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Proposed Wallarah 2 Coal Project:

Ecology Assessment of the Proposed Mining Area, Wyong, NSW.

Report prepared by

OzArk Environmental & Heritage Management Pty Limited

for

Wyong Areas Coal Joint Venture

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1. INTRODUCTION

1.1 Background

OzArk Environmental and Heritage Management Pty Ltd (OzArk) has been commissioned by International Environmental Consultants Pty Ltd (IEC) on behalf of Wyong Areas Coal Joint Venture to undertake ecological assessment within the W2CP Proposed mining area. This area is defined as all land with potential to be affected by subsidence as delineated by the "zero subsidence line". This proposal comprises a continuation of earlier projects for which there is a considerable body of literature. The majority of the field work for this report was undertaken in 2007 however, the report has been updated. 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 may require addendums.

1.1.1 Proponent

The W2CP is being undertaken by Wyong Areas Coal Joint Venture (WACJV). 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 2**.
- 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 3.** 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 eight 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 reports 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 4.2.1 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.
ERM	Wyong Coal Project Flora	As per title.	Western mining lease

Company / Author / Year Finalised See Section 4.2.1 for a full summary	**Title**	**Specialist components**	**Location**
August 2002a	and Fauna Review (Terrestrial) – western area EL4911		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.
OzArk Environmental & Heritage Management December 2007	Ecological & Heritage Assessments – Proposed Wallarah No.2 Coal Project (Direct impact and offset areas).	Indigenous, non-Indigenous and Ecological assessments.	Proposed surface facilities at Tooheys Rd and Buttonderry. Hue Hue Rd ecological offset investigation area were also received preliminary assessment and a review of existing reports was undertaken.
ERM 2008	Wallarah 2 Coal Project Flood Impact Assessment	Flood impact assessment.	Dooralong, Hue Hue and Yarramalong Valleys.
Mackie Environmental Research	Wallarah 2 Coal Project Groundwater Management Studies June 2008	Hydrological assessment.	Dooralong, Hue Hue and Yarramalong Valleys.

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:** The western target area is the proposed mining area which possesses land with potential to be affected by subsidence due to long wall mining (**Figures 1 and 3**). Land with potential to be affected by mining subsidence occurs entirely within the zero subsidence line. This area is the focus of the current study.

3. Areas of **no impact:** Habitat compensation areas or zones set aside for inter-generational equity. This property is not shown within this report however it can be seen in the associated OzArk report for the direct impact areas.

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 established the absolute ecological values (according to state and federal legislation) of these locations. The resultant report has provided mitigation measures and long-term management recommendations (OzArk 2006).

For areas of **indirect impact,** such as the current study area where underground mining activities will result in some surface impacts, assessment has been undertaken 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 ecological values.

Locations that are being considered as **habitat compensation** or as **areas of conservation for inter-generational equity** required a more general assessment, primarily focussed on predictive modelling accompanied by targeted survey. These include portions of the Tooheys Rd and Buttonderry sites, but also include the property west of the F3 that joins or is near to the Tooheys Rd. A substantial portion of the Buttonderry properties will not be developed and may, for the purposes of this report be managed for the benefit of flora and fauna. Assessment at these locations established 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 (OzArk 2007).

1.2.1 Aim and scope of the current investigation

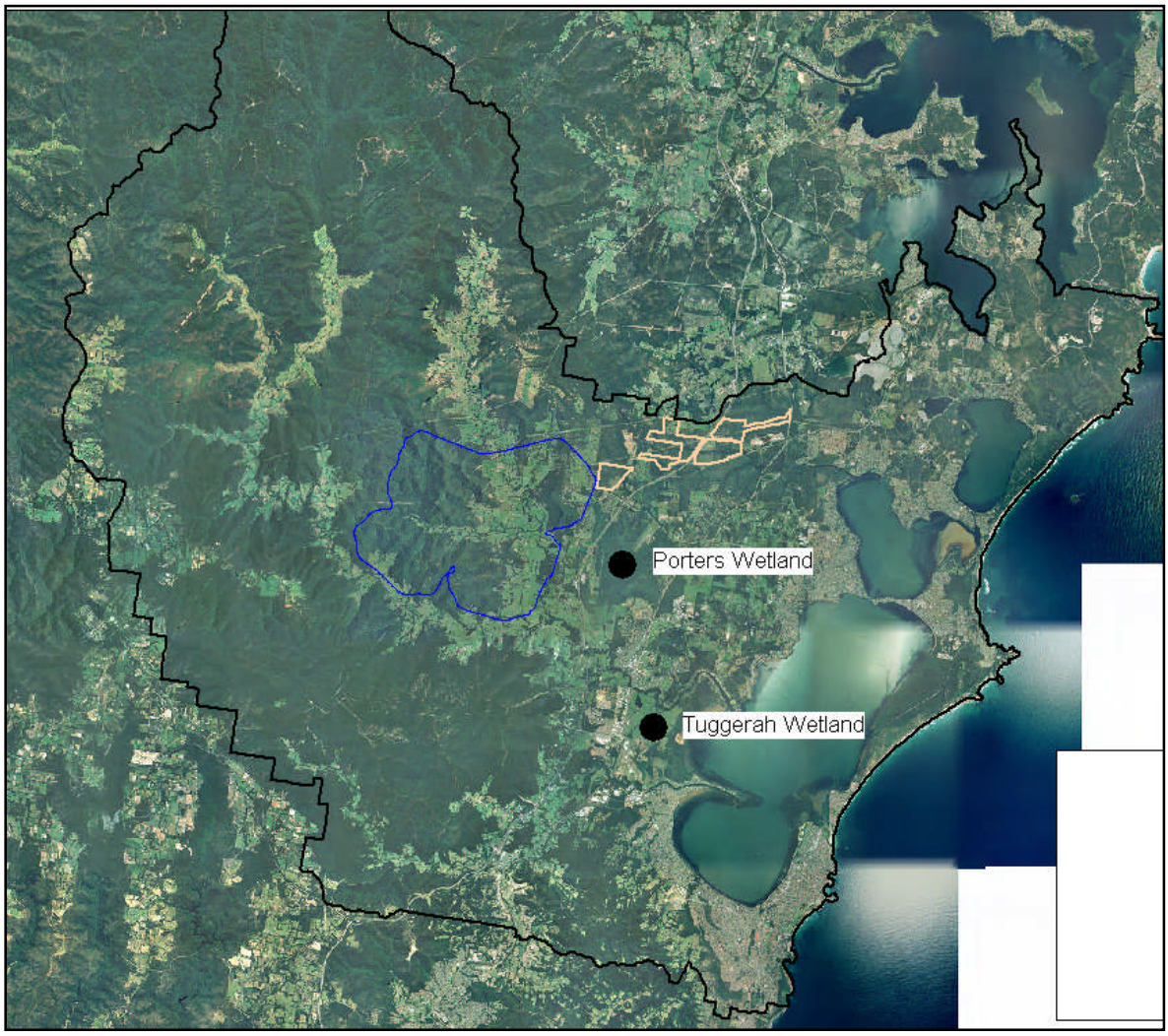
The consultant was briefed to assess proposed impacts of the W2CP upon flora and fauna species, particularly those species, populations and ecological communities with legislative protection listed under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC

Act) in the indirect impact areas (i.e. within the zero subsidence line **Figure 1**). Direct impact associated with the Tooheys Rd, Hue Hue Rd ecological offset investigation area and Buttonderry are not part of the current assessment and were addressed in a separate report.

1.2.2 The zero subsidence area

The zero subsidence line is the point where underground mining activities no longer have an appreciable effect on vertical surface movement. It is effectively the point at which up to 20 mm of vertical movement by subsidence is within background levels of movement that can be attributed to normal ground swell/shrinkage etc. This report is focussed on land within the subsidence line as shown in blue on **Figure 1**.

Figure 1: Aerial photograph showing the boundaries of the zero subsidence line (blue) in relationship to the direct impact and potential offset areas (salmon) and the Wyong Local Government Area (black).



Note: The resource extraction area / mine plan area lies principally within the zero subsidence line.

Figure 2: Locality map: resource extraction / mine plan area (black dotted line) in the western area (red line showing EL4911 and A405 west of the F3) (Source: IEC)**.**

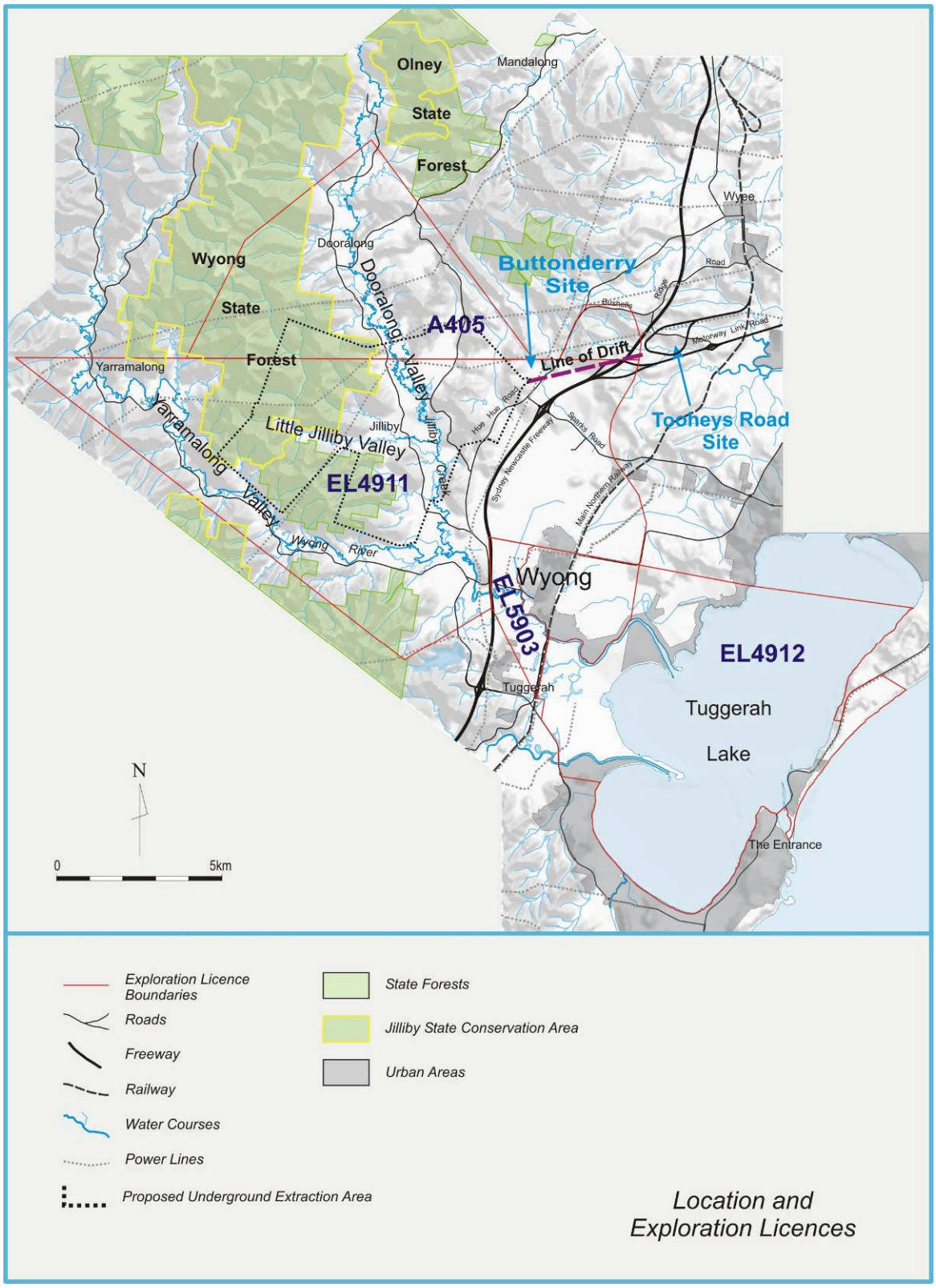
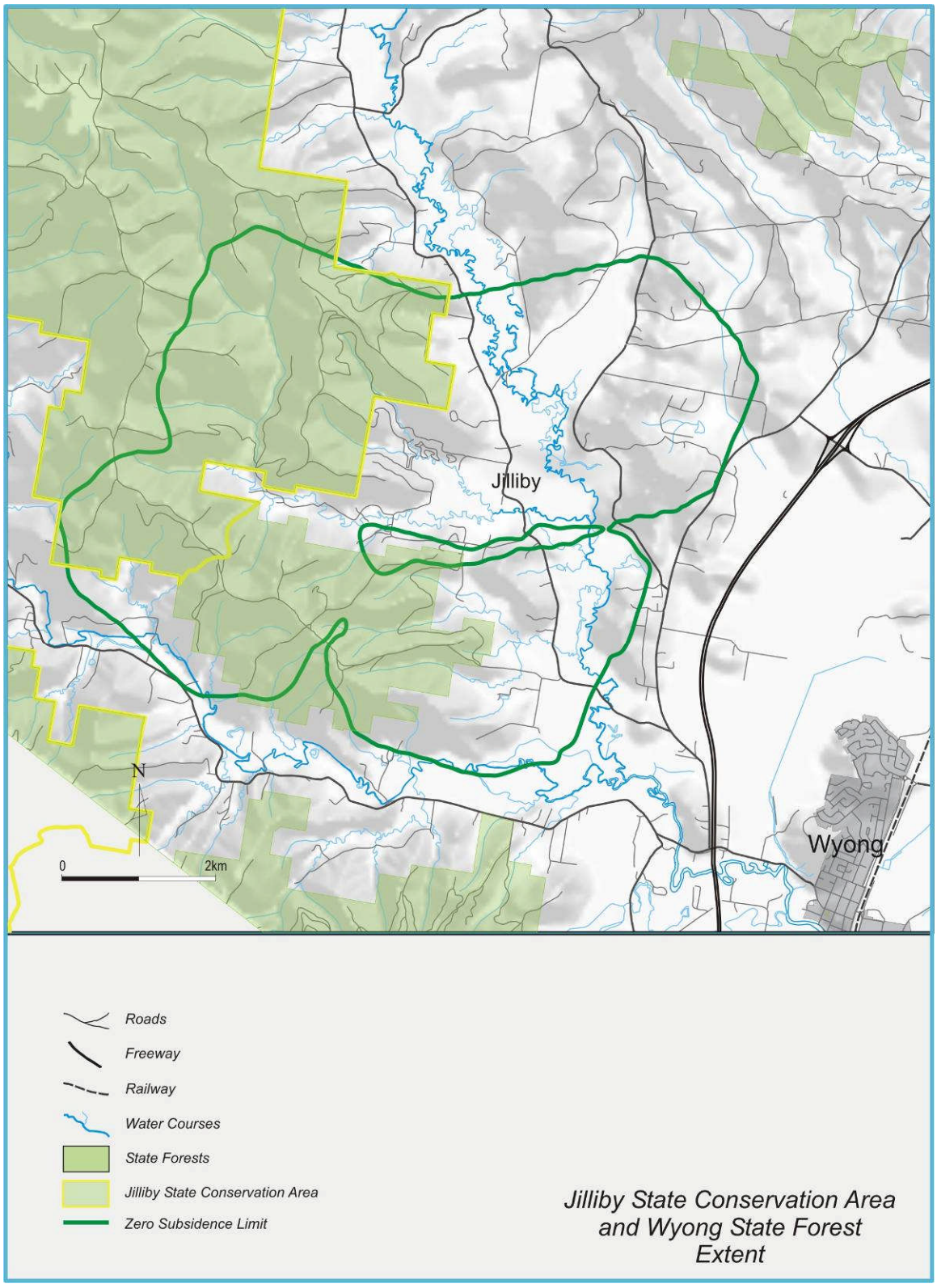


Figure 2a: Zero subsidence line showing the Jilliby State Conservation Area and the Wyong State Forest boundaries.



Database searches and literature reviews were undertaken and the results were used to compliment / supplement previous survey and desktop assessments 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 indirect impact areas.

A general observation is relevant here to the ongoing use of nomenclature from previous studies. 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 and was assessed as a direct impact area in the OzArk Direct Impact & Offset report (**Figure 2**).
- **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 and was assessed as a direct impact area in the OzArk Direct Impact & Offset report (**Figure 2**).
- **Hue Hue Rd ecological offset investigation area,** referred to by ERM (1999b) as Site 2. The property is immediately west of the F3 Freeway and backs onto the Hue Hue and Bushells Ridge Rds.
- **Western Area**. This is the general western exploration licence area including the Wyong State Forest, the 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 2.** Within this is the smaller western target area for proposed coal extraction.
- **Underground Extraction Area** is the zone under which longwall mining will occur. This is marked on **Figure 2** with a black dotted line west of the F3 highway. The zero subsidence line is the limit of subsidence associated with this mining area (**Figure 3**).

1.3 Proposed works (Source: IEC 2007)

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 2011.

As this document is specific to the coal extraction area, only the proposed works in this area will be detailed below. Other proposed works for surface facilities have been described in detail in OzArk 2009.

The proposed longwall mine plan has been designed to minimise impacts to the environment as much as is practicable, particularly potential impacts to the local community and water supply system. The proposed underground mining area has been significantly reduced in response to identified geological and environmental constraints as well as the views of the community. The proposed mine plan, **Figure 3**, extends from

deep beneath a portion of the Hue Hue rural residential area and continues at deeper levels below the Dooralong Valley before progressively mining beneath the Wyong State Forest area. Longwall mining will not take place directly beneath the Wyong River or within the vast majority of the floodplain of the Yarramalong Valley.

The region's water supplies will be safeguarded. No mining will occur in or under the Mangrove Creek Dam catchment, or Mardi Dam, or under the Wyong River, Wyong Weir, and Ourimbah Creek, Porters Creek Wetland or related water facilities and infrastructure.

The project has incorporated a number of protection measures to safeguard against adverse impacts on the local community. The amount of coal to be extracted beneath the Hue Hue area has been significantly reduced to ensure that surface movement (referred to as subsidence), will readily comply with the levels stipulated by the declared Subsidence District. Houses built in accordance with the Hue Hue Mine Subsidence District criteria should therefore accommodate the effects of mining.

