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Proposed Wallarah 2 Coal Project:

Ecology Assessment of the Direct Impact and Proposed Conservation Offset areas, Wyong, NSW.

Report prepared by

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for

Wyong Areas Coal Joint Venture

December 2009

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1. INTRODUCTION

1.1 Background

OzArk Environmental & Heritage Management Pty Ltd (OzArk) has been commissioned by International Environmental Consultants Pty Ltd (IEC) on behalf of Wyong Areas Coal Joint Venture (WACJV) to undertake ecological assessment within Wallarah 2 Wyong Coal Project (W2CP) direct impact (surface facility) and adjacent company owned land that may be available for potential offset areas. This proposal comprises a continuation of earlier projects for which there is a considerable body of literature. The majority of field assessment was completed in 2007 however flora surveys continued into 2008 with spot checks occurring in 2009. Although this report is comprehensive, the recommendations of the current report may generate the need for some additional minor studies or alternately minor alterations to the proposal.

1.1.1 Proponent

The W2CP is being undertaken by Wyong Areas Coal Joint Venture. For the purposes of this report W2CP is the name of the project and WACJV is the name used to refer to the Proponent. A change in majority share ownership saw a new project scope defined to manage resource extraction. A brief history of project ownership is as follows:

- WACJV was founded in 1995, at the invitation of the NSW Government, to submit a competitive tender for the Wyong Coal Development Areas, as shown on **Figure 1**.
- The majority partner in the successful tender was Coal Operations Australia Ltd, with minority partners including Wyong Areas Coal Joint Venture and other Korean and Japanese interests. BHP Billiton subsequently became a majority shareholder through the acquisition of Coal Operations Australia Ltd.
- In 2005, Kores acquired the BHP Billiton interest in the project, taking its equity in the venture to 82.25%. The WACJV proposes to develop the coal resource with a new project scope, referred to as the Wallarah 2 Coal Project (W2CP). Wyong Areas Coal Joint Venture is undertaking final feasibility studies for the W2CP which is a mining option re-configured from that which had been pursued in the past.

1.1.2 W2CP project overview

The W2CP will involve the underground extraction of export quality thermal coal with associated surface facilities and infrastructure. The project is comprised of an underground longwall mine, a coal handling plant (dry processing only) and storage facilities, rail loop and loading infrastructure, an underground drift entry, ventilation shafts and gas management facility.

The combined Wallarah Great Northern Seam, averaging around 6 m thick, will be mined by a longwall system, conveyed to the surface via a drift conveyor system and processed to produce 4-5 million tpa of product coal from the mine. The coal processing consists of crushing only and, because the mine will not require a coal washing plant, no tailings or bulk reject will be produced. Water generated by the mine will be used in the crushing and stockpiling process and any excess water will be treated before discharge or transfer

to appropriate reuse. The mine will produce a single 14-18% ash product to be marketed for export and domestic electricity generation.

The mine will also produce natural gas as an integral part of the mining process and this will be marketed for domestic electricity generation or other commercial uses.

The proposed mine area covers a 42 year period of underground mining operations. In order to provide certainty for the proponent and to secure mining title to the proposed mining area, a Project Approval will be sought for the entire mine plan as shown on **Figure 1**. The Project Approval will enable mining operations within a Mining Lease granted for a lesser period than 42 years.

1.1.3 Project background

Over the past nine years, a number of environmental and engineering studies have been completed. These include:

- Detailed Flood Study covering both the Yarramalong and Dooralong Valleys. This work has been provided to Wyong Shire Council to assist in strategic planning for the area and has been exhibited to the community;
- Detailed environmental investigations covering climate, ecology, heritage and social issues. A full bibliographic summary of relevant ecological report is presented in **Table 1;**
- Engineering assessments and geotechnical investigations, including subsidence and groundwater which have led to the formulation of the proposed mine plan for the target area;
- Extensive exploration work involving 352 drill holes, which represents 158 km of drill core being logged and analysed; and
- Detailed financial evaluation covering several development options. These options have included various production rates, equipment alternatives, coal processing and handling, transportation options and marketing factors.

A Pre-Feasibility Study was produced in early 2003 by the WACJV. This work has now been refined for the W2CP and will result in a more detailed Feasibility Study which is currently near completion. The full Feasibility Study will not affect the production of the Environmental Assessment documentation as the economic viability of the project has already been confirmed. The Feasibility Study concentrates on detailed engineering design but will include all environmental protection initiatives developed as part of the Environmental Assessment process.

Table 1: Previous environmental studies relevant to the current study areas.

Company / Author / Year Finalised See Section 4.2.2 for a full summary	**Title**	**Specialist components**	**Location**
ERM April 1995 a+b	Environmental Appraisal of Proposed Coal Mining Operations – Wyong Development Areas Combined Eastern (Tuggerah) and North-western Areas.	Mine planning and operation, zoning, existing land uses, sites and surrounds, environmental issues (terrestrial and aquatic ecology). Hydrodynamics of Tuggerah Lake and terrestrial subsidence impacts.	Western and eastern mining lease areas. Notes that some of the data from the eastern area was obtained from PPK Consultants (1992).
ERM September 1997	Seagrass survey at Coal Exploration site C200 V 200 – Tuggerah Lake.	As per title.	Eastern mining lease. Not part of the current study areas.
ERM 1997b	Monitoring Report – January & February 1997 Wyong Coal Development Area.	Air quality, weather, and surface water.	Western and eastern mining lease areas.
ERM February 1998	Unnamed draft "Ecology". Assessment of Precinct 15 and Pacific Power sites.	Fauna and flora assessment.	Western and eastern mining lease areas including Tooheys Rd, Hue Hue Rd and Buttonderry.
ERM February 1999a	Wyong Coal Development Area - Environmental Studies 1998 progress report	Summary of projects and studies to date. Lists previous studies: maintenance of an environmental monitoring network, Wyong valley flood study, community consultation, lake ecology study, lake hydrodynamics study, ground water study, valley aquatic study, terrestrial flora and fauna study, strategic advice to COAL regarding environmental constraints.	Western and eastern mining lease areas including Tooheys Rd, Hue Hue Rd and Buttonderry. .
ERM October 1999	Draft Wyong Areas Coal Joint Venture Project Proposed Surface Facilities.	Flora and fauna assessment.	Western and eastern mining lease areas including Tooheys Rd, Hue Hue Rd and Buttonderry.
ERM November 1999b	Wyong Areas Coal Joint Venture Project – Proposed Surface Facilities.	Flora and fauna assessment.	Buttonderry, Hue Hue Rd and Tooheys Rd study areas.
ERM 1999c	Wyong Coal Development Project 1999 Environmental Studies Progress Report.	Desk top review of previous studies.	Western and eastern mining lease areas Buttonderry, Hue Hue Rd and Tooheys Rd study areas.
ERM March 2000	A Socio-economic profile of the Shire of Wyong.		Not relevant to ecology or heritage assessments
ERM October 2000	Wyong Areas Coal Joint Venture Project Proposed Surface Facilities.	Species Impact Statement (preliminary draft).	Western mining lease area – surface facilities Buttonderry, Hue Hue Rd and Tooheys Rd study areas.

Company / Author / Year Finalised See Section 4.2.2 for a full summary	**Title**	**Specialist components**	**Location**
ERM August 2002a	Wyong Coal Project Flora and Fauna Review (Terrestrial) – western area EL4911	As per title.	Western mining lease areas, Buttonderry, Hue Hue Rd and Tooheys Rd study areas.
ERM August 2002b	Wyong Coal Project - Aquatic flora and fauna review.	As per title.	Western and eastern mining lease areas, Buttonderry, Hue Hue Rd and Tooheys Rd study areas.
BHP Billiton April 2002	Wyong Coal Concept Study.	Undertook a strategic assessment of the planning and environmental issues associated with the Wyong Coal Project.	Western and eastern mining lease areas, Buttonderry, Hue Hue Rd and Tooheys Rd study areas.
ERM 2003	Wyong Coal Project Summer Surveys – Western Area	Flora and Fauna.	The western mining lease area including Tooheys Rd, Buttonderry and Hue Hue Rd ecological offset investigation area (OzArk was unable to obtain a copy of the report).
Orbis Environmental September 2005	Review of Environmental Parameters.	Desk top review of existing literature. Primarily focussed on ecology, paucity of information associated with heritage aspects.	Western mining lease area and Buttonderry, Hue Hue Rd and Tooheys Rd study areas.
International Environmental Consultants February 2006	Wallarah Coal Project No. 2 Briefing Paper.	Produced for Planning Focus Meeting.	Western mining lease area and Buttonderry, Hue Hue Rd and Tooheys Rd study areas.

1.2 Project scope

The Wallarah 2 Coal Project (W2CP) is a very large study area. The overall methodological approach for the final assessment of terrestrial ecology for the W2CP has seen the study area divided into three major groups according to the levels of proposed impact:

1. Areas of **direct impact**: Surface facilities and associated infrastructure at the Buttonderry, Tooheys Rd and Western shaft study areas (mine heads, rail loop, buildings, materials stockpiles; utilities and ventilation, **Figure 2**).

2. Areas of **indirect impact:** Western target area / Proposed mining area subsidence zones (**Figure 1**).

3. Areas of **no impact:** Habitat compensation areas or zones set aside for inter-generational equity (**Figure 2)**.

The assessment requirements for land within each division are deemed to be different due to the nature and extent of the proposed impacts. In areas of **direct impact**, detailed assessment will establish the absolute ecological values (according to state and federal legislation) of these locations. Once the values are known, mitigation measures can be devised where possible and long-term management recommendations formulated.

For areas of **indirect impact** such as subsidence, assessment will be required to establish the likely ecological values, with a significant focus on the manner in which the proposed impacts (subsidence, tilt, altered hydrology etc.) may affect these values. Targeted survey work and review of previous studies placed in their regional context has provided an understanding of the potential impacts to the terrestrial and heritage values.

Locations that are being considered as **habitat compensation** or as **areas of conservation for inter-generational equity** require a more general assessment, primarily focussed on predictive modelling accompanied by targeted survey. The areas shown in yellow on **Figure 2** include the Tooheys Rd and Buttonderry sites, but also include areas of potential compensation. The aim here is to establish the ecological values of these potential compensatory areas to determine whether they are equitable to what is being destroyed or impacted as a result of the direct and indirect impacts of the W2CP.

1.2.1 Aim and scope of the current investigation

The consultant was briefed to assess proposed impacts of the W2CP upon flora and fauna species, particularly those species, populations and ecological communities with legislative protection listed under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Biodiversity Conservation Act 1999* (EPBC Act) in the direct impact areas. This assessment also included describing the existing environment, highlighting areas or species of conservation concern within areas not proposed for direct impact associated with the Tooheys Rd, Hue Hue Rd ecological offset investigation area and on Buttonderry.

Issues affecting the indirect impact areas (those potentially affected by subsidence) have been addressed in a separate report.

The Tooheys Rd, Buttonderry, Hue Hue Rd potential offsets and Western shaft study areas (**Figure 2**) are defined as:

1.2.1a Direct impact areas

- *Tooheys Rd study area (Figures 2& 4).*
- This land will be used for surface infrastructure and a rail loop. This study area includes a circa (c.) 1.8 km portion (c. 10 ha) of the rail loop on Darkinjung Local Aboriginal Land Council land (DLALC).
- *Buttonderry study area (Figures 2 & 5).*
- This study area comprises surface facilities associated with the project.

- *Western shaft study area (Figures 3 & 6).*
- This study area comprises the location of a future air ventilation shaft in the Wyong State Forest.

1.2.1b Potential conservation offset study areas

- *Buttonderry potential offset (Figures 2 & 5).*
- Land occurring outside the direct impact area was assessed to determine its potential conservation value.
- *Hue Hue Rd ecological offset investigation area (Figure 2).*
- This study area comprises of four rural / residential blocks between the F3 and Hue Hue Rd.

Database searches and literature reviews were undertaken with the results used to compliment survey and assessment of the existing natural terrestrial environment. Baseline information gathered was subsequently analysed to determine significance of impact upon items of conservation value known, or having the potential to occur, within the assessed direct impact areas. Similarly database searches and literature reviews were undertaken for the potential offset properties however, as impacts are not scheduled the properties known environmental values were documented.

A general observation relevant to the ongoing use of previous studies nomenclature follows. The terms used for the various locations over the years have changed. For clarity, the following equivalences are useful:

- **Buttonderry study area**, formerly referred to as Hue Hue Road and by ERM (1999b) as Site 3. This is the location for ventilation shafts and limited surface infrastructure (**Figure 5**). The size of the area assessed by ERM (1999b) to that assessed by OzArk has not changed.
- **Tooheys Rd study area**, formerly referred to as Bushells Ridge and by ERM (1999b) as Site 1. It is the location of coal handling infrastructure and rail loop (**Figure 4**). The size of the area assessed by ERM (1999b) to that assessed by OzArk has changed and is now much reduced (**Figure 14**).
- **Hue Hue Rd ecological offset investigation area,** referred to by ERM (1999b) as Site 2. The size of the area assessed by ERM (1999b) to that assessed by OzArk has changed, it is slightly reduced, no longer containing the two rectangular portions of land between DP 719762 Lot 1 and DP 719762 Lot 4 (**Figure 2**).
- **Western Area**. This is the general western mining lease area including Wyong State Forest and Jilliby State Conservation Area and the Yarramalong and Dooralong valleys. This area is west of the F3 highway and marked with a thin red line on **Figure 1**. Within this is the smaller Western target area.
- **Proposed mining Area** is the likely mining zone where longwall mining will be expected to occur. This is otherwise currently defined as the limit of the subsidence zone of the W2CP and is marked on **Figure 1** with a blue dotted line

west of the F3 highway. This area is the subject of a separate OzArk ecological assessment.

1.3 Proposed works

WACJV will undertake a range of activities including resource exploration, development of infrastructure, mine planning and the development of a project schedule to achieve its goal to have commercial quantities of coal and gas extracted by 2010.

This report is specific to works associated with surface infrastructure development for the proposed underground mine and land identified as proposed conservation offsets. For the purpose of this report four study areas have been defined with the nature and extent of the impacts being different for each. The locations of the study areas are detailed on **Figures 4 to 7** and the details of proposed works, as provided by IEC (2006), are as follows:

1.3.1. Tooheys Rd study area

The proposed infrastructure for the Tooheys Road study area is detailed on **Figure 4** and includes:

- Rail spur and loop with coal loader and two rail overbridges along Tooheys Road;
- Office facility, inclusive of administration offices, bathrooms, training facilities;
- Site access roads including at least partial relocation of Tooheys Road;
- Mine access drift and portal;
- Gas extraction and treatment plant;
- Coal stockpiles and material handling facilities;
- Car parking facilities;
- Surface workshop and secure store;
- Bulk store;
- Yard storage;
- Air compressor installation;
- Machinery wash down bay, incorporating oil separator and sumps;
- Fuel, oil and hazardous materials storage area;
- Fire fighting water storage tanks and surface fire station;
- Incoming electric power lines, switchyard and transformers;
- Sewage treatment facilities;
- Emergency services helicopter landing area;
- Powder magazine;
- Environmental monitoring station;
- Mine water and surface runoff settling ponds; and

- Mine Water Treatment Plant.

The facilities for handling the ROM coal consist of:

- A 4,000 t/h receival system;
- A 50,000 t raw coal surge stockpile;
- A 2,000 t/h raw coal reclaim, crushing and stacking system;
- A 250,000 t product stockpile;
- A portal bridge reclaimer that operates at 3,500 t/h;
- A 3,500 t/h train loading system including a 1000 t loading bin; and
- A balloon loop coming off the Main Northern Line that will be able to hold three of the anticipated 3400 t trains.

1.3.2 Buttonderry impact study area

The layout of the Buttonderry Study area is shown on **Figure 5** and consists of:

- Upcast ventilation shaft and fan for mine ventilation;
- Downcast ventilation shaft for mine ventilation and man-riding;
- Main office facility for 40 staff, inclusive of administration offices and training rooms; Bathroom and showers for 120 men and 20 women with the ability to vary the numbers;
- Car parking facilities for 150 cars;
- Small fuel, oil and hazardous materials storage area;
- Explosives magazine;
- Fire fighting water storage tanks for surface fire;
- Sewerage treatment facilities;
- Emergency services helicopter landing area;
- Air compressor installation;
- Environmental monitoring station;
- Ballast borehole; and
- Electrical switchyard, hardstand and pollution control facilities.

The Buttonderry study area will be accessed off Hue Hue Road via a sealed road. The road will have 3.5 m lane widths and 2 m shoulders. The width of the seal will be 11 m. Tree screening and landscaping is proposed either side of the road up to the main administration building and adjoining car park.

1.3.3 Western shaft study area

The Western ventilation shaft facility will be required by mining year 10 and is to be located adjacent to Brothers Road, off Little Jilliby Road, within the Wyong State Forest as shown on **Figure 6**. This shaft facility will house a downcast shaft only (for air intake) and occupy 0.91 ha of land.

Limited facilities will be constructed at this location and it will also serve as a secondary emergency access point. There will be a head-frame structure of approximately 8 x 8 x 15 m (H) to allow for the emergency egress winder. The downcast ventilation shaft will be 6 m in diameter and sunk to c. 490 m depth. An 11kV substation will be required during construction of the shaft and this will remain for the remaining life of the mine.

Brothers Road will be upgraded prior to construction and the shaft study area will be fenced on completion.

1.3.4 Ecological offset investigation areas (Buttonderry and Hue Hue Rd properties)

The location of these properties is detailed on **Figure 2**. Not all the land will be available for conservation offsets. There may be other offsets for agricultural land lost and possibilities are being investigated for some industrial land offerings.

Figure 1: Locality map: resource extraction area (blue hatched line) in the western area (red line showing EL4911 and A405 west of the F3) (Source: IEC)**.**

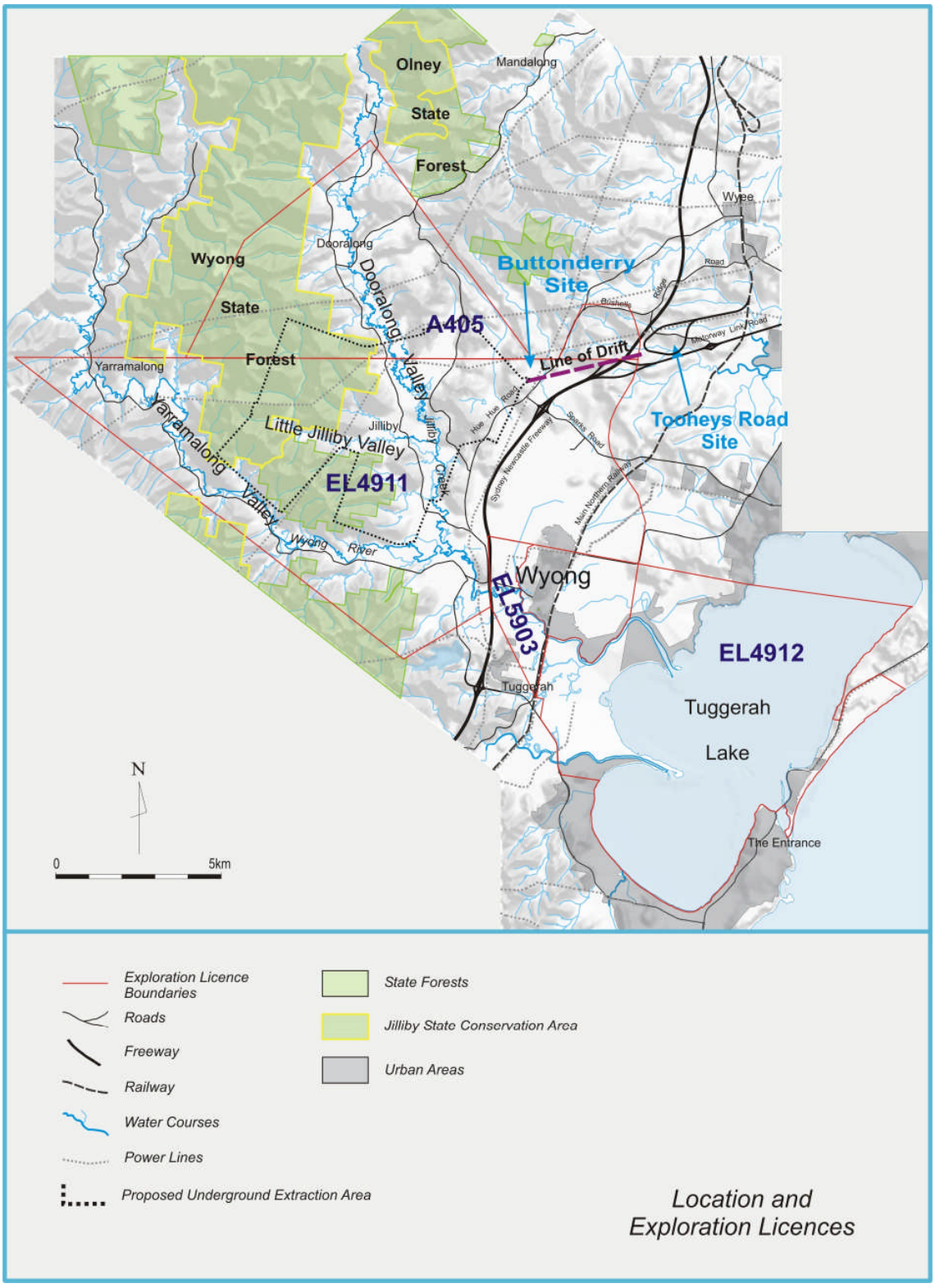


Figure 2: Study area locations: Tooheys Rd, Buttonderry and potential conservation offsets (Source: IEC).

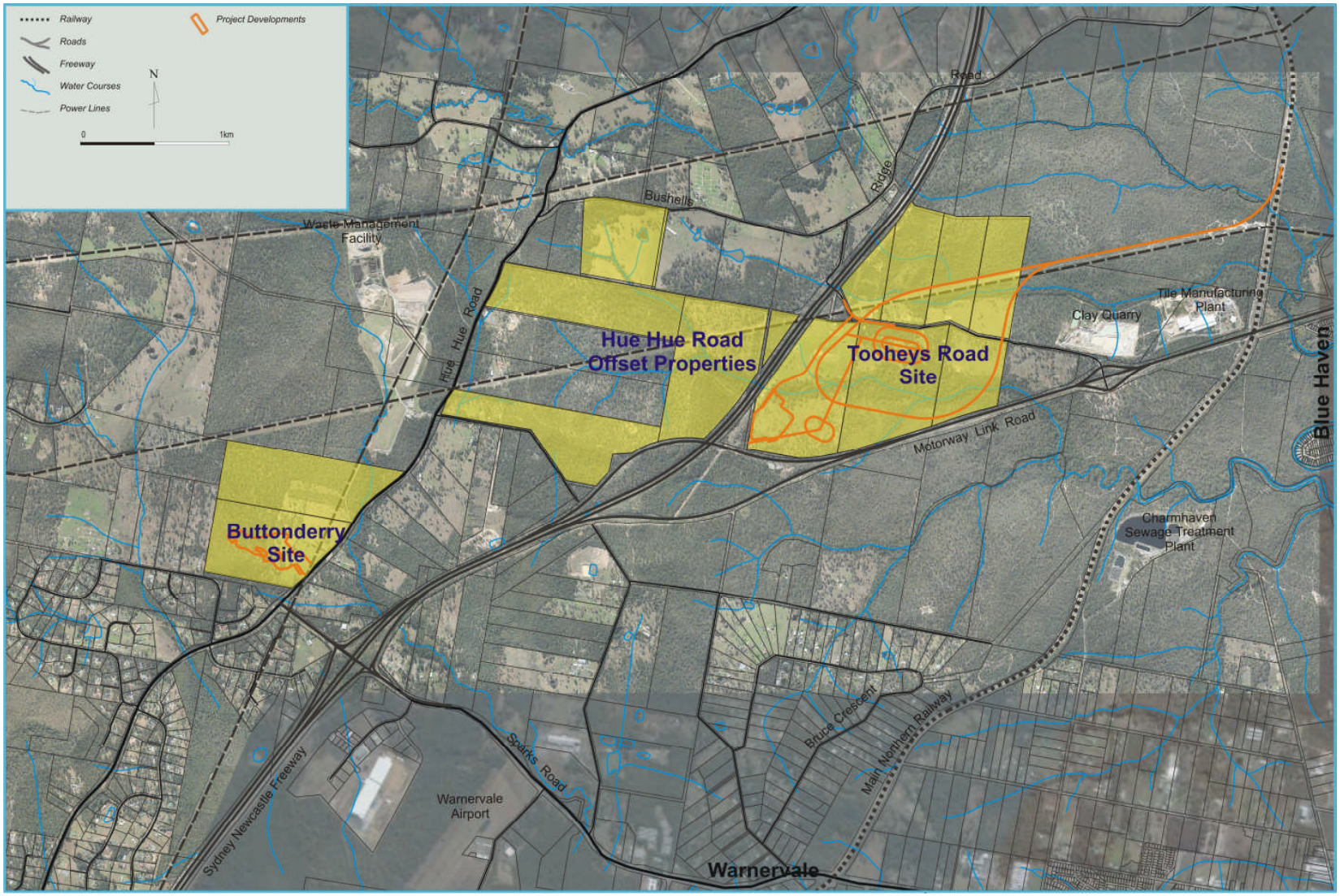


Figure 3: Study area location: Western shaft study area – blue circle (Source: IEC).

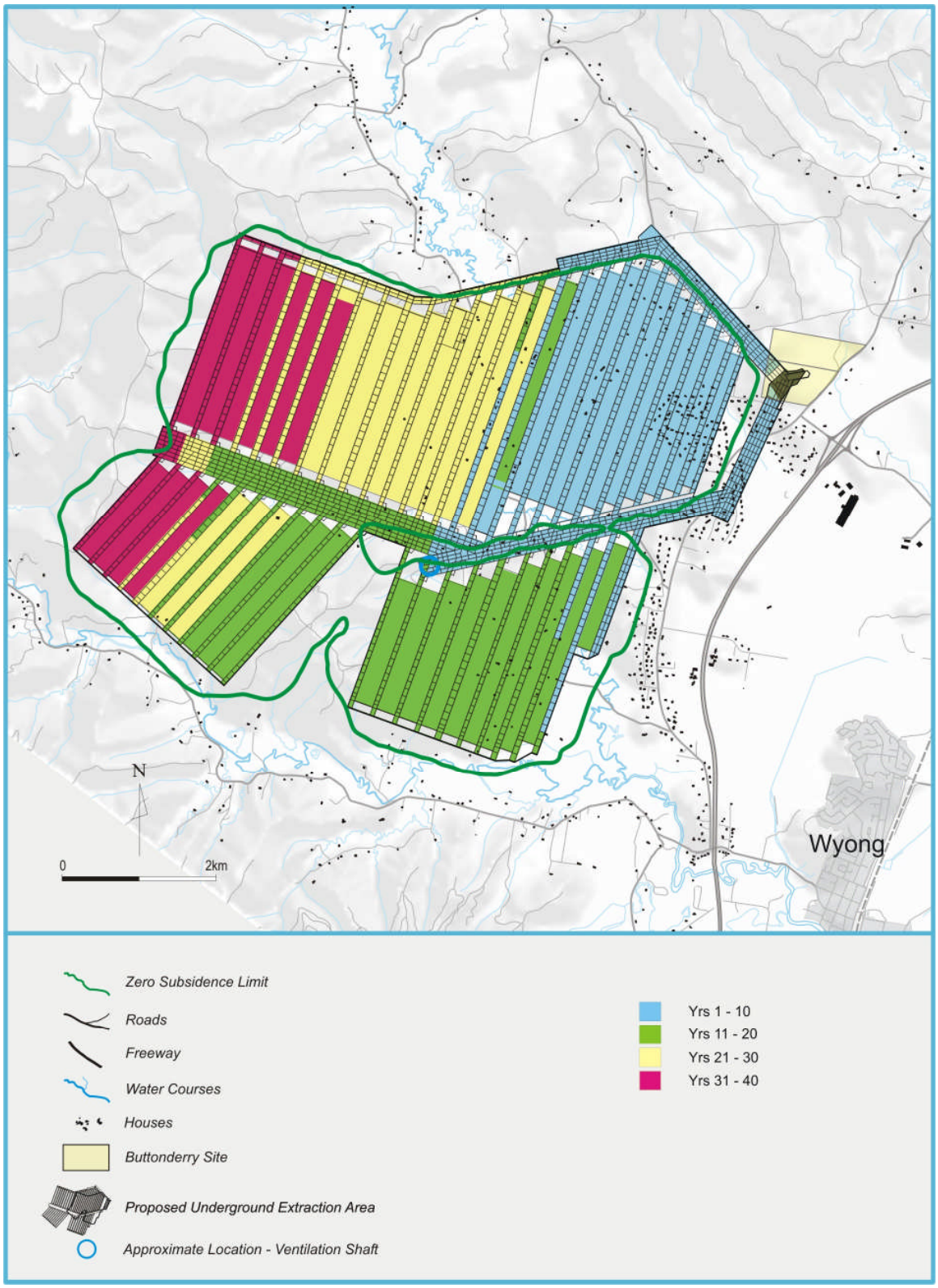


Figure 4: General layout of Tooheys Rd surface infrastructure (Source: IEC).

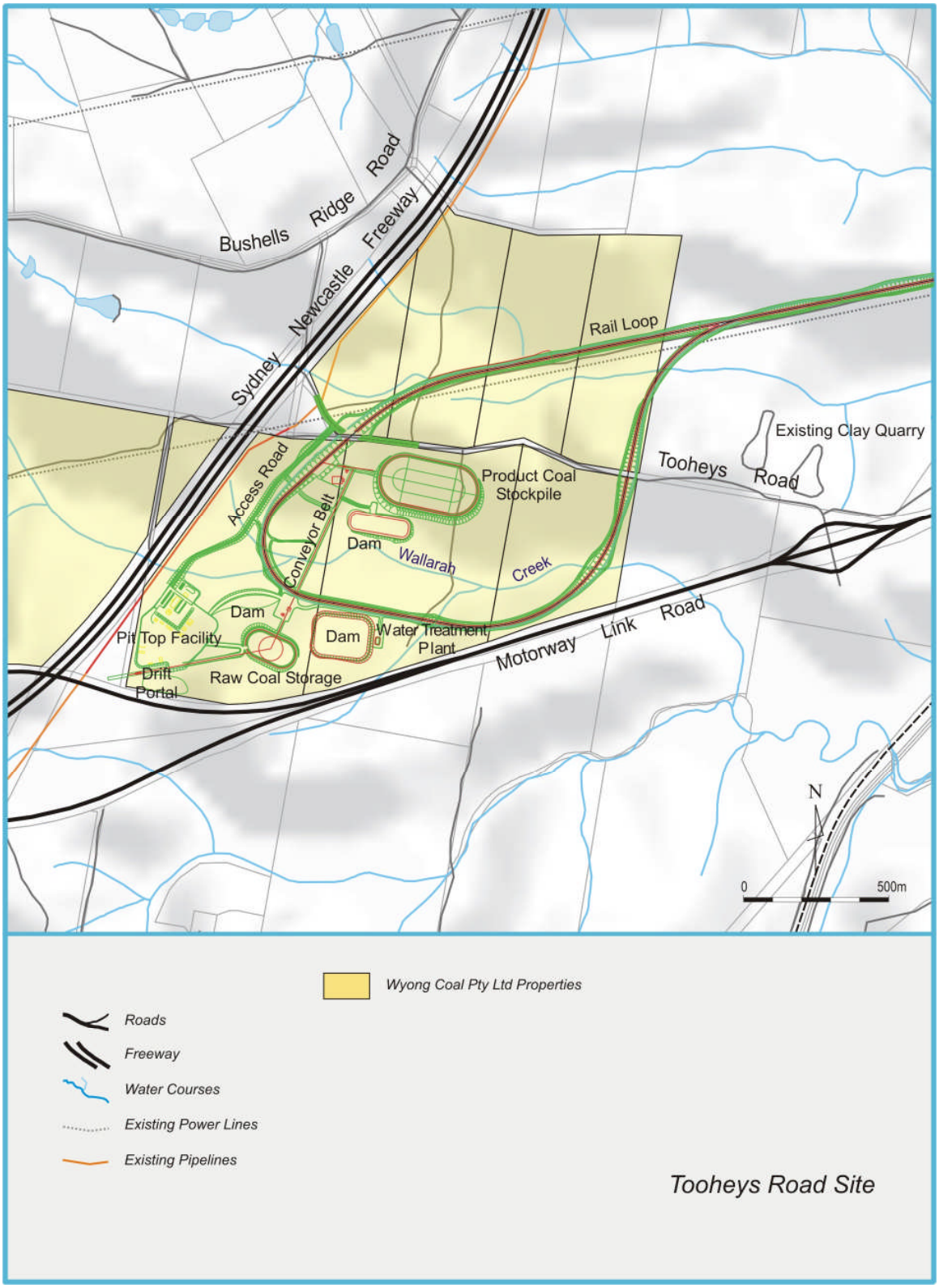


Figure 5: General layout of Buttonderry surface infrastructure (Source: IEC).

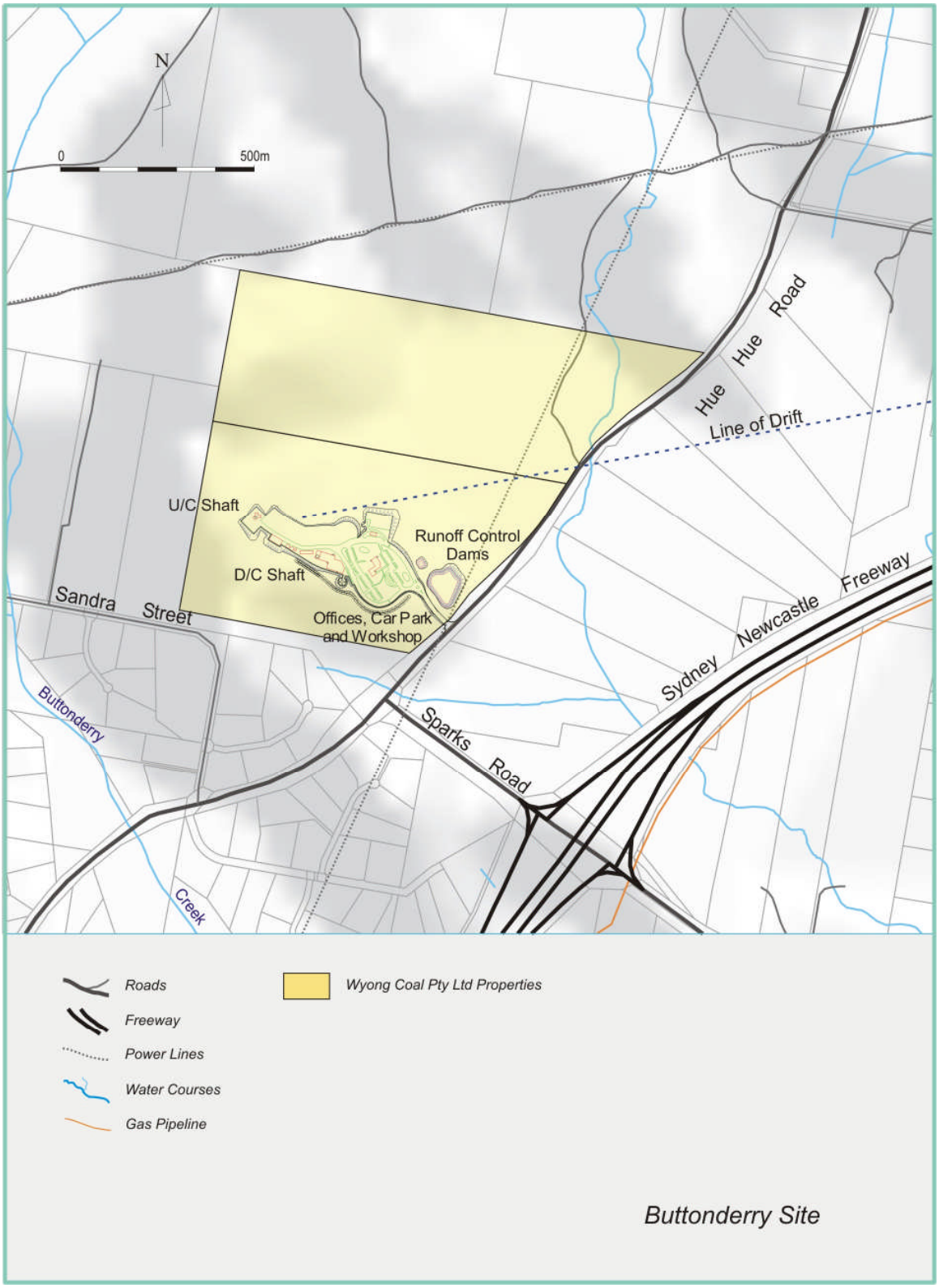


Figure 6: General layout of the Western shaft study area surface infrastructure (Source: IEC)**.**

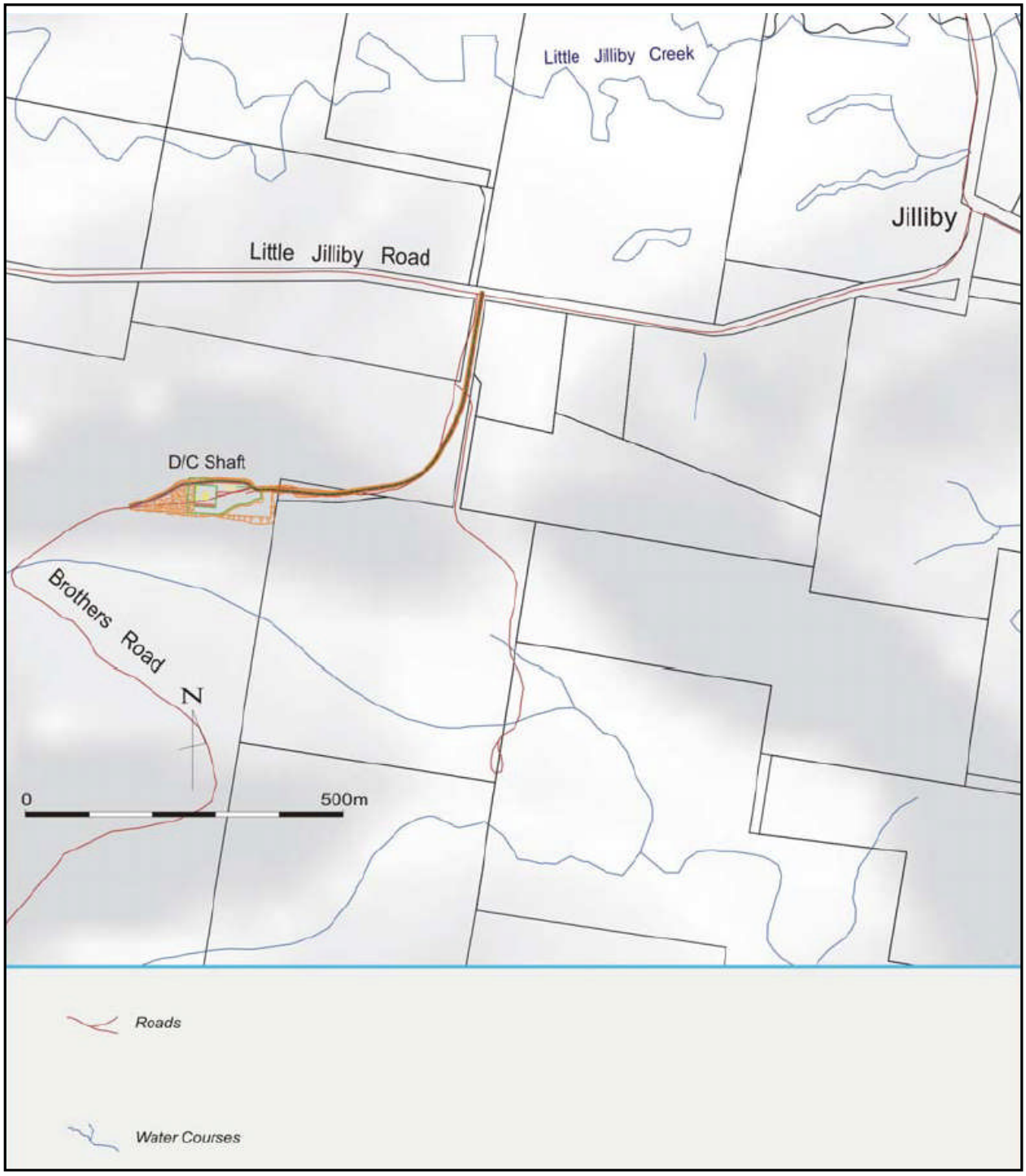
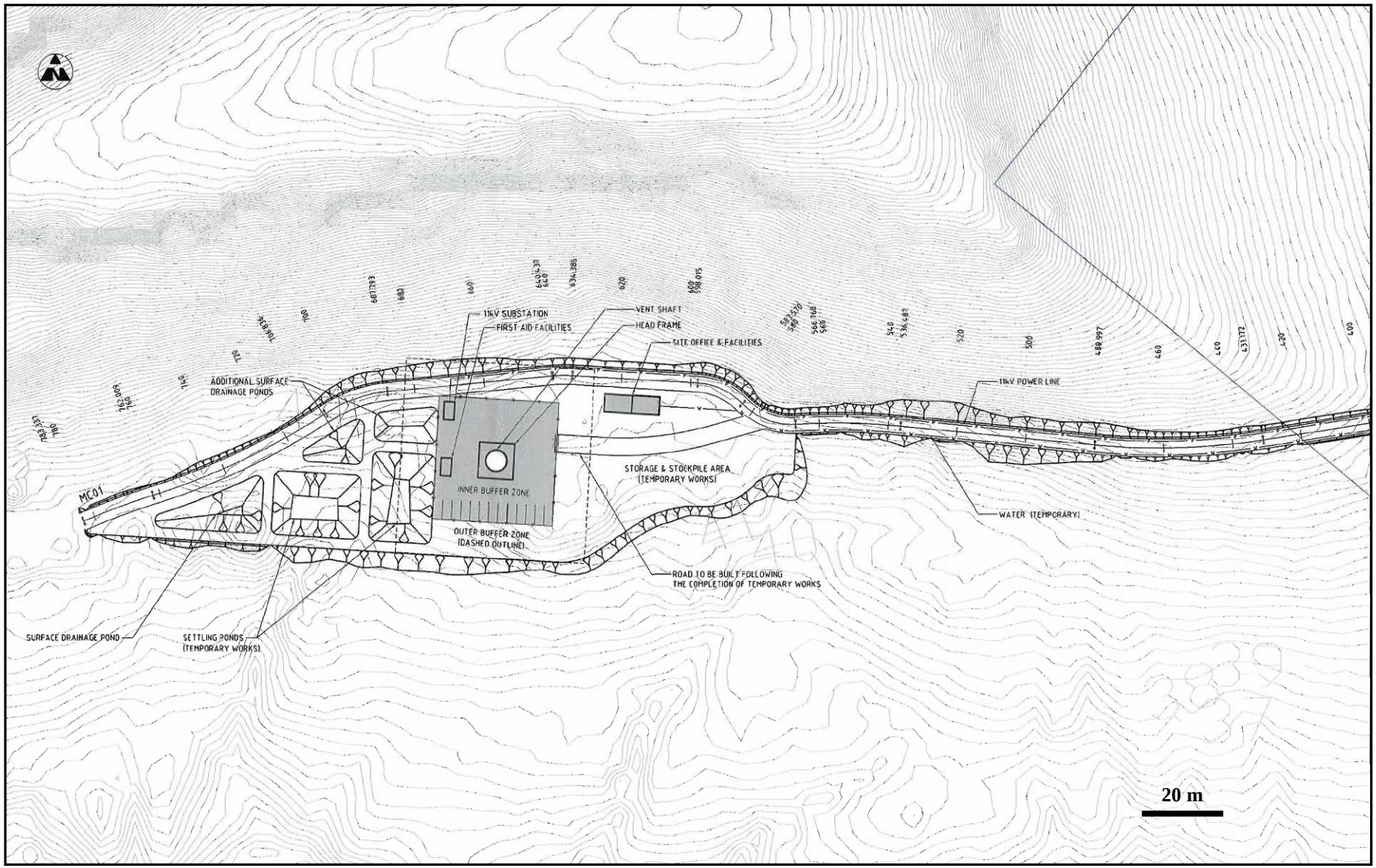


Figure 7: Detail of the proposed Western shaft study area (Source: Parsons Brinckerhoff).



1.4 Project constraints and limitations

Survey was limited to the areas identified in **Figures 2 to 7.** The study areas showed evidence of multiple prior uses and stocking levels which had the potential to affect native species diversity and density, particularly those susceptible to grazing by livestock and predation from rabbits. A high abundance of foxes and cats were noted within the Tooheys Rd and Buttonderry study areas. The effects of these species on environments within NSW are collectively detrimental to native wildlife and as such have been listed by the NSW government as *Key Threatening Processes* in the TSC Act. The OzArk ecological and heritage teams sighted these species frequently and regarded any ground or midstorey dwelling threatened fauna species is considered to be at serious risk from predation.

To ensure adequate assessment of threatened species known, or having the potential to occur, within the region was undertaken NSW State and Commonwealth agency records were reviewed for the Wyong Local Government Area to establish baseline information concerning the likelihood of flora and fauna species to occur within the project area. Any shortcomings of the database records have been mentioned within the appropriate sections of the following report.

Vegetation community nomenclature consistent with the Wyong LGA classification has been used throughout this study. This should enable direct comparisons by Wyong Shire Council data and thus to many other studies in the LGA.

Animals and plants by nature cannot be fully accounted for within any given study area. The potential for inaccuracy increases exponentially with the size of a survey area. This report is based upon data acquired from recent and current surveys and although the study areas have received a lot more attention than most development related projects, it should be recognised that the data gathered is indicative of the environmental conditions of the site at the time each report was prepared. It should be recognised that the presence of threatened species is not static; it changes over time, often in response to longer term natural external forces that can at any time be dramatically influenced by anthropomorphic disturbance.

1.5 Report authorship

This report was written by Phillip Cameron and Dr. Jodie Benton (OzArk Environmental & Heritage Management P/L) and Stephen Bell (Eastcoast Flora Survey).

2. LEGISLATIVE FRAMEWORK

2.1 Federal legislation

Environment Protection and Biodiversity Act 1999 (EPBC Act) provides for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance. These include:

a) World and National heritage areas;

b) Ramsar wetlands;

c) nationally listed threatened species and ecological communities;

d) internationally listed migratory species;

e) all nuclear actions; and

f) Commonwealth areas and Commonwealth marine areas.

Relevance to the current proposal: In relation to this Act, items of national environmental significance are reported in Section 7 of this report.

2.2 State government legislation

Threatened Species Conservation Act 1995 (TSC Act): This Act provides for the protection of all threatened plants and animals native to NSW and their habitats (including endangered populations, ecological communities and their habitats). Threatened 'fish' and marine vegetation are specifically excluded as these are covered by the *Fisheries Management Act 1994*.

Relevance to the current proposal: Items within the TSC Act relevant to the current proposal (see below) have been included in the body of this report.

- The assessment of significance; and
- Reference to relevant environmental planning instruments (EPI's) such as *SEPP (Major Projects) 2005.*

Environmental Planning and Assessment Act 1979 (EP&A Act 1979). The W2CP is a mining project as defined in Schedule 1 of *State Environmental Planning Policy (Major Projects) 2005*. The Minister for Planning has advised that it will be a project to which Part 3A of the EP&A Act applies. This means that the Project will be determined by the Minister for Planning.

Although the provisions of other relevant Acts listed below do not apply for developments assessed under Part 3A of the EP&A Act, their intent has been considered:

- *Water Management Act 2000;*
- *Native Vegetation Act 2003;*
- *Rivers and Foreshores Improvement Act 1948;*
- *National Parkes and Wildlife Act 1974;*
- *State Environmental Planning Policy 44 – Koala Habitat Protection*;
- *SEPP 14* (C*oastal Wetlands Protection).*
- *Fisheries Management Act 1994;* and
- *Wyong Local Environment Plan 1991*.

3. STUDY AREA

3.1 Property information

3.1.1 Direct impact study areas

3.1.1a Tooheys Rd study area (**Figure 2**)

- *Property north of Tooheys Rd (80 ha)*

WACJV property north of Tooheys Rd consists of three c. 300 x 700 m (63 ha) and one c. 210 x 490 m (10.3 ha) blocks. It encompasses DP 260217 Lots 1 & 3, DP 755245 Lots 102 & 103 and c. 10 ha of DLALC property on DP 1032847 Lot 195 & 193. A very small section of Boral Industries Pty Ltd property DP 1032847 will be used for the rail loop. Due to the small scale of this portion of land to be impacted it will be included in all assessments as a portion of the DLALC land DP 1032847 Lot 195.

- *Property south of Tooheys Rd (117 ha)*

Property south of Tooheys Rd to be impacted includes DP 755245 PT 126 & 124 and DP 558436 Lot 128.

3.1.1b Buttonderry impact study area (c. 5 ha)

Land to be impacted at the Buttonderry study areas is confined to DP 79157 Lot 2 (**Figure 2 & 5**).

3.1.1c Western shaft study area (0.92 ha)

Approximately 0.91 ha of land within the Wyong State Forest on Brothers Rd will be impacted by the proposal (**Figures 3 & 6**).

3.1.2 Indirect impact study areas

3.1.2a Buttonderry offset (75 ha)

DP 79157 Lot 1 which is located north of DP 79157 Lot 2, is owned by WACJV and included in the assessed area but will not be affected by the proposal (**Figures 2 & 5**).

3.1.2b Hue Hue Rd potential offset properties (159 ha)

Four parcels of land are owned by WACJV that may be utilised for proposed conservation offsets. These include DP 719762 Lot 4, DP 2598692 Lot 31, DP 755245 Lot 118 and DP 719762 Lot 1 (**Figure 2**).

3.2 Environmental settings (topography, hydrology, climate, geology and soils)

The assessed areas lie within the Sydney Basin Bioregion (SBBR), on the east coast of NSW and includes a significant proportion of the catchments of the Hawkesbury- Nepean, Hunter and Shoalhaven river systems, all of the smaller catchments of Lake Macquarie, Lake Illawarra, Hacking, Georges and Parramatta Rivers, and smaller portions of the headwaters of the Clyde and Macquarie rivers.

According to DECCW (2002), the SBBR is a geological basin filled with near horizontal sandstones and shales of Permian to Triassic age that overlie older basement rocks of the Lachlan Fold Belt. These rocks have been subject to uplift with minor folding and faulting during the formation of the Great Dividing Range. Erosion by coastal streams has in some areas of the bioregion (for example the Illawarra) created deep cliffed gorges and remnant plateaus with an east-west rainfall gradient and differences in soils. Other atypical environs include coastal landscapes of cliffs, beaches and estuaries.

The study area is within the geological Sydney-Bowen Basin. This basin was formed when the earth's crust expanded, subsided and filled with sediment between the late Carboniferous and Triassic. The stages of development saw the continental rift filled with sediments (marine volcanic). Subsequent deposition therefore shifted to river and swamps during the cold climates of the early Permian. Coal deposits accumulated in the upper parts of the basin that were then covered in quartz sands by extremely large, braided rivers whose headwaters lay hundreds or even thousands of kilometres away (when Antarctica was joined to the current Australian continent). These waterways flowed in from the south and the northwest to deposit the sands that later formed the Hawkesbury Sandstone. Shallow marine sediments and later more river sediments continued to accumulate in the basin during the Jurassic Period (all currently eroded). There is presently only a thin cap of these latter deposits (shale) over the resistant sandstones.

The considerable range of rock types, topography and climates in the Sydney Basin has resulted in a large variety of soils and vegetation communities. The coastal area of the bioregion consists of frontal dunes. Dunes behind this accumulate organic matter and begin to develop coloured subsoil. The oldest dunes on the inland side of the barrier and the parabolic dunes high in the landscape, even on headlands, have well-developed podsol profiles. Limited areas of rainforest can be found in the lower Hunter, Illawarra escarpment and on Robertson basalts, as well as in the protected gorges and on richer soil in most subregions. Species composition and structural form are similar on sandy soils of the sandstone plateaus and the sandy soils of the dunes. Better quality shale soils form caps on sandstone and on the coastal ramps.

Soils in the Munmorah Conglomerate Formation have moderately deep (50 to 150 cm) yellow earths, yellow podsolic soils and soloths (Murphy 1993) with low usable nutrients. More specifically, according to the Sydney 1:25K Geological Series Sheet SI 56-5, the Wyong study area is at the margins of the Clifton Subgroup of the Narrabeen Group and forms part of the Munmorah Conglomerate Formation.

The SBBR is dominated by a temperate climate characterised by warm summers with no dry season. A sub-humid climate occurs across significant areas in the northeast of the bioregion such as that experienced in the assessed Wyong area. Rainfall can occur

throughout the year, but varies across the bioregion in relation to altitude and distance from the coast, with wetter areas being closer to the coast or in higher altitudes. Temperature varies across the bioregion, with areas of higher temperature occurring along the coast and in the Hunter Valley and areas of lower temperature on the higher plateaux and western edge.

More specifically, climate data from the Bureau of Meteorology monitoring station located in Gosford shows that the area has an average annual temperature of 22.9°C (Maximum annual average of 27.5°C and minimum annual average of 4.5°C) with an annual average rainfall of 1,320.8 mm (most of the rainfall occurs in March with the least occurring in October).

3.2.1 Direct impact properties

3.2.1a Tooheys Rd study area

Topography within the assessed area is characterised by gentle rises ranging in elevation from c. 10 m Australian Height Datum (AHD) surrounding Wallarah and Spring Creeks to c. 50 m AHD at Bushells Ridge to the north and in the south western portion of the assessed area, where the pit top facilities are to be located (**Figure 4**).

Hydrology of the Tooheys Rd study area consists of two second order creek lines and their associated tributaries and one unnamed drainage line and headwater (**Figure 8**). All water features drain east into Wallarah Creek then eventually into Lake Budgewoi.

Spring Creek, a permanent source of water, is on land owned by the Darkingjung Local Aboriginal Land Council (DLALC) north of Tooheys Rd in the north-eastern section of the study area. Only a very small portion of this creek (c. 200 m) is within the assessed rail easement impact footprint and buffer zone. Spring Creek is fed by two main un-named headwaters, from northwest and due west of the existing rail bridge, south of Bushells Ridge Road. At the time the Dooralong 9131-1S map was printed (2002) there were no agricultural dams altering the natural hydrology of this waterway.

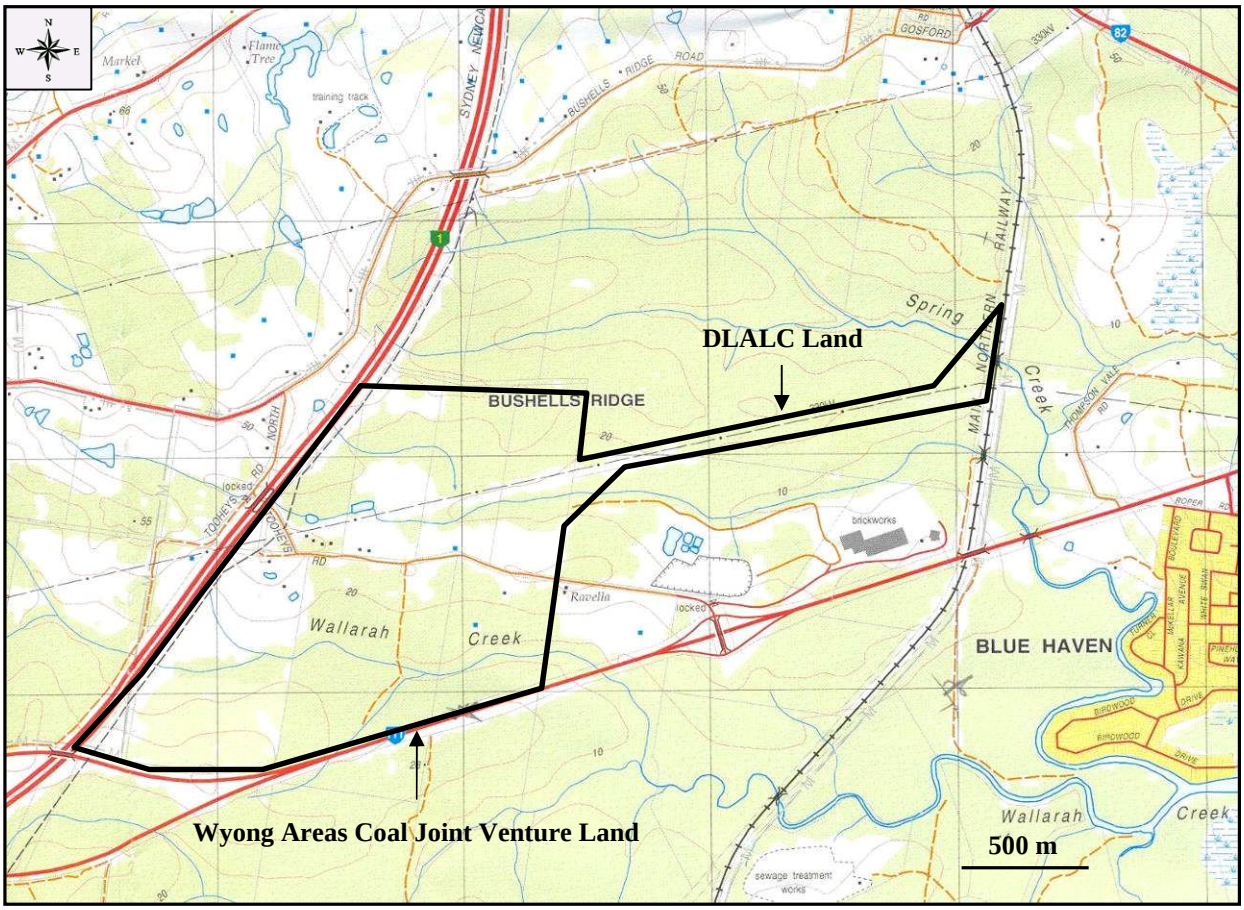
South of Tooheys Rd lays Wallarah Creek, also a permanent water source. The headwaters for this creek are c. 2 km west, largely within the Hue Hue Rd ecological offset investigation area owned by Wyong Areas Coal Joint Venture. Approximately 1.5 km of this creek line is within the study area, flowing east-west and dissecting the property into two equal portions of land. This creek has two main tributaries within the study area, one to the north which drains c. 200 m south and is barely noticeable occurring in cleared, ploughed land adjoining the Sydney – Newcastle Freeway. The second is south of the creek approximately 500 m in length (300 m in the study area) and has its origins on the southern side of the Pacific Highway (the southern border of the study area). The Dooralong 9131-1S map of 2002 shows only one agricultural dam (large), occurring upstream of the Tooheys Road site and land now owned by Wyong Areas Coal Joint Venture, south of Bushells Ridge Rd, altering the natural hydrology of this waterway.

A smaller, unnamed drainage feature is situated north of Tooheys Rd, loosely paralleled by the TransGrid 330kV transmission line. Both headwaters for this feature are located on private property south of Bushells Ridge Rd, c. 1 km west of the Sydney – Newcastle

Freeway. Approximately 1.3 km (or 1/3 of the entire length) of this feature is within the study area. This waterway is characterised by multi-channel shallow, separated, mostly permanent pools and waterlogged soils. The Dooralong 9131-1S map of 2002 shows six agricultural dams on private property south of Bushells Ridge Rd, altering the natural hydrology of this waterway.

As previously noted the study area is within the Clifton Subgroup of the Narrabeen Group, forming part of the Tuggerah Formation. These areas have moderately deep (50-150 cm) yellow earths, yellow podsolic soils and soloths with low usable nutrients.

Figure 8: Topography and hydrology Tooheys Rd study area - black outline (Source: Dooralong 9131-1S 1:25K).



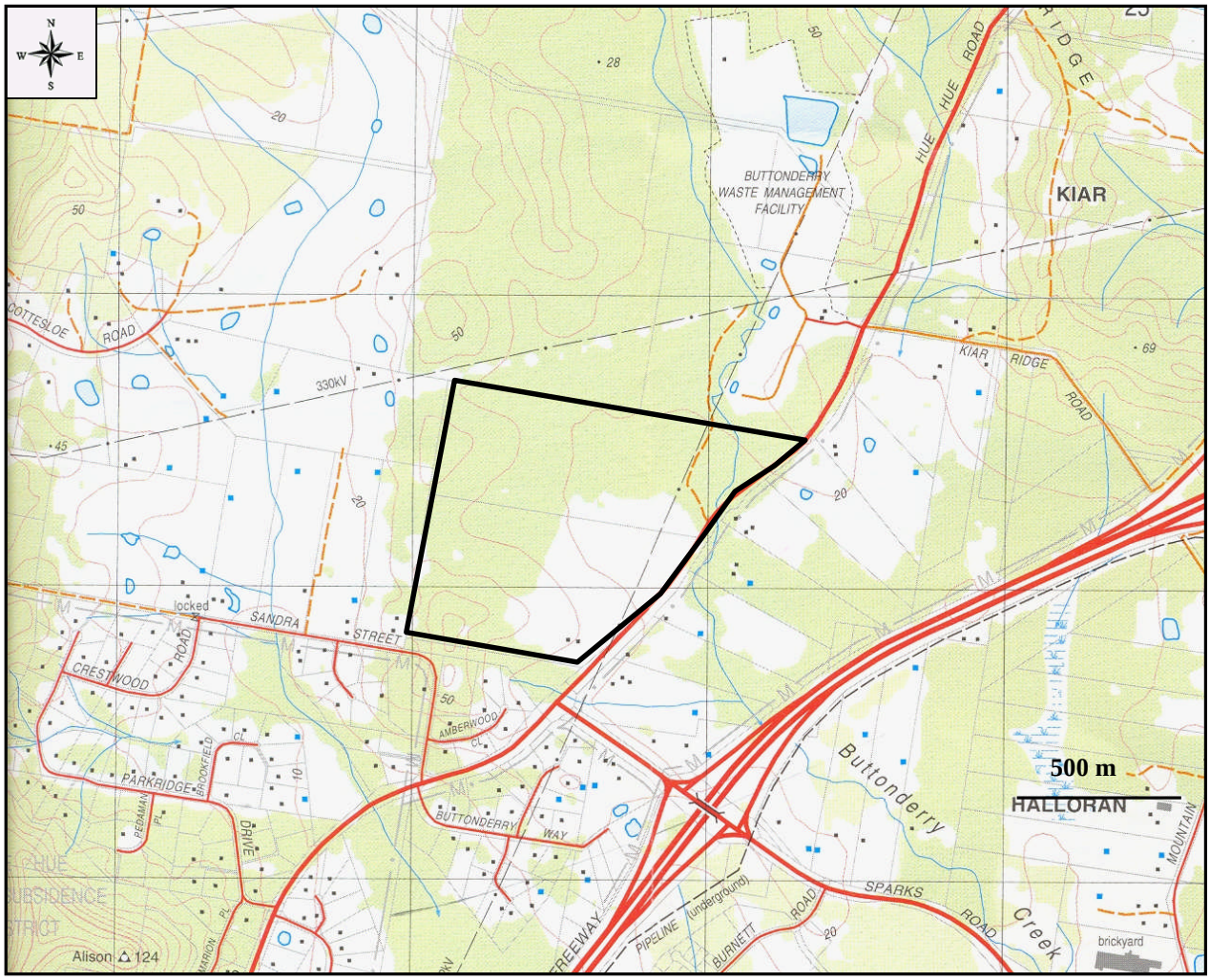
3.2.1b Buttonderry direct impact study area

Topography within this assessed area is characterised by a gentle rise ranging in elevation from c.5 m AHD next to Hue Hue Rd and Buttonderry Creek to c. 60 m AHD in the south-western and most elevated portion of the study area, and to 40 m AHD in the north-western corner.

Surface water within the Buttonderry study area moves from the higher ground in the west and south toward Hue Hue Rd and Buttonderry Creek. Once in the creek, water flows southeast for c. 3 km where it then peters out near the Warnervale aerodrome. Only c. 200 m of this permanent waterway dissects the most north-eastern portion of the property

(**Figure 9**). Mapping identifies only one agricultural dam on a private property in-between Bloomfield Rd and Kiar Ridge Rd which alters the natural hydrology of this waterway. There are, however, several dams within a hundred metres of the creek that would affect the volume of water entering the creek during low flow periods. Land adjacent to the creek at lower elevations is wet / boggy underfoot and would have been a swamp prior to clearing.

Figure 9: Topography and hydrology of the Buttonderry study area - black outline
(Source: Dooralong 9131-1S 1:25K).



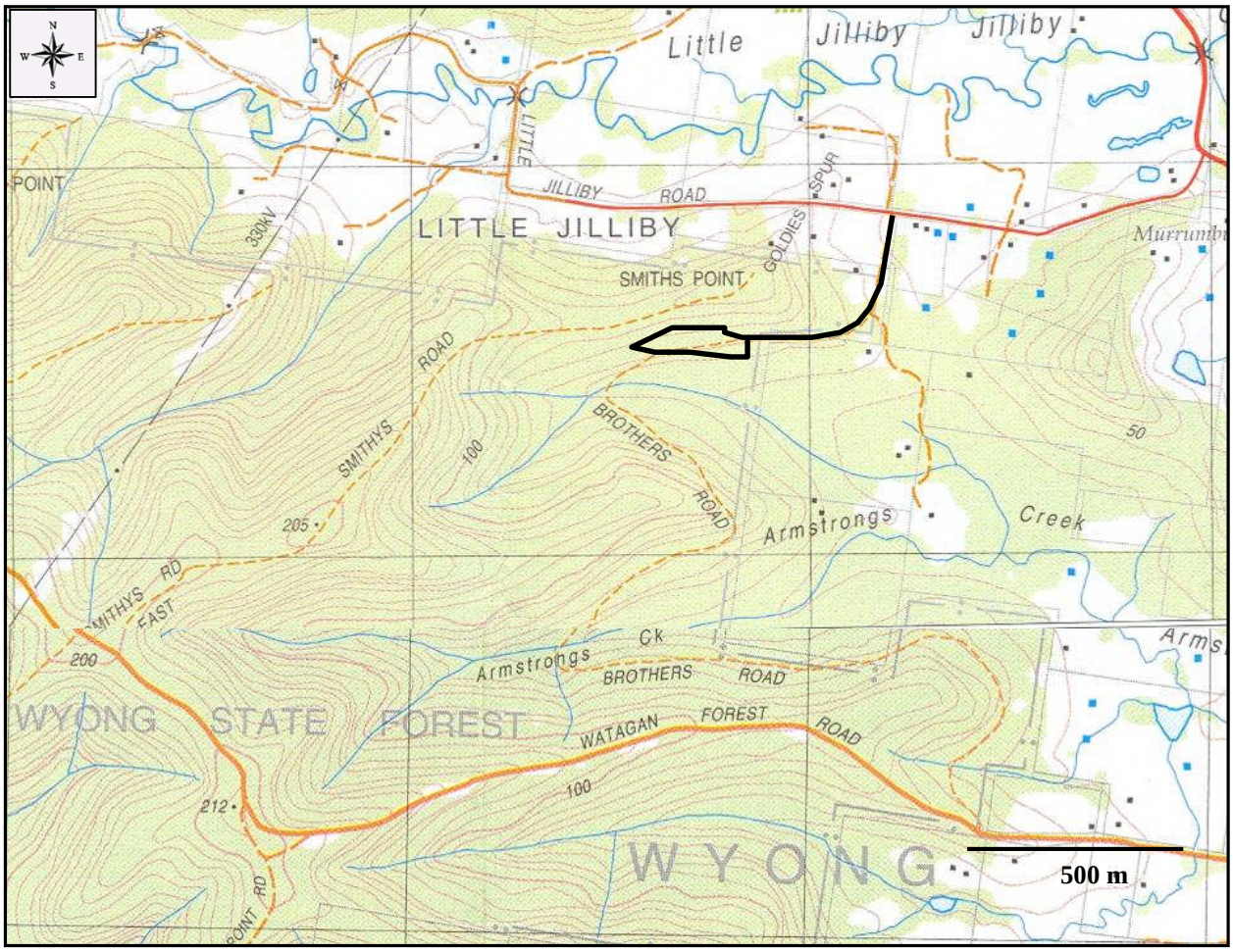
Soils on this study area are similar to those at Tooheys Rd but the low nutrient yellow to brown duplex soils are formed from Patonga Claystone sediments near the boundary of the Tuggerah Formation.

3.2.1c Western shaft study area

Topography within this area is generally hilly with steep slopes along an east-westerly oriented ridge. Areas to be upgraded on Brothers Rd are 21 m AHD and rise in elevation along the 700 m long impact footprint road and facilities area to 45 m AHD at the site proposed for the western shaft facility.

There are no drainage features within this impact footprint (**Figure 10**). Surface water from the ridgeline drains south into a small east-west oriented valley and Armstrongs Creek. This creek flows for c. 3 km southeast before its confluence with Jilliby Jilliby Creek, which then flows south into the Wyong River. Apart from the existing Brothers Rd there are no other factors altering natural hydrology within the proposed impact footprint.

Figure 10: Topography and hydrology of the Western shaft study area - black outline (Source: Dooralong 9131-1S {top} & Wyong 9131-2N {bottom} 1:25K).



Geology in this area is underlain by rocks of the Triassic Clifton-Subgroup, mainly consisting of claystone and sandstone (Sydney 1:25K Geological Series Sheet SI 56-5). Soils are comprised of yellow podsolics and have low amounts of usable nutrients.

3.2.2 Ecological offset investigation areas

3.2.2a Buttonderry offset

These environmental settings are adequately described in section 3.1.1b of this report and will not be repeated here.

3.2.2b Hue Hue Rd potential offset properties

Topography within this area is generally hilly with moderate to occasionally steep slopes. Two ridgelines influence the topography and hydrology within these parcels of land. Kiar Ridge (c. 70 m AHD) which has a fork oriented north-south and another east-west and Bushells Ridge (c. 60 m AHD), situated north of Kiar Ridge, and oriented east-west. Areas of lower elevation (5 to 10 m AHD) within these parcels of land occur toward Hue Hue Rd in the west and in association with the headwaters of Wallarah Creek and Wallarah Creek itself.

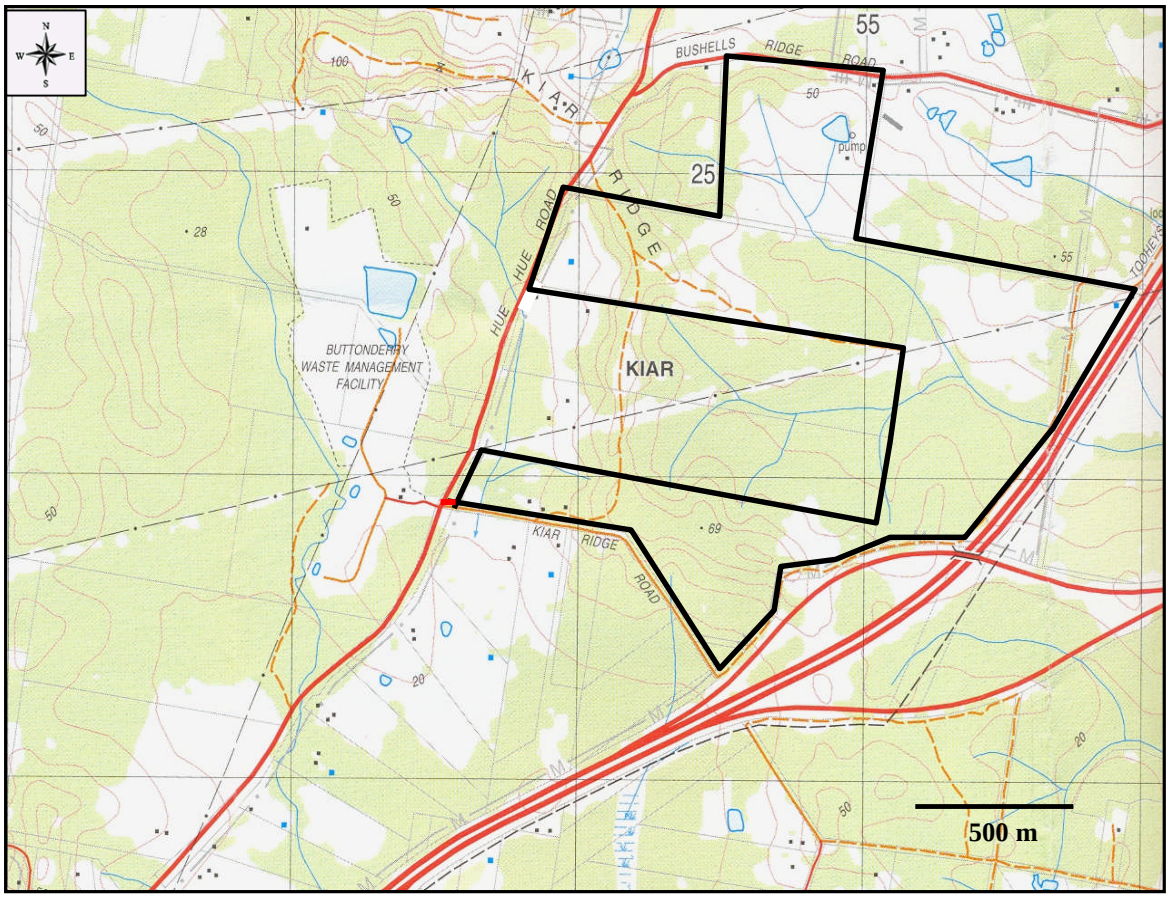
All drainage lines seen on **Figure 11** associated with Wallarah Creek are a result of surface runoff entering drainage depressions from elevated areas toward land of lower elevation (c. 5 to 10 m AHD). This east-west oriented creek drains to the east flowing under the Sydney Newcastle Freeway, through the Tooheys Rd study area and then eventually Lake Budgewoi approximately 7 km east of these parcels of land.

The northern headwaters of Wallarah Creek are predominantly within land owned by WACJV and originate from the slopes of Bushells Ridge. The southern main headwater is derived from the slopes of Kiar Ridge and one headwater has been dammed. The upper parts of the southern headwaters are not within land owned by Wyong Areas Coal Joint Venture.

In the south-western portion of the Hue Hue Rd study area is another ephemeral drainage feature not associated with Wallarah Creek. It is derived from the slopes of Kiar Ridge but in this case has its origin from slopes on the western side of Hue Hue Rd. Prior to European impact this feature would have flowed south into Buttonderry Creek. One of the three ephemeral drainage lines forming the headwaters of this feature has changed hydrology due to an agricultural dam in the (Precinct 14 area).

Geology and soils on this study area are the same as Tooheys Rd (forms part of the Tuggerah Formation and low nutrient yellow soils).

Figure 11: Topography and hydrology of the ecological offset investigation offset area (Hue Hue Rd) - black outline (Source: Dooralong 9131-1S 1:25K).



3.3 Current land uses and existing levels of disturbance

3.3.1 Direct impact study areas

3.3.1a Tooheys Rd study area

Generally, the waterways within the Tooheys Rd study area have been highly modified, despite the intact appearance given by regrowth in some areas. The following paragraphs present in greater detail the prior impact to each waterway in the Tooheys Rd study area.

- *(i) Waterways*

Spring Creek

Spring Creek (**Figure 8**), located on DLALC property provides a permanent fresh water supply within the assessed area however, within a few hundred metres downstream it becomes estuarine. It is largely unmodified west of the Main Northern Rail Line and lined with large hollow bearing eucalyptus (**Plate 1**). The assessed impact footprint adjoins an existing area of very heavy disturbance and waterway modification where a rail bridge is constructed of the Main Northern Railway is located (**Plate 2**). There is some evidence of

prior surface impacts from vehicle tracks and ruts to the banks of the creek in discrete places however, these appear to be old and are overgrown by vegetation.

Unnamed tributary of Spring Creek

Located in the north of Tooheys Rd this freshwater waterway is approximately 4.5 km long. Today only approximately 7 ha (c. 60%) of remnant vegetation derived from Narrabeen Alluvial Drainage Line Complex and its derivatives remains (on DP 755245 Lot 103 and DP 755245 Lot 102, **Figure 2**). It is has been impacted by the TransGrid easement, by a farm dam, clearing associated with residential housing and the Morisset to Warnervale Water Trunk Main (Hunter Water Pipeline) and other services.

Wallarah Creek

The western end of Wallarah Creek (**Figure 8**) close to the F3 has undergone heavy disturbance resulting in highly modified open channels or areas of intensive erosion that has been caused by land clearing and previous agricultural use (**Plates 3 and 4**) and more recently by activities associated with the construction of the Morisset to Warnervale Water Trunk Main (Hunter Water Pipeline) and numerous other buried services and pipelines. The entire structure of the creek and its banks within the direct impact footprint has been modified and is now all artificial. Some other areas of Wallarah Creek in the western portion of the study area have been cleared within the past 50 – 80 years but the vegetation since that point in time has regenerated (**Plate 5)**.

The second tributary of Wallarah Creek, originating from the southern side of Doyalson Link Rd appears to be largely unmodified, however, all vegetation within this portion of land has been cleared and grazed, and has regenerated in the past 50 years. The 4WD track shown on the topographic map close to the confluence with Wallarah Creek, and running immediately west of the waterway, is barely recognisable in the field and has been largely reclaimed by regrowth.

Only one portion of Wallarah Creek in the central southern part of the study area (**Figure 2**) features native vegetation that remains unmodified from 40 to 100 m either side of its existing banks. The presence of few old growth eucalypts behind former agricultural fence lines indicates the creek has been recently excluded from both direct and indirect impacts (excluding the former vehicle crossing).

- *(ii) Terrestrial environments*

DLALC land

The study area within DLALC land[1] is c. 1,800 x 60 m (10.8 ha, **Figure 2**). This land is not managed for any specific purpose by the DLALC. The only infrastructure present (apart from agricultural fencing) on the property is associated with the TransGrid 330kV powerline within a dedicated easement **(Figure 12)**. The assessed area for the project included 10 to 15 m of the northern portion of the TransGrid easement and extended for

[1] Including a small portion of land to be purchased from Boral Industries only a few metres wide and long.

