coal Precinct. Billiton
BHP.
2008. Monitoring and Impact Assessment. Threatened Species. Kooragang Island.
Newcastle Coal Infrastructure Group.
2008. Plan of Management. Green and Golden Bell frogs. Port Kembla Coal terminal.
2008. Impact Assessment. V-8 Super-car. Sydney Olympic Parklands.
- 2008 Ryde Flora and Fauna Study. Ryde City Council.
- 2007-2009. Threatened species monitoring. Desalination Plant, Kurnell.
2007. Plan of Management. Green and Golden Bell frogs. ILC Site Enfield. Sydney
Ports.
2007. Fauna Surveys and Impact Assessment. Coal Emplacement Site. Metropolitan
Colliery Helensburgh.
- 1996/2007 Monitoring program: Green and Golden Bell Frogs, Olympic Site, Homebush
Bay. Olympic Co-ordination Authority and AMBS.

Publications

- White, A.W. and G.H. Pyke. 2015. Vegetation mounds as over-winter habitat for the Green and Golden Bell Frog *Litoria aurea*. *Australian Zoologist* 37(4): 510-516.
- White, A.W. 2013. "Frogs and Wetlands", in *Workbook for Managing Urban Wetlands in Australia*, E-book ed. S. Paul. Ch. 2.7. Sydney Olympic Parklands Authority. Ppp122-142.
- White, A. W. 2012. Gulf Snapping Turtle *Elseya lavarackorum*. In *Queensland's Threatened Animals*. Ed. Curtis L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. Pp 199-200.
- White, A.W. 2011. Roosting dynamics of Eastern Bent-wing Bats *Miniopterus schreibersii oceanensis* in disused military areas in eastern Sydney. In "The Biology and Conservation of Australasian Bats". Eds. B. Law, P. Eby, D. Lunney and L. Lumsden. Royal Zoological Society of New South Wales, Mosman. Pp 471-480.
- White, A.W. 2011. Factors in the Design of an urban microbat flyway. In "The Biology and Conservation of Australasian Bats". Eds. B. Law, P. Eby, D. Lunney and L. Lumsden. Royal Zoological Society of New South Wales, Mosman. Pp 464-470.
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- White, A. W. 2010. The distribution and conservation status of Barred frogs in the Sydney Basin. Part 2: Great Barred Frog *Mixophyes fasciolatus*. *Herpetofauna*.
- White, A.W., Worthy, T.H., Hawkins, S., Bedford, S., and M. Spriggs. 2010. Novel megafaunal meiolaniid horned turtle survived until early human settlement in Vanuatu, Southwest Pacific. Submitted to Proceedings of the National Academy of Science.
- White, A. W., and R. Shine. 2009. The extra-limital spread of an invasive species via "stowaway" dispersal: toad to nowhere? *Animal Conservation* 12:38-45.
- White, A.W. 2008. Predation of frogs in northern Australia by pigs. *Herpetofauna* 38(1): 35-38.
- White, A.W., Magarey, E., Barker, C., and N. Williams. 2008. The distribution and conservation status of Barred frogs in the Sydney Basin. Part 2: Stuttering Frog *Mixophyes balbus*. *Herpetofauna* 38(2): 84-95.
- White, A.W. 2008. The distribution and conservation status of Barred frogs in the Sydney Basin. Part 1: Giant Barred Frog *Mixophyes iteratus*. *Herpetofauna* 38(1): 24-34.
- White, A.W., and G.H. Pyke. 2008. Green and Golden Bell frogs in New South Wales: current status and future prospects. *Australian Zoologist* 34(3): 319-333.

G.H. Pyke, J. Rowley, J. Shoulder and A.W. White. 2008. Attempted reintroduction of the Green and Golden Bell Frog to Long Reef Golf Course: a step towards recovery? *Australian Zoologist* 34(3): 361-372.

White, A.W., and G.H. Pyke. Frogs on the Hop: translocations of Green and Golden Bell Frogs *Litoria aurea* in Greater Sydney. *Australian Zoologist* 34(3): 249-260.

White, A.W. 2008. May I touch that frog? In *Too Close for Comfort- Contentious Issues in Human-wildlife Encounters*. Ed. D. Lunney, A. Munn and W.Meikle. Royal Zoological Society of New South Wales, Mosman. Pp 45-48.

White, A.W. 2007. Living with Bufo. In *Pest or Guest- the zoology of overabundance*. Eds. D. Lunney, P. Eby, P. Hutchings and S. Burgin. Royal Zoological Society of New South Wales, Mosman. Pp 16-29.

White, A.W. 2007. Herpetofauna of the Malabar Headland. *Herpetofauna* 37(1): 36-41.

White, A.W. 2006. A trial using salt to protect Green and Golden Bell frogs from Chytrid infection. *Herpetofauna* 36(2): 93-96.

White, A.W. 2004. Frogs as Bio-indicators. *Frog Facts* 9:1-4. Frog and Tadpoles Study Group of New South Wales

White, A.W., and S. Burgin. 2004. Current status and future prospects of reptiles and frogs in Sydney's urban-impacted bushland reserves. In "Urban Wildlife: more than meets the eye", Ed. D. Lunney and S. Burgin. Royal Zoological Society of New South Wales, Mosman. Pp109-123.

White, A.W. (2003). Herpetofauna of Boodjamulla National Park and the Riversleigh World Heritage Area, north-western Queensland. *Herpetofauna* 33(2): 65-77.

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Pyke, G.H., White, A.W., Bishop, P.J., and Waldman, B. (2002). Habitat-use by Green and Golden Bell frog *Litoria aurea* in Australia and New Zealand. *Australian Zoologist* 32(1): 12-31.