Similarly, when underground mining occurs deep beneath the Dooralong Valley floodplain, which is necessary to access coal reserves within the surrounding State Forest, less coal will be extracted to reduce the subsidence effects and to ensure that shallow alluvial aquifers are appropriately protected.

Evaluation of a series of alternative mine layout plans has been undertaken and the current proposed mine plan is the preferred layout, although some minor adjustment to panel orientation may be made as a result of detailed environmental and engineering studies. The mine layout incorporates a variety of longwall panel widths in order to optimise economic reserve recovery whilst taking into account environmental and subsidence constraints (**Figure 4**). Detailed long wall width information is as follows:

- 120 m and 150 m wide panels below the north-eastern portion of the Hue Hue Mine Subsidence District;
- 150 m, 170 m or 200 m wide panels (depending on depth of cover) below the 1-in-100 year flood zone; and
- predominantly 250 m elsewhere.

In a few panels, panel width varies along the length of the panel, as the panel moves from one zone to another zone of higher or lower permissible tilt levels. This process has achieved successful outcomes at other mines. The narrow sections of the variable width panels would have three-heading gate roads on the tailgate side of the panel.

As shown in **Figure 3** extraction commences in the north-eastern corner of the mine layout (shown coloured blue), adjacent to the pit bottom facilities. Due to surface subsidence restrictions, the initial longwall panels are relatively narrow. Extraction in each panel will move in an updip direction (south to north)

While these first ten longwall panels are being developed and extracted, an additional development unit drives the various main set of tunnels or headings that enable permanent access and ventilation corridors throughout the mining area.

The end of one of the main headings in the centre of the mining area is the selected location for an additional ventilation shaft (downcast). This shaft is required prior to longwall extraction from the southern mains.

Following extraction of the initial ten longwall panels from the northern main headings, extraction of the south-eastern panels commences (shown green in **Figure 3**). This sequence provides the following advantages:

- Better quality coal is extracted first, improving project economics; and
- Better mining conditions are anticipated, as entry into the Awaba Tuff floor areas is delayed.

The initial south-eastern-most longwall panels are reduced in length, due to the large number of flood affected properties within the Kidmans Lane area. Continuity of the southern longwall panels is interrupted by Smithys Sill. This effectively splits the southern longwall panels into two discrete blocks. Extraction of the southern panels continues in the remaining panels that are coloured green in the southwest quadrant of the mine in **Figure 3**.

The order of preferential extraction of coal in the mining areas is on the basis of pursuing the higher margin coal where possible. Deterioration in coal quality in the south-west corner of the W2CP Target Area results in extraction moving back to the northern panels after the extraction of the three yellow-shaped panels in the south-western quadrant (**Figure 3**).

The resulting mine layout shown in **Figure 3** has an extraction height range of 3.0 m to 4.5 m, recoverable reserves are calculated to be over 150 Mt (ROM). The overall longwall to development tonnage ratio is 12.1: 1. The depth of the mine ranges from 350 m to over 650 m in some areas (refer **Figure 13**).

Figure 3: Proposed mining sequence.

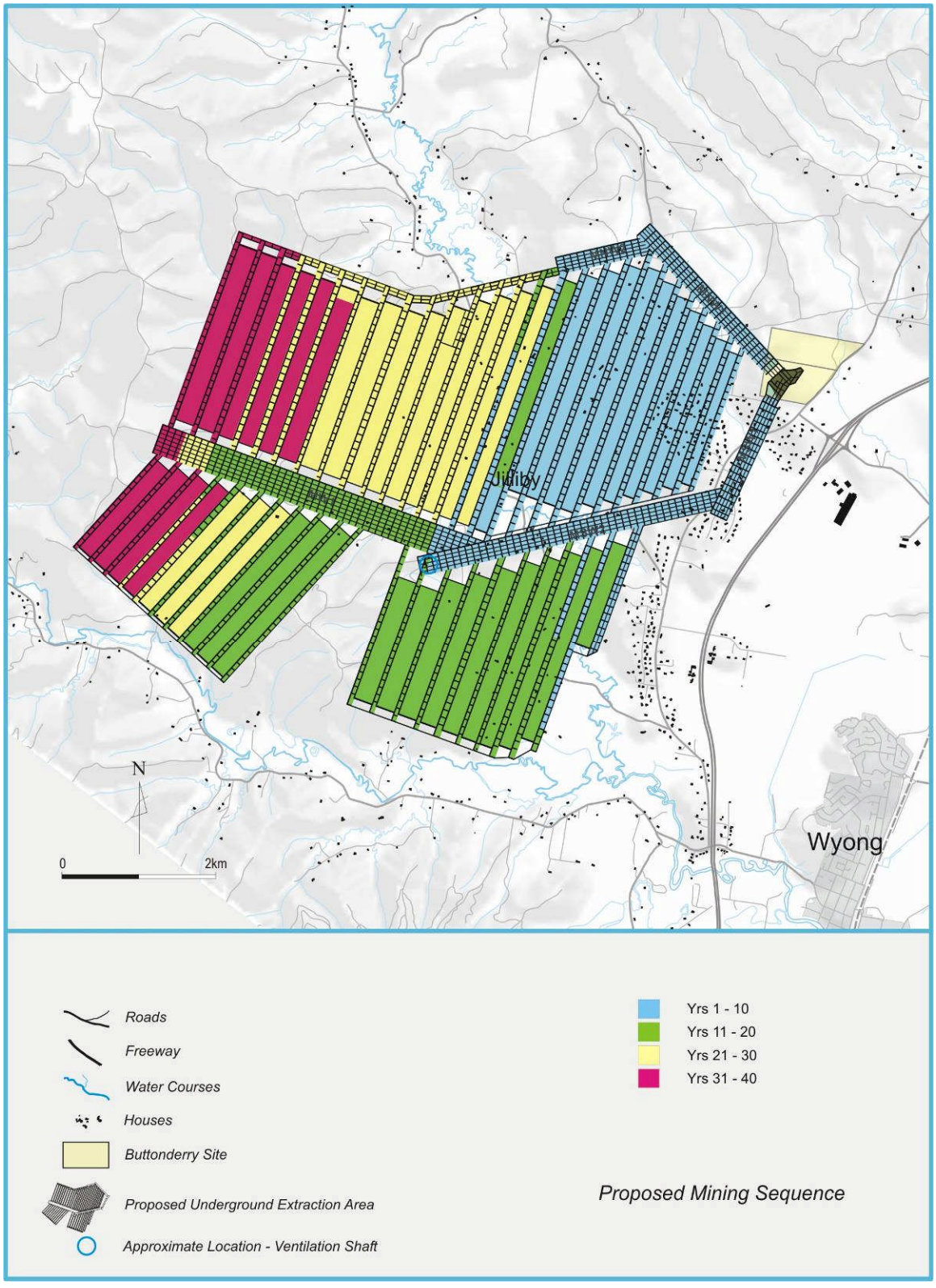
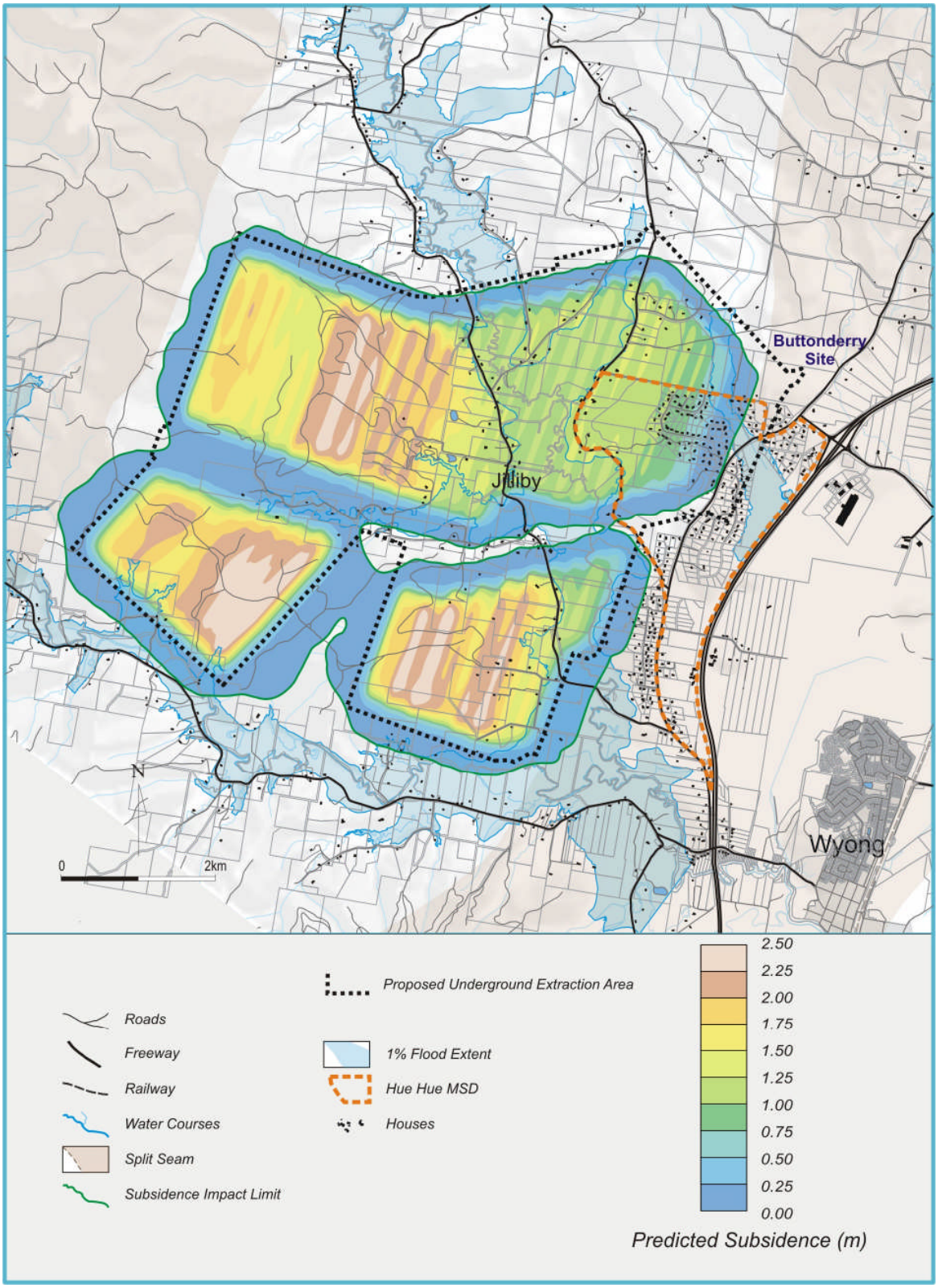


Figure 4: Predicted subsidence (Source: WACJV 2008).



1.4 Project constraints and limitations

This report is limited to the area subject to subsidence and enclosed by the zero subsidence line (**Figures 1, 3 and 4).** The determinations of impact to the natural environment are based upon results from the subsidence (WACJV 2008), flooding (ERM 2008) and groundwater specialist. (Mackie Environmental Research 2008) studies. These specialist assessments are included in the Environmental Assessment report if the reader requires further information.

The consultants were allowed access to public lands and were not permitted to enter private property. Access into some areas of the Wyong State Forest (SF) and Jilliby State Conservation Area (SCA) was limited in some cases due to fallen trees blocking tracks and slippery conditions. To reach an understanding of the environments on private land which primarily comprised the valley floors, binoculars were used from road side vantage points and detailed aerial photography was inspected.

To ensure adequate assessment was undertaken of threatened species known or having the potential to occur, within the region, NSW state and Commonwealth agency records were reviewed for the Wyong Local Government Area (LGA's). This review established 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 with 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 with the size of a survey area. This report is based upon data acquired from recent and current surveys and although the subsidence 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. Also the presence of threatened species is not static, it changes over time, often in response to longer term natural external forces that can be dramatically influenced by anthropomorphic disturbance.

1.5 Personnel

Field assessments for the current series of investigations were undertaken by Phillip Cameron (OzArk, Bsc, Ass Dip App Sci, Animal Research Authority 07/1601, Scientific Licence 11194, MECA) and Stephen Bell (Eastcoast Flora Survey, Bsc,(hons)) with assistance from Dr Jodie Benton (OzArk).

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

1.6 Report authorship

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

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 documented in 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.

- Reference to relevant Environmental Planning Instruments (EPI's) such as *SEPP (Major Projects) 2005;*

- The Assessment of Significance.

  - *Threatened species, populations and ecological communities*

    Relevance to the current proposal: In relation to the current study area desktop and field investigations have occurred to identify if any threatened species, populations and ecological communities occur in the study area.

    Key threatening process

    Relevance to the current proposal: In terms of the threatening processes as listed in Schedule 3 of the TSC Act, the current proposal would include:

- Alteration of habitat following subsidence due to longwall mining;
- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands; and
- Human-caused climate change.

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*. As such, if the Minister for Planning is also satisfied that it meets this definition, 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. ENVIRONMENTAL SETTINGS

Property information can be directly sourced from the Environmental Assessment report and project application.

Where possible, relevant data from previously commissioned studies have been drawn upon to document the environmental settings of the current study area. Specifically, data from the ERM 2001 assessment has been particularly useful, while also relevant are the flood and subsidence studies, ERM 2008 and Mackie Environmental Research 2008.

3.1 General

The study area lies within the Sydney Basin Bioregion (SBBR, also known as the Sydney–Bowen Basin) which is 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 the Department of Environment and Climate Change and Water (DEC 2002), the SBBR is a geological basin formed when the earth's crust expanded and then filled with sediment forming near horizontal sandstones and shales between the late Carboniferous and Triassic ages. These 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 (such as Illawarra and Blue Mountains) 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 stages of development saw the continental rift filled with sediments (marine volcanic). Subsequent deposition therefore shifted to rivers 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 most succinct descriptions of locally occurring hydrology, geology and soils can be found within ERM 2008 and Mackie Environmental Research 2008 and other sections of the Environmental Assessment report. Subsidence-related issues of potential ecological importance include the effects on the flood plain of two drainage systems above the proposed mining area and the potential impacts on shallow alluvial aquifer systems and flooding. These issues have been assessed by the above reports respectively. It is not the intent of this report to reproduce the detail of these reports and where required the reader should consult these primary sources of information.

For the purposes of the current assessment, the rockhead under the valley floors is covered with up to 35 m of saturated alluvium with the zone of greatest permeability within the first 5 to 10 meters.

3.2 The area of subsidence

The proposed zone of subsidence is bounded by the line of zero subsidence and includes the Yarramalong and Dooralong Valleys, parts of the Wyong State Forest and Jilliby State Conservation Area and encompasses numerous waterways including small portions of Wyong River Hue Hue Creek, Jilliby Jilliby Creek, and smaller unnamed drainage lines associated with the Wyong River and Jilliby Jilliby Creek.

3.2.1 Topography

The topography beyond the Yarramalong and Dooralong Valleys to the west, the Wyong SF and Jilliby SCA, is generally steep and rugged, consisting of steep to very steep slopes with narrow crests and ridges. The local relief for this portion of the study area is generally between RL 50-220 metres ASL with slope gradients between 20-60 percent. Several smaller, steep-sided valleys are associated with tributaries into the Wyong River and Jilliby Jilliby Creek, and these often intersect the steep high slopes, crests and ridges of the Wyong SF and Jilliby SCA. The Yarramalong and Dooralong Valleys are comprised of low slopes and floodplains consisting mainly of flat to gently sloping floodplain terraces and low slopes / toe slopes. The local relief within the valleys is usually less than 30 metres with a slope gradient not exceeding 15 percent.

3.2.2 Geology

The general geology of the mining area, including a description of the stratigraphic column, is indicated in **Figures 5 and 6**. The Wyong area is located south of the Newcastle Coalfield on the north eastern margin of the Sydney Basin. The coal resources are contained within the upper part of the Permian Newcastle Coal Measures. Depth of cover to the uppermost coal seam in the region ranges from 200 to 650 metres (ERM 2001: 2.2) and from 350 m to 650 m in the proposed W2CP mining area.

This sequence is overlain by the Triassic Narrabeen Group which outcrops across the proposed subsidence area. Although Hawkesbury Sandstone, the uppermost and youngest geological unit present in the general region is commonly found on top of ridge tops within the wider Wyong Valleys area, none is evident over the subsidence study area. Instead, the study area comprises Narrabeen Group sandstone(s) including the Gosford (sandstone, siltstone) and Clifton (softer sandstone, claystone, shales) Subgroups. Quaternary alluvium occurs along valley floors and floodplains of the Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks.

A note on nomenclature is necessary here. Today Narrabeen Group sandstones have been divided into three major units which are the uppermost Terrigal Formation, the Patonga Formation and the underlying Tuggerah Formation. Previous geological division nomenclature, however, saw the Narrabeen Group comprised of the Gosford Formation and the Clifton Sub-groups. As each of these geological units are described below, reference will be made to their previous names as much of the forthcoming regional archaeological context comprises studies that were undertaken using the old nomenclature and for these results to remain meaningful they need to be understood in terms of the new names for these geological zones.

The uppermost strata of the outcropping Narrabeen Group is the Terrigal Formation (Rnt) which consists of sandstones and minor siltstones. This equates in the old nomenclature to the Gosford Formation (Rng). This stratum occurs over the most elevated landforms of the western portion of the subsidence zone, which is partially covered by State Forests. Although this layer can be up to 25 m in thickness, it is more commonly around 10 m thick within the current study area. This geological unit constitutes around 1900 ha or about 46% of the surface geology within the subsidence area.

The Terrigal Formation is underlain by the Patonga Claystone (Rnp) which consists of inter-bedded grey-green and red-brown claystones and minor fine grained sandstones with depths of up to 45 m, but more commonly around 20 m. This unit (together with the Tuggerah Formation) was considered to be part of the Clifton sub-group using the old nomenclature. It commonly outcrops in the mid hillslopes and undulating areas of the Yarramalong and Dooralong Valleys and constitutes around 350 ha or around 32% of the zero subsidence area.