50 m to the north. The alignment of the electrical towers does not occur within the assessed easement. Specific disturbance within the assessed areas (**Figure 12**) included:

- Manual vegetation thinning and removal of understorey layers for early grazing agricultural practices. Vegetation has been allowed to regrow in the past 40 years (approximately);
- Vegetation clearing for the purpose of creating the 330 kV easement;
- Fire events (study area was burnt again Dec 2006 after the main survey effort was undertaken);
- Illegal rubbish dumping;
- Impacts associated with former and current vehicle tracks (authorised and unauthorised use including trail bikes); and
- Very high level impacts associated with many unregulated motorcycle tracks.

Figure 12: Aerial photograph of disturbance within the DLALC property study area (Base photo source: Wyong Areas Coal Joint Venture).

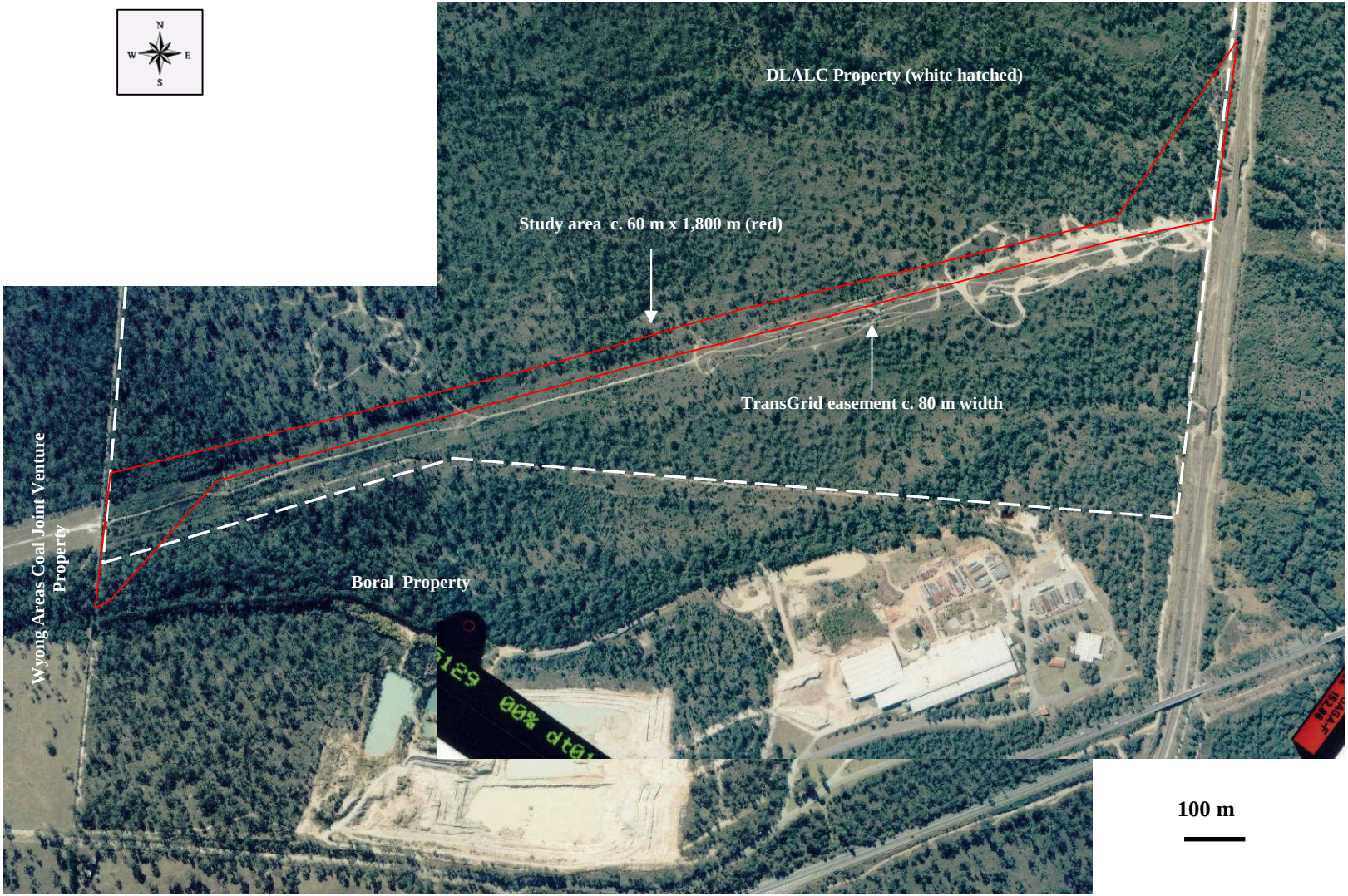


Figure 13: Aerial photograph of the Tooheys Rd, offset properties and Buttonderry study areas (Base photo source: WACJV).

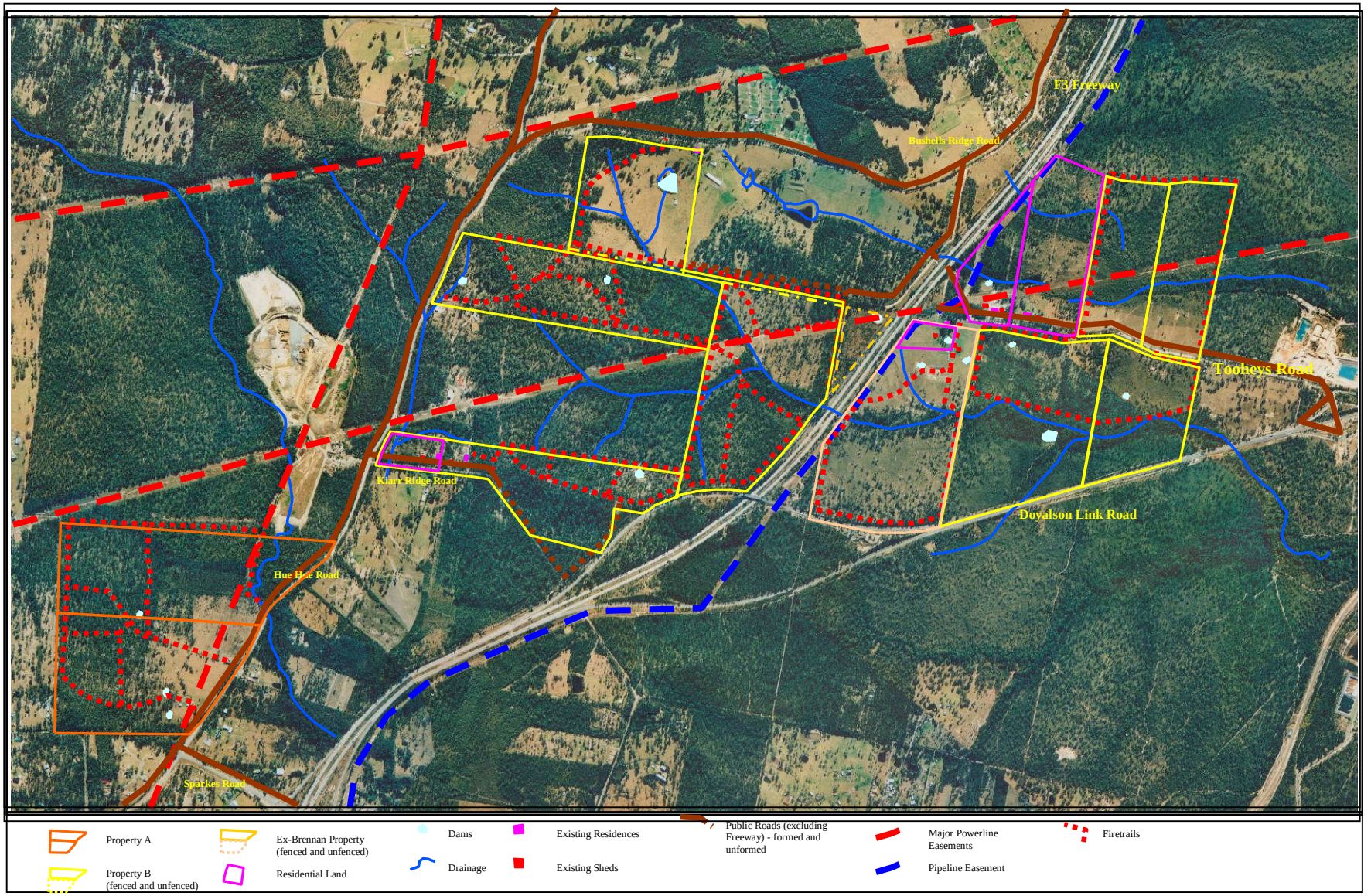


Figure 12 provides a fairly accurate overview of macroscopic surface disturbances however, at the time of survey many more motorcycle tracks were present. This area is used daily by multiple unauthorised groups for recreational dirt bike riding and as a result surface impacts are increasing. As a rough indicator, the DLALC land study area can be described as having:

- 15% heavy disturbance to all vegetation and soil structure in the eastern portion of the assessed area excluding the riparian zone (1.62 ha);
- 17% moderate disturbance in areas cleared for the 330kV easement that are not impacted by motorcycle tracks (1.34 ha);
- 58% low disturbance in vegetated areas adjoining the easement impacted only by former agricultural practices (6.76 ha); and
- 10% very low disturbance in the riparian corridor associated with Spring Creek (1.08 ha).

Property north of Tooheys Rd

WACJV property north of Tooheys Rd comprises three c. 300 x 700 m (63 ha) and one c. 210 x 490 m (10.3 ha) blocks (**Figure 13**). The Lot and DP's of these parcels of lands are shown on **Figure 2**. These portions of land are currently used for grazing agriculture and domestic dwellings on two of the four properties.

Common impacts to all four blocks include:

- Manual vegetation thinning and removal of understorey layers for early grazing agricultural practices. Vegetation has been allowed to regrow in the past 20 - 60 years depending on block ownership;
- Vegetation clearing for the purpose of creating the 330kV easement;
- Installation of 330kV electricity towers;
- Changes in hydrology due to impacts to vegetation and drainage lines;
- Fire events;
- Illegal rubbish dumping; and
- Impacts associated with former and current authorised vehicle tracks.

Specific impacts include:

DP 755245 Lots 102 & 103 - The most eastern of the four parcels of land, adjoins the DLALC land and the Boral property. These two parcels of land have undergone similar management. Of the 42 ha (c. 21 ha each):

- 50% has moderate disturbance with discrete areas of high disturbance (21 ha). Disturbance activities include vegetation removal (including impacting a minor drainage line), stump pushing, agricultural fencing, creation of farm dams and other minor infrastructure (environmental monitoring station for the mine), gas

line installation, continuous grazing, clearing for the 330kV easement, creation of TransGrid and rural service tracks and installation of electricity towers;

- 40% low disturbance in vegetated areas north of the 330kV easement impacted only by former agricultural practices (16.8 ha); and

- 10% very low disturbance in the riparian corridor south of the TransGrid easement (4.2 ha). It is important to note that vegetation associated with a northern anabranch of the riparian corridor described as occurring south of the 330kV easement has been heavily impacted within the TransGrid easement. The estimated area has been included in the first calculation.

DP 260217 Lot 1 & DP 260217 Lot 3 (west, toward the F3 of the land described above). These two parcels of land have undergone similar management and both have been reduced in size to make way for the Sydney – Newcastle Freeway. Two domestic dwellings are situated on these properties. Of the c. 30 ha owned by WACJV approximately:

- 80% has moderate disturbance with discrete areas of high disturbance (24 ha). This land has undergone vegetation removal within the past 20 years, stump pushing, agricultural fencing, creation of farm dams and other minor infrastructure, residential housing construction, continuous grazing, clearing for the 330kV easement (including through the riparian vegetation) and the Morisset to Warnervale water trunk main, creation of TransGrid and rural service tracks and installation of electricity towers; and
- 15% has low disturbance in vegetated areas north of the 330kV easement impacted only by former agricultural practices and areas surrounding the drainage feature (4.5 ha).

Property south of Tooheys Rd

WACJV property south of Tooheys Rd consists of three blocks totalling c. 99 ha (**Figure 13**). The Lot and DP's of these parcels of land are shown on **Figure 2** however**,** DP's and the Lots east of DP 755245 PT 124 are not readable on this figure. Due to the varying layers of disturbance associated with these parcels of land, disturbances in each DP will be described as occurring north or south of Wallarah Creek.

DP 755245 PT 124 north of Wallarah Creek

This portion of land is bounded to the west by the Sydney to Newcastle Freeway, to the north by Tooheys Rd and to the west by DP 755245 PT 126. This area has been heavily modified. Nearly all trees have been cleared, arable land ploughed and elevated lands suitable Indigenous occupation impacted by a residential house or former farming infrastructure (dairy shed). In 2006 large amounts of rubbish (car bodies, equipment and materials storage containers) were stacked up in multiple loose piles toward and along the banks of Wallarah Creek. These materials, including potentially hazardous materials (old pesticide containers and asbestos sheeting) have been subsequently removed by the Proponent. The western boundary of the property has been heavily impacted by the Morisset to Warnervale water trunk main (Hunter Water Pipeline).

DP 755245 PT 124 south of Wallarah Creek

This portion of land is bounded to the west by the Sydney to Newcastle Freeway, to the south by the motorway Link Rd and to the west by DP 755245 PT 126. It includes a very small corner of former portion of DP25869 Lot 31 (now occurring west of the highway) that was dissected by the Sydney to Newcastle Highway.

Until recently DP 755245 was used for grazing agriculture (goats) and has no understorey layer whilst the two adjoining blocks to the east remained fallow for more than 30 years (estimation) as a mature understorey layer and moderate sized trees. It is likely that all blocks underwent tree clearing during the early settlement of the area. These portions of land are currently used for grazing agriculture and domestic dwelling on two of the four properties.

DP 755245 PT 126 & DP 658436 Lot 128 north of Wallarah Creek

These portions of land are used for grazing agriculture (cattle, horses) and has limited patches of understorey and young to moderate sized trees. It is likely that all blocks underwent tree clearing during the early settlement of the area. A domestic dwelling is on one of these properties.

DP 755245 PT 126 & DP 658436 Lot 128 south of Wallarah Creek

At first glance these two portions of land appear to be remnant native vegetation similar to the areas adjacent to Wallarah Creek. Closer inspection shows that much of the areas was once cleared but has since substantially regenerated to support a fully functional native ecosystem. Whilst many trees are present few are of an age to possess hollows. Very little ground disturbance appears to be associated with these blocks, it may be limited to prior tree pushing / clearing, fencing farm tracks (now overgrown) and impacts from hard hoofed animals. Wallarah Creek in these portions of land was fenced from domestic stock and the composition of the vegetation within that area has a high conservation value and habitat complexity.

3.2.1b Buttonderry impact study area

Buttonderry is currently and was formerly used for grazing agriculture. It compromises two blocks with separate DP's. DP 791157 Lot 2 (c. 35 ha) is the southernmost and is the location where direct impacts will occur (**Figures 2 and 5**). The type and extent of impacts to this parcel of land are directly related to topography. The hills are currently treed but have been subject to previous logging (only a few isolated trees are of hollow bearing age) whilst the flat ground has had all vegetative layers removed except with all stumps pushed in areas that are water-logged, in this area three small farms dams have been constructed (**Figure 13**). Several small tracks and fire breaks occur within the property. A portion of this DP has the potential to be set aside for potential conservation offset and therefore that component will be discussed in 3.2.1.

3.3.1c Western shaft study area

The Western shaft study area occurs on land within the Wyong State Forest. Disturbance in the immediate areas is limited to the prior construction and ongoing maintenance of Brothers Road and selective logging.

3.3.2 Proposed offset properties

3.3.2a Buttonderry potential offset

It is known that DP 791157 Lot 1 (c. 24.5 ha and the northern block of the two) will not receive any direct impacts from the proposal. For the purposes of this report it will be considered as those areas not directly impacted by the c. 5 ha proposed pit top facilities. Levels of disturbance for these areas are adequately described in 3.2.1b.

3.3.2b Hue Hue Rd potential offset

Previous impacts to these parcels of land are varied and are as follows:

- *DP 755245 Lot 118*

This is the most northern block of land in the potential offset group and has Bushells Ridge Rd frontage (**Figures 2 and 13**) and, is c. 25 ha. It is, and was, formerly used for grazing agriculture. All drainage lines present are impacted by vegetation removal with one large dam being constructed in one of the headwaters to Wallarah Creek in the north east corner of the block. The vast majority of vegetation on the block has been removed except on areas where there is steep topography (**Figure 13**).

- *DP 719762 Lot 1*

This c. 36 ha portion of land has frontage to Hue Hue Road along its western boundary and is joined (in part) by DP 755245 Lot 118 as described above. The block of land shows low levels of prior disturbance with only selective tree clearing have been undertaken (**Figure 13**).

- *DP 258692 Lot 31*

This c. 48 ha portion of land is joined (in part) to the west by DP 719762 Lot 1 and to the east by the F3 freeway (**Figure 13**). Similarly with most of the surrounding properties, all flatter land has been cleared for grazing agriculture whilst the steeper slopes remain timbered only having undergone prior selective logging. In this block generally all land north of the tributary to Wallarah Creek has been cleared and the only clearing on the slopes is associated with the TransGrid 330kV electricity easement. There are several vehicle tracks within the parcel of land.

- *DP 791157 Lot 2*

This c. 36 ha portion of land is the southernmost and most irregular in shape of the potential offset group and is bounded to the south by Kiar Ridge Road and the west by Hue Hue Road (**Figure 2 and 13**). The western c. 5 ha where the residence is located has been heavily impacted by residential infrastructure which has in turn caused modification of the waterways running parallel to Hue Hue Rd on the property. Similarly as with all land in the vicinity the flat areas, prior to housing development the land was cleared for agricultural purposes and the steeper slopes have been historically selectively logged. One moderately sized farm dam is present on elevated land in the east of the property and several vehicle tracks exist.

4. METHODS

4.1 Personnel

Field assessments for the current series of investigations were undertaken by Mr Phillip Cameron (OzArk, Bsc. Ass Dip App Sci, Animal Research Authority 07/1601, Scientific Licence 11194, and MECA) and Stephen Bell (East Coast Flora Survey) with assistance from Dr Jodie Benton (OzArk). Specialist analysis of Anabat calls was undertaken by LesryK environmental consultants Pty Ltd with frog call analysis by Mr Frank Lemckert.

Many other specialists have been involved with assessments of land owned by WACJV over the years. Details of personnel can be obtained by reviewing the original reference documents.

4.2 Database searches and literature reviews

4.2.1 Database searches

Records of threatened species of plants and animals were obtained from the Department of Environment and Climate Change and Water (DECCW) for the project locality using the Dooralong 9131-1S and Wyong 9131-2N 1:25k map sheets. Species, populations, communities and migratory species noted by the Department of Environment, Water, Heritage and the Arts (DEWHA) as having the potential to occur within the Local Government Area (LGA) was accessed through the DEWHA online protected matters report database.

The BioNet and NSW Fisheries Fish files online database was also searched so that any gaps in DECCW data from other agencies (Royal Botanic Gardens, DPI-Fisheries and Forest NSW and the Australian Museum) could be identified.

4.2.2 Literature review

Other sources of information used for this project included aerial photographs, design detail, property information and internal progress reports commissioned by/or undertaken for the Proponent.

As previously noted there is a body of information directly related to this project. **Table 1** provides a summary of reports commissioned for the development of the coal resource underneath Wyong while **Table 2** provides a chronological summary of other external reports that have relevance to the current project.

Table 2: External reports relevant to the current assessment.

Company / Author / Year Finalised	Title	Specialist components	Comment
Forest Fauna Surveys and Eastcoast Flora Surveys for Lake Macquarie City Council July 2001.	Flora and Fauna Survey Guidelines V 2.0.	Methodologies recommended by Wyong Shire Council for Fauna and Flora assessment within their bailiwick.	Applies to the Wyong LGA.
Ecotone Ecological Consultants Pty Ltd November 2001	Lower Hunter and Central Coast Regional Biodiversity Conservation Project Module 1. Fauna survey.	Fauna survey.	Applies to the Wyong LGA. For the steering committee for the Lower Hunter & Central Coast Regional Environmental Management Strategy.
Wyong Shire Council August 2003	Wyong Conservation Strategy.	Planning tool to assess environmental impact against set conservation values.	Applies to the Wyong LGA. Prepared by the Wyong Shire Council Strategic Planning Department.
Parsons Brinckerhoff Pty Ltd. December 2005.	Munmorah Gas Turbine Facility Environmental Assessment Technical Paper 1.	Flora and fauna assessment.	Assessed area includes the northern portions of the Tooheys Rd study area. Assessed within the 330kV TransGrid easement.
Patterson Britton & Partners. Draft REF January 2006.	Morisset to Warnervale Water Trunk Main & Morisset Water Pumping Station.	REF including heritage and ecological studies.	Assessed area includes the western boundary of the Tooheys Rd study area.

In relation to those studies identified in **Table 1**, the current assessment is built upon the most relevant and recent of these, as our aim was to supplement and build upon existing information. Review of these assessments and other related information is presented chronologically below:

PPK Consultants (1992) undertook environmental assessment that included portions of the western area (current assessed areas are part of the western area). Unfortunately, OzArk does not have a copy of this report.

ERM (1995a) Environmental Constraints Report. This assessment concentrated on the combined western and eastern mining leases. This report is essentially aimed at documenting environmental constraints and describes requirements needed for an EIS. In relation to ecology, the report describes vegetation communities by aerial photography and application of Specht classification system (with limited field investigation) whilst using previous works by PPK Consultants (1992). Six vegetation communities (habitat areas) were described (ERM 1995a: 4.2-4.6):

- casuarina forests: swamp forests;
- open forests;
- open woodland type 1;
- open woodland type 2; and
- grasslands.

The conservation significance of these vegetation communities was assessed. The casuarina forests and swamp forests mainly around the foreshores of Tuggerah Lake were classified as 27a *Freshwater Swamp Complex* (Benson vegetation map) and are considered to be poorly conserved in the Wyong region (Benson 1986) and thus were considered to be of high conservation significance. These are outside of the current study areas.

Open forest communities (Benson vegetation map - 9g) were noted as common throughout the central coast region (covering approximately 80,000 ha) however ERM 1995: 4.7) noted that is poorly protected with only 240 ha within reserves of this 170 ha is within Forests NSW preserves. The community was noted as being of high conservation significance due to its rich, floristically diverse structure and variation of habitats it contains. This classification was applied to Open Forest and Woodland Type 1.

Woodland type 2 was classified as belonging to Bensons 10e *Woodland* and is noted as not being widely distributed on the central coast. It is conserved in the Munmorah State Recreation Area and generally well conserved within the region. Low conservation significance was allocated to this community.

A list of rare or endangered flora and fauna species was documented from searches of the NPWS Wildlife Atlas. This list is consistent (although slightly dated) with the most recent information supplied by NSW DECCW.

The degree of 'naturalness' in the open forest community and woodland type 2 was considered to be fairly high despite evidence of clearing, impacts from infrastructure and minor rubbish dumping. A significant variety of habitat was noted.

Special natural features to be noted was the presence of *Melaleuca biconvexa* within the swamp forest community and noted that it is almost locally extinct.

ERM (1995b) Aquatic ecology. This study focussed on the Tuggerah Lake environs that are not directly applicable to the current assessment.

ERM (1997) Seagrass survey. This study assessed Coal exploration study area C200 V200 – Tuggerah Lake. This assessment is not directly applicable to the current terrestrial ecology assessment at W2CP. Consequently, a summary of the report has been omitted.

ERM (1998) draft ecology Tooheys Rd (Precinct 15) and Pacific Power study areas (not within the current study areas). It is important to note that these study areas whilst encompassing the current Tooheys Rd study area are not the same, they were much larger. Due to the size of that study area additional issues and items of conservation significance

that are not relevant for the current assessment had been discussed in the associated report. Vegetation communities were identified by aerial photographs and ground truthing and flora studies were undertaken in February and March 1998. A series of 20 x 20 m quadrants were used and were placed in each of following vegetation communities identified. A summary of the two study areas is presented below:

Tooheys Rd (Precinct 15)

Vegetation communities:

- Scribbly gum / red bloodwood woodland;
- Scribbly gum / red bloodwood open woodland;
- Scribbly gum / smooth-barked apple woodland red bloodwood open forest;
- Blackbutt / brown stringybark tall open forest;
- Swamp mahogany / red bloodwood open forest
- Melaleuca low open forest; and
- Heathland

Habitat types:

- Dry sclerophyll woodland;
- Wet sclerophyll forest; and
- Heathland

Flora assessment:

Target searches were undertaken for *Angophora inopina*, *Eucalyptus camfieldii, Cryptostylis hunteriana*, *Tetratheca juncea* and *Caladenia tessellata* during March and November 1998. The following threatened flora (under TSC and EPBC Acts) species were detected:

- *Angophora inopina*; and
- *Tetratheca juncea*

Fauna Assessment:

Fauna surveys were undertaken using:

- Hair funnels;
- Elliot ground traps;
- Tree trapping;
- Bat detection;
- Spotlighting;
- Bird Point Census; and

- Reptile and Amphibian searches (with specialist frog census by Dr Arthur White).

Note: same methods for both study areas.

Fifteen native mammal species were recorded, three were threatened species (TSC Act) – Squirrel Glider, Large-footed Myotis and Little Bentwing Bat. 14 species of birds were recorded (mostly in sclerophyll forest), 3 reptiles and 13 species of frogs in the drainages lines through the study area.

Pacific Power Site / Pioneer Dairy (on the shores of Tuggerah Lake between Wyong River and Ourimbah Creek, not part of the current assessed areas). As this study area is not directly relevant to the current assessment therefore a summary is not presented.

ERM (1999a) progress report for the Wyong Coal Development Area. This report synthesised the results of the studies listed above: No further information is relevant.

ERM (1999b) Wyong Areas Joint Venture Project proposed surface facilities. This is the most relevant previous study in respect to the current W2CP. The report estimated that the four study areas comprise c. 904 ha of which 139 ha will be directly impacted. Further detail and nomenclature is provided below (Source ERM 1999b: s2)

- Study area 1 (Tooheys Rd pit top facilities and rail loop in DLALC land) - 51 of 488 ha (10.4%) of the study area destined for rail loop and associated surface facilities and is referred to as the LALC land. Note the ERM (1999b) study area was larger than the current study area (**Figure 14**).
- Study area 2 (Hue Hue Rd ecological offset investigation area). 67 of 322 ha (20.8%) of this study was at that stage proposed for pit top facilities (**Figures 2 & 11**). Note: the ERM 1999b study areas included the two rectangular portions of land in-between DP 719762 Lots 1 & 4.
- Study area 3 (Buttonderry). 13 of 81 ha (16%) of the study area destined for impact). Referred to as previous grazing land with remnant forest and woodland in the north and west (**Figure 5**). Note: the study size of the current study area is the same.
- Study area 4 (land south of Buttonderry no longer proposed for impacts and not part of the current assessment).

The report continues to note that there is c. 611,287 ha of native vegetation remaining in the LGA of which 0.02% would be impacted by the proposed surface facilities. At least 18 threatened and regionally significant species were identified as having the potential to be significantly impacted by the proposal. These include:

- Wallum Froglet (*Crinia tinnula*, TSC Act);
- Green and Golden Bell frog (*Litoria aurea*, TSC Act, EPBC Act);
- Pale-headed snake *(Hoplocephalus bitorquatus*, TSC Act*);*
- Squirrel glider (*Petaurus norfolcensis*, TSC Act);
- Brush-tailed phascogale (*Phascogale tapoatafa*, TSC Act);

- Spotted-tail quoll (*Dasyurus maculatus,* TSC Act, EPBC Act);
- Greater broad-nosed bat (*Scoteanax rueppellii,* TSC Act);
- Little bentwing bat *(Miniopterus australis,* TSC Act*);*
- Common bentwing bat *(Miniopterus schreibersii,* TSC Act*);*
- Large footed mytosis (*Mytosis adversus,* TSC Act);
- Eastern freetail bat (*Mormopterus norfolkensis,* TSC Act);
- Yellow bellied Sheathtailed bat *(Saccolaimus flaviventris,* TSC Act*);*
- *Tetratheca juncea,* TSC Act, EPBC Act*;*
- *Angophora inopina,* TSC Act, EPBC Act*;*
- *Caladenia tessellata,* TSC Act, EPBC Act*;*
- *Cryptostylis hunteriana,* TSC Act, EPBC Act*;* and
- *Diuris praecox,* TSC Act, EPBC Act.

Potential impacts on threatened species were noted as:

- Loss of breeding, foraging and sheltering areas for frog and mammal species;
- Potential degradation of frog breeding and foraging areas as a result of weed invasion and water and sediment runoff;
- Removal of individuals of threatened plants due to habitat clearing;
- Fragmentation of wildlife movement corridors thus limiting the dispersal of frogs and mammals;
- Mortality or injury of individual threatened fauna during construction and operational phases of the proposed development; and
- Noise and visual disturbances to threatened fauna during construction and operational phases.

ERM (1999c) Wyong Coal Development Project 1999 Environmental Studies Progress Report. Relevant to the current assessment were:

Stream ecology – The report states that fresh water ecology studies undertaken in 1999 targeting areas where surface facilities were to be located and in the valleys where underground mining is to occur. Results indicated a high diversity of healthy macroinvertebrate species which was expected as runoff occurred through native bushland. One threatened frog species, (Tinkling Frog[2]) was identified, although it was noted that the Green-thighed Frog which was known to occur in the area was not recorded. Further assessment of waterways and frog populations was recommended.

[2] The Tinkling frog is listed as a vulnerable species by DEWHA. Unfortunately the scientific name was not provided in the report (*Taudactylus rheophilus).* A Review of the DEWHA species profile shows that this species is a mid to north coast Qld species. ERM does not mention this recording in subsequent documents.

During a 1997 survey water quality tests by DEWHA in Spring Creek showed that this study area had a pH of 5.5 in February however, one month prior, in January the results complied with the acceptable pH range of 6.5 to 9.0 (ERM 1998). Electrical conductivity was within ANZECC (1992) guideline values, however turbidity was quite high in January (120 NTU) but lower in February (47 NTU). All levels of dissolved oxygen were below ANZECC (1992) guidelines.

Wallarah Creek during the same time period was only one of all eight tested locations that were within ANZECC (1992) guidelines for pH during wet weather events (pH of 6.5). Electrical conductivity, turbidity and dissolved oxygen levels were all within acceptable limits during the monitoring events.

The terrestrial ecology part of the report repeats the finding as described above (ERM October 1999) and states that the D-G of NPWS had forwarded requirements for SIS's.

ERM (2000) draft Species Impact Statement (SIS). The following species (all TSC and EPBC listed) at the surface facility areas to be impacted were assessed:

Flora:

- *Tetratheca juncea* – recorded in the Tooheys Rd study area;
- *Angophora inopina* – recorded Tooheys Rd study area;
- *Caladenia tessellata* - noted as having potential to occur;
- *Cryptostylis hunteriana*- noted as having potential to occur; and
- *Diuris praecox* - noted as having potential to occur.

In the case of the two species recorded in the Tooheys Rd study area the proposed impact was seen as not significant due to a high recorded abundance of the species in the event of appropriate mitigative measures. In the case of *Tetratheca juncea* it was noted that the species was expected to occur in suitable habitat in adjacent areas.

Fauna – Birds (noted as having the potential to occur in the current study areas).

- Australian Bittern *(Botaurus poiciloptilus*, TSC Act*);*
- Bush Stone Curlew (*Burhinus grallarius*, TSC Act);
- Glossy Black Cockatoo (*Calyptorhynchus lathami*, TSC Act);
- Black-necked Stork (*Ephippiorhynchus asiaticus*, TSC Act);
- Painted Honeyeater (*Grantiella picta*, TSC Act);
- Swift Parrot *(Lathamus discolour*, TSC Act, EPBC Act*);*
- Turquoise Parrot (*Neophema pulchella*, TSC Act);
- Barking Owl *(Ninox connivens*, TSC Act*);*
- Powerful Owl *(Ninox strenua*, TSC Act*)* – recorded in ERM's study area 4 (no longer in the current study area);

- Masked owl (*Tyto novaehollandiae*, TSC Act) – recorded in study area 1; and
- Regent honeyeater (*Xanthomyza phrygia,* TSC Act, EPBC Act).

All species were noted as likely to experience a loss of foraging / hunting habitat and roosting / resting areas if impacts were to occur. The honeyeaters and parrots (with the exception of the regent honey and the glossy black cockatoo) were noted as potentially losing nesting sites. It was assessed that neither owl species was likely to lose breeding / nesting habitat however, a note within the text stated that the loss of one pair of Powerful Owls (recorded in study area 4 – no longer part of the current assessment) as a result of the project would be a negligible impact on the NSW population. The Masked Owl is a known user of urbanised areas and was not considered to be impacted. The greatest impact to all species was associated with habitat removal in study area 2 (which is now the Hue Hue Rd potential ecological offset investigation area).

Fauna – bats:

- Greater Broad-nosed Bat (*Scoteanax rueppellii*, TSC Act*)* – recorded in the Hue Hue Rd ecological offset investigation area;
- Eastern Falsistrelle (*Falsistrellus tasmaniensis*, TSC Act) – previously recorded as having the potential to occur, later recorded by OzArk at the Tooheys Rd study area;
- Little Bentwing Bat (*Miniopterus schreibersii*, TSC Act*)* - recorded at the Tooheys Rd study area;
- Common Bentwing Bat (*Miniopterus australis*, TSC Act) – recorded as having the potential to occur;
- Large Footed Mytosis (*Mytosis adversus*, TSC Act) recorded at Tooheys Rd study area;
- Eastern Freetail Bat (*Mormopterus norfolkensis*, TSC Act*)* recorded as having the potential to occur; and
- Yellow-bellied Sheathtailed Bat (*Saccolaimus flaviventris*, TSC Act*)* – recorded in the Tooheys Rd and Hue Hue Rd study areas.

The SIS's concluded that all species would experience a reduction of foraging territory and potentially an increase in predation due to artificial lighting. The cave dwelling bats would not lose roosting habitat (Common bentwing bat & little bentwing bat), however the remaining species may experience a reduction of population size if significant clearing were to be undertaken particularly in the Hue Hue Rd ecological offset investigation area study area.

Fauna – other mammals

- Squirrel Glider (*Petaurus norfolcensis*, TSC Act) recorded in the Tooheys Rd study area;
- Yellow-bellied Glider (*Petaurus australis*, TSC Act) recorded in study area 2 (tentative);
- Brush-tailed Phascogale (*Phascogale tapoatafa*, TSC Act);

- Spotted-tail Quoll (*Dasyurus maculatus*, TSC Act, EPBC Act); and
- Common Planigale (*Planigale maculata*, TSC Act).

The study concluded that there would be a net loss of foraging (and winter flowering), den and breeding habitat at the Tooheys Rd study area and Hue Hue Rd study area (ecological offset investigation area), fragmentation of habitat and dispersal corridors would be reduced. In the case of the glider species recorded it was expected that a local population may be reduced by the proposed action.

Fauna - reptiles and amphibians:

- Pale Headed Snake (*Hoplocephalus bitorquatus*, TSC Act);
- Stephens Banded Snake (*Hoplocephalus stephensii*, TSC Act*);*
- Wallum Froglet (*Crinia tinnula*, TSC Act) recorded in the Tooheys Rd, and Hue Hue Rd study areas and ERM's area 4 (no longer part of the current assessment). It is unclear why the population at Hue Hue Rd was not discussed further or mapped on the species locality map of this report, however habitat at that location exists and the species has potential to occur;
- Green and Golden Bell Frog (*Litoria aurea*, TSC Act, EPBC Act); and
- Green-thighed Frog (*Litoria brevipalmata*, TSC Act) – later recorded in 2003 at Buttonderry.

The snakes were considered to be adequately conserved in conservation reserves in the region, however the frogs were assessed as likely to be affected by the potential for the introduction of mosquito fish if any changes to habitat if hydrological regimes were to occur. With regard to the Wallum Froglet, there was expected to be a loss of forage, shelter and breeding habitat in Tooheys Rd and Buttonderry, loss of acidic swamps along Spring Creek and the tributaries of Wallarah Creek in study area 2. A potential loss in net population was postulated (based on a previously proposed development option).

ERM (2002a) Review of impacts to flora and fauna at the proposed surface facilities.

In this report, ERM summarises that:

- Vegetation at the surface facilities had been recorded in detail and no further work was required;
- Vegetation in the subsidence areas was assessed as requiring further work to define its nature boundaries and potential to provide habitat for threatened species;
- Of the threatened species of flora in Wyong Shire, further work was recommended to survey for *Acacia bynoeana* (TSC Act, EPBC Act) at the Tooheys Rd study area, *Genoplesium insigna* at the surface facility and subsidence areas and for *Melaleuca biconvexa*, *Tetratheca juncea*, *Tetratheca glandulosa* and *Grevillea parviflora* spp *parviflora* (all TSC Act, EPBC Act) in the subsidence areas; and
- Of the threatened fauna species in the Wyong Shire, further work was recommended for: the Australia Bittern (*Botaurus poiciloptilus*, TSC Act) and the Black Bittern (*Ixobrychus flavicollis* TSC Act) in all creeks and rivers in the

subsidence study area. Further work was also recommended for frog species in the subsidence areas.

ERM (2002b) Aquatic flora and fauna review**.** This report summarises:

- None of the aquatic species encountered to date are threatened species;
- There was a need to verify that no threatened aquatic plants occur within Jilliby Jilliby Creek and Wyong River that are most at risk due to subsidence; and
- Additional aquatic surveys are required for fish species in both surface facility study areas and subsidence areas and more information was required regarding macroinvertebrates at these locations.

BHP Billiton (2002) Wyong Coal Concept Study. This report provided a summary of the local environment and assessments undertaken to that time. Issues raised within the text added further information to the current body of knowledge and include:

- The vegetation mapping, then able to be based upon the Wyong Council State of the Environment Report for 2000 / 2001 shows a number of vegetation types as having significant conservation value (Appendix 1: 49). It was noted in the text that the Wyong Shires new vegetation map, to be released in 2002, would utilise terminology significantly different to that used in the current text.

- The Magenta Lillypilly (*Syzygium paniculatum*), became an additional species of concern (also a threatened species in TSC Act and EPBC Act) within the regions' blue gum forests and the platypus (*Ornithorhynchus anatinus*) also became a regionally significant species.

- Mine subsidence was noted as having the potential to create new wetlands in some circumstances if surface depressions were created or by turning existing wetlands into open-water ponds. Depending on the coal quality and geological factors, subsidence was noted as having potential to create acidic water that may change existing water chemistry. Other factors are also listed in the body of the report.

- Ten fauna species were noted as being previously recorded in the subsidence areas (Sooty Owl, TSC Act, Black Bittern, TSC Act, Black-necked Stork, TSC Act, Tiger Quoll TSC Act, EPBC Acts, Masked Owl, Squirrel Glider, Yellow-bellied Glider, Great Pipistrelle, Green-thighed Frog – all TSC Act and Green and Golden Bell frog, TSC Act, EPBC Act and six species were listed as having the potential to be affected at the proposed surface facility study areas (*Angophora inopina, Tetratheca juncea* (both TSC Act, EPBC Act), Masked Owl, *Mytosis adversus*, Squirrel Glider and the Wallum Froglet – all TSC Act).

ERM (2003) Wyong Coal Project Summer Surveys – Western Area. OzArk has not been able to obtain a copy of this report and relies on summaries provided by other authors. Orbis (2005: 23-25) notes additional threatened species in the subsidence area were recorded as a result of this survey, including *Syzygium paniculatum* TSC Act and EPBC Act, Black Necked Stork TSC Act, Sooty Owl, Black Bittern, Glossy Black Cockatoo, Green-thighed Frog – all TSC Act, Giant Barred Frog (part of a population), Stuttering

Frog, Grey Headed Flying Fox, Spotted-tailed Quoll all TSC and EPBC Acts. On Buttonderry *Grevillia parviflora* subsp *parviflora*, *Tetratheca juncea*, and the Green-thighed Frog were noted and at Tooheys Rd Byones Wattle and *Cryptostylis hunteriana* (all TSC and EPBC Acts*)* were recorded by desktop assessments.

Orbis (2005) The Wyong Coal Project – Review of Environmental Parameters. This report focuses on the W2CP and lists the following additional studies to complement the existing information that may be required for an adequate development assessment of the W2CP (Orbis 2005: 16):

1. Confirm the presence of newly identified threatened flora and fauna species.
2. Identify terrestrial vegetation communities and habitat which are most subject to subsidence (i.e. along creeks and rivers) and a selection of compensatory habitat.
3. Survey for the presence and extent of threatened species.
4. Assess the impact of the mining project on these threatened species and habitats to identify appropriate mitigation measures.
5. Preparation of additional Species Impact Statements.
6. Develop fauna and flora management plans.
7. Consider the new DECCW Biodiversity Banking Policy to see if it is applicable to the project area.

Other reports, not commissioned by the Proponent but with direct relevance to the current assessment are presented on **Table 2** and are presented below:

Murray, Bell & Hoye (2001). Flora and fauna survey guidelines have been produced for the region by Murray, Bell & Hoye (2001). These aim to standardise the methods used for surveying for flora and fauna diversity and are based on similar guidelines produced by State and federal government departments. Similar guidelines focusing on the Wyong local government area have also been produced and adopted by Council.

Ecotone Ecological Consultants (2001). Commissioned by Lake Macquarie City Council to document fauna survey methods for consultants when undertaking work in the Wyong LGA. This report forms part of the draft Wyong Conservation Strategy (August 2003). This assessment:

- identifies threatened and significant fauna species of the Wyong Shire;
- classifies and maps habitats in the Wyong Shire and assesses their representation in regional reserves and protected areas;
- models and maps the potential distribution of individual threatened and significant species;
- identifies and recommends strategies for identification and conservation of wildlife corridors throughout the Shire; and
- identifies and recommends strategies for protection and management of threatened and significant species and areas of high conservation value.

Draft Wyong Shire Conservation Strategy (2003). The ecology components of this report were undertaken by Eastcoast Flora Survey and Ecotone Ecological Consultants. The relevant components have been detailed above.

Parsons Brinckerhoff Pty Ltd. (2005) – Environmental Assessment Munmorah gas turbine facility (Volume 2 technical papers). Approximately one third of this assessment was undertaken within the Tooheys Rd study area. The type of specialist fauna assessment undertaken and study area locality map is presented as **Figure 14**. Salient points of the results are:

Vegetation communities:

- Six main vegetation types were recorded using data supplied by the Lower Hunter & Central Coast Regional Environmental Management Strategy (LHCCREMS) in the Tooheys Rd study area. This classification scheme is a much broader scheme than utilised within the current assessment however, the current assessments microscale is derived from groundtruthing the same baseline data and making amendments were required. Vegetation communities described in LHCCREMS included:
    - Coastal Plains Smooth-barked Apple Woodland;
    - Coastal Plains Scribbly Gum Woodland;
    - Alluvial Tall Moist Forest;
    - Wyong Paperbark Swamp Forest;
    - Coastal Foothills Spotted Gum; and
    - Riparian Melaleuca Swamp Woodland.

    No Endangered Ecological Communities were identified in the gas pipeline study area in the current Tooheys Rd or rail loop study areas.

- Species of plants: 147 species of plants were recorded through the gas pipeline study area (85% native) and no noxious weeds were noted. *Angophora inopina* (vulnerable, TSC Act and EPBC Act) was recorded within Tooheys Rd study area along the TransGrid 330kV easement on Darkingjung Local Aboriginal Land Council (DLALC) land.

- Fauna habitats: Two main fauna habitats were identified, the first was associated with the 300kV easement and the remainder associated with Coastal Plains Open Woodland (Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland).

    Easement habitat presented limited habitat features, however in places, regrowth (as in the case in DLALC land for the rail loop) provided a shrub layer noted as suitable for ground dwelling native mammal species, such as the bush rat and brown antechinus as well as providing an area of ecotone suitable for various macropods and insectivorous bats. Amphibian diversity was noted to be seasonally dependant on ephemeral drainage lines for species such as Leseurs Frog and Stripped Marsh Frog. The transmission line fauna habitats were regarded as generally disturbed and in poor condition.

Habitat associated with Coastal Plain Open Woodland was recorded as being in moderate to good condition and the most abundant throughout the assessed area. Vegetation was noted as providing both summer and winter food reserves for a number of birds and arboreal mammals throughout the year and medium to large sized hollows were recorded as well as trees with various stages of hollows suitable for microchiroptean bats. The Squirrel Glider was thought likely to use foraging and resources and breeding habitats in the denser areas of woodland in the central and eastern areas of the study area (not within the current study area).

- Species of animals: 52 vertebrates were recorded and consisted of four amphibian species, five species of reptile, 32 species of birds, seven species of native mammal and four introduced species. No threatened species were recorded.

Patterson Britton & Partners (2006) – Morisset to Warnervale Water Trunk Main & Morisset Water Pumping Station Review of Environmental Factors Issue No. 2 January 2006. Slightly less than a quarter of this assessment was undertaken on property owned by WACJV study area. The main trunk line alignment was at the western end of the Tooheys Rd study area and ran parallel to the F3 (**Figure 14**). An offshoot of the water main was on land west of the F3 on the property DP 719762 Lot 4 that is part of the Hue Hue Rd, ecological offset investigation area.

Vegetation communities:

- Eight main vegetation types were recorded within these study areas using data supplied by LHCCREMS and by Bell (2002). Vegetation communities, described in order of abundance, include:
    - Smooth-barked Apple – Scribbly Gum Forest with Native Forest (Map unit 1a – Tooheys Rd);
    - Spaced Trees With Pasture (Map unit 13 – Tooheys Rd);
    - Regenerating Shrubs (Map unit 12 – Tooheys Rd);
    - Spotted Gum Lowland Forest (Map unit 6b – Hue Hue Rd potential offset property);
    - Spotted Gum Ironbark Forest (Map unit 6a – Hue Hue Rd potential offset property);
    - Blackbutt Temperate Forest (Map unit 17 – Wallarah Creek Tooheys Rd);
    - Red Mahogany – Smoothbarked Apple Forest (Map unit 4 – tributary of Spring Creek – Tooheys Rd); and
    - Swamp Mahogany – Paperbark Forest (Map unit 2 – tributary of Spring Creek near 330kV easement).

  According to Patterson Britton & Partners (2006: 33) map units 2, 4 and 6b have 'affinities' to Endangered Ecological Communities. The location of these communities in the current study areas is depicted on **Figure 15**. It is noteworthy that the Parsons Brinckerhoff 2005 study did not record vegetation at the western end of the 330kV easement as an EEC, while Patterson, Britton & Partners (2006: 33) did.
- Species of plants: No species list was compiled for this assessment as the project aim was to allot vegetative composition to mapped vegetation units. Targeted

threatened species assessment recorded four flora species with legislative protection. These were *Tetratheca juncea*, *Angophora inopina*, *Melaleuca biconvexa* (all TSC Act, EPBC Act) and *Rutidosis heterogama* (TSC Act). None of these threatened species were recorded on land owned by Wyong Areas Joint Coal Venture, however previously recorded populations of *Tetratheca juncea* and *Angophora inopina* were noted on neighbouring properties to the north and south.

- Fauna habitats: This study notes that only a general investigation was conducted with the aims of identifying fauna assemblage, habitat qualities as well as local and important habitat in the assessed area such as large hollows. Similarly, no list of observed species or survey effort methods were presented in the report. It is assumed that the fauna component was largely based upon desktop review, local knowledge and limited observation. All further analysis of threatened fauna is based upon the number of species identified through desktop analysis and their habitat requirements based upon the mapped vegetation units.
- Species of animals: 22 vertebrates were identified though desktop analysis as occurring within 5 km of the subject study area, consisting of four species of amphibians, no reptiles, eight species of birds and ten species of native mammal (three marsupials and seven flying mammals).

A summary of available literature relevant to the current direct impact areas showed that vegetation mapping consistent with that used by LHCCREMS was required to contextualise existing data such that national, state, regional and local significance can be determined.

Several threatened species of flora (listed in TSC Act and EPBC Act) are known to occur in the currently assessed areas these include:

- *Tetratheca juncea* – recorded in the Tooheys Rd study area;
- *Angophora inopina* – recorded Tooheys Rd study area; and
- *Grevillea parviflora* spp *parviflora* – recorded in the Hue Hue Rd ecological offset investigation area;

Three EEC's have been previously identified within the Tooheys Rd study area with one additional EEC being recorded on the Hue Hue Rd ecological offset investigation area (**Figure 15**).

Several threatened species of fauna are known to occur in the currently assessed areas these include:

- Greater Broad-nosed Bat (*Scoteanax rueppellii*, TSC Act*)* – recorded in Hue Hue Rd ecological offset investigation area;
- Eastern Falsistrelle (*Falsistrellus tasmaniensis*, TSC Act) – recorded as having the potential to occur, later recorded by OzArk at Tooheys Rd study area;
- Little Bentwing Bat (*Miniopterus australis*, TSC Act) - recorded at Tooheys Rd study area;
- Large Footed Mytosis (*Mytosis adversus*, TSC Act) recorded at Tooheys Rd study area;

- Yellow-bellied Sheathtailed Bat (*Saccolaimus flaviventris,* TSC Act) – recorded in the Tooheys Rd and Hue Hue Rd study areas.
- Squirrel Glider (*Petaurus norfolcensis,* TSC Act) recorded in the Tooheys Rd study area;
- Yellow-bellied Glider (*Petaurus australis,* TSC Act) tentatively recorded in Hue Hue Rd ecological offset investigation area;
- Wallum Froglet (*Crinia tinnula,* TSC Act) recorded in the Tooheys Rd and Hue Hue Rd study areas; and
- Green-thighed Frog (*Litoria brevipalmata,* TSC Act) – recorded at Buttonderry.

4.2.3 Significant flora in the region.

A review undertaken in 2000 of significant flora within the region revealed there to be a high diversity of rare, endemic and restricted plant species (Bell 2000). Since that time, a number of plant taxa and populations have been added to the Schedules of the TSC Act. There are currently ten endangered and eighteen vulnerable plant species listed for the Hunter-Central Rivers CMA (DECCW Database).

The Hunter Rare Plants Group, a sub-committee of the Hunter Region Botanic Gardens, is in the process of compiling a database of significant plant species, populations and communities in the region (see www.huntergardens.org.au/ for more details). This database currently shows there to be 1278 significant plant taxa, populations or communities within the Hunter Valley and Central Coast, including 52 endemic entities. Those species not currently listed as endangered or vulnerable could potentially qualify for listing in the future.

For the Wyong local government area, a number of species-specific studies have been published. Payne (1991) reported on new locations of the vulnerable *Syzygium paniculatum* in the Wyong area, and described the habitat in these areas. Later, Payne (1997) examined the distribution and reproductive ecology of *Syzygium paniculatum* from the Gosford-Wyong region, comparing this species with the more common and widespread *Syzygium australe*.

The distribution and habitat requirements of the TSC and EPBC vulnerable *Tetratheca juncea* in the northern part of the Shire have also been examined by Payne (1993). In his conclusion, it was suggested that the occurrence of *Tetratheca juncea* can be predicted on the basis of topographical, soil, vegetation and distance-from-the-sea attributes. A conservation management plan incorporating these results was completed for the species across its range (Payne 2001). Since that time, significant new research has been published on the pollination ecology of the TSC and EPBC vulnerable *Tetratheca juncea* (Driscoll 2003) and sizeable new populations have been uncovered.

Bell (2004) surveyed and mapped the distribution of the TSC and EPBC vulnerable *Angophora inopina* in Wyong and Lake Macquarie LGA's and identified major habitat types for the species. Tierney (2004) also examined the pollination and germination requirements in this species, concluding that population structure is significant in determining the ability of the population to respond to recruitment clues.

Figure 14: Locality map of previous surveys on Wyong Areas Coal Joint Venture property. (Base map source: Parsons Brinckerhoff Pty Ltd 2005: Fig 2).

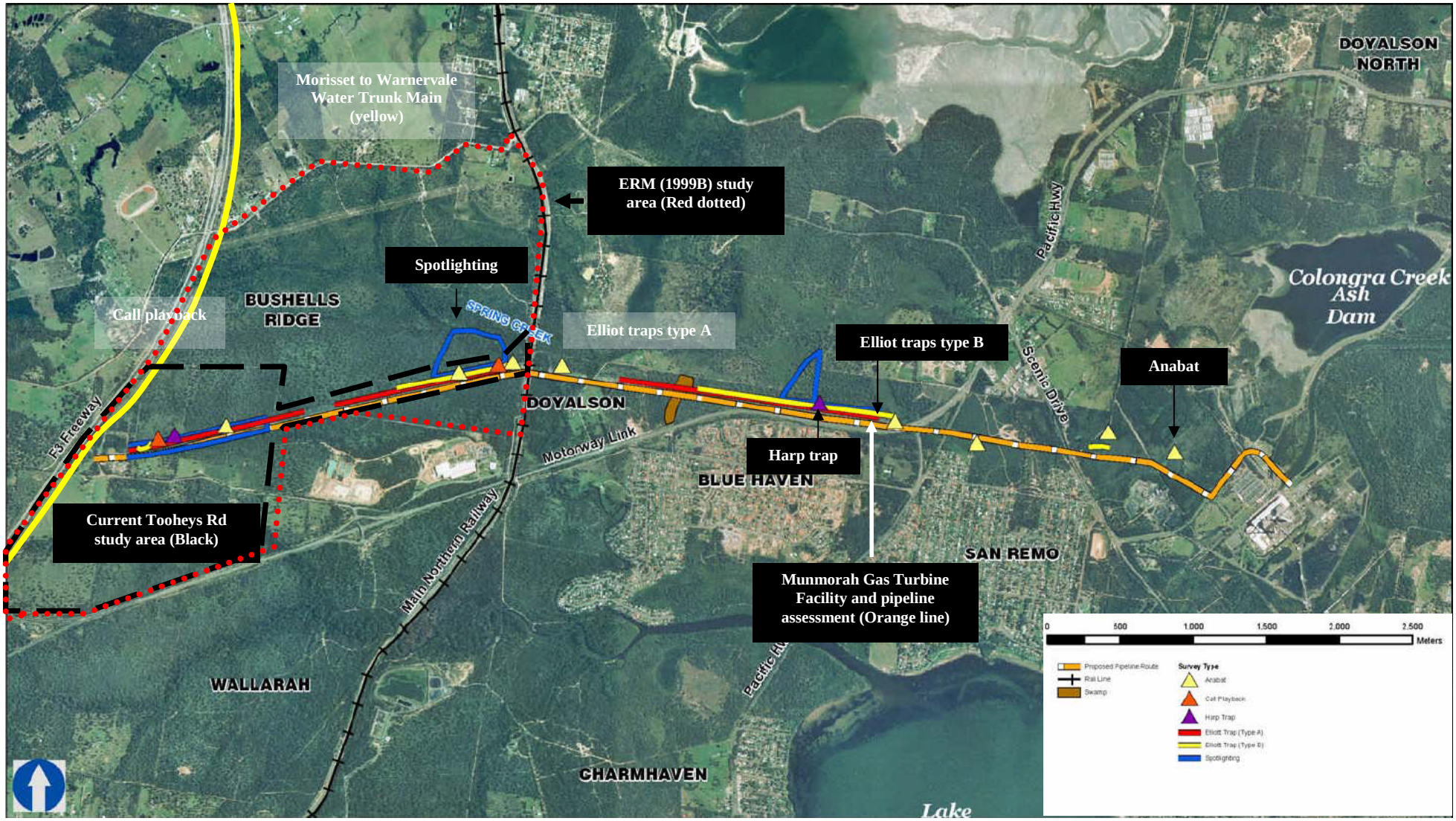
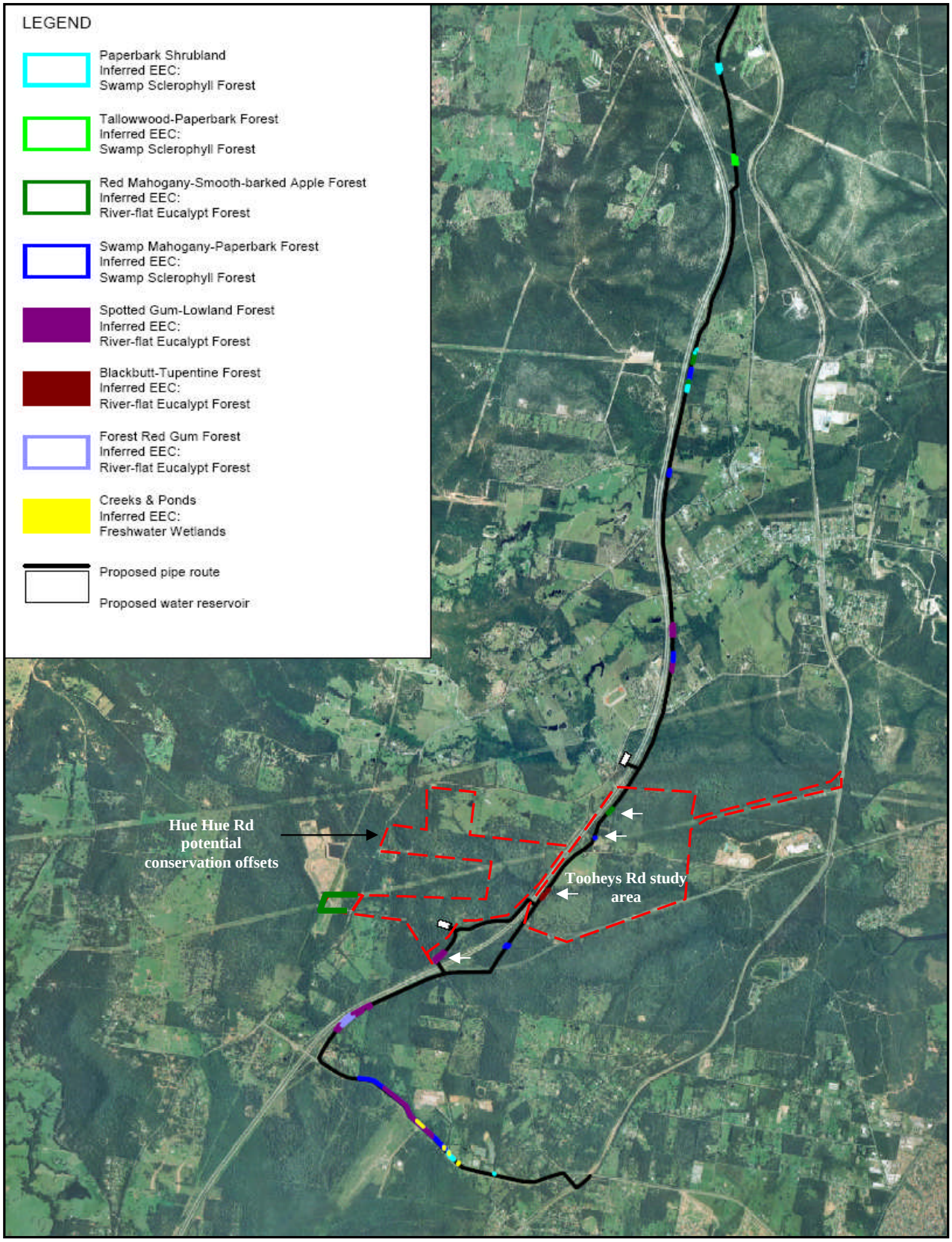


Figure 15: Locality map EEC's previously identified (white arrows) on WACJV property through literature review – (Source: Patterson Britton & Partners 2006: Fig 4.2.2).



Information on the distribution and habitat of the EPBC and TSC vulnerable *Melaleuca biconvexa* within Wyong Shire has been compiled by Duncan (2001). This study aimed to collate sufficient data to enable the development of a management strategy for the species, as well as providing a map of the species for Wyong LGA. One outcome of the study was the formulation of a conservation management strategy which identifies a number of locations for potential conservation reserves.

Three papers examine the habitat and population sizes of the TSC endangered *Hibbertia procumbens* (Bell 2002; Bell & Driscoll 2005) and the TSC and EPBC vulnerable *Cryptostylis hunteriana* from the Wyong area (Bell 2001). Information in these papers summarises the known habitat of both these species from throughout their known ranges and provides suggested conservation measures. Although currently unlisted, details on population size and habitat for the local, endemic and highly restricted *Thelymitra adorata* Jeanes ms is provided in Bell, Branwhite and Driscoll (2005).

Driscoll (2006) has collated all available information on the TSC and EPBC endangered *Acacia bynoeana* in the region, incorporating Wyong-specific studies detailed in Bell and Driscoll (2003). A review of regional records of the TSC vulnerable *Rutidosis heterogama* is contained in Bell and Driscoll (2004).

4.2.4 Significant fauna of the Wyong region

Although the Sydney Basin Bioregion has the highest human population of any NSW bioregion, significant areas of native vegetation remain unchanged since European occupation. Despite this, serious rates of decline of grassland, woodland and forest bird species, as well as ground-nesting birds and ground-feeding insectivorous birds, have occurred. Sightings of rainforest birds, which increased significantly across Australia, did not follow this trend in the Sydney Basin despite the presence of areas of relatively intact rainforest (Australian Terrestrial Biodiversity Assessment 2002).

Forest and woodland birds of the bioregion are thought to be somewhat protected in Hawkesbury sandstone communities contained within conservation reserves (Australian Terrestrial Biodiversity Assessment 2002). General threats to species in the bioregion include broad-scale vegetation clearing and loss of remnants as well as grazing by stock. Urbanisation is also a major threat to many species in built-up areas.

A search of the DECCW threatened species website area using a combined geographic and habitat search showed that there are 118 items of conservation concern in the Hunter / Central Rivers > Wyong CMA (search date 7 November 2009, Appendix 2). Of these, 76 are species of threatened or endangered animals (1 insect, 39 birds, 10 mammals {not including bats}, 12 bats, 6 reptiles and 8 species of frog). A search of the BioNet database focussed on the LGA showed that nearly all these species listed by DECCW as having the potential to occur in the CMA region have been previously recorded in the LGA.

The Department of Primary Industries - NSW Fisheries on line database lists 10 endangered species in NSW (9 fish and 1 dragonfly), 2 endangered populations, 3 EEC's, 1 presumed extinct species and 8 vulnerable species (1 dragonfly, 1 shrimp, 4 fish, 1 shark and 1 species of algae – Appendix 2).

The DEWHA online database (protected matters report) shows that there are 46 threatened species and 31 migratory species in the Wyong LGA (Appendix 2). Of the threatened species 33 are animals (13 birds, 5 frogs, 7 mammals, 2 fish, 3 reptiles and 3 sharks, Appendix 2). A significant overlap of protected species occurs between the DEWHA and DECCW databases and where differences occur (i.e. DEWHA protected species not appearing on the DECCW database) it is with regard to marine species.

The Lake Macquarie City Council has produced guidelines for flora and fauna survey within the LGA. Appendix 3 of this document lists regionally significant species. Any species identified as 'regionally significant' in this document, that were recorded within current the study areas, have been appropriately identified.

4.2.5 Significant wetlands in the bioregion, region and local area

4.2.5a Bioregion

The Directory of Important Wetlands (DEWHA 2001 – a DEWHA online search tool) lists 43 wetlands totalling c. 93,745 ha (**Appendix 2**) occurring in the Sydney Basin Bioregion. None of the wetland areas identified in the abovementioned searches occur in or close to the current study areas.

Nine wetlands in the Sydney Basin Bioregion are regarded as being bioregionally significant. The bioregion is densely populated and pressures from recreational activities (horse riding, jet skis, boats, fishing, erosion from the wash from speedboats, from walking and access tracks), can threaten the biodiversity of the wetlands. Feral animals and exotic weeds, changed fire regimes, sedimentation, salinity, weir construction and some mining activities can also impact local biodiversity. Disturbances and threats to wetlands include impacts from urban, agricultural and industrial development. All of these activities have the potential to decrease water quality from runoff. Rubbish tips, as well as increased stormwater and pollution from sewage treatment works also play a role in water quality.

Of the 43 wetlands listed above, the Australian Terrestrial Biodiversity Assessment (2002) recognised nine bioregionally significant wetlands:

- Swan Lake provides breeding habitat for prawns and fish and is a key feeding and roosting area for waterfowl. The lake also supports an extensive area of seagrass.
- Lake Conjola provides nesting habitat for a number of threatened shorebirds. The lake also supports a significant area of seagrass.
- Lake Liddell supported over 3,000 waterbirds in 1995. The TSC vulnerable Freckled Duck (*Stictonetta naevosa*) and the TSC and EPBC endangered Green and Golden Bell Frog (*Litoria aurea*) have both been recorded at the lake.
- North Avoca Swamp is bioregionally significant as it provides key habitat for the TSC and EPBC endangered Green and Golden Bell Frog.
- Narrabeen Lagoon and Deep Creek support the TSC vulnerable black bittern (*Ixobrychus flavicollis*), Australasian Bittern (*Botaurus poiciloptilus*), Osprey (*Pandion haliaetus*) and Glossy Black Cockatoo (*Calyptorhynchus lathami*).
- Bakers Lagoon supports a range of TSC vulnerable species such as the Freckled Duck (*Stictonetta naevosa*), Australasian Bittern (*Botaurus poiciloptilus*), Blacktailed Godwit (*Limosa*

limosa) and Black Bittern (*Ixobrychus flavicollis*). Sightings of a Star Finch (*Neochmia ruficauda*), a species that is classified as extinct under the TSC Act, as well as the endangered Black-necked Stork (*Ephippiorhynchus asiaticus*) have occurred at the Lagoon.

- The wetlands of the Cecil Hoskins Nature Reserve are described as being in fair condition, although feral animals, exotic weeds, changed hydrology, and pollution due to runoff from agricultural lands threatens their status.
- Brundee Swamp provides key habitat for the TSC vulnerable Australasian Bittern.

4.2.5b Region

The DEWHA online database (protected matters report) shows that there is one Ramsar[3] wetland in the LGA (**Appendix 2**). The Hunter Estuary Wetlands comprises Kooragang Nature Reserve (designated to the Ramsar list in 1984) and Shortland Wetlands. Kooragang Nature Reserve is located in the estuary of the Hunter River, approximately 7 km north of Newcastle. Shortland Wetlands are located in the Ironbark Creek Catchment in the suburb of Shortland, 12 km northwest of Newcastle and 2.5 km from Kooragang Nature Reserve.

4.2.5c Local area

A search of the Wyong Shire Development Control Plan No 30 2003 (WSDCP No 30) was undertaken to identify SEPP 14 wetlands. One wetland area is identified as 7(g) zoning, a development control plan area, within the WSDCP No 30. In relation to the current assessment, this area can be identified on **Figure 21** as vegetation, Narrabeen Alluvial Drainage Line Complex #d and Narrabeen Alluvial Drainage Line Complex #e (an EEC) occurring within the Tooheys Rd study area, on DP 755245 Lots 102 and 103, immediately south and paralleling the TransGrid 300kV easement.

Although not directly within the assessed areas, the Porters Creek Wetlands occurs within one kilometre of the Buttonderry and the Hue Hue Rd potential offset properties (WSDCP No 30: 22). Porters Creek Wetland is listed as a specific example in the determination for the Sydney Freshwater Wetlands Endangered Ecological Community. This Wetland occurs downstream within the catchment of the W2CP's Buttonderry surface facility (as well as the Warrenvale Business Park of the WEZ) and supports a range of wetland and swamp forest vegetation communities. A management plan has been prepared for the wetland (Andrews-Neil 1995).

According to NSW Legislative Council Hansard (1996), Porters Creek Wetland acts as the natural flood storage area for Porters Creek and Wyong River and is the most significant coastal wetland in Wyong Shire, while the National Parks and Wildlife Service (NPWS) has referred to it as the most significant wetland between Newcastle and the Hawkesbury. The Warnervale Business Park study area forms part of a larger land holding which includes the majority of Porters Creek Wetland and Warnervale Airport. The wetland is largely undisturbed and contains endangered plant species, rare and endangered fauna and a high level of biodiversity. 19 endangered species - rare marsupials,

[3] Under the EPBC Act, a Ramsar wetland is either:

- an Australian wetland on the List of Wetlands of International Importance kept under the Ramsar Convention; or
- a wetland declared to be a Ramsar wetland by the Commonwealth Environment Minister.

Ramsar is the name of the place in Iran where the treaty was first signed in 1971.

wading birds, frogs and significant local plants were identified in the EIS as known or likely to occur within the area. The wetland is also significant in the filtration and flood mitigation of Tuggerah Lakes. It provides a much-needed drought refuge for wildlife and is an important study area along the migratory route of birds and bats.

According to the Dooralong 9131-1S 1:25K topographical map sheet, Buttonderry Creek is not continuous, but ultimately flows into this wetland. However, the direct impacts associated with the surface facilities will not affect the wetland.

4.2.6 Bioregional, regional and local scale conservation

4.2.6a Bioregion

The Australian Terrestrial Biodiversity Assessment (2002) states that the Sydney Basin Bioregion has the third highest area of conservation oriented tenures of the NSW bioregions, occupying about 1,384,418.33 ha or 38.20% of the bioregion. A synthesis of this land is presented below:

- National parks and nature reserves occupying a total area of 1,280,935.95 ha, or about 35.35% of the bioregion.
- Included in the above figure are 6 wilderness areas occupying about 559,624.92 ha or 15.44% of the bioregion.
- The Greater Blue Mountains NP (1.03 million ha or almost 28.42% of the bioregion) has been included on the World Heritage list and is only 1 of 3 world heritage areas in NSW.
- Reserves under the Crown Lands Act 1989, managed by DECCW (under the NPW Act 1974) for biodiversity conservation, contributes 1,196.23 ha to the area.
- Other lands managed under the NPW Act 1974 include: land managed as Aboriginal areas (84.80 ha), historic study areas (128.34 ha), regional parks (4,675.39 ha) and land managed as state recreation areas (81,904.26 ha).
- Nine flora reserves under the provisions of the Forestry Act 1916 occupying about 1,163.47 ha or 0.03% of the bioregion and land managed for forestry activities occupy about 178,066.51 ha or 4.91% of the bioregion.
- Three State Environmental Planning Policies operate in the Sydney Basin Bioregion: SEPP 14 (Coastal Wetlands) 13,400.29 ha or 0.37%, SEPP 26 (Littoral Rainforests) 61.82 ha or 0.002% of the bioregion and SEPP 58 (Protecting Sydney's Water Supply) 570,111.54 ha or 15.73% of the bioregion.

4.2.6b Region

The Wyong Shire Council strategic planning department commissioned the Wyong Conservation Strategy (WCS). The strategy report was submitted as a draft in 2003 but was never ratified by Council. This draft document is the best source of information to contextualise regional conservation values and as such should be viewed directly. Table 5.5 (Draft WCS 2003:73) of this report ranks conservation status of fauna habitats associated with land zoning in the 1991 LEP whilst table 5.6 (Draft WCS: 74) expands on land zonings identified as 'high conservation ranking' relative to recommended conservation targets based upon existing vegetation cover.

4.2.6c Local area

There are no local conservation reserves in the immediate vicinity of the study areas. The western shaft study area is the only exception to the rule as it is part of a managed state forest and as such offers a degree of protection to the fauna and flora that occur within it.

4.2.6d Regional conservation reserves

The Department of Environment & Climate Change (DECCW) manages a large number of conservation reserves in the Hunter-Central Rivers CMA, however only five, totalling 14,927 ha are within the Wyong LGA (**Table 3**):

Table 3: Regional conservation reserves

Reserve	LGA	Major Geology	Size Ha
Bird Island NR	Wyong	Triassic	7
Munmorah SCA	Wyong	Quaternary/ Triassic	1,463
Jilliby SCA	Wyong / Lake Macquarie	Triassic	12,140
Wyrrabalong NP	Wyong / Gosford	Quaternary	621
Lake Macquarie SCA	Wyong / Lake Macquarie	Permian	696
Total			***14,927***

4.3 Survey Methods

4.3.1 Flora

This component of the assessment was undertaken and written by S.Bell of Eastcoast Flora Survey on behalf of OzArk.

4.3.1a Terrestrial orchid survey

- *Rationale*

Survey for threatened terrestrial orchid species is highly reliant on accessibility to fertile flowering material to enable confident identifications. In some species (e.g.: the leafless saprophyte *Cryptostylis hunteriana*) plants are not visible at any other time of the year, and indeed one species (the underground Orchid, *Rhizanthella slateri*) undergoes its entire life cycle within the leaf litter and upper layers of soil (Bishop 1996). As a consequence, it is imperative that any survey for terrestrial orchid species is undertaken during the relevant flowering periods. For the orchids targeted during this survey, flowering seasons range throughout the year except for March and April (**Table 4**):

Table 4: Documented flowering periods for targeted terrestrial orchid species.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thelymitra atronitida												
Arachnorchis tessellata												
Cryptostylis hunteriana												
Genoplesium insignis												
Diuris praecox												
Microtis sp. aff.											?	?

angusii												
Caladenia sp. aff. catenata												

The surveys for terrestrial orchid species commenced in late September 2006, following commissioning of the project, and continued until February 2008. Due to the time differences between submission of the draft report and finalisation of the project as well as the recent listing of *Thelymitra sp. adorata* as an endangered species in NSW, the results of the full orchid assessment have been provided as **Appendix 7** of this report.

- *Survey method*

Within the primary impact areas, targeted meander transects were walked at a slow pace, in habitat known to support threatened orchid species elsewhere. Co-ordinates of all orchid species detected (including common species) were recorded using a handheld Garmin© GPS and then later transferred to Mapinfo© GIS. Meander paths were downloaded from the GPS directly into the GIS to map meander transects. Meanders were not restricted to areas currently under natural vegetation, but included powerline easements and previously underscrubbed areas where direct impacts from development were likely.

Orchid species encountered in the field were identified primarily from previous field experience of the authors, assisted by Bishop (1996) and unpublished reference material on other significant orchids provided by local orchid enthusiasts, or as contained in Gunninah Environmental Consultants (2003). Where necessary, specimens were collected in the field for closer examination under a microscope, as well as the use of additional orchid texts to confirm identification. Botanical nomenclature follows Harden (1990a-1993; 2002), Harden and Murray (2000), and other recent taxonomic updates generally accepted by the National Herbarium of New South Wales. The scientific papers of Jones (1996; 2001) and Jones *et al*. (2001; 2002), together with Riley and Banks (2002), were used to aid identification for some species.

In addition, opportunistic survey of orchid species was undertaken while surveying and mapping the remaining vegetation in the study area. This generally involved extensive field traverses across the study area to ground truth the vegetation map, as well as the completion of standard 0.04ha floristic survey plots. Several orchid specimens were recorded during the quadrat sampling phase, which occurred sporadically throughout the full study period.

4.3.1b Vegetation survey & mapping

- *Rationale*

The methodology adopted for use in describing and mapping the vegetation of the study area recognised the amount of existing vegetation data in the local area and the region, and the techniques used to collect such data. The Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) incorporated standard NPWS survey techniques, which itself allowed use of a considerable body of data to be incorporated into regional analysis. The Shire-wide survey of vegetation also used identical methods (Bell 2002a), as do the Wyong Shire Flora and Fauna Survey Guidelines. Consequently, it followed that any new investigation would benefit from using the same techniques, so that comparisons with existing datasets could be made with ease.

- *Mapping*

Prior to mapping vegetation communities, the collection of Rapid Data Points (RDPs) was undertaken across the full study area to ensure that an accurate final map could be produced. The collection of RDPs is a new method of vegetation mapping being developed by Bell & Driscoll (in prog.) for accurate spatial depiction of vegetation biodiversity. Central to this method is the recognition that variability in vegetation distribution cannot yet be predicted using computer GIS programs, and that simply documenting what actually occurs on the ground is the simplest yet most important fact to be reflected in a final map. Many recent mapping programs have relied heavily on GIS capabilities to predict where certain vegetation communities occur, with disappointing results.

RDPs are essentially summaries of floristic information recorded at specific points in the field. At specific and regular locations waypoints are taken on a GPS, and summaries of the vegetation are recorded. Information recorded includes:

- Canopy layer dominant species;
- Shrub layer dominant species;
- Ground layer dominant species;
- Draft vegetation unit; and
- Miscellaneous notes.

Initially, all trafficable paths across the study areas are driven in 4WD vehicle recording RDPs. Those areas lacking extensive trail networks are then walked on foot with hand-held GPS units, recording the same information which is later added to the main database. In this way, a large dataset of summary information can be rapidly collected to use in modelling and vegetation mapping procedures. This mapping technique has been recently used with much success in the Watagans National Park and Jilliby State Conservation Area (Bell & Driscoll 2006) and on the Tomago Sandbeds (Bell & Driscoll 2006b).

- *Floristic survey*

Standard floristic survey quadrats (0.04ha, or 20 x 20m) were located in areas displaying characteristic traits of observed vegetation communities, or in areas considered unusual (both floristically and due to micro-habitat). At each quadrat, all vascular plant species were recorded and attributed an index of abundance using a modified Braun-Blanquet cover abundance scale (Poore 1977). Other characteristics of the site were also recorded, such as soil type and depth, fire history, aspect, slope, structural details of each layer, etc.

- *Data analysis*

Quadrat data was entered into a licensed copy of the DECCW vegetation survey database, running on a Microsoft Access© platform. Analysis of data was undertaken using the PATN statistical package (Belbin 1995a; 1995b), to assist in understanding the trends present in the vegetation. Data was subjected to a taxonomic review prior to analysis and weed species were ignored. Both the Kulzcynski and Bray-Curtis association measures were tested and other default PATN settings were employed. An unweighted pair-group arithmetic averaging clustering strategy (UPGMA) was applied to the data matrix to derive a hierarchical classification and the default beta value of –0.1

was used. Dissimilarity between individual sites and groups of sites were illustrated through the generation of dendrograms. Comparisons of delineated vegetation communities were made with the classification of Bell (2002a), so that consistency of community definitions could be achieved. The naming of communities also adopted those present in that work. Community relationships to the regional classification of LHCCREMS were also made.

4.3.1c Threatened flora species (non-orchid) survey

- *Rationale*

Any study site subject to a high level of investigation will undoubtedly be considered well sampled for threatened species. As targeted orchid surveys were not a feature of previous assessments repeated visits to the current study areas that have potential for orchid species to occur over varying seasons was adopted as the best method to detect rare or threatened species.

- *Survey method*

Targeted threatened (non-orchid) plant species survey was incorporated within each of the terrestrial orchid survey periods, and the general quadrat / map production surveys. Both of those survey programs included extensive periods of targeted meander searching across the primary impact areas, evidently suitable to detecting threatened species. Intensive survey for threatened plant species was not undertaken in the proposed conservation offset / ecological offset investigation areas, although any plants observed during the mapping phase were recorded. Emphasis was placed on those threatened species considered to potentially occur in the study area (due to existing nearby records or suitable habitat). These included (excluding orchids): *Acacia bynoeana, Angophora inopina, Callistemon linearifolius, Eucalyptus camfieldii* (Wyong variant – see Hill 2003), *Grevillea parviflora* subsp. *parviflora, Melaleuca biconvexa,* and *Tetratheca juncea.* In view of the determination of *Eucalyptus parramattensis* subsp. *parramattensis* as an Endangered Population in Wyong Shire, any redgum eucalypts located were also examined.