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Voigt, L. and White, A.W. (2001). . Collecting, Raising and Releasing Tadpoles *FrogFacts* 6: 1- 4. NSW Frog and Tadpole Study Group Inc.

White, A.W. (2000). Where to find fossils in Australia. *Riversleigh Notes* **45**: 21-30.

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Thomson, S. White, A.W., and Georges, A. (1997) Re-evaluation of *Emydura lavarackorum*: identification of a living fossil. *Memoirs of the Queensland Museum* **42**: 327-336.

White, A.W. (1997). Green and Golden Bell Frog *Litoria aurea*. In *Threatened Frogs of New South Wales*. Ed. H.Ehmann. Frog and Tadpole Study Group of New South Wales. Pp 149-156.

Ehmann, H., and A.W.White (1997). The Southern Bell Frog *Litoria raniformis*. In

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White. A.W.and Ehmann ,H. (1997). The New England Bell Frog *Litoria castanea*. In *Threatened Frogs of New South Wales*. Ed. H.Ehmann. Frog and Tadpole Study Group of New South Wales. Pp 165-170.

White. A.W. and Ehmann,H (1997). The Southern Tablelands Bell Frog *Litoria castanea* (part). In *Threatened Frogs of New South Wales*. Ed. H.Ehmann. Frog and Tadpole Study Group of New South Wales.Pp 171-176.

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White, A.W. (1995). Disappearing frogs. *Aust. Zool.* **30**:1-9.

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- White, A.W. (1993) Ecological and behavioural observations on the toadlets *Pseudophryne coriacea* and *Pseudophryne bibronii* on the central coast of New South Wales. In "*Herpetology in Australia, a diverse discipline*", eds D. Lunney and D. Ayers. Trans. of the Royal Zoological Society of New South Wales. Pp139-149.
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- White, A.W. (1992a). Riversleigh's midget submarines. Riversleigh's Notes 16: 4-5. (First report of dwarf Chelid turtles from Riversleigh).
- White, A. W. (1992b). Edentology - teeth, who needs them ? Riversleigh Notes 17: 2-3.
- Gaffney, E.S., Archer, M. and A.W. White (1992). *Warkalania*, a new meiolanid turtle from the tertiary Riversleigh deposits of Queensland, Australia. *Records Northern Terr. Mus. Sci.* **9**: 35-48.
- White, A.W. (1991a). Ripping along with the Lesser Ripper. Riversleigh Notes 14: 2-6 (First report of Riversleigh Meiolanid turtles).
- White, A.W. (1990a). Murgon's Salad Bowl. Riversleigh Notes 10: 6-7. (First morphological report of Eocene trionychid turtles in Australia).
- White, A.W. (1990b). Frogs, in "Care and Handling of Australian Native Animals", S. Hand (ed). Surry Beatty and Sons, Chipping Norton. Pp 17-42.
- White, A.W. and M. Archer (1989). Riversleigh's turtles - so far. Conference on Aust. Verteb. Evol. Systematics abstract p17.
- Gaffney, E.S., Archer, M. and A.W. White (1989). Chelid turtles from the miocene limestone of Riversleigh Station, north western Queensland. *Amer. Mus. Novitat.* **2959**: 1-10.
- White, A.W. (1988). Riversleigh's turtles - all shell be revealed. Riversleigh Notes 4: 3-4.
- White, A.W. (1984a). Origin and early radiation of amphibians, in "Vertebrate Zoogeography and Evolution in Australasia", M. Archer and G. Clayton (eds) Hesperian Press, Perth. Pp255-261

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- Whitford, D., Fanning, D. and A.W. White (1982). Some information on the reproduction, growth and development of *Planigale gilesii*, in "Carnivorous Marsupials" vol. 1. (p78-81). M. Archer (ed). Royal Zool. Soc. N.S.W. Sydney
- White, A. W. (1981). Insulin-like activity in grey kangaroo serum. *Bull. Aust. Mammal Soc.* **7: 64-65.**
- White, A.W., Whitford, D. and G. Watson (1980). A redescription of the Jervis Bay tree Frog *Litoria jervisiensis* (Anura: Hylidae), with notes on Krefft's Frog (*Litoria krefftii*). *Aust. Zool.* **20: 375-390.**
- White, A. W. (1980a). Zoogeography of the Amphibia, in "Aspects of Australian Vertebrate Zoogeography". M. Archer (ed). University of New South Wales Press, Sydney.
- White, A. W. (1980b). Biogeography of Australian Amphibians, in "Aspects of Australian Vertebrate Zoogeography", M.Archer (ed). University of New South Wales Press, Sydney.
- White, A.W. and D. Whitford (1978). A new species of trees frog in New South Wales. *Bull. Aust. Herp. Soc.* **1978:12.**
- White, A. W. and the late C.J.F. Harrop (1978). Ontogeny of Kangaroo pancreas. *Bull. Aust. Mammal Soc.* **3: 18-19.**
- White, A.W. (1978). Insulin receptor proteins in the erythrocytes of monotremes and other vertebrates. *Aust. Zool.* **19: 327-334.**
- White, A.W. and C.J.F. Harrop (1977). The ontogeny of kangaroo pancreas. *Aust. J. Zoology* **26: 487-499.**
- White, A. W. and C.J.F. Harrop (1975a). The islets of Langerhans of macropodid marsupials: a comparison with eutherian species. *Aust. J. Zoology* **23: 309-319.**
- White, A. W. and C.J.F. Harrop (1975b). The islets of Langerhans of macropodid marsupials. *Bull. Aust. Mammal Soc.* **3: 33.**