Underlying this and outcropping beyond the north east of the zero subsidence line is the Tuggerah Formation (Rnu), a sequence of sandstones with minor siltstones and rare conglomerates. This unit is a transitional unit between the Patonga Claystone Tuggerah Formation and the underlying Munmorah Conglomerate. Using the old nomenclature, this formation was not separated out from the Patonga Formation and both were considered as part of the Clifton sub-group.

Unconsolidated Quaternary alluvium (Qa) (silts and sands) occur as fill along the Yarramalong and Dooralong Valleys with recorded depths of up to 50 m (ERM 2001: 2.2). Qa comprises around 910 ha or about 22% of the surface geology within the subsidence study area.

Figure 5: Regional Geology Stratigraphic Column (Source: WAJV).

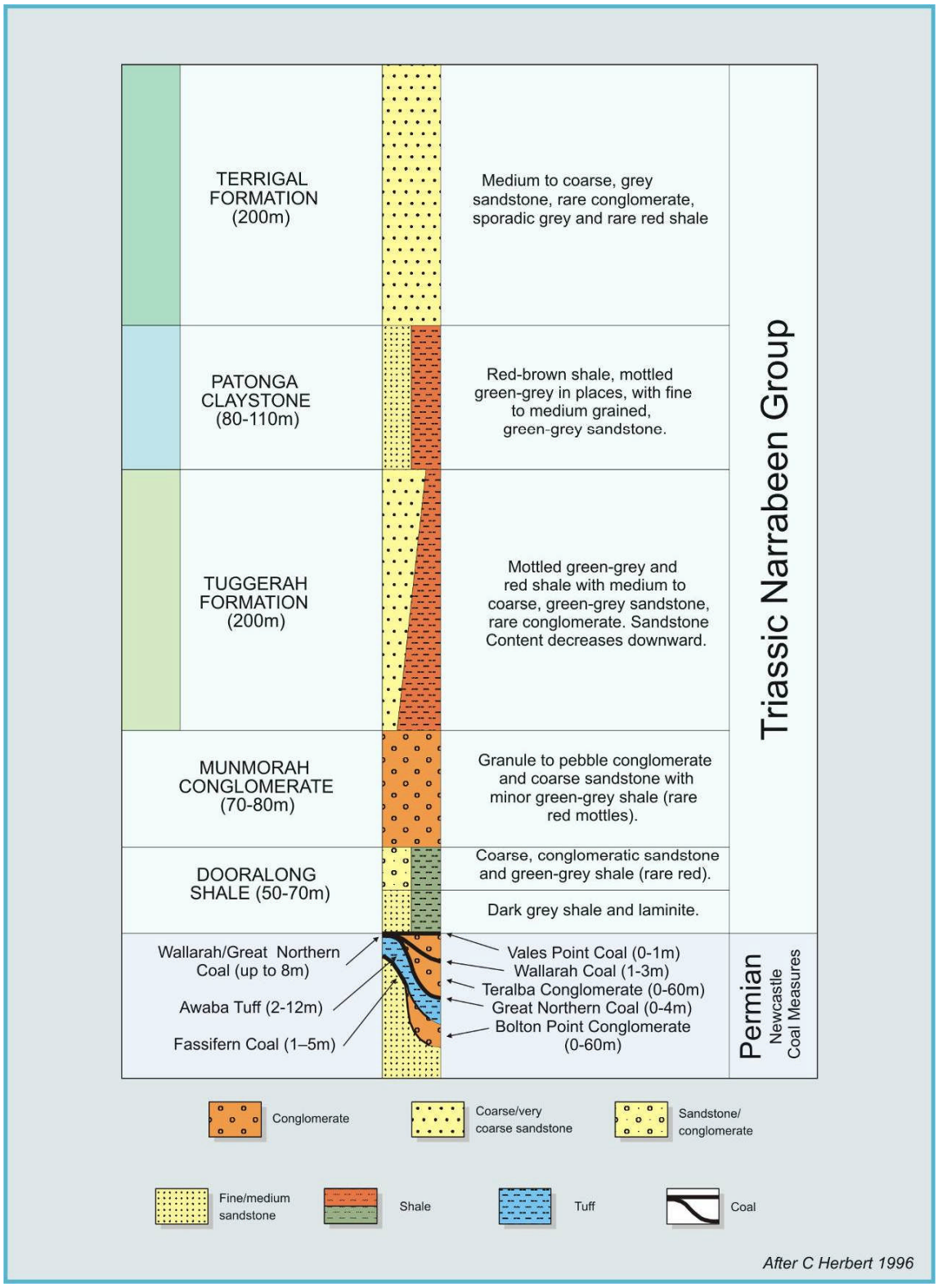
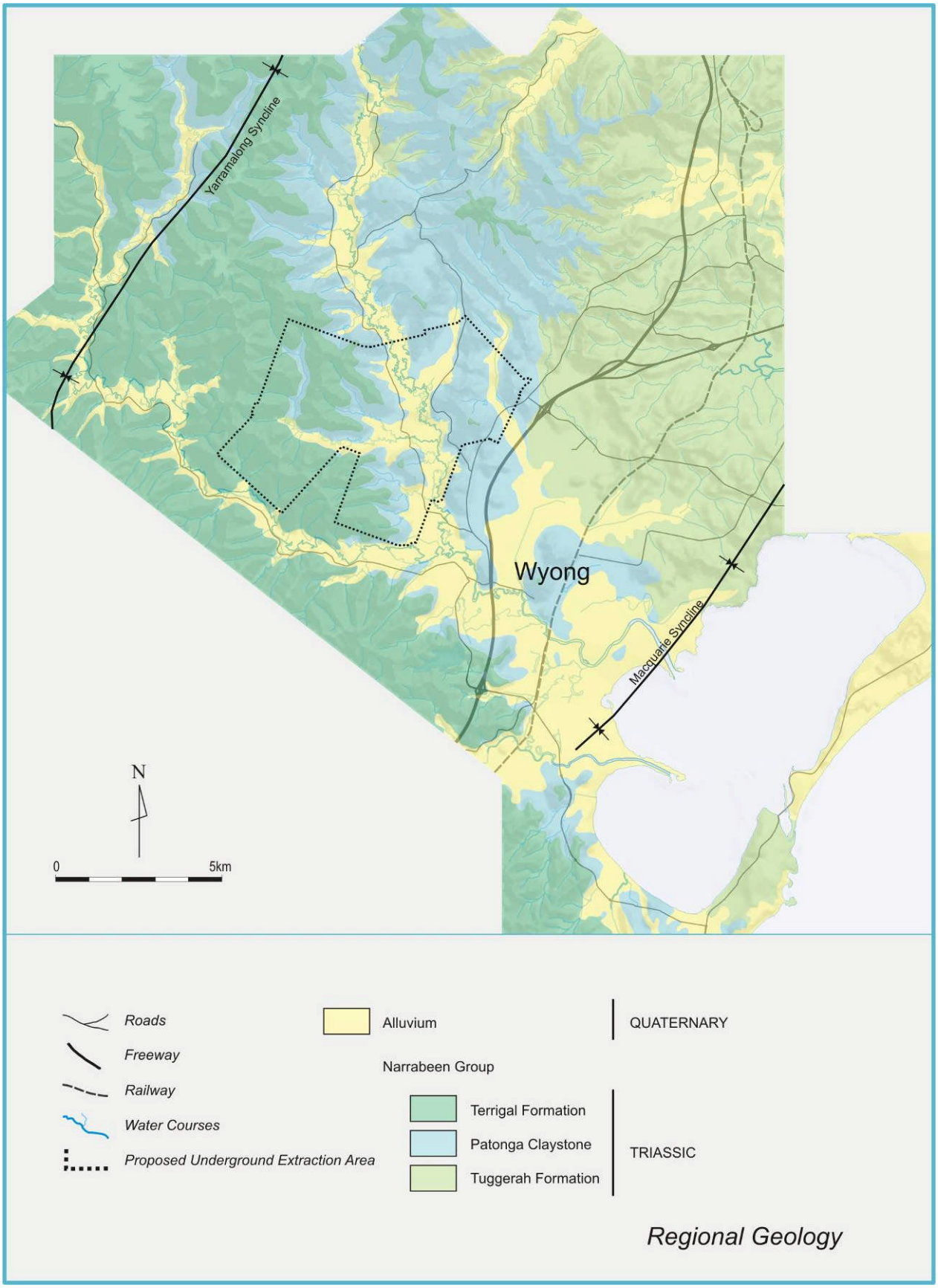


Figure 6: Regional Geology (Source: WAJV).



2.1.2a General potential for caves & rock shelters (microbat niche habitat) in terms of surface geology

To appropriately research this topic the best analogue available was associated with Indigenous heritage i.e. considerable survey effort in the region is associated with finding rock shelters suitable for human habitation. By default these areas also possess potential for niche habitat for threatened microbats. The study area contains no Hawkesbury Sandstone caps, which comprises a geological unit known to yield rock shelters appropriate for human habitation. Evidence of human occupation has been recorded in shelters within this unit to the south and west of the current subsidence zone. Surface geology within the current study area is instead dominated by the Narrabeen Group sandstone(s), which exhibit some areas of outcropping rock and claystones. As the consists of a number of elements apart from sandstone, including claystone, siltstone and shale - which are susceptible to erosion, there remains potential for sandstone shelter sites to occur in these areas.

While much of the recorded sandstone-based archaeology known in the wider Wyong area is found in Hawkesbury Sandstone, there is also evidence of sandstone sites in Narrabeen Group sandstone(s). As discussed further in Section 2.4 of the OzArk 2007 heritage report for the subsidence areas, much of the previous research in the Wyong area has been based in areas much further south where Hawkesbury Sandstone is prevalent and while this geological formation is considered to be archaeologically richer in terms of sandstone sites, the extent to which Narrabeen Group sandstone(s) are archaeologically significant has not been adequately tested and as such it is difficult to extrapolate a predictive assessment of the type of shelters that may be suitable for microbats in the area.

2.1.3 Soil landscapes

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.

The subsidence zone is comprised of four types of soil formations, colluvial, alluvial, erosional and residual. Mapping of these soil landscapes mirrors to some extent, the geological units from which they are derived. The colluvial soils will be discussed first followed by alluvial, erosional and residual deposits.

The largest of the colluvial soil deposits is the Watagan which is derived from the weathering of the massive beds of quartz-lithic sandstone, siltstone and claystone of the Terrigal Formation, which is the uppermost stratum of the Narrabeen Group. These deposits occur north of Wyong River and west of Jilliby Jilliby Creek, comprising the uplands of the Wyong SF and Jilliby SCA. In these areas massive sandstone exposures form minor cliff exposures, local relief is c. RL 50-220 m ASL with slope gradients of up

to 25% or more. Soils of this group are very complex and include shallow (<50 centimetres) lithosols/siliceous sands and yellow earths on coarse sandstone, shallow to deep (<50->150 centimetres) yellow podzolic soils and some red podzolic soils on fine-grained bedrock, deep (>150 centimetres) sandstone colluvial deposits, yellow earths, yellow podzolic soils and siliceous sands and alluvial sands along drainage lines. Some of these soils are potentially prone to mass movement with extreme erosion hazards for shallow soils, rock fall hazards (rock outcropping) and localised seasonal waterlogging (ERM 2001: 2.7).

The second of the colluvial soil deposits is the Mandalong soil landscape, which is derived from the weathering of the massive beds of quartz-lithic sandstone, siltstone and claystone of the Patonga Claystone. This soil landscape generally occurs between the Watagan and Woodbury Bridge landscapes, and is identified as rolling to steep low hills on the Watagan Mountains with narrow crests and ridges, short steep slopes and narrow closely spaced drainage lines. Local relief is to 120 m and slope gradients between 20-60 percent. Soils are moderately deep to deep (100->150 centimetres) red podzolics, brown podzolic soils, yellow podzolic soils on claystone, shallow to moderately deep (<50-150 centimetres) yellow podzolic soils on sandstones with clays or rock outcrop on drainage lines. This landscape is potentially prone to mass movement and foundation hazards, extreme erosion and has low fertility soils (ERM 2001: 2.8).

The only alluvial soil landscape within the subsidence study area is the Yarramalong alluvial soil landscape which follows Jilliby Jilliby Creek, Little Jilliby Jilliby Creek and the Wyong River. This soil landscape incorporates alluvial terraces in association with various water bodies such as back swamps and oxbows. Local relief is less than 10 metres with slope gradients of less than 5 percent. The deep (>150 centimetres) alluvial soils and red earths are present along levee banks while deep (< 200 centimetres) yellow and brown podzolic soils are present along the back plains and deep (> 200 centimetres) alluvial soils and yellow earths on the terraces. The Yarramalong landscape is prone to flooding, seasonal water logging and creek bank erosion. The soils are commonly of low fertility (ERM 2001: 2.9).

One erosional soil landscape, the Gorokan soil landscape is present in small areas along the eastern margin of the current study area, situated between Woodburys Bridge and the Yarramalong alluvials. It is identified topographically by undulating low hills, long gently inclined slopes, extensive crests and ridges and broad drainage lines. Soils consist of light coloured lithic sandstone, pebbly in part, red brown and grey green claystone and siltstone with rare conglomerate. Local relief is less than 30 metres with slope gradients no more than 15 percent. The landscape in the Wyong area is usually partially cleared low open-forest. Soils are moderately deep (50-150 centimetres) soloths; yellow podzolic soils on crests and ridges; soloths, yellow podzolic soils and grey-brown podzolic soils on slopes and along drainage lines. The Gorokan soil landscape has high erodibility (especially along stream banks), seasonal waterlogging, low fertility and impermeable soils.

Woodburys Bridge, a residual soil landscape, commonly occurs in association with Mandalong, Watagan and Yarramalong landscapes and is in the eastern half of study area as well as along the Wyong River and Little Jilliby Jilliby Creek. It is characterised by gently undulating rises to rolling low hills on the Patonga Claystone. Local relief is 40-80 m with slope gradients up to 20 %. Sandstone capping on the crests of steeper hills is common and much of the Woodburys Bridge soil landscape is cleared tall open-forest.

Soils are generally by deep (>150 centimetres) red podzolic soils with some soloths in poorly drained areas on claystone bedrock; and shallow to moderately deep (50-150 centimetres) yellow podzolic soils on sandstone bedrock. This landscape is potentially prone to extreme erosion with high foundation hazards, seasonal waterlogging and comprising acid soils of low fertility (ERM 2001: 2.11)

2.1.4 Climate

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).

3.3 Current land uses and existing levels of disturbance

The Wyong area has been subject to a wide variety of documented land use practices since initial European settlement in the early 1820s. At that time large land grants of over 1000 acres were granted in the Dooralong Valley and by the 1840s land grants were given in the Ourimbah, Wyong and Jilliby areas. Accompanying European settlement was the inevitable need for timber – for housing, heating and cooking as well as for fencing. Hence the timber industry has been a major influence in the Wyong Valley throughout the 1800s with timber getters felling cedar, forest oak and rarer rainforest trees with the timber often being shipped to Sydney. By the 1880s, there were three timber mills operating in the Yarramalong Valley producing rims for wagon wheels, fruit cases and construction timber (ERM 2001: 2.14).

The incidental impact of the timber harvesting was the opening up of the valleys which attracted farmers and settlers who cleared the river flats in the 1850s. These were mainly subsistence farmers growing fruit and vegetables and grazing stock. By the 1860's, settlement incentives offered as part of the Robertson Land Acts attracted an influx of settlers along the Wyong River and its tributaries and Jilliby Jilliby Creek and by the 1880s most of the river flats of the valleys were cleared and under cultivation, with a particular focus on citrus orchards. With the opening of the Sydney/Newcastle railway in 1889, the population of Wyong increased, new timber mills opened and produce of the area become available to overseas markets as a result. The height of the timber industry was reached in the early 1900s when exports boomed, however by the late 1920s much of the local timber had been felled and the area exhausted (ERM 2001: 2.14).

Dairy farming became a major industry of the Wyong valleys in the 1930s, and by 1970 there were over 100 operational dairies in the area. Decline in this industry followed and

by 1995/6 no dairy farms were operational in the Wyong Valley. Poultry farming remained a smaller industry, which peaked in the 1960s.

Residential development significantly increased once the Sydney Freeway was opened in 1987. This brought an influx of hobby farmers and rural residential development centred on the Yarramalong Valley. Traditional large acreage agriculture has given way in the last twenty years to smaller hobby farms running stud and beef cattle, rural weekend retreats, market gardens, orchards, nurseries, horse studs and turf farms (ERM 2001:2.14).

Review of the past and present land use patterns within the current zero subsidence study area demonstrates that substantial parts of the landscape, especially along river flats and low slopes around the Yarramalong and Dooralong Valleys, have undergone significant physical modification as a result of European settlement. These activities have disturbed and/or destroyed any ecological niches that may have been located in the resource rich valleys in prehistory. Other processes of transformation have also no doubt been responsible for the modification / destruction of the environment, including increased erosion and soil movement as a result of tree clearance and agriculture as well as the altered hydrological impacts of flooding, both of which may have contributed to the disturbance and/or redistribution of topsoils.

4. DATABASE SEARCHES & LITERATURE REVIEW

4.1 Literature review

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

As previously noted there is a significant body of information directly related to this project. **Table 2** provides a summary of reports commissioned specifically for the development of the coal resource underneath the Wyong region 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

Company / Author / Year Finalised	Title	Specialist components	Comment
			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 within the current assessment is 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, which includes the zero subsistence zone Unfortunately OzArk has not been able to source this report.

ERM (1995a) Environmental Constraints Report. This assessment concentrated on the combined western and eastern mining leases and was 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 the current study area.

Open forest communities (Benson vegetation map - 9g) were noted as common throughout the central coast region (covering approximately 80,000 ha) however poorly protected, with only 240 ha within reserves and of this 170 ha in Forests NSW reserves (ERM 1995: 4.7). The community was noted as being of high conservation significance

due to its rich, floristically diverse structure and varied of habitats. 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 and is not directly applicable to the current assessment.