- *Mapping*

Where recorded, locality co-ordinates were collected for all threatened species, using a Garmin© GPS, and transferred to Mapinfo© GIS for the construction of maps. All co-ordinates were in Geodetic Datum of Australia (GDA94), zone 56 (GDA94, z56).

4.3.1d Survey for Endangered Ecological Communities

- *Rationale*

As part of general flora surveys, areas of the site were examined in the light of the following Endangered Ecological Communities which are present within the forests landscapes of Wyong LGA:

- Swamp Sclerophyll Forest on Coastal Floodplains NSW North Coast, Sydney Basin and South-East Corner bioregions (SSFCF);
- Sydney Freshwater Wetlands (SFW);

- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (FWCF);
- River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (RFEFCF);
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-East Corner bioregions (SOFF); and
- Low Woodland with Heath on indurated sands at Norah Head (LWHISNH).

During late 2009, it became apparent that the Lower Hunter Spotted Gum- Ironbark Forest (LHSGIF) EEC may also be present in the locality, based on ongoing regional research. A separate study was undertaken to address this possibility, and is included as Appendix 9.

- *Survey method*

Assessment of the presence of any EEC was based on general reconnaissance of the study area, together with examination of detailed floristic plot survey as detailed above. Comparisons of delineated vegetation communities were made against species lists and descriptions provided in the relevant Final Determinations.

- *Mapping*

Where located, vegetation considered equivalent to any listed EEC was mapped as part of the general vegetation mapping.

4.3.2 Fauna

Fauna surveys included general habitat searches and targeted surveys for threatened species.

A large body of previous literature focussed on the immediate environs of the current study areas was drawn upon, enabling tailored searches for species identified as likely to occur, based upon the habitat present, but not previously recorded.

Specific focus was also given to re-confirming populations of those threatened species previously identified in the various study areas (Squirrel Glider, Large-footed Mytosis, Little Bentwing Bat and Wallum Froglet) and subsequently undertaking targeted searches for these species in similar habitats in other locations.

The condition of habitats was identified through field observation and for project consistency through assessment and mapping undertaken by the project botanist[4]. The vegetation map codes provided in this report have a direct relationship to the characteristics of the vegetation present and are not difficult to interoperate. For example:

- Map unit code 43 (Alluvial Riparian Blackbutt Forest) is remnant, has a low or nil degree of prior anthropomorphic disturbance and possesses a full range of structural layers and habitat components such as old-growth trees, fallen timber, feeding and roosting resources. The

[4] Stephen Bell of Eastcoast Flora Survey.

description of vegetation associated within this unit not only indicates the diversity of flora present and the current degree of weed invasion, it also highlights to the ecologist the vegetation's potential to support species of fauna able to exploit those resources.

- Map unit code 43Xr (Alluvial Riparian Blackbutt Forest – canopy only) has some fauna habitat components missing (understorey layers and fallen timber). The remaining vegetation is usually intact but may be degraded. It still has the potential to possess suitable hollows for a range of species however, the diversity of species able to utilise linkages to other remnant habitats through these areas is often reduced. Similarly, the description of vegetation associated within this unit highlights its potential to support species of fauna able to exploit those resources and the degree of weed invasion.

- Map unit code 43Xs (Alluvial Riparian Blackbutt Forest – regrowth) has lost many of the key fauna elements such as old-growth trees. These areas have often undergone a high level of anthropomorphic disturbance such as land clearing or timber harvesting with little fallen timber remaining and tree canopies highly fragmented. Often habitat linkages with other remnant patches have been severely compromised for disturbance sensitive species (usually threatened species), however, those species with the ability to be primary colonisers will often flourish in these landscapes. Again, the species list of flora will indicate what fauna has the potential to utilise the resources present and the degree of weeds invasion.

Generally the mapped units also indicate linkages / degree of connectivity to other vegetation units.

4.3.2a Targeted surveys

Targeted surveys were used to supplement the habitat based assessments. Also utilised are the results of previous fauna assessments undertaken by ERM (1999b) and Parsons Brinckerhoff (2005), which have been contextualised to the current project nomenclature and study areas, while still noting the results as respective[5]. To this end it is important to note that ERM undertook survey in March 1998 (four nights), November 1998 (four nights) and February 1999 (four nights) within areas that remain the focus of the current assessment (**Figure 2**), excluding the Western shaft study area. Parsons Brinckerhoff only undertook assessment over land north of Tooheys Rd in March 2005, also over four nights (**Figure 14**). OzArk undertook survey within the Tooheys Rd study area between the 26th of September to the 1st of October 2006 (five nights) and at Buttonderry between the 14th to 16th (two nights) November 2006. OzArk has been unable to obtain a copy of ERM's 2003 surveys and as such cannot comment on this document other than noting that certain threatened species were recorded in particular properties without further context.

- *Call playback surveys*

Call playback was used by all assessment teams within their respective study areas and followed the methods described by Kavanagh and Peake (1993) and Debus (1995). This method requires an initial listening period of 10 to 15 minutes after playing the respective call, followed by a spotlight search for ten minutes to detect any animals in the immediate vicinity, followed by intermittently

[5] As previously noted the recent assessment by Patterson Britton & Partners (2006) for the Morisset to Warnervale Water Trunk Main only appeared to have a desk top review of fauna issues. Therefore, there are no field based results that can be utilised for the current assessment.

playing the call for another five minutes and a ten minute listening period. A general search of the immediate environs was then undertaken to see if any non-vocalising birds were present.

It is unclear as to the precise locations at which ERM (1999b) undertook call playback however, it is known that it occurred on existing roads and tracks in the Tooheys Rd, Buttonderry and Hue Hue Rd potential conservation offset properties in March and November 1998 and February 1999.

Parsons Brinckerhoff (2005) also undertook call playback (same species targeted by OzArk see below) in two locations for the Munmorah gas turbine assessment (**Figure 14**). Both of these were within the Tooheys Rd proposed rail loop impact footprint, more specifically, at the most western end of the TransGrid easement and the most eastern extent of the easement near the Spring Creek / Great Northern Rail Line intersection. Vegetation units in the immediate vicinity of the calls are presented in **Table 5**.

OzArk played calls from the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Sooty Owl (*Tyto tenebricosa*), Yellow-bellied Glider (*Petaurus australis*) and Squirrel Glider (*Petaurus norfolcensis*).

Calls at the Tooheys Rd study area were played at the proposed location for the bulk of the surface infrastructure south of Wallarah Creek (immediately adjoining an area with a large patch of native vegetation), in the location where ERM (1999b) previously recorded Squirrel Glider and on DLALC land on a hill within a large patch of remnant woodland (**Figure 40**). Vegetation units in the immediate vicinity of the calls are presented on **Table 5.** Playback at Buttonderry focussed on the main infrastructure location and within open land bordering large patches of remnant good quality woodland.

Call playback was not undertaken at the Western shaft study area or the Hue Hue Rd ecological offset investigation area. The Western shaft study area proposed impact footprint is small (150 x 80 m), there is a lack of key habitat elements such as hollows and there is a very large extent of interconnecting woodland. Call playback was not undertaken within the Hue Hue Rd ecological offset investigation area due to time constraints however, the high quality and quantity of habitat available suggests that several species of threatened microbats, Powerful Owl and Squirrel Gliders are likely to occur.

Table 5: Vegetation map units in the immediate vicinity of call playbacks.

Study	Location	Vegetation unit
ERM (1999b)	Unspecific – tracks and trails in the Tooheys Rd, Buttonderry and Hue Hue Rd ecological offset investigation area	Report does not have a transect map – however we can assume that vegetation units surveyed would be similar to OzArk
Parsons Brinckerhoff (2005)	Proposed rail loop north of Tooheys Rd.	26b, 26d, 28, 31, 32.
OzArk (1996)	Tooheys Rd	20a, 26d, 26e, 28, 31, 31a, 31c, 31Xr, 43 and 43Xr.
OzArk (1996)	Buttonderry	20a, 26d, 35, 26dXr, 30

- *Elliot trapping*

Elliot trapping either followed the DPI D-G's Policy of *Cage Trapping and the Animal Research Review Panel's Animals Care Guidelines for Wildlife Surveys* or in the case of ERM (1999 pre these guidelines) their basic intent. Small ground dwelling animals were targeted using Type A Elliot traps positioned in suitable areas (near the bases of trees in areas with understory and dead

wood). Type B Elliot traps (Tree-mounted) were placed on wooden platforms c. two to three meters above ground level on large trees. All traps were baited with a basic mixture of peanut butter and rolled oats with tree traps having a honey mixture applied.

Type A Elliot traps

ERM (1999b) laid a total of 190 Type A traps. These included 90 along five transects in March 1998, 50 along four transects in November 1998 and 50 along five transects in February 1999 in the Tooheys Rd, Buttonderry and Hue Hue Rd ecological offset investigation area. Forest, woodland, grassland and wetland areas were sampled at the Tooheys Rd and Buttonderry sites over a four night period. Unfortunately a map of the transect locations was not included in this report.

Parsons Brinckerhoff (2005) laid a total of 75 Type A Elliot traps during their assessment with two of the three transect lines being located within the Tooheys Rd study area. Ground traps were placed 10 m apart and 50 traps were open for four nights with the remaining 25 traps open for three nights. The location of transects used is shown on **Figure 14**. Vegetation units the traps were laid in are presented in **Table 6**.

OzArk laid a total of 50 Type A Elliot traps along three transects for four nights in the Tooheys Rd study area (**Figure 16**). Transects were located within direct impact areas possessing intact vegetation i.e. near Spring Creek where the proposed rail loop joins the main northern rail line, along Wallarah Creek and in the impact footprint for the proposed rail loop north of Tooheys Rd. Vegetation units the traps were laid in are presented in **Table 6**.

Type A Elliot traps were not laid in the Buttonderry study area as inclement weather was predicted during the respective time in the field, however, desk top review of ERM's results showed that previous trapping at the location had yielded no results. Notwithstanding, other less invasive methods were employed that targeted ground dwelling mammal species. Similarly, the Western shaft study area was not assessed using Type A Elliot traps due to the small scale of the disturbance footprint within a larger extent of interconnecting woodland.

Table 6: Vegetation map units sampled using type A Elliot traps.

Study	Location	Vegetation unit
ERM (1999b)	Unspecific – tracks and trails in the Tooheys Rd, Buttonderry and Hue Hue Rd ecological offset investigation area.	Report does not have a transect map – however we can assume that it would be similar to OzArk
Parsons Brinckerhoff (2005)	Proposed rail loop north of Tooheys Rd.	20f, 26b, 26d, 26dXr, 26e, 31, 31a, 31d, 31Xs, 32, 35 and 43Xs.
OzArk (1996)	Tooheys Rd	26d, 31, 31c, 43 and 43Xr.

Type B Elliot traps (targeting Squirrel Glider)

ERM (1999b) laid a total of 71 Type B traps. These included 19 along four transects in March 1998, 32 along four transects in November 1998 and 20 along five transects in February 1999. Tree traps were set on larger trees within suitable habitat over four night periods in 1998 and a five night period in 1998.

Parsons Brinckerhoff (2005) laid a total of 25 Type B Elliot traps with approximately half of these being laid within the Tooheys Rd study area in vegetation suitable to support Squirrel Gliders bordering the TransGrid easement. Traps were placed c. 30 m apart and ten traps were open for four

nights with the remaining 15 traps open for three nights. The location of transects used is shown on **Figure 14**. Vegetation map units sampled included Narrabeen Alluvial Drainage Line Complex, Narrabeen Alluvial Drainage Line Complex #d, Narrabeen Snappy Gum Forest, Narrabeen Doyalson Scribbly Gum Woodland and Narrabeen Doyalson Scribbly Gum Woodland a.

OzArk did not lay Type B Elliot traps. Survey results from the two above assessments showed that the species is present along Wallarah Creek and the recent trapping effort in December 2005 (by Parsons Brinckerhoff) showed that the species was not present and unlikely to occur in the proposed rail loop impact footprint north of Tooheys Rd with a higher probability of it occurring to the east, in more favourable habitat. Other less invasive survey techniques were employed to assist in the detection of this species.

- *Hair funnel trapping*

ERM (1999b) laid hair funnels baited with rolled oats, peanut butter and vanilla essence in March and November 1998 and February 1999 within the Tooheys Rd, Hue Hue Rd ecological offset investigation area and Buttonderry study areas. Transects were within areas possessing the greatest variety of vegetation communities with each line of 20 funnels being placed at 10 m intervals. 60 funnels were laid in March 1998 over 14 nights along three transects, 100 in November 1998 over 21 nights along five transects and 100 laid along five transects over 35 nights in February 1999. Unfortunately a map of the transect location was not included in this report.

Parsons Brinckerhoff (2005) did not undertake hair funnel trapping.

OzArk laid 50 hair funnel wafers (Faunatech Pty Ltd) spaced 20 m apart and baited with rolled oats and peanut butter, along three transects for four nights in the Tooheys Rd study area (**Figure 16**). Transects were located within direct impact areas possessing intact vegetation i.e. Narrabeen Doyalson Scribbly Gum Woodland #c, Narrabeen Snappy Gum Forest and Narrabeen Doyalson Scribbly Gum Woodland #d near Spring Creek where the proposed rail loop joins the Main Northern Rail Line, vegetation map units Narrabeen Alluvial Drainage Line Complex #d, Narrabeen Doyalson Scribbly Gum Woodland, Narrabeen Doyalson Scribbly Gum Woodland a along Wallarah Creek and Narrabeen Alluvial Drainage Line Complex #d and Narrabeen Alluvial Drainage Line Complex #e in the impact footprint for the proposed rail loop north of Tooheys Rd.

Within the Buttonderry study area 40 hair funnels baited with rolled oats and peanut butter were laid 20 m apart in the direct impact area in Narrabeen Dooralong Spotted Gum - Ironbark Forest Xr and Narrabeen Dooralong Spotted Gum - Ironbark Forest in a potential conservation offset area with Narrabeen Buttonderry Footslopes Forest, Narrabeen Buttonderry Footslopes Forest Xs and Narrabeen Alluvial Drainage Line Complex #d (**Figure 18**). Hair funnels at this location were left for two nights.

All wafers were professionally analysed by Robyn Carter (formerly an assistant to Barbra Triggs).

- *Spotlighting*

Spotlighting targeted ground dwelling and arboreal mammals, amphibians and nocturnal birds.

ERM (1999b) spotlighted along in March and November 1998 and February of 1999 within the Tooheys Rd, Hue Hue Rd ecological offset investigation area and Buttonderry study areas for a few hours every night, by vehicle, during these week long surveys.

Parsons Brinckerhoff (2005) spotlighted for three consecutive nights at each of the three transect locations. Two of the three PB transects are within the proposed rail loop north of Tooheys Rd (**Figure 14**), the first near Spring Creek and the remainder within the TransGrid easement at the western end of the Tooheys Rd study area. All transects were surveyed on foot using two handheld 100 watt spotlights with dimmer switches. Vegetation map units sampled during spotlighting can be seen on **Table 7**.

OzArk undertook spotlighting on the Tooheys Rd study area for five consecutive nights at Tooheys Rd and for two consecutive nights at Buttonderry. Areas known to be impacted by the proposal were targeted however, several attempts were made to identify potential populations of Squirrel Gliders and Wallum Froglets based upon previous sighting records and existing habitat values. A handheld 100 watt spotlight was used to target one discrete habitat for a particular species (Pygmy Possum, Glider or Froglet) by foot then observing the general surroundings whilst driving slowly to other selected areas for targeted assessments. Surveys were undertaken primarily in the early to late evenings however, one prolonged predawn survey was undertaken at the Tooheys Rd study area. **Figure 14** shows the major tracks and trails throughout the study areas where the spotlighting survey effort was concentrated, when working outside of the direct impact footprints.

Spotlighting was not undertaken in the Hue Hue Rd ecological offset investigation area or the Western shaft study area. As with other types of assessment already noted the Western shaft study area does not possess key habitat elements suitable for those threatened species known to occur in the LGA and the scale of the impact is small. The Hue Hue Rd ecological offset investigation area does possess key habitat elements for threatened species and they are very likely to occur. As this area is not proposed for impact and the goal of assessment in this area was to identify broad conservation values.

Table 7: Vegetation map units sampled during spotlight assessments.

Study	Location	Vegetation unit
ERM (1999b)	Unspecific – tracks and trails in the Tooheys Rd, Buttonderry and Hue Hue Rd ecological offset investigation area.	Report does not have a transect map – however we can assume assessments would have occurred in the same vegetation units assessed by OzArk.
Parsons Brinckerhoff (2005)	Proposed rail loop north of Tooheys Rd.	20f, 26b, 26d, 26dXr, 26e, 31, 31a, 31d, 31Xs, 32, 35 and 43Xs.
OzArk (1996)	Tooheys Rd	20a, 20f, 26b, 26d, 26dXr, 26e, 28, 28Xr, 28Xs, 30, 30Xr, 31, 31c, 31d, 31Xr, 31xs, 32, 35, 43 and 43Xr.
OzArk (1996)	Buttonderry	20a, 20aXs, 26d, 26Xr, 28, 28Xr, 28Xs, 30, 30Xr, 43 and 43Xs

- *Anabat II recordings*

ERM (1999b) undertook ultrasonic bat detection using delay switches for four nights (survey periods varied from 30 minutes to 12 hours) in March 1998. Detectors were set in suitable flyways or roosting areas. In November 1998 and February 1999 two Anabat II detectors were used during the survey period, under similar circumstances as noted above, for four nights per survey event. Unfortunately details of the exact location of where these were set up in the Tooheys Rd, Hue Hue

Rd ecological offset investigation area and Buttonderry study area are not known, however several species of threatened bats were recorded and their locations (**Figure 40)** are indicative of the Anabat II stations.

Parsons Brinckerhoff (2005) set eight Anabat II detectors, five in the Tooheys Rd study area (**Figure 14**). All detectors were set on delay switches to record throughout the night with recording beginning at dusk. Calls were analysed by Ecotone Pty Ltd. Vegetation map units sampled in the current study area can be seen in **Table 8**.

OzArk was able to target Anabat II detection in areas of potential environmental sensitivity including remnant vegetation along Wallarah and Spring Creeks. Also assessed were randomly selected areas with 'a good patch size' of native vegetation possessing, a diverse shrub layer (**Figure 16**). Only one night of assessment was undertaken at each location in the Tooheys Rd study area due to the large body of existing information for the site in the immediate environs. Assessment at Buttonderry was undertaken in the immediate vicinity of the proposed surface infrastructure, with only one night of detection due to inclement weather. Prior results from ERM (1999b) indicate sufficient survey effort to detect microchiroptean within this study area.

The detector, with a Compact Flash Storage ZCAIM, was set on a delay switch to record throughout the night with recording beginning at dusk. Calls were analysed by LesryK Environmental Consultants Pty Ltd. Vegetation map units sampled can be seen on **Table 8**.

OzArk did not undertake Anabat II assessment within the Western shaft study area or the Hue Hue Rd ecological offset investigation area for similar reasons as stated previously.

Table 8: Vegetation map units within the immediate vicinity of Anabat II detection

Study	Location	Vegetation unit
ERM (1999b)	Unspecific – tracks and trails in the Tooheys Rd, Buttonderry and Hue Rd ecological offset investigation area.	Report does not have a transect map however we can assume assessments would have occurred in the same vegetation units assessed by OzArk.
Parsons Brinckerhoff (2005)	Proposed rail loop north of Tooheys Rd.	20f, 26b, 26d, 26dXr, 26e, 31, 31a, 31d, 31Xs, 32, 35 and 43Xs.
OzArk (1996)	Tooheys Rd	26b, 26d, 26dXr, 31, 31a, 31c, 31d, 32, 43 and 43Xr.
OzArk (1996)	Buttonderry	20a, 20aXs, 26d, 26Xr, 28, 28Xr, 28Xs, 30, 30Xr, 43 and 43Xs

- *Harp trapping*

Harp trapping has only been undertaken once by Parsons Brinckerhoff (2005) within the impact footprint of the proposed rail loop north of Tooheys Rd (**Figure 14**). This harp trap was set at the western end of the TransGrid easement adjoining highly modified vegetation near Narrabeen Buttonderry Footslopes Forest.

- *Bird point census*

ERM (1999b) undertook bird point census at all ground transect locations (locations not recorded) at Tooheys Rd, Buttonderry and the Hue Hue Rd ecological offset investigation area. All birds seen or heard over a 20 minute period were recorded.

Parsons Brinckerhoff (2005) did not undertake formal bird point census but relied on incidental sightings.

OzArk undertook bird point assessment, complimenting the results obtained from general observations and spotlighting, listening and observing periods. The task was combined with checking trap lines each morning or alternately walking late afternoon through the proposed impact footprint of the Tooheys Rd rail loop and assessing tree hollows. Taking into consideration the discussion in the DECCW working draft on methods to survey diurnal birds, an area-search method was used at each site. A 30 minute search was used where the observer walked around each site, as well as observing and listening for calls from a single point. The usual search time is 20 minutes, but this was increased to 30 minutes to increase the likelihood of recording more species. Craig (as cited in Denny 2005) states that recent studies have shown that an area search of 30 minutes duration detected a similar number of species as line transects and point counts, but gave higher estimates of overall bird density. The difference is likely due to the longer survey period and the greater chance of detecting cryptic species.

Vegetation assessed included Alluvial Footslopes Redgum Forest, Alluvial Floodplain Shrub Swamp Forest, Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant), Narrabeen Alluvial Drainage Line Complex, Narrabeen Alluvial Drainage Line Complex #c, Narrabeen Alluvial Drainage Line Complex #d, Xr, Narrabeen Alluvial Drainage Line Complex #e, Narrabeen Buttonderry Footslopes Forest, Narrabeen Buttonderry Footslopes Forest #b, Narrabeen Buttonderry Footslopes Forest Xr, Narrabeen Buttonderry Footslopes Forest Xs, Narrabeen Dooralong Spotted Gum - Ironbark Forest , Narrabeen Dooralong Spotted Gum - Ironbark Forest Xr, Narrabeen Doyalson Scribbly Gum Woodland, Narrabeen Doyalson Scribbly Gum Woodland #c, Narrabeen Doyalson Scribbly Gum Woodland #d, Narrabeen Doyalson Scribbly Gum Woodland Xr, Narrabeen Doyalson Scribbly Gum Woodland xs, Narrabeen Snappy Gum Forest, Coastal Range Moist Layered Forest, Alluvial Riparian Blackbutt Forest and Alluvial Riparian Blackbutt Forest Xr in the Tooheys Rd study area and Narrabeen Buttonderry Footslopes Forest, Narrabeen Buttonderry Footslopes Forest Xr, Narrabeen Dooralong Spotted Gum - Ironbark Forest ,and Narrabeen Dooralong Spotted Gum - Ironbark Forest Xr in the Buttonderry study area.

- *Herpetological searches*

Systematic searches for reptiles and amphibians were undertaken by ERM (1999b) at Tooheys Rd, Buttonderry and the Hue Hue Rd ecological offset investigation area. Litter was raked and rocks and logs turned over. Loose bark was prised from the trunks of dead trees. Searches for amphibians took place at night using spotlights and recognition of characteristic calls. Spotlighting searches were also attempted for reptiles. Dr Arthur White was employed as sub-consultant in November 1998 to assess the Tooheys Rd study area over a three day period.

Parsons Brinckerhoff (2005) did not undertake formal herpetological searches but relied on incidental sightings.

OzArk used similar methods to those adopted by ERM (1999b). At Tooheys Rd within the proposed rail loop footprint at Wallarah and Spring Creek, frog calls were recorded using a remote device supplied by Faunatech Pty Ltd. The device was set to record for 45 minutes each evening (2130 to 2215 hrs) and for 45 minutes prior to dusk (0500 to 0545 hrs). Specific searches of farm dams and previously recorded locations of threatened frog species were undertaken. Prior to the spotlight search, a recording was taken using a portable hand held cassette tape recorder. All tapes and

photographs of frogs observed were clearly labelled and sent to Frank Lemckert for professional analysis. Vegetation units the frog calls were recorded in including Alluvial Riparian Blackbutt Forest, Alluvial Riparian Blackbutt Forest Xr, Narrabeen Alluvial Drainage Line Complex at the Tooheys Rd study area, Narrabeen Alluvial Drainage Line Complex #d and Narrabeen Buttonderry Footslopes Forest in the Buttonderry study area and all farm dams in both locations.

The Western shaft study area was given particular attention as a sandstone escarpment occurs within 150 m of the impact footprint. Although not destined for disturbance this escarpment has the potential to provide key habitat elements for both of the LGA's threatened species of snake. This was the only place within any of the assessed areas that possessed suitable habitat for the Broad Headed or Stephens Banded Snake.

- *Animal track recognition*

OzArk assessed areas of sand on tracks for evidence of animal movement. Paw prints and other animal signs were identified and recorded.

- *Opportunistic observations*

All of the assessment teams recorded any sightings of fauna whilst moving throughout their respective study areas.

4.3.3 Survey effort

The combined survey effort undertaken over the study areas is detailed in **Table 9**. The location of vegetation plots and fauna and flora assessments can be seen on **Figures 16 to 19.**

Table 9: Survey effort (Source: ERM {1999: 3.5 to 3.6} and Parsons Brinckerhoff {2005: 10}).

Assessment undertaken by	Type of assessment	Survey Area	Total trap nights / hours / days
ERM (1999b)	Hair funnel	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	4940
OzArk	Hair funnel	Tooheys Rd, Buttonderry	540
Total			***5480***
ERM (1999b)	Elliot trapping (Type A)	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	760
Parsons Brinckerhoff (2005)	Elliot trapping (Type A)	Proposed rail loop nth of Tooheys Rd	115
OzArk	Elliot trapping (Type A)	Tooheys Rd	200
Total			***1075***
ERM (1999b)	Elliot trapping (Type B)	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	284
Parsons Brinckerhoff (2005)	Elliot trapping (Type B)	Proposed rail loop nth of Tooheys Rd	40
Total			***324***
ERM (1999b)	AnaBat II	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	19
Parsons Brinckerhoff (2005)	AnaBat II	Proposed rail loop nth of Tooheys Rd	3
OzArk	AnaBat II	Tooheys Rd and Buttonderry	5
Total			***26***
ERM (1999b)	Spotlighting	Tooheys Rd, Buttonderry, Hue Hue Rd	16 (hours)

Assessment undertaken by	Type of assessment	Survey Area	Total trap nights / hours / days
		ecological offset investigation area.	
Parsons Brinckerhoff (2005)	Spotlighting	Proposed rail loop nth of Tooheys Rd	8 (hours)
OzArk	Spotlighting	Tooheys Rd and Buttonderry	12 (hours)
Total			***36 (hours)***
Parsons Brinckerhoff (2005)	Harp trap	Proposed rail loop nth of Tooheys Rd	1
Total			***1***
ERM (1999b)	Call playback	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	11
Parsons Brinckerhoff (2005)	Call playback	Proposed rail loop nth of Tooheys Rd	1
OzArk	Call playback	Tooheys Rd and Buttonderry	6
Total			***18***
ERM (1999b)	Field days (fauna assessments)	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	12
Parsons Brinckerhoff (2005)	Days in the field (fauna assessments)	Proposed rail loop nth of Tooheys Rd	2
OzArk	Field days (fauna assessments)	Tooheys Rd, Buttonderry, western shaft and Hue Hue Rd ecological offset investigation area.	6
Total			***20***
ERM (1999b)	Field days (flora assessments)	Tooheys Rd, Buttonderry, Hue Hue Rd ecological offset investigation area.	12
Parsons Brinckerhoff (2005)	Days in the field (flora assessments)	Proposed rail loop nth of Tooheys Rd	2
Patterson Britton & Partners (2006)	Field days (flora assessments)	Western most extent of Tooheys Rd study area and a very small portion of a Hue Hue Rd ecological offset investigation area (**Figure 15**)	0.5
OzArk	Field days (flora assessments to date)	Tooheys Rd , Buttonderry, western shaft and Hue Hue Rd ecological offset investigation area.	7
Total			***21.5***

Note: figures for PB (2005) have been adjusted to only include the current study areas.
ERM 2003 summer surveys - survey effort remains unknown as we have been unable to obtain a copy of this report.

4.4 Assessment of conservation value

The conservation value of native flora and fauna is determined by national, state, regional and local significance. National significance is afforded when an ecosystem, plant, animal or population is listed as threatened or endangered under the EPBC Act 1999. Plants listed in *Rare or Threatened Plants* (Briggs & Leigh 1996) are also included in this category.

State significance is afforded when an ecosystem, plant, animal or population is listed as threatened or endangered under the TSC Act 1995. Plants listed as poorly known in *Rare or Threatened Plants* (Briggs & Leigh 1996) are also included in this category as well as referencing information by Keith (2004).

Regional significance is more challenging to determine due to a lack of accepted criteria. Perhaps the most widely accepted information determining regional significance is a bioregional study on published by Thackway & Cresswell (1995). Bioregion descriptions seek to describe the dominant landscape scale attributes of climate, lithology, geology, landform and vegetation. Most Endangered Ecological Communities (EEC's) under the TSC Act and EPBC Act are based upon assessments of

distribution and abundance in bioregions. Reviewing ecological data of a bioregion assists to contextualise the impact of a proposed development at a regional level. The use of bioregions to contextualise regional significance is best undertaken with additional information derived from more local sources, such as Catchment Management Authorities, Regional Vegetation Management Plans or from various published studies or mapping projects.

In relation to vegetation, regional significance of species, communities and populations was sourced from:

- Lower Hunter & Central Coast Biodiversity Assessment (Eco Logical Australia 2002);
- Regionally significant vegetation, Wyong LGA (Bell 2002a);
- Condition of remnant vegetation (regrowth, grazing history etc); and
- Local knowledge of the regional vegetation.

Figure 16: Survey effort map for the Tooheys Rd study area (proposed impact footprint is shown).

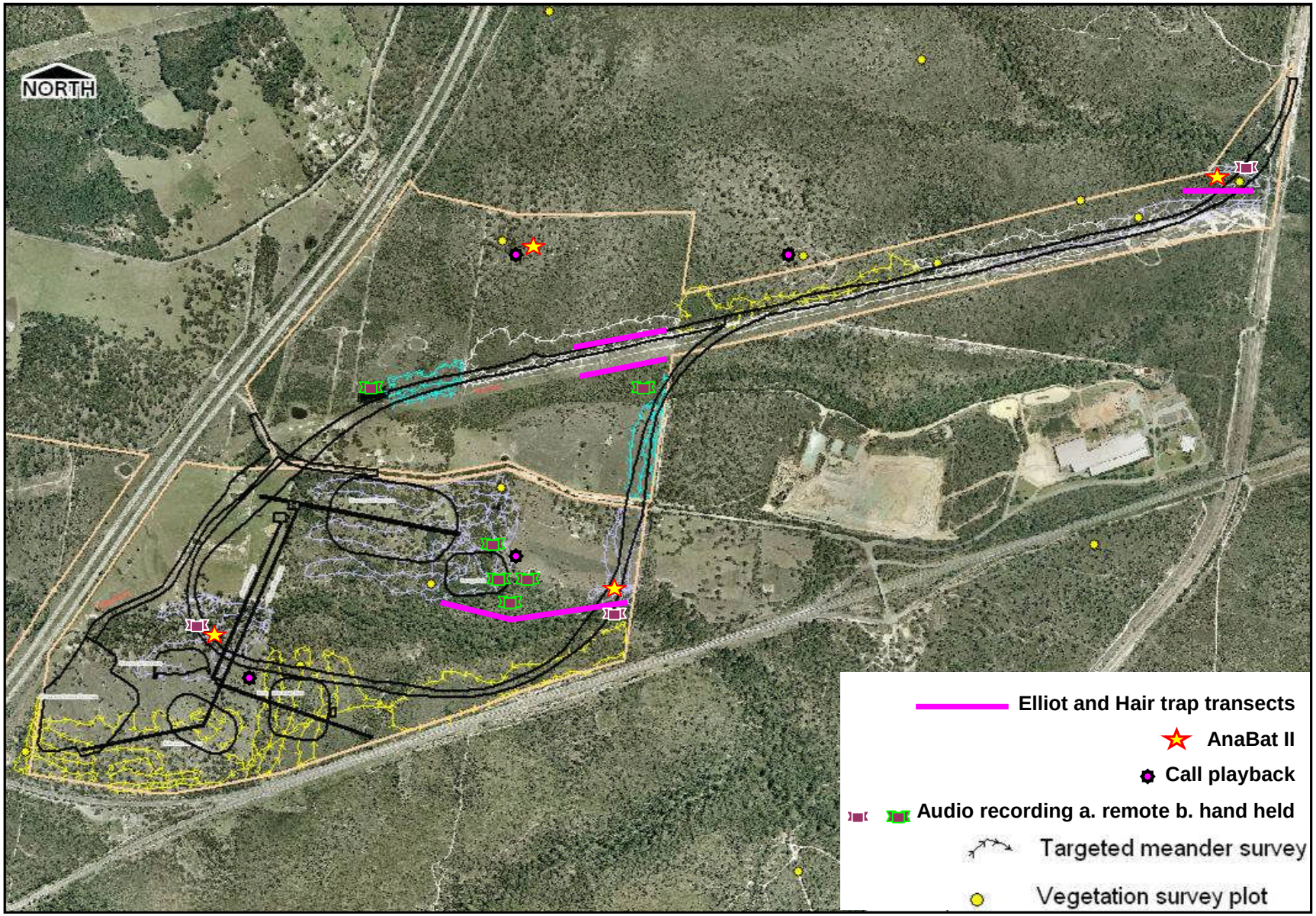


Figure 17: Survey effort map for the Hue Hue Rd ecological offset investigation area.

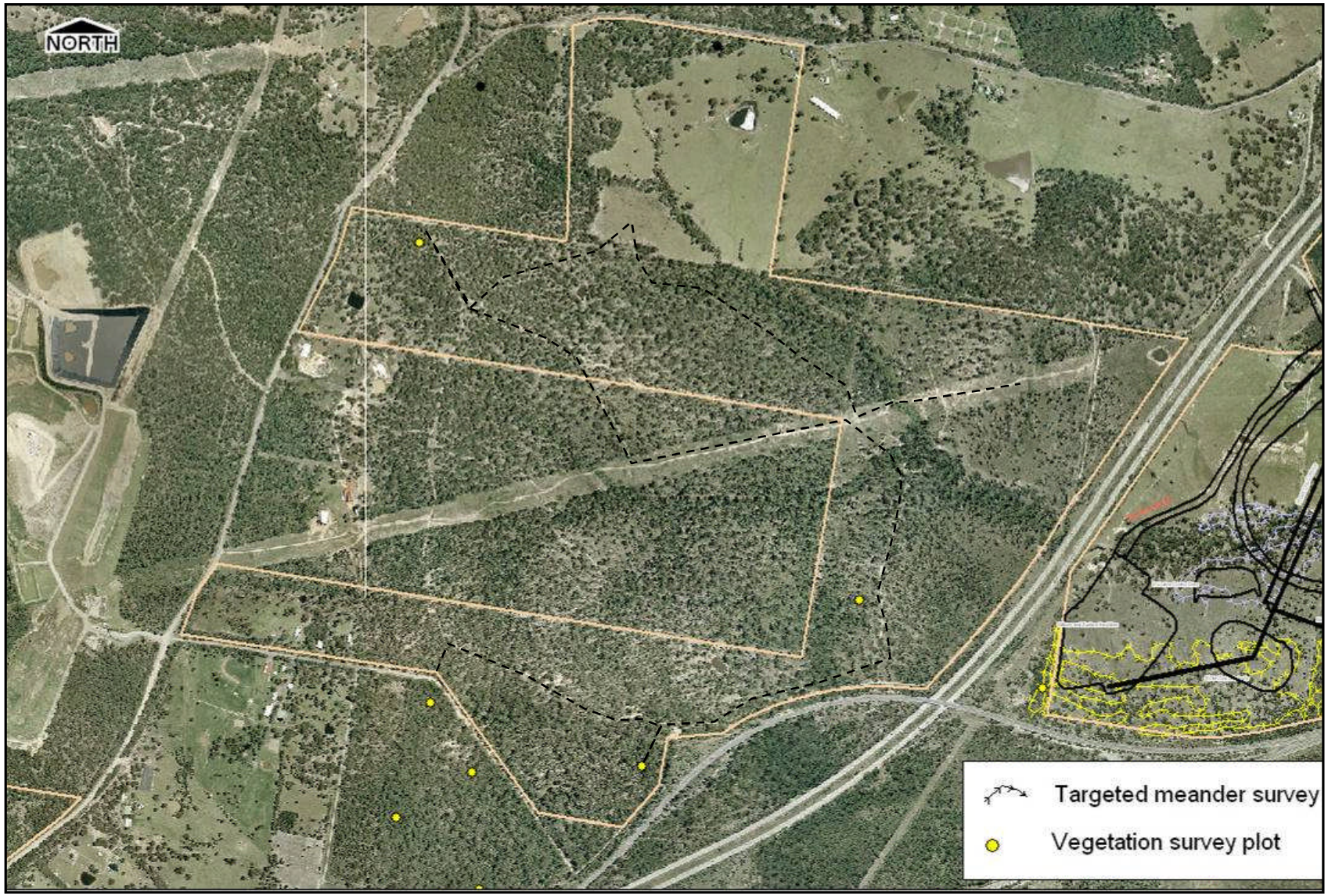


Figure 18: Survey effort map for the Buttonderry study area (proposed impact footprint is shown).

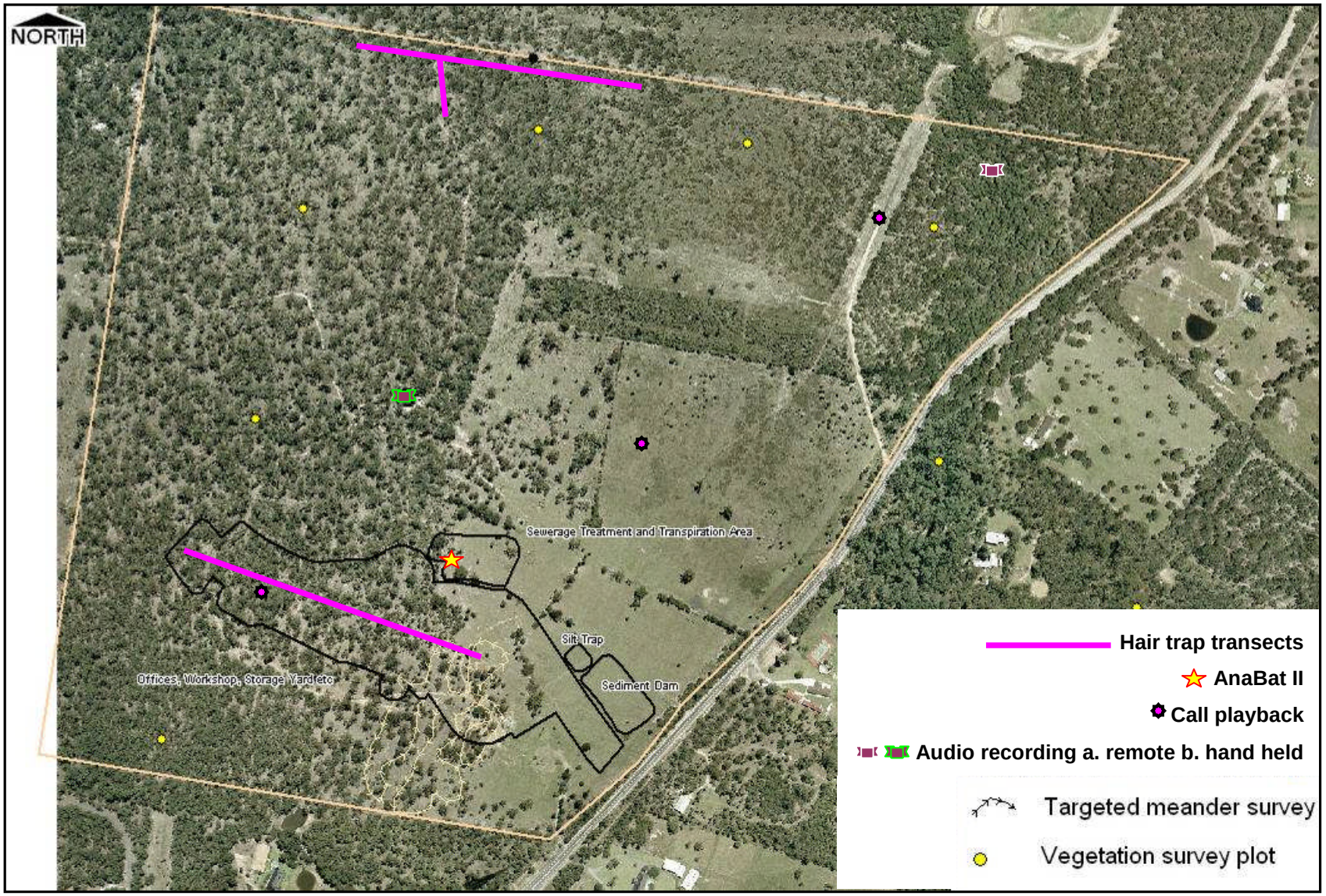
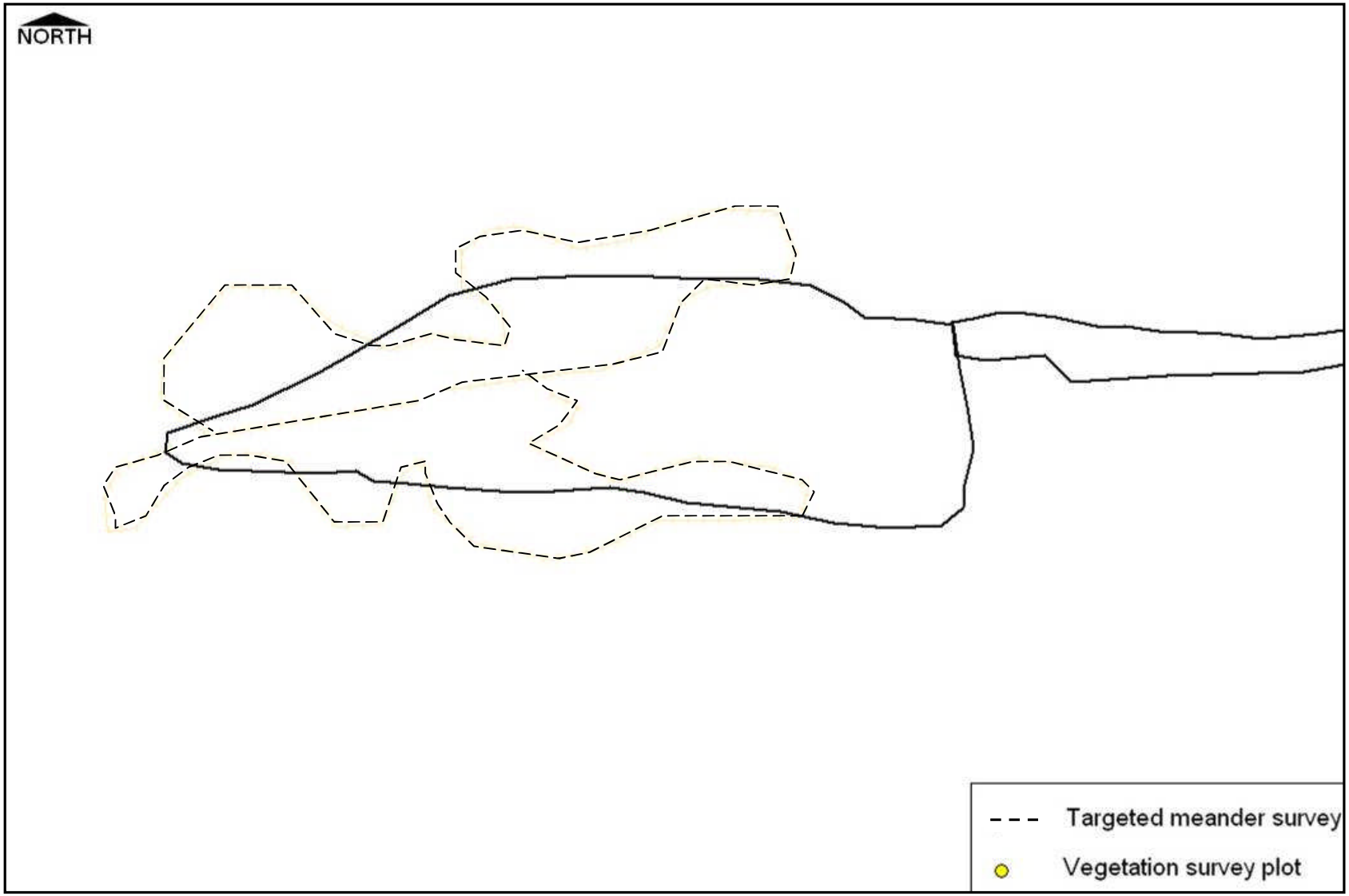


Figure 19: Detail of survey effort over the Western shaft study area (proposed impact footprint is shown).



In relation to fauna, two primary sources of information were reviewed in relation to regionally significant fauna. The Draft Wyong Conservation Strategy (2003) and Appendix 3 of the Lake Macquarie City Council Flora and Fauna Survey Guidelines V2. The draft Wyong Conservation Strategy (2003) was used as the primary reference and whilst this strategy was never adopted by the Wyong Council it appears to be one of the best resources available that has scientifically assessed regional and local significance of the Shires' natural biological resources.

Local significance is again a subjective matter open for interpretation. For the purposes of this report each specialist was given the opportunity to identify items of conservation significance within the assessed areas' that may not be protected under national or state legislation or considered to be regionally significant. Where items of local conservation significance are mentioned in the report they have been contextualised. Factors such as the size of a vegetation remnant, its degree of intactness and connectivity may be considered as important in assessing locally significance.

Potential significance, as noted by Parsons Brinckerhoff (2005:12), can be applied as a descriptive tool for the management of items of conservation concern in particular instances. Examples would include a situation where habitat is being investigated that closely matches habitat close by that is known to support a threatened species but the species was not recorded despite an intensive search. The level of significance of this area may be qualified by "potential". Alternately time constraints, limitations in the field, weather conditions or equipment failure may make it impossible to confirm the presence of an item of conservation concern without a rigorous search, again 'potential' may be applied as an appropriate descriptor.

4.5 Impact assessment

There are two independent mechanisms used to determine the significance of an impact and both directly relate to state or national legislative frameworks[6]:

- The *NSW Threatened Species Conservation Act 1995* (TSC Act) has been modified by the *Threatened Species Conservation Amendment Act 2002 (*TSCA Act*)*. The *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) incorporates these changes by including in section 5A seven factors that are to be considered when determining "whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats". These seven factors must be taken into account by consent or determining authorities when considering a development proposal or Development Application, particularly in administering Sections 78, 79 and 112 of the EP&A Act; However this does not apply to Part 3A projects in this way ,and

- The DEWHA provide guidelines for determining the significance of an impact to nationally listed (EPBC Act 1999) threatened species and ecological communities, migratory species, wetlands of international importance, commonwealth marine environments, World Heritage properties, national heritage places and nuclear actions. Criteria for each assessment of significance are specific to each matter of national environmental significance.

[6] In some instances individual species may be listed in the schedules of both the TSC Act and the EPBC Act, however separate assessments of significance are required.

5. RESULTS

5.1 Baseline ecological values

5.1.1 Vegetation communities in the study areas

Cluster analysis (using the Bray-Curtis association measure, flexible UPGMA and Beta = -0.1) of seventeen standard floristic survey plots revealed four distinct groups of sites at the 0.7368 level of dissimilarity. **Figure 20** shows the site dendrogram produced as part of the PATN cluster analysis. From the top, the first five sites represent Narrabeen Doyalson Coastal Woodland (MU31), while the next group of seven sites depicts the closely related Narrabeen Buttonderry Footslopes Forest (MU28). The next two sites sample the Narrabeen Dooralong Spotted Gum-Ironbark Forest (MU30). The final three sites represent the moister swamp forest complex, and includes a single site in the Alluvial Swamp Forest Complex (MU20) and two sites in the Narrabeen Alluvial Drainage Line Complex (MU26). Small areas of three other vegetation communities are also present, but have not been sampled systematically. These include Alluvial Footslopes Redgum Forest (MU15), Coastal Ranges Moist Layered Forest (MU35), and Alluvial Riparian Blackbutt Forest (MU43). A small area of Narrabeen Snappy Gum Forest (MU23) near Spring Creek was also sampled, however the proximity of this patch to the surrounding Narrabeen Doyalson Scribbly Gum Woodland meant that understorey floristics was more closely aligned with that unit, and hence did not separate out in the analysis. This unit, dominated by *Eucalyptus racemosa* in the canopy, has been mapped separately as it is uncommon in the local area. Mapped vegetation units within the assessed areas can be seen on **Figures 21 to 24.**

MU15: Alluvial Footslopes Redgum Forest (Bell 2002a)

At the corner of Kiar Ridge and Hue Hue Roads, a small area of remnant Alluvial Footslopes Redgum Forest occurs. This vegetation has been partially cleared and grazed in the past, but still retains important elements of this community. The canopy is dominated by *Eucalyptus tereticornis, Eucalyptus resinifera* and *Angophora floribunda*, over a mid-storey of *Melaleuca decora, M. linariifolia* and *M. nodosa*. Ground layer vegetation consists of various grasses, sedges and herbs. This vegetation type can perhaps be considered a drier form of the Alluvial Floodplain Shrub Swamp Forest (MU20), but in that community *Eucalyptus robusta* is prominent and the understorey supports a higher diversity of moisture loving sedges. Within Wyong LGA, Alluvial Footslopes Redgum Forest is highly restricted and has suffered from fragmentation and clearing, with estimates of 86% loss having been made (Bell 2002a). Within the regional NPWS classification (2000), this community falls into the Wyong Paperbark Swamp Forest (Alluvial Riparian Blackbutt Forest). Alluvial Footslopes Redgum Forest can be considered part of the River Flat Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (RFFCF).

MU20a: Alluvial Floodplain Shrub Swamp Forest (Bell 2002a)

Alluvial Floodplain Shrub Swamp Forest occurs at two main locations in the study area. In the Tooheys Road site, the broad drainage line (outside of the impact zone) supports vegetation variously dominated by *Eucalyptus robusta*, *Angophora floribunda* and *Eucalyptus resinifera*, with a sub-canopy of *Melaleuca linariifolia* and *Melaleuca decora*. The understorey is characterised by a dense layer of sedges and grasses, a scattered shrub layer of *Leptospermum juniperinum, Gahnia clarkei* and juvenile *Melaleuca linariifolia* and *Eucalyptus* species. Further downstream, this area

changes into Narrabeen Alluvial Drainage Line Complex #d as it continues into the adjacent Boral property. The second location lies in the north-eastern corner of the Buttonderry property, again outside the immediate impact zone. *Eucalyptus robusta, Angophora floribunda* and *Eucalyptus tereticornis* dominate at this location, over a distinctive understorey of *Lomandra longifolia* and various grasses. It is evident that this area has been subject to light-to-moderate grazing pressure over the years. These forms of swamp forest are distinct from that supported in other drainage lines in the study area (e.g.: Narrabeen Alluvial Drainage Line Complex #d), and can be considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

The Alluvial Floodplain Shrub Swamp Forest, as described in Bell (2002a), is highly variable depending on depth to water table, soil type and other factors. Estimates of 67% loss have been made for this vegetation type (Bell 2002a). Within the regional classification of NPWS (2000), this community falls into either the Swamp Mahogany – Paperbark Swamp Forest (MU37) or the Wyong Paperbark Swamp Forest (Alluvial Riparian Blackbutt Forest). This community can be considered part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

MU20f: Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant) (Bell 2002a)

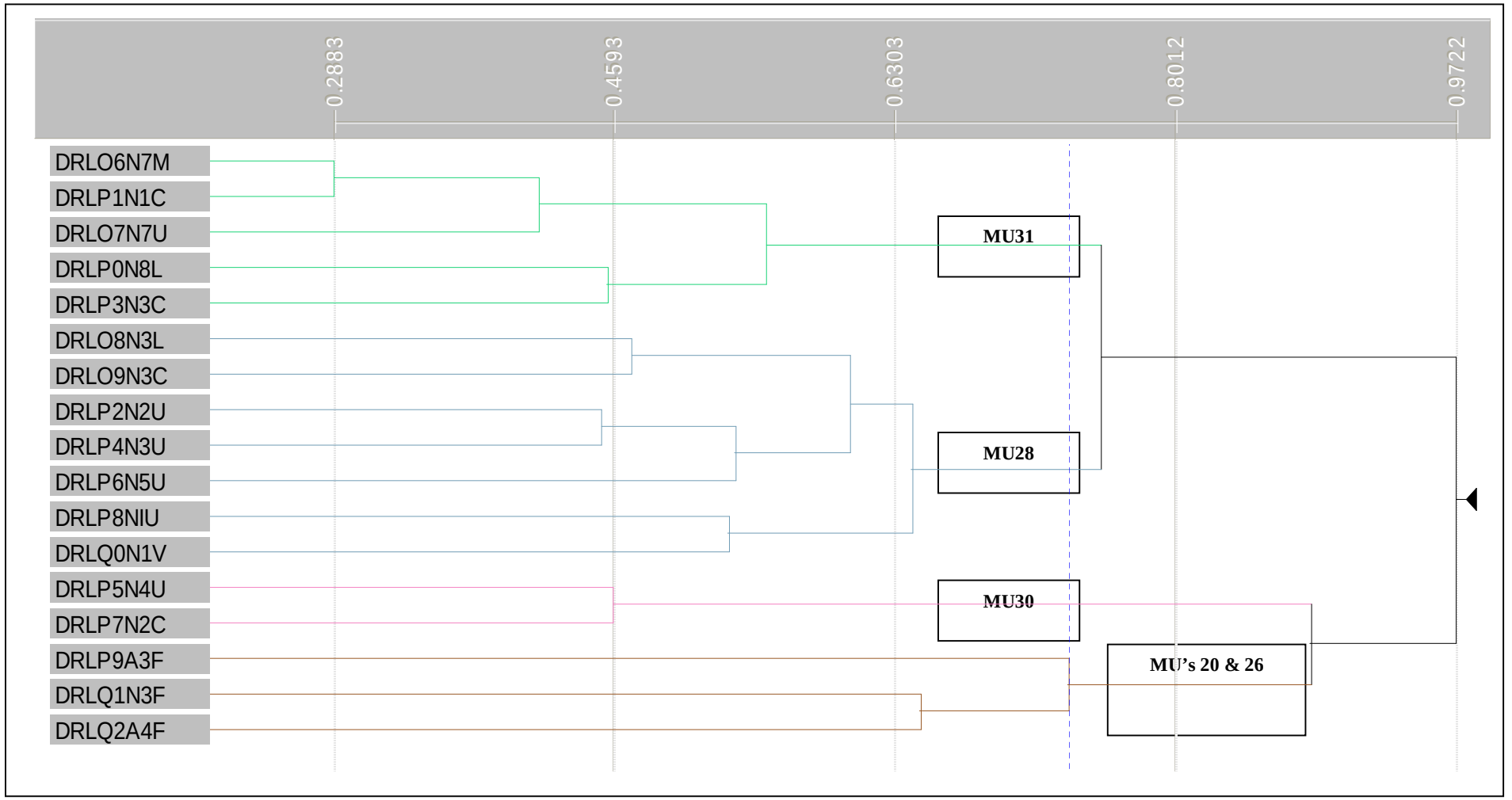
Two small areas in the Tooheys Road section of the study area support low, scrubby heath vegetation that fits best within Alluvial Floodplain Shrub Swamp Forest (Sedge-scrub variant) of Bell (2002a). At this site, it is dominated by *Angophora inopina, Melaleuca sieberi,* and *Leptospermum trinervium* in the canopy, over a sedge-dominated understorey. This vegetation is only known regionally from within the Wallarah Creek and Porters Creek catchments. Portions of this community have been partially cleared in the past, however recovery has been good.

The Alluvial Floodplain Shrub Swamp Forest, as described in Bell (2002a), is highly variable depending on depth to water table, soil type and other factors. Estimates of 67% loss have been made for this vegetation type (Bell 2002a). Within the regional classification of NPWS (2000), this community falls into either the Swamp Mahogany – Paperbark Swamp Forest (MU37) or the Wyong Paperbark Swamp Forest (Alluvial Riparian Blackbutt Forest). This community is likely to form part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

MU26b: Narrabeen Alluvial Drainage Line Complex (Bell 2002a)

Two small areas support this vegetation type within the study area. At Tooheys Road, the vegetation occurring along Spring Creek near the Great Northern Railway best fits this unit. Scattered *Eucalyptus robusta* and *Eucalyptus resinifera* occur over a moderately dense understorey of *Acacia longifolia,* and various *Melaleuca* species. A range of sedges and grasses occurr on the ground and along the banks of the creek line itself. A similar area occurs in a small tributary of Wallarah Creek in the south of the Tooheys Road parcel, although *Eucalyptus robusta* is not present. In both instances, the construction of the rail loop may impact on this community, at least initially. Regionally, this type is equivalent to the Riparian Melaleuca Swamp Woodland (MU42) of NPWS (2000). An estimated reduction of 17% since 1750 has been made for this vegetation type within Wyong LGA (MU26: Bell 2002a). This community is likely to form part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions EEC (SSFCF).

Figure 20: Vegetation dendrogram of the assessed areas produced as part of the PATN cluster analysis.



Note: Appendix 9 provides an updated dendrogram of sample sites considering LHSGIF EEC

Figure 21: Mapped vegetation - Tooheys Rd study area including rail loop (proposed impact footprint shown).

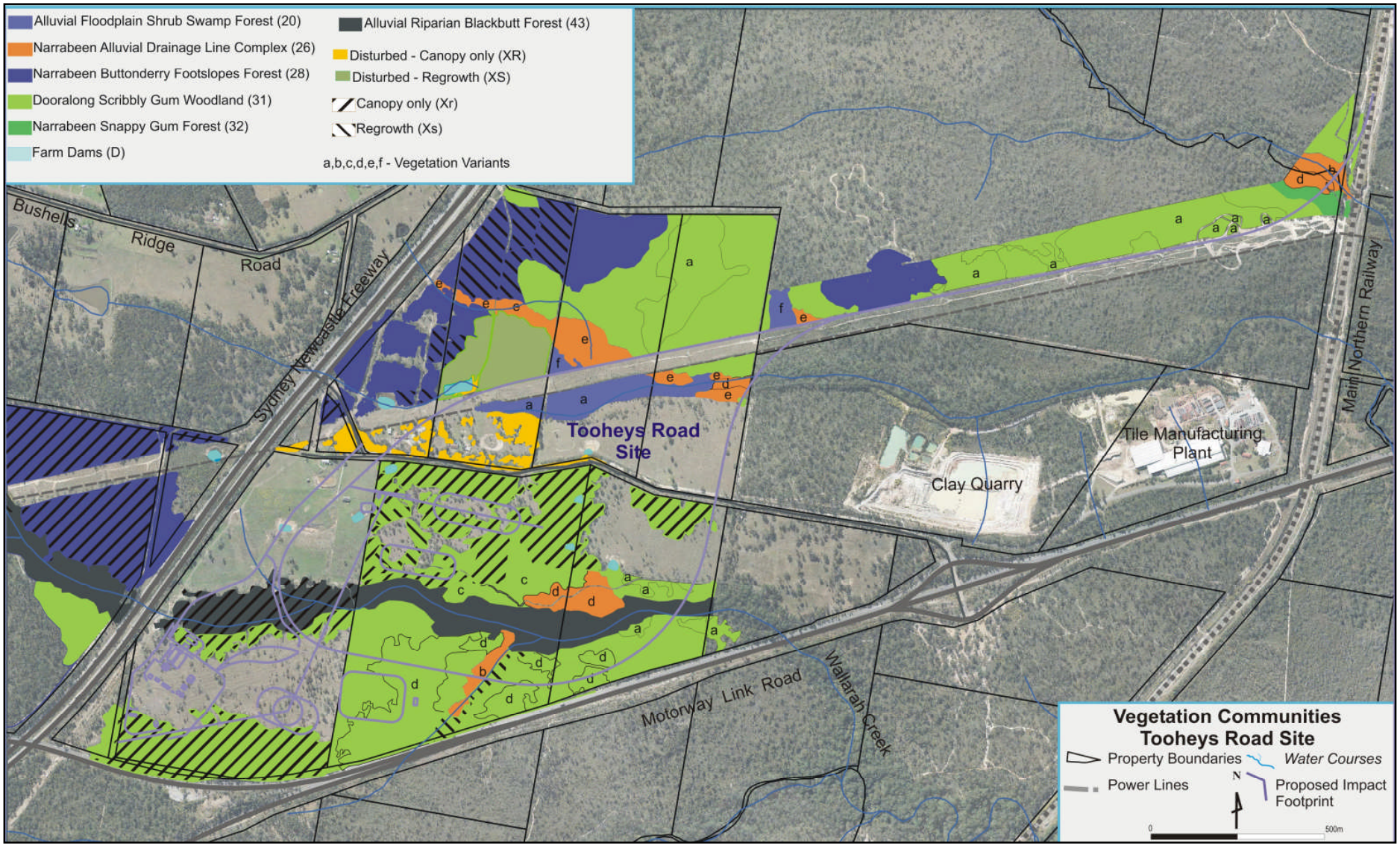


Figure 22: Mapped vegetation - Hue Hue Rd ecological offset investigation area.

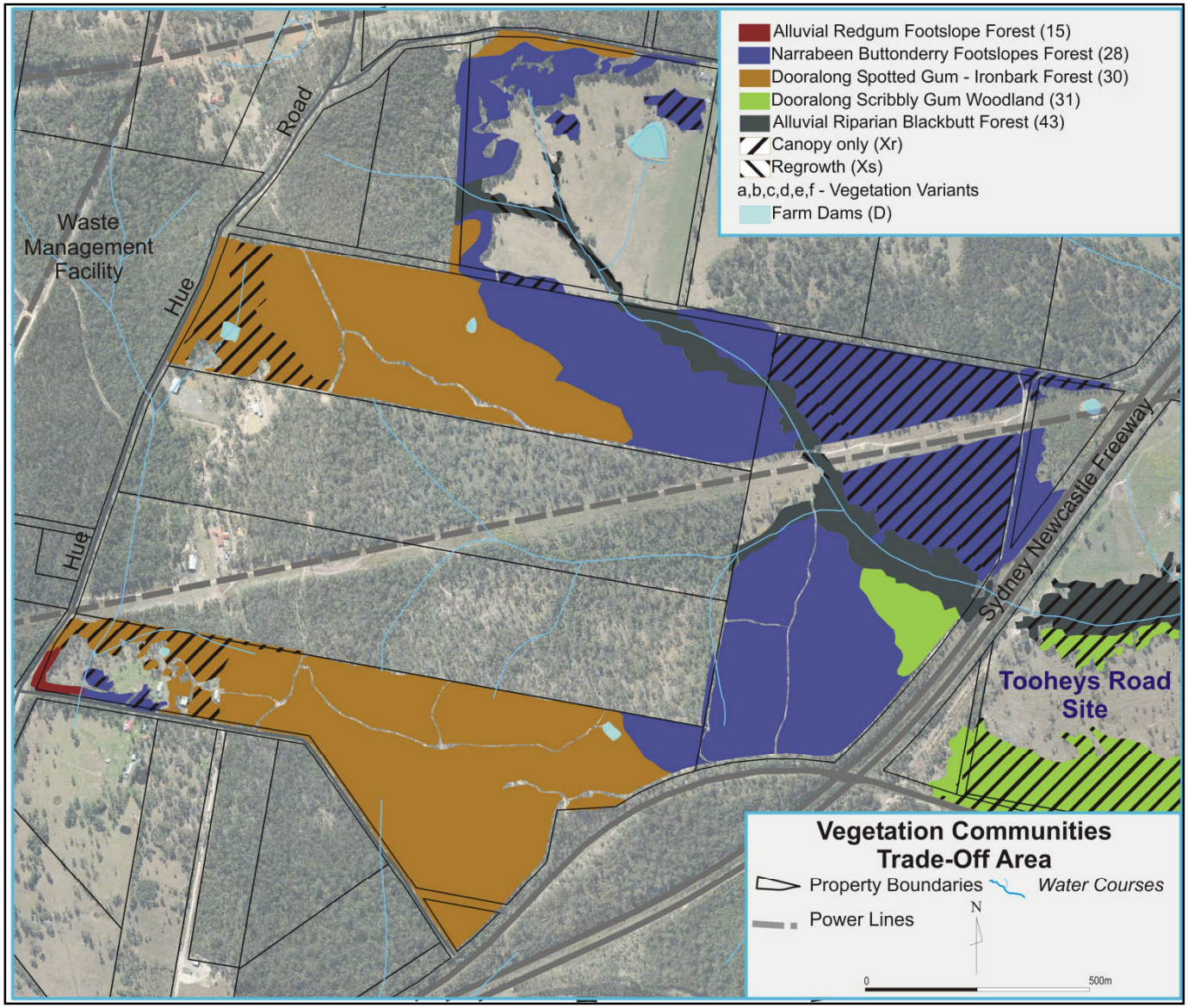


Figure 23: Mapped vegetation units - Buttonderry study area (proposed impact footprint shown).

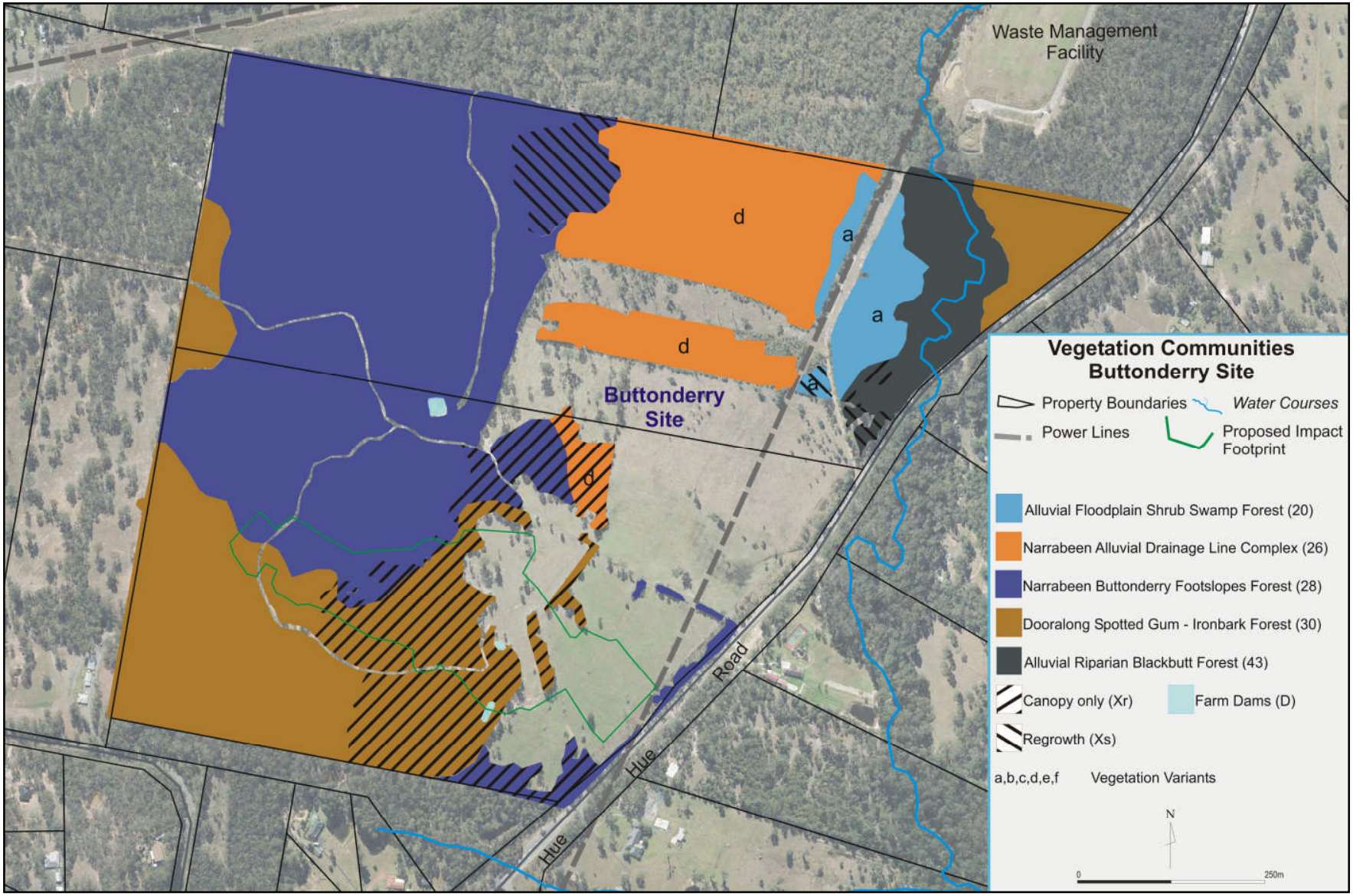
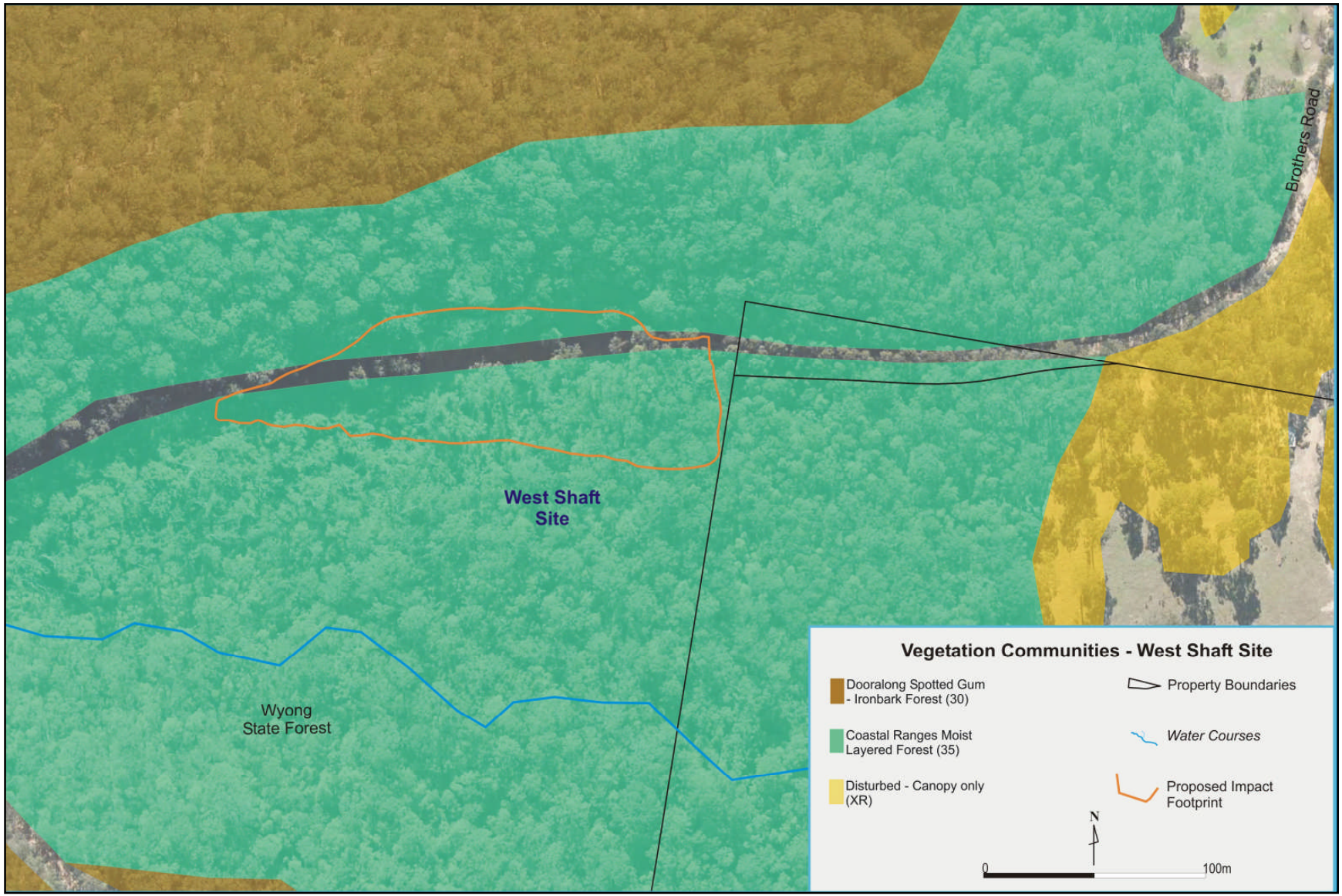


Figure 24: Mapped vegetation unit of the Western shaft study area (proposed impact footprint shown).



MU26d: Narrabeen Alluvial Drainage Line Complex #d (Bell 2002a)

Broad, shallow drainage lines in the Buttonderry and Tooheys Road areas support open sedge woodland where *Angophora costata, Eucalyptus resinifera, Melaleuca sieberi*, and *Melaleuca linariifolia* form the emergents. Occasional individuals of *Eucalyptus robusta* may also be present. Understorey vegetation is clearly dominated by sedge and grass species, with shrub species occurring often in dense patches. Ground layer vegetation includes *Banksia spinulosa* var. *collina, Melaleuca thymifolia, Acacia longifolia, Leprodia scariosa, Chorizandra cymbaria, Hemarthria uncinata* var. *uncinata, Schoenus brevifolius, Entolasia stricta, Gahnia clarkei, Leptospermum juniperinum, Pseudoraphis paradoxa, Empodisma minus, Deyeuxia quadriseta, Plinthanthesis paradoxa,* and *Baumea teretifolia.* This community is typified by a very undulated ground surface which serve as water storage refuges during dry periods, and provide fauna habitat.

Regionally, this type is equivalent to *Variant d* (Sedge Woodland) of the Narrabeen Alluvial Drainage Line Complex (MU26d) of Bell (2002a), and the Riparian Melaleuca Swamp Woodland (MU42) of NPWS (2000). An estimated reduction of 17% since 1750 has been calculated for this vegetation type (MU26: Bell 2002a). Within the study site, there is some dieback of mature *Eucalyptus resinifera* individuals, possibly related to previous diversions of water flows upstream (Buttonderry Tip).

MU26e: Narrabeen Alluvial Drainage Line Complex #e (MU26e in Bell 2002a)

One drainage line in the Tooheys Road portion supports thickets of *Melaleuca linariifolia*, and other paperbarks that are closest to Narrabeen Alluvial Drainage Line Complex #e in Bell (2002a). Scattered emergents of *Angophora costata* and *Eucalyptus resinifera* are also present and it is likely that at least some of this community has developed in response to past clearing for agricultural purposes.

MU28: Narrabeen Buttonderry Footslopes Forest (Bell 2002a)

Narrabeen Buttonderry Footslopes Forest occurs extensively in the Buttonderry and Tooheys Road parcels, where it forms a mosaic pattern with Narrabeen Dooralong Spotted Gum - Ironbark Forest and Narrabeen Doyalson Scribbly Gum Woodland. It is characterised by a canopy of *Angophora costata, Eucalyptus capitellata, Corymbia gummifera, Melaleuca decora,* and *Eucalyptus fibrosa*. Understorey vegetation includes such species as *Banksia spinulosa, Melaleuca nodosa, Bossiaea obcordata, Daviesia squarrosa, Epacris pulchella, Leptospermum trinervium, Goodenia heterophylla, Lomandra obliqua, Themeda australis,* and *Entolasia stricta*. In some areas, soils are notably more sandstone-based than others, and this is reflected in the local understorey composition (e.g.: *Banksia spinulosa, Lomandra obliqua, Grevillea sericea, Comesperma ericinum* are present in the more sandy soils). In some locations, evidence of past clearing and regrowth is shown as dense thickets of *Allocasuarina littoralis*.

Within the context of regional vegetation studies, this vegetation community may be considered as part of the Coastal Plains Scribbly Gum Woodland (Narrabeen Doyalson Scribbly Gum Woodland: NPWS 2000). Within Wyong Shire, an estimated loss of 47% in distribution has been made since 1750 for this community (Narrabeen Buttonderry Footslopes Forest: Bell 2002a).

MU30: Narrabeen Dooralong Spotted Gum – Ironbark Forest (Bell 2002a)

Areas mapped as supporting MU30 are open forests dominated by Spotted Gum (*Corymbia maculata*) and Ironbarks (predominately *Eucalyptus fibrosa*), over a sparse understorey of shrubs such as *Daviesia ulicifolia* and *Podolobium ilicifolium*, and grasses such as *Themeda australis, Entolasia stricta, Imperata cylindrica* var. *major,* and *Microlaena stipoides* var. *stipoides.* In areas where previous clearing or under-scrubbing has occurred, dense thickets of *Melaleuca nodosa* predominate, greatly reducing the diversity of shrub and ground layer species. In some areas, sections of MU30 have been partially cleared and underscrubbed for grazing purposes, and support a disturbed forest of variable density and canopy retention, and have been coded MU30Xr. The main areas of occurrence of this community are in the Hue Hue Road proposed conservation area, and in parts of the Buttonderry portion.

Regionally, this vegetation type is equivalent to Coastal Foothills Spotted Gum – Ironbark Forest (Alluvial Footslopes Redgum Forest) in NPWS (2000). Bell (2002a) has estimated that the Narrabeen Dooralong Spotted Gum – Ironbark Forest within Wyong Shire has undergone a 53% loss in areal extent since 1750. Ongoing work in the classification of communities dominated by Spotted Gum in the region (Bell & Driscoll in prog.) has suggested that the Spotted Gum – Ironbark forests in the Warnervale area are distinct from all others regionally (from the Karuah River to the Hawkesbury River), and may qualify for listing as an Endangered Ecological Community. In the interim, these forests are considered regionally significant (see Appendix 9 for further discussion on this forest type and the Lower Hunter Spotted Gum – Ironbark Forest EEC).

MU31: Narrabeen Doyalson Scribbly Gum Woodland (Bell 2002a)

Narrabeen Doyalson Scribbly Gum Woodland is a distinct healthy woodland occurring in the southern Lake Macquarie-Wyong region. It is characterised by a canopy of *Eucalyptus haemastoma, Corymbia gummifera, Eucalyptus capitellata* and *Angophora inopina,* with occasional occurrences of *Angophora costata* and *Banksia serrata.* A rich and diverse understorey includes *Lambertia formosa, Hakea laevipes* subsp. *laevipes, Persoonia linearis, Bossiaea heterophylla, Leptospermum trinervium, Epacris pulchella, Pimelia linifolia* subsp. *linifolia, Isopogon anemonifolius, Tetratheca juncea, Hibbertia vestita, Pultenaea palaceae, Ptilothrix deusta, Melichrus procumbens, Aristida warburgii, Entolasia stricta,* and *Xanthorrhoea latifolia* subsp. *latifolia*.

This community is widespread in the local region, with over 3100 ha mapped for Wyong LGA (Bell 2002a), 4250 ha mapped for the region (NPWS 2000).

MU31a: Narrabeen Doyalson Scribbly Gum Woodland # a (Bell 2002a)

Similar to Narrabeen Doyalson Scribbly Gum Woodland, this frequent-fire variant of the Narrabeen Doyalson Scribbly Gum Woodland differs in the higher proportion of grasses and graminoids in the ground layer vegetation, with woody shrubs such as *Banksia spinulosa* var. *collina, Hakea laevipes* subsp. *laevipes* and *Lambertia formosa* only sporadically occurring. This variant most likely originates through frequent fires which cause localised extinctions of sensitive species, and promote graminoid growth.

Within the current study area, Narrabeen Doyalson Scribbly Gum Woodland occurs almost exclusively in the DLALC lands on the site of the proposed rail loop.

MU31c: Narrabeen Doyalson Scribbly Gum Woodland # c (Bell 2002a)

This variant (Black She-oak) of the Narrabeen Doyalson Scribbly Gum Woodland is characterised by dense thickets of *Allocasuarina littoralis* under a scattered canopy of *Eucalyptus haemastoma, Angophora costata* and *Eucalyptus capitellata*. It occurs in response to past clearing and underscrubbing for grazing activities, which has then been left to regenerate. The rapidly growing *Allocasuarina* often forms monospecific stands in these situations, with little understorey vegetation present apart from grasses such as *Microlaena stipoides* var. *stipoides,* and the herbs *Pratia purpurascens, Goodenia hederaceae* and *Dichondra repens*.

Vegetation dominated by *Allocasuarina* and attributed to this variant occur only in the Tooheys Road portion, partially on the site of the proposed storage dam and coal stockpile.

MU31d: Narrabeen Doyalson Scribbly Gum Woodland # d (Bell 2002a)

Narrabeen Doyalson Scribbly Gum Woodland #d represents a moist heath variant of the Narrabeen Doyalson Scribbly Gum Woodland. It is known only from the Wallarah Creek area, and is similar to its parent community except that a greater proportion of sedges (*Lepyrodia scariosa, Leptocarpus tenax*) and other moisture loving shrubs (e.g. *Hakea teretifolia, Banksia oblongifolia, Melaleuca sieberi*) are present. In addition, this area supports often mallee-form and stunted *Angophora inopina*. This variant has been mapped only for the southern area of the Tooheys Road portion, where the proposed rail loop and waste water dam occur.

MU 32: Narrabeen Snappy Gum Forest (MU32 in Bell 2002a)

Narrabeen Snappy Gum Forest occurs in close proximity to the Narrabeen Doyalson Coastal Woodland (Unit 31) in the northern parts of the Shire. Snappy Gum (*Eucalyptus racemosa*) is normally present as a characteristic component of the canopy, with other species such as *Angophora costata, Corymbia gummifera,* and *Eucalyptus capitellata* co dominating. Understorey vegetation comprises a relatively dense shrub layer of *Acacia longifolia, Dodonaea triquetra, Acacia myrtifolia, Banksia spinulosa, Allocasuarina littoralis, Pultenaea paleacea, Pteridium esculentum, Pimelea linifolia,* and *Persoonia levis*. Grasses such as *Themeda australis* and *Entolasia atricta* are important components of the ground layer, together with *Dianella caerulea, Lomandra obliqua,* and *Lindsaea linearis*.

A single occurrence of this vegetation type is present on Darkingjung land adjacent to the Main Northern Railway.

MU 35: Coastal Ranges Moist Layered Forest (MU35 in Bell 2002a)

Coastal Range Moist Layered Forest represents a vegetation type that is widespread in the western half of the Wyong LGA, much of which is contained in State Forests. These areas are generally tall forests with a moist mesic understorey, although long term disturbance may in some cases have resulted in a simple shrub component with a well developed herbaceous layer. Canopy species present can be highly variable, but those most consistently occurring include *Syncarpia glomulifera*

subsp. *glomulifera*, *Allocasuarina torulosa*, and *Eucalyptus acmenoides*. Areas closer to drainage lines may support *Eucalyptus deanei* or *Eucalyptus saligna*, *Eucalyptus agglomerata* or *Angophora floribunda* may occur on moister slopes, while exposed slopes and ridges can be dominated locally by *Corymbia maculata*, *Eucalyptus pilularis, Eucalyptus propinqua*, or *Eucalyptus umbra*.

This vegetation type is present only within the western shaft study area.

MU43a: Alluvial Riparian Blackbutt Forest (Bell 2002a)

The bulk of Buttonderry Creek, including where it passes through the study area on the Buttonderry study area, supports Alluvial Riparian Blackbutt Forest. Dominant canopy species here include *Eucalyptus pilularis, Corymbia maculata* and in some places, *Eucalyptus saligna*, together with a well developed sub-canopy of *Melaleuca biconvexa* and *Melaleuca linariifolia*. A variety of sedges and herbs occur in the understorey, but *Gahnia clarkei* is prominent. This vegetation type is closely associated with major creek lines on the Wyong sub-coastal plain, and generally occupies only a limited habitat niche. It appears that Buttonderry Creek is being impacted upon by the Buttonderry Waste Management Facility located adjacent and further upstream, as local residents have reported a reduction in water quality over recent years.

Alluvial Riparian Blackbutt Forest equates to the Alluvial Tall Moist Forest of NPWS (2000), of which approximately 4,565 ha remains in the region. However, narrow bands of Blackbutt and Spotted Gum are generally restricted to within Wyong LGA, with only 237 ha extant being mapped in Bell (2002a). This community is also included within the River Flat Eucalypt Forest on Coastal Floodplains EEC.

MUXr: Canopy-only vegetation (includes, for example, units such as "Narrabeen Dooralong Spotted Gum - Ironbark Forest Xr")

Several locations within the study area support vegetation where understorey structure has been completely or partially removed or modified, such that only emergent canopy trees remain. In such cases, these areas have been mapped with the MU 'Xr' appended to the main vegetation map unit. For example, Narrabeen Dooralong Spotted Gum – Ironbark Forest Xr refers to canopy-only vegetation of Narrabeen Dooralong Spotted Gum - Ironbark Forest. In areas where it has been difficult to assign remnant trees to a particular vegetation community, the tag "Xr" only has been applied, representing unspecified canopy-only vegetation.

MUXs: Regrowth vegetation

A number of areas within the study area support regrowth vegetation that does not align well with any specific vegetation type. In such cases, these areas have been mapped with the MU 'Xs' to indicate opportunist regrowth. In certain areas, the floristic composition present in regrowth areas allows alignment with established vegetation communities, and these are included within the general mapping for those communities, but with the suffix 'Xs'. For example, Narrabeen Dooralong Spotted Gum – Ironbark Forest Xs refers to regrowth vegetation of Narrabeen Dooralong Spotted Gum - Ironbark Forest.

MUW: Water bodies

Old farm dams scattered throughout the study area, and any other bodies of water, are marked as "D" in the accompanying mapping.

5.1.2 Species of flora

A total of 275 vascular plant taxa were recorded within the entire study area during the survey (**Appendix 3**). Seventeen full floristic survey plots were undertaken throughout the area (see **Figure 27** for locations), and extensive meander surveys were also completed as part of terrestrial orchid and threatened species surveys.

5.1.2a Terrestrial Orchid Survey

Orchid surveys undertaken between late September 2006 and February 2008 recorded 15 species of terrestrial orchid and one epiphytic species. None of these orchid species are presently listed as endangered, two are listed as vulnerable and none are listed as rare. However, there is a previous DECCW Atlas record for the threatened orchid *Arachnorchis tessellatus* (syn. *Caladenia tessellata*) adjacent to the Pacific Highway on the southern portion of the Tooheys Rd study area, but this record was not confirmed during the present survey. **Appendix 7** of this report provides a specific addendum to this report which fully discusses orchid assessments. The recorded species recorded were:

- *Arachnorchis tessellatus* (Vulnerable)
- *Caladenia alata;*
- *Caladenia catenata;*
- *Calochilus paludosus;*
- *Calochilus robertsonii;*
- *Cryptostylis hunteriana* (Vulnerable)
- *Cryptostylis subulata;*
- *Dipodium punctatum;*
- *Diuris alba;*
- *Diuris aurea;*
- *Genoplesium fimbriatum;*
- *Glossodia minor;*
- *Prasophyllum elatum;*
- *Thelymitra ixioides* var. *ixioides*
- *Thelymitra pauciflora*; and
- *Cymbidium suave.*

5.1.2b Threatened Flora Species (non-orchid) Survey

Table 10 summarises the significant plant species present within the whole study area, and **Figures 24 to 27** shows their locations. Two of the seven targeted threatened flora species (*Angophora inopina*, *Tetratheca juncea*) were evident in large numbers across the Tooheys Rd study area, while *Acacia bynoeana* was present in two locations along the proposed rail loop. **Appendix 6** of this assessment provides a specific addendum report on *Angophora inopina* which maps the distribution of the local population beyond the study area boundaries such that questions regarding the extent of the impact on the local population could be adequately addressed, **Figure 26a 1** shows the

distribution of *Angophora inopina* in context to the study area. *Grevillea parviflora* subsp. *parviflora*) was present at two locations only (Hue Hue Rd ecological offset investigation area and Buttonderry), while *Melaleuca biconvexa* was present only along Buttonderry Creek. In addition, two nationally rare species (*Callistemon shiressii*, *Eucalyptus fergusonii* subsp. *dorsiventralis*) were recorded at the Western shaft study area, and one (*Macrozamia flexuosa*) on the Buttonderry study area in the non-impact area.

Table 10: Threatened flora recorded during the current assessment.

Species	Status	Location
Acacia bynoeana	TSC, EPBC Vulnerable	Tooheys Rd portion
Arachnorchis tessellatus	TSC Endangered	Tooheys Rd (DECCW Atlas)
Angophora inopina	TSC, EPBC Vulnerable	Tooheys Rd portion
Cryptostylis hunteriana	TSC, EPBC Vulnerable	Tooheys Rd portion
Grevillea parviflora subsp. *parviflora*	TSC, EPBC Vulnerable	Hue Hue Rd offsets
Tetratheca juncea	TSC, EPBC Vulnerable	Tooheys Rd portion
Melaleuca biconvexa	TSC, EPBC Vulnerable	Buttonderry Ck, Buttonderry portion
Callistemon shiressii	Rare (3RC-)	western shaft site
Eucalyptus fergusonii subsp. *dorsiventralis*	Rare (2RC-)	western shaft site
Macrozamia flexuosa	Rare (2K)	Buttonderry portion

5.1.3 Fauna habitats and key habitat elements

The four study areas possess varying amounts of native vegetation and have varying levels of disturbance. Nonetheless, habitat for a large number of native species occurs and the suitability of habitat for locally occurring species is dependent on vegetation structure, floristics, connectivity, quality and the presence of key threatening processes (as defined by the NSW Scientific Committee) and domestic livestock and animals. Condition of the available habitat should be referenced via the maps and descriptions contained Section 5.1.1 of this report. As previously discussed the general rule of thumb to follow for each vegetation unit are that vegetation units without X's and R's have not been cleared and contain old growth trees, dead and down timber, low levels of weed invasion, have good internal connectivity and all their vegetation strata.

Five broad habitats were observed within the assessed areas:

- Dry sclerophyll habitat;
- Wet sclerophyll habitat;
- Swamp forest/ woodland;
- Open wetland; and
- Disturbed areas.

5.1.3a Dry sclerophyll habitat

- *Vegetation communities - Narrabeen Buttonderry Footslopes Forest, Narrabeen Dooralong Spotted Gum - Ironbark Forest , Narrabeen Doyalson Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and their derivatives (Figures 21 to 24).*

Habitat elements – Where the tree canopy is moderately dense it provides a range of breeding, feeding, sheltering and roosting locations for the regions' mammals and birds. The majority of resources available are fairly generic such as provision of pollen, nectar, fruit and hollow logs. The

abundance and quality of tree hollows associated with this habitat are discussed in detail in section 5.1.3(f). Understorey species include winter flowering species (*Banksia spinulosa* and *Acacia sp*) that when combined with summer flowering species, provide important food resources for a wide variety of birds, arboreal mammals and bats throughout the year. The Squirrel Glider is likely to use the foraging and breeding resources in denser areas of woodland within vegetation map codes that have not been modified (i.e. have and X or R following the vegetation code number).

The height and density of the shrubby understorey varies with the abundance of species present, giving a degree of habitat complexity in places. There is a moderate amount of leaf litter and fallen timber throughout. Ground cover vegetation provides habitat for many reptiles and smaller terrestrial mammals such as the Bush Rat and Brown Antechinus. Many species of shrub dwelling birds are present in suitable parts of the study area.

Fire has played an active part within dry sclerophyll forests in the study area with many trees of all ages showing evidence of frequent mosaic fire events between the last 5 to 20 years. Incidentally, fire swept through the DLALC portion of the study area in December 2006 after the first draft of this report had been prepared.

5.1.3b Wet sclerophyll habitat

- *Vegetation communities - Coastal Range Moist Layered Forest and Alluvial Riparian Blackbutt Forest (Figures 21 to 24).*

It should be noted that cattle have impacted on this vegetation within Wallarah Creek at the Tooheys Rd site to reduce its technical grouping into this description however; it has been included for the purposes of this report.

Habitat elements – The majority of habitat elements present is the same for dry sclerophyll forest (see above). One difference is the presence of decorating bark on trees, which is suitable for microchiroptean bat and gecko habitat. Another difference is the nature of pools within Wallarah Creek. This is a low flow creek and as such many pools exist. These environments provide a multitude of complex microhabitats for frogs and species that are dependent on them. As previously noted Wallarah Creek within the Tooheys Rd study area does not have the degree of habitat complexity as seen within the Hue Hue Rd ecological offset investigation area and Buttonderry Creek however, high potential exists for this to rehabilitate through the restriction of access from domestic stock.

5.1.3c Swamp forest/ woodland

- *Vegetation communities - Alluvial Floodplain Shrub Swamp Forest and Narrabeen Alluvial Drainage Line Complex and their derivatives (Figures 21 to 24).*

Habitat elements – The basic habitat elements are the same as for dry and wet sclerophyll forest, however the degree of habitat complexity is greater. This diverse habitat supports a very diverse range of native species. This environment is suitable for small insectivorous and nectar feeding birds, frogs and reptiles (especially snakes and goannas) and it possesses a higher abundance of dead and down timber. This habitat is where ground dwelling native mammals and small skinks are most likely to be recorded.

Figure 25: Location of threatened species of plants on the Tooheys Rd main infrastructure and proposed rail loop study area.

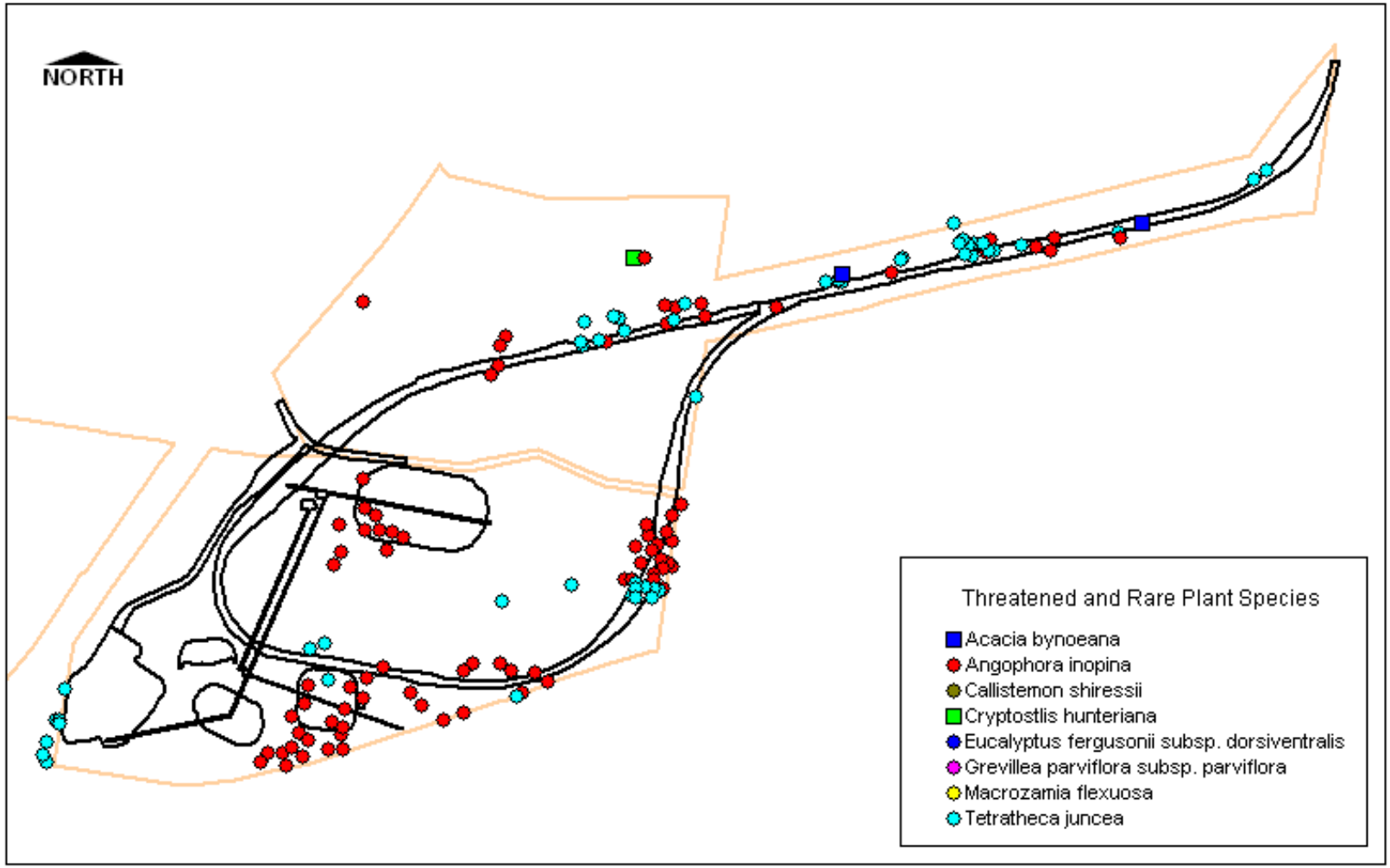


Figure 25a: Distribution of *Angophora inopina* showing the study area.

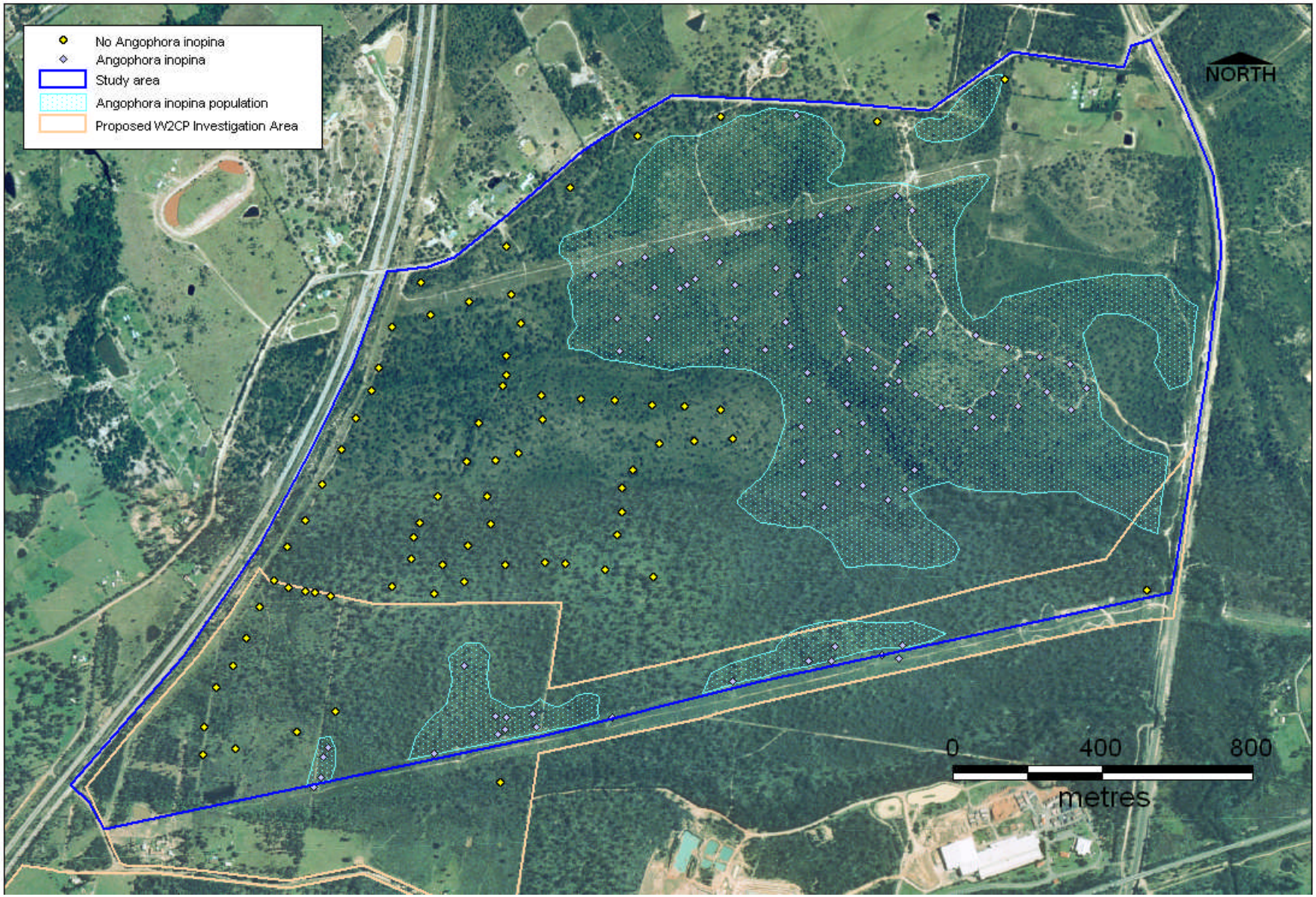


Figure 26: Location of threatened species of plants on the Hue Hue Rd ecological offset investigation area.

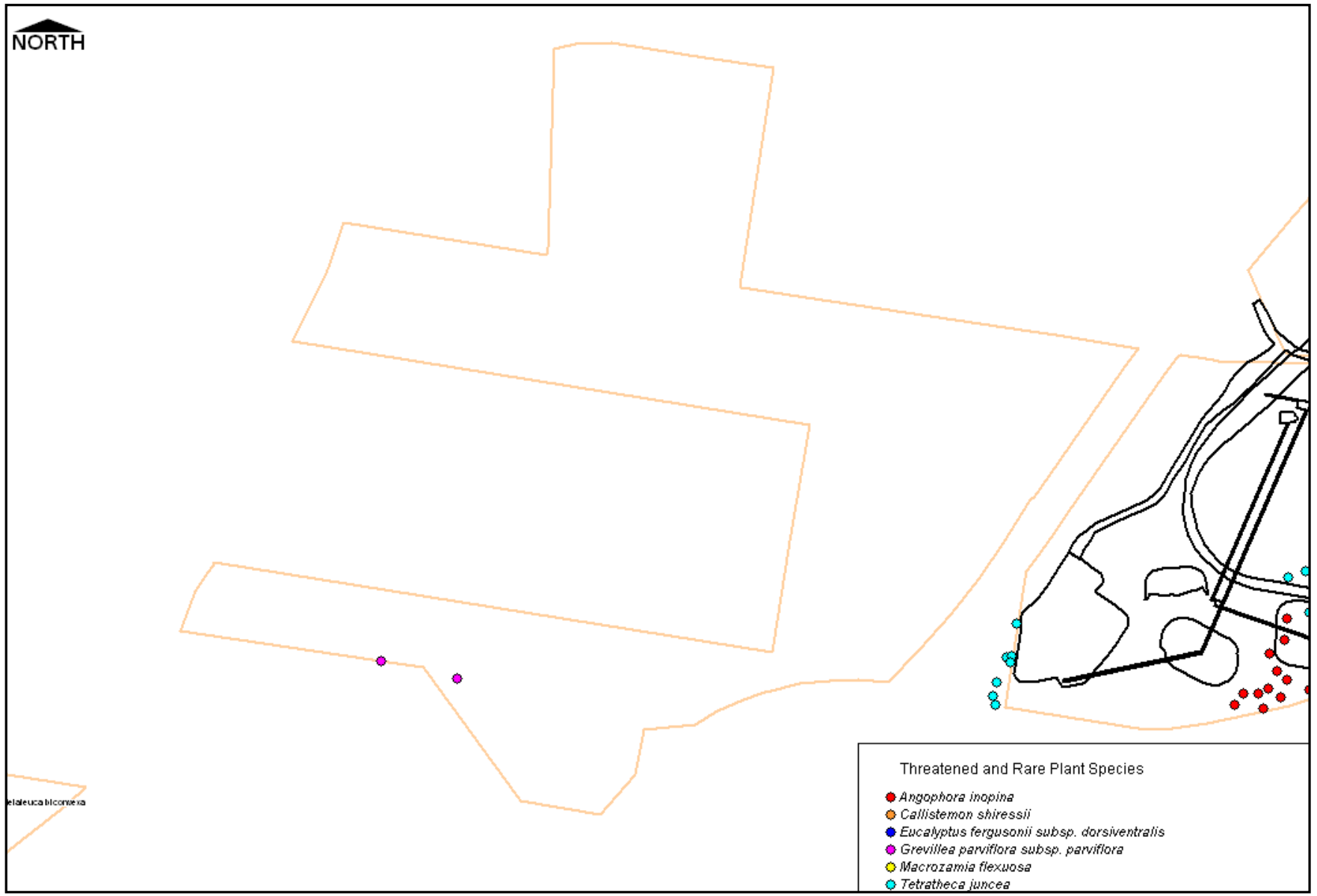


Figure 27: Location of threatened species of plants on the Buttonderry study area (Impact footprint superimposed).

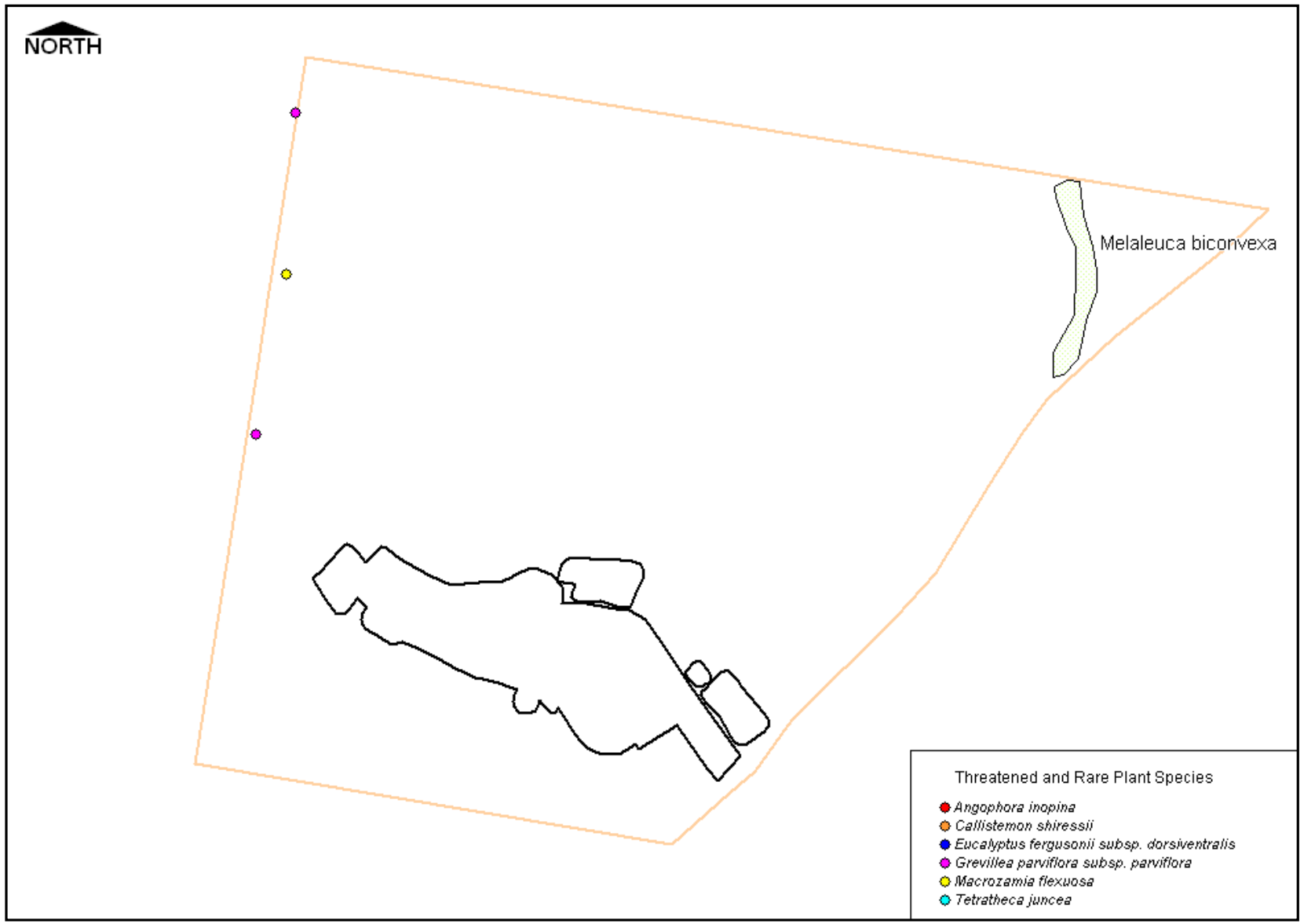
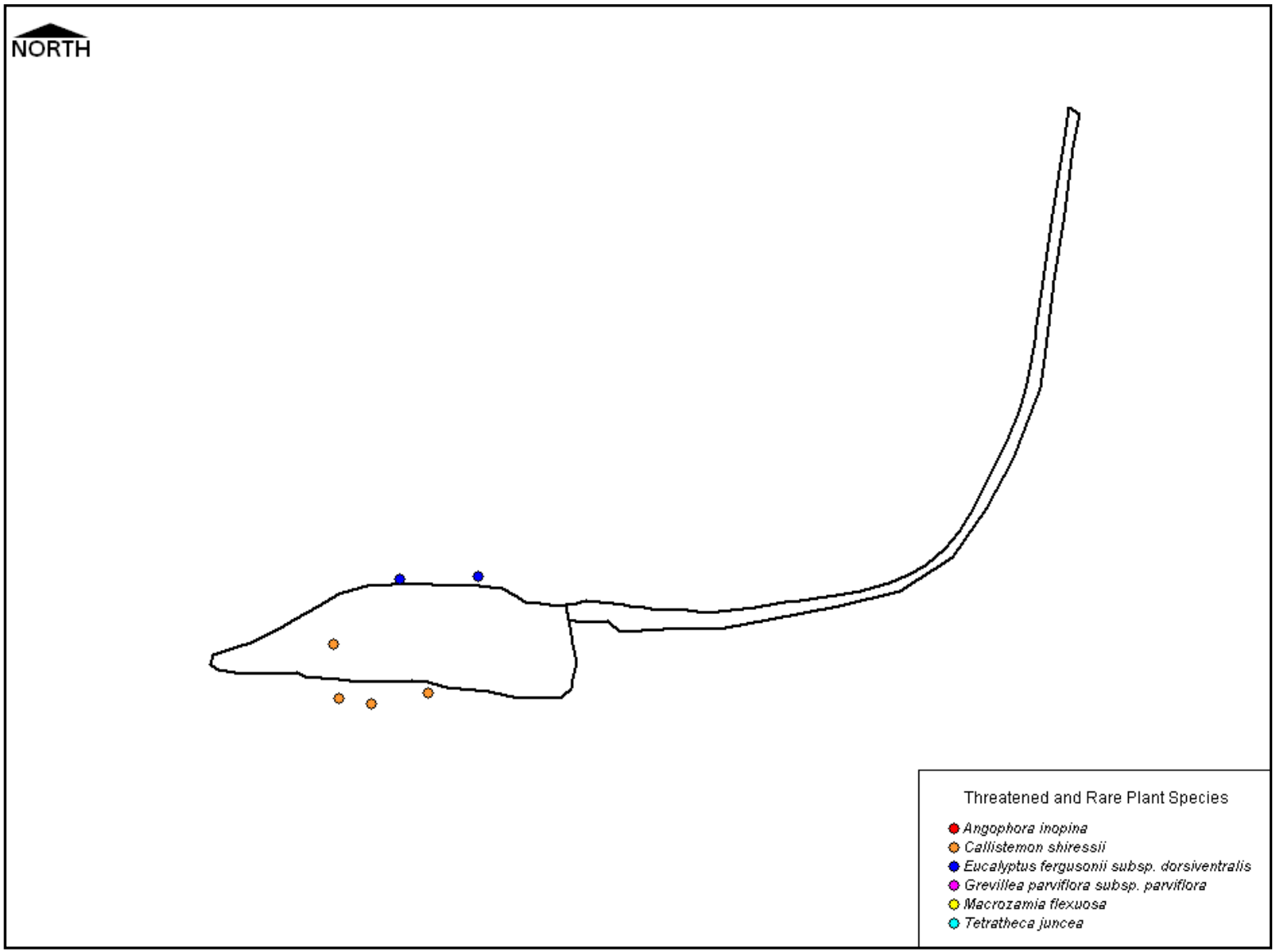


Figure 28: Location of threatened species of plants on the Buttonderry study area (Impact footprint superimposed).



5.1.3d Open wetland

- *Vegetation communities - Map unit D (Figures 21 to 24).*

These environments are characterised by farm dams with a varying degree of wetland vegetation such as sedges and rushes.

Habitat elements – All but one dam owned by WACJV in the direct impact areas have been de-silted in the very recent past. Despite this high level of disturbance many frogs were seen and recorded at each location. It is expected that these areas are also an important feeding resource for snakes.

5.1.3e Disturbed areas

- *Vegetation communities - Clear areas on the vegetation maps.*

Habitat elements – Often the only habitat elements present in these areas is grassland for large macropods and the odd, remnant hollow bearing tree.

- *5.1.3(f) Tree hollows within the direct impact study areas*

Terminology used to describe the size of hollows includes:

- Small – suitable for species up to the size of a microbat;
- Medium - suitable for species larger than a microbat up to the size of a Squirrel Glider and a small parrot;
- Moderate - suitable for species larger than Squirrel Glider such as Brushtail Possum and or a large parrot such as a Galah; and
- Large – suitable as a nesting location for an owl or as habitat for greater glider.

It is duly noted that these criteria are subjective. It is neither practical nor time efficient to measure the size of hollows in centimetres.

Terminology used to describe the quality of hollows includes:

- Poor quality – can be the physical description of the hollow, for example it can be orientated such that rain will go directly into it, or the hollow limb is split to allow light or weather into it or it may be positioned in a bad location such as a large hollow suitable for a large owl being located within 30 m of the F3;
- Average quality – is a hollow suitable for use by the respective species without anything obviously wrong with it that is also located in a suitable environment;
- High quality – This may relate to the number of hollows present, for example where a tree has more than c. 5 average quality microbat hollows it will be recorded as the one tree with a high quality hollow value. Alternately it simply may describe the structure and location of the hollow, for example a large hollow suitable for an owl located in undisturbed riparian vegetation with excellent connectivity or alternately in one case a

tree in a disturbed location that had owl down and egg shell at the base of it (an actual nesting location).

Again it is understood that these assessments subjective. It must also be noted that some hollows may not have been observed or observable form a terrestrial survey.

The impact footprint for all three direct impact areas are was pegged in the field. In total 142 trees within the impact footprints were identified as having hollows (**Figures 29 to 39**). Rudimentary observations were taken to determine what species could potentially occupy those hollows and secondly document the quality of hollow present. These two albeit, limited values, could then provide a better understanding of the species potentially affected by the proposal.

Cumulatively, only 14.7% (n=21) of all trees with hollows recorded contained large hollows, 37.3% contained moderately sized hollows (n=53), 45.7% (n=65) contained medium sized hollows whilst only 2.1% (n=3) contained small hollows.

In terms of quality of the hollows observed, 78.2% (n=111) were of average quality, 11.3% (n=16) were of high quality, 5.6% (n=8) were of poor quality and an additional 7 possessed other traits such as being a recognised perching location.

Hollows were only recorded within c. 100 m of the proposed rail loop however, all land likely to be cleared for the Tooheys Rd infrastructure south of Tooheys Rd was assessed. The banks of Wallarah Creek were only assessed within c. 100 m of a rail loop crossing point. This assessment was effectively a worst case scenario as not all trees are likely to be removed in these areas as a result of the W2CP.

Tooheys Rd study area

A total of 131 hollow bearing trees were recorded in the impact footprint. A breakdown of location, species and hollow quality for each of the assessed areas is presented on **Figures 29 to 36**.

The rarest key habitat element within this property is trees possessing high quality large hollows that may be suitable as a breeding location for large forest owls such as the Powerful Owl. Only three trees (tree 7 north of Tooheys Rd on WACJV land, tree 37 south of Tooheys Rd also south of Wallarah Creek and tree 24 north of Tooheys Rd in DLALC land near Spring Creek) with suitable owl nesting sites are located within the impact footprint. Tree 37 (**Figure 30**) had evidence of eggshell, down and fledging feathers at the base of the tree and it is assumed to be a nesting location most likely for a Tawny Frogmouth Owl (**Plates 6 to 9**). Other high quality hollows identified were as follows:

- Tree numbers 9, 25 and Narrabeen Alluvial Drainage Line Complex in the Tooheys Rd study area south of Wallarah Creek had moderate hollows that were of high quality;
- Tree numbers 18, 19 and 20 in the Tooheys Rd study area south of Wallarah Creek had medium hollows that were of high quality; and
- Tree numbers 21 and 22 north of Tooheys Rd on DLALC land have small hollows of high quality.

Buttonderry direct impact study area

Only 11 hollow bearing trees will be impacted as a result of the proposal in the Buttonderry direct impact area. Although many old growth trees were observed down slope of this area, the hill comprising the impact footprint has undergone prior logging such that the majority of trees on site are not of hollow bearing age. A breakdown of location, species, and hollow quality is presented on **Figures 37 to 39**. Note the total number of trees to be removed on these figures is for all direct impact study areas.

Western shaft study area

Trees within the Western shaft study area did not appear to be of an age to possess visible hollows.

5.1.4 Species of fauna

Birds comprise the most common species, 51 species recorded or assessed as having the potential to occur (**Appendix 3**). Two of these, the Powerful Owl (*Ninox strenua*) and the Masked Owl (*Tyto novaehollandiae*) are threatened in NSW and the location of these species records is shown on **Figure 40.** The Powerful Owl was sighted during call playback in the Tooheys Rd study area, where ERM (1999b) had previously twice recorded Squirrel Glider. An individual Powerful Owl responded within seconds of call playback which took place after a series of Squirrel Glider calls were broadcast. Additionally, feather down, eggshell and small fledging feathers were noted at the base of tree No. 37 (main infrastructure impact footprint south of Wallarah Creek) in a high quality, large hollow of a *E. haemastoma* in the proposed location for the ROM stock pile (**Figures 29 to 31, Plates 6 to 9**). Although it is possible that these may be from Powerful Owl it is more likely that they were from Tawney Frogmouth Owl given the extremely exposed location of the hollow (paddock tree). The Masked Owl responded to call playback north of Tooheys Rd. Although clear, the call was faint and appeared to originate several kilometres north of the Tooheys Rd study area.

Three other species of birds recorded, White Bellied Sea Eagle, Chestnut-rumped Hylacola and Painted Button Quail were noted as regionally significant (**Appendix 3**).

Mammals were next in frequency. Of the 38 species recorded, eleven were microchiroptean bats of which five are threatened (Little Bentwing-bat *{Miniopterus australis},* Large-footed Myotis *{Myotis adversus},* Yellow-bellied Sheathtail-bat {*Saccolaimus flaviventris},* Greater Broad-nosed Bat {*Scoteanax rueppellii},* Eastern false pipistrelle {*Falsistrellus tasmaniensis}.* Five were arboreal mammals with one, the threatened Squirrel Glider (*Petarus norfolcensis*), positively identified within the Tooheys Rd study area by ERM in 1999. This species is also highly likely to occur in the Hue Hue Rd ecological offset investigation area where a potential recording of the threatened Yellow-bellied Glider was also taken. Despite a targeted search at the Tooheys Rd study area where the previous Squirrel Glider record occurred, this species was not relocated. Six mammals were introduced species (**Appendix 3**). The location of where these species were recorded is shown on **Figure 40.**

Figure 29: Location and species of trees possessing hollows within the Tooheys Rd impact footprint.

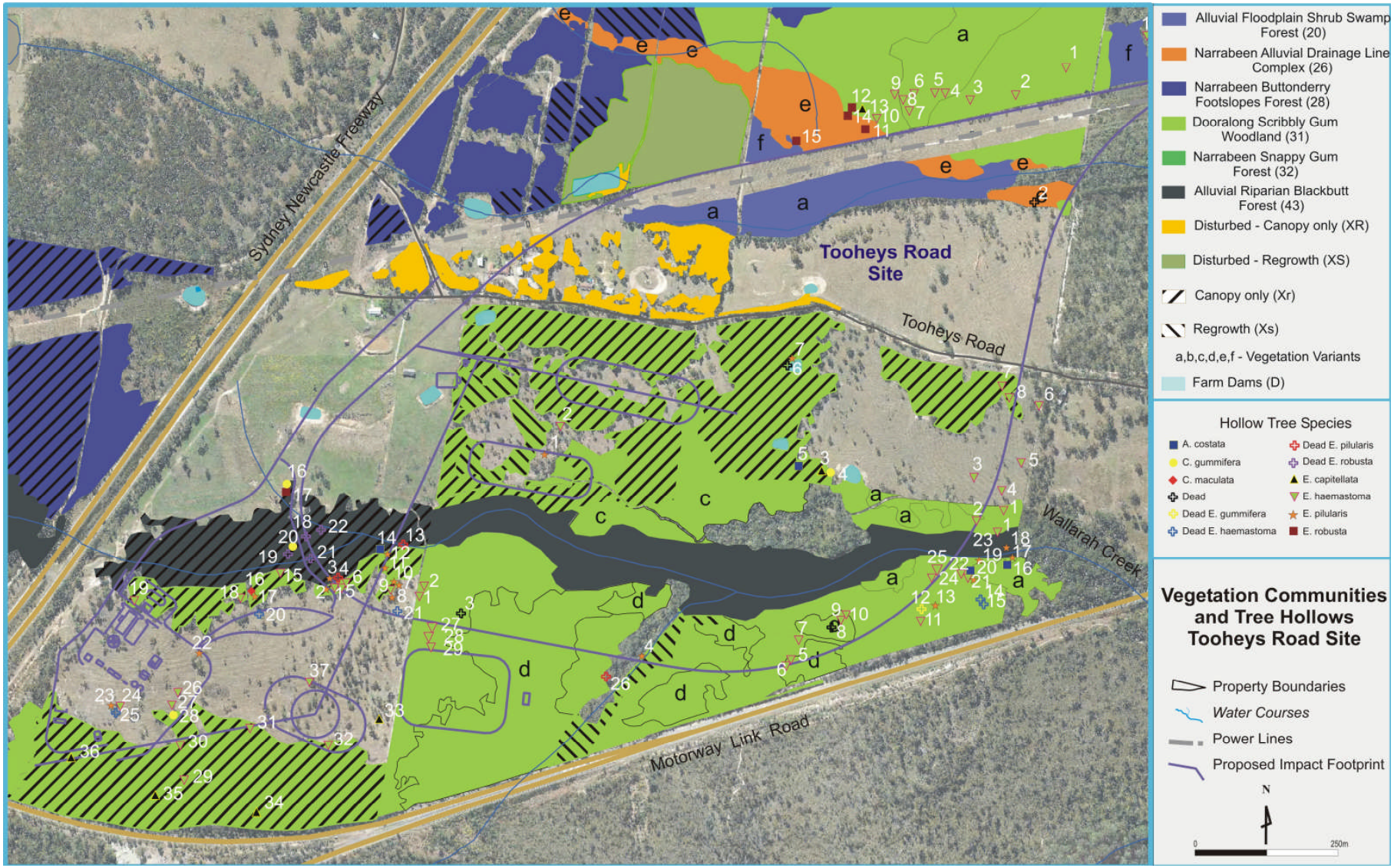


Figure 30: Location and size of tree hollows within the Tooheys Rd (Sth) study area (No's relate to numbers painted on trees in the field).

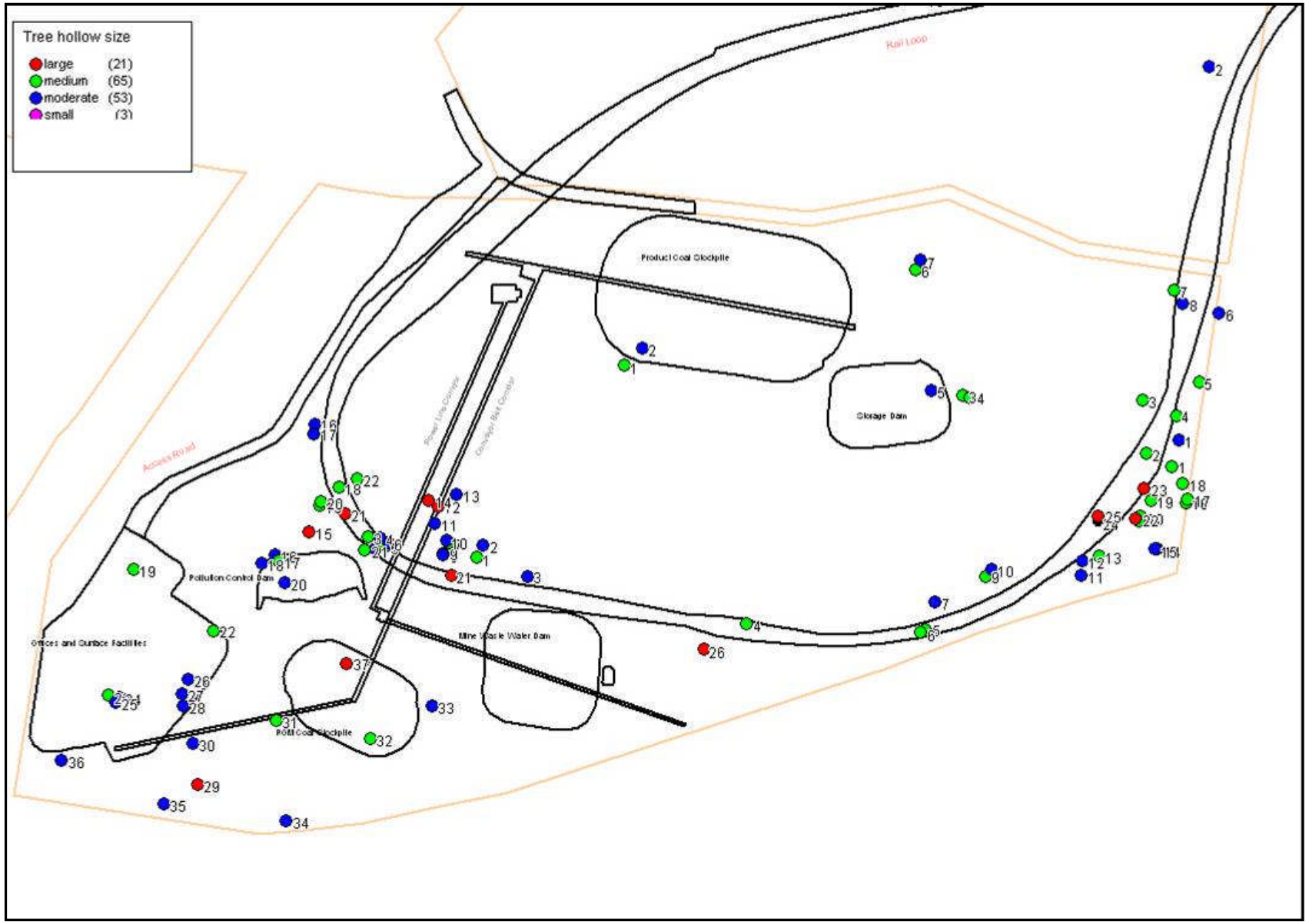


Figure 31: Location and quality of tree hollows over the Tooheys Rd (Sth) study area (No's relate to numbers painted on trees in the field).

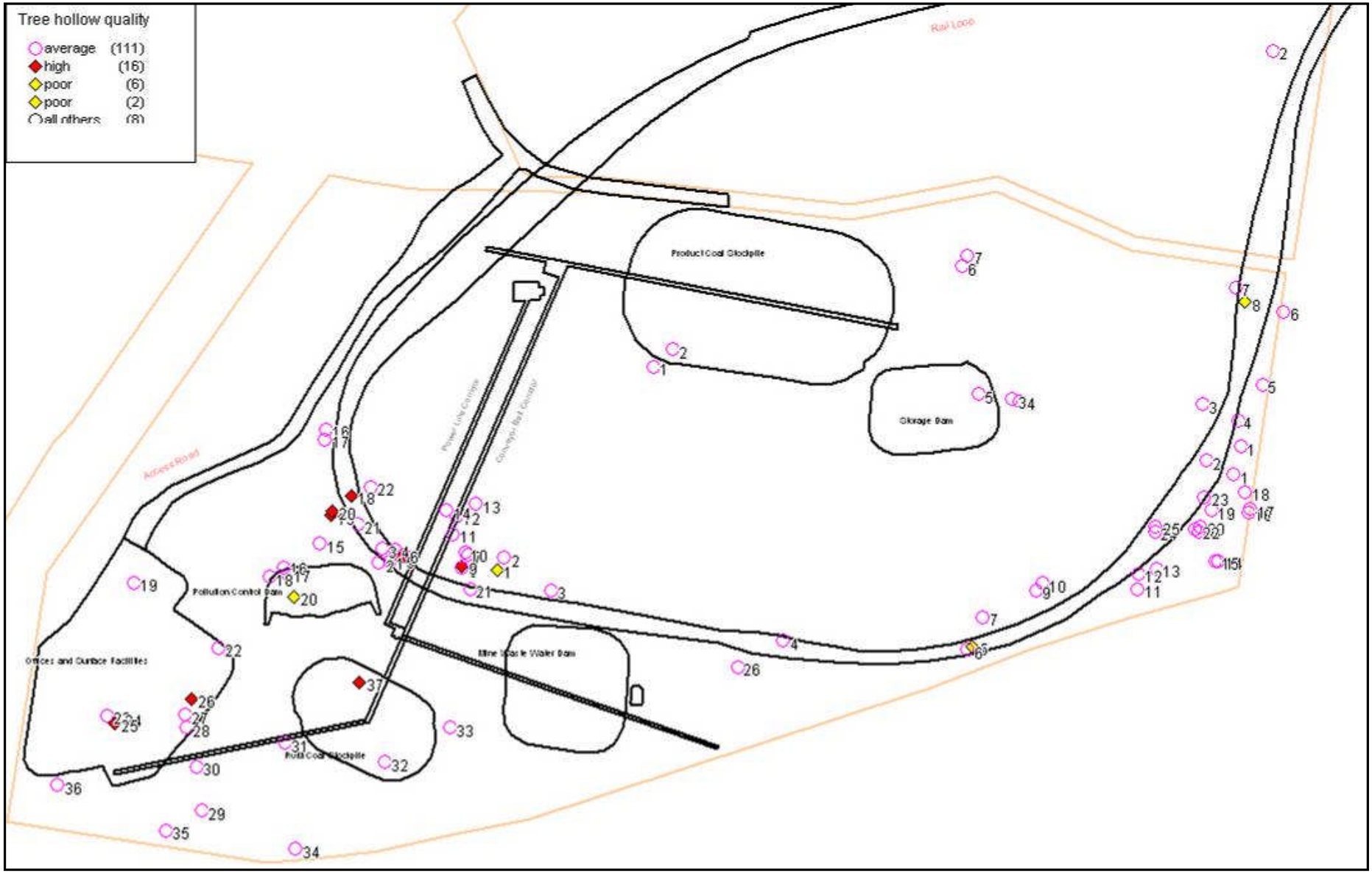


Figure 32: Location and size of tree hollows over the proposed rail loop Nth of Tooheys Rd (No's relate to numbers recorded on the database).

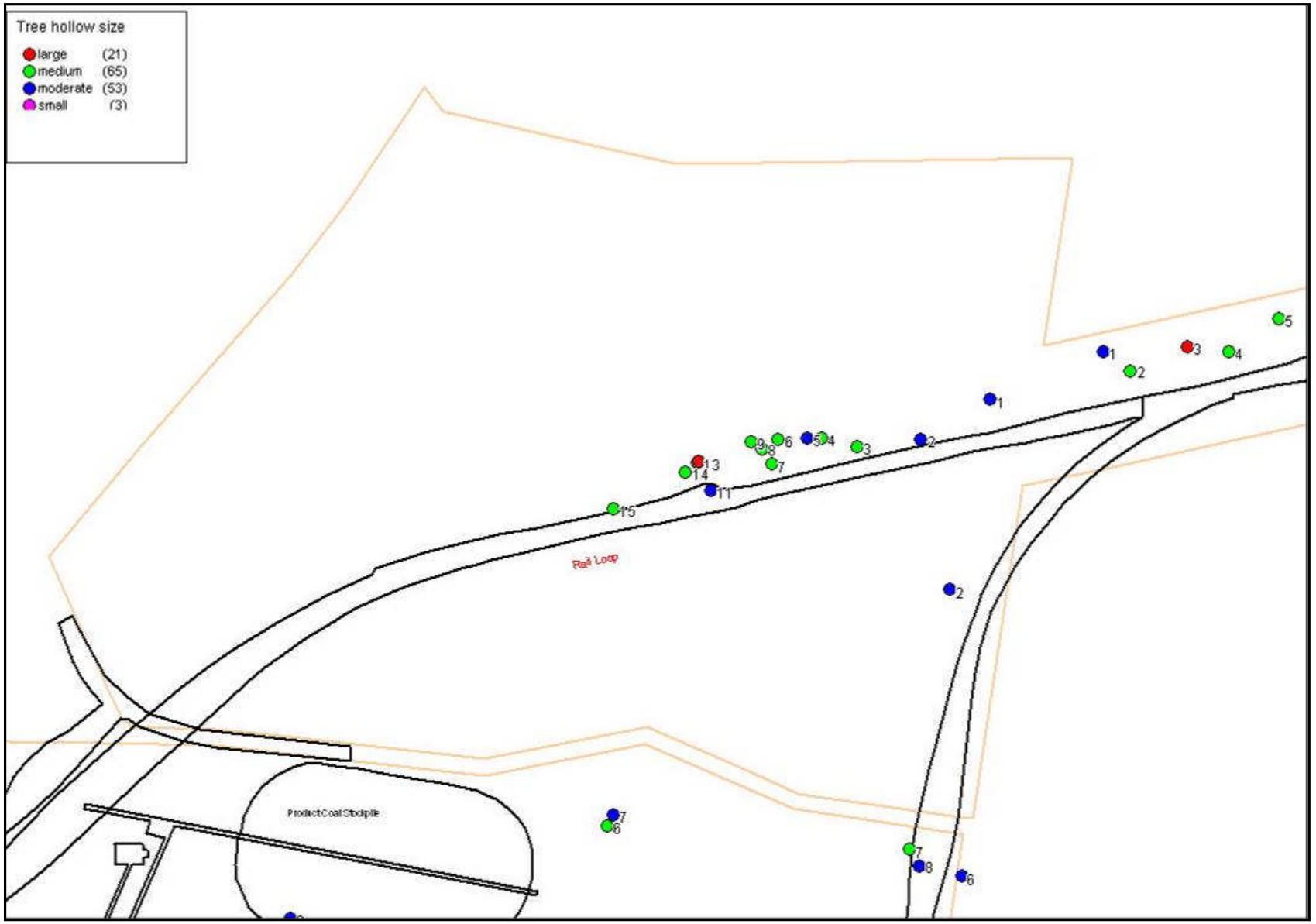


Figure 33: Location and quality of tree hollows over the proposed rail loop Nth of Tooheys Rd (No's relate to numbers recorded on the database).

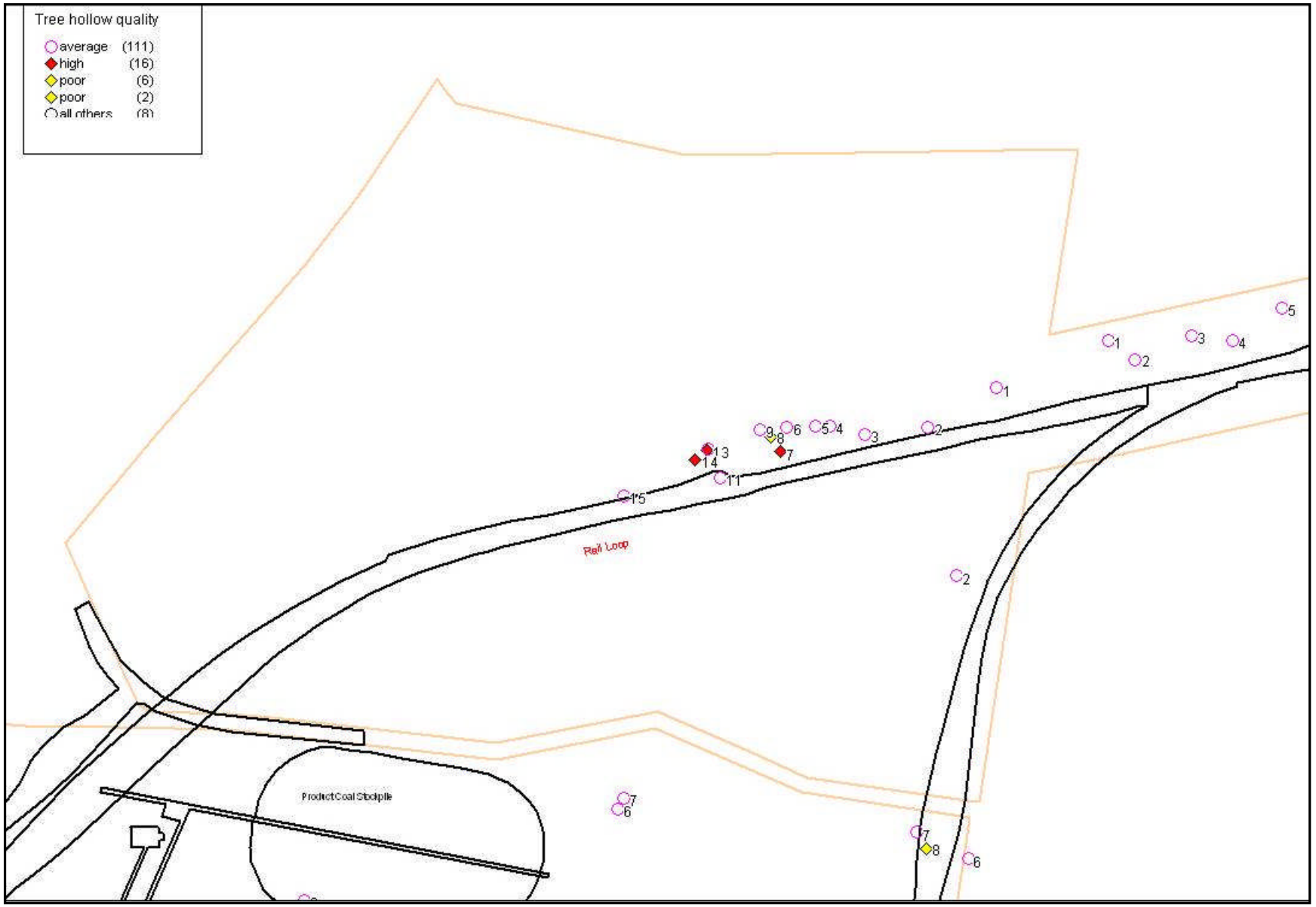


Figure 34: Location and species of trees possessing hollows within the Tooheys Rd rail loop impact footprint on DLALC land.

Figure 35: Location and size of tree hollows over the proposed rail loop Nth of Tooheys Rd (No's relate to numbers recorded on the database).

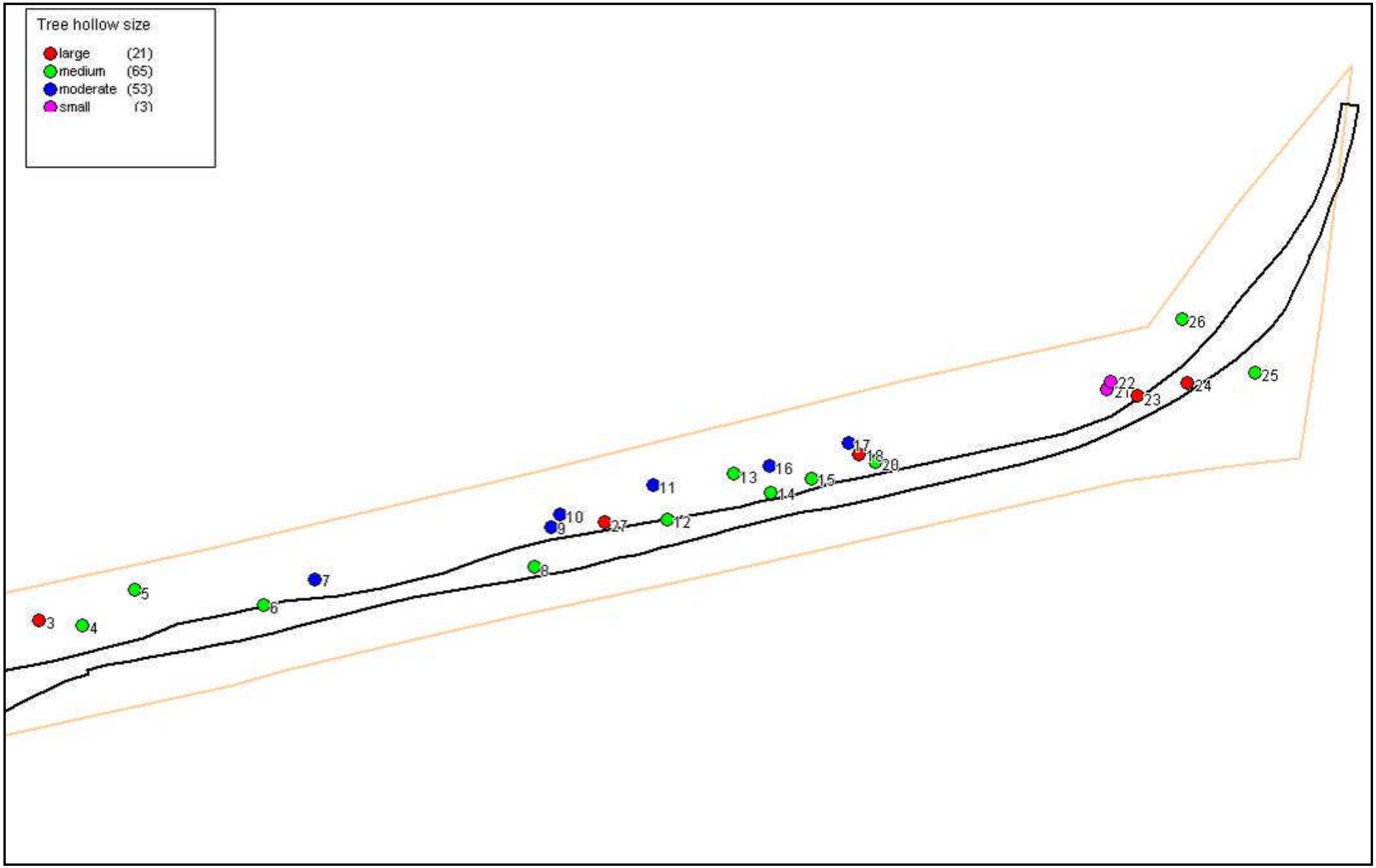


Figure 36: Location and quality of tree hollows over the proposed rail loop Nth of Tooheys Rd (No's relate to numbers recorded on the database).

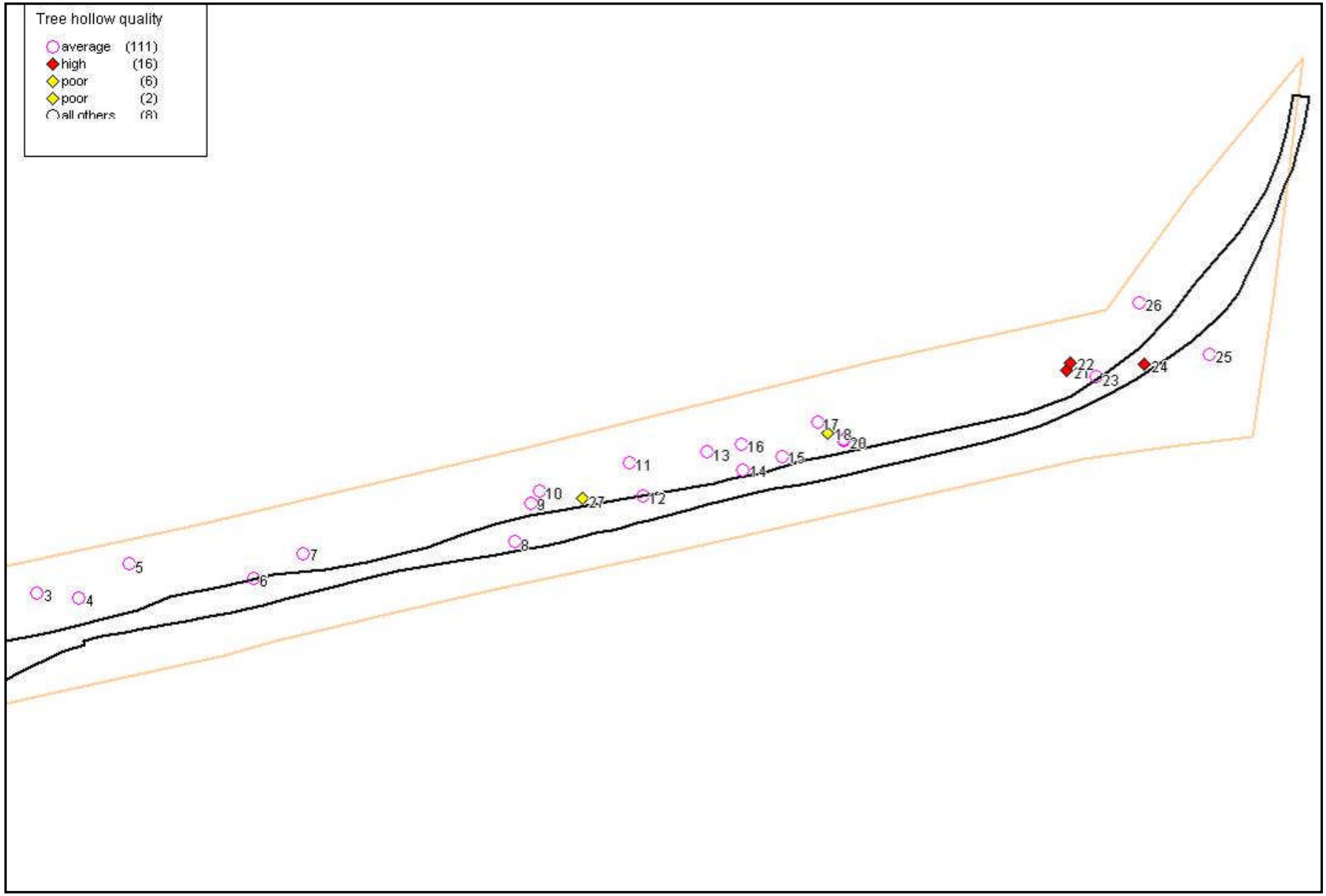


Figure 37: Location and species of trees possessing hollows within the Buttonderry study area.

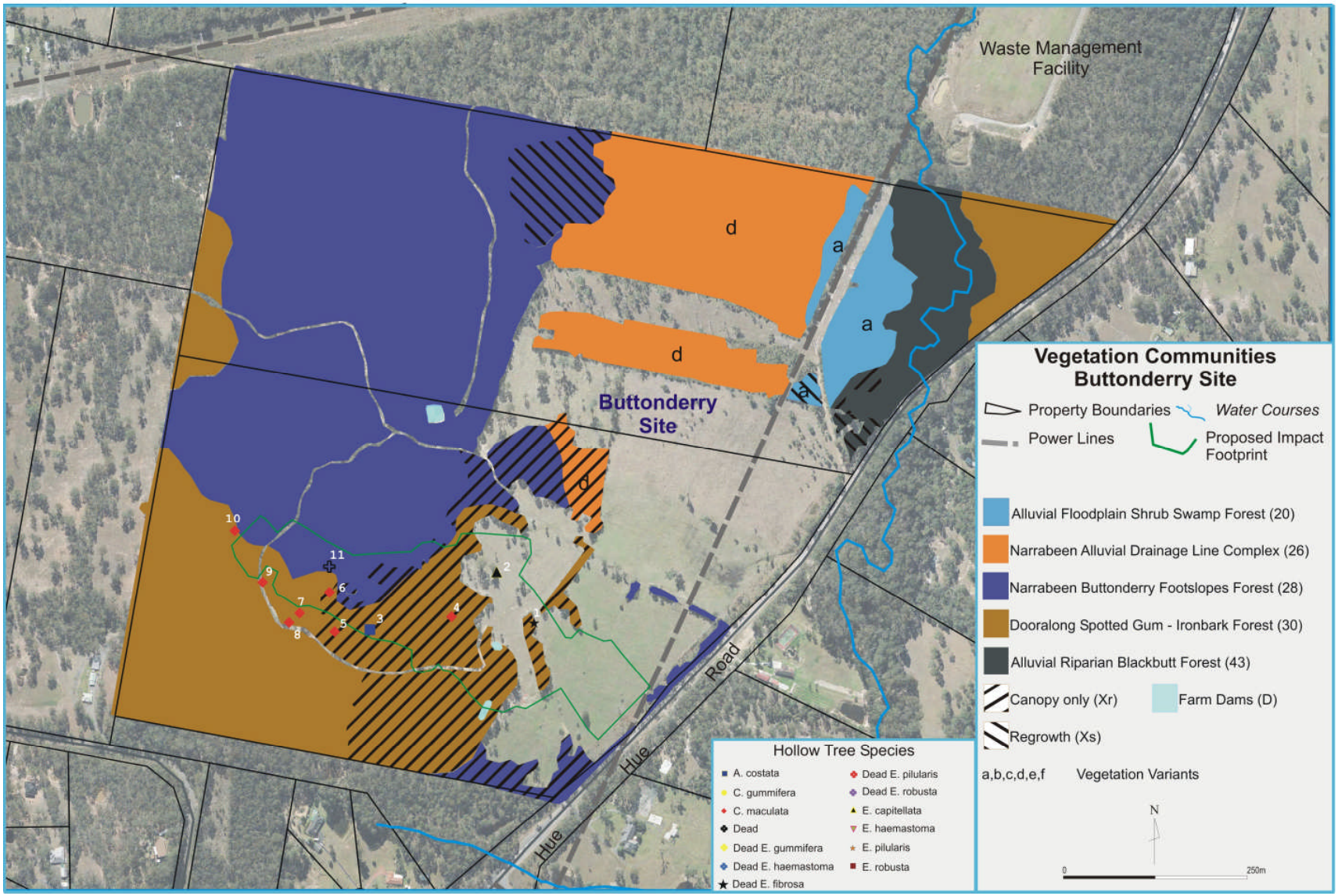


Figure 38: Location and hollow size within the Buttonderry impact footprint (numbers indicate numbers painted on the trees in the field).

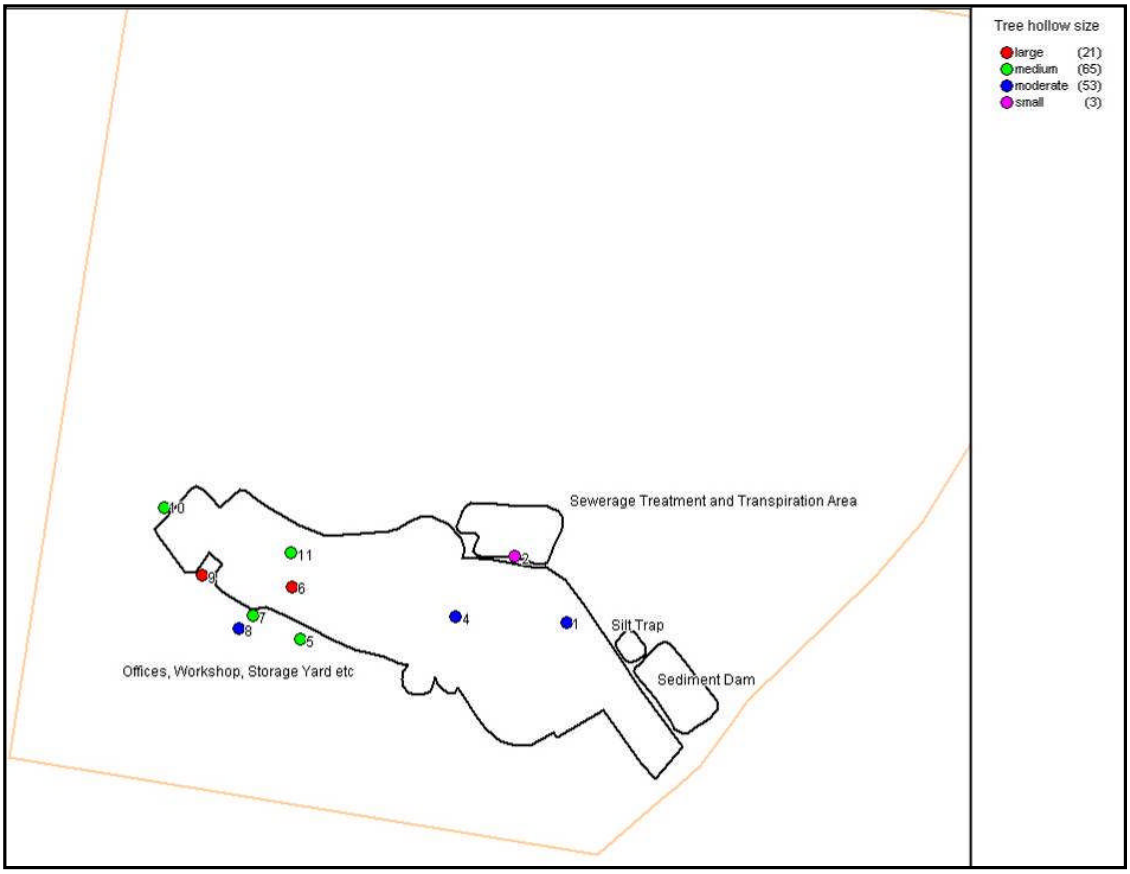
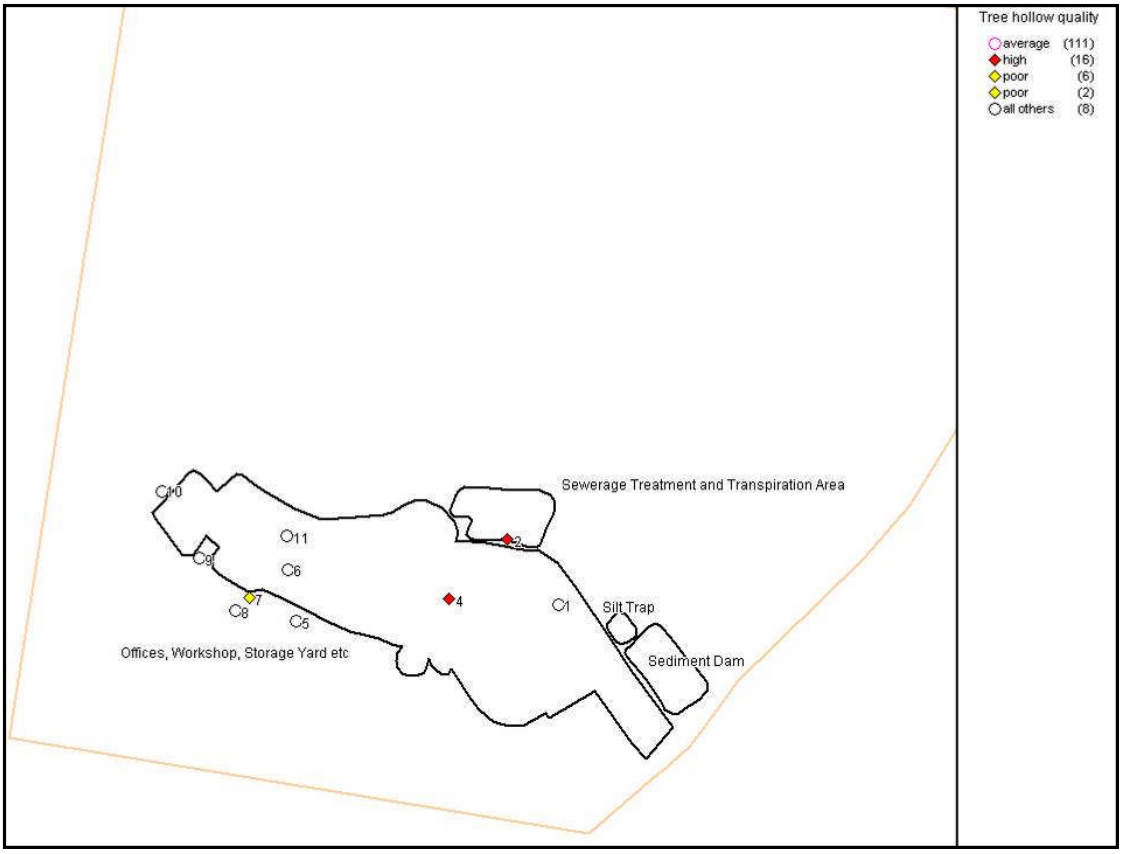


Figure 39: Location and hollow quality within the Buttonderry impact footprint.