ERM (1997) Seagrass survey. This study assessed coal exploration study area C200 V200 – Tuggerah Lake, and is not directly applicable to the current terrestrial ecology assessment at W2CP.

ERM (1998) draft ecology Tooheys Rd (Precinct 15) and Pacific Power (not within the current study area) It is important to note that the study area for this assessment, whilst encompassing the Tooheys Rd study area, is much larger and incorporates land with issues or items of conservation significance that are not relevant for the current assessment. 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 the 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 species were detected:

- *Angophora inopina* (TSC Act, EPBC Act); and
- *Tetratheca juncea* (TSC Act, EPBC Act).

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). This study area is not directly relevant to the current assessment.

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

ERM (1999b) Wyong Areas Joint Venture Project proposed surface facilities. 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 OzArk (2007) study area.

- 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. 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. Note: the study size of the OzArk (2006) study area was 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 – Fresh water ecology studies were 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[1]) 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.

During a 1997 survey water quality tests by ERM in Spring Creek showed 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), while 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) Species Impact Statement (SIS). The following species at the surface facility areas to be impacted were assessed:

Flora (all listed in TSC and EPBC Acts):

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

[1] The Tinkling Frog is listed as a vulnerable species by DEWHA. Unfortunately the scientific name was not provided in the report (*Taudactylus rheophilus).*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.

- *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 not seen as significant due to a high recorded abundance of the species and in the event of appropriate mitigative measures being implemented. 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 surface facility 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 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 bat 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 study area (now proposed for potential conservation offsets).

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 for these species there would be a net loss of foraging (and winter flowering), den and breeding habitat at the Tooheys Rd and Hue Hue Rd study area (now the ecological offset investigation area), fragmentation of habitat would occur 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 as a result of 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 previously proposed site development options).

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 waterways, that are most at risk due to the associated impacts of subsidence; and
- Additional aquatic surveys are required for fish species in both surface facility 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 environmental 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, showed a number of vegetation types as having significant conservation value (Appendix 1: 49). It was noted 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 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 coat 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 this 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 potentially requisite(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 listed in **Table 2** and summaries are presented below:

Forest Fauna Surveys & Eastcoast Flora Survey (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 over a corridor within the Tooheys Rd study area. Salient points of the results are:

Vegetation communities:

- Six main vegetation types were recorded over the Tooheys rd study area using data supplied by the Lower Hunter & Central Coast Regional Environmental Management Strategy (LHCCREMS). This classification scheme broader than that 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.

As a result of the gas pipeline study no Endangered Ecological Communities were identified in 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 the 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 corridor 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 the Striped 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. (Hunter Water Pipeline) Slightly less than a quarter of this assessment was undertaken on property owned by WACJV in the study area. The main trunk line alignment was at the western end of the Tooheys Rd study area and ran parallel to the F3. 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 locally occurring Endangered Ecological Communities. 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.

Reviewing the location of previously recorded EEC's was not fruitful due to differences in vegetation community descriptions and classifications being used.

4.2 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 1:25 k 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 and then mapped using the DECCW wildlife atlas.

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.

As noted above, determining the location and extent of EEC's in the Wyong LGA was problematic due to different methods employed to describe vegetation over the years. To properly address the presence of EEC's in the study area vegetation mapping within the zero subsidence line was undertaken. The map generated from this process will be presented in the results section of this report.

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

- *Tetratheca juncea*;
- *Melaleuca biconvexa*; and
- *Grevillea parviflora* spp *parviflora*;

The locations of threatened plants in the Wyong LGA can be seen in **Figure 7** with those occurring within the zero subsidence line seen as **Figure 8.** It is important to remind the reader that the pattern of documented distribution is influenced by previous survey efforts, i.e. developed areas theat have undergone assessment show recordings while lands that have not been previously developed will have fewer such records. Nonetheless, these records presented however, are use to indicate similarities in landforms and potential for species to occur in the current study area.

Several threatened species of fauna are known to occur in the zero subsidence line (**Figure 10**) these include:

- Giant Barred Frog (*Mixophyes iterates,* TSC Act);
- Stuttering Frog (*Mixophyes balbus,* TSC Act, EPBC Act);
- Grey-headed Flying-Fox (*Pteropus poliocephalus,* TSC Act, EPBC Act);
- Spotted-tailed Quoll (*Dasyurus maculates,* TSC Act, EPBC Act);
- Masked Owl (*Tyto novaehollandiae*, TSC Act; and
- Black-necked Stork (*Ephippiorhynchus asiaticus*, TSC Act).

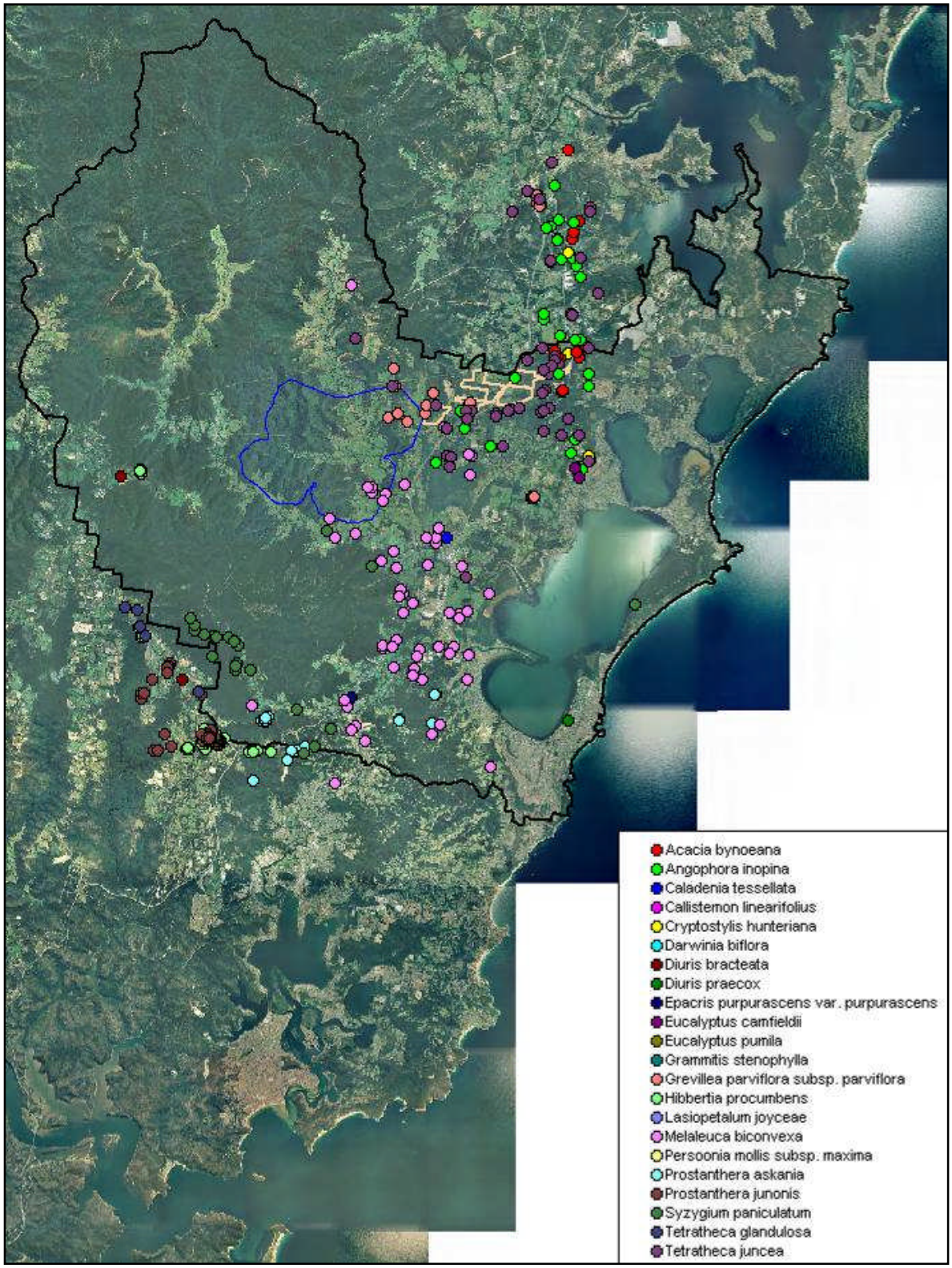
Those species recorded outside the zero subsidence line but within the same landform units (i.e. treed hills and cleared valleys) include (**Figure 9**):

- Sooty Owl (*Tyto tenebricosa,* TSC Act);

- Powerful Owl (*Ninox strenua,* TSC Act);
- Barking Owl (*Ninox connivens,* TSC Act);
- Koala (*Phascolarctos cinereus,* TSC Act);
- Black Bittern (*Ixobrychus flavicollis,* TSC Act);
- Australasian Bittern (*Botaurus poiciloptilus,* TSC Act);
- Giant Burrowing Frog (*Heleioporus australiacus,* TSC Act, EPBC Act);
- Glossy Black Cockatoo (*Calyptorhynchus lathami,* TSC Act);
- Gang Gang Cockatoo (*Callocephalon fimbriatum,* TSC Act);
- Regent Honeyeater (*Xanthomyza phrygia* TSC Act, EPBC Act);
- Greater Broad-nosed Bat (*Scoteanax rueppellii,* TSC Act);
- Eastern Falsistrelle (*Falsistrellus tasmaniensis,* TSC Act);
- Little Bentwing Bat (*Miniopterus australis,* TSC Act);
- Large Footed Mytosis (*Mytosis adversus,* TSC Act);
- Yellow-bellied Sheathtailed Bat (*Saccolaimus flaviventris,* TSC Act) tentative sighting only*;*.
- Squirrel Glider (*Petaurus norfolcensis,* TSC Act);
- Yellow-bellied Glider (*Petaurus australis,* TSC Act);
- Wallum Froglet (*Crinia tinnula,* TSC Act); and
- Green-thighed Frog (*Litoria brevipalmata,* TSC Act);.

With regard to Migratory Wetland Species listed by DEWHA, species previously recorded in the Wyong LGA can be seen of **Figures 11 & 12**. As can be seen, the Fork-tailed Swift, Latham's Snipe, Cattle Egret, Rufous fantail and Black-faced Monarch have all been previously recorded within the zero subsidence line.

Figure 7: Threatened flora in the area of the Wyong LGA (black) and the zero subsidence line (blue) (Source: Eastcoast Flora Surveys).



Note: Proposed surface facilities and ecological offset investigation area are outlined in salmon.

Figure 8: Threatened flora within and near the zero subsidence line (blue) (Source: Eastcoast Flora Surveys).

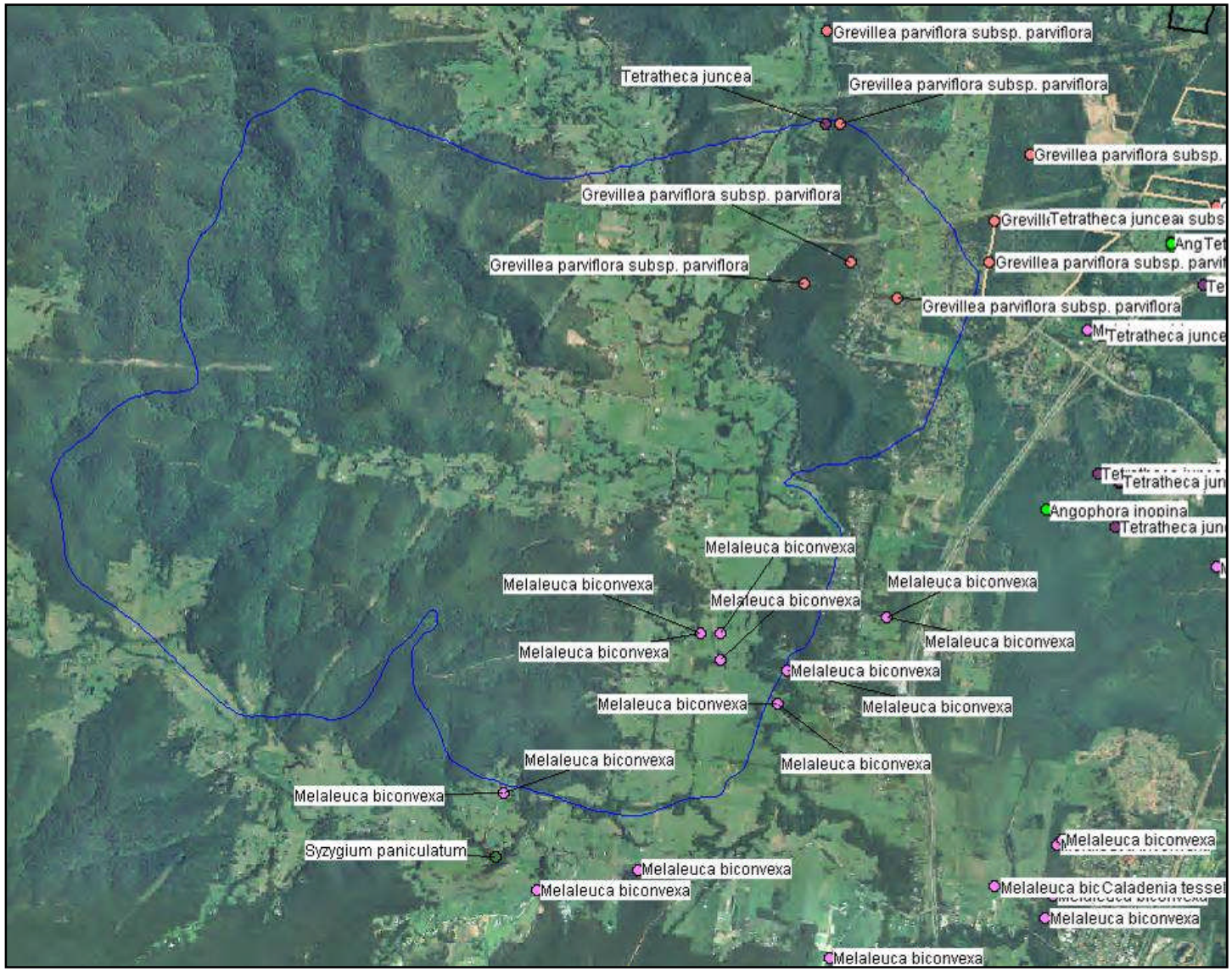
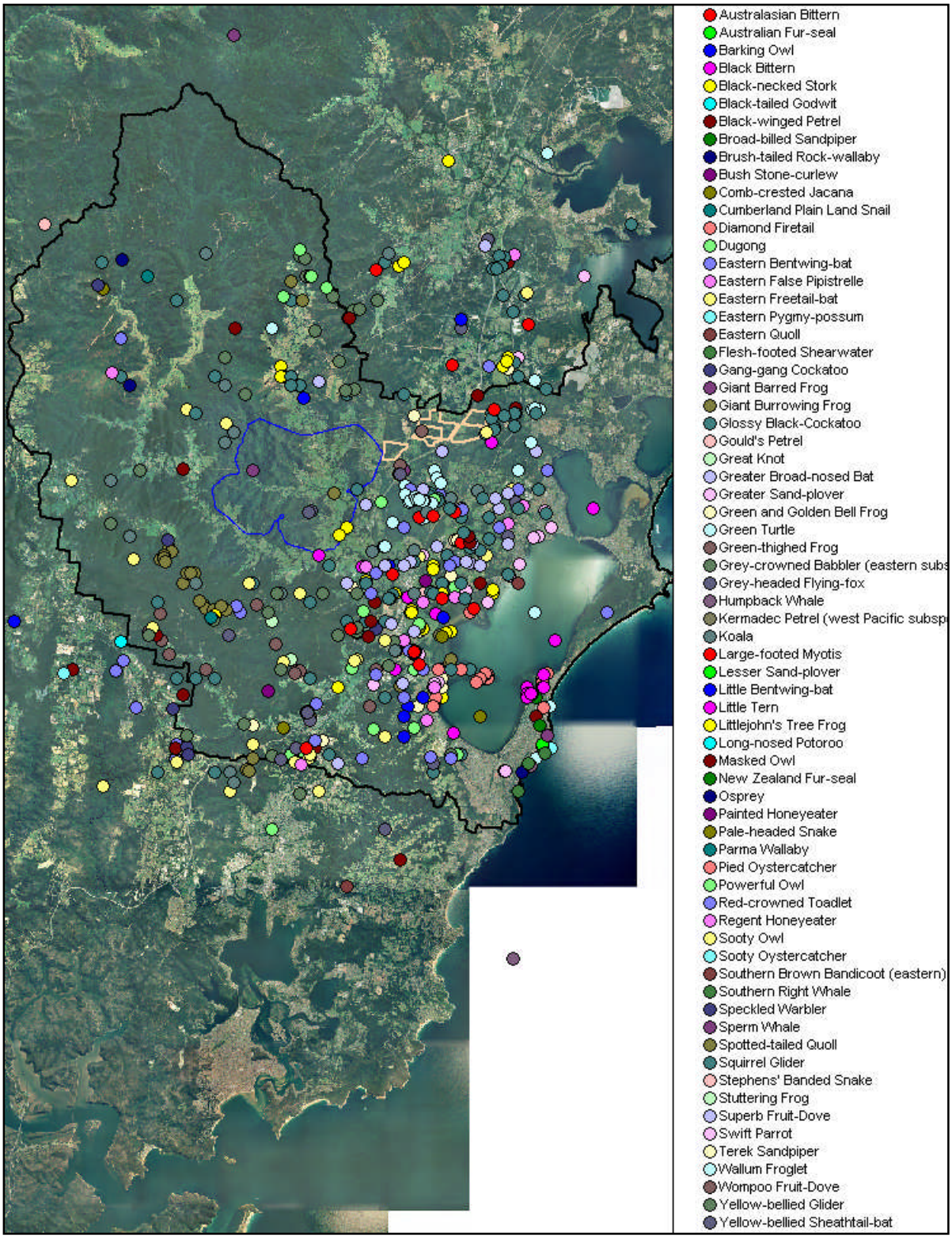


Figure 9: Threatened fauna within the Wyong LGA (black). The zero subsidence line is shown in blue and proposed surface facilities and ecological offset investigation area in salmon (Source: Eastcoast Flora Surveys).