Three species of mammals were identified as regionally significant, Eastern Grey Kangaroo, Red-necked Wallaby and the Greater Glider (**Appendix 3**). It is highly likely that the Sugar Glider remains within the assessed areas however, this regionally significant species was not recorded as a result of the assessments.

A large number of frogs have been identified within the study areas (**Appendix 3**), however only 2 of the 16 species recorded are threatened. The Wallum Froglet (*Crinia tinnula*) was recorded on the Tooheys Rd site by ERM in 1999 and according to Orbis citing ERM (2003), in the proposed Hue Hue Rd ecological offset investigation area. This species was not relocated during the OzArk assessment. The second threatened frog recorded was a Green-thighed Frog (*Litoria brevipalmata*) on Buttonderry by ERM in 2003. Dwarf Green Tree Frogs occurring at the dam in Buttonderry look very similar to Green-thighed Frogs. A precautionary approach adopted by OzArk was to frog record calls in the study area, take detailed photographs of observed animals and send them to Mr Frank Lemckert for expert identification. Notwithstanding, frog habitat at Buttonderry will not be impacted however, due diligence has resulted in this species considered as present in the property. Two regionally significant species the Tusked Frog and Lesueur's Frog were recorded in agricultural dams in the Tooheys Rd study area.

Only eight species of reptiles were recorded in the study areas (**Appendix 3**).

5.1.5 Corridors and connectivity

The Draft Wyong Conservation Strategy (2003: 99-105) discusses in detail corridor pathways and environmental fragmentation in the Wyong Shire and maps these as Appendix 9 of the report. According to this map the biggest wildlife corridor is located c. 3 km north of the Tooheys Rd study area, running loosely east – west. Of more relevance to the current study area are four sub-regional pathways identified in the Shire:

- Hawkesbury dry forest pathways;
- Wet forest pathways;
- Riparian pathways; and
- Dry forest and woodland pathways.

Directly applicable to the current study area are findings that state riparian corridors are the most heavily fragmented ecosystems in the Wyong Shire. These of course feature significantly in the assessed areas and retain the highest conservation value of all vegetation map units identified with c. 60% of riparian corridors identified require further plantings or a degree of environmental restoration. The report noted that, due to anthropomorphic impacts most species within this ecosystem that may serve as indicator species are now rare, restricted or too widespread and if pushed, the Wallum Froglet and Green-thighed Frog may be used (as indicator species for a functional riparian community). The Wallum Froglet was recorded by ERM (1999b) in the north of Tooheys Rd proposed rail loop study area in vegetation Narrabeen Alluvial Drainage Line Complex #d and also in the same vegetation unit just north of Wallarah Creek in small farm dam at the same location Squirrel Glider was recorded.

The bulk of wet forest pathways are on private land and are well represented within the Shire. Two indicator species were identified for this ecosystem, the Greater Glider and the Yellow-bellied Glider, both requiring larger areas for conservation however, the Greater Glider has more sensitive corridor requirements. The Greater Glider was recorded by ERM (1999b) and although

the actual location was not contained within the report, assessment of the available habitat would suggest that it was along Spring Creek (Narrabeen Alluvial Drainage Line Complex and its derivatives on DLALC property) on land that is no longer within the current study area. Notwithstanding, Spring Creek, by regional definition is an important wildlife corridor. A tentative sighting of the Yellow-bellied Glider was made by ERM during late 1998. Again location details were not recorded, however site inspection results indicate that it was in association with Wallarah Creek (Alluvial Riparian Blackbutt Forest) where there is a high degree of environmental complexity surrounding the ecotones of the Hue Hue Rd ecological offset investigation area. These environments are considered important as they are the link between remaining vegetation units across a wide variety of topographies.

Dry forest and woodland pathways are also associated with highly fragmented environments. It is within these that most urbanisation has occurred, and as such they are poorly represented in the regions' conservation reserves (Draft Wyong Conservation Strategy 2003: 102). The Squirrel Glider is an indicator species for these environments and extensive studies (Smith 2000, cited by the DWCS 2003: 102) have shown dispersal limits for the distribution of this species in the face of human impact. This species prefers spotted gum/ ironbark (Narrabeen Dooralong Spotted Gum - Ironbark Forest) angophora / scribbly gum woodland, dry sclerophyll forest and some types of swamp forests (Alluvial Footslopes Redgum Forest, Alluvial Floodplain Shrub Swamp Forest, Narrabeen Alluvial Drainage Line Complex, Narrabeen Buttonderry Footslopes Forest, Narrabeen Doyalson Scribbly Gum Woodland and their derivatives) all of which occur throughout the assessed areas. The Squirrel Glider recorded within the Tooheys Rd study area was within Narrabeen Doyalson Scribbly Gum Woodland and Narrabeen Alluvial Drainage Line Complex and their derivatives however this was close to Alluvial Riparian Blackbutt Forest where more abundant and higher quality sheltering habitat occurred. Targeted re-survey of this area did not result in identification of the species again, but it was noted that key habitat elements required for the species remain extant and will remain largely unchanged as a result of the current proposal.

Perhaps the greatest opportunity for keystone species conservation associated with the current project lies with the protection of wildlife corridors for the Squirrel Glider. The Hue Hue Rd ecological offset investigation area provides a range of vegetation map units favoured by this species, as well as the best connectivity and patch size of all the current study areas. Despite the potential removal of habitat elements within the main impact footprint at Tooheys Rd in Wallarah Creek will remain largely unaffected and resources associated with mining are more likely to result in habitat restoration and protection of this wildlife corridor than that associated with continued grazing agriculture.

Figures 21 to 23 clearly show the degree of connectivity available within the currently assessed areas. The Western shaft site is part of a managed State Forest and by default has good connectivity.

The mapped units and their description give the reader an excellent overall picture of how disturbance within the study area can limit movement to surrounding remnants by particular species. A general rule of thumb is that mapped units with solid colour retain all vegetative layers and are more likely to be used as wildlife corridors for the full range of potential species and as such have a higher conservation value. Connectivity of the existing environment will be affected in the following ways:

Tooheys Rd and DLALC land

The rail loop will only fragment one area of high quality vegetation (Alluvial Riparian Blackbutt Forest) south of Wallarah Creek for a proposed rail crossing (**Figure 29**). All other areas to be impacted are either already modified i.e. Alluvial Riparian Blackbutt Forest Xr or alternately habitat to be removed is an extension of an existing area of disturbance i.e. proposed rail loop north of Tooheys Rd associated with the TransGrid easement. The area to undergo the highest degree of fragmentation are Narrabeen Doyalson Scribbly Gum Woodland and Narrabeen Alluvial Drainage Line Complex and their derivative south of Wallarah Creek, within the proposed rail loop impact footprint. On a broader perspective this patch of remnant vegetation is itself isolated from other remnants to the south by Motorway Link Rd and to the north, east and west of Wallarah Creek by previous clearing.

Buttonderry direct impact footprint area

Figure 37 shows the extent of habitat fragmentation within this study area. The impact footprint overlain on this figure clearly indicates that fragmentation of an existing corridor will not occur.

Western shaft study area (Wyong State Forest)

The Western shaft study area is located within a managed state forest (DPI- Forests NSW). As such there are good levels of connectivity associated with the area. The proposal will see an approximate 150 x 80 m area cleared for this proposed facility which is located on Brothers Rd. The size and extent of the study area in association with existing levels of disturbance associated with the road does not affect the degree of connectivity in the immediate environs.

5.2 Species, populations and communities of conservation concern

5.2.1 Critically endangered, endangered and ecological communities of regional and local significance

A search of the DEWHA online database (Protected matters report, **Appendix 2**) shows that there are two Critically Endangered Ecological Communities with potential to occurr within the Wyong LGA - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland and Littorial Rainforest and Coastal Vine Thickets of Eastern Australia are noted as having the potential to occur within the LGA.

A combined geographic and habitat search on the DECCW databases focussed on the Hunter/Central Rivers > Wyong Catchment Management Area showed that there are 12 EEC's have the potential to occur within the Catchment Management Area. Of these six are known to be recorded in the Wyong LGA:

- Swamp Sclerophyll Forest on Coastal Floodplains NSW North Coast, Sydney Basin and South-East Corner bioregions (SSFCF);
- Sydney Freshwater Wetlands (SFW);
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (FWCF);

- River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions (RFEFCF);
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-East Corner bioregions (SOFF); and
- Low Woodland with Heath on indurated sands at Norah Head (LWHISNH).

EECs and vegetative communities with regional and local significance within the study area are discussed in greater detail in Section 5.1.1 of this report where their relationship to the mapped vegetation units is applied.

Two of the Endangered Ecological Communities listed in the TSC Act are present (Swamp Sclerophyll Forest on Coastal Floodplains, River Flat Forest on Coastal Floodplains), as are several of regional and local significance (see Section 5.3 and **Table 14**). A third EEC (Lower Hunter Spotted Gum - Ironbark Forest) is also present, and is the subject of a detailed additional assessment contained in **Appendix 9.**

5.2.2 Endangered populations

A search of the DEWHA online database (Protected matters report, **Appendix 2**) shows that there are no endangered populations within the Wyong LGA.

A combined geographic and habitat search on the DECCW databases focussed on the Hunter/Central Rivers > Wyong Catchment Management Area showed that there are two endangered populations occurring in the search area. Neither *Eucalyptus oblonga* (Narrow leaved Stringybark) population at Bateau Bay nor the *Eucalyptus parramattensis* subsp. *parramattensis* population in the Wyong and Lake Macquarie LGA's was recorded within the assessed areas.

5.2.3 Endangered, threatened, regionally and locally significant flora species

Appendix 2 shows DECCW and DEWHA search results for flora and section 5.1.1, 4.2.3 and **Table 11** explains in detail what threatened species are likely to occur and contextualises regionally and locally significant flora species.

5.2.4 Endangered, threatened, regionally and locally significant fauna species

A search of the DEWHA online database shows that there are a number of fauna species with legislative protection within the Wyong LGA (**Table 11**). A full transcript of these listings can be seen as **Appendix 2**. No fauna species listed as endangered or threatened under the EBPC Act were recorded within the assessed areas, however the White Bellied Sea Eagle, a migratory terrestrial species, was recorded overflying the Tooheys Rd study area and the fork-tailed swift (Listed Marine Species) has been recorded adjacent to the proposed rail loop study area in what appears to be DLALC land.

Table 11: Summary of items with legislative protection under the EPBC Act in the Wyong LGA.

Threatened Ecological Communities:	2
Threatened Species:	51
Migratory Species:	60
Listed Marine Species:	89

A combined geographic and habitat search on the DECCW databases focussed on the Hunter/Central Rivers > Wyong Catchment Management Area showed that there are 75 species of animals with legislative protection within the Wyong area (**Appendix 2**). These include:

- 39 bird species (5 endangered and 34 vulnerable);
- 6 reptile species (2 endangered and 4 vulnerable);
- 8 frog species (3 endangered and 5 vulnerable);
- 11 mammal species excluding bats (1 endangered and 10 vulnerable); and
- 11 species of bats (all vulnerable).

Of these animals, ten (10) threatened species of fauna were recorded as a combined result of previous and current environmental assessments of the W2CP study areas (**Table 12**). The most commonly recorded animal species were microchiroptean bats (n=4) with two threatened species of arboreal mammals, two species of owl and two species of frog, known to occur within the boundaries of the current study areas. The locations of these species and the vegetative communities they were recorded in are shown on **Figure 40.** The location for the Green-thighed Frog cannot be given as it is only known to have been recorded at Buttonderry.

Other species noted by DECCW and DEWHA as having the potential to occur, but had not been recorded underwent further assessment based upon a desktop review of habitat requirements documented by DECCW and their potential to occur based upon previous DECCW records for the area. These were overlain with the potential impact from the proposal on key habitat elements essential for their survival. Of these, thirteen were considered likely to be affected by the proposed development and as such require assessments of significance (**Appendix 4).**

Table 12: Threatened species recorded within the current study areas.

Scientific name	Common name	NSW status	Comment
Myotis adversus	Large-footed Myotis	V	Tooheys Rd
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	Tooheys Rd, Hue Hue Rd pot offset
Scoteanax rueppellii	Greater Broad-nosed Bat	V	Hue Hue Rd pot offset
Falsistrellus tasmaniensis	Eastern false pipistrelle	V	Tooheys Rd (diff ID is *Scoteanax rueppellii)*
Petaurus norfolcensis	Squirrel Glider	V	Tooheys Rd
Petaurus australis	Yellow-bellied glider	V	Hue Hue Rd pot offset
Crinia tinnula	Wallum Froglet	V	Tooheys Rd
Litoria brevipalmata	Green-thighed Frog	V	Buttonderry
Ninox strenua	Powerful Owl	V	Tooheys Rd
Tyto novaehollandiae	Masked Owl	V	North of Tooheys Rd

Review of the Draft Wyong Conservation Strategy (2003: Appendix 6) revealed that there are nine species of animals that are considered regionally significant. These include:

- Great Barred Frog (*Mixophyes fasciolatus*) and the Brown Toadlet (*Pseudophryne bibronii*) which are considered as declining in the region (DWCS 2003 citing Mahony 1993);
- Red-eyed Tree Frog (*Litoria chloris*) which is considered as an indicator species for wet riparian fauna habitat;
- Southern Angle-headed Dragon (*Hypsilurus spinipes*) which is considered as an indicator species for wet sclerophyll habitat and gully rainforests in the southern range limit;
- Southern Emu-wren (*Stipiturus malachurus*)is an indicator species for heath / scrub;
- Northern Brown and Long-nosed bandicoots (*Isoodon macrourus* and *Permeles nasuta*) are indicator species however are also considered to be at risk from predation by foxes and cats;
- Gould's Long-eared Bat (*Nyctophilus gouldi*) is an indicator species that are impacted by frequent burning in moist forest (DWCS 2003 citing Smith *et al.* 1994 and 1995);
- Greater Glider (*Petauroides volans*) is considered to be an indicator species for forestry and wet sclerophyll forests; and
- Feather-tailed Glider (*Acrobates pygmaeus*) is considered an indicator species in relation to the affects of fragmentation.

Only the Greater Glider has been previously recorded within the Tooheys Rd study area (ERM 1999b). As previously mentioned this study area was much larger than the current and the only habitat suitable for this species is no longer within the W2CP impact footprint. Those species identified as regionally significant in the Lake Macquarie City Council Flora and Fauna Survey Guidelines V 2.0 (2001) was included in the earlier text.

Figure 40: Locations of threatened fauna species recorded in relation to vegetation units within the Tooheys Rd study area.

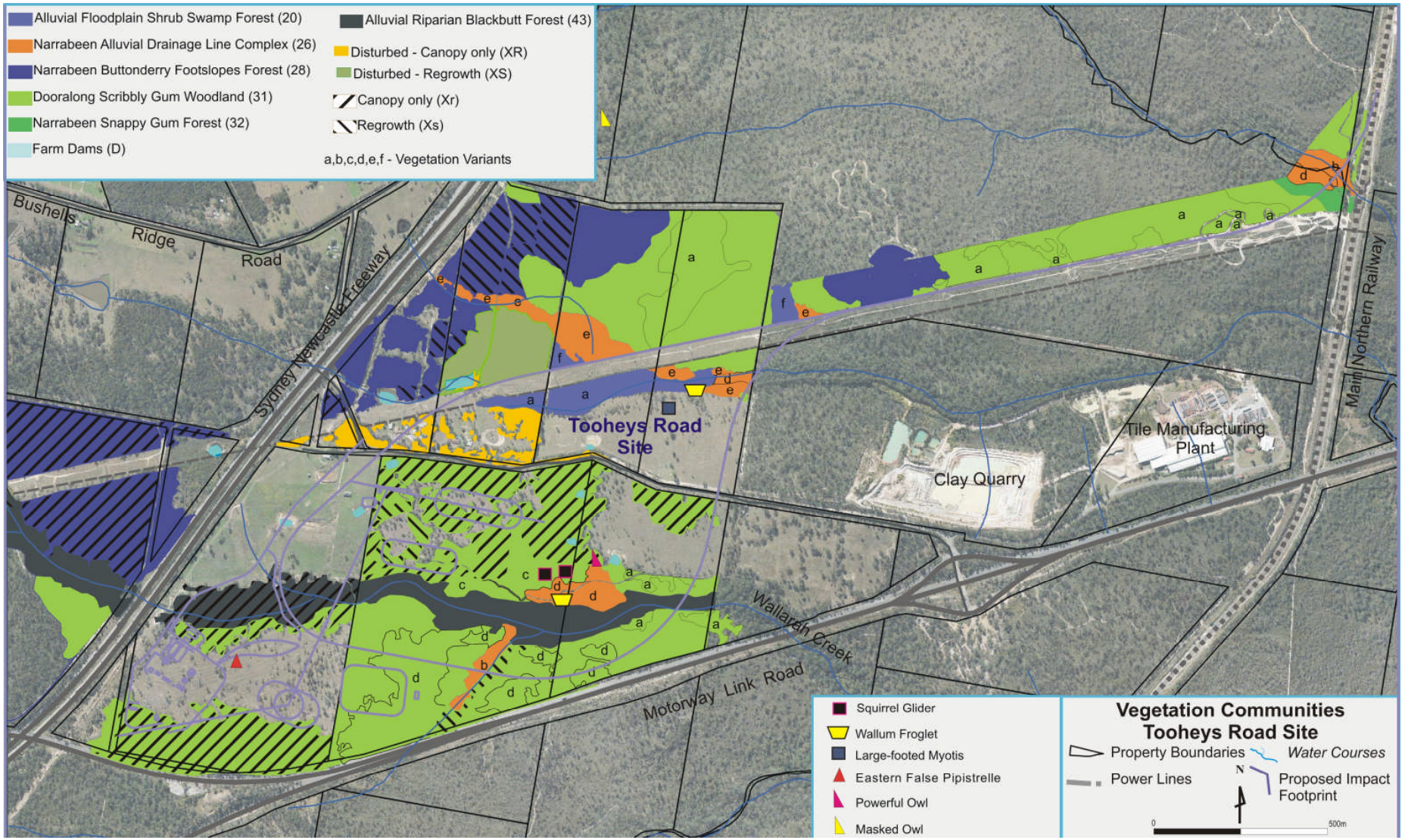
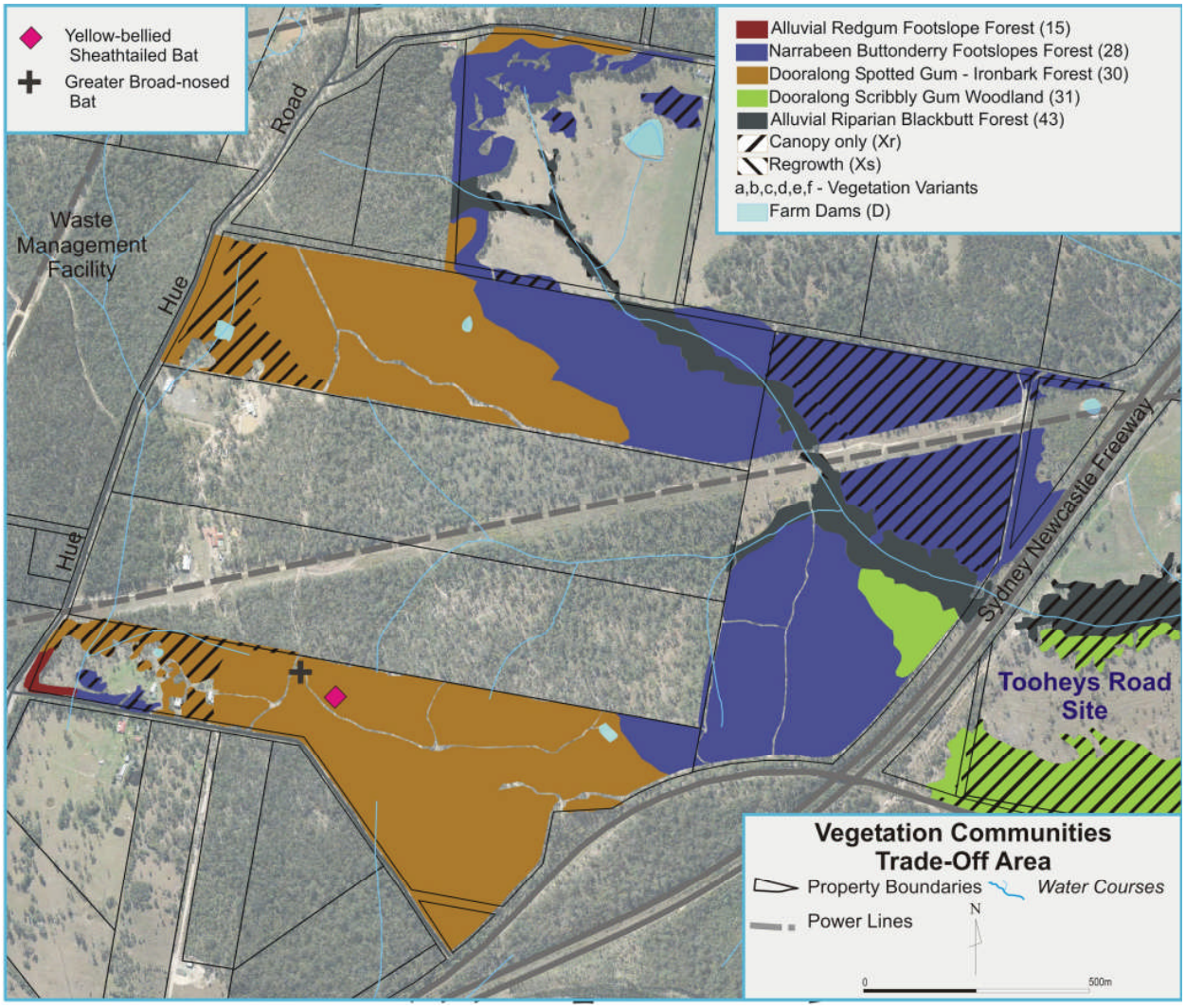


Figure 41: Locations of threatened fauna species recorded in relation to vegetation units within the Hue Hue Rd ecological offset investigation area.



5.2.5 Migratory species

Only one migratory species, the White Bellied Sea Eagle *(Haliaeetus leucogaster),* was observed current assessments. The fork-tailed swift has been previously recorded on DLALC land (unknown auspices). The eagle species is listed under the EPBC Act as a migratory terrestrial species and a listed marine species, the swift is a listed marine species.

5.2.6 Key threatening processes

5.2.6a Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* include (As at Feb 2008):

A list of Key Threatening Processes in NSW has been provided as **Table 13**.

Table 13: NSW Key Threatening Processes

KTP	Active in Study Area Prior to activity ?	Will the activity exacerbate the KTP?	Will the activity offset the KTP?
Alteration of habitat following subsidence due to longwall mining	No	No	No
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Yes	Yes	Yes
Anthropogenic climate change	Yes	Yes	Unknown
Bushrock removal	No	No	No
Clearing of native vegetation	Yes	Yes	Yes
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	Yes	No	Yes
Competition and habitat degradation by feral goats (*Capra hircus*)	No	No	No
Competition from feral honey bees (*Apis mellifera*)	Yes	No	No
Death or injury to marine species following capture in shark control programs on ocean beaches	No	No	No
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments	No	No	No
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	Unknown – suspect not	No	No
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Yes	No	No
Herbivory and environmental degradation caused by feral deer	No	No	No
Importation of red imported fire ants (*Solenopsis invicta*)	No	No	No
Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	No	No	No
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Unknown – suspect not	No	No
Infection of native plants by *Phytophthora cinnamomi*	No	No	No
Introduction of the large earth bumblebee (*Bombus terrestris*)	No	No	No
Invasion and establishment of exotic vines and scramblers	Yes	No	Yes
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	No	No	No
Invasion and establishment of the cane toad (*Bufo marinus*)	No	No	No
Invasion, establishment and spread of *Lantana camara*	Yes	No	Yes
Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed)	No	No	No
Invasion of native plant communities by exotic perennial grasses	Yes	No	Yes
Invasion of the yellow crazy ant (*Anoplolepis gracilipes* (Fr. Smith)) into NSW	No	No	No
Loss of hollow-bearing trees	Yes	Yes	Yes
Loss or degradation (or both) of sites used for hill-topping by butterflies	No	No	No
Predation and hybridisation of feral dogs (*Canis lupus familiaris*)	No	No	No
Predation by the European red fox (*Vulpes vulpes*)	Yes	No	Yes
Predation by the feral cat (*Felis catus*)	Yes	No	Yes
Predation by *Gambusia holbrooki* Girard, 1859 (plague minnow or mosquito fish)	Unknown – suspect they are present	No	No
Predation by the ship rat (*Rattus rattus*) on Lord Howe Island	N/A	N/A	N/A
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	No	No	No
Removal of dead wood and dead trees	Yes	Yes	Yes

With respect to the above:

- Alteration of habitat following subsidence due to longwall mining:
    - The direct impact area is not within the limits of the subsidence area thus this KTP is not associated with this assessment.

- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands:
    - This KTP is relevant within the direct impact areas as Spring Creek and Wallarah Creeks will be impacted by the proposed rail loop. Section 5.2.9 of this report discusses the issues with respect to DPI (Fisheries) issues.
- Clearing of native vegetation:
    - The primary impact of the proposed W2CP surface facilities is the removal of 4.54 of 56.59 ha of native vegetation at the Buttonderry study area, 17.27 ha (of 261.97 ha) of native vegetation at the Tooheys Rd study area and 0.92 ha of native vegetation within the Wyong State Forest. Cumulatively, W2CP direct impacts will removal 22.73 ha of native vegetation. An estimated additional 10 ha of native vegetation will also be removed within DLALC land adjoining the TransGrid easement for the purpose of the proposed rail loop. Section 6.1.1 addresses the impacts of the proposed works to native vegetation within the study area.
- Loss of Hollow-bearing Trees:
    - In total 142 trees within the impact footprints were identified as having hollows (**Figures 29 to 39**). Cumulatively, only 14.7% (n=21) of all trees recorded contained large hollows, 37.3% contained moderately sized hollows (n=53), 45.7% (n=65) contained medium sized hollows whilst only 2.1% (n=3) contained small hollows. Section 5.1.3(f) of this report provides more information.
- Removal of dead wood and dead trees:
    - Very few dead trees will be removed as a result of this project and of those trees to be removed some have 'dead wood' in the canopy. Section 5.1.3(f) of this report provides more information.

5.2.6b Key threatening processes identified in the *Fisheries Management Act 1994*

- **Current shark meshing program in NSW waters.** This key threatening process has no relevance to the current proposal.
- **Hook and line fishing in areas important for the survival of threatened fish species.** This key threatening process has no relevance to the current proposal.
- **The introduction of fish to fresh waters within a river catchment outside their natural range.** This key threatening process has no relevance to the current proposal.
- **The removal of large woody debris from NSW rivers and streams.** An assessment of the impact footprint where the rail loop crosses Spring and Wallarah Creeks has shown that there is no woody debris to be removed. This key threatening process has no relevance to the current proposal.
- **The degradation of native riparian vegetation along New South Wales water courses.** An area of native vegetation is likely to be cleared for the proposed development. While this is a small area of riparian vegetation it may contribute to the cumulative degradation of native riparian vegetation in the area.
- **In stream structures and other mechanisms that alter natural flow - see also: cold water pollution.** All infrastructure will be designed to be sympathetic with recommended structures in Fairfull and Witheridge (2003) and as such will not alter the natural flow of Spring or Wallarah Creeks.

- **Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales.** This key threatening process has no relevance to the current proposal.

5.2.7 Critical habitat

A search of the DECCW and DEWHA online databases shows there are no critical habitats in the study areas.

5.2.8 SEPP 44 – Koala Habitat Protection

The Wyong Local Government Area is identified under Schedule 1 – Local Government Areas of *State Environmental Planning Policy No 44 (SEPP 44) – Koala Habitat Protection*. This policy seeks to protect the species by encouraging the proper conservation and management of areas that provide habitat for Koalas. All study areas except for the Western shaft area contains two preferred Koala feed tree species listed in Schedule 2 of the policy, *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus haemastoma* (Broad-leaved Scribbly Gum).

The study areas are also within the Central Coast Koala Management Unit area identified in the Draft Koala Recovery Plan, which includes *E. tereticornis* (Forest Red Gum) as a primary feed tree and *E. capitellata* (Brown Stringybark) as a supplementary feed tree species, but only Brown Stringybark occurs in the study areas (excluding Western shaft).

A colony of Koala was once known from the Wyong LGA (Parsons Brinckerhoff 2005 citing Payne 2002b), however records are scattered and the nearest record of a Koala is two kilometers to the south of the Tooheys Rd study area (Parsons Brinckerhoff 2005 citing Department of Environment and Climate Change 2005a).

Habitats connecting each study area to the location of the above mentioned record are fragmented by urban development. Scattered emergent eucalypts including *Eucalyptus robusta* and *Eucalyptus capitellata* occur within vegetation Narrabeen Alluvial Drainage Line Complex, Narrabeen Buttonderry Footslopes Forest and Narrabeen Doyalson Scribbly Gum Woodland. The density of feed trees in these areas does not meet the SEPP44 definition of potential Koala habitat.

5.2.9 NSW DPI (Fisheries) issues

5.2.9a Assessment of existing fish communities and aquatic habitats

This section has been written following the guidelines in *Why do Fish Need to Cross the Road? Fish Passage requirements for Waterway Crossings* (Fairfull and Witheridge 2003).

- *1. Importance of the waterway and its associated fish and fish habitat:*

Spring and Wallarah Creeks are named waterways with permanent to intermittent flows. Free standing water, pools and aquatic vegetation is present along these creeks in the current study areas. As the banks of the creeks are well defined and the creeks connect to other wetland areas, a Class 2 classification is relevant as there may be potential for refuge, breeding or feeding areas for some aquatic fauna (e.g. fish & yabbies). Class 2 classification equates with Moderate Fish Habitat. Minimum crossing requirements recommended for Class 2 waterways are a bridge, arch structure, culvert (*2)* or ford. Culvert *2* = High priority should be given to the "High Flow

Design" presented in the final design of these culverts by referring to design considerations in the following section of this document.

- *2. Habitat compensation:*

Under NSW Fisheries Policy and Guidelines for Aquatic Habitat Management and Fish Conservation 1999, a 2:1 habitat compensation policy for any fish habitat losses associated with development exists. Within the immediate environs of the creeks several mature trees, understory and ground layer vegetation exists which has been described as Narrabeen Alluvial Drainage Line Complex, Narrabeen Doyalson Scribbly Gum Woodland, Narrabeen Snappy Gum Forest and Alluvial Riparian Blackbutt Forest. Due to the linear nature of the proposed development, impacts will transect the creek bank vegetation thus keeping vegetation removal associated with the waterways to a minimum. The replacement of the removed trees with twice of that which was removed will be recommended in the site rehabilitation. As Wallarah Creek is generally dry, fish habitat is usually absent however, Spring Creek may provide habitat for native species of fish.

- *3. Blockages to fish passage:*

A permit to temporarily or permanently block fish passage is required if either creek is to be blocked by silt fencing, construction of mounded access tracks or any other work that requires modifying the creek bed in a way that will prevent the natural flow of the creek. Given that this project is being assessed under Part 3A of the EP&A Act, a Permit will not be required however, work should be undertaken with a duty of care to ensure both creeks will not be blocked as a result of the proposal. In this event best practice is to following advice from DPI –Fisheries re: maintaining fish passage during construction.

- *4. Significance of impacts of the development on threatened species listed under the Fisheries Management Act 1994:*

Items of conservation concern identified by the NSW DPI (Fisheries) include:

Species presumed extinct

A species is eligible to be listed as presumed extinct if, in the opinion of the Fisheries Scientific Committee, it has not been recorded in its known or expected habitat over a time frame appropriate to its life cycle.

- Bennetts seaweed - *Vanvoorstia bennettiana*
- Green sawfish - *Pristis zijsron*
- Haswells caprellid - *Metaprotella haswelliana*

Critically endangered species

- Grey nurse shark - *Carcharias taurus*
- Murray hardyhead - *Craterocephalus fluviatilis*
- Marine brown alga - *Nereia lophocladia*
- Flathead galaxias - *Galaxias rostratus*
- Marine slug - *Smeagol hilaris*

Endangered species

- Eastern freshwater cod - *Maccullochella ikei*
- Oxleyan pygmy perch - *Nannoperca oxleyana*
- River snail - *Notopala sublineata*
- Southern bluefin tuna - Thunnus maccoyii
- Trout cod - *Maccullochella macquariensis*
- Sydney hawk dragonfly - *Austrocordulia leonardi*
- Adams emerald dragonfly - *Archaeophya adamsi*
- Macquarie perch - *Macquaria australasica*
- Southern pygmy perch - *Nannoperca australis*
- Purple spotted gudgeon - *Mogurnda adspersa*

Vulnerable species

- Black cod - *Epinephelus daemelii*
- Buchanans fairy shrimp - *Branchinella buchananensis*
- Great white shark - *Carcharodon carcharias*
- Silver perch - *Bidyanus bidyanus*

Endangered populations

- Western population of olive perchlet - *Ambassis agassizii*
- Snowy River population of river blackfish - *Gadopsis marmoratus*
- Murray-Darling Basin population of eel tailed catfish - *Tandanus tandanus*

Critically endangered ecological communities

There are currently no critically endangered ecological communities listed

Endangered ecological communities

- Lowland Murray River aquatic ecological community
- Lowland Darling River aquatic ecological community
- Lowland Lachlan River aquatic ecological community

Vulnerable ecological communities

- There are currently no vulnerable ecological communities listed.

The DEWHA notes the following species as having potential to occur within the Wyong LGA:

- Australian Grayling (*Prototroctes maraena);* and
- Macquarie Perch (*Macquaria australasica*).

A review of the BioNet database shows that no species of threatened fish, crustaceans, molluscs or algae have been previously recorded within the Wyong LGA. Consultation with the DPI[7] (NSW Fisheries) confirms that none of these fish species have been recorded in or near the study area locality and from local knowledge they are unlikely to occur. A review of DPI sample point data in the Wyong area (**Appendix 2**) shows that Adams Dragonfly has been previously recorded in Tuggerah and given the species ecological niche requirements, it has potential to occur within Spring Creek and to a lesser degree the Tooheys Rd study area.

An assessment of significance for the Adams Dragonfly has been provided in Section 6.3.2 of this report.

- *5. Predictions regarding the type and extent of impact on fish, fish habitat and fish passage:*

The impact on fish habitat will be minimal if the Proponent ensures and monitors compliance with environmental protection though their standard operating procedures for soil and water management. Fish passage will not be affected however, if any barrier permanent or temporary is to be erected during construction then consultation with DPI-Fisheries will be required (see point 3 above).

- *6. Potential impacts to surface water and groundwater flows as a result of the project:*

Potential impact to surface water could arise through sediment movement associated with removal of vegetation, dredging, excavation, and construction. Ground water quality will not be impacted if appropriate mitigative measures are undertaken. The direction of ground water flow will not change after the proposed works are completed.

- *7. Map of all waterways and drainage lines on the project, indicating connectivity and direction of flow both pre and post construction.*

See section 3.2.1a of this report.

5.2.9b Fisheries licences and permits

This project will be assessed under Part 3A of the EP&A Act. No permits will be required under Part 7, Div 3 of the *FM* Act 1994, however a Statement of Commitments is required in lieu of permits.

If the Proponent is to engage in a dredging and reclamation activity it would be advisable to seek advice from DPI (NSW Fisheries) in writing prior to any proposed dredging or reclamation associated with bridge work. Copies of the proposed construction and bridge design plans and the timing of all proposed waterway construction should be forwarded to DPI Fisheries for consideration. Early notification will ensure that any concerns identified can be adequately addressed.

[7] Brett, Field Officer – DPI (Fisheries) The Entrance Office 13.12.06

Where bridges have been identified in the drawings provided, the following constraints are relevant:

1. No temporary culverts shall be built, only bridges shall be used to cross these waterways. This may be negotiated on a case by case basis with the Project Manager and the DPI (NSW Fisheries);
2. In-stream pylons are to be kept to an absolute minimum;
3. No earthen platforms for driving pylons will be constructed; and
4. Embankments must be kept away from the edge of waterways.

5.2.9c Recreational fishing activities

Wallarah Creek is dry unless significant rainfall occurs. There is no opportunity to fish in the creek within the study area, or downstream, hence there is no significant potential impact from the proposed works on fishing activities. Spring Creek however, may provide opportunity for anglers downstream. The Proponent will undertake appropriate erosion and sediment control during and post construction, to ensure mitigative measures are undertaken at all relevant times.

5.2.9d Design considerations for crossing Class 1 – 4 Waterways

All waterway crossings must be designed in accordance with *Why do fish Need to Cross the Road? Fish passage requirements for Waterway Crossings. Fairfull & Witheridge (2003).* Wallarah and Spring Creeks have been assessed as Class 2 Waterways using the document policy and gridlines. Specific of design consideration for Class 2 Waterways can be seen in Fairfull & Witheridge (2003: 8-15).

The DPI recommends that work within the waterways be scheduled within dry seasons, outside of fish migratory seasons and during periods of low flow to minimise impact.

- *Bridges and tunnels*

Wallarah and Spring Creeks will not be diverted to facilitate bridge construction or removal. It is proposed that three to four sections of 5 – 7 m length bridge spans will be used in the proposed bridge with no pylons being placed within the creek bed. The abutments will be situated away from the high bank to avoid scouring and alteration of water flow direction during high flow events.

5.3 Conservation significance

5.3.1 Representativeness of communities

The representativeness of vegetation communities identified within each study area is presented on **Table 14** and their local and regional size (in ha) is shown. Vegetation Alluvial Footslopes Redgum Forest, Alluvial Floodplain Shrub Swamp Forest, Narrabeen Alluvial Drainage Line Complex, Alluvial Riparian Blackbutt Forest and Dooralong Spotted Gum – Ironbark Forest is of state significance, protected under the TSC Act, and as such is recognised as being under-represented within NSW. Narrabeen Buttonderry Footslopes Forest, Narrabeen Doyalson Scribbly Gum Woodland and Narrabeen Snappy Gum Forest are considered to be well

represented in NSW but not within the Wyong LGA and are consequently not afforded the same legislative protection under the TSC Act.

5.3.2 Threatened species

Collectively, ten species of threatened fauna were recorded within the Tooheys Rd, Hue Hue Rd ecological offset investigation area, Buttonderry and Western shaft study areas (**Appendix 3**). These species are protected under the TSC Act and have state significance.

Ten threatened species of flora were collectively recorded in the study areas. All study areas contain species of flora that have state significance and thus protection under the TSC Act. Tooheys Rd, Hue Hue Rd ecological offset investigation area and Buttonderry study areas also contain species that are nationally significant (**Appendix 3**).

5.3.3 Degree of disturbance

All land owned by WACJV or proposed for impact as a result of the current assessment has been disturbed. Each property has varying levels and aetiology of disturbance and Section 3.2 of this report provides greater detail concerning disturbance.

The least disturbed property and perhaps that with the highest conservation significance is the Hue Hue Rd ecological offset investigation area. The most important ecological values have, for the most part, been conserved within the area i.e. old growth riparian vegetation that has a continuous connection with surrounding undisturbed ecological communities. Only minor surface disturbance has occurred for fencing, roads and a light regime of logging for ironbark is evident in places. Other more heavily disturbed environments have been cleared of all understory vegetation and a portion of trees for grazing agriculture. These disturbed areas front Bushells Ridge and Tooheys Rds and thus are more suited for development than other, more difficult to access portions of land. Where clearing has occurred local levels of high soil disturbance are evident.

The Western shaft study area has only undergone prior logging and has been heavily impacted by Brothers Rd. It is assessed as having a lower conservation than above as it is small, does not contain old growth with hollows nor the degree of habitat complexity.

Buttonderry has been heavily impacted for the purpose of farming. Large open spaces have been created through logging and tree clearing to encourage pasture growth. Fortunately the area of native vegetation to be impacted as a result of the current proposal has undergone logging and is largely regrowth with a few old growth trees remaining. Two small farm dams have been created as well as several tracks, trails and fence lines however, where unmodified native vegetation occurs there is a very low level of prior disturbance. Many old growth elements are present in these areas.

The Tooheys Rd study area has undergone the highest level of disturbance of all the assessed areas. It is probable that all vegetation communities have been altered by human agricultural or infrastructure development. The least disturbed areas within the property are those which are difficult to build structures on or farm such as within drainage lines, creeks or dam areas and it is believed that much of the vegetation appearing to be undisturbed today is actually mature regrowth. The only exception to this generalisation would be old growth vegetation associated with Alluvial Riparian Blackbutt Forest within the eastern portion of Wallarah Creek. One

interesting observation is that Tooheys Rd has presented a higher number of threatened species than any other portion of land assessed. This may be as a result of a higher degree of survey attention, the use of the area by many species as a feeding ground and the ability to see things in the field more clearly in areas that are partially cleared.

5.3.4 Special natural features

A 7 (g) zoned wetland has been recorded on the Tooheys Rd rail loop study area (see 4.2.3c). Other natural features include the EEC's occurring within the Tooheys Rd, Hue Hue Rd ecological offset investigation area and Buttonderry study area. These EEC's also encompass the area of land identified as 7 (g) wetland.

The presence of a stand of *Melaleuca biconvexa* within the swamp forest community at Buttonderry was noted, this species is noted by some authors as 'almost locally extinct' however, Bell (2009) pers comm. States that it can be locally common if you know where to look.

5.3.5 Size of the study areas

Collectively, the Tooheys Rd, Hue Hue Rd ecological offset investigation area, Buttonderry and Western shaft study areas occupy 437.1 ha:

- Buttonderry = 81 ha;
- Hue Hue Rd conservation area (between F3 and Hue Hue road) = 159 ha;
- Tooheys road study area (south of Tooheys road) = 117 ha;
- Tooheys road study area (north of Tooheys road) = 80 ha; and
- Western shaft = 0.92 ha

5.3.6 Links

Section 5.1.5 of this report gives greater detail of wildlife corridors within the study areas. Generally links from the study areas (excluding the western shaft) to other patches of remnant vegetation are restricted by the Sydney to Newcastle Freeway (F3), the Main Northern Rail Line and Doyalson's Link Rd. Land clearing on neighbouring properties augments these barriers to effectively isolate populations of terrestrial animals or plants.

6. IMPACT AND AMELIORATION

6.1 Potential impacts on the natural environment

6.1.1 Vegetation clearing

There are seven major vegetation map units in the assessed areas and three other non-specific vegetation types (**Table 13**). Cumulatively these MU's represent 31,497 ha of remnant vegetation in the Wyong LGA and within the current study areas they occupy 323.10 ha of the 437.1 ha assessed. The greatest amount of native vegetation to be removed as a result of the proposed development will be within Narrabeen Doyalson Scribbly Gum Woodland of which only its derivative Narrabeen Doyalson Scribbly Gum Woodland #d has local significance (**Tables 13 and 14**). Of those communities identified as having conservation significance, the

most affected (in ha) will be Alluvial Riparian Blackbutt Forest where 1.05 ha will be cleared. The percentages of each MU to be affected as a result of the proposed development are provided on **Figures 42 and 43**.

Table 14: Overview of the extent of vegetation clearing associated with the proposal.

MU and their derivatives	Significance	Ha of MU avail in study areas	Ha of MU to be impacted	Ha of MU to be retained
15	State	0.44	0	0.44
20	State	2.27	0.18	4.15
26	State	18.62	0.62	17
43	State	23.44	1.05	25.77
28	Local	103.37	1.35	102.15
30	State [8]	74.52	3.2	71.32
31	Only 31d has local sig	85.91	14.29	71.63
35			0.92	0
Unspecified regrowth		4.72	0.48	4.24
Unspecified canopy		3.47	0.59	2.88
Dams		1.79	0.05	1.74

[8] See **Appendix 9** for a reappraisal of this community.

Table 15: Vegetation communities – extent, conservation significance and proposed impacts.

Vegetation Community		Signif.	Extant LGA (ha)	Buttonderry (ha)			Tooheys Rd / Hue Hue Rd (excl. DLALC) (ha)			Wyong SF (ha)	
MU	**Name**			**Ha to be Impacted**	**Offset**	**Total of each MU**	**Ha to be Impacted**	**Offset**	**Total of each MU**	**Direct Impact**	**Total**
15	Alluvial Footslopes Redgum Forest	State	145	-	-	-	-	0.44	0.44	-	-
20a	Alluvial Floodplain Shrub Swamp Forest (variant a)	State	895	-	1.93	1.93	-	1.90	1.90	-	-
20Xs	Alluvial Floodplain Shrub Swamp Forest (regrowth)	State		-	0.13	0.13	-	-	-	-	-
20f	Alluvial Floodplain Shrub Swamp Forest (variant f)	State		-	-	-	0.18	0.19	0.37	-	-
26b	Narrabeen Alluvial Drainage Line Complex (variant b)	State	254	-	-	-	0.13	0.87	1.00	-	-
26d	Narrabeen Alluvial Drainage Line Complex (variant d)	State		-	8.64	8.64	0.09	3.99	4.07	-	-
26dXr	Narrabeen Alluvial Drainage Line Complex (variant d canopy only)	State		-	0.65	0.65	-	-	-	-	-
26e	Narrabeen Alluvial Drainage Line Complex (variant e)	State		-	-	-	0.40	2.79	3.19	-	-
26eXs	Narrabeen Alluvial Drainage Line Complex (variant e regrowth)	State		-	-	-	-	0.06	0.06	-	-
28	Narrabeen Buttonderry Footslopes Forest	Local	1016	1.01	24.28	25.29	-	52.61	52.61	-	-
28Xr	Narrabeen Buttonderry Footslopes Forest (canopy only)	Local		0.31	1.95	2.26	0.03	18.52	18.55	-	-
28Xs	Narrabeen Buttonderry Footslopes Forest (regrowth)	Local		-	1.60	1.60	-	3.19	3.19	-	-
30	Dooralong Spotted Gum-Ironbark Forest	State	2215	0.58	10.81	11.39	-	50.24	50.24	-	-
30Xr	Dooralong Spotted Gum-Ironbark Forest (canopy only)	State		2.62	3.16	5.78	-	7.11	7.11	-	-
31	Doyalson Scribbly Gum Woodland		3119	-	-	-	3.28	35.28	38.56	-	-
31a	Doyalson Scribbly Gum Woodland (variant a)			-	-	-	0.05	1.02	1.06	-	-
31c	Doyalson Scribbly Gum Woodland (variant c)			-	-	-	1.15	2.05	3.20	-	-
31d	Doyalson Scribbly Gum Woodland (variant d)	Local		-	-	-	2.28	7.63	9.91	-	-
31Xr	Doyalson Scribbly Gum Woodland (canopy only)			-	-	-	7.35	19.80	27.15	-	-
31Xs	Doyalson Scribbly Gum Woodland (regrowth)			-	-	-	0.18	5.85	6.03	-	-
32	Narrabeen Snappy Gum Forest	Local	175	-	-	-	-	-	-	-	-
35	Coastal Foothills Moist Layered Forest		23440	-	-	-	-	-	-	0.92	0.92
43a	Alluvial Riparian Blackbutt Forest	State	238	-	3.04	3.04	0.24	15.93	16.16	-	-
43Xr	Alluvial Riparian Blackbutt Forest (canopy only)	State		-	0.16	0.16	0.81	4.94	5.75	-	-
43Xs	Alluvial Riparian Blackbutt Forest (regrowth)	State		-	0.17	0.17	-	1.53	1.53	-	-
W	Water (dams)	-	-	0.02	0.07	0.09	0.03	1.67	1.70	-	-
Xr	Unspecified Canopy only	-	-	-	-	-	0.59	2.88	3.47	-	-
Xs	Unspecified regrowth	-	-	-	-	-	0.48	4.24	4.72	-	-
Totals			***31497***	***4.54***	***56.59***	***61.13***	***17.27***	***244.73***	***261.97***	***0.92***	

Figure 42: Graphical representation of the hectares of each vegetation community impacted and / or retained as a result of the proposed W2CP – Tooheys Rd and Hue Hue Rd ecological offset investigation area (white numbers indicate ha's to be retained as a percentage of the total).

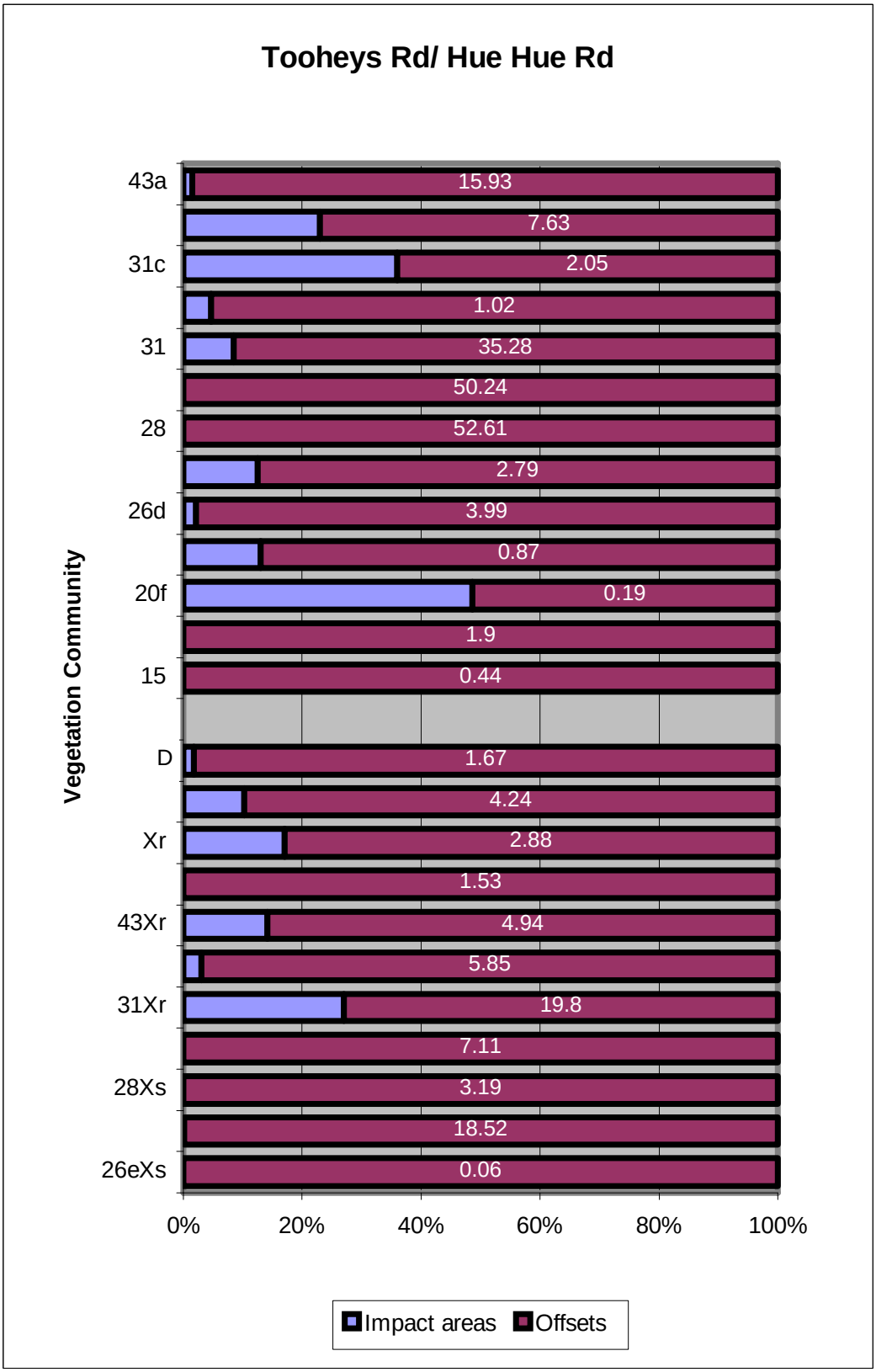
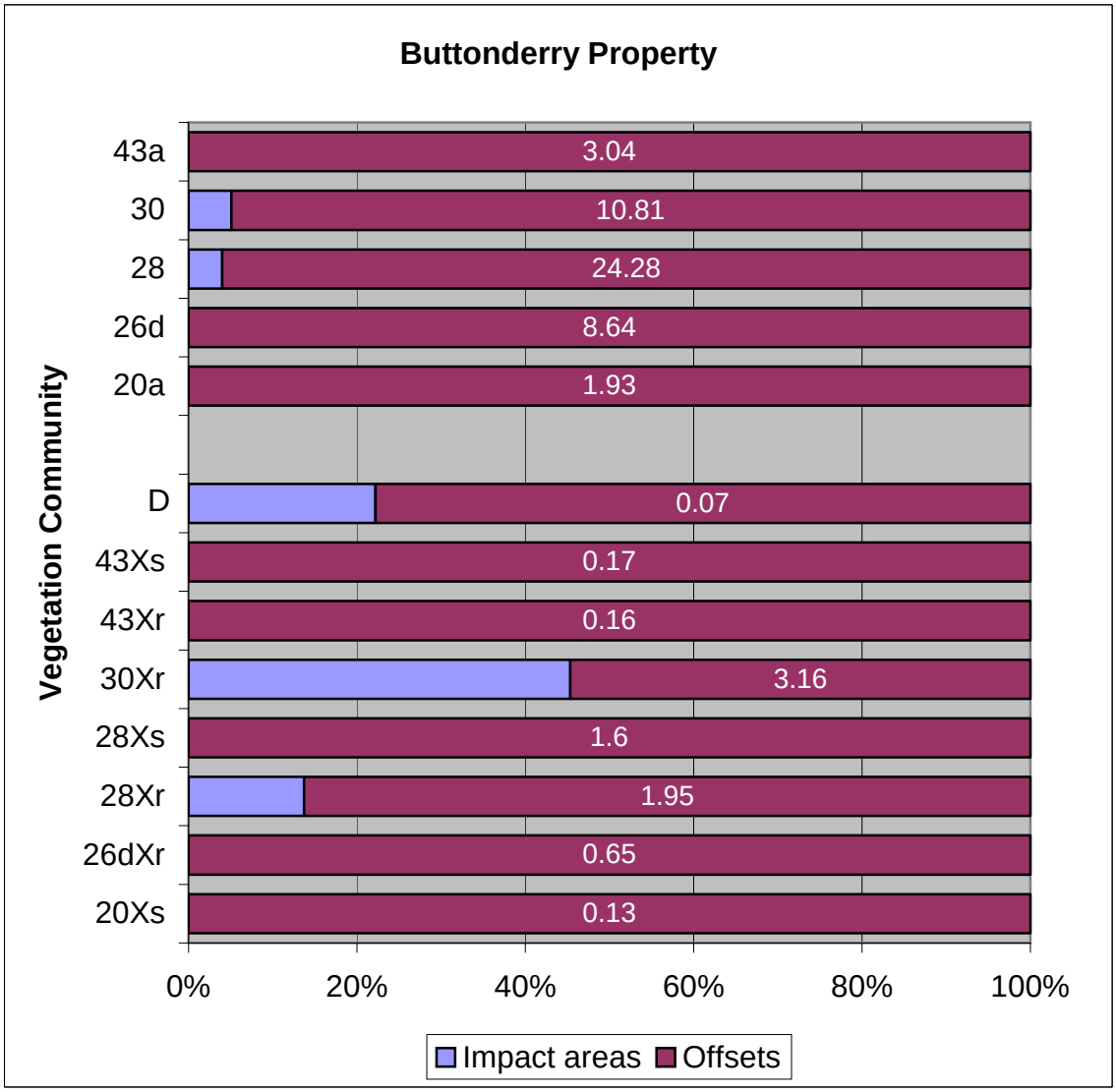


Figure 43: Graphical representation of hectares of each vegetation community impacted on by the proposed development – Buttonderry study area (white numbers indicate ha to be retained).



General recommendations for vegetation clearing include:

- Human movement should be restricted to dedicated tracks and specific areas to be impacted such that the development will have no impacts occurring beyond those boundaries. This can be achieved by marking out the limits of the site with an easily identified boundary marker;
- Install orange road work curtilage delimiting the extent of the impact footprint in areas where EEC's have been identified to ensure there are no inadvertent impacts on the EEC outside of the impact footprint. Induct all contractors and staff undertaking work within the locality of the presence of the EEC. The induction should inform staff of the legal requirements the Proponent has undergone to impact the EEC and enforce a due diligence ethic for minimising all unnecessary impacts. Part of the induction should focus on an environmental risk assessment

where the employee or contractor considers what action they are do undertake within the locality, what affect it will have on the species and what can be done to minimise impact. This induction should be documented and signed and sporadically audited; and

- Minimise clearing of vegetation as much as practicable, only remove what has to be removed and have no impact on vegetation outside of the impact footprint.

If a tree has to be cleared:

- Identify hollow bearing trees from painted numbers on their trunks or by the red and white flagging tape tied around it and clearly mark it again with a distinctive identifier. If too much time has elapsed and the paint has faded or there is potential that the tape has been removed use the GPS coordinates provided in this report to relocate the trees;
- Avoid tree clearing in spring due to bird nesting;
- Remove all trees not identified as hollow bearing first;
    - Check all trees for the presence of birds or nestlings and arboreal mammals before felling or pushing. Start tree removal immediately after visual inspection; and
    - It is advisable to gradually nudge the tree at intermittent intervals so that any animal occupying a habitat tree can have the chance of vacating the area after the initial disturbance period;
- Engage an ecologist when hollow bearing trees are to be removed to check all hollow bearing trees for the presence of birds or nestlings and arboreal mammals before felling or pushing. Start tree removal immediately after visual inspection;
- Have an appropriate plan in place and equipment on site to cater for injured animals. Seek advice from a qualified wildlife veterinarian prior to preparing this plan and ensure veterinary assistance has been organised prior to work commencing. Note – **do not allow any person to handle any species of bat**. Potential exists for the transmission of a virus that is detrimental to the health of humans; and
- No vegetation is to be burnt on site.

6.1.2 Fragmentation and edge effects

Habitat fragmentation will cause eventual reduction of population sizes and the ability of species within it to disperse to others areas of remnant vegetation. Edge effects result in new boundaries being created in a given habitat as a result of environmental modification (i.e. weed invasion may encroach new areas as a result of an easement cutting though a closed forest alternately the new access may favour the movement of predators within this previously inaccessible environment).

The area most affected by habitat fragmentation will be land south of Wallarah Creek in the Tooheys Rd study area, within the impact footprint for the proposed rail loop (**Figure 21**). The overall effect however, is diminished on a broader perspective as this 'patch' of remnant vegetation is in itself an isolated fragment. Failure to relocate Squirrel Glider recorded by ERM twice in 1999 in this area was concerning and if the population is

present, further habitat fragmentation will pressure this species. There are several ways to ameliorate potential effects on this potentially extant species, such as habitat restoration within degraded areas of Wallarah Creek using favoured food species, the implementation of a long-term monitoring programme, provision of nesting boxes, feral animal control and investigation into developing effective materials / methods to re-instate dispersal of animals over the existing man made barriers surrounding the Tooheys Rd property.

The degree of habitat fragmentation has been reduced by the Proponent designing the rail loop so that it will run adjacent to the existing TransGrid 330kV easement north of Tooheys Rd. This will result in an edge effect occurring that will effectively push back existing habitat boundaries for native species c. 50 m north of where it currently located. There is a low abundance of weeds in the Tooheys Rd study area and a high population of foxes and cats and this will not change the status of the existing environmental pressures, therefore the edge effect on most fauna species is largely inconsequential.

Despite the comments above, clearing of woodland habitat and construction of the rail line will increase the width of the TransGrid easement, which separates woodland habitats. This further fragments the northern part of the Tooheys Rd study area and would increase barriers to movement and dispersal for some plant species with low dispersal ability and fauna species with low powers of dispersal such as frogs, reptiles, and small ground mammals. Other species are highly mobile and are able to tolerate or negotiate cleared areas such as arboreal mammals, birds, insectivorous bats and large ground mammals.

Within Buttonderry, the construction of the proposed development would further fragment the habitat within the study area. It would reduce the amount of habitat for flora and fauna.

6.1.3 Erosion

Soil disturbance within any of the study areas has potential to effect surrounding areas of vegetation and waterways a summary of proposed general safeguards for soil and water management for each construction project includes:

- All erosion and sediment control devices shall be developed in accordance with a recognised publication such as the RTA Road Design Guide 1989, Section 8 – *Erosion and Sedimentation,* the Landcom 2004 publication *Managing Urban Stormwater-Soils and Construction* as well as relevant DIPNR soil conservation guidelines such as *Construction Site Erosion and Sediment Control Manual.*
- Effective erosion and sediment controls shall be constructed immediately after earthworks have commenced. Maintain these structures until ground surfaces are stabilised and design the maintenance tracks to minimise potential for erosion. Steep reconstructed embankments may require the use of hydromulch or a similar other effective soil erosion control measure;
- Minimise the disturbance and exposure of soils. Address measures in an Erosion and Sediment Control Plan and implement as soon as possible. Pay particular attention to preventing soil loss on any steep embankment;

- Construct catch drains with erosion and sediment control devices as soon as possible to ensure transverse drainage is in place in the early stages of construction site excavation;
- Complete waterway protection works as soon as possible;
- If temporary stockpiles are to be used ensure they should be within areas assessed by the commissioned environmental impact assessment and are above the 1:10 year flood level;
- Progressively stabilise and revegetate disturbed areas with endemic species or sterile crop species as required;
- Regularly monitor and maintain all sediment and erosion control devices particularly after a significant rain event, during construction and before vegetation is established;
- Retain as much vegetation as practicable and retain topsoil for final site rehabilitation;
- Educate site personnel for the implementation of sediment and erosion control plans;
- Do not impact within 20 m of any readily identifiable ephemeral drainage line or Creek unless is it part of an approved action.

6.1.4 Dust

Dust is not expected to impact the locality. Mining and construction companies operate within stringent guidelines that require regimented dust suppression.

6.1.5 Noise

In the absence of any existing noise data for the Tooheys Rd study area, it can be stated that the main infrastructure location currently has a very audible background noise from the F3 highway. For example, call playback had to be abandoned in that area as nothing could be heard above the road noise in response to the broadcast calls.

During construction there will be increased levels of noise that has the potential to cause disturbance to fauna. In reality it can be suggested that animals living within the current study areas (particularly Tooheys Rd and Buttonderry) would be somewhat habitualised to anthropomorphic noise, however, potential may exist for particular species to be affected by unusual levels of noise during sensitive times of their life cycle (i.e. during breeding or whilst rearing neonates). Owls rely on acoustics for hunting and thus may be negatively impacted if certain noise thresholds are exceeded.

6.1.6 Artificial lighting

Artificial lighting has the potential to change predator – prey relationships and species densities for a number of animals i.e. large floodlights often associated with mining areas provide light that attracts insects that in turn attracts bats, these bats will then be preyed upon by other species such as owls. Whilst this dynamic may be self determining, a negative impact on Squirrel Glider is possible where they do not benefit from the

increased insects at the locality due to the exposed and isolated nature of the area. Additionally there may potentially be a higher density of predators occurring in the area, thus reducing the long term survivability of a locally occurring population.

6.1.7 Introduced species

Exotic species have been detected in all study areas. Impacts would increase the edge effect and allow species such as blackberry (*Rubus ulmifolius*) and Lantana (*Lantana camara*) to colonise and out compete native species. Feral animals are already common within the assessed areas, however it is likely that local populations of rabbits would increase. Changes in drainage and hydrology may result in colonisation by Mosquito Fish (*Gambusia holbrooki)* and threaten frog populations, while changes in structure of vegetation may give advantage to the Indian Mynah (*Acridotheres tristis*) and the native Pied Currawong (*Strepera graculina*) that will compete for the same resources or prey upon existing fauna.

General recommendations include:

- To combat the spread of weeds prior, during and after construction work all surface disturbing equipment should be thoroughly washed down (including removing excess grease and oil) and possess a wash down certificate prior to coming on site. An inspection of problem weeds should be undertaken 3 months and 12 months after ground disturbing works have ceased;

- Develop a feral animal management plan primarily targeting foxes, cats and rabbits. This plan should extend to other invasive species that have potential to colonise the study areas as a result of W2CP i.e. Mosquito Fish.

6.1.8 Hydrology and water quality

Creeks and drainage lines have the potential to be impacted if there is a change or alteration in site hydrology and species dependant on these habitats would decline.

The proposed rail loop in the Tooheys Rd study area may affect the quality and amount of water reaching these habitats (and down-stream) and as such have implications for species in those environs.

Removal of riparian vegetation at Wallarah Creek for the rail loop and surface facilities would increase surface runoff (speed and volume), change the hydrology and reduce water quality in a worst case scenario. Species likely to be affected would include amphibians, reptiles, birds, ground dwelling mammals and to a lesser degree microbats. A change such as this may also add to the cumulative impact on the local Squirrel Glider population.

Similarly removal of native vegetation at Buttonderry and the Western shaft study areas has the potential to effect water quality in a worst case scenario.

General recommendations include:

- Undertake soil and sediment controls as per Landcom publication Managing Urban Stormwater Soils and Construction Manual 2004;

- Monitor the quality of runoff entering water using a recognised system (changes in acidity in waterways should also be targeted);

- Ensure design will not affect the direction or flow of waterways within the project.

6.1.9 Potential changes to fire regimes

Frequent fire events are evident throughout the study areas and appear to be heavily influenced by arson within the DLALC land and accidental or natural causes in the other properties. As assets would require protection from fire there would be a reduced frequency in fire on the properties. Development of a fire management plan for the purposes of managing vegetation would be an important consideration for the long term management of WACJV land.

6.1.10 Disease

The fungal pathogen *Batrachytrium* is suggested as the cause of reduction in amphibian populations. It is waterborne and causes the disease Chytridiomycosis. The fungus can only be transported by water and as such the general movement of humans through the study areas is unlikely to be the medium of infection if the fungus were to occur. Although the disease does not currently occur within the study area, a change in hydrology would increase the risk of infection if nearby surrounding populations of frogs were infected.

General recommendation:

- If management of frog populations are to occur as a result of W2CP, the disease status of the population would need to be investigated. This will require negotiation with government authorities for appropriate permission, consultation with wildlife veterinarians and culling of tadpoles.

6.1.11 Potential land contamination

Sources of land contamination include ‘spills’ from water running off coal stockpiles, fuels, oils, sewerage and other wastes. Any contaminant has the potential to affect water bodies. To this end the design plans (December 2006) shows that several dams have been included in the proposal for the purpose of containing runoff and their volume capacity suggests that the risk of pollution to the surrounding waterways would be low.

6.2 Potential impact on threatened and regionally significant species

Within the study area, threats to threatened flora include agriculture, mineral extraction, urban development, altered fire regimes, grazing and/or trampling, disease, pollution, weeds, forestry operations and changed hydrological regimes.

Broadly, the principles for the use of biodiversity offsets in NSW and the DEWHA Draft Policy Statement: Use of environmental offsets under the EPBC Act 1999 would be followed.

Within the study areas the main potential impacts on flora from construction, operation and decommissioning of the proposed project include:

- loss of habitat as a result of clearing and trampling. This results in a removal or reduction of vegetation;
- creation of disturbed edge areas which can encourage introduction of competitive native and introduced species that out-compete other native species and dominate native vegetation;
- changes in hydrology which could lead to changes in vegetation assemblages; and
- erosion and sedimentation which could promote introduced species and alter conditions for native species.

Threats to threatened birds are essentially the same as noted above, however, a shortage of nesting hollows (due to a variety of causes) is the greatest potential impact to those species that rely on hollows for breeding.

The other important potential impacts on bird species abundance and distribution from construction, operation and decommissioning of the proposed project include:

- loss of habitat as a result of clearing, resulting in removal or reduction of foraging resources, nesting sites and materials, breeding opportunities, roosting sites, shelter and dispersal areas and corridors used by migratory or nomadic species;
- creation of disturbed edge areas which favour the introduction of competitive native and introduced species displace native resident birds resulting in a reduction of overall bird biodiversity and abundance within an area;
- changes in habitat resources can disrupt extant food-chain processes such as an increase in cleared areas encouraging an increase in aerial predation from raptors;
- disruption to essential behavioural patterns as a result of noise generation, artificial lighting, dust and air quality, road traffic, human interference, invasion of introduced species and predation by feral animals; and
- mortality due to drinking polluted waters, collision with artificial structures such as powerlines, road traffic and trains.

Mitigation measures for an earlier manifestation of this project were made by ERM (2000). These remain relevant to the current proposal and have been extended with reference to new data. Specific mitigation measures for birds include:

- use native species that provide resources for birds in rehabilitation areas, such as trees that will bear hollows in the future;
- raise awareness of employees and contractors in relation to road kills and train strikes through environmental training and signs; and

- identify opportunities to create effective wildlife corridor at the planning stage and enhance those identified corridors within the sites so that the vegetation provides enough cover for bird dispersal.

Specific mitigation recommended for the Powerful Owl recorded in the Tooheys Rd study area includes:

- Develop a specific management plan to remove tree 37 south of Wallarah Creek that contains a bird of prey nest (possibly powerful owl, probably tawny frogmouth);
- This plan should detail the timing and method of tree removal and should be supervised by a qualified ecologist; and
- Appropriate habitat compensation should occur for the values removed such as replacement of the tree with up to four nesting boxes for this species that should be placed in adjoining woodland.

Threats to threatened mammals include past and on-going land uses, as listed for plants and birds (above), which have resulted in the removal and modification of habitats. Within the study areas and subject sites, the main potential impacts on mammal species and abundance from construction, operation and decommissioning of the proposed project include:

- loss of habitat as a result of clearing that removes, reduces or modifies foraging resources, nesting sites or materials, breeding opportunities, roosting sites, shelter areas, dispersal areas and corridors;
- creation of disturbed edge areas which can encourage introduction of competitive native and introduced fauna species that out-compete other native species and prey on native species; and
- invasion of native vegetation by introduced flora species, which results in a loss or modification for feeding, shelter and resources. This may result in changes in relative abundance of mammal species because some mammals can persist or are advantaged by disturbed areas, in comparison to others that would not persist.
- disruption to essential behavioural patterns as a result of noise generation, artificial lighting, dust and air quality, road traffic, human interference, invasion of introduced species and predation by feral animals; and
- mortality due to drinking polluted waters and road-kills.

Mitigation measures for threatened mammals are essentially the same as for threatened birds, with the following additions:

- using native species that provide resources for mammals in rehabilitation areas, such trees that will bear hollows in the future and native grasses and sedges that form thick ground layers;
- salvage hollows logs from areas to be cleared and place these in areas to be rehabilitated; and
- erect nest boxes in adjacent vegetation or rehabilitation areas for arboreal fauna including insectivorous bats, and monitoring their use.

Existing threats to threatened amphibians and reptiles are the same for flora, birds and mammals as detailed above. Some amphibians in the region have also declined because of the Chytrid fungus[9]. Frogs have almost certainly declined in the region due to this disease, however, major declines appear mostly in upland areas. Declines at lower altitudes near the coast appear to be chronic rather than catastrophic infections. It seems that this fungus is still causing localised problems in various places from time to time, but the primary wave of infection has already occurred. Recovery patterns are unknown, although there are some hints it might be happening. The frog species recorded in the area are not amongst those known to be badly affected by the fungus and population densities remains in most coastal areas.

Within the study areas, the main potential impacts on amphibians and reptiles from construction and operation of the proposed project include:

- loss of habitat as a result of clearing resulting in a removal, reduction or modification of foraging resources, nesting sites, breeding sites for amphibians and shelter areas;
- predation by introduced species such as feral cats, dogs and foxes;
- pollution or degradation (including sedimentation) of streams, ponds and swamps which prohibits breeding of some amphibians;
- invasion of native vegetation (including swamps) by introduced flora species resulting in a loss or modification of feeding, shelter and resources. This may result in changes in relative abundance of reptiles and amphibians due to changes in food availability and shelter sites.
- disruption to essential behavioural patterns as a result of changes in hydrology and water quality;
- noise generation, artificial lighting, dust and air quality; and
- road traffic, human interference.

Mitigation measures to ameliorate impacts for threatened amphibians and reptiles are the same for threatened flora and fauna (above), however additional measures include:

- using native species that provide resources for reptiles in rehabilitation areas, such as trees with peeling bark, hollows or crevices for geckos, lizards and snakes;
- ensuring the acidity of the water in adjacent swamps and streams remains the same to preserve amphibian habitat;
- salvage hollows logs and debris from areas to be cleared and place in rehabilitation areas or identified corridors to provide habitat for reptiles;
- create artificial ponds and wetlands on the site to compensate for swamps, and dams that may be impacted by the proposed project. Design these so that they can be drained to control populations of Mosquito Fish should they encroach on the

[9] Mr. Frank Lemckert Pers Comm Dec 15 2006.

area – parallel drainable ponds would best suit management of frogs and Mosquito Fish;

- raise awareness of employees and contractors in relation to sensitivity of water bodies for amphibian habitat; and
- enhance identified corridors within the sites so that the vegetation is appropriate for reptile and amphibian dispersal.

Specific measures for the Wallum Froglet include:

- installing culverts beneath the proposed rail loop;
- connecting areas of known habitat; and
- erecting and maintaining frog-exclusion fencing along both sides of the proposed rail loop in riparian areas.

The use of frog culverts has recently been investigated as a result of the Tugun Bypass project. According to Parsons Brinckerhoff (2006b), frog-exclusion fencing used in conjunction with culverts have been trailed in Denmark (Graff 1996), England (Cooke 1988), Luxembourg (Engel and Bressanutti 1993), Netherlands (Chardon *et al.* 1996), Spain (Yanes *et al.* 1995) and in the United States (Piersan 1987). It has also been trialled at Bulahdelah in NSW.

Further research would be required to determine the appropriate culvert length, height and width for the Wallum Froglet, however use by amphibians is expected to decrease with length and to increase with height, width and openness (Yanes *et al.* 1995 as cited by Parsons Brinckerhoff {2006b}). At minimum design of these structures ensure that they:

- connect known habitats to the east and west of the proposal area;
- be a minimum of 1 m high and 3 m wide;
- have a channel through the centre of the culverts to hold water, even in dry times to better encourage frogs to use the structures; and
- be otherwise lined with a natural substrate comprising earth or humus have a fence (either made from fine mesh or 50 cm vertical metal), constructed at the entrance of the culverts to prevent other larger species of adult frogs from entering to limit their predation on the smaller frogs within the culverts.

Frog-exclusion fencing could be constructed along the eastern and western sides of the proposed rail loop or access tracks in the general vicinity of known populations, or anywhere mapped vegetation Narrabeen Alluvial Drainage Line Complex or Alluvial Riparian Blackbutt Forest occur. Fencing would minimise mortality and would act to guide frogs into culverts. The exact form of the frog exclusion fencing would need to be researched and trialled, however as an example the Tugun Bypass used a solid sheet of durable material (for example hard plastic or metal) measuring approximately 400 mm high, with a small, possibly curved overhang at the top to discourage individuals from climbing over it. It was designed to allow surface water flow across the bypass and to be relatively maintenance free (Parsons Brinckerhoff 2006).

The translocation of individuals from the impact footprint may be implemented just prior destruction. It must be noted that this is not a mitigation measure, but is a duty of care so that the unnecessary death of individuals can be minimised where possible. Further research with relevant government agencies would be required to determine the need for a translocation permit.

Any systematic handling of frogs would require the development hygiene protocol to minimise the spread of the Chytrid fungus. It should be noted that testing a population for the disease requires culling of tadpoles for testing (dissection of their mouthparts). Further research into obtaining the appropriate approvals to undertake this would also need to occur. Prior to clearing, an impermeable fence would be erected to delineate the footprint and to prevent subsequent dispersal of individual Wallum Froglet into the area post-capture, and a combination of trapping methods including pit falling, dip-netting and active daytime and night-time searches should be undertaken. Pre-construction surveys would commence in September, after high rainfall events, and in warm temperatures and continue until repeated searches yield few or no new individuals. Captured individuals would be marked and immediately transferred to the nearest available habitat.

6.2.1 Critically endangered and endangered ecological communities affected by the proposal

There are no critically endangered ecological communities that will be affected as a result of the proposal. **Table 14** shows that Alluvial Footslopes Redgum Forest, Alluvial Floodplain Shrub Swamp Forest, Dooralong Spotted Gum – Ironbark Forest and Alluvial Riparian Blackbutt Forest have legislative protection as EEC's (or their respective components) and documents the number of hectares of each to be impacted and retained as a result of the proposal.

Nationally listed EEC and CEECs will remain unaffected by the Proposal.

6.2.2 Endangered populations affected by the proposal

There are no endangered populations within the assessed study areas.

6.2.3 Endangered, threatened and regionally significant flora species affected by the proposal

There is one endangered, six vulnerable and three regionally significant species occurring within the study areas (**Table 10**). All of these have the potential to be affected either directly or indirectly as a result of the proposal.

- *Angophora inopina (V TSC Act, V EPBC Act)*

Although not counted in detail, the study area is likely to support several hundred plant clumps of *Angophora inopina*, principally in the Tooheys Road portion. Many of these will be destroyed through construction of the proposed rail loop and other surface facilities. Being a long-lived, resprouting species any above-ground disturbance of *Angophora inopina* during construction activities will subsequently resprout: many specimens have been slashed under the power line easement and continue to grow but in a

mallee habit. Given the existence of extensive populations to the immediate west and north, the local population of plants is unlikely to be placed at risk of extinction through the proposed development.

- *Arachnorchis tessellatus (V TSC Act)*

The single record of this species recorded from the southern boundary of the Tooheys Road portion lies outside of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

- *Grevillea parviflora subsp. parviflora (V TSC Act, V EPBC Act)*

The two populations of this species within the Hue Hue Road and Buttonderry portions lie outside of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

- *Melaleuca biconvexa (V TSC Act, V EPBC Act)*

The single population of this species within the Buttonderry portion lies well outside and upstream of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

- *Tetratheca juncea (V TSC Act, V EPBC Act)*

Although not counted in detail, the study area is likely to support several hundred plant clumps of *Tetratheca juncea*, principally in the Tooheys Road portion. Many of these will be destroyed through construction of the proposed rail loop and other surface facilities. *Tetratheca juncea* is pollinated by at least two sonicating bees (Driscoll 2003), and based on the amount of fruiting *Tetratheca juncea* in adjacent lands (S.Bell, pers obs.), it is likely that these bees are active in the area. Given the existence of extensive populations to the immediate west and north, the local population of plants is unlikely to be placed at risk of extinction through the proposed development.