Note: Proposed surface facilities and ecological offset investigation area are outlined in salmon.

Figure 10: Threatened fauna within the zero subsidence line (blue) (Source: Eastcoast Flora Surveys).

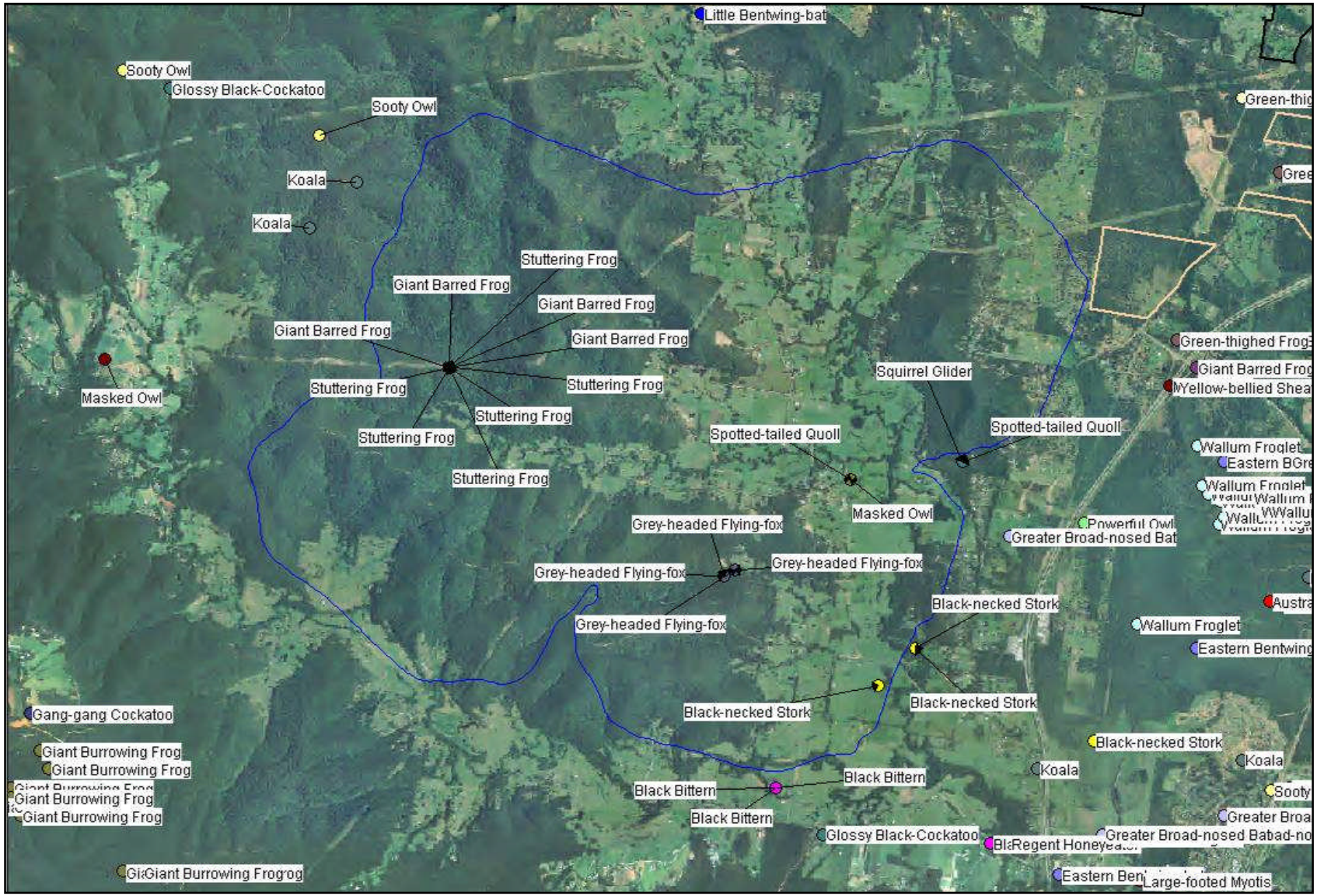


Figure 11: EPBC Migratory Wetland and Marine Species (Base map source: BioNet)

Figure 11 (continued)

Figure 11 (continued)

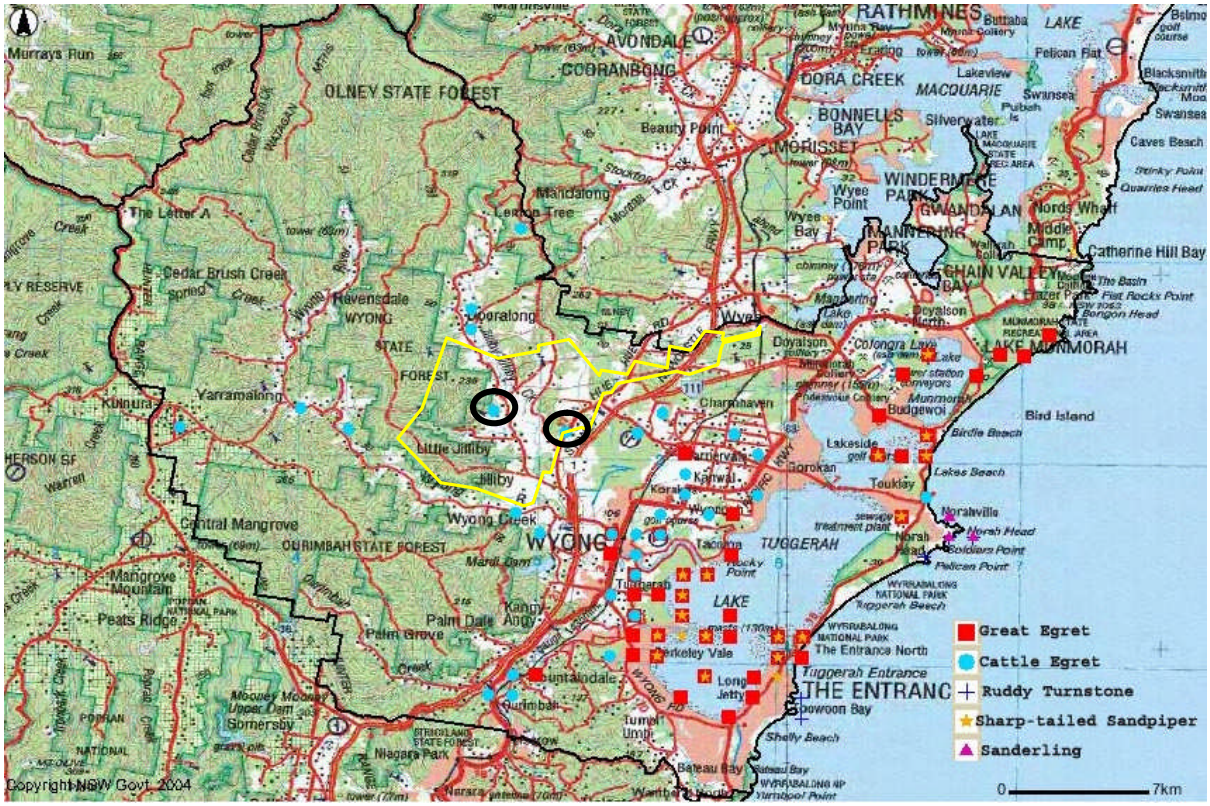
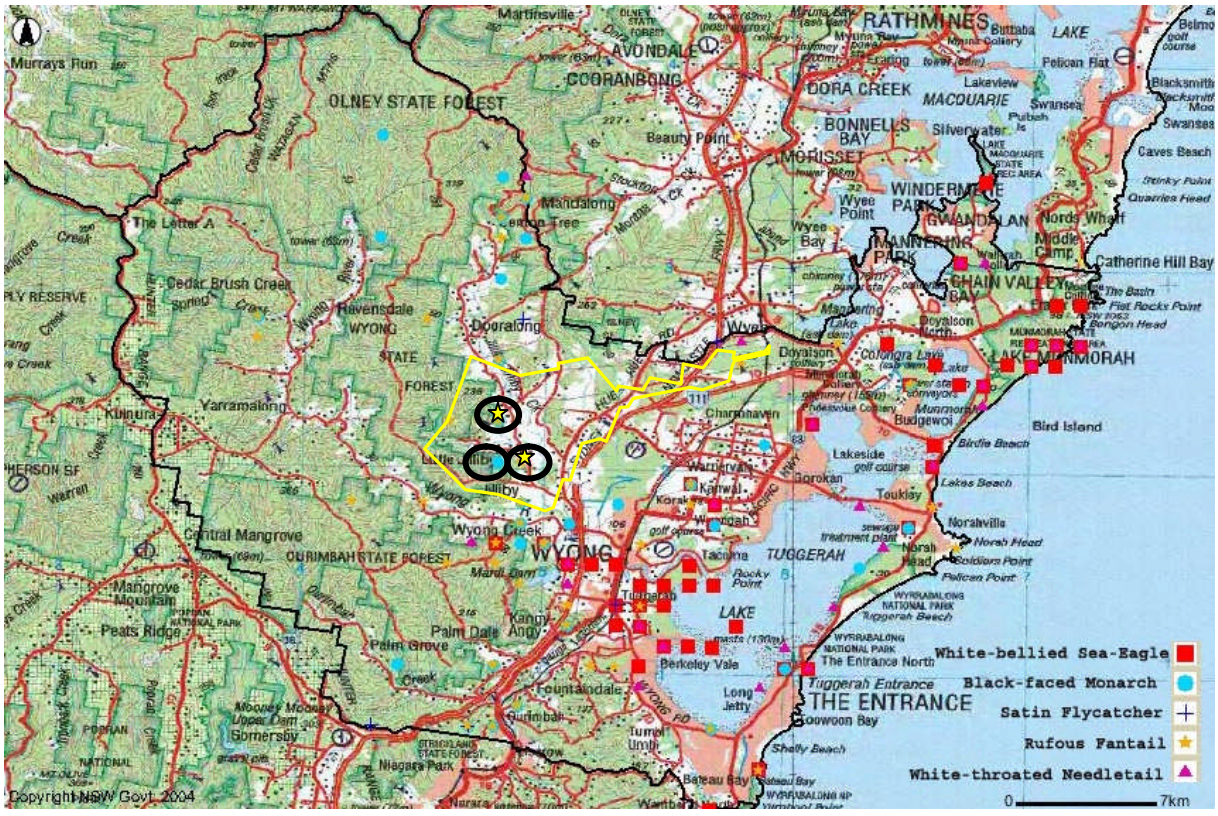


Figure 12: EPBC Migratory Terrestrial Species (Source: BioNet)



4.3 Bioregional, regional and local scale conservation

4.3.1 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.

4.3.2 Region

The Wyong Shire Council strategic planning department commissioned the Wyong Conservation Strategy (WCS). The draft 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 the WCS 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.

4.3.3 Local area

The Jilliby State Conservation Area and Wyong State Forest occurs in part within the forests hills of the W2CP project. There are no other local conservation reserves in the immediate vicinity of the study area.

4.3.4 Regional conservation reserves

The Department of Environment & Climate Change 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***

4.4 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.

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 Shire's 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.

5. IMPACT ASSESSMENT CONSIDERATIONS

5.1 The impact assessment process

There are two independent mechanisms used to determine the significance of an impact, one at state level and the other at a national level:

- 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; 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.

5.2 Overview of subsidence implications

Subsidence is predictable such that damage to buildings and other civil structures can be prevented or moderated (Darmody n.d:153). Because of its efficiency, safety and predictability, longwall mining is the method of choice for high extraction coal mining. Its use is increasing, however it has higher start-up equipment costs and fears of planned subsidence hinder its acceptance in the community (DuMontelle *et al*., 1981).

Higher extraction mining methods include retreat mining and longwall mining. Longwall mining is more efficient than either room, pillar or high extraction retreat mining as all of the coal within the mine panel is removed with a continuous longwall mining machine.

The subsidence pattern at the surface is a reflection of the coal extraction pattern underground in the coal mine which varies from mine to mine due to the depth of the seam, width of the panel and associated geology between the seam and the surface. While most of the subsidence associated with longwall mining occurs promptly, slight residual subsidence may continue as long as three years

(Darmody n.d:153). Within NSW, alteration of habitat following longwall mining has been listed as a key threatening process by the NSW Scientific Committee.

Shallow tension cracks in the soil may appear at the soil surface in some circumstances as the dynamic subsidence passes a given spot. Cracks at the advancing edge close, due to compression after the area fully subsides. Some cracks along the panel edges may persist until the adjacent panel is extracted (or until remediated) because they are in a tensile-strained area between the unsubsided ground beyond the panel and the subsided panel center). Any soil cracking will be independent of and not hydraulically connected to hard rock cracking at deeper levels in the geological profile nearer the coal seam.

The key possible effects of subsidence on the surface that could have ecological implications relate to:

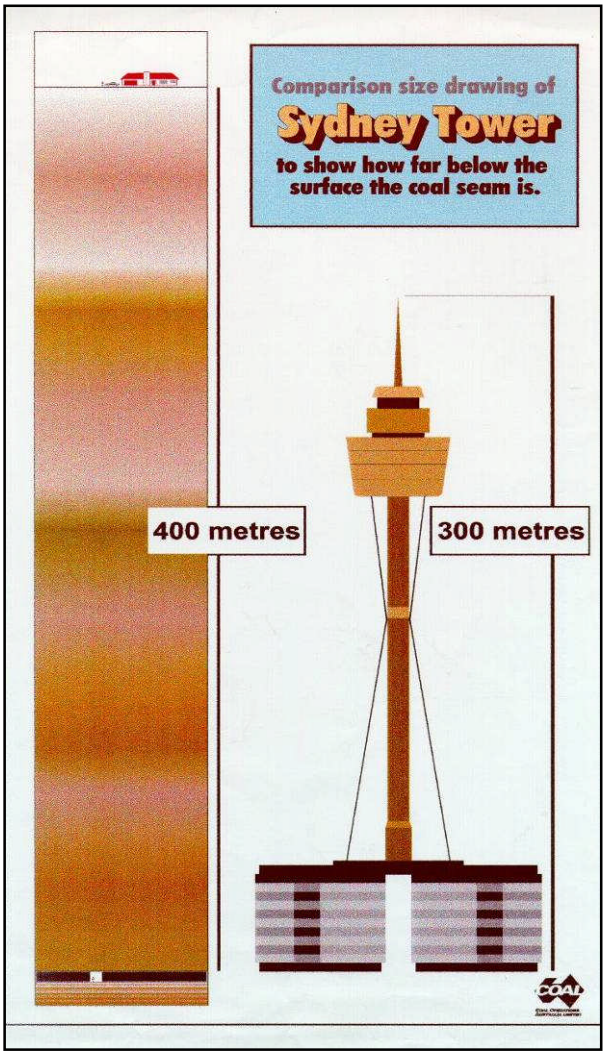
- the potential for, and nature of, any surface soil cracking;
- the potential for localized topographic change or differential lowering of ground surfaces to alter slopes, soil moisture, drainage conditions and flooding;
- the potential for changes to river profile, such as ponding;
- the potential for any changes to near-surface groundwater conditions in the alluvial areas; and
- the potential for any risks to stability of major rock outcrops.

Information from specialist subsidence study (WACJV 2008), flooding study (ERM 2008) and groundwater study (MER 2008) indicate the following impacts from subsidence:

- there will be no discernible troughs developed along longwall centrelines due to the existing variation in topography, and thus no significant potential for additional ponding in floodplain surfaces;
- no major clifflines occur in the mining area;
- minor additional areas subject to flooding will not affect areas of significant native vegetation (as it will primarily be located in cleared agricultural land);
- minor additional ponding may occur to parts of Jilliby Jilliby Creek's existing ponding conditions but streambed lowering will be less than 1.2 m and there will be only very gradual changes to bed slope;
- the managed subsidence behaviour due to mine plan design will ensure that no significant impacts will occur to alluvial aquifers and regional soil moisture conditions;
- soil and sediments in the floodplain area are highly resilient and are unlikely to result in any cracking of concern or of a permanent nature.

Further information on the subsidence, flooding and groundwater issues are fully discussed in the respective specialist studies in the Environmental Assessment.

Figure 12: Comparative diagram showing the depth of the Wallarah seam from the surface which varies according to location. (Source: W2CP).



- Average depth within Dooralong Valley is about 410 m (shown)
- Depth beneath Watagan Forest ranges from about 450 to 650 m
- Depth beneath Yarramalong Valley ranges from 500 to 550 m

6. VEGETATION WITHIN THE SUBSIDENCE ZONE

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

6.1 Significant flora in the Wyong 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 1,278 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 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 *Tetratheca juncea* (Driscoll 2003) and sizeable new populations have been discovered.

Bell (2004) surveyed and mapped the distribution of the 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.

Information on the distribution and habitat of the 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 endangered *Hibbertia procumbens* (Bell 2002; Bell & Driscoll 2005) and the vulnerable *Cryptostylis hunteriana* from the Wyong area (Bell 2001a). Information in these papers summarises the known habitat of both these species from throughout their known ranges and provides suggested conservation measures. 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). The NSW Scientific Committee has made a final determination to support a proposal to list this species (Wyong Sun Orchid) as Critically Endangered.

Driscoll (2006) has collated all available information on the endangered *Acacia bynoeana* in the region, incorporating Wyong-specific studies detailed in Bell and Driscoll (2002). A review of regional records of the vulnerable *Rutidosis heterogama* is contained in Bell and Driscoll (2004).

6.2 Methods

6.2.1 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. A live feed to a laptop computer, running Manifold© GIS, records locational information in real-time. At specific and regular locations, summaries of the vegetation are entered onto a spreadsheet linked to the GIS. 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 2006a) and on the Tomago Sandbeds (Bell & Driscoll 2006b).

Floristic survey & data analysis

Given the limited access to privately owned remnant vegetation within the subsidence zone, no additional plot sampling or analysis was undertaken. In its place, reliance was placed on the floristic classification undertaken for the Wyong LGA and reported on in Bell (2002a), and all remnant vegetation present in the study area was attributed the appropriate community code based on key indicator species detailed in that work.

6.2.2 Threatened flora species survey

Rationale

Survey method

Targeted survey for threatened plant species was restricted by access constraints to private property. In the main, such searches were undertaken along public roads and other access points during the mapping phase. 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 *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, zone 56 (GDA94, z56).

6.2.3 Survey for endangered ecological communities

Rationale

As part of general flora and mapping surveys, areas of the site were examined in the light of the following Endangered Ecological Communities which are present within the forest 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).

More recently, consideration was also given to the possibility of the Lower Hunter Spotted Gum – Ironbark Forest EEC being present within the study area, and is the subject of a separate report. This EEC is currently undergoing a review on behalf of the DECCW, with parts of the northern Wyong LGA supporting vegetation with strong affinities to that in the lower Hunter Valley.

Survey method

Assessment of the presence of any EEC was based principally on general reconnaissance of the study area, as in most cases access to private lands to examine floristic composition was not possible. 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.

6.3 Results

6.3.1 Vegetation communities in the study area

Definition of vegetation communities within the subsidence zone was based on previous survey and analysis for the Wyong LGA (Bell 2002a). Limited access to most stands of remnant vegetation present due to private ownership meant that new floristic data could not be collected, and a re-analysis of such data was not undertaken. Key indicator species, as defined in Bell (2002a), were used to attribute each stand of vegetation to a particular vegetation unit. Mapped vegetation units within the subsidence zone can be seen on **Figure 14** and the extent in the study area seen on **Table 4.** The following descriptions are based on observations made from publicly accessible roads, together with vegetation unit descriptions contained in Bell (2002a).

MU15: Alluvial Footslopes Redgum Forest (Bell 2002a)

Small remnants of Alluvial Footslopes Redgum Forest are present principally in the southern sections of the study area, although prior to clearing it would have been quite extensive along the floodplains. In nearly all cases, these remnants are characterised by small groups of *Eucalyptus amplifolia* and/ or *Angophora floribunda* over a highly cleared or modified understorey, such as with the establishment of turf farms. In some areas, sub-canopies of *Melaleuca linarifolia, Melaleuca biconvexa* or *Melaleuca decora* may also be present, and 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 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).

MU19: Alluvial Woollybutt-Melaleuca Sedge Forest (Bell 2002a)

A few small pockets of Alluvial Woollybutt-Melaleuca Sedge Forest occur in the eastern sections of the study area, and originally would have formed a continuum of similar vegetation extending to the south towards Porters Creek Wetland. It is dominated by *Eucalyptus longifolia* (regionally uncommon), together with paperbarks such as *Melaleuca linarifolia, Melaleuca nodosa, Melaleuca sieberi* and *Melaleuca decora*. In intact examples, sedges such as *Schoenus brevifolius, Lepidosperma quadrangulatum* and *Chorizandra cymbaria* are prominent, along with scattered shrubs such as *Melaleuca thymifolia* and *Leptospermum juniperinum*. In areas where partial clearing has occurred, such as along Dickson Road, *Melaleuca nodosa* responds in the form of dense thickets. Within Wyong LGA, Alluvial Woollybutt-Melaleuca Sedge Forest is highly restricted to the Porters Creek catchment, and estimates of 70% loss have been made (Bell 2002a). Within the regional NPWS classification (2000), this community falls into the Wyong Paperbark Swamp Forest. Alluvial Woollybutt-Melaleuca Sedge 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 a single location in the study area, in a small patch of vegetation near Dickson Road. Although occurring on private property and not inspected, it is evident that the canopy is dominated by *Eucalyptus robusta*, with a sub-canopy of *Melaleuca linariifolia* and *Melaleuca decora* also apparent. The understorey is characterised by a dense layer of sedges and grasses, a scattered shrub layer of (probably) *Leptospermum juniperinum, Gahnia clarkei* and juvenile *Melaleuca linariifolia* and *Eucalyptus* species. 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. 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).

MU28: Narrabeen Buttonderry Footslopes Forest (Bell 2002a)

Narrabeen Buttonderry Footslopes Forest occurs in the north-eastern section of the study area, where it forms a mosaic pattern with Narrabeen Dooralong Spotted Gum - Ironbark Forest. 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). 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, there has been an estimated loss of 47% in distribution since 1750 for this community (Narrabeen Buttonderry Footslopes Forest: Bell 2002a).

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

Narrabeen Dooralong Spotted Gum-Ironbark Forest occurs extensively across the study area. This community is dominated by Spotted Gum (*Corymbia maculata*) and Ironbarks (predominately *Eucalyptus fibrosa* at lower elevations, or *Eucalyptus fergusonii* and *Eucalyptus placita* at higher elevations), 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. Regionally, this vegetation type is equivalent to (at higher elevations) Coastal Foothills Spotted Gum – Ironbark Forest (MU15) or (at lower elevations) Lower Hunter Spotted Gum-Ironbark Forest (MU17) in NPWS (2000). Bell (2002a) has estimated that the Narrabeen Dooralong Spotted Gum – Ironbark Forest within Wyong Shire has undergone a 53% loss in extent since 1750.

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

Coastal Range Moist Layered Forest represents a vegetation type that is widespread in the western half of the Wyong LGA, and quite extensive within the current study area. 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*.

NPWS (2000) describe Coastal Ranges Open Forest, which equates to this community elsewhere in the region. Bell (2002a) has estimated a 21% loss of this vegetation type within the Wyong LGA.

MU 40: Riverine Alluvial Gallery Rainforest-Moist Forest (Bell 2002a)

Riverine Alluvial Gallery Rainforest-Moist Forest occurs only on the deeper alluvium associated with the larger streams, and it merges into MU42 higher up in the catchment where Narrabeen Sediments are found. It often forms narrow zones restricted to the immediate creek line environment. This vegetation type is prone to weed invasion, particularly Camphor Laurel (*Cinnamomum camphora*) and Privet (*Ligustrum* spp.). Native species characterising this vegetation type include emergent *Eucalyptus saligna, Syncarpia glomulifera* subsp. *glomulifera* or *Eucalyptus deanei*, over a canopy of *Acmena smithii, Alphitonia excelsa, Cryptocarya glaucescens, Cryptocarya microneura, Guioa semiglauca, Alectryon subcinereus, Symplocos stawellii, Melicope micrococca, Wilkea heugeliana,* and *Daphnandra* sp. A. Understorey vegetation is usually sparse, but the climbers *Morinda jasminoides, Dioscorea transversa, Cissus antarctica* and *Geitonoplesium cymosum* are common. NPWS (2000) have identified this vegetation type as a specific form of their Coastal Wet Gully Forest (MU1). Within Wyong LGA, Bell (2002a) has estimated a 16% loss of this community regionally since 1750 (83.4% loss locally). Riverine Alluvial Gallery Rainforest-Moist Forest forms part of the Lowland Rainforest in the NSW North Coast and Sydney Basin EEC.

MU 42: Narrabeen Warm Temperate-Subtropical Rainforest (Bell 2002a)

Narrabeen Warm Temperate-Subtropical Rainforest occurs in the ranges to the west of the Jilliby Valley, and occurs extensively outside of the study area elsewhere. It is restricted to the protected south-to-easterly facing gullies and lower slopes along the escarpment. A variety of tree species co-dominate these rainforests, although the more typical ones include *Acmena smithii, Doryphora sassafras, Cryptocarya glaucescens, Ceratopetalum apetalum, Eucalyptus saligna, Alphitonia excelsa, Syncarpia glomulifera* subsp. *glomulifera, Guioa semiglauca, Neolitsea dealbata, Synoum glandulosum, Sloanea australis, Syzygium oleosum, Wilkea huegeliana, Caldcluvia paniculosa, Polyosma cunninghamii, Dysoxylon rufum,* and *Syzygium australe*. Understorey vegetation is typically sparse although ferns and climbers are normally prominent. Subtropical influences include epiphytic species (e.g.: *Arthropteris tenella, Microsorum pustulatum, Hymenophyllum australe, Asplenium australasicum* forma *australasicum, Microsorum scandens, Platycerium bifurcatum* var. *bifurcatum, Pyrrosia rupestris*), tree ferns (*Cyathea leichhardtiana, Cyathea australis, Cyathea cooperi*) and palms (*Archontophoenix cunninghamiana, Livistona australis*). This vegetation type equates to the Coastal Warm Temperate-Subtropical Rainforest of NPWS (2000). Within Wyong LGA, a 16% loss since 1750 (20.3% loss locally) has been reported (Bell 2002a).

MUXr: Canopy-only vegetation

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'.

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.

MUW: Water body

Bodies of water that do not appear to be directly attributable to farm dams are marked as "W" in the accompanying mapping. Examples of these include billabongs and other bodies of water associated with the major creeks, and are likely to be natural.

6.3.2 Groundwater Dependant Ecosystems recorded in the study area

MU 40, Riverine Alluvial Gallery Rainforest-Moist Forest is reliant on deep alluvium in close proximity to a permanent water source, and in this context may be considered a Groundwater Dependent Ecosystem. The current extent of this community has been mapped on **Figure 13**.

6.3.3 Vegetation within the Jilliby State Conservation Area and Wyong State Forest

The location of the Jilliby SCA and Wyong State Forest is shown of **Figure 2a**. Approximately 1158 ha of native vegetation within the subsidence area occur within the Jilliby State Conservation Area and 640 ha occur within the Wyong State Forest.

Breakdown of vegetation types and number of hectares is provided below:

	SCA (ha)	State Forest (ha)
Total in subsidence area[2]	*1158*	*640*
XS (Disturbed Regrowth)	14	7
MU42 Narrabeen WTSR	292	91
MU40 Riverine AGRMF		1
MU35 Coastal Ranges MLF	470	310
MU30 Dooralong SGIF	349	219
Total MU in ha	*1124*	*628*

[2] Difference between number of ha in subsidence line versus number of ha in Mapped Vegetation Units (MU's) is due to the volume of un-identified areas along roads and tracks.

Figure 13: Vegetation map showing the current extent of the current 1:100 year flood inundation.

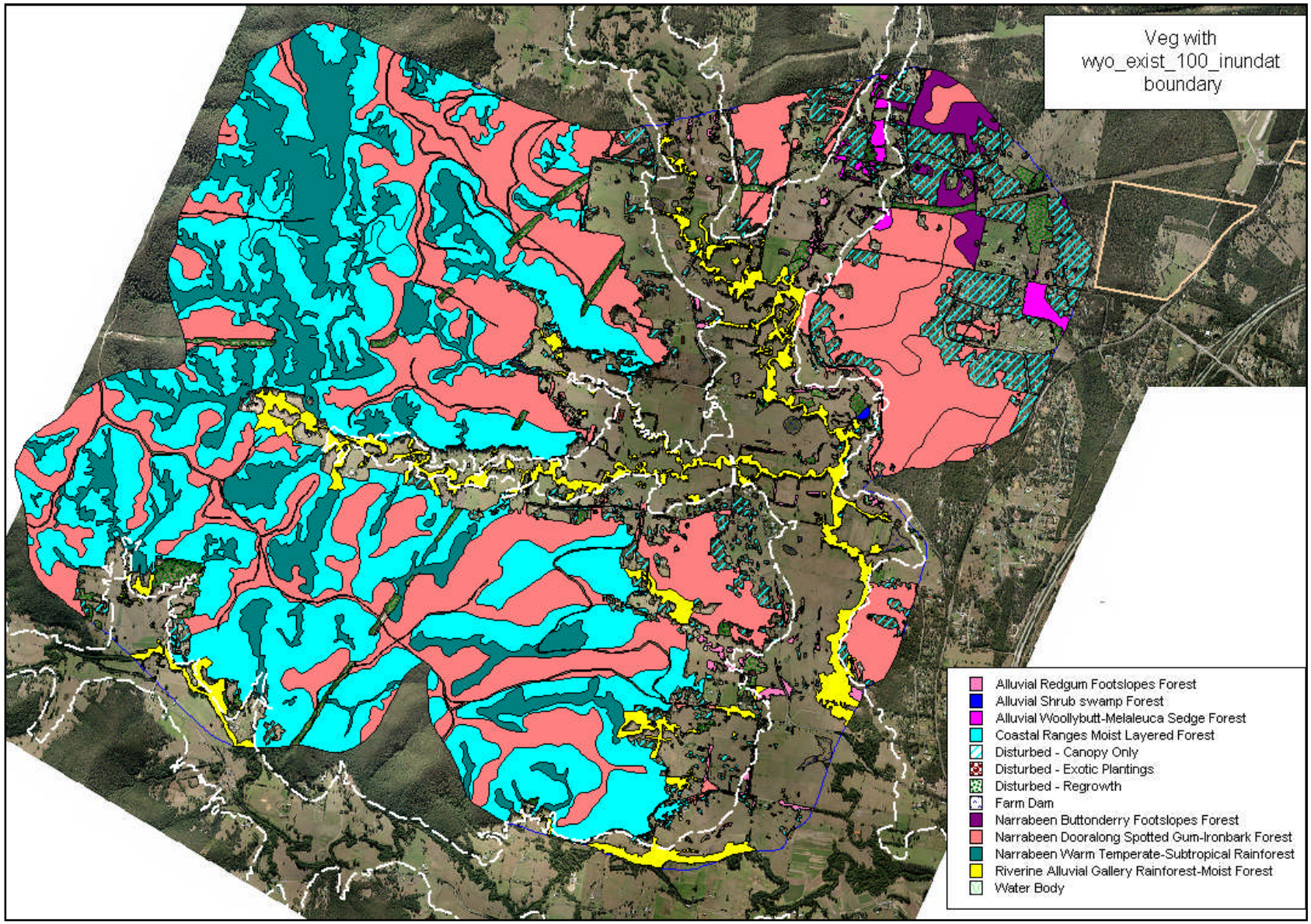


Figure 14: Predicted changes - 1:100 year flood inundation. (1% flood)

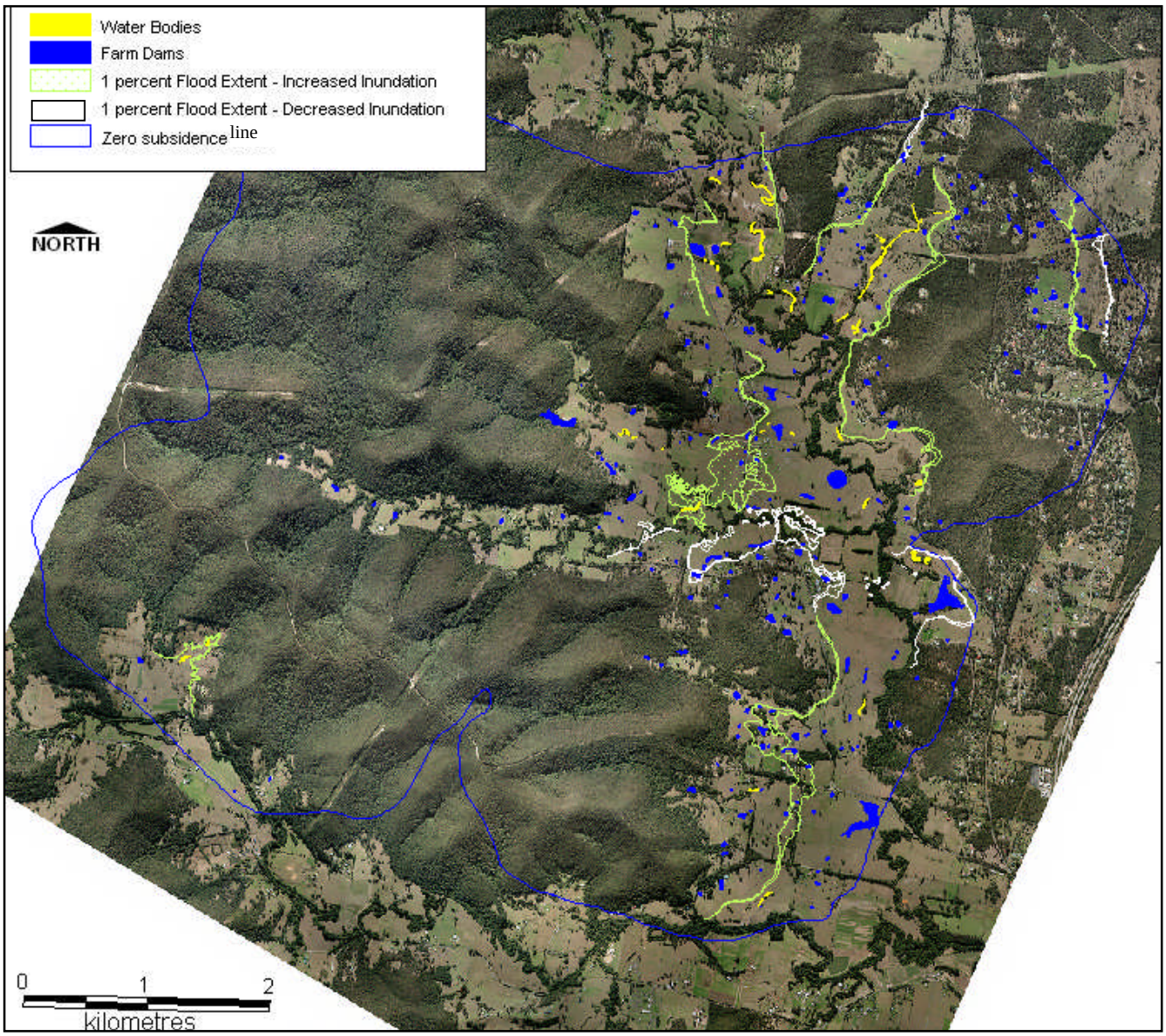


Figure 15: Predicted changes - 5:100 year flood inundation. (5% flood or 1 in 20 yr flood)