- *Acacia bynoeana (V TSC Act, V EPBC Act)*

Bell & Driscoll (2002) have detailed known populations of *Acacia bynoeana* from the Wyong LGA, and several populations are present within a 2-3 km radius of the site. Extensive populations occur in the Wyee area on Crown or DLALC land. Two plants were located on the edge of the existing transmission easement during the current survey. Consequently, it is unlikely that an adverse effect will occur on the local population of this species.

***Cryptostylis hunteriana* (V TSC Act, V EPBC Act)**

The single plant located within the study area occurs in a proposed conservation offset, approximately 200m upslope from any development. Consequently, no adverse effect is likely on the species.

6.2.4 Endangered, threatened and regionally significant fauna species affected by the proposal

There are ten species of threatened and three species of regionally significant mammals, one species of regionally significant reptile, two threatened and regionally significant frogs and two threatened and three regionally significant species of birds recorded within the study area (**Appendix 3**). All of these have the potential to be directly and indirectly affected as a result of the proposal.

Desk top analysis shows that an additional eight species of mammals, three birds, two frogs and one insect have the potential to be impacted as a result of the proposal (**Appendix 4**).

6.2.5 Migratory species affected by the proposal

The White Bellied Sea Eagle (*Haliaeetus leucogaster)* is a Migratory Wetland Species and Listed Marine Species in the EPBC Act 1999. This species frequents large rivers, fresh and saline lakes, reservoirs, coastal areas and seas. They are opportunistic carnivores, feeding on birds, mammals, fish, reptiles and carrion (Green 1959, Quinn 1969, Smith 1985 cited by the Victorian Dept of Environment & Sustainability web page {2005}). Birds often have favoured roosts on prominent trees and soar in large circles with wings upswept during flight. While hunting they may hover low and dive close to the water to catch prey. Pairs may hunt together and they are known to harass other bird species (such as terns) and either steal prey or have them regurgitate it. White Bellied Sea Eagles have been recorded in the northern hemisphere from India to China and south through Asia, New Guinea and Australia. They occur along the coastline of Australia and also range inland over large rivers and wetlands.

Core habitat elements for this species will not be affected by the proposed action and therefore there is no requirement to refer the matter to the D-G of the DEWHA.

6.2.6 Critical habitat affected by the proposal

Habitat listed as critical will not be affected by the proposal.

6.3 Impact assessments

6.3.1 EEC's & Flora

<u>6.3.1a NSW legislation – 7 part tests for direct impact areas</u>

- *Swamp Sclerophyll Forest on Coastal Floodplains*

Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) essentially represents those vegetation communities where Swamp Mahogany (*Eucalyptus robusta*) forms a prominent component in the canopy, principally on the coastal floodplains draining east from the Great Dividing Range. It is based on the work of Keith and Scott (2004). One small area of SSFCF occurs at Tooheys Road, and a further small area at Buttonderry.

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

SSFCF is not a threatened species.

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

SSFCF is not an endangered population.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

The proposed development will not impinge on the areas supporting SSFCF. It is proposed that a rail crossing be constructed along the eastern boundary of the site, crossing the drainage line downstream of areas supporting this community.

No modification of the community is expected given that no disturbance is planned for areas supporting the SSFCF. Within the Wyong LGA, there is approximately 2,000ha of this community and greater than 12,500ha in the Central Coast – Lower Hunter Valley region (NPWS 2000; Bell 2002a).

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) No habitat of SSFCF is to be directly removed as part of this development.

(ii) The single drainage line supporting this species at Tooheys Road already occurs in a fragmented landscape, and further fragmentation will not occur through this development. The Buttonderry site is also already fragmented, and will not be fragmented further.

(iii) No habitat of SSFCF is to be directly removed as part of this development.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for SSFCF.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local occurrence of Swamp Sclerophyll Forest on Coastal Floodplains is **unlikely** to be significantly impacted upon by the proposed development.

- *River Flat Eucalypt Forest on Coastal Floodplains*

River Flat Eucalypt Forest on Coastal Floodplains (RFEFCF) essentially represents those vegetation communities on coastal floodplains supporting vegetation outside of areas of SSFCF, populated by a range of eucalypt species. It is based on the work of Keith and Scott (2004). Within the current study area, Wallarah Creek and an un-named creek at Tooheys Road/ Hue Hue, and Buttonderry Creek at Buttonderry support RFEFCF.

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

RFEFCF is not a threatened species.

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

RFEFCF is not an endangered population.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

The proposed development will impinge on RFEFCF where rail crossings and a single access road will be constructed. Rail crossings will be constructed in such a way that minimises direct impact, and allows the natural flows of water to continue.

No significant modification of the community is expected given that minimal direct disturbance is planned for areas supporting the RFEFCF. Within the Wyong LGA, there are approximately 700 ha of vegetation equating to this community, and approximately 2,000 ha in the Central Coast – Lower Hunter Valley region (NPWS 2000; Bell 2002a).

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) At Tooheys Road, 1.67ha of RFEFCF (including disturbed variants) is to be directly impacted upon as part of this development, representing 5.3% of the total 31.76ha within the Tooheys Rd/ Hue Hue Road portions. At Buttonderry, none of the 12.66ha of RFEFCF will be impacted upon.

(ii) No further fragmentation is expected through this development, given that rail crossings will be constructed where required and will retain most vegetation.

(iii) RFEFCF is relatively widespread along the major drainage lines in the Wyong and southern Lake Macquarie areas (Bell 2002; NPWS 2000). Buttonderry Creek supports good stands of the vulnerable *Melaleuca biconvexa*, however no direct impact is proposed for this area.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for RFEFCF.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local occurrence of River Flat Eucalypt Forest on Coastal Floodplains is **unlikely** to be significantly impacted upon by the proposed development.

- *Lower Hunter Spotted Gum – Ironbark Forest*

Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) is based on the NPWS (2000) classification of vegetation in the Lower Hunter Valley and Central Coast. Formerly not thought to occur in the Wyong LGA, recent research on LHSGIF has confirmed its presence there. LHSGIF occurs predominantly at Hue Hue Road, with a further small area at Buttonderry.

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

LHSGIF is not a threatened species.

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

LHSGIF is not an endangered population.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

The proposed development will directly impact only 3.2ha of LHSGIF. It is proposed that a further 71.32ha of LHSGIF will be retained in conservation.

No modification of the community is expected given that minimal disturbance is planned for areas supporting the LHSGIF. Within the Wyong LGA, there is approximately 2,215ha of this community and greater than 30,000ha in the Central Coast – Lower Hunter Valley region (NPWS 2000; Bell 2002a).

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Just over 3.2ha of LHSGIF is to be directly removed as part of this development, representing 4.3% of that present in the study area.

(ii) The proposed area of disturbance of LHSGIF occurs on the edge of the extant stand, hence no fragmentation or isolation is expected.

(iii) The portion of LHSGIF to be directly removed as part of this development is minimal and lies on the existing edge of the stand. It is not considered important for the long-term survival of the EEC.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for LHSGIF.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local occurrence of Lower Hunter Spotted Gum – Ironbark Forest is **unlikely** to be significantly impacted upon by the proposed development.

- *Angophora inopina*

Angophora inopina is widespread in the southern Lake Macquarie-Wyong area, but its full distribution currently extends from Warnervale to Bulahdelah. It occupies a range of habitats within this region, but principally occurs in open healthy woodland. Large numbers of plants occur within the Tooheys Road portion of the current study area. Further assessment (**Appendix 6**) mapped the population to show that it predominately occurs on land adjoining the study area (**Figure 25a)**.

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

Although not counted in detail, the study area is likely to support several hundred plant clumps of *Angophora inopina*, principally in the Tooheys Road portion. Many of these will be destroyed through construction of the proposed rail loop and other surface facilities. Being a long-lived, resprouting species any *Angophora inopina* disturbed during construction activities will subsequently resprout: many specimens have been slashed under the power line easement and continue to grow but in a mallee habit. Given the existence of extensive populations to the immediate west and north (see **Appendix 6** for details), the local population of plants is unlikely to be placed at risk of extinction through the proposed development.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
>
> ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

Angophora inopina is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) in relation to the habitat of a threatened species, population or ecological community:

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

(i) Habitat supporting *Angophora inopina* will be removed during construction of the rail loop and other surface facilities, however the majority of suitable habitat will remain undisturbed (**Figure 25a**, **Appendix 6**). Elsewhere in the region, *Angophora inopina* occupies a wide range of habitat types (Bell 2004), and the Coastal Plains Scribbly Gum Woodland (in particular) is widespread (NPWS 2000).

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north and west, where *Angophora inopina* occurs in sizeable numbers. Further fragmentation of the population is therefore unlikely.

(iii) The Coastal Plains Scribbly Gum Woodland is widespread in the Wyong LGA, and in the southern Lake Macquarie/ Wyong region (NPWS 2000); in excess of 5800 ha of this habitat type has been reported (LHCCREMS 2003). Consequently, habitat to be removed from the study area is not considered of importance to the long term survival of the species.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Angophora inopina*. However, a conservation management plan has been prepared for the species on behalf of Wyong Shire Council (Bell 2001).

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Angophora inopina* is **unlikely** to be significantly impacted upon by the proposed development.

- *Arachnorchis tessellatus*

Very few recent records of *Arachnorchis tessellatus* exist in the region, which extend south from the Swansea area in southern Lake Macquarie. It occupies a range of habitats within this region, from coastal headlands to open forests and alluvial soils. Although no specimens were observed during the current surveys, a record does exist for the southern edge of the Tooheys Road portion.

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

The single record of this species recorded from the southern boundary of the Tooheys Road portion lies outside of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

Arachnorchis tessellatus is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Habitat supporting *Arachnorchis tessellatus* will not be removed during construction of the proposed development, and the area will be retained as a buffer between the rail loop and the Pacific Highway.

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north, south and west, where suitable habitat for *Arachnorchis tessellatus* occurs. Further fragmentation of the population is therefore unlikely.

(iii) The Coastal Plains Scribbly Gum Woodland is widespread in the Wyong LGA, and in the southern Lake Macquarie/ Wyong region (NPWS 2000); in excess of 5800 ha of this habitat type has been reported (LHCCREMS 2003). Consequently, the habitat to be removed from the study area is not considered of importance to the long term survival of the species.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Arachnorchis tessellatus*.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Arachnorchis tessellatus* is **unlikely** to be significantly impacted upon by the proposed development.

- *Grevillea parviflora subsp. parviflora*

Grevillea parviflora subsp. *parviflora* occurs from the Karuah area north of Newcastle to the outskirts of Sydney. It occupies a range of habitats within this region, with the Cessnock area in particular supporting large numbers of species across a variety of habitat. Recent investigations into the taxonomy of this species has revealed considerable morphological variations not currently recognised in the group, and hence taxonomic revisions are required. Two small populations of this species occur in the Buttonderry area, one on the edge of Kiar Ridge Road and the other at the rear of the Buttonderry portion.

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

The two populations of this species within the Hue Hue Road and Buttonderry portions lie outside of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

Grevillea parviflora subsp. *parviflora* is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Habitat supporting *Grevillea parviflora* subsp. *parviflora* will not be removed during construction of the proposed development, and the area will be retained as a conservation area with appropriate management.

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north, south and west, where suitable habitat for *Grevillea parviflora* subsp. *parviflora* occurs. Further fragmentation of the population is therefore unlikely.

(iii) The Coastal Plains Scribbly Gum Woodland is widespread in the Wyong LGA, and in the southern Lake Macquarie/ Wyong region (NPWS 2000); in excess of 5800 ha of this habitat type has been reported (LHCCREMS 2003). Consequently, the habitat to be removed from the study area is not considered of importance to the long term survival of the species.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Grevillea parviflora* subsp. *parviflora*.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Grevillea parviflora* subsp. *parviflora* is **unlikely** to be significantly impacted upon by the proposed development.

- *Melaleuca biconvexa*

Melaleuca biconvexa occurs principally south from southern Lake Macquarie, although there are records from Port Macquarie on the North Coast. It occupies a range of swamp or moist forest habitats within this region, although in the Wyong area riparian or swamp communities of Blackbutt, Bluegum or Swamp Mahogany are the most common. One population of this species occurs along Buttonderry Creek in the north-eastern corner of the Buttonderry portion.

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

The single population of this species within the Buttonderry portion lies well outside and upstream of the direct area of impact for the proposed development, hence there will be no adverse impact on the species.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***

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

Melaleuca biconvexa is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Habitat supporting *Melaleuca biconvexa* will not be removed during construction of the proposed development, and the area will be retained as a conservation area with appropriate management.

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north, south and west, but suitable habitat for *Melaleuca biconvexa* is very limited. Downstream of the current study area, Buttonderry Creek supports many individuals of *Melaleuca biconvexa* which will be retained as part of ongoing developments in the Warnervale area.

(iii) None of the riparian Blackbutt community supporting the species in the study area is to be removed.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Melaleuca biconvexa*.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Melaleuca biconvexa* is **unlikely** to be significantly impacted upon by the proposed development.

- *Tetratheca juncea*

Tetratheca juncea is widespread in the southern Lake Macquarie area, but its full distribution currently extends from Wyong to Bulahdelah. It occupies a range of habitats within this region, from coastal headlands to open forests, on conglomerates, sandstones and coastal sands. Large numbers of plants occur within the Tooheys Road portion of the current study area.

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

Although not counted in detail, the study area is likely to support several hundred plant clumps of *Tetratheca juncea*, principally in the Tooheys Road portion. Many of these will be destroyed through construction of the proposed rail loop and other surface facilities. *Tetratheca juncea* is pollinated by at least two sonicating bees (Driscoll 2003), and based on the amount of fruiting *Tetratheca juncea* in adjacent lands (S.Bell, pers obs.), it is likely that these bees are active in the area. Given the existence of extensive populations to the immediate west and north, the local population of plants is unlikely to be placed at risk of extinction through the proposed development.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
>
> ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

Tetratheca juncea is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) <u>in relation to the habitat of a threatened species, population or ecological community:</u>

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Habitat supporting *Tetratheca juncea* will be removed during construction of the rail loop and other surface facilities, however the majority of suitable habitat will remain undisturbed. Elsewhere in the region, *Tetratheca juncea* occupies a wide range of habitat types (S. Bell, unpubl. data), and the Coastal Plains Scribbly Gum Woodland (in particular) is widespread (NPWS 2000).

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north and west, where *Tetratheca juncea* occurs in sizeable numbers. Further fragmentation of the population is therefore unlikely.

(iii) The Coastal Plains Scribbly Gum Woodland is widespread in the Wyong LGA, and in the southern Lake Macquarie/ Wyong region (NPWS 2000); in excess of 5800 ha of this habitat type has been reported (LHCCREMS 2003). In addition, *Tetratheca juncea* reportedly occurs in a range of other habitats. Payne (2000) has examined several aspects of the ecology of this species, as part of the Lake Macquarie Conservation Management Plan. His study has revealed that *Tetratheca juncea* has a preference for ridge tops on south-east to south-westerly aspects on Munmorah Conglomerate geology and the Awaba soil landscape. Further, Payne (2000) states that the species primarily grows in dense undisturbed understorey vegetation, in open forest dominated by *Angophora costata, Corymbia gummifera, Eucalyptus haemastoma* and *Eucalyptus capitellata*. The species is also known from several other habitat types (see Table 2 in Payne 2000; and also Payne 1993; Winning 1992; Kidd 1991; Bartim & Martin 1986), and hence the habitat to be removed from the study area is not considered of importance to the long term survival of the species.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

(f) <u>whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,</u>

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Tetratheca juncea*, although Payne (2001) has prepared a conservation management plan.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Tetratheca juncea* is **unlikely** to be significantly impacted upon by the proposed development.

- *Acacia bynoeana*

Acacia bynoeana occurs from south of Sydney to the lower Blue Mountains, and north to the Cessnock district. On the Central Coast, it typically occurs in healthy woodlands or open forests. A few small populations were recorded in proximity to the proposed rail corridor on DLALC land.

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

Bell & Driscoll (2002) have detailed known populations of *Acacia bynoeana* from the Wyong LGA, and several populations are present within a 2-3 km radius of the site. Extensive populations occur in the Wyee area on Crown or DLALC land. Two plants were located on the edge of the existing transmission easement during the current survey. Consequently, it is unlikely that an adverse effect will occur on the local population of this species.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

extinction,

Acacia bynoeana is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Habitat supporting *Acacia bynoeana* is extensive on the Central Coast. NPWS (2000) describe and map the Coastal Plains Scribbly Gum Woodland for the region. A narrow corridor (~20-30m) of this habitat supporting *Acacia bynoeana* is proposed to be removed, adjacent to the existing powerline easement.

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north, south and west, where suitable habitat for *Acacia bynoeana* occurs. Further fragmentation of the population is therefore unlikely.

(iii) The Coastal Plains Scribbly Gum Woodland is widespread in the Wyong LGA, and in the southern Lake Macquarie/ Wyong region (NPWS 2000); in excess of 5800 ha of this habitat type has been reported (LHCCREMS 2003). Consequently, the habitat to be removed from the study area is not considered of importance to the long term survival of the species.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Acacia bynoeana*.

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

process.

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Acacia bynoeana* is **unlikely** to be significantly impacted upon by the proposed development.

- *Cryptostylis hunteriana*

Cryptostylis hunteriana occurs along the east coast of Australia from Victoria and southern NSW, into southern Queensland. On the Central Coast, it typically occurs in healthy woodlands or open forests (Bell 2001), while further south wetter habitats are preferred (Clark et al. 2004). A single flower spike was recorded on the Tooheys Road property.

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

The single plant located within the study area occurs in a proposed conservation offset, approximately 200m upslope from any development. Consequently, no adverse effect is likely on the species.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

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

Cryptostylis hunteriana is not an "Endangered Ecological Community" (EEC) identified under Part 3 of Schedule 1 of the TSC Act 1995.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) Habitat supporting *Cryptostylis hunteriana* is extensive on the Central Coast, however confirmed records are few (Bell 2001). NPWS (2000) describe and map the Coastal Plains Scribbly Gum Woodland for the region, which occurs extensively in the adjacent areas to the north. A narrow strip of suitable habitat will be removed, however targeted surveys in this area did not reveal any individuals of this species.

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north, south and west, where suitable habitat for *Cryptostylis hunteriana* occurs. Further fragmentation of the population is therefore unlikely.

(iii) The Coastal Plains Scribbly Gum Woodland is widespread in the Wyong LGA, and in the southern Lake Macquarie/ Wyong region (NPWS 2000); in excess of 5800 ha of this habitat type has been reported (LHCCREMS 2003). Consequently, the habitat to be removed from the study area is not considered of importance to the long term survival of the species.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for *Cryptostylis hunteriana*.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and their relevance to the current project.

Summary - This Section 5A assessment concludes that the local population of *Cryptostylis hunteriana* is **unlikely** to be significantly impacted upon by the proposed development.

6.3.1b National legislation – Assessments of significance

- *Angophora inopina*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

Angophora inopina is widespread in the Tooheys Road portion of the study area, and a large number of adult and juvenile plants will be removed through construction of surface facilities. Good populations are also present in the DLALC/ Crown land to the immediate north (**Figure 25a**, **Appendix 6** and Bell 2004b).

Angophora inopina is known to occur from the Bulahdelah area of the North Coast to the Warnervale area on the Central Coast, a geographic range of ~120km. Populations within the Warnervale area are recognised as occurring at the species southern limit of distribution, where they occur as small, highly restricted populations (Bell 2004b).

Under the meaning of the Act, an "important" population is one that is necessary for a species' long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range. By definition, the occurrence of *Angophora inopina* within the Warnervale locality occurs at the limit of its geographical range, and hence impacts on the species in this area may be considered significant.

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

The proposed development will result in the reduction of occupancy area of an important population of *Angophora inopina*, and may consequently be considered as significant.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

The population of *Angophora inopina* at Tooheys Road is already highly fragmented through existing land uses. No further fragmentation of the large population present will occur despite the loss of many individuals, particularly if the adjacent and contiguous DLALC/ Crown lands are considered.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Angophora inopina* has been declared under the *EPBC Act 1999*.

The Warnervale area does not constitute habitat critical to the survival of *Angophora inopina* as the species occupies an extensive range north to Bulahdelah. Within this range, many populations and the habitat occur on Crown Land, State Forest or National Park/ Nature Reserve.

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

Plants within the local area are considered an "important population" as the population occurs at the southern limit of the species' range. Several individuals will be destroyed during the proposed development, and this loss may impact on the breeding cycle of this species through reduced opportunities for outcrossing amongst the population. In addition, alteration to fire regimes may also impact on the long-term survival of this species (see Tierney 2004).

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The known habitat for this species on the Central Coast has been documented in Bell (2004b). In this region, *Angophora inopina* occurs within three broad habitat types, centred mainly on the Gorokan, Doyalson and Wyong soil landscapes. Hybrid forms of the species also occur on the Cockle Creek landscape in northern Lake Macquarie. Most stands are evident within open woodland/ forest vegetation where *Eucalyptus haemastoma, Corymbia gummifera,* and *Eucalyptus capitellata* dominate with *Angophora inopina*. Other populations occur in wet-dry heath, and swamp forest environments where sedge species are characteristic. These habitat types together occupy over 4,200 ha in the region (NPWS 2000), with approximately 1,500 ha of occupied habitat currently supporting the species (Bell 2004b).

Habitat for this species within the study area is typical of the species elsewhere, and is extensive in the immediate area north and east of the site (**Figure 25a** and **Appendix 6**).

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

There is the possibility that invasive species may become established within the habitat of *Angophora inopina* proximate to the proposed development, although currently there is little evidence of problematic weed invasion. Any increase in weed invasion, particularly exotic grass species, is likely to impact on the germination of seedlings due to competition and hence the potential impact is considered significant.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Proposed development activity within the study area will not substantially interfere with the recovery of *Angophora inopina*, as it is a relatively widespread species present in a large number of locations, and hence any potential impacts would be not significant.

Summary

The action (development in the study area) is considered likely to impact on *Angophora inopina*, as the local population represents an "important population" at the limit of its distribution. Impacts may be felt due to increased fragmentation, loss of occupancy area and potential for invasion by exotic weed species. Impacts to *Angophora inopina* have been referred to the Minister of the Department of Environment, Heritage and the Arts and have been subsequently determined as a Controlled Action (**Appendix 8**).

- *Arachnorchis tessellatus*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

Arachnorchis tessellatus is known in the study area from a previous record located on the southern boundary of the Tooheys Road portion. No individuals of the species were recorded during investigations for the current study.

An "important" population is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range. *Arachnorchis tessellatus* occupies a widespread range south from Swansea to Victoria. However records of the species within this range are few (Bishop 1996).

Populations of the species in Wyong LGA occur near the northern distributional limit of the species, with the most northern populations in southern Lake Macquarie LGA. Despite intensive survey effort for the species, none were documented to indicate a significant population exists within the study area. Therefore, the potential impact of future development of the study area is considered insignificant as an "important population" has not been identified.

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

An important population of *Arachnorchis tessellatus* has not been identified within the study area despite intensive survey effort. Future development of the study area is not considered likely to reduce the area of occupancy of an important population of *Arachnorchis tessellata*. Any reduction of occupancy area is considered insignificant.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

The single record of the species within the study area occurs in habitat that is outside of the direct impact zones. No other populations of the species are known to occur despite intensive survey effort. Hence, it is considered that future development of the study area is unlikely to further fragment habitat of *Arachnorchis tessellatus*, and therefore potential impacts are considered insignificant.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Arachnorchis tessellatus* has been declared under the *EPBC Act 1999*.

Arachnorchis tessellatus reportedly occurs in a range of habitats, but generally within dry forests and heaths from the Swansea area (Munmorah SRA) south to Gippsland in Victoria (Bishop 1996). In the Wyong LGA, preferred habitat appears to be dry forest and heath on Pleistocene, beach and dune barrier sands in most situations. However, records of the species in the Warnervale area occur on Quaternary alluvium (Payne 1997a, cited in Gunninah Environmental Consultants 2003). Such habitat is widespread in the Warnervale area and Porters Creek catchment.

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

Future development of the study area is not considered to impact on the breeding cycle of this species. Habitat supporting the known location of the species is located outside of direct impact zones, and consequently potential impacts likely to disrupt the breeding cycle are considered unlikely to occur.

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The habitat of *Arachnorchis tessellatus* on higher quality alluvial soil (described in Gunninah Environmental Consultants, 2003) is widespread in the Porters Creek catchment and Wyong alluvial floodplains. Consequently, it is unlikely that future development of the study area will reduce the extent of high quality habitat such that local populations of the species will decline.

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

Disturbance to habitat by development will increase the potential for invasive species such as exotic grasses becoming established within habitat of *Arachnorchis tessellatus*. It is therefore expected that any increase in invasive species may impact on flowering and germination of a local population of this species. However, the distance of the known record from direct impact areas will lessen the potential impacts of invasive species invading this population.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Future development activity within the study area is considered not to substantially interfere with the recovery of *Arachnorchis tessellatus*, as it is a relatively widespread species occupying a range of habitats (despite few records). Impacts of future development are not considered likely to interfere in the recovery process of the species.

Summary

The action (development in the study area) is considered unlikely to impact on local populations of *Arachnorchis tessellatus.*

- *Grevillea parviflora subsp. parviflora*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

Two populations of *Grevillea parviflora subsp. parviflora* have been recorded within the study area, one adjacent to Kiar Ridge Road in the Hue Hue Road offset portion, and the other along the western boundary of the Buttonderry portion. No development is proposed within the Hue Hue road portion, while direct impacts on the Buttonderry portion occur down slope by ~200m. Significant impacts are therefore considered unlikely at either population.

The wider Warnervale area supports a locally significant population of *Grevillea parviflora* subsp. *parviflora*, which includes the study area. This significance is attributed to the large number of plants occurring, but also in the variations of flower and leaf morphologies displayed and their importance in on-going taxonomic studies (Driscoll & Bell, in progress).

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

No direct impact is expected on either of the two areas supporting this species, with no development at all proposed for the Hue Hue Road offset portion. Consequently, there will be no reduction in the area of occupancy of an important population by any future development within the study area.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

No direct impact is expected on either of the two areas supporting this species, with no development at all proposed for the Hue Hue Road offset portion. Consequently, there will be no impacts due to fragmentation of habitat.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Grevillea parviflora* subsp. *parviflora* has been declared under the *EPBC Act 1999*.

Grevillea parviflora subsp. *parviflora* occurs in a range of habitat throughout its distribution (Bell & Driscoll in progress). In the Wyong area, this habitat is generally tied to the distribution of the Narrabeen Buttonderry Footslopes Forest (MU28), which occupies an area of 1,015 ha (Bell, 2002a).

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

No direct impact is expected on either of the two areas supporting this species, with no development at all proposed for the Hue Hue Road offset portion. Consequently, there will be no disruption to the breeding cycle of this population. Considerable areas of proposed conservation offsets will also ensure that pollinators of this species remain in the local area.

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The habitat supporting the *Grevillea parviflora* subsp. *parviflora* population located within the study area is to be conserved within proposed conservation offset areas. Consequently, proposed development of parts of the study area is unlikely to destroy, remove, isolate or decrease the availability or quality of habitat such that the species is likely to decline.

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

Disturbance to habitat by development within the study area will increase the potential for invasive species such as exotic grasses becoming established. However, the location of the two populations of *Grevillea parviflora* subsp. *parviflora* are well distant from proposed impact areas, and any such invasion will be minor or non-existent.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Grevillea parviflora subsp. *parviflora* occurs from the Sydney area north to Karuah in a large number of disjunct populations (pers. obs.). While the taxonomy of this species is currently under review, the current understanding of this species suggests the Warnervale area is significant from a regional perspective, in that it is a large meta-population occurring within presently intact bushland. However, the two locations supporting this species are well distant from any proposed direct impact areas, and consequently potential impacts due to interference of recovery processes is considered insignificant.

Summary

The action (development in the study area) is unlikely to impact on local populations of *Grevillea parviflora* subsp. *parviflora*. The proposed development of the subject site is not considered to impact upon an 'important population' of *Grevillea parviflora* subsp. *parviflora*.

- *Melaleuca biconvexa*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

Melaleuca biconvexa occurs in reasonable numbers along Buttonderry Creek, in the north-east corner of the Buttonderry portion.

An "important" population under the Act is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

The Buttonderry Creek population occurs within the middle of the regional distribution of this species (Cooranbong to Gosford). Therefore, it is consequently not considered to be an important population for the species long-term survival and recovery, and potential impacts due to a reduction in the size of an important population are insignificant.

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

The habitat supporting this species within the study area is associated with Buttonderry Creek, and is well distant from any proposed direct impacts of development. The watercourse of Buttonderry Creek is heavily impacted upon by contaminated runoff and leaching from the adjacent Buttonderry Waste Management Facility, and the riparian zone is impacted by clearing and grazing. This impact does not appear to have adversely impacted on the health and vigour of this population, but will require ongoing monitoring to ensure longer term viability.

The habitat contained within the Buttonderry Creek population is to be conserved, and under the restrictions imposed by the *Rivers and Foreshore Act 1949*, any development within 40 metres of a major water course such as Buttonderry Creek is prohibited.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

No development is proposed in the area supporting *Melaleuca biconvexa*, and consequently no fragmentation of habitat and populations is likely. The construction of the F3 Freeway to the east in the 1980's resulted in fragmentation of habitat and potential isolation of the once contiguous population of this species.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Melaleuca biconvexa* has been declared under the EPBC Act 1999.

Melaleuca biconvexa occurs in a range of habitats within Wyong Shire, most commonly within the Alluvial Bluegum-Paperbark Mesic Palm Forest (MU16) and the Alluvial Robusta-Paperbark Sedge Palm Forest (MU17) of Bell (2002a). These habitats respectively occupy 493 ha and 1,837 ha within Wyong Shire (Bell 2002a). Consequently, the study area is not considered to support habitat critical to the survival of this species.

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

Future development of the study area will not impact on the area supporting this species, and is unlikely to disrupt the breeding cycle of *Melaleuca biconvexa.* The habitat and large population of *Melaleuca biconvexa* along Buttonderry Creek is to be retained for conservation.

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

A total of over 2,000 ha of potential habitat for *Melaleuca biconvexa* has been mapped in Wyong Shire (Bell 2002a). Duncan (2001) mapped stands totalling 372 ha of the species within Wyong LGA. The majority of habitat and populations occur along major creek lines and water courses. Development actions within this zone are unlikely due to restrictive land uses and legislative protection. Consequently, potential impacts due to loss or modification of habitat quality is considered insignificant.

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

There is potential for the population of *Melaleuca biconvexa* present along Buttonderry Creek to be impacted upon by invasive species, however this is more likely to occur as a result of localised pollution from the upstream Buttonderry Waste Management Facility. Development proposed for the Buttonderry portion occurs >600m to the south-west (down slope), and consequently potential impacts through invasive species are considered insignificant.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Melaleuca biconvexa is relatively widespread within the Wyong-Gosford region. Proposed development in the study area is considered unlikely to interfere with the recovery of the species.

Summary

The action (development of the study area) is unlikely to impact (either directly or indirectly) on local populations of *Melaleuca biconvexa*, as no specimens are planned for removal. The local population of *Melaleuca biconvexa* is not considered an 'important population' under the Act.

- *Tetratheca juncea*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

An "important" population is one that is necessary for a species long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range.

Extensive areas of *Tetratheca juncea* occur in the Tooheys Road portion, and also along the proposed rail loop in DLALC lands. Although comparative survey effort has not been undertaken in the adjacent lands, it is likely that large numbers of plants also occur there. Until this is done, it likely that removal of the known plants for the current development will result in a significant impact on the local population of the species.

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

Many individuals of *Tetratheca juncea* were recorded within the proposed direct impact areas at the Tooheys Road site. Removal of these plants will likely lead to a reduction in occupancy area of this population, although it remains to be seen how extensive the population is in the adjacent DLALC lands.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

The existing habitat of *Tetratheca juncea* within the Warnervale-Buttonderry area is already fragmented due to historical land uses which have cleared portions of the study area. Further minor fragmentation of habitat is expected following development. The *Tetratheca juncea* population in the locality is considered part of a larger population associated with forest surrounding the Porters Creek Wetland, and extending to the north-west into the DLALC and Crown lands around Wyee.

Plants to be destroyed by the current proposal occur mostly on the route of the proposed rail loop, which for the majority of its length occur in either previously cleared land or along an existing powerline easement. Consequently, additional fragmentation of populations is minimal and is not considered significant.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Tetratheca juncea* has been declared under the *EPBC Act 1999*.

Tetratheca juncea currently occupies a range of habitats throughout its distribution (Driscoll 2003; Bell & Driscoll in prog. 1), and the habitats observed within the current study area are typical of the species on the Central Coast.

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

Driscoll (2003) has documented the pollination process of *Tetratheca juncea* and identified several species of native bees responsible. Such pollinators are highly mobile and are not restricted solely to *Tetratheca* for their nourishment. Several bee species include *Tetratheca juncea* as a minor component of their diet. *Tetratheca juncea* clumps located within the study area are likely to form part of the diet of these bees should they be present in the area, along with several other native shrubs. Given the extent of plants occurring immediately outside of the direct impact areas, a significant impact is not expected through disruption to the breeding cycle.

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Habitat supporting *Tetratheca juncea* on the proposed development site is typical of the species elsewhere in Wyong LGA and the region (Bell & Driscoll in prog.), and is also contiguous with the DLALC and Crown lands to the immediate north and west. This entire habitat is of good quality, and hence a significant impact on the availability or quality of habitat is not expected.

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

There is some possibility that invasive species (e.g. exotic grasses) will become established within the habitat of *Tetratheca juncea*, particularly for the areas adjacent to the existing powerline easement. However, the contiguous bushland is likely to limit penetration of invasive weeds into undisturbed populations.

Populations in the southern section of the Tooheys Road portion are already in close proximity to existing roads and clearings, and hence weed invasion is already a threat.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Tetratheca juncea occurs at the southern limit of distribution in the Warnervale-Buttonderry district. Within this southern limit, *Tetratheca* reportedly occurs only as isolated individuals rather than the expansive populations known from further north (Payne 2000). As a consequence, any impacts felt by the species would not impinge on its recovery, and it is possible that the Warnervale populations are undergoing a process of insidious delayed extinction due to pollinator limitation (sensu Driscoll 2003). The potential impact of interference to recovery processes is therefore considered not significant.

Summary

The action (development of the study area) will impact on a number of local sub-populations of *Tetratheca juncea* within the study area. Several tens of plants will be removed through the construction of the proposed rail loop and other surface facilities, resulting in loss of occupied habitat. Other plants will be excluded from development, and while not surveyed in detail, several other sub-populations were observed in adjacent areas, both in WACJV ownership and the contiguous DLALC / crown lands (the populations of the crown lands were observed whilst undertaking detailed assessment work for *A. inopina*). Impacts to *Tetratheca juncea* will require referral to the Minister of the Department of Environment, Heritage and the Arts following the referral format (see EPBC website).

- *Acacia bynoeana*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

Acacia bynoeana is relatively widespread in the Wyee area to the north of the study area, but only a few plants will be removed during construction of the proposed rail corridor. Good populations are also present in the DLALC/ Crown land to the immediate north (Bell & Driscoll 2002).

Under the meaning of the Act, an "important" population is one that is necessary for a species' long-term survival and recovery, and may include key source populations for breeding and dispersal, populations necessary for maintaining genetic diversity and populations near the limit of the species range. *Acacia bynoeana* within the Warnervale locality occurs in the middle of its geographical range, and hence impacts on the species in this area are not considered significant.

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

The proposed development will not result in the reduction of occupancy area of an important population, as *Acacia bynoeana* is not considered such under the meaning of the Act.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

The location of *Acacia bynoeana* at Tooheys Road occurs on the edge of an existing powerline easement, which is regularly slashed. Much larger populations of the species occur in the adjacent and contiguous DLALC/ Crown lands (Bell & Driscoll 2002). Further fragmentation than is otherwise already present in the area is not expected.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Acacia bynoeana* has been declared under the *EPBC Act 1999*.

The Warnervale area does not constitute habitat critical to the survival of *Acacia bynoeana* as the species occupies a range between southern Sydney and Cessnock. Within this range, several populations and habitat occur on Crown Land, State Forest or National Park/ Nature Reserve (Driscoll 2006).

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

Plants within the local area are not considered an "important population" as greater numbers of the plant occur in the immediate and contiguous lands. A single individual only will be destroyed during the proposed development, but this loss is not expected to impact on the breeding cycle of this species.

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The known habitat for this species on the Central Coast has been documented in Bell & Driscoll (2002). In this region, *Acacia bynoeana* occurs within one broad habitat types, centred mainly on open woodland/ forest vegetation where *Eucalyptus haemastoma, Corymbia gummifera*, and *Eucalyptus capitellata* dominate with *Angophora inopina*. These habitat types together occupy large areas of the region (NPWS 2000).

Habitat for this species within the study area is typical of the species elsewhere on the Central Coast, which is extensive in the immediate area north and east of the site.

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

There is the possibility that invasive species may become established within the habitat of *Acacia bynoeana* proximate to the proposed development, although currently there is little evidence of problematic weed invasion. Any increase in weed invasion, particularly exotic grass species, is likely to impact on the germination of seedlings due to competition and hence the potential impact is considered significant.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Proposed development activity within the study area will not substantially interfere with the recovery of *Acacia bynoeana*, as much larger populations occur elsewhere in the immediate locality, on Crown and reserve lands.

Summary

The action (development in the study area) is considered unlikely to impact on *Acacia bynoeana*, as much larger populations and contiguous habitat occur in the wider area. Invasion by exotic weed species may impact on the species long-term survival, however there is minimal risk of this occurring in this habitat.

- *Cryptostylis hunteriana*

Criteria 1. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to lead to a long-term decrease in the size of an important population of a species.

Cryptostylis hunteriana is rarely recorded in the Central Coast area (see Bell 2001), but no plants will be removed during the current proposal as the single location occurs within a proposed conservation area.

Criteria 2. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to reduce the area of occupancy of an important population.

The proposed development will not result in the reduction of occupancy area of an important population, as *Cryptostylis hunteriana* has not been recorded in area proposed for development.

Criteria 3. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to fragment an existing important population into two or more populations.

The location of *Cryptostylis hunteriana* at Tooheys Road occurs in a proposed conservation offset area. Fragmentation of habitat due to activities associated with the proposal will not impact on this location.

Criteria 4. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to adversely affect habitat critical to the survival of a species.

No critical habitat for *Cryptostylis hunteriana* has been declared under the *EPBC Act 1999*.

The Warnervale area does not constitute habitat critical to the survival of *Cryptostylis hunteriana* as the species occupies a range between southern Australia and Queensland.

Criteria 5. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to disrupt the breeding cycle of an important population.

No plants will be destroyed during the proposed development, as the only recorded location lies 200m north and upslope of the proposed development.

Criteria 6. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The known habitat for this species on the Central Coast has been documented in Bell (2001). In this region, *Cryptostylis hunteriana* occurs within one broad habitat type, centred mainly on open woodland/ forest vegetation where *Eucalyptus haemastoma, Corymbia gummifera,* and *Eucalyptus capitellata* dominate with *Angophora inopina*. These habitat types together occupy large areas of the region (NPWS 2000).

Habitat for this species within the study area is typical of the species elsewhere on the Central Coast, which is extensive in the immediate area north and east of the site.

Criteria 7. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.

There is no possibility of invasive species becoming established within the habitat of *Cryptostylis hunteriana*, as the proposed disturbance is approximately 200m down slope from the only known record of this species in the area.

Criteria 8. An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to interfere substantially with the recovery of the species.

Proposed development activity within the study area will not interfere with the recovery of *Cryptostylis hunteriana*, as no disturbance will occur at the only known site.

Summary

The action (development in the study area) is considered unlikely to impact on *Cryptostylis hunteriana*, as the proposed development will occur approximately 200m down slope of the only known record of this species in the study area.

6.3.2 Fauna

6.3.2a NSW legislation – 7 part tests for direct impact areas

- *Microchiroptean bats*

The following threatened species are known to occur or have potential to occur in the direct impact study areas and require further assessment:

- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*);
- Common Bent-wing Bat (*Miniopterus schreibersii*);
- Little Bent-wing Bat (*Miniopterus australis*);
- Large-footed Myotis (*Myotis adversus);*
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis);*
- Greater Broad-nosed Bat (*Scoteanax rueppellii);* and
- Eastern Freetail-bat (*Mormopterus norfolkensis).*

The Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) occurs in rainforests, sclerophyll forests and woodlands. They roost alone or with up to ten others in large hollow trees, in buildings or abandoned nests of Sugar Gliders (Churchill 1998). This species has been previously recorded in the study area at the Tooheys Rd and Hue Hue Rd potential offset properties.

Common Bent-wing Bats (*Miniopterus schreibersii*) occur in a range of habitats, from grasslands through to subtropical rainforest, but are typically found in well timbered valleys. The species is distributed throughout the coastal plains and highlands of NSW, VIC and SA. The species is reliant on caves for maternity and over wintering roosts. This species has been not previously recorded in the study area but has the potential to occur.

The Little Bentwing-bat (*Miniopterus australis*) occupies caves and tunnels during the day and at night forages for small insects beneath the canopy of well-timbered habitats including rainforest, *Melaleuca* swamps and dry sclerophyll forests. Distribution in Australia becomes increasingly coastal towards the southern limit of its range which is in NSW. The Little Bentwing-bat relies on specific nursery sites to rear its young, with the most southern known site, being in the Macleay River water shed (Dwyer, 1995). This species has been previously recorded in the study area at the Tooheys Rd study area.

Large-footed Myotis (*Myotis adversus)* has disproportionately large feet; more than 8 mm long, with widely-spaced toes which are distinctly hairy and with long, curved claws. It has dark-grey to reddish brown fur above and is paler below. It weighs up to 15 grams and has a wingspan of about 28 cm. The species is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December (Churchill 1998). This species has been previously recorded in the study area at the Tooheys Rd study area.

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis)* is relatively large with a head-body length of about 65 mm. It weighs up to 28 grams. It is dark to reddish-brown above and paler grey on its underside. It has long slender ears set well back on the head and some sparse hair on the nose. This species is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania where it prefers moist habitats, with trees taller than 20 m and roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It hunts beetles, moths, weevils and other flying insects above or just below the tree canopy and hibernates in winter. Females are pregnant in late spring to early summer. This species has been previously recorded in the study area at the Tooheys Rd study area.

The Greater Broad-nosed Bat (*Scoteanax rueppellii)* has been included in this assessment as its call is very similar to those of the Eastern False Pipistrelle, as this is also a threatened species in NSW duty of care requires additional assessment of this species. This is large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Great Pipistrelle *Pipistrellus tasmaniensis*, it differs by having only two (not four) upper incisors. The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m. It utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. It forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young (Churchill 1998). This

species has been previously recorded in the Hue Hue Rd ecological offset investigation area.

Eastern Freetail-bat (*Mormopterus norfolkensis)* has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (3 - 4 cm) bare tail protruding from the tail membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to 10 grams. It is found along the east coast from south Queensland to southern NSW proffering 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 and is solitary and probably insectivorous (Churchill 1998). This species has not been previously recorded however it has the potential to occur within the assessed areas.

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

The Yellow-bellied Sheathtail, Bat Large-footed Myotis (*Myotis adversus),* Eastern False Pipistrelle (*Falsistrellus tasmaniensis),* Greater Broad-nosed Bat (*Scoteanax rueppellii),* and Eastern Freetail-bat (*Mormopterus norfolkensis)* may roost and breed in some of the scattered older trees on site near the proposed rail loop. Local populations of the Yellow-bellied Sheathtail Bat may be impacted by the proposed works as potential breeding and nursery roosts and foraging habitat may be destroyed.

More specifically, there are 142 trees within the impact footprint assessed as, at minimum, able to provide suitable hollows for species of microchiroptean bats (see Section 5.3.1(i) of this report). Additionally, these trees are located within 4.54 ha of vegetation to be cleared (with 11 hollow bearing trees) at the Buttonderry study area where 56.59 ha will remain (c. 8% of available habitat removed with 92% remaining) this action will not cause any local populations of these species to become extinct.

The Tooheys Rd and Hue Hue Rd ecological offset investigation area for the purpose of this assessment are considered to be within the one home range for these species and as such have been assessed as the one habitat. Cumulatively c.33 ha of native vegetation will be cleared within the Tooheys Rd study area that is known to possess 131 hollow bearing trees suitable as nesting, roosting locations. Approximately 248 ha of analogous native vegetation will remain in these areas (88.6% of existing vegetation) and as such the action is unlikely to disrupt local populations such that they are placed at risk of local extinction.

The Common Bent-wing Bat and Little Bent-wing bats are not likely to breed on site; instead they use it as a foraging area. The little bentwing bat was recorded in woodland to the north of the affected area. Foraging habitat for these species would be reduced by the construction activities. However, considering the excellent dispersal potential of these species and the small amount of habitat clearance required for the development, it is expected that the development is unlikely to disrupt a viable local population such that it is placed at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered

population such that a viable local population of the species is likely to be placed at risk of extinction,

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
>
> ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

Not relevant.

(d) in relation to the habitat of a threatened species, population or ecological community:

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

(i) The extent of habitat to be removed is given in detail on **Figure 14** and discussed in Section 5.3.1(i) of this report. Cumulatively, 142 hollow bearing trees in 36.54 ha of native vegetation will be removed, all habitat values for these species will be lost however 243.46 ha of habitat will remain (75% of all native vegetation assessed) the majority of which has the potential to be retained as a conservation area with appropriate management.

(ii) Although already fragmented from past agricultural activities, the study area is contiguous with large tracts of land to the north, south and west however, this is interrupted by the Great Northern Rail Line, F3 Freeway and Doyalson Rd for terrestrial species (as such not a serious impediment for bats). Section 5.1.5 of this report and 6.2 discuss in existing wildlife corridors and detail potential impacts and amelioration.

(iii) All hollow bearing trees and native vegetation are important for the survival of native species. Perhaps the most important habitat observed for species of microbats was associated with riparian Blackbutt community (MU43 - Alluvial

Riparian Blackbutt Forest and its derivatives) that has the greatest likelihood to support the various species in the study area. 98.5% of Alluvial Riparian Blackbutt Forest that has not been previously impacted (i.e. of high quality) will remain and 0.24 ha will be impacted. 0.81 ha of previously impacted riparian Blackbutt community will be removed and 6.44 ha will remain, effectively 88% of this vegetation unit and the habitat it supports for these species will be unaffected by the proposal.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plans for any species of microbats.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and there relevance to the current project.

Summary - This Section 5A assessment concludes that the local populations of Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Common Bent-wing Bat (*Miniopterus schreibersii*), Little Bent-wing Bat (*Miniopterus australis*), Large-footed Myotis (*Myotis adversus),* Eastern False Pipistrelle (*Falsistrellus tasmaniensis),* Greater Broad-nosed Bat (*Scoteanax rueppellii)* and Eastern Freetail-bat (*Mormopterus norfolkensis)* are **unlikely** to be significantly impacted upon by the proposed development.

- *Arboreal Mammals*
- Squirrel Glider (*Petaurus norfolcensis*);
- Yellow Bellied Glider (*Petaurus australis*); and
- Brush-tailed Phascogale (*Phascogale tapoatafa)*

The Squirrel Glider inhabits dry sclerophyll forest and woodland. In the south east Davey (1984, cited by ERM 1999b) recorded the species in *E. botryoides* and stands of Blackbutt (*E. pilularis)* and Spotted Gum (*Corymbia maculata*). Fifteen years later ERM (1999b) recorded the species twice in an area of map unit 26d: Narrabeen Alluvial Drainage Line Complex, map unit 31c: Narrabeen Doyalson Scribbly Gum Woodland map unit 43a: Alluvial Riparian Blackbutt Forest. Diet consists of arthropods, acacia gum, eucalypt sap, nectar and pollen. The species nests in a bowl-shaped leaf lined nest within a tree hollow. Home range is reported to be between 20-30 hectares.

The Yellow Bellied Glider occupies coastal forests and adjacent sub-coastal forests of mid-high elevations. It prefers tall mature eucalypt forests in regions with high rainfall. It has a patchy distribution that is largely determined by the availability of suitable flowering eucalypts with overlapping blossoming periods (Strahan, 1995). Plant and insect exudates i.e. sap, nectar, honeydew, pollen and manna, make up the bulk of the diet. The species requires an abundance of large deep hollows which are only provided by mature and older trees (Strahan, 1995). Yellow-bellied Gliders live in small family groupings which occupy large and exclusive home ranges (30-65 ha), apparently because of the ephemeral nature of their food resources (Goldingay and Kavanagh 1991).

Brush-tailed Phascogale (*Phascogale tapoatafa)* is tree-dwelling marsupial carnivore with a patchy distribution around the coast of Australia. In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW. This species prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. It may also inhabit heath, swamps, rainforest and wet sclerophyll forest. They are agile climbers foraging preferentially in rough barked trees of 25 cm DBH or greater. They Feed mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 60 ha, while males have overlapping territories of up to 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span. Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter (DECCW threatened species web site 2006).

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

Squirrel Gliders were not relocated as a result of the current assessment. It was thought that the environs would be at the threshold of the species home range requirements and a population would be isolated from interconnecting remnants and thus an extant population may have already become locally extinct. The client, since reviewing final draft of this report, has moved a proposed dam to avoid habitat for this species. Further research is needed to determine whether the population still remains such that assessment can be undertaken to see if proposed development will disrupt a viable local population such that it is placed at risk of extinction. Further research will also assist to develop appropriate management for local recovery of a population if it is feasible.

Yellow-bellied Glider was potentially recorded by ERM (1999b) in the Hue Hue Rd ecological offset investigation area. This species will not significantly impacted by the clearing of potential breeding and nursery roosts, and foraging habitat occurring in Hue Hue Rd ecological offset investigation area as impacts are not scheduled in the locality. The Yellow-bellied Glider has a home range of 30-60 ha and suitable habitat is available in this locality. The species therefore will not be disrupted such that a viable local population is placed at risk of extinction.

Brushtail phascogale has never been recorded in the study area however there is possibility, albeit small that it may occur in the Hue Hue Rd ecological offset investigation area.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
>
> ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

Not relevant.

(d) in relation to the habitat of a threatened species, population or ecological community:

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

(i) The extent of Squirrel Glider habitat to be removed is given in detail on **Figure 14** and discussed in Section 5.3.1(i) of this report. In the area the species is known to occupy 1.05 ha of map unit Alluvial Riparian Blackbutt Forest is proposed for clearing with 21.3 ha remaining intact which has the potential to be retained as a conservation area with appropriate management. Habitat within the Hue Hue Rd ecological offset investigation area suitable for Yellow-bellied Glider and Brush-tailed Phascogale will not be impacted as a result of the proposal.

(ii) Specifically in relation to the area known to previously support Squirrel Glider, it has already been fragmented from past agricultural activities and the only remnant left with a decent patch size is contained within land cleared to the north and west, bordered by the F3 Freeway to the west and Doyalson Rd to the south and east. It is this section of land that the proposal rail loop will dissect. Section 5.1.5 of this report and 6.2 discusses existing wildlife corridors and details potential impacts

and amelioration. The area is and will remain isolated for this species unless other amelioration opportunities are implemented.

(iii) All hollow bearing trees and native vegetation are important for the survival of native species. Perhaps the most important habitat observed for species of Squirrel Glider was the capture of an animal with riparian Blackbutt community (Alluvial Riparian Blackbutt Forest and its derivatives) and thus it has the greatest likelihood to support the species in the Tooheys Rd study area. 98.5% of Alluvial Riparian Blackbutt Forest that has not been previously impacted (i.e. of high quality) will remain and 0.24 ha will be impacted. 0.81 ha of previously impacted riparian Blackbutt community will be removed and 6.44 ha will remain, effectively 88% of this vegetation unit and the habitat it supports for these species will be unaffected by the proposal.

Within the forest remnant where the Squirrel Glider was recorded, there are approximately 6 large, 11 moderate and 16 medium sized tree hollows within the impact footprint. As previously noted, these may be avoided due to a recent change in dam location however, a worst case scenario should still be considered.

On a broader perspective, there is an additional 61.63 ha of preferred habitat (Narrabeen Dooralong Spotted Gum - Ironbark Forest and its derivatives) for Squirrel Glider within the study areas and only 0.58 ha will be impacted by the proposal. The rest has the potential to be retained as a conservation area with appropriate management.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for Squirrel Glider, Yellow-bellied Glider or Brush-tail Phascogale.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and there relevance to the current project.

Summary - This Section 5A assessment concludes:

- The potential population of Yellow-belied Glider and Brush-tailed Phascogale in the Hue Hue Rd ecological offset investigation area **will not** be impacted upon by the proposed development;
- Should a local population of Squirrel Glider remain extant in the Tooheys Rd study area at Wallarah Creek it is **has potential** to be significantly impacted by the proposed development. Further study in this location is required to make a more accurate prediction; and
- Local populations of Squirrel Glider occurring in the Buttonderry, Hue Hue Rd ecological offset investigation area and the western shaft site are **unlikely** to be significantly impacted upon by the proposed development.

- *Frogs*
- Wallum Froglet (*Crinia tinnula)*; and
- Green-thighed Frog (*Litoria brevipalmata).*

Wallum Froglet are small frogs, usually no more than 15 mm long. They are extremely variable in colour and pattern, from light grey or brown to dark grey above and cream to dark grey below. The species is found only in acid paperbark swamps and sedge swamps of the coastal 'wallum' country. The species is a late winter breeder. Males call in choruses from within sedge tussocks or at the water edge. The Wallum Froglet is thought to be sensitive to reduction of water quality resulting from logging, roading, grazing and burning. They are highly sensitive to environmental conditions, preferring a narrow pH range and specific depth and water retention properties in their wetland habitats. Wetland destruction and eutrophication associated with sand mining, coastal development and agriculture are also primary threats. Invasion by common generalist frogs following eutrophication also threatens the species (Parsons Brinckerhoff 2006b citing Ingram and Corben 1975b). The primary habitat components for this species are a dense herb layer, with an intermittent canopy cover for refuge. Ephemeral water bodies such as larger puddles in heath or in watercourses and creek lines are required for breeding purposes. Little is known about the ecology of the Wallum Froglet but some evidence suggests that fidelity to breeding sites is maintained (Parsons Brinckerhoff 2006b citing White 1995).

This species was recorded by ERM (1999b) at two locations in the Tooheys Rd study area (**Figure 40**).

The Green-thighed Frog is known from riparian rainforest, wet and dry sclerophyll forest and woodland communities east of the dividing ranges. Its range extends from Jimna Queensland to Gosford in the south. The species requires temporary water holes for breeding, often using ponds, waterholes in creeks, oxbows, depressions, artificial dams, scrapes and ditches. Water bodies often have shallows which are exposed to sunlight. Vegetation is characterised as submerged either totally (e.g. grasses) or partially emerging (shrubs, tussocks or sedges) rather than emergent (Ehmann 1997). This species was recorded by ERM (1999b) at the Buttonderry study area, unfortunately no further detail of the exact location was given however, it is not within the impact footprint as no suitable habitat for this species occurs in that location.

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

Wallum Froglet was recorded in two locations within the Tooheys Rd study area by Dr Arthur White for ERM (1999b) and the Green-thighed Frog was recorded on one occasion within the Buttonderry study area (not during Dr Whites assessment). Habitat the Wallum Frog was recorded is was wetland associated with Narrabeen Alluvial Drainage Line Complex #d and Narrabeen Alluvial Drainage Line Complex #e and a small well vegetated farm dam in Narrabeen Alluvial Drainage Line Complex #d that was on the boundary of Alluvial Riparian Blackbutt Forest.

The Wet Sclerophyll Forest community in the study area where the species was previously recorded contains a creek and dams which are important habitat features for these two frog species. The both species are known from the local area and fortunately removal of native vegetation within the Buttonderry impact footprint will not affect habitat for these species and in addition ERM (1999b) states that the Green-thighed Frog appears to tolerate disturbance, utilising artificial scrapes and dams as breeding sites. As the proposal will inadvertently create such habitat features it is unlikely that a local viable population would be placed at risk of extinction by the proposed development.

Due to the Wallum Frog sensitivity to changes in hydrology and water quality some basic environmental values and monitoring would need to be documented within the known population areas prior to any impacts. Water quality, pH, size and extent of any remnant population etc is all key information that could be used to determine if the proposal were to have an effect on a Wallum Frog population. Additionally the design of the rail loop would need to be designed in a frog friendly manner across wetland areas and drainage patterns understood. To this end it is noted that only a small area of habitat will be removed for this species but due to a lack of basic information and design detail it is not known if the proposal will place a local population of Wallum Froglet as risk of extinction.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***

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

Not relevant.

(d) <u>in relation to the habitat of a threatened species, population or ecological community:</u>

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) The extent of habitat to be removed is given in detail on **Figure 14** and discussed in Section 5.3.1(i) of this report. In the area the species is known to occupy is associated with Narrabeen Alluvial Drainage Line Complex and Alluvial Riparian Blackbutt Forest and their derivatives. 1.05 ha of Alluvial Riparian Blackbutt Forest is proposed for clearing (4.6%) with 21.3 ha remaining intact which has the potential to be retained as a conservation area with appropriate management. All 9.29 ha of Narrabeen Alluvial Drainage Line Complex will remain intact at Buttonderry with 0.62 ha being impacted in Tooheys Rd study area of the 8.86 ha available in the Tooheys Rd and Hue Hue Rd potential conservation offsets.

(ii) Specifically in relation to the area known to previously support Wallum Froglet, it has already been fragmented from past agricultural activities and the only remnant left with a decent patch size are contained within cleared land associated with the drainage line however, limited movement through the riparian corridor itself is possible. On a broader view, the Tooheys Rd study area is bordered by the F3 Freeway to the west and Doyalson Rd to the south and east and the Great Northern Rail Line also to the east. Habitat will be affected by the proposed rail loop. Section 5.1.5 of this report and 6.2 discuss in existing wildlife corridors and detail potential impacts and amelioration. The area is and will become isolated for this species unless amelioration opportunities are implemented.

(iii) All riparian vegetation and its role in maintaining water quality for this species is important for the survival of this species. If amelioration and monitoring is undertaken and further research shows that runoff from the project will not affect water quality the long term survival for this species will not be compromised and opportunities for dispersal will remain. Further, development of feral animal control measures will remove one manageable existing population pressure. The remaining habitat for this species has the potential to be retained as a conservation area with appropriate management.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plans for the Green-thighed Frog or the Wallum Froglet.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* their relevance to the current study areas.

Summary - This Section 5A assessment concludes:

- The potential population of Green-thighed Frog in the Buttonderry study area **will not** be impacted upon by the proposed development;
- Should a local population of Wallum Froglet remain extant in the Tooheys Rd study area it **has the potential** to be significantly impacted upon by the proposed development. This assessment may change with further research; and
- Local populations of Green-thighed Frogs or Wallum Froglet occurring in the Buttonderry, Hue Hue Rd potential conservation offsets and the western shaft site that were not observed but have the potential to occur are **unlikely** to be significantly impacted upon by the proposed development.
- *Tree hollow dependant birds*

Turquoise Parrot (*Neophema pulchella*)

The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from Aug to Dec. It lays four or five white, rounded eggs on a nest of decayed wood dust (DECCW threatened species website 2006).

Once common even near Sydney, the population of this species crashed in the early 1900s and at one stage feared extinct. The population has since recovered and its range still appears to be increasing. Habitat clearance, overgrazing and a delay in adapting to the seeds of exotic weeds as an alternative food source were the reasons for the decline. Lack of high quality breeding hollows is still restricting population growth in some areas.

Powerful Owl *(Ninox strenua)*

This is the largest of Australia's owls, ranging from 600 to 660 mm in height. It can be readily detected by listening for its call, and identified by its large size and bold chevrons on the underparts, with males being somewhat larger than females (Schodde and Tidemann, 1996). The powerful owl occupies an extensive home range of up to 1000 hectares, generally within 200 kilometres of the coast in south-eastern Australia and inhabits a range of vegetation communities especially those with a dense canopy, such as rainforests. The Powerful Owl is a generalist predator feeding on smaller birds and arboreal mammals. The species roosts by day in dense foliage often within ridges covered by eucalypt forest. The species depends upon large mature hollow eucalypts for nesting in a hollow trunk or limb 8 metres to 20 metres or more high in a tree, generally in areas with a range of vegetation communities that sustain a high diversity of ground dwelling mammals and avifauna (Debus and Chafer, 1994) The species breeds between June and September.

The main threat to the Powerful Owl is the loss of old-growth forests, particularly those with tree hollows that are large enough to be used for breeding by the owls. Intensive forestry and clearing for pastoralism and other agricultural purposes can also reduce the prey densities of the Powerful Owl (Braithwaite *et al.* 1988).

Barking Owl (*Ninox connivens*)

The Barking Owl is distributed sparsely throughout temperate and semi-arid areas of mainland Australia, however is most abundant in the tropical north (Kavanagh 2002a). Most records for this species occur west of the Great Dividing Range (Kavanagh 2004). Habitat for this species includes dry forests and woodlands (Kavanagh 2002a), often in association with hydrological features such as rivers and swamps (Taylor *et al.* 2002). It's a medium-sized robust owl, smoky-brown above with large white spots on the wings, whitish below with dark grey to rusty streaks, feathered legs and powerful feet. Males grow larger than females. It typically roosts by day in pairs in leafy trees, sometimes in exposed conditions (Pizzey and Doyle, 1980). They are usually found in pairs which occupy 30 - 2000 hectare territories all year round (Schodde and Tidemann, 1993). This species is fairly widespread in NSW, except in the far north-west of the state, and it is rare east of the Great Dividing Range (Blakers *et al.* 1984). It is distributed in well-forested hills and flats, eucalypt savannah and riverine woodland in coastal and subcoastal eastern, northern and south-western mainland Australia. The species breeds from July to November and nests in an open hollow 10 - 250 centimetres deep in a trunk or spout of a tree at 3 - 30 m above ground. The chief prey items are mammals and birds, but it also feeds on insects and other invertebrates. Typical prey species include young hares, rats, mice, small bats and some marsupials, including possums.

The main threat to this species is the reduction in the number nest trees due to habitat clearance for forestry, agriculture and urban development (Lacey *et al.* 1990). Pesticides may also be a problem when territories are adjacent to agricultural land.

Masked Owl *(Tyto novaehollandiae)*

The masked owl occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002a), except in the arid interior where it is absent (Blakers *et al*. 1984). This species is generally recorded from open forest habitat with sparse mid-storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land (Kavanagh 2004). Masked owls nest (and roost) in large hollows of old trees and they also roost among dense foliage in variety of sub-canopy trees (Kavanagh 2004). It has a home range of between 400 and 500 hectares.

The main threat to this species is the reduction in the number nest trees due to habitat clearance for forestry, agriculture and urban development (ERM 1999b citing Lacey *et al.* 1990). Pesticides may also be a problem when territories are adjacent to agricultural land.

Sooty Owl *(Tyto tenebricosa)*

A medium-sized owl to 45 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc. Dark sooty-grey in colour, with large eyes in a grey face, fine white spotting above and below, and a pale belly. The plumage of the fledglings is similar to the adult, but has tufts of down on the head and underparts. The Sooty Owl has the largest eyes and roundest wings of all of the masked owls (Schodde and Tidemann, 1993). This species inhabits tall, wet forests of south-eastern Australia, particularly rainforest gullies that contain emergent eucalypt forests. It lives in pairs with permanent territories of 200 - 800 ha. It roosts in large hollows in tall eucalypt trees (Schodde and Mason 1980) the interlacing stems of a giant fig or a crevice under a bank or cliff (Hollands 1991). The species preys upon mammals including possums and gliders, rats and bandicoots and birds (Garnett, 1993; Schodde and Tidemann, 1993). It breeds opportunistically but produces only one brood a year, and nests in a spacious hollow that is 40 - 500 cm in depth, and located in a tall eucalypt in or on the edge of rainforest.

Historically, the main threat has been habitat clearance for agriculture with large areas of rainforest being completely eliminated. This activity has largely ceased and the species is most threatened by disturbance of creek side rainforest, particularly of nest trees, and by clearfelling for forestry (Garnett 1993). Suitable habitat is also vulnerable to fire, either wildfires or prescribed burns that are allowed to move into the rainforest fringes.

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

A Powerful Owl was identified in the Tooheys Rd study area as a result of the current assessment and it was thought that it is likely to occur and or use breeding resources in the Hue Hue Rd ecological offset investigation area and or the Buttonderry study area. A nest in a large hollow in disturbed land on Tooheys Rd south of Wallarah Creek was also

located with what appeared to be owl down, fledgling feathers and egg shell but was thought to be of the Tawny Frogmouth Owl. Tree hollows are a limiting key habitat element, for example, of the 142 hollow bearing trees in the impact footprint, only three of the 21 large hollows identified were high quality and one of these contained material thought to be from a Owl nest

A call of a Masked Owl was heard north of the Tooheys Rd study area where larger tracts of remnant forest occur. Other species such as Barking Owl, Sooty Owl and Turquoise Parrot are not thought to occur within the study areas however, key habitat elements essential for life cycles do occur within the study areas (excluding the Western shaft study area).

These species will not be significantly impacted by the clearing of potential breeding and nursery roosts, and foraging habitat occurring in the study areas however care will need to be taken as to how to appropriately manage the Owl nesting site as it has not been confirmed which species the nesting material was from (thought to be Tawny Frogmouth but not an absolute identification). Powerful Owls are known to successfully utilise disturbed habitats and Alluvial Riparian Blackbutt Forest (most likely to support a nesting tree) will remain largely unaffected by the proposed works (many large hollow bearing tress occur here that are not within the impact footprint) and Hue Hue Rd ecological offset investigation area will not be impacted. The species therefore will not be disrupted such that a viable local population is placed at risk of extinction.

Of the 324 ha of native vegetation within the assessed areas only 0.92 ha in the Western shaft study area, 4.54 ha in Buttonderry and 17.27 at Tooheys Rd with an additional c. 10 ha on DLALC land will be removed (32.73 ha). The rest of the vegetation will retain the same density of hollows as that assessed in the impact footprint i.e. 142 bearing trees in 32.73 ha or 4.33 / ha with the greatest amount of hollows being protected along the waterways as they are part of an EEC. Given these considerations the proposed project is unlikely to place any hollow bearing species of bird at risk of local extinction.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
>
> ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

Not relevant.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) The extent of habitat to be removed is given in detail on **Figure 14** and discussed in Section 5.3.1(i) of this report. In the area the Powerful Owl is known to occupy 1.05 ha of Alluvial Riparian Blackbutt Forest is proposed for clearing with 21.3 ha remaining intact which has the potential to be retained as a conservation area with appropriate management. Habitat within the Hue Hue Rd ecological offset investigation area suitable for hollow dependant species of birds will not be impacted as a result of the proposal.

(ii) Specifically in relation to the area known to have Powerful Owl, it has already been fragmented from past agricultural activities and the only remnant left with a decent patch size is contained within land cleared to the north and west, bordered by the F3 Freeway to the west and Doyalson Rd to the south and east. It is this section of land that the proposal rail loop will dissect. Section 5.1.5 of this report and 6.2 discuss in existing wildlife corridors and detail potential impacts and amelioration. The area is and will remain isolated for this species unable to fly.

(iii) All hollow bearing trees and native vegetation is important for the survival of native species. Perhaps the most important habitat observed for Powerful Owl was the observation of an animal on the fringe of riparian Blackbutt community (Alluvial Riparian Blackbutt Forest and its derivatives) and thus it has the greatest likelihood to support the species in the Tooheys Rd study area. 98.5% of Alluvial Riparian Blackbutt Forest that has not been previously impacted (i.e. of high quality) will remain and 0.24 ha will be impacted. 0.81 ha of previously impacted riparian Blackbutt community will be removed and 6.44 ha will remain, effectively 88% of this vegetation unit and the habitat it supports for these species will be unaffected by the proposal.

Within the forest remnant where the Powerful Owl was recorded there are only six large tree hollows within the impact footprint, only three of these were of high quality.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is a draft pending finalisation form the Barking Owl and a recovery plan for large forest owl. The basic tenant of these recovery plans is not to remove large hollow bearing trees and to protect habitat such as Alluvial Riparian Blackbutt Forest from clearing.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* and there relevance to the current project.

Summary - This Section 5A assessment concludes:

- It is **unlikely** that Masked Owl, Barking Owl, Sooty Owl and the Turquoise Parrot will be affected by the proposal given that the majority of habitat available for these species will not be impacted; and
- It is **unlikely** that a local population of Powerful Owl will become extinct as a result of the proposed work however, care should be undertaken for the management of a potential nesting tree (tree 37) in the Tooheys Rd study area south of Wallarah Creek. A specific management plan should be documented detaining appropriate actions to take and to identify replacement of those habitat values lost as a result of the project.

- *Insects*

The **Adam's Emerald Dragonfly** (*Archaeophya adamsi*) is a moderately large, robust dragonfly. Larvae grow to about 23 mm in length and have a large two-lobed frontal plate on the head, which distinguishes them from any other species found in NSW. The adults have a brown-black body with yellow markings, and a slight green or bluish metallic reflection on some parts. The abdomen length is around 46 mm and wingspan around 37 mm. It is one of Australia's rarest dragonflies. Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region. Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation. All dragonflies are predatory. The larvae stalk or ambush their aquatic prey while the adults capture their prey on the wing. Adam's emerald dragonfly larvae live for 7 years or so and undergo various moults before metamorphosing into adults. Adults probably live for a few months at most. Adult dragonflies generally fly away from the water to mature before returning to breed. Males congregate at breeding sites and often guard a territory. Females probably lay their eggs into the water. Adam's emerald dragonflies seem to have a low natural rate of recruitment and limited dispersal abilities (DECCW threatened species webpage 2006).

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

A viable local population of Adams Dragonfly are not known to exist within the study area. The proportion of habitat to be removed as opposed to that which will be preserved will ensure that if a local population does exist and the species was not observed it would not be placed at risk of local extinction.

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

The study site and adjacent areas do not support an "endangered population" identified under Part 2 of Schedule 1 of the TSC Act 1995.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

> ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
>
> ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

Not relevant.

(d) in relation to the habitat of a threatened species, population or ecological community:

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

(i) The extent of habitat to be removed is given in detail on **Figure 14** and discussed in Section 5.3.1(i) of this report. In the area the species is likely to be associated with Narrabeen Alluvial Drainage Line Complex and Alluvial Riparian Blackbutt Forest and their derivatives. 1.05 ha of Alluvial Riparian Blackbutt Forest is proposed for clearing (4.6%) with 21.3 ha remaining intact which has the potential to be retained as a conservation area with appropriate management. All 9.29 ha of

Narrabeen Alluvial Drainage Line Complex will remain intact at Buttonderry with 0.62 ha being impacted in Tooheys Rd study area of the 8.86 ha available in the Tooheys Rd and Hue Hue Rd potential conservation offsets.

(ii) Specifically in relation to the area known to previously support wetland areas, the majority have already been fragmented from past agricultural activities and these are now largely contained within the drainage line itself.

(iii) All riparian vegetation is important for the survival of this species. Although some potential habitat may be removed the remaining habitat for this species has the potential to be retained as a conservation area with appropriate management.

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

The study area and adjacent areas are not currently considered as part of "critical habitat" as described and listed in the Register of Critical Habitat kept by the Director General of the Department of Environment and Climate Change.

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

Only a limited number of draft and approved recovery plans and threat abatement plans are currently available. There is currently no Recovery Plan for the Adams Dragonfly.

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

See Section 5.2.6 of this report for a list of Key Threatening Processes listed in Schedule 3 of the *Threatened Species Conservation Act 1995* their relevance to the current study areas.

Summary - This Section 5A assessment concludes:

- If the Adams Dragonfly were to occur within the study areas the extent of habitat suited for this species to be removed compared to what will remain intact is small and as such the proposal is **unlikely** to cause a significant impact to the species.

6.3.2b National legislation – assessments of significance

There were no nationally significant fauna identified as likely to be impacted as a result of the current proposal (**Appendix 2, 3 & 4**).

6.4 Impact amelioration for direct impact areas

Potential impacts on threatened species were noted as:

- Loss of breeding, foraging and sheltering study areas for frog and mammal species;

- Potential degradation of frog breeding and foraging study areas as a result of weed invasion and water and sediment runoff;
- Removal of individuals of threatened plants due to habitat clearing;
- Fragmentation of wildlife movement corridors thus limiting the dispersal of frogs and mammals;
- Mortality or injury of individual threatened fauna during construction and operational phases of the proposed development; and
- Noise and visual disturbances to threatened fauna during construction and operational phases.

Table 16: Examples of measures to manage impacts (Source: DECCW 2004:6-107).

Category	Examples	Relevance to the current proposal
Protection and avoidance	• Relocating or changing the design of the proposal • Restricting access of construction crew and machinery • Implementing stringent sediment and erosion control measures • Creating buffer areas between a significant area and the footprint of the proposal.	➢ The current site has been selected as the preferred option for the W2CP project. ➢ Restricting access to only areas to be impacted is feasible. ➢ Soil and sediment control devices are an integral component of the proposal. ➢ Buffer areas have been incorporated as part of the proposal and restriction of access will occur.
Enhancement	• Bush regeneration activities • Replacing animal habitats such as tree hollows and rocky outcrops • The use of underpasses /overpasses in order to allow passage of native animals between natural areas	➢ Revegetation / habitat restoration will be undertaken as part of the conditions of approval. ➢ Potential exists for replacing tree hollows with nest boxes within the scope of this project. ➢ Highly desirable outcome if possible however, resourcing will need to be approved by the Proponent.
Compensation	• Land acquisition Construction of artificial replicas of important habitat features (e.g. artificial nesting sites for birds, frog-friendly ponds).	➢ Land has been acquired for potential conservation offsets. ➢ There is scope within the project to undertake construction of artificial habitats.
Management	• Weed and feral animal control programs	➢ The area is virtually free of exotic weeds however a weed management strategy will be developed as part of the proposal. The weed management plan will combat the spread of weeds prior during and after construction work. All weeds identified as requiring removal will be addressed having particular regard to the requirements for weed species listed as 'noxious' under the *NSW Noxious Weeds Act 1993.* ➢ Weed inspection should occur at three months and twelve months after the ground disturbing works. ➢ A feral animal management strategy will be developed as a result of this proposal.

Category	Examples	Relevance to the current proposal
	• Bushfire management • Ongoing monitoring programs • Restricting livestock, domestic pets and humans to certain areas	➢ All species present are believed to respond to fire, however *A. inopina* is fire sensitive. Controlled burning may be beneficial but not recommended within the context of this study. A Fire Management Plan would be developed by the Proponent. ➢ Identification of the Squirrel Glider population then long term monitoring would provide invaluable information for the management of the local population. Ongoing vegetation monitoring will be a part of the proposal. ➢ Restricting livestock and human movement (vehicles etc) will benefit all species present.

When clearing mature trees:

- Minimise clearing of vegetation as much as practicable, only remove what has to be removed at a given time and have no impact on vegetation outside of the impact footprint. Mark each area to be cleared with night line so that impacts cannot occur outside of the proposed impact footprint.
- Identify trees as hollow bearing or non-hollow bearing by referencing coordinates supplied in the tree hollow database associated with this report (**Appendix 5**). If the paint and / or tape is left, identification will be easier however all trees should be clearly marked again with a new method for removal.
- Check all trees for the presence of bird or nestlings and arboreal mammals before felling or pushing. Start tree removal immediately after visual inspection and avoid removing trees during spring (nesting season) and in mid to late winter when the bats may be in torpor. Refer to the tree hollow database so that the tree with the owl nest in can be identified and appropriately managed well prior to removal.
- Remove non habitat trees first to ensure that the associated disturbance will flush out any animals from within the habitat trees.
- Fell habitat trees after all non habit trees have been removed. It is advisable to wait for at least 24 hrs (or overnight) so that any animal occupying a habitat tree can have the chance of vacating the area after the initial disturbance period.

7. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The proposed works do not impact on Commonwealth land.

The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* identifies eight areas of National Significance that can trigger the Commonwealth Governments involvement in the environmental assessment and approval process. In relation to the current study area:

- The locality is not part of any world heritage property;

- It is not part of, in the vicinity of, or immediately connected to any listed wetlands of international importance;

- Seven Commonwealth listed flora species were located within the study area (**Table 10**). Three of these, *Acacia bynoeana, Tetratheca juncea* and *Angophora inopina* are likely to be impacted by the W2CP. An important population of *Angophora inopina* will be disturbed creating further fragmentation, loss of occupancy area and will be exposed to possible weed invasion while the W2CP will impact on a number of local sub-populations of *Tetratheca juncea*. At least one individual of *Acacia bynoeana* is likely to be impacted upon, while a further five plants occur along the edge of proposed disturbance. Impacts to *Tetratheca juncea* (referral No not available) and *Angophora inopina* (referral 2007/3881) have been referred to the Minister of the DEWHA following the referral format.

- No other of the Commonwealth listed vulnerable or endangered flora species observed is considered to inhabit the study area. No flora classified as "Extinct in the wild" or as "Critically Endangered" is listed for the locality of the study area;

- No Commonwealth listed vulnerable or endangered fauna species are considered to be in the study area or have portions of their life cycle dependant on the study area. No fauna species classified as "Extinct in the wild" or as "Critically endangered" are listed for the locality. The proposed development is unlikely to impact on the distribution, connectivity of known habitat, life cycle or availability of habitat of any of the species listed on the schedules under the *Environment Protection and Biodiversity Conservation Act 1999*;

- No Commonwealth listed Critically Endangered Community occurs within the study area. It is highly unlikely that the proposed works will impact on any critically endangered or endangered fauna, flora or community representative; and

- One Commonwealth listed migratory species was observed flying over the Tooheys Rd study area (white bellied sea eagle). This species does not have key habitat elements within any of the assessed areas and will not be adversely affected by the proposal.

- Commonwealth marine areas do not occur within the study areas; and

- Nuclear actions (including uranium mining) are not associated with the proposal.

8. SUMMARY AND CONCLUSIONS

The majority of direct impacts associated with W2CP are proposed in currently cleared and disturbed land. Where vegetation clearing is to occur, it will be located adjacent to existing cleared areas or within previously isolated fragments of native vegetation. This vegetation generally has a high diversity of native species, low weed invasion and is in moderate to good condition. Vegetation communities recorded in the study area, their status and modification as a result of the proposal are shown on **Tables 13 and 14.** The associate fauna habitats were moderate to good in areas that have undergone low levels of prior disturbance. These can be seen as solid colours on **Figures 21 to 24**.