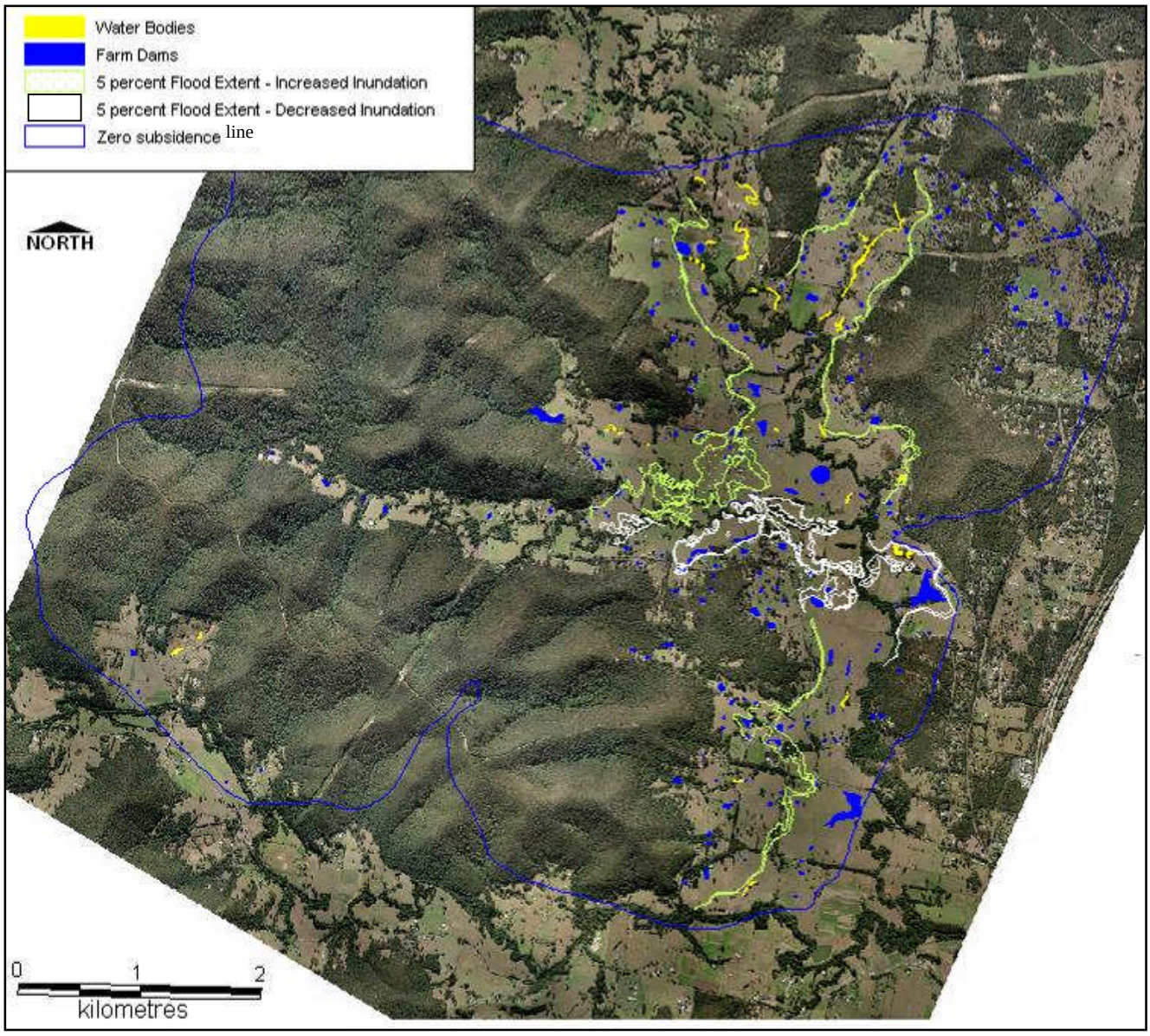


Figure 16: Predicted changes - 20:100 year flood inundation. (20% flood or 1 in 5 yr flood)

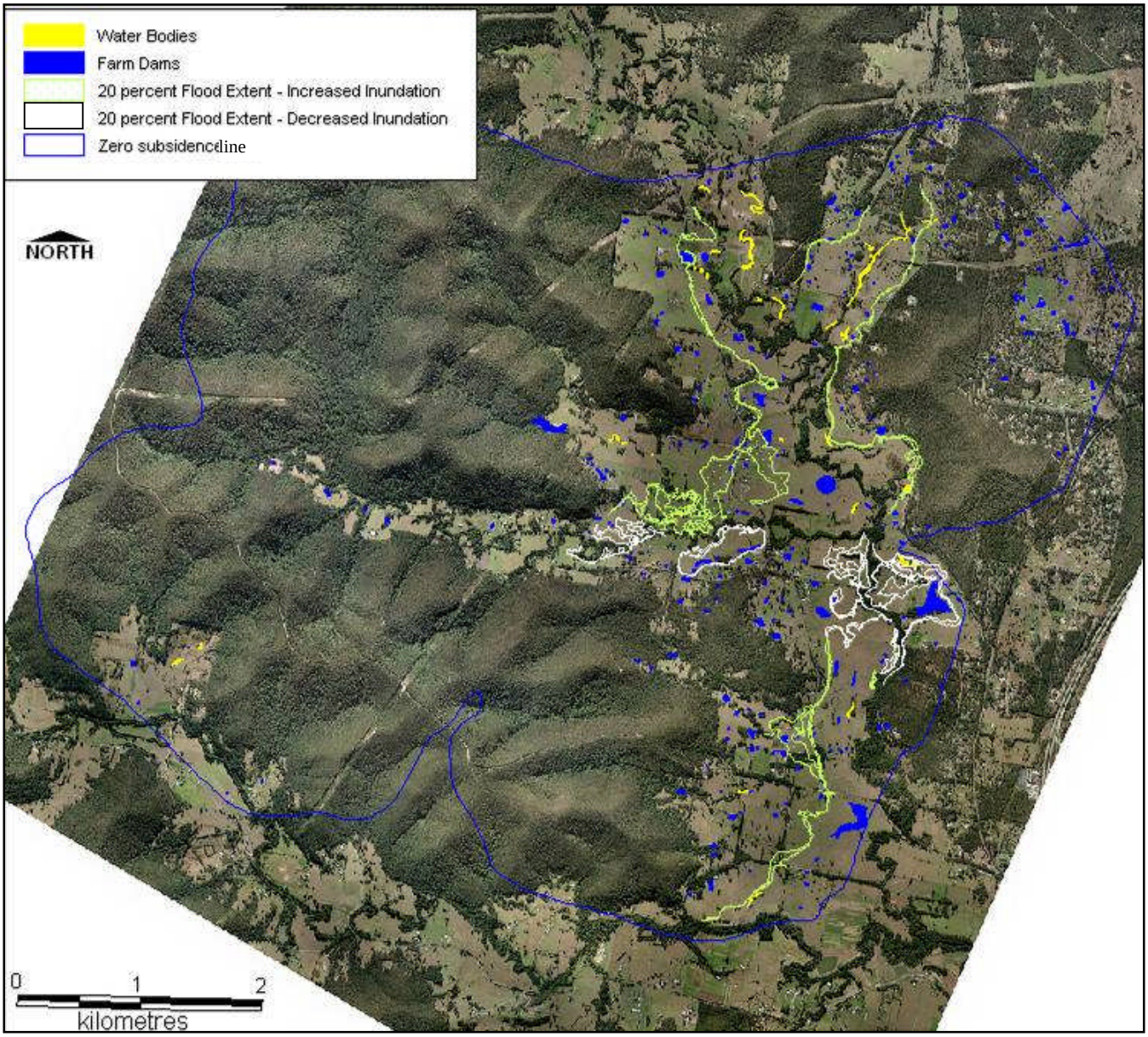


Table 4: Extent of native vegetation within the LGA, proposed subsidence area and its relationship to flood levels (current and future floods similar in extent of affect on vegetation types).

Vegetation Community		Signif.	Extant LGA	Existing mine study area	1% flood extent		5% flood extent		20% flood extent	
MU	**Name**		**ha**	**ha**	**ha**	**% of extant**	**ha**	**% of extant**	**ha**	**% of extant**
15	Alluvial Footslopes Redgum Forest	State	145	19.11	14.02	73.4	11.71	61.3	9.87	51.6
19	Alluvial Woollybutt-Melaleuca Sedge Forest	State	308	17.72	14.71	83.0	8.44	47.6	8.36	47.2
20a	Alluvial Floodplain Shrub Swamp Forest (variant a)	State	895	0.72	0.72	100.0	0.72	100.0	0.72	100.0
28	Narrabeen Buttonderry Footslopes Forest	Local	1016	34.30	0.07	0.2	0.03	0.1	0.02	0.1
30	Dooralong Spotted Gum-Ironbark Forest	Local	2215	1019.00	3.13	0.3	1.92	0.2	1.07	0.1
35	Coastal Foothills Moist Layered Forest	-	23440	998.75	3.21	0.3	2.30	0.2	1.76	0.2
40	Riverine Alluvial Gallery Rainforest-Moist Forest	State	565	163.01	116.12	71.2	112.48	69.0	108.22	66.4
42	Narrabeen Warm Temperate-Subtropical Rainforest	-	4386	398.05	2.65	0.7	1.86	0.5	1.19	0.3
D	Farm Dams	-	-	25.56	14.70	57.5	13.53	52.9	12.80	50.1
W	Water Bodies	-	-	3.85	3.80	98.7	3.80	98.7	3.80	98.7
Xr	Unspecified Canopy only	-	-	238.82	21.44	9.0	18.28	7.7	16.91	7.1
Xs	Unspecified regrowth	-	-	74.37	28.36	38.1	15.11	20.3	13.77	18.5
Totals	-	-	-	***2994.64***	***222.93***	***7.45***	***190.18***	***6.35***	***178.49***	***5.96***

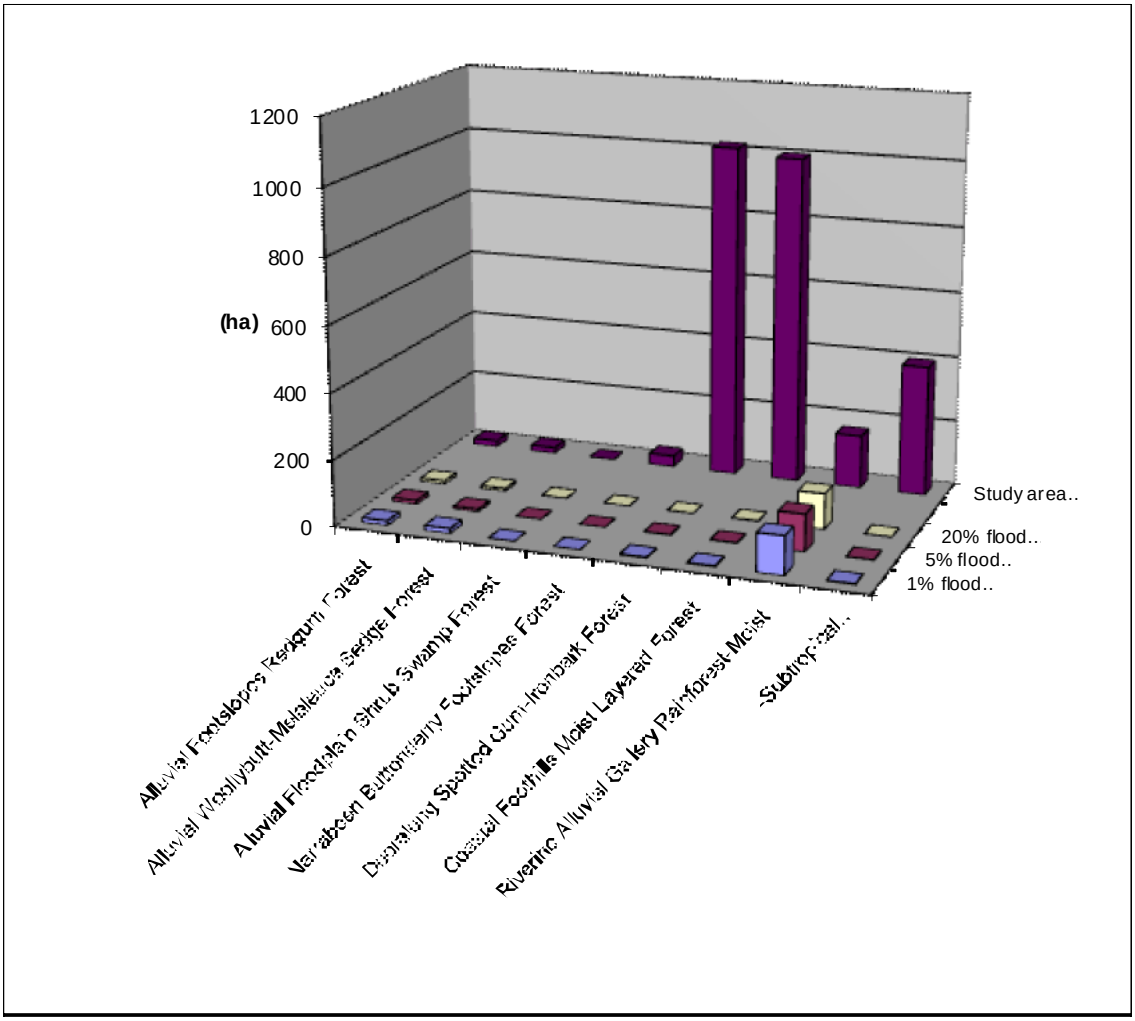
6.4 Discussion

6.4.1 Impacts to vegetation communities

No vegetations communities listed under the EPBC Act were recorded, as such no further discussion of these nationally listed communities is requisite.

Figures 15 to **17** show which of the eight native mapped vegetation communities in the study area will be potentially impacted upon by changes in flooding regimes due to mine subsidence and **Table 4** provides quantification and legislative status for each map unit. It indicates that only 7.45% of the existing natural vegetation in the study area is currently subject to flooding in the 1:100yr (1% AEP) flood and the vast majority of this vegetation is also subject to flooding in smaller floods (1:5yr or 20% AEP events). Modelling completed by ERM and WACJV for 1:100yr, 5:100yr (5% AEP) and 20:100yr (20% AEP) flooding regimes shows that the range of existing flooding events primarily affect the Riverine Alluvial Gallery Rainforest-Moist Forest, with minor effect on Alluvial Floodplain Shrub Swamp Forest, Alluvial Woollybutt-Melaleuca Sedge Forest and Alluvial Footslopes Redgum Forest. All four of these communities occur on floodplain alluvium and equate to existing EEC's. Other communities occupy little or none of the land surface within the three current or future flood zones.

Figure 17: Vegetation types within the subsidence area and existing flooding regimes.



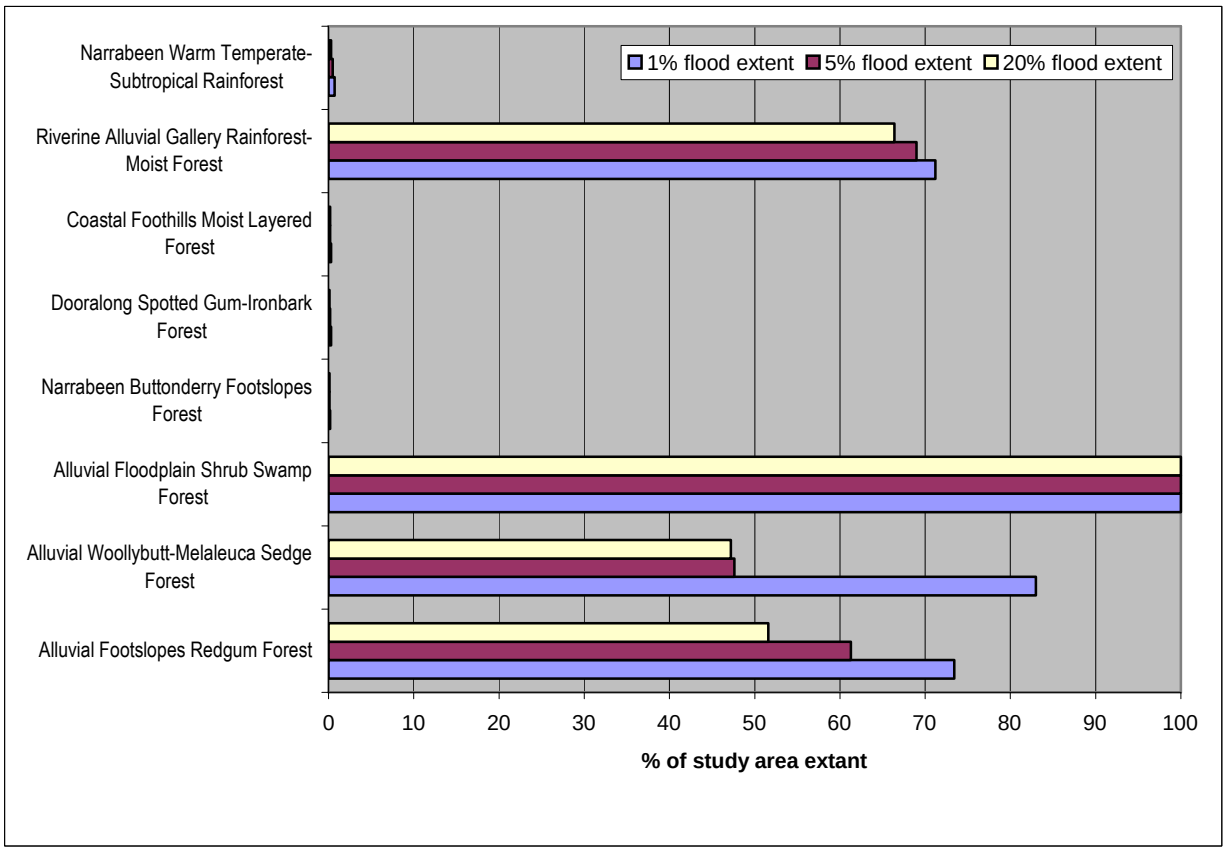
The changes to flood extents following the completion of mining subsidence are depicted in **Figures 15** & **17** and demonstrate that the newly flood-prone areas (totalling 56 ha) and newly flood-free areas (totalling about 10 ha) consist almost entirely of cleared grazing land.