The primary impact of the proposed W2CP surface facilities is the removal of 4.54 of 56.59 ha of native vegetation at the Buttonderry study area, 17.27 ha (of 261.97 ha) of

native vegetation at the Tooheys Rd study area and 0.92 ha of native vegetation within the Wyong State Forest. Cumulatively, W2CP direct impacts will removal 22.73 ha of native vegetation. An estimated additional 10 ha of native vegetation will also be removed within DLALC land adjoining the TransGrid easement for the purpose of the proposed rail loop.

Impact assessments were completed for the following EEC's and flora species recorded in the study area:

- River Flat Eucalypt Forest on Coastal Floodplains EEC, Tooheys Rd, Buttonderry and Hue Hue Rd offsets study areas;
- Swamp Sclerophyll Forest on Coastal Floodplains EEC, Tooheys Rd and Buttonderry study areas;
- Lower Hunter Spotted Gum – Ironbark Forest EEC, Buttonderry and Hue Hue Rd offsets study areas;
- *Arachnorchis tessellatus*, TSC Act Endangered, recorded in Tooheys Rd study area;
- *Angophora inopina,* TSC Act, EPBC Act Vulnerable, recorded in Tooheys Rd study area;
- *Grevillea parviflora* subsp. *Parviflora,* TSC Act, EPBC Act Vulnerable, Buttonderry and Hue Hue Rd offsets;
- *Tetratheca juncea,* TSC Act, EPBC Act Vulnerable, Tooheys study area;
- *Melaleuca biconvexa,* TSC Act, EPBC Act Vulnerable, Buttonderry Ck, Buttonderry study area;
- *Acacia bynoeana,* TSC Act, EPBC Act Vulnerable, Tooheys Rd rail loop study area on DLALC land; and
- *Cryptostylis hunteriana,* TSC Act, EPBC Act Vulnerable, Tooheys Rd study area.

Regionally significant species recorded during the assessment include *Callistemon shiressii, Eucalyptus fergusonii subsp. dorsiventralis* and *Macrozamia flexuosa.*

Assessments under the TSC Act showed that none of these species will be significantly impacted as a result of the W2CP.

Results of Assessments of significance under the EPBC Act showed that the action (direct impacts in the study area) is considered likely to impact on *Angophora inopina*, as the local population represents an "important population" at the limit of its distribution. Impacts may be felt due to increased fragmentation, loss of occupancy area and potential for invasion by exotic weed species. Similarly, W2CP will impact on a number of local sub-populations of *Tetratheca juncea* within the study area. Several tens of plants will be removed through the construction of the proposed rail loop and other surface facilities, resulting in loss of occupied habitat. Other plants will be excluded from development, and while not surveyed in detail, it is likely that several other unrecorded sub-populations occur in adjacent areas, both in WACJV ownership and the contiguous DLALC / Crown lands.

Impact to these two species will require referral to the Minister of the Department of Environment, Heritage and the Arts following the referral format (see EPBC website http://www.environment.gov.au/epbc/assessments/process.html)

Ten threatened species of threatened fauna listed in the TSC Act were recorded as a result of the current and previous surveys within the study areas. Species recorded included four species of microbat:

- Large-footed Myotis (*Myotis adversus)*, recorded in the Tooheys Rd study area*;*
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris)*, recorded in the Tooheys Rd and Buttonderry study areas*;*
- Greater Broad-nosed Bat (*Scoteanax rueppellii)*, recorded in the Buttonderry study area*;* and
- Eastern false pipistrelle (*Falsistrellus tasmaniensis);* recorded in the Tooheys Rd study area.

Two arboreal mammals:

- Squirrel Glider *(Petaurus norfolcensis)* recorded in the Tooheys Rd study area; and
- Yellow-bellied Glider *(Petaurus australis),* potentially recorded in the Hue Hue Rd ecological offset investigation area.

Two species of frog:

- Wallum Froglet (*Crinia tinnula);* recorded in the Tooheys Rd and Hue Hue potential conservation offset properties; and
- Green-thighed Frog (*Litoria brevipalmata)*, recorded in the Buttonderry study area.

Two species of large forest owl:

- Powerful Owl *(Ninox strenua)*, recorded in the Tooheys Rd study area; and
- Masked Owl (*Tyto novaehollandiae)*, recorded in proximity to the Tooheys Rd study area.

In addition to legislatively protected species, other species within the study areas were identified as being regionally significant, these include:

- White Bellied Sea Eagle (also a migratory species in the EPBC Act);
- Painted Quail (*Turnix varia*);
- Chestnut-rumped Hylacola (*Sericornis pyrrhophanus*);
- Eastern Grey Kangaroo (*Macropus giganteus*);
- Red-necked Wallaby (*Macropus rufogriseus*);
- Greater Glider (*Petauroides volans*);
- Jacky Lizard (*Amphibolurus muricatus*),

- Tusked Frog (*Adelotus brevis*); and
- Lesueur's Frog (*Litoria lesueuri*).

Seven part tests undertaken on those threatened species recorded in the study area and additional species not recorded during the assessments but likely to occur (see Section 6.3.2a of this report) concluded that:

- A local population of Squirrel Glider is at risk of local extinction if the population still extant along Wallarah Creek in the Tooheys Rd study area. Further research has been recommended to confirm the status of the population so that appropriate management of this species can occur. If still present, appropriate monitoring for the species should be instigated and investigation into ways the species can be assisted to disperse from the existing fragmented and isolated habitat should occur.

- Another species with a local population that has potential to be negatively impacted by W2CP is the Wallum Froglet recorded in the Tooheys Rd study area. This species also requires further research to determine the affect of the proposal on the species. Baseline data on water quality, disease status, population extent and reviewing the design of the rail loop which transects known habitat needs to occur to determine appropriate species management options.

- Although a significant impact was unlikely to occur on a local population of Powerful Owl, a management plan need to be documented that details methods of removing a nesting tree within the impact footprint and replacing its habitat values in other nearby protected locations. It is thought unlikely that the tree provided a nesting site for the species due to its location in the landscape (open paddock) however, due diligence ensures that the potential cannot be ruled out.

All other impact assessments undertaken for those threatened species listed above and those species listed in section 6.3.2a of this report concluded that the proposal would not have a significant impact on threatened species or populations. Mitigation measures designed to minimise the potential for environmental impacts have been recommended in this report and would be required to be implemented during the proposed construction activities. It is concluded that by adopting these mitigation measures there would be no significant environmental impacts from the proposed works and therefore, that no further assessment should be required.

9. RECOMMENDATIONS

This section has been included as a quick reference resource for the project manager as many recommendations are included within a large body of information contained in Chapters 5 & 6 of this report. The following recommendations are summarised and should be contextualised by referring to the relevant subheading in the report given below.

9.1 NSW DPI (Fisheries) issues

- Under NSW Fisheries Policy and Guidelines for Aquatic Habitat Management and Fish Conservation 1999, a 2:1 habitat compensation policy for any fish habitat

losses associated with development exists. Although Part 3A projects are not bound by the FM Act 1994, replacement of the removed trees and shrubs with twice of that removed is recommended for site rehabilitation.

- Given that this project is being assessed under Part 3A of the EP&A Act, a Permit to temporarily or permanently block fish passage by silt fencing, construction of mounded access tracks or any other work that requires modifying the creek bed in a way that will prevent the natural flow of the creek will not be required. Due diligence dictates that work should be undertaken with a duty of care to ensure both creeks will not be blocked as a result of the proposal. In this event best practice is to following advice from DPI –Fisheries re: maintaining fish passage during construction.

- Impact on fish habitat will be minimal if the Proponent ensures and monitors compliance with environmental protection though their standard operating procedures for soil and water management. Prevention of hydrocarbons entering the water from grease and oil / fuel spills should also have emphasis.

- As rail bridges have been identified in the drawings provided, the following constraints are relevant:
    - No temporary culverts shall be built, only bridges shall be used to cross these waterways. This may be negotiated on a case by case basis with the Project Manager and the DPI (NSW Fisheries);
    - In-stream pylons are to be kept to an absolute minimum;
    - No earthen platforms for driving pylons will be constructed; and
    - Embankments must be kept away from the edge of waterways.

9.2 Special natural features

A 7 (g) zoned wetland has been recorded on the Tooheys Rd rail loop study area (see 4.2.3c) this is also part of an EEC's and as such impacts to the area should be kept to a minimum. The impact corridor in this location should be delineated with nightline prior to impacts so that inadvertent impacts can be avoided. Fuels / hydrocarbons should be kept from entering any of these wet environments.

9.3 Vegetation clearing

General recommended for vegetation clearing include:

- Human movement should be restricted to dedicated tracks and specific areas to be impacted such that the development will have no impacts occurring beyond those boundaries. This can be achieved by marking out the limits of the site with an easily identified boundary marker;
- Install orange road work curtilage delimiting the extent of the impact footprint in areas where EEC's have been identified to ensure there are no inadvertent impacts on the EEC outside of the impact footprint. Induct all contractors and staff undertaking work within the locality of the presence of the EEC. The induction

should inform staff of the legal requirements the Proponent has undergone to impact the EEC and enforce a due diligence ethic for minimising all unnecessary impacts. Part of the induction should focus on an environmental risk assessment where the employee or contractor considers what action they are do undertake within the locality, what affect it will have on the species and what can be done to minimise impact. This induction should be documented and signed and sporadically audited; and

- Minimise clearing of vegetation as much as practicable, only remove what has to be removed and have no impact on vegetation outside of the impact footprint.

If a tree has to be cleared:

- Identify hollow bearing trees from painted numbers on their trunks or by the red and white flagging tape tied around it and clearly mark it again with a distinctive identifier. If too much time has elapsed and the paint has faded or there is potential that the tape has been removed use the GPS coordinates provided in this report to relocate the trees;
- Avoid tree clearing in spring due to bird nesting;
- Remove all trees not identified as hollow bearing first;
    - Check all trees for the presence of birds or nestlings and arboreal mammals before felling or pushing. Start tree removal immediately after visual inspection; and
    - It is advisable to gradually nudge the tree at intermittent intervals so that any animal occupying a habitat tree can have the chance of vacating the area after the initial disturbance period.
- Engage an ecologist when hollow bearing trees are to be removed to check all hollow bearing trees for the presence of birds or nestlings and arboreal mammals before felling or pushing. Start tree removal immediately after visual inspection;
- Have an appropriate plan in place and equipment on site to cater for injured animals. Seek advice from a qualified wildlife veterinarian prior to preparing this plan and ensure veterinary assistance has been organised prior to work commencing. Note – **do not allow any person to handle any species of bat**. Potential exists for the transmission of a virus that is detrimental to the health of humans;
- No vegetation is to be burnt on site.

9.4 Erosion

Soil disturbance within any of the study areas has potential to effect surrounding areas of vegetation and waterways a summary of proposed general safeguards for soil and water management for each construction project includes:

- All erosion and sediment control devices shall be developed in accordance with a recognised publication such as the RTA Road Design Guide 1989, Section 8 – *Erosion and Sedimentation,* the Landcom 2004 publication *Managing Urban Stormwater-Soils and Construction* as well as relevant DIPNR soil conservation guidelines such as *Construction Site Erosion and Sediment Control Manual;*

- Effective erosion and sediment controls shall be constructed immediately after earthworks have commenced. Maintain these structures until ground surfaces are stabilised and design the maintenance tracks to minimise potential for erosion. Steep reconstructed embankments may require the use of hydromulch or a similar other effective soil erosion control measure;
- Minimise the disturbance and exposure of soils. Address measures in an Erosion and Sediment Control Plan and implement as soon as possible. Pay particular attention to preventing soil loss on any steep embankment;
- Construct catch drains with erosion and sediment control devices as soon as possible to ensure transverse drainage is in place in the early stages of construction site excavation;
- Complete waterway protection works as soon as possible;
- If temporary stockpiles are to be used ensure they should be within areas assessed by the commissioned REF / SEE and are above the 1:10 year flood level;
- Progressively stabilise and revegetate disturbed areas with endemic species or sterile crop species as required;
- Regularly monitor and maintain all sediment and erosion control devices particularly after a significant rain event, during construction and before vegetation is established;
- Retain as much vegetation as practicable and retain topsoil for final site rehabilitation;
- Educate site personnel for the implementation of sediment and erosion control plans; and
- Do not impact within 20 m of any readily identifiable ephemeral drainage line or Creek unless is it part of an approved action.

9.5 Introduced species

General recommendations include:

- To combat the spread of weeds prior, during and after construction work all surface disturbing equipment should be thoroughly washed down (including removing excess grease and oil) and possess a wash down certificates prior to coming on site. An inspection of problem weeds should be undertaken 3 months and 12 months after ground disturbing works have ceased;
- Develop a feral animal management plan primarily targeting foxes, cats and rabbits. This plan should extend to other invasive species that have potential to colonise the study areas as a result of W2CP i.e. Mosquito Fish.

9.6 Potential changes to fire regimes

General recommendations include:

- Development of a fire management plan for the purposes of managing vegetation would be an important consideration for the long term management of WACJV land.

9.7 Disease

The fungal pathogen *Batrachytrium* is suggested as the cause of reduction in amphibian populations.

General recommendation:

- If management of frog populations are to occur as a result of W2CP, the disease status of the population would need to be investigated. This will require negotiation with government authorities for appropriate permission, consultation with wildlife veterinarians and will result in culling of tadpoles to test for the disease.

9.8 Potential impact on threatened and regionally significant species

Specific mitigation measures for birds include:

- Use native species that provide resources for birds in rehabilitation areas, such as trees that will bear hollows in the future;
- Raise awareness of employees and contractors in relation to road kills and train strikes through environmental training and signs; and
- Identify opportunities to create effective wildlife corridor at the planning stage and enhance those identified corridors within the sites so that the vegetation provides enough cover for bird dispersal.

Mitigation measures for threatened mammals are essentially the same as for threatened birds, with the following additions:

- Using native species that provide resources for mammals in rehabilitation areas, such trees that will bear hollows in the future and native grasses and sedges that form thick ground layers;
- Salvage hollows logs from areas to be cleared and place these in areas to be rehabilitated; and
- Erect nest boxes in adjacent vegetation or rehabilitation areas for arboreal fauna including insectivorous bats, and monitoring their use.

Specific mitigation recommended for the Powerful Owl (V TSC Act) recorded in the Tooheys Rd study area includes:

- Develop a specific management plan to remove tree 37 south of Wallarah Creek that contains a bird of prey nest (possibly powerful owl);
- This plan should detail the timing and method of tree removal and should be supervised by a qualified ecologist; and

- Appropriate habitat compensation should occur for the values removed such as replacement of the tree with up to four nesting boxes for this species that should be placed in adjoining woodland.

Mitigation measures to ameliorate impacts for threatened amphibians and reptiles are the same for threatened flora and fauna (above), however additional measures include:

- Using native species that provide resources for reptiles in rehabilitation areas, such as trees with peeling bark, hollows or crevices for geckos, lizards and snakes;
- An appropriately qualified and experienced ecologist would be engaged to provide advice and assist with pre-clearing surveys and be present during the removal of habitat trees;
- Ensuring the acidity of the water in adjacent swamps and streams remains the same to preserve amphibian habitat;
- Salvage hollows logs and debris from areas to be cleared and place in rehabilitation areas or identified corridors to provide habitat for reptiles;
- Create artificial ponds and wetlands on the site to compensate for swamps, and dams that may be impacted by the proposed project. Design these so that they can be drained to control populations of Mosquito Fish should they encroach on the area – parallel drainable ponds would best suit management of frogs and Mosquito Fish;
- Raise awareness of employees and contractors in relation to sensitivity of water bodies for amphibian habitat;
- Enhance identified corridors within the sites so that the vegetation is appropriate for reptile and amphibian dispersal;
- It is not anticipated that translocation of wildlife into new areas of occupation would be required. Should an appropriately qualified species of interest 'expert' recommend this is requisite during the project, DECCW would be approached and translocation would be undertaken in accordance with DECCW Policy – *Policy for the Translocation of Threatened Fauna in NSW.* The Proponent would seek at the same time to acquire the appropriate licence. If fauna is translocated they will be monitored (under a specific DII ethics approval) using appropriate methods to gather data relating to the success of the activity.

Specific measures for the Wallum Froglet (V TSC Act) include:

- Installing culverts beneath the proposed rail loop;
- Connecting areas of known habitat; and
- Erecting and maintaining frog-exclusion fencing along both sides of the proposed rail loop in riparian areas.
- Further research would be required to determine the appropriate culvert length, height and width for the Wallum Froglet, at minimum it should:
    - be a minimum of 1 m high and 3 m wide;
    - have a channel through the centre of the culverts to hold water, even in dry times to better encourage frogs to use the structures; and

  - be otherwise lined with a natural substrate comprising earth or humus have a fence (either made from fine mesh or 50 cm vertical metal), constructed at the entrance of the culverts to prevent adult Cane Toads from entering to limit their predation on the smaller frogs within the culverts.

- The translocation of individuals from the impact footprint may be implemented just prior destruction. Further research with relevant government agencies would be required to determine the need for a translocation permit;
- Any systematic handling of frogs would require the development hygiene protocol to minimise the spread of the Chytrid fungus. It should be noted that testing a population for the disease requires culling of tadpoles for testing (dissection of their mouthparts);
- Further research into obtaining the appropriate approvals to undertake this would also need to occur.

Specific measures for threatened plants include:

- develop a Vegetation Management Plan (VMP). The VMP would document the locations of threatened flora and audit their status annually. The VMP would aim to 'improve or maintain' the status of these species in the study area.

Specific measures for *Acacia bynoeana* (V TSC Act, V EPBC Act) include:

- attempts could be made to translocate plants (either through extraction of the entire plant, or via propagation from cuttings) from the impact zones, and relocate them into more secure bushland nearby. This should not be undertaken without the consent of the relevant authorities, and ideally in concert with researchers at the University of Newcastle (Mike Cole & Colin Driscoll).

Specific measures for *Angophora inopina* (V TSC Act, V EPBC Act) include:

- physically marking and tagging trees present within the impact areas prior to construction; and
- propagating the species from locally collected seed, and enhancing existing populations in adjacent, undisturbed lands. However, given the large numbers of plants already present in the area (Bell 2004), this may not be necessary.
- creating a Fire Management Plan. This FMP would need to be written inconjuction with the DLALC as the bulk of the population occurs within land under their bailiwick. As this species is fire sensitive the aim of the FMP would be to reduce the risk of high intensity fire where the population occurs.

Specific measures for *Tetratheca juncea* (V TSC Act, V EPBC Act) include:

- instigating a translocation and monitoring program. A similar translocation program has been running in the northern Wyong area for 3 years (Driscoll & Bell 2004), with some degree of success. Any translocation program should follow the guidelines published by the Australian Network for Plant Conservation (Brown et al. 2003). However, such a program would require the agreement of relevant government agencies. Given the large number of *Tetratheca juncea* in the lands

not directly impacted upon, together with the adjacent lands, such a translocation may not be required.

9.9 Endangered, threatened and regionally significant flora species affected by the proposal

Results of Assessments of significance under the EPBC Act showed that the action (direct impacts in the study area) is considered likely to impact on *Angophora inopina* (V TSC Act, V EPBC Act), as the local population represents an "important population" at the limit of its distribution. Impacts may be felt due to increased fragmentation, loss of occupancy area and potential for invasion by exotic weed species. Similarly, W2CP will impact on a number of local sub-populations of *Tetratheca juncea* within the study area. Several tens of plants will be removed through the construction of the proposed rail loop and other surface facilities, resulting in loss of occupied habitat. Other plants will be excluded from development, and while not surveyed in detail, it is likely that several other unrecorded sub-populations occur in adjacent areas, both in WACJV ownership and the contiguous DLALC / Crown lands.

- Impact to these two species will require referral to the Minister of the Department of Environment, Heritage and the Arts following the referral format (see EPBC website http://www.environment.gov.au/epbc/assessments/process.html.

9.10 Endangered, threatened and regionally significant fauna species affected by the proposal

- A local population of Squirrel Glider (V TSC Act) is at risk of local extinction if the population still extant along Wallarah Creek in the Tooheys Rd study area. Further research has been recommended to confirm the status of the population so that appropriate management of this species can occur. If still present, appropriate monitoring for the species should be instigated and investigation into ways the species can be assisted to disperse from the existing fragmented and isolated habitat should occur.
- Another species with a local population that has potential to be negatively impacted by W2CP is the Wallum Froglet (V TSC Act) recorded in the Tooheys Rd study area. This species also requires further research to determine the affect of the proposal on the species. Baseline data on water quality, disease status, population extent and reviewing the design of the rail loop which transects known habitat needs to occur to determine appropriate species management options. Determining disease status in the frogs will require culling of tadpoles and as such appropriate ethics and research approvals will need to be obtained.
- Although a significant impact was unlikely to occur on a local population of Powerful Owl (V TSC Act), a management plan need to be documented that details methods of removing a possible nesting tree within the impact footprint and replacing its habitat values in other nearby protected locations.

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Works in progress

Spotted Gum:

Bell, S. & Driscoll, C. (in prog.) Diversity and dominance in Spotted Gum (*Corymbia maculata*) communities in the lower Hunter Valley, New South Wales.

Grevillea parviflora:

Bell, S.A.J. & Driscoll, C. (in prog.) *Habitat and population size of the vulnerable* Grevillea parviflora *subsp.* parviflora *in the lower Hunter and Central Coast*.

Mapping methodology:

Bell, S. & Driscoll, C. (in prog.) An improved method of mapping native vegetation at local and regional scales: alternatives to modeling using environmental variables.

Tetratheca juncea:

Bell, S.A.J. & Driscoll, C. (in prog.) *Habitat of* Tetratheca juncea *(Tremandraceae) across its distributional range.*

Appendix 1 - Plates

Plate 1
View west up Spring Creek c. 20 m west from the end of a concrete platform used as foundations for the existing Main Northern Railway.

Plate 2
View east of Spring Creek of the existing Main Northern Railway bridge crossing Spring Creek.

Plate 3
View north over the Wallarah Creek crossing put in by the Morrisseet to Warnervale project on the western boundary of the Tohheys Rd study area.

Plate 4
View south from disturbed farming land at the western end of the Tooheys Rd study area of soil erosion associated with the north tributary of Wallarah Creek.

Plate 5
View east in Wallarah Creek where the rail loop will cross showing a young tree canopy and a regenerated shrub layer. These environs have previously been cleared during early European settlement.

Plate 6
Down, egg shell fragment and small feathers *in situ* at tree 37 south of Wallarah Creek. Potentially from Tawny frogmouth owl.

Plate 7
Tree 37 south of Wallarah Creek. Potential owl nesting site

Plate 8
Hollow in tree 37 south of Wallarah Creek. Potentially a Tawney Frgmouth Owl nesting site

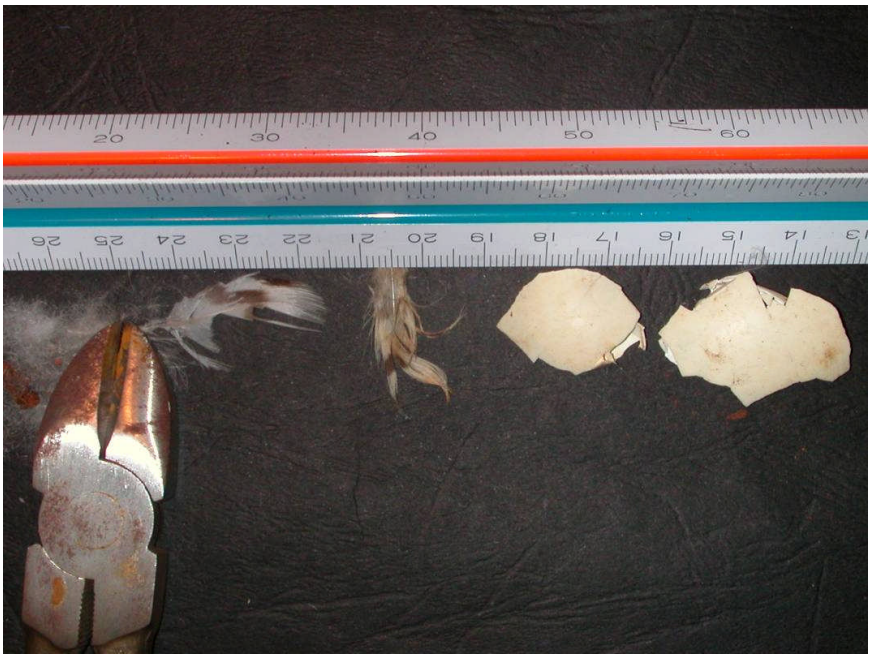

Plate 9
Detail of down, feathers and egg shell from tree 37 Sth of Wallarah Creek.

Appendix 2 – Database search results

DECCW search results

Combined geographic and habitat search results
Your search returned **120** results. You searched for the following information:
geographic region: **Hunter/Central Rivers > Wyong**
vegetation type: **all**
type: **all**

Search Results

Scientific Name	Common Name	Level of Threat
Caladenia porphyrea	Caladenia porphyrea	Endangered
Diuris bracteata	*Diuris bracteata*	Endangered
Botaurus poiciloptilus	Australasian Bittern	Vulnerable
Ninox connivens	Barking Owl	Vulnerable
Melaleuca biconvexa	Biconvex Paperbark	Vulnerable
Ixobrychus flavicollis	Black Bittern	Vulnerable
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Vulnerable
Tetratheca juncea	Black-eyed Susan	Vulnerable
Ephippiorhynchus asiaticus	Black-necked Stork	Endangered
Limosa limosa	Black-tailed Godwit	Vulnerable
Oxyura australis	Blue-billed Duck	Vulnerable
Limicola falcinellus	Broad-billed Sandpiper	Vulnerable
Hoplocephalus bungaroides	Broad-headed Snake	Endangered
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Vulnerable
Petrogale penicillata	Brush-tailed Rock-wallaby	Endangered
Burhinus grallarius	Bush Stone-curlew	Endangered
Acacia bynoeana	Bynoe's Wattle	Endangered
Eucalyptus camfieldii	Camfield's Stringybark	Vulnerable
Angophora inopina	Charmhaven Apple	Vulnerable
Senecio spathulatus	Coast Groundsel	Endangered
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Endangered Ecological Community
Irediparra gallinacea	Comb-crested Jacana	Vulnerable
Planigale maculata	Common Planigale	Vulnerable
Nettapus coromandelianus	Cotton Pygmy-goose	Endangered
Prostanthera askania	Cut-leaf Mint-bush	Endangered
Darwinia glaucophylla	*Darwinia glaucophylla*	Vulnerable
Baloskion longipes	Dense Cord-rush	Vulnerable
Stagonopleura guttata	Diamond Firetail	Vulnerable
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable
Vespadelus troughtoni	Eastern Cave Bat	Vulnerable
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	Vulnerable
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable
Mormopterus norfolkensis	Eastern Freetail-bat	Vulnerable
Cercartetus nanus	Eastern Pygmy-possum	Vulnerable
Epacris purpurascens var. purpurascens	*Epacris purpurascens* var. *purpurascens*	Vulnerable
Eucalyptus oblonga -	*Eucalyptus oblonga* (Narrow-	Endangered Population

endangered population	leaved Stringybark) population at Bateau Bay	
Eucalyptus parramattensis subsp. decadens	*Eucalyptus parramattensis* subsp. *decadens*	Vulnerable
Eucalyptus parramattensis subsp. parramattensis - endangered population	*Eucalyptus parramattensis* subsp. *parramattensis* population in the Wyong and Lake Macquarie LGAs	Endangered Population
Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Freshwater wetlands on coastal floodplains	Endangered Ecological Community
Callocephalon fimbriatum	Gang-gang Cockatoo	Vulnerable
Mixophyes iteratus	Giant Barred Frog	Endangered
Heleioporus australiacus	Giant Burrowing Frog	Vulnerable
Calyptorhynchus lathami	Glossy Black-cockatoo	Vulnerable
Kerivoula papuensis	Golden-tipped Bat	Vulnerable
Calidris tenuirostris	Great Knot	Vulnerable
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable
Charadrius leschenaultii	Greater Sand-plover	Vulnerable
Litoria aurea	Green and Golden Bell Frog	Endangered
Litoria brevipalmata	Green-thighed Frog	Vulnerable
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	Vulnerable
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable
Melaleuca groveana	Grove's Paperbark	Vulnerable
Rutidosis heterogama	Heath Wrinklewort	Vulnerable
Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions	Endangered Ecological Community
Kincumber Scribbly Gum Forest in the Sydney Basin bioregion	Kincumber Scribbly Gum Forest	Critically Endangered Ecological Community
Phascolarctos cinereus	Koala	Vulnerable
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable
Myotis macropus (formally Myotis adversus)	Large-footed Myotis	Vulnerable
Cryptostylis hunteriana	Leafless Tongue Orchid	Vulnerable
Dermochelys coriacea	Leathery Turtle	Vulnerable
Charadrius mongolus	Lesser Sand-plover	Vulnerable
Miniopterus australis	Little Bentwing-bat	Vulnerable
Sterna albifrons	Little Tern	Endangered
Litoria littlejohni	Littlejohn's Tree Frog	Vulnerable
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Endangered Ecological Community
Caretta caretta	Loggerhead Turtle	Endangered
Potorous tridactylus	Long-nosed Potoroo	Vulnerable
Low woodland with heathland on indurated sand at Norah Head	Low woodland with heathland on indurated sand at Norah Head	Endangered Ecological Community
Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion	Lower Hunter Spotted Gum - Ironbark Forest	Endangered Ecological Community
Syzygium paniculatum	Magenta Lilly Pilly	Vulnerable
Anseranas semipalmata	Magpie Goose	Vulnerable
Tyto novaehollandiae	Masked Owl	Vulnerable

Maundia triglochinoides	*Maundia triglochinoides*	Vulnerable	
Callistemon linearifolius	Netted Bottle Brush	Vulnerable	
Pandion haliaetus	Osprey	Vulnerable	
Grantiella picta	Painted Honeyeater	Vulnerable	
Rostratula benghalensis	Painted Snipe	Endangered	
Hoplocephalus bitorquatus	Pale-headed Snake	Vulnerable	
Macropus parma	Parma Wallaby	Vulnerable	
Haematopus longirostris	Pied Oystercatcher	Vulnerable	
Ninox strenua	Powerful Owl	Vulnerable	
Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion	Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion	Endangered Community	Ecological
Pseudophryne australis	Red-crowned Toadlet	Vulnerable	
Thylogale stigmatica	Red-legged Pademelon	Vulnerable	
Xanthomyza phrygia	Regent Honeyeater	Endangered	
River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	River-Flat Eucalypt Forest on Coastal Floodplains	Endangered Community	Ecological
Ptilinopus regina	Rose-crowned Fruit-dove	Vulnerable	
Varanus rosenbergi	Rosenberg's Goanna	Vulnerable	
Diuris praecox	Rough Double Tail	Vulnerable	
Chamaesyce psammogeton	Sand Spurge	Endangered	
Calidris alba	Sanderling	Vulnerable	
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	Vulnerable	
Prostanthera junonis	Somersby Mintbush	Endangered	
Tyto tenebricosa	Sooty Owl	Vulnerable	
Haematopus fuliginosus	Sooty Oystercatcher	Vulnerable	
Pyrrholaemus saggitatus	Speckled Warbler	Vulnerable	
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	
Hibbertia procumbens	Spreading Guinea Flower	Endangered	
Lophoictinia isura	Square-tailed Kite	Vulnerable	
Petaurus norfolcensis	Squirrel Glider	Vulnerable	
Hoplocephalus stephensii	Stephens' Banded Snake	Vulnerable	
Mixophyes balbus	Stuttering Barrred Frog	Endangered	
Ptilinopus superbus	Superb Fruit-dove	Vulnerable	
Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	Swamp oak floodplain forest	Endangered Community	Ecological
Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Swamp sclerophyll forest on coastal floodplains	Endangered Community	Ecological
Lathamus discolor	Swift Parrot	Endangered	
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	Sydney Freshwater Wetlands in the Sydney Basin Bioregion	Endangered Community	Ecological
Xenus cinereus	Terek Sandpiper	Vulnerable	
Caladenia tessellata	Tessellated Spider Orchid	Endangered	
Tetratheca glandulosa	*Tetratheca glandulosa*	Vulnerable	
Astrotricha crassifolia	Thick-leaf Star-hair	Vulnerable	
Neophema pulchella	Turquoise Parrot	Vulnerable	
Umina Coastal Sandplain	Umina Coastal Sandplain	Endangered	Ecological

Woodland in the Sydney Basin Bioregion	Woodland in the Sydney Basin Bioregion	Community
Genoplesium insignis	Variable Midge Orchid	Endangered
Crinia tinnula	Wallum Froglet	Vulnerable
Cynanchum elegans	White-flowered Wax Plant	Endangered
Ptilinopus magnificus	Wompoo Fruit-dove	Vulnerable
Petaurus australis	Yellow-bellied Glider	Vulnerable
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Vulnerable
Zannichellia palustris	*Zannichellia palustris*	Endangered

Fisheries Management Act 1994:

Species presumed extinct
A species is eligible to be listed as presumed extinct if, in the opinion of the Fisheries Scientific Committee, it has not been recorded in its known or expected habitat over a time frame appropriate to its life cycle.

- Bennetts seaweed - *Vanvoorstia bennettiana*
- Green sawfish - *Pristis zijsron*
- Haswells caprellid - *Metaprotella haswelliana*

Critically endangered species
Critically endangered species face an extremely high risk of extinction in the immediate future as determined by the Fisheries Scientific Committee. A species is eligible for listing as critically endangered if it has undergone an extremely large reduction in abundance, geographic distribution or genetic diversity and is affected by a threatening process.

- Grey nurse shark - *Carcharias taurus*
- Murray hardyhead - *Craterocephalus fluviatilis*
- Marine brown alga - *Nereia lophocladia*
- Flathead galaxias - *Galaxias rostratus*
- Marine slug - *Smeagol hilaris*

Endangered species
Endangered species face a very high risk of extinction in the near future as determined by the Fisheries Scientific Committee. A species is eligible for listing as endangered if it has undergone a very large reduction in abundance, geographic distribution or genetic diversity and is affected by a threatening process.

- Eastern freshwater cod - *Maccullochella ikei*
- Oxleyan pygmy perch - *Nannoperca oxleyana*
- River snail - *Notopala sublineata*
- Southern bluefin tuna - *Thunnus maccoyii*
- Trout cod - *Maccullochella macquariensis*
- Sydney hawk dragonfly - *Austrocordulia leonardi*
- Adams emerald dragonfly - *Archaeophya adamsi*
- Macquarie perch - *Macquaria australasica*
- Southern pygmy perch - *Nannoperca australis*
- Purple spotted gudgeon - *Mogurnda adspersa*

Vulnerable species
Vulnerable species face a high risk of extinction in the medium term future as determined by the Fisheries Scientific Committee. A species is eligible for listing as vulnerable if it has undergone a large reduction in abundance, geographic distribution or genetic diversity and is affected by a threatening process.

- Black cod - *Epinephelus daemelii*
- Buchanans fairy shrimp - *Branchinella buchananensis*
- Great white shark - *Carcharodon carcharias*
- Silver perch - *Bidyanus bidyanus*

Endangered populations
Endangered populations face a very high risk of extinction in the near future as determined by the Fisheries Scientific Committee. For a population to be eligible for listing it must be clearly defined and satisfy one or more of the following:
It is disjunct or near the limit of its geographic range,
It is genetically, biologically, morphologically, or ecologically distinct,
It is otherwise of significant conservation value
The population must have undergone a very large reduction in abundance, distribution or genetic diversity and be affected by a threatening process.

- Western population of olive perchlet - *Ambassis agassizii*
- Snowy River population of river blackfish - *Gadopsis marmoratus*
- Murray-Darling Basin population of eel tailed catfish - *Tandanus tandanus*

Critically endangered ecological communities
Critically endangered ecological communities face an extremely high risk of extinction in the immediate future as determined by the Fisheries Scientific Committee. An ecological community is eligible for listing as critically endangered if it has undergone an extremely large reduction in ecological function, geographic distribution or genetic diversity, and is affected by a threatening process.

- There are currently no critically endangered ecological communities listed

Endangered ecological communities
Endangered ecological communities face a very high risk of extinction in the near future as determined by the Fisheries Scientific Committee. An ecological community is eligible for listing as endangered if it has undergone a very large reduction in ecological function, geographic distribution or genetic diversity, and is affected by a threatening process.

- Lowland Murray River aquatic ecological community
- Lowland Darling River aquatic ecological community
- Lowland Lachlan River aquatic ecological community

Vulnerable ecological communities
Vulnerable ecological communities face a high risk of extinction in the medium term future as determined by the Fisheries Scientific Committee. An ecological community is eligible for listing as vulnerable if it has undergone a large reduction in ecological function, geographic distribution or genetic diversity, and is affected by a threatening process.

- There are currently no vulnerable ecological communities listed.

Key threatening processes
Key threatening processes are threatening processes that, in the opinion of the Fisheries Scientific Committee, adversely affect threatened species populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened.

- Current shark meshing program in NSW waters
- Hook and line fishing in areas important for the survival of threatened fish species
- The introduction of fish to fresh waters within a river catchment outside their natural range
- The removal of large woody debris from NSW rivers and streams
- The degradation of native riparian vegetation along New South Wales water courses
- Instream structures and other mechanisms that alter natural flow
- Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales

Matters of National Environmental Significance Wyong LGA

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	2
Threatened Species:	51
Migratory Species:	60
Commonwealth Lands:	3
Commonwealth Heritage Places:	None
Places on the RNE:	7
Listed Marine Species:	89
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information
This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Other Commonwealth Reserves:	None
Regional Forest Agreements:	1

Details
Matters of National Environmental Significance

Wetlands of International Significance [Dataset Information] (Ramsar Sites)	
HUNTER ESTUARY WETLANDS	Within same catchment as Ramsar site

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Diomedea exulans antipodensis Antipodean Albatross	Vulnerable	Species or species habitat may occur within area
Diomedea exulans gibsoni Gibson's Albatross	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Vulnerable	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western)	Vulnerable	Species or species habitat may occur within area
Rostratula australis	Vulnerable	Species or species habitat may occur within

Australian Painted Snipe		area
Thalassarche *bulleri* Buller's Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta *cauta* Shy Albatross, Tasmanian Shy Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta *salvini* Salvin's Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta *steadi* White-capped Albatross	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris *impavida* Campbell Albatross	Vulnerable	Species or species habitat may occur within area
Frogs		
Heleioporus *australiacus* Giant Burrowing Frog	Vulnerable	Species or species habitat likely to occur within area
Litoria *aurea* Green and Golden Bell Frog	Vulnerable	Species or species habitat may occur within area
Litoria *littlejohni* Littlejohn's Tree Frog, Heath Frog	Vulnerable	Species or species habitat may occur within area
Mixophyes *balbus* Stuttering Frog, Southern Barred Frog (in Victoria)	Vulnerable	Species or species habitat likely to occur within area
Mixophyes *iteratus* Southern Barred Frog, Giant Barred Frog	Endangered	Species or species habitat likely to occur within area
Mammals		
Chalinolobus *dwyeri* Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat may occur within area
Eubalaena *australis* Southern Right Whale	Endangered	Species or species habitat likely to occur within area
Megaptera *novaeangliae* Humpback Whale	Vulnerable	Species or species habitat known to occur within area
Petrogale *penicillata* Brush-tailed Rock-wallaby	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus *tridactylus* Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
Pteropus *poliocephalus* Grey-headed Flying-fox	Vulnerable	Roosting known to occur within area
Ray-finned fishes		
Macquaria *australasica* Macquarie Perch	Endangered	Species or species habitat may occur within area
Prototroctes *maraena* Australian Grayling	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta *caretta* Loggerhead Turtle	Endangered	Species or species habitat may occur within area
Chelonia *mydas* Green Turtle	Vulnerable	Species or species habitat may occur within area
Dermochelys *coriacea* Leatherback Turtle, Leathery Turtle, Luth	Endangered	Species or species habitat may occur within area
Hoplocephalus *bungaroides* Broad-headed Snake	Vulnerable	Species or species habitat likely to occur within area
Natator *depressus* Flatback Turtle	Vulnerable	Species or species habitat may occur within area
Sharks		

Carcharias taurus (east coast population) Grey Nurse Shark (east coast population)	Critically Endangered	Species or species habitat may occur within area
Carcharodon carcharias Great White Shark	Vulnerable	Species or species habitat may occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark	Conservation Dependent	Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Acacia bynoeana Bynoe's Wattle, Tiny Wattle	Vulnerable	Species or species habitat likely to occur within area
Angophora inopina	Vulnerable	Species or species habitat likely to occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid	Vulnerable	Species or species habitat may occur within area
Diuris praecox Newcastle Doubletail	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus camfieldii Camfield's Stringybark	Vulnerable	Species or species habitat likely to occur within area
Grevillea parviflora subsp. parviflora Small-flower Grevillea	Vulnerable	Species or species habitat likely to occur within area
Melaleuca biconvexa Biconvex Paperbark	Vulnerable	Species or species habitat known to occur within area
Prostanthera askania Tranquility Mintbush	Endangered	Species or species habitat likely to occur within area
Prostanthera junonis Somersby Mintbush	Endangered	Species or species habitat likely to occur within area
Rhizanthella slateri Eastern Underground Orchid	Endangered	Species or species habitat may occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Pocket-less Brush Cherry, Scrub Cherry, Creek Lilly Pilly, Brush Cherry	Vulnerable	Species or species habitat likely to occur within area
Tetratheca glandulosa Glandular Pink-bell	Vulnerable	Species or species habitat likely to occur within area
Tetratheca juncea Black-eyed Susan	Vulnerable	Species or species habitat likely to occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area

Xanthomyza Regent Honeyeater	*phrygia*	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species			
Birds			
Actitis Common Sandpiper	*hypoleucos*	Migratory	Roosting known to occur within area
Ardea Great Egret, White Egret	*alba*	Migratory	Species or species habitat may occur within area
Ardea Cattle Egret	*ibis*	Migratory	Species or species habitat may occur within area
Arenaria Ruddy Turnstone	*interpres*	Migratory	Roosting known to occur within area
Calidris Sharp-tailed Sandpiper	*acuminata*	Migratory	Roosting known to occur within area
Calidris Sanderling	*alba*	Migratory	Roosting known to occur within area
Calidris Red Knot, Knot	*canutus*	Migratory	Roosting known to occur within area
Calidris Curlew Sandpiper	*ferruginea*	Migratory	Roosting known to occur within area
Calidris Red-necked Stint	*ruficollis*	Migratory	Roosting known to occur within area
Calidris Great Knot	*tenuirostris*	Migratory	Roosting known to occur within area
Charadrius Double-banded Plover	*bicinctus*	Migratory	Roosting known to occur within area
Charadrius Greater Sand Plover, Large Sand Plover	*leschenaultii*	Migratory	Roosting likely to occur within area
Charadrius Lesser Sand Plover, Mongolian Plover	*mongolus*	Migratory	Roosting known to occur within area
Gallinago Latham's Snipe, Japanese Snipe	*hardwickii*	Migratory	Roosting known to occur within area
Glareola Oriental Pratincole	*maldivarum*	Migratory	Roosting likely to occur within area
Heteroscelus Grey-tailed Tattler	*brevipes*	Migratory	Roosting known to occur within area
Limicola Broad-billed Sandpiper	*falcinellus*	Migratory	Roosting likely to occur within area
Limosa Black-tailed Godwit	*limosa*	Migratory	Roosting known to occur within area
Numenius Eastern Curlew	*madagascariensis*	Migratory	Roosting known to occur within area
Numenius Little Curlew, Little Whimbrel	*minutus*	Migratory	Roosting likely to occur within area
Numenius Whimbrel	*phaeopus*	Migratory	Roosting known to occur within area
Pluvialis Pacific Golden Plover	*fulva*	Migratory	Roosting known to occur within area
Pluvialis Grey Plover	*squatarola*	Migratory	Roosting known to occur within area
Rostratula benghalensis s. lat. Painted Snipe		Migratory	Species or species habitat may occur within area
Tringa Wood Sandpiper	*glareola*	Migratory	Roosting likely to occur within area
Tringa Common Greenshank, Greenshank	*nebularia*	Migratory	Roosting known to occur within area

Tringa Marsh Sandpiper, Little Greenshank	*stagnatilis*	Migratory	Roosting known to occur within area
Xenus Terek Sandpiper	*cinereus*	Migratory	Roosting known to occur within area
Migratory Marine Birds			
Apus Fork-tailed Swift	*pacificus*	Migratory	Species or species habitat may occur within area
Ardea Great Egret, White Egret	*alba*	Migratory	Species or species habitat may occur within area
Ardea Cattle Egret	*ibis*	Migratory	Species or species habitat may occur within area
Diomedea Antipodean Albatross	*antipodensis*	Migratory	Species or species habitat may occur within area
Diomedea Gibson's Albatross	*gibsoni*	Migratory	Species or species habitat may occur within area
Macronectes Southern Giant-Petrel	*giganteus*	Migratory	Species or species habitat may occur within area
Macronectes Northern Giant-Petrel	*halli*	Migratory	Species or species habitat may occur within area
Sterna Little Tern	*albifrons*	Migratory	Breeding likely to occur within area
Thalassarche Buller's Albatross	*bulleri*	Migratory	Species or species habitat may occur within area
Thalassarche cauta (sensu Shy Albatross, Tasmanian Shy Albatross	*stricto)*	Migratory	Species or species habitat may occur within area
Thalassarche Campbell Albatross	*impavida*	Migratory	Species or species habitat may occur within area
Thalassarche Salvin's Albatross	*salvini*	Migratory	Species or species habitat may occur within area
Thalassarche White-capped Albatross	*steadi*	Migratory	Species or species habitat may occur within area
Migratory Marine Species			
Mammals			
Balaenoptera Bryde's Whale	*edeni*	Migratory	Species or species habitat may occur within area
Caperea Pygmy Right Whale	*marginata*	Migratory	Species or species habitat may occur within area
Eubalaena Southern Right Whale	*australis*	Migratory	Species or species habitat likely to occur within area
Lagenorhynchus Dusky Dolphin	*obscurus*	Migratory	Species or species habitat may occur within area
Megaptera Humpback Whale	*novaeangliae*	Migratory	Species or species habitat known to occur within area
Orcinus Killer Whale, Orca	*orca*	Migratory	Species or species habitat may occur within area
Reptiles			
Caretta Loggerhead Turtle	*caretta*	Migratory	Species or species habitat may occur within area
Chelonia Green Turtle	*mydas*	Migratory	Species or species habitat may occur within area
Dermochelys Leatherback Turtle, Leathery Turtle, Luth	*coriacea*	Migratory	Species or species habitat may occur within area
Natator Flatback Turtle	*depressus*	Migratory	Species or species habitat may occur within area
Sharks			

Carcharodon Great White Shark	*carcharias*	Migratory	Species or species habitat may occur within area
Rhincodon Whale Shark	*typus*	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper	Listed	Roosting known to occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Listed	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper	Listed	Roosting known to occur within area
Calidris alba Sanderling	Listed	Roosting known to occur within area
Calidris canutus Red Knot, Knot	Listed - overfly marine area	Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper	Listed - overfly marine area	Roosting known to occur within area
Calidris melanotos Pectoral Sandpiper	Listed - overfly marine area	Roosting known to occur within area
Calidris ruficollis Red-necked Stint	Listed - overfly marine area	Roosting known to occur within area
Calidris subminuta Long-toed Stint	Listed - overfly marine area	Roosting likely to occur within area
Calidris tenuirostris Great Knot	Listed - overfly marine area	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover	Listed - overfly marine area	Roosting known to occur within area
Charadrius dubius Little Ringed Plover	Listed - overfly marine area	Roosting likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover	Listed	Roosting likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover	Listed	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover	Listed - overfly marine area	Roosting known to occur within area
Diomedea antipodensis Antipodean Albatross	Listed	Species or species habitat may occur within area
Diomedea gibsoni Gibson's Albatross	Listed	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Roosting known to occur within area
Gallinago megala Swinhoe's Snipe	Listed - overfly marine area	Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe	Listed - overfly marine area	Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Roosting likely to occur within area
Haliaeetus leucogaster	Listed	Species or species habitat likely to occur within

White-bellied Sea-Eagle		area
Heteroscelus brevipes Grey-tailed Tattler	Listed	Roosting known to occur within area
Heteroscelus incanus Wandering Tattler	Listed	Roosting likely to occur within area
Himantopus himantopus Black-winged Stilt	Listed - overfly marine area	Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Listed - overfly marine area	Species or species habitat likely to occur within area
Limicola falcinellus Broad-billed Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Limnodromus semipalmatus Asian Dowitcher	Listed - overfly marine area	Roosting likely to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Numenius madagascariensis Eastern Curlew	Listed	Roosting known to occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly marine area	Roosting likely to occur within area
Numenius phaeopus Whimbrel	Listed	Roosting known to occur within area
Phalaropus lobatus Red-necked Phalarope	Listed	Roosting likely to occur within area
Philomachus pugnax Ruff (Reeve)	Listed - overfly marine area	Roosting likely to occur within area
Pluvialis fulva Pacific Golden Plover	Listed	Roosting known to occur within area
Pluvialis squatarola Grey Plover	Listed - overfly marine area	Roosting known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet	Listed - overfly marine area	Roosting likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Sterna albifrons Little Tern	Listed	Breeding likely to occur within area
Stiltia isabella Australian Pratincole	Listed - overfly marine area	Roosting likely to occur within area
Thalassarche bulleri Buller's Albatross	Listed	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross	Listed	Species or species habitat may occur within area
Thalassarche impavida	Listed	Species or species habitat may occur within

Campbell Albatross		area
Thalassarche salvini Salvin's Albatross	Listed	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross	Listed	Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover	Listed - overfly marine area	Roosting likely to occur within area
Tringa glareola Wood Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Roosting known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank	Listed - overfly marine area	Roosting known to occur within area
Tringa totanus Common Redshank, Redshank	Listed - overfly marine area	Roosting likely to occur within area
Xenus cinereus Terek Sandpiper	Listed - overfly marine area	Roosting known to occur within area
Mammals		
Arctocephalus forsteri New Zealand Fur-seal	Listed	Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal	Listed	Species or species habitat may occur within area
Ray-finned fishes		
Acentronura tentaculata Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish	Listed	Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus abdominalis Eastern Potbelly Seahorse, New Zealand Potbelly, Seahorse, Bigbelly Seahorse	Listed	Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse	Listed	Species or species habitat may occur within area
Histiogamphelus briggsii Briggs' Crested Pipefish, Briggs' Pipefish	Listed	Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish	Listed	Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish	Listed	Species or species habitat may occur within area
Notiocampus ruber Red Pipefish	Listed	Species or species habitat may occur within area
Phyllopteryx taeniolatus Weedy Seadragon, Common Seadragon	Listed	Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Listed	Species or species habitat may occur within area
Solenostomus paradoxus Harlequin Ghost Pipefish, Ornate Ghost	Listed	Species or species habitat may occur within area

Pipefish		
Stigmatopora argus Spotted Pipefish	Listed	Species or species habitat may occur within area
Stigmatopora nigra Wide-bodied Pipefish, Black Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish	Listed	Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Listed	Species or species habitat may occur within area
Chelonia mydas Green Turtle	Listed	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Listed	Species or species habitat may occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin	Cetacean	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale	Cetacean	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Cetacean	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area
Commonwealth Lands [Dataset Information]		
Communications, Information Technology and the Arts - Australian Postal Corporation		
Communications, Information Technology		

and the Arts - Telstra Corporation Limited

Defence - Defence Housing Authority

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Historic

Alison Homestead NSW

Felton Mathews Tree NSW

Norah Head Lighthouse NSW

Norah Head Lightstation Group NSW

Noraville NSW

Old Maitland Road Section NSW

Indigenous

Norah Head NSW

Extra Information

State and Territory Reserves [Dataset Information]

Wyrrabalong National Park, NSW

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

Lower North East NSW RFA, New South Wales

Wetland name	Old Reference No.	New Reference No.	IBRA Region(s)	Area (ha)	Wetland type(s)	Criteria for inclusion
Bicentennial Park	SB001NS	NSW071	SB	56	A6, A7, A8	1, 2, 3, 5
Blue Mountains Sedge Swamps	SB002NS	NSW072	SB	35	B15	1, 2, 5
Botany Wetlands[C]	SB003NS	NSW073	SB	64	B5, B13	1, 6
Boyd Plateau Bogs	SB004NS	NSW074	SB	-	B15	1, 2, 5
Budderoo National Park and Barren Grounds Nature Reserve Heath swamps	SB005NS	NSW075	SB	1150	B13, B15	1, 2, 5
Coomonderry Swamp	SB006NS	NSW076	SB	670	A11, A12	1, 3, 4
Eve St. Marsh, Arncliffe	SB007NS	NSW077	SB	2	A7, A8	3, 6
Jervis Bay[C]	SB008NS	NSW078	SB	41044	A2, A6, A7, A8, A9, B2, B7	1, 3, 4, 5 6
Killalea Lagoon	SB009NS	NSW079	SB	20	A11	1, 3
Kooragang Nature Reserve	SB010NS	NSW080	SB	2926	A4, A5, A6, A7, A8, A9, A11	1, 3, 4, 5, 6
Lake Illawarra	SB011NS	NSW081	SB	3227	A10	1, 3, 5
Long, Hanging Rock, Mundego & Stingray Swamps (Paddys River Swamps)	SB012NS	NSW082	SB	88	B15	1, 3, 5
Longneck Lagoon	SB013NS	NSW083	SB	24	B9, B10	3, 5, 6
Minnamurra River Estuary	SB014NS	NSW084	SB	200	A2, A6, A7, A8, A9, A10, A11	1, 5
Newington Wetlands	SB015NS	NSW085	SB	71	A8, B1, B11	1, 2, 6
O'Hares Creek Catchment	SB016NS	NSW086	SB	9000	B9, B10, B13, B15	1, 3, 5, 6
Pitt Town Lagoon	SB017NS	NSW087	SB	41	B10	1
Shoalhaven / Crookhaven Estuary	SB018NS	NSW088	SB	2500	A2, A5, A6, A7, A8, A9	1, 3, 4, 5
Shortland Wetlands Centre	SB019NS	NSW089	SB	45	A11, A12	3, 6
St. Georges Basin	SB020NS	NSW090	SB	4400	A2, A6, A7, A8, A9	1, 3
Thirlmere Lakes	SB021NS	NSW091	SB	50	B5, B15	1, 2, 3, 4,

						6
Towra Point Estuarine Wetlands	SB022NS	NSW092	SB	1161	A2, A5, A6, A7, A8, A9	1, 3, 4, 5, 6
Wingecarribee Swamp	SB023NS	NSW093	SB	691	B15, C1, C5	1, 4, 5, 6
Wollumboola Lake	SB024NS	NSW094	SB	850	A2, A8, A9, A10	1, 2, 3, 5, 6

Appendix 3 – Observed species

This appendix details the animals recorded on site during the current and previous surveys.

MAMMALS RECORDED (Study Areas: 1 = Tooheys Rd, 2 = Hue Hue Rd ecological offset investigation area, 3 = Buttonderry & 4 = Western Shaft)					
	Scientific Name	**Common Name**	**Status**	**Habitat**	**Study area**
Ground Mammals	*Antechinus stuartii*	Brown Antechinus	P	Dry Sclerophyll.	1,2,3
	Macropus giganteus	Eastern Grey Kangaroo	P, R	Grassland (disturbed area)	1,2
	Macropus rufogriseus	Red-necked Wallaby	P, R	Grassland (disturbed area)	2,3
	Perameles nasuta	Long-nosed Bandicoot	P, R	Dry Sclerophyll	1
	Rattus fuscipes	Bush Rat	P	Dry Sclerophyll/Tall Open Forest- site	1,2
	Rattus lutreolus	Swamp Rat	P	Heath	1
	Wallabia bicolor	Swamp Wallaby	P	Dry Sclerophyll, grassland	1
Bats	*Chalinolobus gouldi*	Gould's Wattled Bat	P	Dry Sclerophyll/Tall Open Forest	1,2,3
	Chalinolobus morio	Chocolate Wattled Bat	P	Dry Sclerophyll/Tall Open Forest	1,2,3
	Miniopteris australis	Little Bentwing-bat	V TSC	Dry Sclerophyll	1
	Mormopterus species 3	Small penis form (Adams *et al*, 1988)	P	Dry Sclerophyll	1
	Myotis adversus	Large-footed Myotis	V	A farm dam in a pasture.	1
	Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	Dry Sclerophyll	1,2
	Scotorepens orion	Eastern Broad-nosed Bat	P	Tall Open Forest	1,2,3
	Scoteanax rueppellii	Greater Broad-nosed Bat	V TSC	Woodland over a dam	2
	Falsistrellus tasmaniensis	Eastern false pipistrelle	V TSC	Dry Sclerophyll	1 (differential ID is *Scoteanax rueppellii)*
	Vespadelus darlingtoni	Large Forest Bat	P	Dry Sclerophyll	2
	Vespadelus vulternus	Little Forest Bat	P	Dry Sclerophyll	1,3
Arboreal Mammals	*Petauroides volans*	Greater Glider	P, R	Dry Sclerophyll	2
	Petaurus norfolcensis	Squirrel Glider	V TSC	Dry Sclerophyll	1
	Petaurus australis	Yellow-bellied glider	V TSC	Dry Sclerophyll	2 (potential sighting only)
	Pseudocheirus peregrinus	Common Ringtail Possum	P	Dry Sclerophyll	1,2
	Trichosaurus vulpecula	Brushtail Possum	P	Dry Sclerophyll	1,2
Exotic Mammals	*Capra hircus*	Goat (feral)		Dry Sclerophyll	1
	Vulpes vulpes	Fox		Dry Sclerophyll	1
	Lepus capensis	Brown Hare		Grassland (disturbed area)	1
	Oryctolagus cuniculus	Rabbit		Grassland (disturbed area)	1,3
	Suis suis	Pig		Grassland (disturbed area)	1
	Felis catus	Feral cat		Dry Sclerophyll	1,2,3

Key to status codes can be seen at the ends of the tables.

BIRDS RECORDED OR LIKELY TO BE RECORDED (Study Areas: 1 = Tooheys Rd, 2 = Hue Hue Rd ecological offset investigation area, 3 = Buttonderry & 4 = Western Shaft)			
Scientific Name	Common Name	Status	Study area
Ardea gazetta	Little Egret	P	1,2
Ardea novaehollandiae	White-faced Heron	P	1,2,3
Chenonetta jubata	Australian Wood Duck	P	1,2,3
Anas gibberifrons	Grey Teal	P	1,2,3
Anas castanea	Chestnut Teal	P	1,2
Haliaeetus leucogaster	White-bellied Sea Eagle	P, MT, LMS, R	1*,2,3
Aquilia audax	Wedge-tailed Eagle	P	1,3
Tyto novaehollandiae	Southern Boobook	P	1,2,3,4
Tyto novaehollandiae	Masked Owl	V TSC	1*,2,3 (call from a neighbouring property)
Ninox strenua	Powerful Owl	V TSC	1*,2,3
Geophaps lophotes	Crested Pigeon	P	1, 2 ,3 ,4
Cacatua galerita	Sulphur-crested Cockatoo	P	1, 2 ,3 ,4
Cacatua roseicapilla	Galah	P	1, 2, 3, 4
Trichoglossus haematodus	Rainbow Lorikeet	P	1, 2, 3, 4
Platycercus eximius	Eastern Rosella	P	1, 2 ,3, 4
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	P	1, 2, 3, 4
Coracina novaehollandiae	Black-faced Cuckoo Shrike	P	1,2,3
Dacelo novaeguineae	Laughing Kookaburra	P	1, 2, 3, 4
Eurystomus orientalis	Dollarbird	P	1,2,3
Hirundo neoxena	Welcome Swallow	P	1, 2, 3, 4
Pachycephala rufiventris	Rufous Whistler	P	1, 2, 3, 4
Pachycephala pectoralis	Golden Whistler	P	1, 2, 3, 4
Micoeca leucophaea	Jacky Winter	P	1, 2, 3, 4
Rhipidura fuliginosa	Grey Fantail	P	1, 2, 3, 4
Rhipidura leucophrys	Willie Wagtail	P	1, 2, 3, 4
Psophodes olivaceus	Eastern Whipbird	P	4
Turnix varia	Painted button quail	P, R	3
Malurus cyaneus	Superb Fairy-wren	P	1, 2, 3, 4
Malurus lamberti	Variegated Fairy-wren	P	4
Sericornis frontalis	White-browed Scrubwren	P	4
Sericornis citreogularis	Yellow-throated Scrubwren	P	1,2,4
Neochmia temporalis	Red-browed Finch	P	1,2,3
Sericornis pyrrhophanus	Chestnut-rumped Hylacola	P, R	1,2,3,4
Acanthiza pusilla	Brown Thornbill	P	1 ,2 ,3 ,4
Acanthiza nana	Yellow Thornbill	P	1, 2, 3,4
Pardalotus punctatus	Spotted Pardalote	P	1,2,3
Daphoenositta chrysoptera	Varied Sittella	P	1, 2, 3,4
Cormobates leucophaea	White-throated Treecreeper	P	1, 2, 3,4
Zosterops laeralist	Silver eye	P	1,2,3
Anthochaera carunculata	Red Wattlebird	P	4
Anthochaera chrysoptera	Little Wattlebird	P	1,2,3,4
Manorina melanocephala	Noisy Miner	P	1, 2, 3, 4
Meliphaga lewinii	Lewins Honeyeater	P	1, 2, 3, 4
Acanthorhynchus tenuirostris	Eastern Spinebill	P	1,2
Phyidonyris nigra	White-cheeked Honeyeater	P	1,2,3
Lichenostomus chrysops	Yellow-faced Honeyeater	P	1, 2, 3, 4
Pardalotus punctatus	Spotted Pardalote	P	1, 2, 3, 4
Grallina cyanoleuca	Australian Magpie-lark	P	1, 2, 3, 4
Cracticus torquatus	Grey Butcherbird	P	1, 2, 3, 4
Gymnorhina tibicen	Australian Magpie	P	1, 2, 3, 4
Strepera graculina	Pied Currawong	P	1, 2, 3, 4
Corvus coronoides	Australian Raven	P	1, 2, 3, 4

REPTILES RECORDED
(Study Areas: 1 = Tooheys Rd, 2 = Hue Hue Rd ecological offset investigation area, 3 = Buttonderry & 4 = Western Shaft)

Genus species	Common Name	Status	Site
Tiliqua scincoides	Blue-tongue Lizard	P	1,2,3
Physignathus lesueurii	Eastern Water Dragon	P	1,2,3
Amphibolurus muricatus	Jacky Lizard	P, R	1,2,3,4
Ctenotus robustus	Robust Ctenotus	P	1,2,3,4
Pseudechis porphyriacus	Red-bellied Black Snake	P	1,2
Lampropholis guichenoti	Garden Skink	P	1,2,3,4
Lampropholis delicata	Grass Skink	P	1,2,3
Varanus gouldii	Gould's Monitor	P	1,2

FROGS RECORDED
(Study Areas: 1 = Tooheys Rd, 2 = Hue Hue Rd ecological offset investigation area, 3 = Buttonderry & 4 = Western Shaft)

Genus species	**Common Name**	**Status**	**Site**
Adelotus brevis	Tusked Frog	P, R	1
Crinia signifera	Common Eastern Froglet	P	1,3
Crinia tinnula	Wallum Froglet	V TSC	1,2
Limnodynastes dumerilii	Eastern Pobblebonk	P	1,3
Limnodynastes peroni	Striped Marsh Frog	P	1,2,3
Limnodynastes tasmaniensis	Spotted Marsh Frog	P	1,3
Litoria dentata	Bleating Tree Frog	P	1,2
Litoria brevipalmata	Green Thighed Frog	V	3
Litoria fallax	Dwarf Tree Frog	P	1,2,3
Litoria freycineti	Freycinet's Frog	P	1
Litoria latopalmata	Broad-palmed Frog	P	1
Litoria peronii	Peron's Tree Frog	P	1,2,3
Litoria lesueuri	Lesueur's Frog	P, R	1
Litoria phyllochroa	Green Leaf Tree Frog	P	1
Litoria tyleri	Tyler's Tree Frog	P	2
Uperolia fusca	Dusky Toadlet	P	1
Uperolia laevigata	Smooth Toadlet	P	1

Key to Status codes

V(TSC) = Listed as vulnerable on Schedule 2 of the TSC Act 1995.

E (TSC) = Listed as endangered on Schedule 1 of the TSC Act 1995.

V (EPBC) = Listed as vulnerable in the Schedules of the EPBC Act 1999.

E (EPBC) = Listed as endangered on Schedule of the EPBC Act 1999

MT (EPBC) = Listed as a migratory terrestrial species on the Schedules of the EPBC Act 1999

MW (EPBC) = Listed as a migratory wetland species on the Schedules of the EPBC Act 1999

LMS (EPBC) = Listed as a marine species on the Schedules of the EPBC Act 1999

P = Protected species

R = Regionally significant (Source: Wyong Conservation Strategy: Appendix 6)

I = Introduced species.

* Positive identification of this threatened species in the field

DPI sampling data from the Wyong area (Source NSW DPI – Fisheries).

LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	**Adams emerald dragonfly**	211 01	
LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	Australian bass	211 01	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	Australian smelt	211 01	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	Cox's gudgeon	211 01	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	Empire gudgeon	211 01	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	Long-finned eel	211 01	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	lower Wyong	Striped gudgeon	211 01	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Ourimbah	**Adams emerald dragonfly**	211 06	
LAKE MACQUARIE/TUGGERAH LAKES	Ourimbah	Australian bass	211 06	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Ourimbah	Empire gudgeon	211 06	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Ourimbah	Gambusia	211 06	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	**Adams emerald dragonfly**	211 02	
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Australian bass	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Australian smelt	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Bullrout	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Common carp	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Empire gudgeon	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Firetailed gudgeon	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Flathead gudgeon	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Freshwater mullet	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Gambusia	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Glassfish	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Gobiomorphus species	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Golden perch	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Grey nurse shark	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Long-finned eel	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Port Jackson Shark	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Rainbow trout	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	shark	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Striped gudgeon	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Tuggerah	Striped mullet	211 02	added from current sightings records 11sept06
LAKE MACQUARIE/TUGGERAH LAKES	Upper Wyong	**Adams emerald dragonfly**	211 04	

Plant species recorded in the study area. * = exotic or non-indigenous species. Threatened species are written in bold text

Class	Family	Species
CLASS FILICOPSIDA (FERNS)		
	Adiantaceae	*Adiantum aethiopicum*
		Adiantum formosum
		Adiantum hispidulum
		Cheilanthes sieberi subsp. *sieberi*
		Pellaea falcata
	Aspleniaceae	*Asplenium australasicum* forma *australasicum*
	Blechnaceae	*Doodia aspera*
	Dennstaedtiaceae	*Pteridium esculentum*
	Dicksoniaceae	*Calochlaena dubia*
	Dryopteridaceae	*Polystichum australiense*
	Gleicheniaceae	*Gleichenia dicarpa*
	Lindsaeaceae	*Lindsaea linearis*
	Schizaeaceae	*Schizaea bifida*
CLASS MAGNOLIOPSIDA (Flowering Plants) **Subclass Magnoliidae (Dicotyledons)**		
	Acanthaceae	*Brunoniella australis*
		Brunoniella pumilio
	Apiaceae	*Actinotus helianthi*
		Actinotus minor
		Centella asiatica
		Hydrocotyle laxiflora
		Hydrocotyle peduncularis
		Platysace ericoides
		Platysace linearifolia
		Trachymene incisa subsp. *incisa*
	Apocynaceae	*Parsonsia straminea*
	Araceae	*Gymnostachys anceps*

Class	**Family**	**Species**
	Araliaceae	*Astrotricha latifolia*
	Asclepiadaceae	*Marsdenia flavescens*
	Asteraceae	*Brachyscome angustifolia* var. *angustifolia*
		Cassinia uncata
		Chrysanthemoides monilifera subsp. *rotundata* *
		Cotula coronopifolia
		Epaltes australis
		Lagenifera stipitata
		Taraxacum officinale *
		Vernonia cinerea var. *cinerea*
	Bignoniaceae	*Pandorea pandorana*
	Casuarinaceae	*Allocasuarina littoralis*
		Allocasuarina torulosa
	Celastraceae	*Maytenus silvestris*
	Clusiaceae	*Hypericum gramineum*
	Convolvulaceae	*Dichondra repens*
	Cunoniaceae	*Ceratopetalum apetalum*
		Ceratopetalum gummiferum
	Dilleniaceae	*Hibbertia aspera* subsp. *aspera*
		Hibbertia dentata
		Hibbertia empetrifolia subsp. *empetrifolia*
		Hibbertia pedunculata
		Hibbertia scandens
		Hibbertia vestita
	Droseraceae	*Drosera auriculata*
	Ebenaceae	*Diospyros australis*
	Epacridaceae	*Epacris pulchella*
		Leucopogon attenuatus
		Leucopogon esquamatus
		Lissanthe strigosa subsp. *subulata*
		Melichrus procumbens
		Monotoca scoparia
		Trochocarpa laurina

Class	**Family**	**Species**
	Euphorbiaceae	*Breynia oblongifolia*
		Claoxylon australe
		Glochidion ferdinandi var. *ferdinandi*
		Phyllanthus hirtellus
		Poranthera ericifolia
	Fabaceae (Faboideae)	*Bossiaea ensata*
		Bossiaea heterophylla
		Bossiaea obcordata
		Bossiaea prostrata
		Bossiaea rhombifolia subsp. *rhombifolia*
		Daviesia squarrosa
		Daviesia ulicifolia subsp. *ulicifolia*
		Desmodium rhytidophyllum
		Dillwynia retorta
		Glycine clandestina
		Glycine microphylla
		Gompholobium latifolium
		Gompholobium pinnatum
		Hardenbergia violacea
		Hovea linearis
		Mirbelia rubiifolia
		Podolobium ilicifolium
		Podolobium scandens
		Pultenaea ferruginea
		Pultenaea paleacea
		Pultenaea tuberculata
		Sphaerolobium minus
	Fabaceae (Mimosoideae)	*Acacia brownii*
		Acacia falcata
		Acacia longifolia subsp. *longifolia*
		Acacia maidenii
		Acacia schinoides
		Acacia suaveolens
		Acacia terminalis subsp. *longiaxialis*
	Goodeniaceae	*Dampiera stricta*
		Goodenia bellidifolia subsp. *bellidifolia*
		Goodenia hederacea subsp. *hederacea*
		Goodenia heterophylla subsp. *heterophylla*
		Scaevola ramosissima
	Haloragaceae	*Gonocarpus tetragynus*

Class	**Family**	**Species**
	Lamiaceae	*Plectranthus parviflorus*
	Lauraceae	*Cassytha glabella* forma *glabella*
	Lobeliaceae	*Lobelia alata* var. *alata*
		Pratia purpurascens
	Loganiaceae	*Logania pusilla*
		Mitrasacme polymorpha
	Loranthaceae	*Dendrophthoe vitellina*
	Malvaceae	*Hibiscus heterophyllus* subsp. *heterophyllus*
	Meliaceae	*Synoum glandulosum* subsp. *glandulosum*
	Menispermaceae	*Stephania japonica* var. *discolor*
	Menyanthaceae	*Villarsia exaltata*
	Monimiaceae	*Wilkiea huegeliana*
	Myrsinaceae	*Embelia australiana*
	Myrtaceae	*Angophora costata*
		Angophora floribunda
		Angophora inopina
		Backhousia myrtifolia
		Baeckea diosmifolia
		Callistemon linearis
		Callistemon salignus
		Callistemon shiressii
		Choricarpia leptopetala
		Corymbia gummifera
		Corymbia maculata
		Eucalyptus acmenoides
		Eucalyptus amplifolia subsp. *amplifolia*
		Eucalyptus capitellata
		Eucalyptus deanei
		Eucalyptus fergusonii* subsp. *dorsiventralis
		Eucalyptus fibrosa
		Eucalyptus globoidea
		Eucalyptus haemastoma
		Eucalyptus placita
		Eucalyptus racemosa
		Eucalyptus resinifera subsp. *resinifera*

Class	Family	Species
		Eucalyptus robusta
		Eucalyptus saligna
		Eucalyptus umbra
		Kunzea ambigua
		Kunzea capitata
		Leptospermum petersonii *
		Leptospermum polygalifolium subsp. *cismontanum*
		Leptospermum trinervium
		Melaleuca decora
		Melaleuca erubescens
		Melaleuca linariifolia
		Melaleuca nodosa
		Melaleuca sieberi
		Melaleuca styphelioides
		Melaleuca thymifolia
		Rhodamnia rubescens
		Syncarpia glomulifera subsp. *glomulifera*
	Oleaceae	*Notelaea longifolia* forma *longifolia*
	Oxalidaceae	*Oxalis perennans*
	Passifloraceae	*Passiflora edulis* *
	Pittosporaceae	*Billardiera scandens*
		Bursaria longisepala
		Bursaria spinosa
		Pittosporum multiflorum
		Pittosporum undulatum
	Polygalaceae	*Comesperma ericinum*
	Polygalaceae	*Comesperma sphaerocarpum*
	Primulaceae	*Anagallis arvensis* *
	Proteaceae	*Banksia oblongifolia*
		Banksia serrata
		Banksia spinulosa var. *collina*
		Grevillea sericea subsp. *sericea*
		Hakea bakeriana
		Hakea laevipes subsp. *laevipes*
		Hakea sericea
		Isopogon anemonifolius
		Lambertia formosa

Class	**Family**	**Species**
		Lomatia silaifolia
		Persoonia levis
		Persoonia linearis
		Petrophile pulchella
		Stenocarpus salignus
		Xylomelum pyriforme
	Ranunculaceae	*Ranunculus inundatus*
		Ranunculus plebeius
	Rosaceae	*Rubus moluccanus* var. *trilobus*
	Rubiaceae	*Morinda jasminoides*
		Opercularia diphylla
		Opercularia varia
	Rutaceae	*Boronia polygalifolia*
		Melicope micrococca
	Sapindaceae	*Diploglottis australis*
		Dodonaea triquetra
	Sterculiaceae	*Commersonia fraseri*
	Stylidiaceae	*Stylidium graminifolium*
	Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*
	Tremandraceae	Tetratheca juncea
	Verbenaceae	*Clerodendrum tomentosum*
		Lantana camara *
	Violaceae	*Hybanthus monopetalus*
		Viola betonicifolia
		Viola hederacea
	Vitaceae	*Cissus antarctica*
		Cissus hypoglauca
CLASS MAGNOLIOPSIDA (Flowering Plants) **Subclass Liliidae (Monocotyledons)**		
	Anthericaceae	*Arthropodium minus*
		Caesia parviflora var. *parviflora*
		Caesia parviflora var. *vittata*

Class	**Family**	**Species**
		Laxmannia gracilis
		Sowerbaea juncea
		Thysanotus tuberosus subsp. *tuberosus*
		Tricoryne elatior
		Tricoryne simplex
	Colchicaceae	*Burchardia umbellata*
	Cyperaceae	*Chorizandra cymbaria*
		Cyathochaeta diandra
		Gahnia clarkei
		Gahnia radula
		Lepidosperma concavum
		Lepidosperma elatius
		Lepidosperma laterale
		Ptilothrix deusta
		Schoenus apogon
	Dioscoreaceae	*Dioscorea transversa*
	Iridaceae	*Patersonia glabrata*
	Iridaceae	*Patersonia sericea*
	Juncaceae	*Juncus subsecundus*
	Lomandraceae	*Lomandra confertifolia* subsp. *pallida*
		Lomandra cylindrica
		Lomandra filiformis subsp. *coriacea*
		Lomandra filiformis subsp. *filiformis*
		Lomandra glauca
		Lomandra longifolia
		Lomandra multiflora subsp. *multiflora*
		Lomandra obliqua
	Luzuriagaceae	*Eustrephus latifolius*
	Orchidaceae	*Calochilus paludosus*
		Calochilus robertsonii
		Cryptostylis subulata
		Cymbidium suave
		Dipodium punctatum
		Diuris alba
		Diuris aurea
		Prasophyllum elatum
		Thelymitra ixioides var. *ixioides*
		Thelymitra pauciflora

Class	**Family**	**Species**
	Phormiaceae	*Dianella caerulea* var. *assera*
		Dianella caerulea var. *caerulea*
		Dianella revoluta var. *revoluta*
		Thelionema caespitosum
	Poaceae	*Andropogon virginicus* *
		Anisopogon avenaceus
		Aristida vagans
		Aristida warburgii
		Austrodanthonia setacea
		Axonopus fissifolius *
		Cynodon dactylon *
		Deyeuxia parviseta var. *parviseta*
		Dichelachne micrantha
		Digitaria diffusa
		Echinopogon caespitosus var. *caespitosus*
		Echinopogon ovatus
		Entolasia stricta
		Eragrostis brownii
		Eragrostis leptostachya
		Hemarthria uncinata var. *uncinata*
		Imperata cylindrica var. *major*
		Joycea pallida
		Lachnagrostis filiformis
		Microlaena stipoides var. *stipoides*
		Notodanthonia longifolia
		Oplismenus imbecillis
		Panicum simile
		Paspalidium distans
		Paspalum urvillei *
		Poa affinis
		Poa labillardierei var. *labillardierei*
		Themeda australis
	Restionaceae	*Empodisma minus*
		Lepyrodia scariosa
	Smilacaceae	*Smilax australis*
	Xanthorrhoeaceae	*Xanthorrhoea latifolia* subsp. *latifolia*
		Xanthorrhoea resinifera

Appendix 4 – Desktop review of potententially occurring fauna species.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Aves Speckled Warbler *Pyrrholaemus sagittatus* *TSC Act*	**Description & Distribution** The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100 ha survive. **Habitat and ecology** The Speckled Warbler lives in a wide range of eucalypt dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside. A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. The eggs are a glossy red-brown, giving rise to the unusual folk names 'Blood Tit' and 'Chocolatebird'. Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo. Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbills.	Low. This species was not observed during the current and previous assessments. This species rarely occurs in coastal regions. Grazing and prior disturbance has limited key habitat elements required for this species. **Further assessment is not required.**
Australasian Bittern *Botaurus poiciloptilus* *TSC Act*	**Description** The Australasian Bittern is a large, stocky bird, reaching up to 75 cm in length. It has a long, thick neck and a straight, brownish-yellow bill. Its upper surface is mottled brown and its undersurface is buff, with dark brown stripes, except for a pale throat. The eyes are yellow and there is a pale eyebrow. The feet and legs are pale green. **Distribution** Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. **Habitat and ecology** Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (Typha spp.) and spikerushes (Eleoacharis spp.). Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish,	Low. This species was not observed during the current and previous assessments. No suitable habitat will be affected on site. **Further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch.	
Black bittern *Ixobrychus flavicollis* *TSC Act*	**Description** The Black Bittern is a heron, dark grey to black in colour, with buff streaks on the throat and a characteristic yellow streak on the sides of the head and down the neck. The female is paler than the male, with a more yellow wash on the underparts. The species has a characteristic booming call that is mainly heard during the breeding season, at day or night. The colour alone readily distinguishes it from the other two much paler bittern species. **Distribution** The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. **Habitat and ecology** Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night. During the day, roosts in trees or on the ground amongst dense reeds. When disturbed, freezes in a characteristic bittern posture (stretched tall, bill pointing up, so that shape and streaked pattern blend with upright stems of reeds), or will fly up to a branch or flush for cover where it will freeze again. Generally solitary, but occurs in pairs during the breeding season, from December to March. Like other bitterns, but unlike most herons, nesting is solitary. Nests, built in spring are located on a branch overhanging water and consist of a bed of sticks and reeds on a base of larger sticks. Between three and five eggs are laid and both parents incubate and rear the young.	Low. This species was not observed during the current and previous assessments. No suitable habitat present on site. **Further assessment is not required.**
Square-tailed Kite	**Description & Distribution**	Low.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Lophoictinia isura *TSC Act*	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. **Habitat and ecology** Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Appears to occupy large hunting ranges of more than 100 km2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs. Coastal and sub-coastal open forest, woodland or lightly timbered habitats and inland habitats along watercourses and mallee that are rich in passerine birds.	This species was not observed during the current and previous assessments. Impacts associated with the current project are unlikely to affect this species – timbered water courses will not be affected to such an extent that the specie will be affected. **Further assessment not required.**
Glossy black cockatoo *Calyptorhynchus lathami* *TSC Act*	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia. Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur. In the Riverina area, inhabits open woodlands dominated by Belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. One or two eggs are laid between March and August.	Low. This species was not observed during the current and previous assessments. Unsuitable key habitat elements within the study area to support this species**;** therefore **further assessment is not required.**
Black-necked Stork *Ephippiorhynchus asiaticus* *TSC Act*	**Description & Distribution** The species is widespread across coastal northern and eastern Australia, becoming increasingly uncommon further south into NSW, and rarely south of Sydney. Some birds may move long distances and can be recorded well outside their normal range. **Habitat and ecology** Inhabits permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands; can also be found	Low. This species was not observed during the current and previous assessments. The study site is too far away from permanent water courses and swamps; therefore further assessment is not

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey including fish, frogs, eels, turtles, crabs and snakes. Breeds in late summer in the north, and early summer further south. A large nest, up to 2 m in diameter, is made in a live or dead tree, in or near a freshwater swamp. Two to four eggs are laid; incubation is by both parents.	required.
Brown treecreeper *Climacteris picumnus* *TSC Act*	**Description & Distribution** Found in the drier open forests and woodlands of eastern Australia. Stays in the same area all year round. **Habitat and ecology** It climbs up the trunks and branches of trees in search of food probing into cavities and under loose bark with its long downward curving bill searching for insects and their larvae. The most favoured insects are ants. Some feeding also takes place on the ground on fallen logs. Feeding normally takes place in pairs or small groups. The species breeds from June to January each year. The nest is a collection of grasses, feathers and other soft material, placed in a suitable tree hollow or similar site.	Low. This species was not observed during the current and previous assessments. Not typically associated with coastal areas such as that present in the current study areas. No further assessment is required.
Diamond Firetail Finch *Stagonopleura guttata* *TSC Act*	**Description & Distribution** The diamond firetail is a sedentary finch species which has a recorded habitat of open grassy woodland, mallee and forest, usually in the vicinity of watercourses, wooded urban fringes and smaller town outskirts. **Habitat and ecology** This species may opportunistically use woodland galleries. The diamond firetail requires regular visits to watering sites during feeding activities.	Low. The Key habitat elements present on site make it unlikely to occur therefore **further assessment is not required.**
Painted Honeyeater *Grantiella picta* *TSC Act*	**Description & Distribution** The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occur on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. **Habitat and ecology** Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema. Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	Low. Breeding locations are west of the dividing range therefore expected impacts will not affect habitat essential for this species to reproduce; **therefore further assessment is not required.**
Black-chinned Honeyeater *Melithreptus gularis gularis*	**Description & Distribution** Occupies mostly upper levels of drier open forests or woodlands dominated by box and	Low. No suitable habitat on site.. This

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
TSC Act	ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (E. *albens*), Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees. **Habitat and ecology** A gregarious species usually seen in pairs and small groups of up to 12 birds. Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares. Moves quickly from tree to tree, foraging rapidly along outer twigs, underside of branches and trunks, probing for insects. Nectar is taken from flowers, and honeydew is gleaned from foliage. Breeds solitarily or co-operatively, with up to five or six adults, from June to December. The nest is placed high in the crown of a tree, in the uppermost lateral branches, hidden by foliage. It is a compact, suspended, cup-shaped nest. Two or three eggs are laid and both parents and occasionally helpers feed the young .	species is not expected to occur in the site; **therefore further assessment is not required.**
Hooded Robin *Melandryas cucullate* *TSC Act*	The Hooded Robin is common in few places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. The south-eastern form is found from Brisbane to Adelaide throughout much of inland NSW, with the exception of the north-west. The species is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 m to 5 m above the ground. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey. Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season. May breed any time between July and November, often rearing several broods. The nest is defended by both sexes with displays of injury-feigning, tumbling across the ground. A clutch of two to three is laid and incubated for fourteen days by the female. Two females often cooperate in brooding.	Low. There is potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur; thus **further assessment is not required.**
Grey-crowned Babbler *Pomatostomus temporalis temporalis*	The Grey-crowned Babbler is found throughout large parts of northern Australia and in south-eastern Australia. In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Hay. It also	Low. This species was observed during the fauna survey. **Further assessment has been provided.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
TSC Act	occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. Live in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. A soft 'chuck' call is made by all birds as a way of keeping in contact with other group members. Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year round, and old nests are often dismantled to build new ones. Breed between July and February. Usually two to three eggs are laid and incubated by the female. During incubation, the adult male and several helpers in the group may feed the female as she sits on the nest. Young birds are fed by all other members of the group. Territories range from one to fifty hectares (usually around ten hectares) and are defended all year. Territorial disputes with neighbouring groups are frequent and may last up to several hours, with much calling, chasing and occasional fighting .	
Turquoise Parrot *Neophema pulchella* *TSC Act*	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from Aug to Dec. It lays four or five white, rounded eggs on a nest of decayed wood dust .	Low. The Key habitat elements are present but it is unlikely to occur within the study area; **further assessment has been provided as a precautionary measure**.
Powerful owl *Ninox strenua*	The powerful owl occupies an extensive home range of up to 1000 hectares, generally within 200 kilometres of the coast in southeastern Australia. Habitat preferences include mountain forests; gullies and forest margins; sparser hilly woodlands; coastal forests,	Moderate. This species has been recorded within the study area.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
TSC Act	woodlands, scrubs; exotic pine plantations; and large trees in private/public gardens. The species breeds between June and September, nesting in a hollow trunk or limb 8 metres to 20 metres or more high in a tree.	**Further assessment has been provided.**
Barking Owl *Ninox connivens* *TSC Act*	The barking owl is distributed sparsely throughout temperate and semi-arid areas of mainland Australia, however is most abundant in the tropical north (Kavanagh 2002a). Most records for this species occur west of the Great Dividing Range (Kavanagh 2004). Habitat for this species includes dry forests and woodlands (Kavanagh 2002a), often in association with hydrological features such as rivers and swamps (Taylor *et al.* 2002). Large hollows are required for breeding.	Low. There is potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur however **further assessment has been provided** as a precautionary measure.
Masked Owl *Tyto novaehollandiae* TSC Act	The masked owl occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002a). This species is generally recorded from open forest habitat with sparse mid-storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land (Kavanagh 2004). Masked owls nest (and roost) in large hollows of old trees and they also roost among dense foliage in variety of sub-canopy trees (Kavanagh 2004).	Low. There is potential for this species to use habitat within the study area – it was recorded north of the study area. The impact would not affect the likelihood of this species to occur however **further assessment has been provided** as a precautionary measure.
Sooty Owl *Tyto tenebricosa* *TSC Act*	**Description** A medium-sized owl to 45 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc. Dark sooty-grey in colour, with large eyes in a grey face, fine white spotting above and below, and a pale belly. The plumage of the fledglings is similar to the adult, but has tufts of down on the head and underparts. **Distribution** Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. There is no seasonal variation in its distribution. **Habitat and ecology** Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum	Low. There is potential for this species to use habitat within the study area – it was recorded north of the study area. The impact would not affect the likelihood of this species to occur however **further assessment has been provided** as a precautionary measure.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	(*Pseudocheirus peregrines*) or Sugar Glider (*Petaurus breviceps*). Nests in very large tree-hollows.	
Regent Honeyeater *Xanthomyza phrygia* *TSC Act* *EPBC Act* Migratory Terrestrial Species *EPBC Act*	**Habitat and ecology** Temperate eucalypt woodlands and open forests including forest edges. Associations of red ironbark, white box, yellow box, yellow gum and red box appear essential. Swamp mahogany and river oak may be used locally.	Low. Species preferred by this species will be largely unaffected by the proposal. **No further assessment is required.**
Australian Painted Snipe *Rostratula benghalensis* *TSC Act* *EPBC Act* Migratory Wetland Species *EPBC Act* Listed Marine Species *EPBC Act* (aka *Rostratula australis)*	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. The nest consists of a scrape in the ground, lined with grasses and leaves. Breeding is often in response to local conditions; generally occurs from September to December. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter .	Low. No suitable habitat present on site. This species is not expected to occur in the site; therefore further assessment is not required.
Swift Parrot *Lathamus discolour* *TSC Act* *EPBC Act* Listed Marine Species *EPBC Act*	Inhabits forests, woodlands, plantations, banksias and also street trees, parks and gardens. Breeds only in Tasmania in tree hollows six metres to twenty metres high. Most individuals migrate in March through to June to south eastern Australia and west to the Mt Lofty Ranges in South Australia. The species returns to Tasmania in August to October.	Low. There is potential for this species to use habitat in the study area. Impacts are unlikely to require removal of hollow bearing trees & wouldn't affect the likelihood of this species to occur thus further assessment isn't required.
Black-tailed Godwit *Limosa limosa* *TSC 1995*	**Description** A large sandpiper reaching 44 cm long, with a wingspan of 63 - 75 cm. It has a distinctive long, straight bill that is pink with a black tip. The wing has a white wing-bar across the dark flight feathers, and white underwing coverts. There is a sharp demarcation between the white rump and the black tail. Legs are greenish-black, long and trailing. The non-breeding plumage, observed in Australia, is greyish-brown above and white below, and a grey breast. A broad white stripe is apparent on the underwing. The iris is brown. Most readily mistaken for the similar and more common Bar-tailed Godwits *Limosa lapponica*. Distinguishing	Low. Impacts to suitable vegetation and habitat for this species will not occur as a result of this project (only one farm dam will be impacted). This species will not be impacted therefore **no further assessment is required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	features of the Black-tailed Godwit include the black tail in flight; longer, more pink, non-upturned bill; and non-streaked breast. Grey to rufous-chestnut coloured breeding plumage may be visible in some Australian birds just after arrival in spring, or prior to departure in autumn, and in some over-wintering birds. **Distribution** The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia (Palaearctic) and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, the it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. The species has been recorded within the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in the far north-western corner of the state. **Habitat and ecology** Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Individuals have been recorded in wet fields and sewerage treatment works. Forages for insects, crustaceans, molluscs, worms, larvae, spiders, fish eggs, frog eggs and tadpoles in soft mud or shallow water. Roosts and loafs on low banks of mud, sand and shell bars. Frequently recorded in mixed flocks with Bar-tailed Godwits.	
Bush stone-curlew *Burhinus grallarius* *TSC 1995*	**Description** The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. **Habitat and ecology** Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare	Low. Remnant size and presence of foxes on the property make it almost impossible for this species to occur in the study area therefore **no further assessment is required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	patch. Two eggs are laid in spring and early summer . Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes.	
Japanese or Latham's Snipe *Gallinago hardwickii* Migratory Wetland Species *EPBC Act* Listed Marine Species *EPBC Act*	Wetland, open wooded marshes and swamps.	Low. No suitable habitat present on site. This species is not expected to occur in the site; therefore **further assessment is not required.**
Fork-tailed Swift *Apus pacificus* Listed Marine Species *EPBC Act*	**Habitat and ecology** Aerial, arthropod-feeder, diurnal, gregarious, migratory, nocturnal, volant Randomly dispersed, seasonal breeder, non-breeding summer migrant, feeds in loose aerial flocks, circling in wide sweeps on fast-beating wings and swallow-like glides, sleeps normally on wing at non-breeding quarters, breeds from southern Siberia to Kamchatka south to Mongolia, central China, Sakhalin, Japan and Ryu Kyu Ils, enters Australia in broad front across north-west and north coasts in Oct. and leaves in Apr., summer visitor only to Torres Strait islands, rarely over-winters on Cape York Peninsula (DEWHA webpage 2005)	Low. This species is not expected to occur in the site; **therefore further assessment is not required.**
Cattle Egret *Ardea ibis* Listed Marine Species *EPBC Act*	**Habitat and ecology** Utilises lakes, swamps and dams. Forages on frogs, fish and crustaceans. Nests in colonies within vegetation associated with waterways (Simpson & Day 1999).	Low. This species will not be affected by the proposal; therefore **further assessment is not required**.
White Egret *Ardea alba* Listed Marine Species *EPBC Act*	**Habitat and ecology** Inhabits floodwaters, rivers, shallows of wetlands, intertidal mud-flats. Runs about actively when feeding chasing prey (Simpson & Day 1999).	Low. This species will not be affected by the proposal; therefore **further assessment is not required**.
White-bellied Sea-Eagle *Haliaeetus leucogaster* Migratory Wetland Species *EPBC Act* Listed Marine Species *EPBC Act*	**Habitat and ecology** Large rivers, fresh and saline lakes, reservoirs, costal areas and seas. They are opportunistic carnivores, feeding on birds, mammals, fish, reptiles and carrion (Green 1959, Quinn 1969, Smith 1985). Birds often have favoured roosts on prominent trees and soar in large circles with wings upswept during flight. While hunting they may hover low and dive close to the water to catch prey. Pairs may hunt together and they are known to harass other bird species	Low. This species although recorded overflying the study area will not be affected by the proposal; therefore **further assessment is not required**.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	(such as terns) and either steal prey or have them regurgitate it. White-bellied Sea-Eagles have been recorded in the northern hemisphere from India to China and south through Asia, New Guinea and Australia. They occur along the coastline of Australia and also range inland over large rivers and wetlands (Victorian Dept of Environment & Sustainability web page 2005).	
White-throated Needletail *Hirundapus caudacutus* Migratory Wetland Species *EPBC Act* Listed Marine Species *Environment Protection and Biodiversity Conservation Act* *1999*	**Description** This large swift (20 - 22 cm) is often mistaken in flight for a small bird of prey, they occur in large numbers over eastern and northern Australia arriving in Australia from their breeding grounds in the northern hemisphere in about October each year and leave somewhere between May and August. It has now been observed that birds will roost in trees, and radio-tracking has confirmed that this is a regular activity. **Habitat and ecology** The species feeds on flying insects, such as termites, ants beetles and flies. They catch the insects in flight in their wide gaping beaks. Birds usually feed in rising thermal currents associated with storm fronts and bushfires and are commonly seen moving with wind fronts. While feeding, the White-throated Needletail protects its eyes with a special membrane and a small ridge of feathers. The birds also drink in flight. White-throated Needletails are non-breeding migrants in Australia. Breeding takes place in northern Asia from May to August. The eggs are laid on a platform of sticks placed in a hollow or similar crevice high in a tall conifer. Little else is known of the breeding behaviour of this species except that courtship displays consist of a series of vertical flights and that copulation is believed to take place in flight (Australian Museum website 2005).	Low. This species is not expected to occur in the site; therefore **further assessment is not required.**
Rainbow Bee-eater *Merops ornatus* Listed Marine Species *EPBC Act*	**Habitat and ecology** Woodland, often near water bodies. Breeding migrant to Australia. Roosts at night in shrubs. Feed on insects caught on the wing. Breeds in burrows dug into sandy banks or bare, flat ground.	Low. There is potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Black-faced Monarch *Monarch melanopsis* Migratory Terrestrial Species *EPBC Act*	**Habitat and ecology** A conspicuous and distinctive flycatcher the Black-faced Monarch is found in rainforests, eucalypt forests and coastal scrubs. An easy bird to observe as they are slow moving and sedate. Similar in appearance to the Black-winged Monarch Flycatcher and the Spectacled Monarch Flycatcher.	Low. There is potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Listed Marine Species *EPBC Act*		occur therefore **further assessment is not required.**
Satin Flycatcher *Myiagra cyanoleuca* Migratory Terrestrial Species *EPBC Act* Listed Marine Species *EPBC Act*	**Habitat and ecology** Inhabits tall and medium open forests, often at height (Simpson & Day 1999).	Low. There is potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Rufous Fantail *Rhipidura rufifrons* Migratory Terrestrial Species *EPBC Act* Listed Marine Species	**Habitat and ecology** Inhabits wet forests, less often open forests. Very active; fans and waves its long tail in all directions. Often observed in deep shade near the ground (Simpson & Day 1999).	Low. There is potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Greater Sand Plover *Charadrius leschenaultii* *TSC 1995*	**Description** The non-breeding Greater Sand Plover (i.e. as expected in Australia) has a grey-brown crown, nape, back and breast patches. The lores, bill and upperwing are dark, with dusky ear-coverts. There is prominent white plumage on the forehead, chin, throat and underparts, including the underwing. The legs and feet are greenish-grey; this helps distinguish it from the very similar Lesser Sand Plover, with dark grey legs. Birds have a hunched, horizontal stance when relaxed, and a more upright extended stance when alert. When breeding in the Northern Hemisphere, the plumage on the breast, crown and nape changes to a dull brick-red and the ear coverts become black. Elements of this plumage may be visible in some Australian birds just after arrival in spring or prior to departure in autumn, and in some overwintering birds. **Distribution** The Greater Sand Plover breeds in central Asia from Armenia to Mongolia, moving further south for winter. In Australia the species is commonly recorded in parties of 10-20 on the west coast, with the far northwest being the stronghold of the population. The species is	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	apparently rare on the east coast, being found usually singly. In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries. **Habitat and ecology** Almost entirely restricted to coastal areas in NSW, occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; begin foraging activity on wet ground at low tide, usually away from the edge of the water; individuals may forage and roost with other waders. Diet includes insects, crustaceans, polychaete worms and molluscs. Prey is detected visually by running a short distance, stopping to look, then running to collect the prey.	
Wompoo Fruit Dove *Ptilinopus magnificus*	**Description** A large and dramatically beautiful rainforest pigeon, almost twice the size of other coloured fruit-doves. It is up to 56 cm long, with a pale grey head shading into rich green back and wings. There is a broken yellow band across each wing. The breast and belly are plum-purple and the underparts are yellow. **Distribution** Occurs along the coast and coastal ranges from the Hunter River in NSW to Cape York Peninsula. It is rare south of Coffs Harbour. Three subspecies are recognised, with the most southerly in NSW and south-eastern Queensland. It used to occur in the Illawarra, though there are no recent records. **Habitat and ecology** Occurs in, or near rainforest, low elevation moist eucalypt forest and brush box forests. Feeds on a diverse range of tree and vine fruits and is locally nomadic - following ripening fruit; some of its feed trees rely on species such as the this to distribute their seeds. Feeds alone, or in loose flocks at any height in the canopy. Despite its plumage, can be remarkably cryptic as it feeds, with the call and falling fruit being an indication of its presence. The nest is a typical pigeon nest - a flimsy platform of sticks on a thin branch or a palm frond, often over water, usually 3 - 10 m above the ground. Breeds in spring and early summer; a single white egg is laid. Most often seen in mature forests, but also found in remnant and regenerating rainforest. Aspects of its behaviour such as social behaviour and structure, movements and breeding	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	biology have not been well-studied.	
Terek Sandpiper *Xenus cinereus*	**Description** The Terek Sandpiper is a medium-sized wader. Individuals are greyish-brown above and white below, with some white on the outer tail feathers and a noticeable white bar on the tips of the secondaries. The species may be distinguished from other waders by its long, slender, upturned black bill, which is dull orange at the base, and its orange legs and feet. **Distribution** A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east. The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary. The latter has been identified as nationally and internationally important for the species. **Habitat and ecology** In Australia, has been recorded on coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools. Generally roosts communally amongst mangroves of dead trees, often with related wader species. Breaks up into smaller flocks or even solitary birds when feeding in open intertidal mudflats. The diet includes worms, crabs and other crustaceans, small shellfish and the adults and larvae of various flies, beetles and water-bugs. Feeding is undertaken by moving rapidly and erratically over soft, wet mud, pecking or probing at the surface.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Pied Oystercatcher *Haematopus longirostris*	**Description** The Pied Oystercatcher is an unmistakable, large, black and white wader, reaching 50 cm in length. The sexes are similar, yet may be separable when together with the female having a slightly longer, more slender bill. When not in flight, the Pied Oystercatcher appears entirely black above, with white underparts. The back, head and breast are black, and the belly, rump and tail are white. The tail is tipped black. The wings are black with a narrow white bar on the upperwing and white underwing coverts. The eye-ring, iris and bill of the Pied Oystercatcher are brilliant scarlet and its legs are stout and coral pink. The most often heard call is a loud, sharp, high-pitched 'kurvee-kurvee-kurvee', usually given in alarm, which increases in pitch and rapidity when a nest site is approached.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	Distribution The species is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast. **Habitat and ecology** Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. The chisel-like bill is used to pry open or break into shells of oysters and other shellfish. Nests mostly on coastal or estuarine beaches although occasionally they use saltmarsh or grassy areas. Nests are shallow scrapes in sand above the high tide mark, often amongst seaweed, shells and small stones. Two to three eggs are laid between August and January. The female is the primary incubator and the young leave the nest within several days.	
Blue-billed Duck *Oxyura australis* *TSC 1995*	**Description** The Blue-billed Duck is one of only two Australian species of stiff-tailed ducks - diving ducks with spine-like tail-feathers. It is a small and compact duck, with a length of 40 cm. The male's head and neck are glossy black, and the back and wings are a rich, chestnut to dark-brown. During the summer breeding season the male's bill turns bright blue. The female is brownish-black above, with narrow bands of light brown and mottled light brown and black below. The female's bill is dark grey-green. In the non-breeding season the male resembles a dark female. The tail is usually held flat on the water, although during courtship, or when alarmed, it is held fully erect. **Distribution** The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas. **Habitat and ecology** The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed. The most common clutch size is five or six. Males take no part in nest-building or incubation. Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes.	
Great Knot *Calidris tenuirostris*	**Description** A medium-sized bulky wader with a straight, dark-brown bill and yellowish-brown legs. It has a striped crown with an indistinct white eyebrow. Its upperparts are grey, with dark feather tips; its underparts are white. The rump is pure white, the tail is tipped with grey. Breeding plumage consists of darker upperparts with black and chestnut markings. **Distribution** In NSW, the species has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. **Habitat and ecology** Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. Migrates to Australia from late August to early September, although juveniles may not arrive until October-November. Most birds return north in March and April, however some individuals may stay over winter in Australia Forages for food by methodically thrusting its bill deep into the mud to search for invertebrates, such as bivalve molluscs, gastropods, polychaete worms and crustaceans	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Broad-billed Sandpiper *Limicola falcinellus*	**Description** The Broad-billed Sandpiper is an uncommon, small, stint-like sandpiper reaching 18 cm in length. It is superficially like the more common Curlew Sandpiper, but smaller in size and with a smaller but distinctive, heavy bill that is longer than the head. The bill is initially	Low. There is limited potential for this species to use habitat within the study area. The impact would not

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	straight and tapering, then downturned and flattened, remaining quite broad at the tip. This is its most important distinguishing feature. In non-breeding plumage, the forehead, crown, hind-neck and sides of neck are pale grey-brown, streaked black. The fore-neck and breast are pale grey-brown, with a fine dark streaking, and the underparts are mostly white. The head feathers have a snipe-like pattern, with two light stripes above the eyes and a dark median stripe. **Distribution** The eastern form of this species breeds in northern Siberia before migrating southwards in winter to Australia. In Australia, Broad-billed Sandpipers overwinter on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast. In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary. There are few records for inland NSW. **Habitat and ecology** Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons. Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches. The species is an active forager, typically feeding by rapidly and repeatedly jabbing its bill into soft wet mud. Feeding also occurs while wading, often in water so deep that they have to submerge their heads and necks in order to probe the underlying mud. Their diet includes insects, crustaceans, molluscs, worms and seeds. Individuals are strongly migratory and only mildly gregarious when not breeding. Large flocks are seldom recorded and birds are often either encountered alone or feeding with other waders such as Red-necked Stints or Curlew Sandpipers	affect the likelihood of this species to occur therefore **further assessment is not required.**
Comb-crested Jacana *Irediparra gallinacae*	**Description** The Comb-crested Jacana is small (up to 25 cm long), with huge toes - its feet are virtually as long as its entire body - to walk on floating vegetation. Brown above, it has a white face and throat and belly, separated by a broad dark breast-band, with a big red forehead comb and red bill. It is a busy and unmistakable walker on lily pads and other floating vegetation. Its strident chittery call is also distinctive. **Distribution** It occurs throughout coastal Australia and well inland in the north from the Kimberley to Sydney. Vagrants occasionally appear further south, possibly in response to unfavourable	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	conditions further north in NSW. **Habitat and ecology** Inhabits permanent wetlands with a good surface cover of floating vegetation, especially water-lilies. Pairs and family groups forage across floating vegetation, walking with a characteristic bob and flick, or flying low with toes dangling behind. They feed primarily on insects and other invertebrates, as well as some seeds and other vegetation. Breeds in spring and summer in NSW, in a nest of floating vegetation. The male builds the nest, incubates the eggs and broods the young. Females defend up to four mated males and their territories (the floating vegetation around their nest) from other females. Young birds will dive and stay submerged with just their nostrils exposed for a very long time. Adults will also dive for safety on occasion.	
Cotton Pygmy-goose *Nettapus coromandelianus*	**Description** The Cotton Pygmy-goose is a small surface-feeding duck with a goose-like bill. The male has a white head, neck and underparts, dark glossy green upperparts and a narrow dark breast band. Females are duskier and have a dark stripe through the eye and a white eyebrow. **Distribution** Although once found from north Queensland to the Hunter River in NSW, the Cotton Pygmy-goose is now only a rare visitor to NSW. Uncommon in Queensland. **Habitat and ecology** Freshwater lakes, lagoons, swamps and dams, particularly those vegetated with waterlilies and other floating and submerged aquatic vegetation. The Cotton Pygmy-goose uses standing dead trees with hollows close to water for roosting and breeding.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Magpie Goose *Anseranas semipalmata* *TSC 1995*	**Description** The Magpie Goose is a large, distinctive black and white water-bird (from 70 - 90 cm long) with a prominent knob on the head, and orange legs. It is black at each 'end' - head, neck and upper chest, plus rump and tail - with white body and wings in between. Immature birds have no head-knob and their white parts are mottled grey or brown. It is not a duck or goose, but is regarded as a primitive relative of them. **Distribution** The Magpie Goose is still relatively common in the Australian northern tropics, but had	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Vagrants can follow food sources to south-eastern NSW. **Habitat and ecology** Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges. Equally at home in aquatic or terrestrial habitats; often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes. Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off; breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level; most breeding now occurs in monsoonal areas; nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW. Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation	
Osprey *Pandion haliaetus*	**Description** The Osprey is a large, water-dependent bird of prey, distinctive in flight and when perched. Despite its wing-span of up to 1.7 m, it is noticeably smaller than the White-bellied Sea-eagle. In flight it can be recognised by its distinctly bowed wings that are dark brown above, and barred underneath, and with white underwing coverts. Perched, the upperparts are dark brown and the underparts are white. The female has a dark streaky collar. The head is mainly white with a blackish stripe through the eye. **Distribution** Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. There are a handful of records from inland areas. **Habitat and ecology** Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea. . Incubation of 2-3 eggs, usually by the female, is about 40 days. Female remains with young almost until they fly, usually after about nine weeks in the nest.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Sooty Oystercatcher *Haematopus fuliginous*	**Description** The Sooty Oystercatcher is an unmistakable, large wader, reaching 50 cm in length. Like the Pied Oystercatcher, the Sooty Oystercatcher has a bright orange-red bill, eye-ring and iris, and coral pink legs and feet. However, the Sooty Oystercatcher has entirely black plumage. Sexes are separable when together, with the female having a longer, more slender bill. The call is similar to the Pied Oystercatcher's, although sharper and more piercing. Gives a loud whistling call before taking flight, and a piercing call if an intruder approaches the nest. **Distribution** Sooty Oystercatchers are found around the entire Australian coast, including offshore islands, being most common in Bass Strait. Small numbers of the species are evenly distributed along the NSW coast. The availability of suitable nesting sites may limit populations. **Habitat and ecology** Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide for foods such as limpets and mussels. Breeds in spring and summer, almost exclusively on offshore islands, and occasionally on isolated promontories. The nest is a shallow scrape on the ground, or small mounds of pebbles, shells or seaweed when nesting among rocks.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Rose-crowned Fruit Dove *Ptilinopus regina* *TSC 1995*	**Description** Rose-crowned Fruit-doves are small, colourful rainforest pigeons to 24 cm in length. Males have a rose crown edged with yellow, and the head and breast are blue-grey, spotted white. The upper parts are grey-green, the tail-tip yellow and the abdomen are orange. Females are mostly grey-green. The call is a loud, explosive, repeated 'hookcoo' which becomes faster and on declining notes as a rapid 'coocoocoocoocoo'. **Location and habitat** **Distribution** Coast and ranges of eastern NSW and Queensland, from Newcastle to Cape York. Vagrants are occasionally found further south to Victoria. **Habitat and ecology** Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful. They are shy pigeons, not easy to see amongst the foliage, and are more often heard than	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	seen. They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruits. Some populations are migratory in response to food availability - numbers in north-east NSW increase during spring and summer then decline in April or May.	
Gang-Gang Cockatoo *Callocephalon fimbriatum* *TSC 1995*	**Description** Gang-gang cockatoos are one of the more distinctive and charismatic members of Australia's avifauna. These birds are primarily slate-grey, with the males easily identified by their scarlet head and wispy crest, while females have a grey head and crest and feathers edged with salmon pink on the underbelly. They range in length from 32 to 37 cm, with a wingspan of 62 to 76 cm. The call has been likened to a creaking gate or cork being pulled from a bottle. **Distribution** The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. **Habitat and ecology** In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. May also occur in sub-alpine Snow Gum *Eucalyptus pauciflora* woodland and occasionally in temperate rainforests. Move to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Favours old growth attributes for nesting and roosting.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Superb Fruit Dove *Ptilinopus superbus* *TSC 1995*	**Description** The Superb Fruit-dove is a small pigeon, approximately 24 cm in length. The male is brightly coloured, with golden-green upperparts, a brilliant orange-vermilion neck, and a rich purple crown. The tail is short and tipped with white. The throat and breast are grey with a lilac tinge, and a broad black band on the lower breast separates the grey breast from the creamy-white belly and green flanks. The female is light green on the back, has a small	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	purple spot on the crown, and no dark breast band. The call is a distinctive cooing, rising in pitch and volume to a loud and clear 'whoop, whoop'. Also gives a low 'oom' in a steady sequence. **Distribution** The Superb Fruit-dove occurs principally from north-eastern in Queensland to north-eastern NSW. It is much less common further south, where it is largely confined to pockets of suitable habitat as far south as Moruya. There are records of vagrants as far south as eastern Victoria and Tasmania. **Habitat and ecology** Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic. There are records of single birds flying into lighted windows and lighthouses, indicating that birds travel at night. At least some of the population, particularly young birds, moves south through Sydney, especially in autumn. Breeding takes place from September to January. The nest is a structure of fine interlocked forked twigs, giving a stronger structure than its flimsy appearance would suggest, and is usually 5-30 metres up in rainforest and rainforest edge tree and shrub species. The male incubates the single egg by day, the female incubates at night.	**assessment is not required.**
Lesser Sand Plover *Charadrius mongolus* *TSC 1995*	**Description** The non-breeding Lesser Sand Plover has a grey-brown crown, nape, back and breast patches. The forehead, lores, bill and upperwing are dark; ear coverts are dusky. There is prominent white plumage on the forehead, chin, throat and underparts, including the underwing. The Lesser Sand Plover is distinguished from the Greater Sand Plover by a smaller body with a more upright stance, more compact appearance and dark grey, rather than greenish legs. When breeding in the Northern Hemisphere, the plumage on the breast, crown and nape changes to a dull brick-red and the ear coverts become black. The brick-red breast is separated from the white throat by a narrow black line. Elements of this plumage may be visible in some Australian birds just after arrival in spring or prior to departure in autumn, and in some overwintering birds. **Distribution** The Lesser Sand Plover breeds in central and north eastern Asia, migrating further south for winter. In Australia the species is found around the entire coast but is most common in the Gulf of Carpentaria, and along the east coast of Queensland and northern NSW. Individuals	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	are rarely recorded south of the Shoalhaven estuary, and there are few inland records. **Habitat and ecology** Almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms. Highly gregarious, frequently seen in flocks exceeding 100 individuals; also often seen foraging and roosting with other wader species. Roosts during high tide on sandy beaches, spits and rocky shores; forage individually or in scattered flocks on wet ground at low tide, usually away from the water's edge. Diet includes insects, crustaceans, molluscs and marine worms. Prey is usually detected visually with the birds making short, quick runs, with abrupt stops to lunge at the ground or look for prey.	
Little Tern *Sterna albifrons* *TSC 1995*	**Description** The Little Tern is a small, slender, migratory or partly migratory seabird. At less than 25 cm long it is two- thirds to half the size of any other south-eastern tern. Pale grey upperparts contrast with the white chest, underbelly and the moderately long, deeply forked tail (80 - 110 mm). The Little Tern has a black cap and black outer wing-edges. During breeding the bill (26 - 32 mm) and legs change from black to yellow, and a black wedge appears from the bill to the eye. During non-breeding, the Little Tern's black cap shrinks to a black nape and its bill becomes black. **Distribution** Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria. It breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months. **Habitat and ecology** Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records). Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands. The nest is a scrape in the sand, which may be lined with shell grit, seaweed or small	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	pebbles. Both parents incubate up to three well-camouflaged eggs for up to 22 days, aggressively defending the nest against intruders until the young fledge at 17 - 19 days. Often seen feeding in flocks, foraging for small fish, crustaceans, insects, annelids and molluscs by plunging in the shallow water of channels and estuaries, and in the surf on beaches, or skipping over the water surface with a swallow-like flight.	
Mammalia Brush-tailed Rock-wallaby *Petrogale penicillata* *TSC Act* *EPBC Act*	**Description** The Brush-tailed Rock Wallaby has a characteristic, long and bushy, dark rufous-brown tail that is bushier towards its tip. It has long, thick, brown body-fur that tends to be rufous on the rump and grey on the shoulders. The fur on its chest and belly are paler. It also has a characteristic white cheek-stripe and a black stripe from its forehead to the back of its head. It is relatively small and muscular, which enables it to be fast and agile in its rocky habitat. The average weight of this species is about 8 kg for males and 6 kg for females. Location and habitat **Distribution** The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. **Habitat and ecology** Dominant males associate and breed with up to four females. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Live in family groups of 2 – 5 adults and usually one or two juvenile and sub-adult individuals. Breeding is likely to be continuous, at least in the southern populations, with no apparent	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	seasonal trends in births.	
Red-legged Pademelon *Thyogale stigmatica* *TSC 1995*	**Description** A small, compact wallaby with soft, thick fur, grey brown above, pale grey below and rufous brown on the face, forearms, flanks and hind legs. The tail is short and thick. **Distribution** Patchily distributed along coastal and subcoastal eastern Australia from Cape York to the Hunter Valley in NSW. Also found in New Guinea. **Habitat and ecology** Inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub. Wet gullies with dense, shrubby ground cover provide shelter from predators. In NSW, rarely found outside forested habitat. They disperse from dense shelter areas to feed from late afternoon to early morning, favouring native grasses and herbs on the edge of the forest. Also known to feed on fruits, young seedling leaves and stems, fungi and ferns.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Parma Wallaby *Macropus parma*	**Description** A small wallaby, with a head and body length up to 52 cm. Fur is a uniform greyish-brown on the back and shoulders with a dark stripe along the spine ending mid-back. It has a white stripe on the cheek and upper lip and a white belly. When hopping, remains close to the ground in an almost horizontal position with the forearms tucked tightly against the body, and the tail curved upwards in a shallow U-shape. **Distribution** Once occurred from north-eastern NSW to the Bega area in the southeast. Range is now confined to the coast and ranges of central and northern NSW. **Habitat and ecology** Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest. Typically feed at night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas. During the day they shelter in dense cover.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Spotted-tailed Quoll *Dasyurus maculatus* *TSC Act*	**Description** The Spotted-tailed Quoll is about the size of a domestic cat, from which it differs most obviously in its shorter legs and pointed face. The average weight of an adult male is about 3500 grams and an adult female about 2000 grams. It has rich-rust to dark-brown fur above,	Low. There is limited potential for this species to use habitat within the study area. The impact would not

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
EPBC Act	with irregular white spots on the back and tail, and a pale belly. The spotted tail distinguishes it from all other Australian mammals, including other quoll species. However, the spots may be indistinct on juvenile animals. **Distribution** The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. **Habitat and ecology** Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and may raid possum and glider dens and prey on roosting birds. Use 'latrine sites', often on flat rocks among boulder fields and rocky cliff-faces; these may be visited by a number of individuals; latrine sites can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects; also eats carrion and takes domestic fowl. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creeklines. Average litter size is five; both sexes mature at about one year of age.	affect the likelihood of this species to occur therefore **further assessment is not required.**
Eastern Chestnut Mouse *Pseudomys gracilicaudatus*	**Description** The Eastern Chestnut Mouse is a large, stocky mouse, up to twice the body length of a House Mouse, and three to four times the weight. It is chestnut-brown above and grey underneath. Its feet, which have long brown hairs on top and are pale beneath, distinguish it from the similar and coexisting Swamp Rat *Rattus lutreolus,* which has all-dark feet, and the Bush Rat *Rattus fuscipes*, with pink feet. Its sparsely hairy tail also differs from the naked tails of the two rats. **Distribution** The Eastern Chestnut Mouse is scattered along the east coast from Townsville to Brisbane Water National Park; in the south-east region it is found at Jervis Bay. Its presence in NSW has only relatively recently been recognised.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	Habitat and ecology In NSW the Eastern Chestnut Mouse 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. Feeds at night via runways through the grassy and sedge understorey, within an area of less than half a hectare. It has a broad diet of grass stems, invertebrates, fungi and seeds, with the relative significance of each component varying seasonally. Up to three litters are produced from spring to autumn; this strategy allows rapid build-up of numbers in years following fire.	
Common Planigale *Planigale maculata*	**Description** Common Planigales are tiny marsupials with a body length of about 8 cm and a tail as long again. They differ from the common house mouse in having a long, pointed snout and large rounded ears. The head has a flattened appearance. Their fur is grey-brown above, sometimes with tiny white spots, and paler below. **Distribution** Coastal north-eastern NSW, coastal east Queensland and Arnhem Land. The species reaches its southern distribution limit on the NSW lower north coast. **Habitat and ecology** Common Planigales inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water. They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks. They are fierce carnivorous hunters and agile climbers, preying on insects and small vertebrates, some nearly their own size. They breed from October to January. The female builds a nest lined with grass, eucalypt leaves or shredded bark.	Low. There is limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Large-footed Myotis *Myotis adversus*	**Large-footed Myotis** is also referred to as *Myotis macropus* or the Southern Myotis. It has disproportionately large feet; more than 8 mm long, with widely-spaced toes which are distinctly hairy and with long, curved claws. It has dark-grey to reddish brown fur above and is paler below. It weighs up to 15 grams and has a wingspan of about 28 cm. The species is found in the coastal band from the north-west of Australia, across the top-end and	Moderate. This species was recorded in the Tooheys Rd study area as a result of current and previous assessments. **Further**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December (Churchill 1998).	**assessment has been provided.**
The Yellow–bellied sheath Bat *Saccolaimus flaviventris*	The Yellow-bellied Sheathtail Bat occurs in rainforests, sclerophyll forests and woodlands. They roost alone or with up to ten others in large hollow trees, in buildings or abandoned nests of Sugar Gliders (Cronin, 1991; Richards, 1995). This species has been previously recorded in the study area.	Moderate. This species was recorded in the Tooheys Rd study area as a result of current and previous assessments. **Further assessment has been provided.**
Golden-tipped Bat *Kerivoula papuensis*	The Golden-tipped Bat has dark brown, curly fur with bright golden tips. The distinctively coloured fur extends along the wings, legs and tail. It has a short, pointed, over-hanging muzzle and pointy, funnel-shaped ears. Adults weigh about 6 grams and have a wingspan of about 25 cm. **Distribution** The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to Bega in southern NSW. **Habitat and ecology** Found in rainforest and adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests located in rainforest gullies on small first- and second-order streams. Will fly up to two km from roosts to forage in rainforest and sclerophyll forest on upper-slopes. Specialist feeder on small web-building spiders.	Low. More often associated with rainforest gullies which are not a feature of the current study areas. Further assessment is not required.
Eastern Freetail-bat *Mormopterus norfolkensis* *TSC Act*	**Description** The Eastern Freetail-bat has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (3 - 4 cm) bare tail protruding from the tail membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to 10 grams. **Distribution** The Eastern Freetail-bat is found along the east coast from south Queensland to southern	Moderate. Although this species has not been recorded as a result of current and previous assessments **Further assessment has been provided** as a precaution**.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	NSW. Habitat and ecology 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. Solitary and probably insectivorous.	
Large-eared Pied Bat *Chalinolobus dwyeri* *TSC Act* *EPBC Act*	**Description** A small to medium-sized bat with long, prominent ears and glossy black fur. The lower body has broad white fringes running under the wings and tail-membrane, meeting in a V-shape in the pubic area. This species is one of the wattled bats, with small lobes of skin between the ears and corner of the mouth. **Distribution** Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. **Habitat and ecology** Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Hirundo ariel), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring.	Low. Cave dwelling species – no habitat on site**. Further assessment is not required.**
Eastern False Pipistrelle *Falsistrellus tasmaniensis* *TSC Act* *TSC Act*	**Description** The Eastern False Pipistrelle is relatively large with a head-body length of about 65 mm. It weighs up to 28 grams. It is dark to reddish-brown above and paler grey on its underside. It has long slender ears set well back on the head and some sparse hair on the nose. **Distribution** The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from	Moderate. This species was recorded in the Tooheys Rd study area as a result of the current assessment. **Further assessment has been provided.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	southern Queensland to Victoria and Tasmania. **Habitat and ecology** Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. Hibernates in winter. Females are pregnant in late spring to early summer.	
Little Bentwing-bat *Miniopterus australis* *TSC Act*	**Description** Little Bentwing-bats are small chocolate brown insectivorous bats with a body length of about 45 mm. The fur is long and thick, especially over the crown and around the neck. The tip of the wing is formed by a particularly long joint of the third finger. **Distribution** Coastal north-eastern NSW and eastern Queensland. **Habitat and ecology** Moist eucalypt forest, rainforest or dense coastal banksia scrub. Little Bentwing-bats roost in caves, tunnels and sometimes tree hollows during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (M. schreibersii) and appears to depend on the large colony to provide the high temperatures needed to rear its young.	Moderate. This species was recorded in the Tooheys Rd study area as a result of current and previous assessments. **Further assessment has been provided.** .
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis* *TSC Act*	**Description** The Eastern Bent-wing Bat has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. It has a short snout and a high 'domed' head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the "bent wing" appearance. It weighs up to 20 grams, has a head and body length of about 6 cm and a wingspan of 30 - 35 cm. **Distribution** Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. **Habitat and ecology** Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels,	Low. Although not recorded as a result of previous and current assessments **further assessment has been provided** as a precautionary measure.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	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. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to 150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops.	
Greater Broad-nosed Bat - *Scoteanax rueppellii* *TSC Act*	**Description** The Greater Broad-nosed Bat is a large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Great Pipistrelle *Pipistrellus tasmaniensis*, it differs by having only two (not four) upper incisors. **Distribution** The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m. **Habitat and ecology** Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.	Moderate. This species has been recorded in the Hue Hue Rd study area. The impact would not affect the likelihood of this species to occur however, **further assessment has been provided** as a precaution.
Eastern Cave Bat *Vespadelus troughtoni*	**Description** A small chestnut-brown bat with rufous tones on the head, and darker wings. It has smallish, conical ears and a short, up-tipped nose. The species is very difficult to separate	Low. The impact would not affect the likelihood of this species to occur

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
TSC Act	from several other closely related species that occur in similar areas. The most reliable physical distinguishing feature is the shape of the male's penis. Location and habitat **Distribution** The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. **Habitat and ecology** Very little is known about the biology of this uncommon species. A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. Occasionally found along cliff-lines in wet eucalypt forest and rainforest. Little is understood of its feeding or breeding requirements or behaviour.	therefore further assessment is not required.
Grey-headed Flying-fox *Pteropus poliocephalus* *TSC Act* *EPBC Act*	**Description** The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23 - 29 cm. It has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck. The wing membranes are black and the wingspan can be up to 1 m. It can be distinguished from other flying-foxes by the leg fur, which extends to the ankle. **Distribution** Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. **Habitat and ecology** Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. Site fidelity to camps is high with some caps being used for over a century. Travel up to 50 km to forage.	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops and can inflict severe crop damage.	
Eastern Pygmy-possum *Cercartetus nanus* *Threatened Species Conservation Act 1995*	Eastern Pygmy-possums are tiny (15 to 43 grams) active climbers, with almost bare, prehensile (capable of curling and gripping) tails, and big, forward-pointing ears. They are light-brown above and white below. Adults have a head and body length between 70 - 110 mm and a tail length between 75 - 105 mm. **Distribution** The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extents from the coast inland as far as the Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes. **Habitat and ecology** Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of vegetation, (eg. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares. Young can be born whenever food sources are available; however most births occur between late spring and early autumn. Agile climbers, but can be caught on the ground in traps, pitfalls or postholes; generally nocturnal. Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.	Low. Targeted searches for this species failed to detect it. The high abundance of exotic predators on site makes it very unlikely to occur therefore **no further assessment is required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Squirrel glider *Petaurus norfolcensis* *TSC Act*	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. 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. Prefers mixed species stands with a shrub or Acacia midstorey. Live in family groups of a single adult male one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein .	High. The impact would affect a population recorded at Wallarah Creek (if still present) however would not affect any potential populations at the other study areas. Further assessment is has been provided.
Yellow-bellied Glider - *Petaurus australis* *TSC Act*	**Description** The Yellow-bellied Glider is a large, active, sociable and vocal glider. Adults weigh 450 - 700 grams, have a head and body length of about 30 cm and a large bushy tail that is about 45 cm long. It has grey to brown fur above with a cream to yellow belly, which is paler in young animals. The dark stripe down the back is characteristic of the group. It has a large gliding membrane that extends from the wrist to the ankle. It has a loud, distinctive call, beginning with a high-pitched shriek and subsiding into a throaty rattle. **Distribution** The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. **Habitat and ecology** Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Live in small family groups of two - six individuals and are nocturnal. Den, often in family groups, in hollows of large trees. Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.	Low. Potential sighting recorded in the potential conservation area. **Further assessment has been provided** as a precautionary measure.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Brush-tailed Phascogale- *Phascogale tapoatafa* *TSC Act*	**Description** The Brush-tailed Phascogale is tree-dwelling marsupial carnivore. It has a characteristic, black, bushy 'bottlebrush' tail, with hairs up to 4 cm long. Its fur is grey above and pale cream below and it has conspicuous black eyes and large naked ears. Adults have a head and body length of about 20 cm, a tail length of about 20 cm and weigh 110 - 235 grams. **Distribution** The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is more frequently found in forest on the Great Dividing Range in the north-east and south-east of the State. There are also a few records from central NSW. **Habitat and ecology** Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater.. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 60 ha, while males have overlapping territories of up to 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span. Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter.	Low. Key habitat elements are present in the potential conservation area and to a lesser degree in the DLALC land . **Further assessment has been provided** as a precautionary measure.
Koala *Phascolarctos cinerus* *TSC Act*	Inhabits both wet and dry forests on high nutrient soils containing preferred feed trees. Habitat consists of eucalypt forest and woodlands containing particular species including red gum, grey gum, manna gum, tallowwood, and swamp mahogany.	Low. Unlikely or occur. **Further assessment is not required.**
Long-nosed Potoroo *Potorous tridactylus* *Tridactylus* *EPBC* *TSC*	Occupies coastal heath or wet sclerophyll forest from southeast Queensland to Tasmania. Prefer areas with sandy soils and higher rainfalls. Feed on seeds, bulbs, roots, insects and their larvae however their main food is underground fungi.	Low. The sites do not provide the preferred habitats of this species. **Further assessment is not required**.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Amphibia Giant Barred Frog *Mixophyes iteratus* *TSC Act* *EPBC Act*	**Description** Giant Barred Frogs are large frogs, up to 115 mm in length. They are olive to dark brown above with paler or darker blotches, and cream to pale yellow below. The skin is finely granular. The pupil of the eye is vertical and the iris is pale golden in the upper half and brown in the lower half. The call is a deep 'ork' breaking into a series of 'orks' and grunts. The Giant Barred Frog can be most easily distinguished from other barred frog species by the black thighs with smaller yellow spots, distinct barring on the limbs, dark blotches on the sides, absence of a creamy stripe on the upper lip and the distinctive eye colour. **Distribution** Coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. North-eastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold. **Habitat and ecology** Giant Barred Frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. Tadpoles grow to a length of 80 mm and take up to 14 months before changing into frogs. When not breeding the frogs disperse hundreds of metres away from streams. They feed primarily on large insects and spiders.	Low. Unlikely to occur however if it were in the study area the impact would not affect the likelihood of this species to occur **therefore further assessment is not required.**
Red-crowned Toadlet *Pseudophryne australis* *TSC Act*	The red-crowned toadlet has a restricted distribution, known from a relatively small area of mid-eastern NSW. It is known from isolated portions of the Sydney Basin, from Pokolbin State Forest, in the north to the Nowra district in the south, and Mt Victoria in the west. Known only from Triassic Sandstones of the Sydney Basin, red-crowned toadlets are found in steep escarpment areas and plateaus as well as low undulating ranges with benched outcroppings.	Low. Unlikely to occur however if it were in the study area the impact would not affect the likelihood of this species to occur **therefore further assessment is not required.**
Giant Burrowing Frog *Heleioporus australiacus* *EPBC* *TSC Act*	A large frog to 90 mm restricted to Hawkesbury Sandstone (Robinson 1993). The range of this species extends from South East NSW to Victoria (NPWS 2001a). Prefers woodland and heath in sandstone ridgetop habitat and broader upland valleys. In particular it is found in small headwater creek lines and slow flowing/intermittent creek lines (NPWS 2001a). This species has a generalist diet, primarily feeding on invertebrates (NPWS 2001a).	Low. Unlikely to occur however if it were in the study area the impact would not affect the likelihood of this species to occur **therefore**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
		further assessment is not required.
Green Thighed Frog *Litoria brevipalmata* *TSC Act*	**Description** Green-thighed Frogs are named for the bright green or blue-green colour on the groin and back of the thighs. They are small frogs (to 40 mm in length), rich brown to chocolate brown on the back, sometimes with smaller black flecks. A broad black stripe runs from the snout to the flank, ending as a series of blotches. The call is a continuous series of 'quack' or 'wok' sounds. **Distribution** Isolated localities along the coast and ranges from the NSW central coast to south-east Queensland. **Habitat and ecology** 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. 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.	Low. Recorded in the Buttonderry study area. **Further assessment has been provided.**
Green and Golden Bell Frog *Litoria aurea* *TSC Act*	**Description** A relatively large, stout frog, ranging in size from approximately 45 mm to approximately 100 mm snout to vent length. The colour varies. Usually a vivid pea-green, splotched with an almost metallic brassy brown or gold. The backs of some individuals may be almost entirely green; in others golden-brown markings may dominate. A creamish white stripe extends from behind the eye almost to the groin. **Distribution** Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. **Habitat and ecology** Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha*	Low. Unlikely to occur however if it were in the study area the impact would not affect the likelihood of this species to occur **therefore further assessment is not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. Preyed upon by various wading birds and snakes.	
Giant Burrowing Frog *Heleioporus australiacus* *TSC Act*	**Description** The Giant Burrowing Frog is a large, squat, slow-moving frog that grows to about 10 cm long. It has prominent, large eyes and has dark chocolate-brown upperparts with white or yellow spots on the side. Adult males have enlarged forearms, with a large conical black spine and several small spines on their first finger. Females have reduced arm-musculature compared to males. Tadpoles can grow to 65 mm, are dark brown in colour and are found in small streams. It has a soft owl-like call "oo oo oo" and may call and breed from August to March. **Distribution** The Giant Burrowing Frog occurs from the NSW Central Coast to eastern Victoria, but is most common on the Sydney sandstone. It has been found from the coast to the Great Dividing Range. **Habitat and ecology** Found in heath, woodland and open forest with sandy soils. Generally lives in the heath or forest and will travel several hundred metres to creeks to breed. Burrows into deep litter or loose soil, emerging to feed or breed after rain. Diet includes ground-dwelling invertebrates such as ants, beetles and spiders. Breeds from August to March and the eggs are laid in a white foam-mass under vegetation in creeks or in yabby holes.	Low. Unlikely to occur however if it were in the study area the impact would not affect the likelihood of this species to occur **therefore further assessment is not required.**
Wallum Froglet *Crinia tinnula*	**Description** Wallum Froglets are small frogs, usually no more than 15 mm long. They are extremely	Moderate. Recorded the Tooheys Rd study

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
TSC Act	variable in colour and pattern, from light grey or brown to dark grey above and cream to dark grey below. A distinctive feature of the species is a fine white line on the underside from the tip of the snout to the base of the abdomen. The call is a short high-pitched ringing 'tching..tching..', heard throughout the year, particularly following rain. **Distribution** Wallum Froglets are found only in acid paperbark swamps and sedge swamps of the coastal 'wallum' country. The species is a late winter breeder. Males call in choruses from within sedge tussocks or at the water edge. **Habitat and ecology** Wallum Froglets are found only in acid paperbark swamps and sedge swamps of the coastal 'wallum' country. The species is a late winter breeder. Males call in choruses from within sedge tussocks or at the water edge.	area. **Further assessment has been provided.**
Stuttering Frog *Mixophyes balbus* *EPBC*	A large stout frog that occurs in rainforest in the mountains of NSW, south-eastern Queensland and Victoria.	Low. Due to a lack of rainforest attributes, no habitat is present for this species**. Additional assessment is not required.**
Littlejohn's Tree Frog *Litoria littlejohni* *TSC Act* *EPBC Act*	**Description** Littlejohn's Tree Frog is pale brown, with dark speckles and a broad, dark band down its back. The belly is white or cream, and it has large orange patches on the groin, armpit and back of the thighs. It also has a brown bar from the tip of the snout through the nostrils to the top of the arm. This species does not have the white patch that extends from under the eye to the back of the jaw that is present on the very similar-looking Jervis Bay Tree Frog. The call is a "low reedy whistle". **Distribution** Littlejohn's Tree Frog has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90 km north of Sydney) south to Buchan in Victoria. **Habitat and ecology** It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. It hunts either in shrubs or on the ground. Breeding is triggered by heavy rain and can occur from late winter to autumn, but is most likely to occur in spring when conditions are favourable.	Low. No suitable habitat on site. No further assessment is required.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	Males call from low vegetation close to slow flowing pools. Eggs are laid in loose gelatinous masses attached to small submerged twigs. Eggs and tadpoles are mostly found in slow flowing pools that receive extended exposure to sunlight, but will also use temporary isolated pools.	
Reptilia Broad-headed Snake - *Hoplocephalus bungaroides* *TSC Act* *EPBC Act*	**Description** The Broad-headed Snake is generally black above with yellow spots forming narrow, irregular cross-bands. Other yellow scales may link these cross-bands laterally to form a straight or zigzagged stripe along the body. These cross-bands help distinguish it from the similar-looking but harmless juvenile Diamond Python. Its head is flattened on top and distinct from the body. The belly is grey or greyish-black. The average length is about 60 cm, with a maximum of around 150 cm. **Distribution** The Broad-headed Snake is largely confined to Triassic sandstones, including the Hawkesbury, Narellan and Shoalhaven formations, within the coast and ranges in an area within approximately 250 km of Sydney. **Habitat and ecology** Nocturnal. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer. Feeds mostly on geckos and small skinks; will also eat frogs and small mammals occasionally. Females produce four to 12 live young from January to March, which is a relatively low level of fecundity.	Low. No suitable habitat on site. **No further assessment is required.**
Pale-headed snake *Hoplocephalus bitorquatus*	This species is semi / partially arboreal and inhabits a wide variety of habitats from forest to woodland. Requires intact understory and proximity to watercourses.	Low. This species was not recorded during the current and previous assessments. Unlikely to occur and if it does very little of the habitat it uses will be affected buy the project. **No further assessment is required.**
Stephens Banded Snake	**Description**	Low.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Hopocephalus stephensii *TSC Act*	Stephens' Banded Snake is a medium-sized partly tree-dwelling snake up to one metre long. It is brown or yellow-brown above, with a series of irregular, broad, dark crossbands. The head is black with a brown crown and a brown or cream patch on either side of the nape and the lips are barred with black and cream. **Distribution** Coast and ranges from Southern Queensland to Gosford in NSW. **Habitat and ecology** Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day. At night it hunts frogs, lizards, birds and small mammals.	No suitable habitat on site. **No further assessment is required.**
Little Whip Snake *Suta flagellum* *TSC Act*	**Description** The Little Whip Snake is a small, slender snake, reaching 45 cm in length. Its most conspicuous feature is the black hour-glass-shaped patch from the back of the nape to between the eyes. Some specimens also have a black snout-band. The body is tan to orange above and creamy below. Each scale is emphasised by its dark edge, giving the animal a "netted" appearance. If disturbed it may hurl itself about, whip-like, and emit a foul smell. They are venomous, though their size and small venom dosage is such that they are virtually harmless, though a bite can be painful. **Distribution** The Little Whip Snake is found within an area bounded by Crookwell in the north, Bombala in the south, Tumbarumba to the west and Braidwood to the east. **Habitat and ecology** Little is known about the habits of this small snake as it is primarily nocturnal. Occurs in Natural Temperate Grasslands and grassy woodlands, including those dominated by Snow Gum *Eucalyptus pauciflora* or Yellow Box *E. melliodora*. Also occurs in secondary grasslands derived from clearing of woodlands. Found on well drained hillsides, mostly associated with scattered loose rocks. Most specimens have been found under rocks or logs lying on, or partially embedded in the soil. Feeds on lizards and frogs. Up to seven live young are born between September and February.	Low. Unlikely to occur but if it did the impact would no affect its potential to occur. No further assessment is required.
Pink-tailed Worm-lizard *Aprasia parapulchella*	**Description** The Pink-tailed Worm-lizard is worm-like, with a dark-brown head and nape, gradually	Low. Habitat is available for this

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
TSC Act *EPBC Act*	merging with the pale grey or grey-brown body. The tail, nearly as long as its body, is pink or reddish-brown towards the tip. Its snout and tail are both rounded. There are no external ear openings. The broad, non-forked tongue, frequently used to wipe the eyes, and the presence of small hind-limb flaps, distinguishes it from a juvenile snake. Specimens grow to about 25 cm in length. **Distribution** The Pink-tailed Worm Lizard is only known from the Central and Southern Tablelands, and the South Western Slopes. There is a concentration of populations in the Canberra/Queanbeyan Region. Other populations have been recorded near Cooma, Yass, Bathurst, Albury and West Wyalong. This species is also found in the Australian Capital Territory. **Habitat and ecology** Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (*Themeda australis*). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks & spend considerable time in burrows below these rocks; burrows have been constructed by and are often still inhabited by small black ants & termites. Feeds on the larvae and eggs of the ants with which it shares its burrows. It is thought that this species lays 2 eggs inside ant nests during summer; the young first appear in March.	species. If it was within the area the impacts would not affect its potential to occur. No further assessment is required.
Rosenberg's Goanna *Varanus rosenbergi* *TSC Act*	**Description** Rosenberg's Goanna reaches up to 1.5 metres in length. It is dark grey above, finely spotted with yellow or white, and with paired, blackish cross-bands from the neck to the end of the tail. The pairs of narrow, regular bands around the entire length of the tail is a distinguishing feature, separating it from the more common Lace Monitor *V. varius*, which has very wide, light and dark bands towards the tip of the tail. Rosenberg's Goanna also has distinct, finely barred "lips", whereas the Lace Monitor has far broader bands around the snout. A pale-edged black stripe runs from the eyes, across the ears and onto the neck. Juveniles are brighter in colour, having an orange wash on the sides of the face and body. **Distribution** Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Also	Low. Unlikely to occur but if it did the impact would no affect its potential to occur. **No further assessment is required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	occurs in South Australia and Western Australia. **Habitat and ecology** Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Individuals require large areas of habitat. Feeds on carrion, birds, eggs, reptiles and small mammals. Shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens. Runs along the ground when pursued (as opposed to the Lace Monitor, which climbs trees). Lays up to 14 eggs in a termite mound; the hatchlings dig themselves out of the mounds. Generally slow moving; on the tablelands likely only to be seen on the hottest days.	
Border Thick-tailed Gecko *Underwoodisaurus sphyrurus* *TSC Act* *EPBC Act*	**Description** The Border Thick-tailed Gecko is a small lizard up to 10 cm long. It is pale fawn to brown above with faint darker brown flecks and many small white spots arranged in rows across the head, back and sides and on the legs. The tail is fat and rectangular with a thin tapering tip and has four pale rings. These Geckos are active at night and shelter by day under rock slabs and fallen timber. **Distribution** Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. **Habitat and ecology** Rocky hills with dry open eucalypt forest or woodland. Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter.	Low. Unlikely to occur. No further assessment is required.
Loggerhead turtle *Caretta Caretta* *TSC Act*	**Description** The Loggerhead Turtle is a large sea turtle to 1.5 m in length. The shell is an elongated heart-shape, dark brown above and white, cream or yellowish below. The large head is dark brown on top becoming pale at the sides, with darker blotches. **Location and habitat** **Distribution** Loggerhead Turtles are found in tropical and warm temperate waters off the Australian coast. In NSW they are occasionally seen as far south as Sydney and have been recorded	Low. No suitable habitat on site. **No further assessment is required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	nesting on the NSW north coast. **Habitat and ecology** Loggerhead Turtles are ocean-dwellers, foraging in deeper water for fish, jellyfish and bottom-dwelling animals. The female comes ashore to lay her eggs in a hole dug on the beach in tropical regions during the warmer months.	
Leathery Turtle *Dermochelys coriacae* *TSC Act*	**Description** A very large sea-turtle up to 3 m long with heavy paddle-shaped limbs lacking claws. Adults are dark brown or black above, sometimes with paler marbling or longitudinal rows of fine dots on the back, while hatchlings are a rich blue-black trimmed with white, and pale below. The adult shell is covered by a thick, smooth, leathery skin. There is a series of seven prominent longitudinal ridges above the shell and four ridges along the lower half of the shell. **Distribution** Throughout the world's tropical and temperate seas and in all coastal waters of Australia. Most sightings are in temperate waters. Large numbers of Leathery Turtles feed in coastal waters from southern Queensland to the central coast of NSW. **Habitat and ecology** Occurs in inshore and offshore marine waters. Rarely breeds in Australia, with the nearest regular nesting sites being the Solomon Islands and Malayan Archipelago. Occasional breeding records from NSW coast, including between Ballina and Lennox Head in northern NSW. Number of sightings in southern waters suggest species actively seeks temperate feeding grounds, rather than occurring only as stray vagrants. Feed on jellyfish.	Low. No suitable habitat on site. **No further assessment is required.**
Australian Grayling *Prototroctes maraena*	**Description** The Australian Grayling is a dark brown to olive-green fish growing to 19 cm, with greenish bronze sides occasionally with a steel blue sheen, silvery gill cover, silvery white to yellowish on the lower part of the head and body, and clear to greyish or straw coloured fins (Allen 1989; McDowall 1996) **Habitat** This species spends only part of its lifecycle in freshwater, where running ripe specimens have been captured (Lake 1971). The Tambo R. population inhabits a clear, gravel-bottomed stream with alternating pools and riffles, and granite outcrops (Berra 1982). It has also been associated with clear, gravel-bottomed habitats in the Mitchell & Wonnangatta	Low. No suitable habitat on site, no previous recorded and advice from local fisheries officers state that is unlikely to occur. **No further assessment is required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	Rivers (Vic.) but was present in a muddy-bottomed, heavily silted habitat in the Tarwin R. (Vic.) (Jackson 1980). In the Tambo R. during Jan.-Nov. 1979, water temperatures ranged from 5-26°C and the pH was c. 8 (Berra 1982). Hall & Harrington (1989) located a population of adult Grayling in consecutive years in the lower, urban reaches of the highly turbid Barwon R., with a salinity of c. 1.5 parts per thousand **Movements** Grayling migrate between freshwater streams and the ocean (Lake 1971; Bishop & Bell 1978a) and as such it is generally accepted to be a diadromous (migratory between fresh and salt waters) species (Bishop & Bell 1978a). The juvenile migration from upstream is not a spawning run, so it cannot be considered to be an anadromous species (migrating from saltwater to freshwater to spawn) (Berra 1982). It is not known whether there are discrete stocks of Grayling that ascend their own natal streams, or whether there is mingling in coastal areas and ascension of any convenient river (Berra 1982). The upstream migration of this species has been effectively terminated in some rivers by dams (e.g. Tallowa Dam) (Bishop & Bell 1978a). **Feeding** They described the species as a microphagic carnivore that feeds principally on small crustaceans, algae and small insects (aquatic insect larvae and terrestrial insects), in decreasing quantities respectively (Bishop & Bell 1978b). The teeth of Grayling are well adapted for combing filamentous algae and Grayling have been observed to nibble on filamentous algae growing on the downstream side of rocks (Berra 1982). It is speculated that the black peritoneum in Grayling is related to the presence of plant material in the diet (Berra *et al*. 1987). **Reproduction** Spawning occurs in freshwater (Lake 1971; McDowall 1976). Different rivers at different latitudes with varying temperature regimes or other environmental influences may produce different spawning seasons (Berra 1982). Bishop & Bell's (1978b) study of a Shoalhaven R. population concluded that spawning occurred from early Feb.-early Mar. Berra (1982). Source DEWHA threatened species profile website.	
Maquarie Perch *Macquaria australasica* *EPBC Act*	Occur in the cooler parts of inland rivers and streams, and also in coastal south-eastern NSW. Not much is known about their status, but they seem to have declined because of overfishing, changes to habitat and river flows, and introduced species. Grow to about 45cm (DPI – NSW Fisheries web page 2005)	**Low.** No suitable habitat on site. No further assessment is required.
Insects	**Description**	**Low.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat** **(Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Adam's emerald *Archaeophya adamsi* *V TSC Act*	The Adam's emerald dragonfly is a moderately large, robust dragonfly. Larvae grow to about 23 mm in length and have a large two-lobed frontal plate on the head (see diagram), which distinguishes them from any other species found in NSW. The adults have a brown-black body with yellow markings, and a slight green or bluish metallic reflection on some parts. The abdomen length is around 46 mm and wingspan around 37 mm. **Distribution** Adam's emerald dragonflies (*Archaeophyta adamsi)* are one of Australia's rarest dragonflies. Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region. **Habitat and ecology** Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation. All dragonflies are predatory. The larvae stalk or ambush their aquatic prey while the adults capture their prey on the wing. Adam's emerald dragonfly larvae live for 7 years or so and undergo various moults before metamorphosing into adults. Adults probably live for a few months at most. Adult dragonflies generally fly away from the water to mature before returning to breed. Males congregate at breeding sites and often guard a territory. Females probably lay their eggs into the water. Adam's emerald dragonflies seem to have a low natural rate of recruitment and limited dispersal abilities.	Unlikely to occur but if it did the impact would no affect its potential to occur. **No further assessment is required.**

Appendix 5 – Tree Hollow Database

location DLALC rail loop DP 1032847						
tree number	species	eastings GDA	northings GDA	hollow size	quality	
1	*E.haemastoma*	357549	6325066	moderate	average	
2	*E.haemastoma*	357583	6325043	medium	average	
3	Dead *E.haemastoma*	357654	6325072	large	average	
4	*A. costata*	357705	6325066	medium	average	
5	*A. costata*	357767	6325108	medium	average	
6	*C. gummifera*	357920	6325090	medium	average	
7	*E. capitellata*	357980	6325121	moderate	average	
8	*C. gummifera*	358241	6325135	medium	average	
9	*C. gummifera*	358260	6325183	moderate	average	
10	*E.haemastoma*	358271	6325198	moderate	average	
11	Dead *C. gummifera*	358382	6325232	moderate	average	
12	*E.haemastoma*	358399	6325192	medium	average	
13	Dead	358477	6325246	medium	average	
14	*E.haemastoma*	358521	6325224	medium	average	
15	*E.haemastoma*	358569	6325240	medium	average	
16	*C. gummifera*	358519	6325256	moderate	average	
17	*C. gummifera*	358613	6325282	moderate	average	
18	Dead	358626	6325269	large	poor	
19	*C. gummifera*	358646	6325261	medium	average	
20	*E.haemastoma*	358645	6325260	medium	average	
21	*E.haemastoma*	358920	6325346	small	high	
22	*E.haemastoma*	358924	6325355	small	high	
23	*E.haemastoma*	358956	6325338	large	average	
24	*E.haemastoma*	359015	6325354	large	high	
25	Dead	359095	6325366	medium	average	
26	*E.haemastoma*	359009	6325429	medium	average	
27	*E.haemastoma*	358325	6325188	large	poor	

Location Rail loop Nth of Tooheys Rd						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	*E.haemastoma*	357409	6325007	moderate	average	
2	*E.haemastoma*	357322	6324958	moderate	average	
3	*E.haemastoma*	357243	6324948	medium	average	
4	*E.haemastoma*	357199	6324959	medium	average	
5	*E.haemastoma*	357181	6324959	moderate	average	
6	*E.haemastoma*	357145	6324957	medium	average	
7	*E.haemastoma*	357137	6324927	medium	high	
8	*E.haemastoma*	357126	6324946	medium	poor	
9	*E.haemastoma*	357111	6324955	medium	average	
10	*E.haemastoma*	357081	6324913	medium	average	
11	*E.robusta*	357061	6324894	moderate	average	
12	*E.robusta*	357046	6324930	large	average	
13	*E. capitellata*	357045	6324929	medium	high	
14	*E.robusta*	357030	6324917	medium	high	
15	*E.robusta*	356941	6324871	medium	average	
16	*C. gummifera*	356064	6324254	moderate	average	
17	*E.robusta*	356063	6324240	moderate	average	
18	Dead *E.robusta*	356099	6324163	medium	high	
19	Dead *E.robusta*	356071	6324136	medium	high	
20	*C. gummifera*	356073	6324142	medium	high	
21	Dead *E.robusta*	356108	6324124	large	average	
22	Dead *E.robusta*	356125	6324175	medium	average	
Location main infrastructure site Tooheys Rd						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	*E.haemastoma*	356151	6324073	moderate	average	
2	*E.pilularis*	356136	6324071	medium	average	

3	*E.pilularis*	356142	6324090	medium	average	ringbarked
4	Dead *E.pilularis*	356159	6324089	moderate	average	
5	*E.haemastoma*	356165	6324076	medium	high	1 stag only
6	*E.haemastoma*	356171	6324082	moderate	average	
7	*E.pilularis*	356258	6324082	medium	average	
8	*E.pilularis*	356250	6324064	moderate	average	
9	*E.haemastoma*	356250	6324067	moderate	high	galah nesting
10	*E.pilularis*	356254	6324085	moderate	average	
11	*E.pilularis*	356238	6324110	moderate	average	
12	*E.pilularis*	356242	6324135	large	average	
13	Dead *E.pilularis*	356269	6324152	moderate	average	
14	*A. costata*	356229	6324143	large	average	
15	*E.haemastoma*	356056	6324097	large	average	
16	*C.maculata*	356006	6324065	moderate	average	
17	*E.pilularis*	356012	6324056	medium	average	
18	*E.haemastoma*	355987	6324052	moderate	average	
19	*E.haemastoma*	355802	6324044	medium	average	1 stag only
20	*Dead E.haemastoma*	356020	6324025	moderate	poor	
21	*Dead E.haemastoma*	356261	6324035	large	average	
22	*E.pilularis*	355917	6323955	medium	average	
23	*E.pilularis*	355765	6323861	medium	average	
24	*E.haemastoma*	355781	6323859	moderate	average	
25	Dead *E.haemastoma*	355775	6323852	moderate	high	
26	*E.haemastoma*	355881	6323885	moderate	high	possum poo
27	*E.haemastoma*	355871	6323863	moderate	average	
28	*C. gummifera*	355874	6323846	moderate	average	
29	*E.haemastoma*	355895	6323732	large	average	
30	*E.haemastoma*	355887	6323792	moderate	average	
31	*E.haemastoma*	356008	6323825	medium	average	
32	*E.haemastoma*	356145	6323798	medium	average	
33	*E. capitellata*	356233	6323846	moderate	average	

34	*E. capitellata*	356022	6323679	moderate	average	
35	*E. capitellata*	355845	6323705	moderate	average	
36	*E. capitellata*	355697	6323768	moderate	average	
37	*E.haemastoma*	356110	6323908	large	high	owl nest
Location T-rd infra sth of Wallarah Ck						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	*E.haemastoma*	356299	6324061	medium	poor quality	
2	*E.haemastoma*	356307	6324079	moderate	avaerage	possum scratches
3	Dead	356372	6324033	moderate	avaerage	
4	*E.pilularis*	356689	6323965	medium	avaerage	
5	*E.haemastoma*	356948	6323957	medium	poor quality	
6	*E.haemastoma*	356941	6323952	medium	avaerage	
7	*E.haemastoma*	356962	6323997	moderate	avaerage	
8	Dead	357019	6324021	large	avaerage	
9	*E.haemastoma*	357035	6324033	medium	avaerage	
10	*E.haemastoma*	357044	6324043	moderate	avaerage	
11	*E.haemastoma*	357174	6324034	moderate	avaerage	
12	Dead *C. gummifera*	357175	6324056	moderate	avaerage	
13	*E.pilularis*	357199	6324063	medium	avaerage	
14	Dead *E.haemastoma*	357283	6324073	moderate	avaerage	
15	Dead *E.haemastoma*	357280	6324073	moderate	avaerage	
16	*A. costata*	357325	6324140	medium	avaerage	
17	*E.pilularis*	357328	6324145	medium	avaerage	
18	*E.pilularis*	357321	6324167	medium	avaerage	
19	*E.pilularis*	357274	6324143	medium	avaerage	
20	*A. costata*	357259	6324120	medium	avaerage	
21	*E.haemastoma*	357257	6324114	medium	avaerage	
22	*E.haemastoma*	357252	6324117	large	avaerage	

23	*E.pilularis*	357264	6324160	large	avaerage	
24	*E.haemastoma*	357197	6324113		avaerage	
25	*E.haemastoma*	357198	6324121	large	avaerage	goanna in tree
26	Dead *E.pilularis*	356627	6323928	large	avaerage	
27	*E.haemastoma*	356319	6323998	medium	avaerage	
28	*E.haemastoma*	356319	6323991	medium	avaerage	
29	*E.haemastoma*	356328	6323984	moderate	avaerage	
Location T-rd infrastructure nth of Wallarah Creek (West)						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	*E.pilularis*	356512	6324339	medium	average	
2	*E.haemastoma*	356539	6324363	moderate	average	
3	*E. capitellata*	357002	6324295	medium	average	Powewrful Owl perching tree, A painted on tree
4	*C. gummifera*	357012	6324292	medium	average	B painted on it
5	*A. costata*	356956	6324302	moderate	average	C painted on it
6	Dead	356933	6324478	medium	average	D painted on it
7	*E.pilularis*	356941	6324491	moderate	average	E painted on it
Location T-rd nth of Wallarah Ck (east)						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	*E.haemastoma*	357305	6324193	medium	average	
2	*E.haemastoma*	357268	6324212	medium	average	
3	*E.haemastoma*	357262	6324288	medium	average	
4	*E.haemastoma*	357311	6324266	medium	average	
5	*E.haemastoma*	357344	6324315	medium	average	
6	*E.haemastoma*	357373	6324415	moderate	average	
7	*E.haemastoma*	357308	6324448	medium	average	
8	*E.haemastoma*	357321	6324428	moderate	poor	

Location nth of T-rd rail loop						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	*E.haemastoma*	357315	6324231	moderate	average	
2	Dead	357358	6324771	moderate	average	
Location Butonderry infrastructure site						
tree number	species	eastings GDA	northings GDA	hollow size	quality	notes
1	Dead *E.fibrosa*	352542	6322963	moderate	average	
2	*E. capitellata*	352490	6323031	small	high	
3	*A. costata*	352320	6322940	large	average	
4	*C.maculata*	352430	6322969	moderate	high	
5	*C.maculata*	352272	6322946	medium	average	
6	*C.maculata*	352264	6322999	large	average	
7	*C.maculata*	352224	6322970	medium	poor	
8	*C.maculata*	352210	6322957	moderate	average	
9	*C.maculata*	352173	6323011	large	average	
10	*C.maculata*	352134	6323080	medium	average	
11	Dead	352263	6323034	medium	average	
Incidental Tetratheca sightings						
		eastings	northings			
	DLALC Land	358178	6325148	20 plants	50 m2	
	DLALC Land	359084	6325364	3 plants	10m2	
	Sth of Wallarah Ck	356962	6323997	5 plants	10m2	
	Sth of Wallarah Ck	356328	6323984	3 plants	5m2	