Figure 18 shows the proportions of the various vegetation types that are currently subject to flooding regimes, with the main flood-prone vegetation type being the Riverine Alluvial Gallery Rainforest-Moist Forest due to its location lining the banks of the Jilliby Jilliby Creek.

Riverine Alluvial Gallery Rainforest-Moist Forest – this community is reliant on deep alluvium in close proximity to a permanent water source, and in this context may be considered a Groundwater Dependent Ecosystem. Currently this community is flooded by the 1%, 5% and 20% AEP flood events and mining subsidence effects will not alter this flood frequency for this vegetation community. A slight increase in the depth of inundation of this already highly flood-prone community has the potential to affect between 66 and 72% of the extant distribution of this community within the study area. However, such an effect is unlikely to be significantly detrimental to this community, and is unlikely to provide any significant risk for loss of rainforest species.

Alluvial Floodplain Shrub Swamp Forest – this community occurs in regularly inundated locations with a high water table. The single stand present within the study area will continue to be potentially affected by all three flooding scenarios. Increased occasional flooding is not expected to significantly alter the composition of this community, although there is a low risk that some species replacement may occur in the lower strata.

Figure 18: Percentage of each vegetation type in each predicted flood change scenario (refer also Figure 17).



Alluvial Woollybutt-Melaleuca Sedge Forest – this community occurs in areas irregularly subjected to flooding events with a high water table. Changes due to subsidence for the 1:100yr flood event will continue to affect 83% of the extant distribution of this community within the study area. The more frequent flood scenarios will continue to affect around 47% of mapped stands. No significant changes to the extent of this community that is flood-prone will occur.

Alluvial Footslopes Redgum Forest – this community typically occurs on alluvial floodplains and associated footslopes, and can withstand some flooding events. Between 51 and 74% of the extant distribution of this community will continue to be affected by flooding events. Flood study results (ERM 2008) demonstrate that there will be no significant change to flood frequencies for the areas hosting this community and there is only a low potential for any likelihood of species replacement in the lower stratum and canopy composition should not change.

6.4.2 Impacts to Ground Water Dependant Ecosystems

There is potential that between 66 and 72% of the extant distribution of Riverine Alluvial Gallery Rainforest-Moist Forest will be affected within the study area (**Table 4**). As flooding and groundwater studies (ERM 2008, Mackie 2008) outline, the potential for hydrological changes to impact significantly on the general stream and alluvial systems is low. The main effect will not be in changing the inundation frequency of this community during the range of flooding regimes but from slightly increased depth of flooding during the major flood events. Accordingly there are unlikely to be detrimental impacts to this community and no significant potential for any loss of some rainforest species.

6.4.2 Impacts to threatened flora

Three species of TSC and EPBC listed flora (*Grevillea parviflora subsp. parviflora, Melaleuca biconvexa and Tetratheca juncea*) are known to occur within the subsidence area (**Figure 8**). These species are all recorded within the valley floor which is subject to the least movement within the project site (c. 0.02 to 1.0 m, **Figure 4).** Flooding and groundwater studies assess probability for hydrological changes on the general stream and alluvial systems as low. The main effects to these species will potential (slight) earth movement that would not place any of these species at risk. The greatest risk to these species is their current management as they occur on private land subject to grazing and mowing.

7. AQUATIC AND SEMI-AQUATIC HABITATS

7.1 Significant wetlands in the bioregion, region and local area

7.1.1 Bioregion

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

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, walking and access tracks), can threaten the biodiversity of the wetlands. Feral animals and exotic weeds, changed fire regimes, sedimentation, salinity, weir construction and mining activities 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 vulnerable Freckled Duck (*Stictonetta naevosa*) and the 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 endangered Green and Golden Bell Frog.
- Narrabeen Lagoon and Deep Creek support the vulnerable black bittern (*Ixobrychus flavicollis*), Australasian Bittern (*Botaurus poiciloptilus*), Osprey (*Pandion haliaetus*) and Glossy Black Cockatoo (*Calyptorhynchus lathami*).
- Bakers Lagoon supports a range of 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 vulnerable Australasian Bittern.

7.1.2 Region

The DEWHA online database (protected matters report) shows that there is one RAMSAR wetland in to consider, however this is not within the Wyong LGA (Appendix 1). The Hunter Estuary Wetlands comprises Kooragang Nature Reserve (designated to the Ramsar list in 1984 and is also a recognised Shorebird Site Network location) and Shortland Wetlands. Kooragang Nature Reserve (includes Hexam Swamp) is located in the estuary of the Hunter River, approximately 7 km north of Newcastle (not in the Wyong LGA). 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. DECCW published a Plan of Management for the Kooragang and Hexam Swamp Nature Reserve in 1988.

Although not listed on any database, background research on the feeding ecology of the Latham's Snipe in the Lower Hunter Valley (Todd 2000) showed that 500 pairs of the species were observed at Cedar Hill Swamp 16 km northwest of Newcastle during December 1997 and 230 birds (115 pairs?) were observed in December 1998. These are the only records of a group that size making this location a site of international importance. Cedar Hill Swamp is part of the Pambalong Nature Reserve, managed by DECCW and a plan of management for the site has been written (DECCW 2006).

7.1.3 Local area

A search of the Wyong Shire Development Control Plan No 30 2003 (WSDCP No 30) was undertaken to identify SEPP 14 wetlands. There are no areas identified as 7g (wetland area) or associated development control plan area west of the F3 freeway.

Although not directly within the assessed areas, the Porters Creek Wetland occurs within one kilometre east of the Buttonderry and Tooheys Rd surface infrastructure properties (WSDCP No 30: 22 and **Figure 1**). 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 part of the W2CP (Buttonderry surface site) as well as the Wyong Employment Zone 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 for which an EIS was prepared. 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, 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 Estuary. 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, approximately 1 km of Hue Hue Creek occurs within the subsidence area. This creek flows into Porters Creek Wetland.

Tuggerah Lakes Estuary is comprised of three shallow lagoons (Tuggerah, Budgewoi and Munmorah Lakes) and occupies an area of 70 km^2 (Bio-Analysis 2006 and **Figure 1**). A Tuggerah Lakes Estuary Management Plan exists, although the 'Tuggerah Lakes Estuary Process Study', a GAP analysis conducted in 2001, provides a better understanding and some base line ecological values of the environment. The key findings included (Bio-Analysis 2006: 2):

- Sedimentation in the estuary is slow. It would take over 1,000 years to fill completely making it one of the slowest infilling estuaries on the NSW Coast. Interestingly, the report notes that the supply of sediment to the environment have probably been above natural background levels in response to Aboriginal burning practices which were followed by farming and urbanisation, resulting in the progressive degradation of water quality (Bio-Analysis: 15);
- Investigations on pollutants within the sediments indicated very small amounts of pesticides whilst heavy metal levels were below those found to cause adverse ecological effects;
- The sediments have significant concentrations of nutrients which are available for plant growth;
- Nutrient concentrations in the water column are above the water quality guidelines while the estuary can be classified as having a medium nutrient status;
- The entrance is now kept open to the sea by sand dredge, however, the overall effects of flushing are believed to be small given the size of the estuary;

- Turbidity in the estuary has decreased since the 1980s although it is unknown if this has any relationship to reduced patterns of rainfall and / or reduced concentrations of suspended materials;
- The extent of seagrass habitat has declined by over 50%. The salt marshes of the estuary have continued to decline by more than 80% as a result of disturbance; and
- The process study found that the Tuggerah Lakes Estuary was healthier than it was during its eutrophic stage in the 1980s and 1990s. The question was raised whether this level can be sustained with increased future development or if the system would be pushed over some threshold returning it to the eutrophic state of the 1980s.

Although OzArk has been unable to find an adequate synthesis of the conservation value of the Tuggerah Lakes Estuary, a review of the local vegetation and DECCW records shows that it possesses several EEC's and habitat for a wide variety of state and nationally listed threatened terrestrial and aquatic flora and fauna.

The Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks (which occur within the subsidence area) flow into Wyong River which in turn drains into the Tuggerah Lakes Estuary.

7.2 Overview of waterways, farm dams / wetlands in the Dooralong and Yarramalong valleys

Within the subsidence area, there are a number of waterways including the Wyong River, Jilliby Jilliby Creek, Little Jilliby Jilliby Creek, Hue Hue Creek, as well as many dams and temporary ponds (**Figure 12)**. A calculation of the areas shows that farm dams equate to 25.56 ha and other water bodies roughly 3.85 ha.

Unfortunately, access to private land prevented detailed investigation of habitat potential for threatened species within the zero subsidence line. Further, several forest tracks were impassable at the time of the assessment preventing an inspection (for terrestrial ecology) of the Narrabeen Warm Temperate-Subtropical Rainforests occurring in the elevated floors of the Wyong State Forest that form the headwaters of Little Jilliby Jilliby Creek.

Collectively, all waterways observed had been modified, the exception being the creek headwaters in the surrounding forested hills (headwaters of Little Jilliby Jilliby Creek provide the best example of these). Land clearing has played a major role in reshaping the environment and remnant native vegetation associated with water bodies is highly fragmented. Grazing livestock has further impacted waterways outside the forested areas, particularly horses and to lesser degree cattle, goats and novelty livestock that have removed or impacted edge vegetation. Vegetation in all dams was noted as generally very sparse, mostly consisting of isolated clumps of *Scenoplectus* sp, *Juncus* sp and *Carex* sp, that was generally cropped by animals that has access to it. Occasionally north of Jilliby in the Dooralong Valley, areas of *Isolepsus* were observed along former waterways (cowls and or extinct meanders of creek lines). In all areas domestic dogs were evident.

Altered surface hydrology is evident on the cleared valley floors with many once shallow depressions either dugout and bunded to make farm dams or filled and levelled to facilitate cultivation. There is undoubted altered water/soil chemistry in the area, although absolute data is not available. A review of the Tuggerah Lakes Estuary report (Bio-Analysis 2006: 2) noted that nutrient concentrations in the water column were (at that point in time) above the water quality guidelines. The Dooralong valley catchment drains into the Wyong River then into the Tuggerah Lakes Estuary and stocking rates and rural activities such as turf farming are known to contribute to elevated nutrient loads. Eutrophication of Jilliby Jilliby Creek was in February 2006, however, later

heavy rains had flushed the system prior to the most recent site visit (July 2007). Results of a water quality measuring programme within the study area has been provided as Appendix 2 for further background information.

The surface hydrology associated with ephemeral headwaters in the forested hills has undergone minor impact from erosion as a result of logging, access track construction and easement clearing by state government authorities (DPI, State Forests and TransGrid).

7.2.1 Impacts to wetlands / water bodies from longwall mining

Much of the impact of subsidence on landscapes is related to the change in relationship of pre-mining and post-subsidence surface topography. Landscapes with erosive soils on long slopes may be subject to potential erosion due to slope increase or displacement of erosion control structures thus polluting water with sediment. In low areas with very high water tables temporary ponding could occur if disrupted surface drainage patterns causes runoff to collect in any newly created low portions if these areas do not freely drain. According to Darmody (n.d: 154), in agricultural areas ponding may be viewed in a positive way because it creates wetlands beneficial to wildlife.

Other detrimental impacts that could be associated with longwall mining in certain circumstances (geology, mine design, etc) include cracking of particular geology types resulting in reduced flow or draining of water bodies (particularly in association with swamps on sandstone geologies), release of dissolved natural salts and hydrogen sulphide that is toxic to aquatic life in shale geologies of the metropolitan catchment and low oxygen and elevated soluble iron levels. These issues have been raised by TEC and other groups in the Southern Coalfields longwall mining inquiry. Another potential impact is the change in the natural relationship of faults within geological strata which has the potential to result in similar impacts as with cracking as described above. More specific data on these potential impacts in relation to WC2P project can be sourced from the subsidence, flooding and groundwater specialists assessments and an internal file note (Keith Bartlett pers comm: June 2007) re: existing fault zones in the subsidence area.

Interpretation of these studies suggests there are no potential impacts to water quality associated with subsidence because:

1. The mine design has been based on avoiding the risk of introducing any continuous cracking from the surface down to the coal seam, thus avoiding the risk of downwards or upwards discernible mixing of the two different water types. At the near-surface are the mostly fresh surface alluvial aquifer groundwaters. These aquifers in most locations are fresher after rain but do not degrade as evidently as the surface waters in the streams and billabongs when they go to low flow and then stagnate. The deep more saline hard rock groundwater at the coal seam level is not capable of migrating to surface and the depressurization of the deep aquifer system will mean that the groundwater flow path will report to the mine void itself (which will be collected and pumped to the mine water management system).
2. Any implications for the surface alluvial groundwaters would be very localised and temporary (days and weeks) but would not involve wholesale loss of water that supports surface ecosystems. The localised re-equilibration of the alluvial aquifer groundwaters would only involve the locally occurring water and not exogenous groundwaters of different quality.
3. There is no high risk acid sulphate soils mapped as occurring within the subsidence zone (**Figure 22**).

The escape of gases is very unlikely as the W2CP project has an associated economically viable natural gas deposit that will be collected by gas drainage systems prior to mining there will be no seam to surface connecting pathways for gas to escape to the surface. The air quality will be unimpacted and thus there will be no toxic effect to native species.

With regard to water energy dissipation, the waterways in the subsidence area reflect a general typical post-European impact pattern where the environment once consisted of thick moisture loving vegetation where many shallow creeks and semi active drainage lines would flood and inundate a wide area. The path of the waterways were active in the deep alluvium and as such meandering corners of the creek were occasionally cut or filled with sediment and 'new', slightly adjusted paths of flow followed. Due to historic changes in surface water hydrology, mostly related to land clearing, the existing waterways are now incised as a result of increased water speed, Jilliby Jilliby Creek is now 1 m wide and c. 1.5 m deep. **Figure 24** shows evidence of the former meanderings of these waterways which are referred to in this document as 'extinct' creek or drainage lines.

Predicted subsidence will have an effect on stream power values in subsided areas and as a result has the potential to cause minor erosion. The potential effect will not however, be associated with large flooding events as backed up water dissipates energy. The most likely impact from a change in energy ration would occur in-stream (progressive scouring) and be associated with minor flooding intervals i.e. 1:3 flooding events that do not overtop banks (reduce energy / water velocity). The most likely time for minor erosion to occur would be during a 1:3yr flood event in the 5 to 6 months during which mining is underneath the creeks when the upstream and downstream edges of subsidence are constantly changing. Many variables would influence the probability for this to occur, however, there is low risk and low associated consequence of this event causing environmental damage, as mitigation will quickly occur under an approved Subsidence Management Plan (SMP), which by nature incorporates surface monitoring. (Pers comm. ERM 2007[3]).

Subsidence effects in the forested areas in the Wyong State Forest / Jilliby State Conservation Area also has potential to alter existing soil erosion and affect water quality downstream. From inspection, the soils are stable within vegetation however, where land has been cleared (i.e. TransGrid easements with access tracks) the clay based soils on the slopes have moderate erodibility. Most, if not all, drainage lines inspected in the hills have a deep layer of mulch and leaf litter but are also choked with *Lantana sp.* whilst this is a noxious weed; the species serves to hold the soil together very efficiently. It is very unlikely that *Lantana* will be controlled in these areas, however, if such a project were to occur, it is a procedural normality (given the land tenure) of habitat restoration projects to mitigate the erodibility of the soils. Similar to above, the SMP will require regular inspection so that upstream scour protection can be implemented in subsided areas as soon as it becomes evident.

Although the hills of the Wyong State Forest includes mainly underlying sandstone geology of the Terrigal formation, the valley floor comprising the headwaters of Little Jilliby Jilliby Creek are mapped as Patonga Claystone (**Figures 20 & 21**). The predicted tilt and tensile strains due to the predicted subsidence in the area are described in the specialist subsidence report[4]. With the Narrabeen Warm Temperate-Subtropical Rainforest community being found wholly on Patonga Claystone, there will be minimal impact to surface hydrology because of subsidence. If any portions

[3] Geoff Herman author of the ERM W2CP Flood Impact Assessment (ERM 2008) 16.7.07.
[4] Refer to primary information contained in the subsidence specialist's report

of the community are underlain by Terrigal Formation sandstone, potential exists for localised changes to surface hydrology if surficial rock fracturing were to occur. Whilst this potential has been noted, the water quality would still remain unaffected because there will be no capability for mixing with saline waters from the seam.

Figure 19: Vertical section showing Dooralong Valley (Jilliby Jilliby Creek), primarily comprising the softer Patonga Claystone (Source: WACJV 2007).

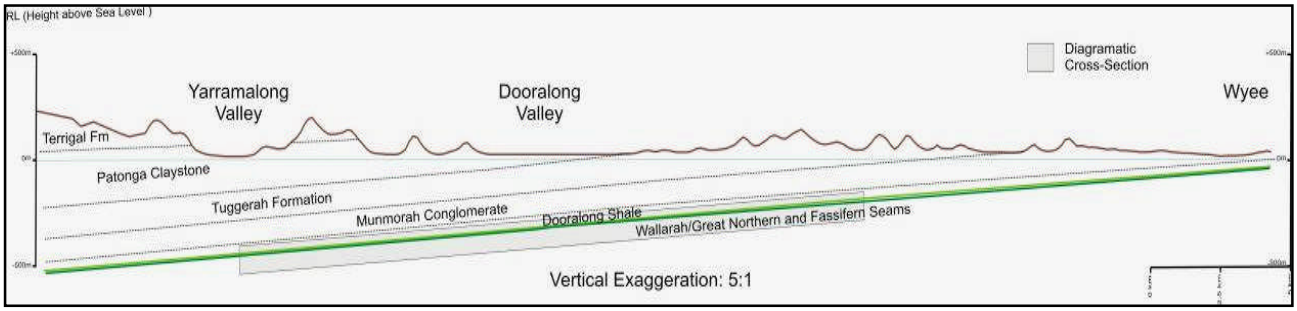
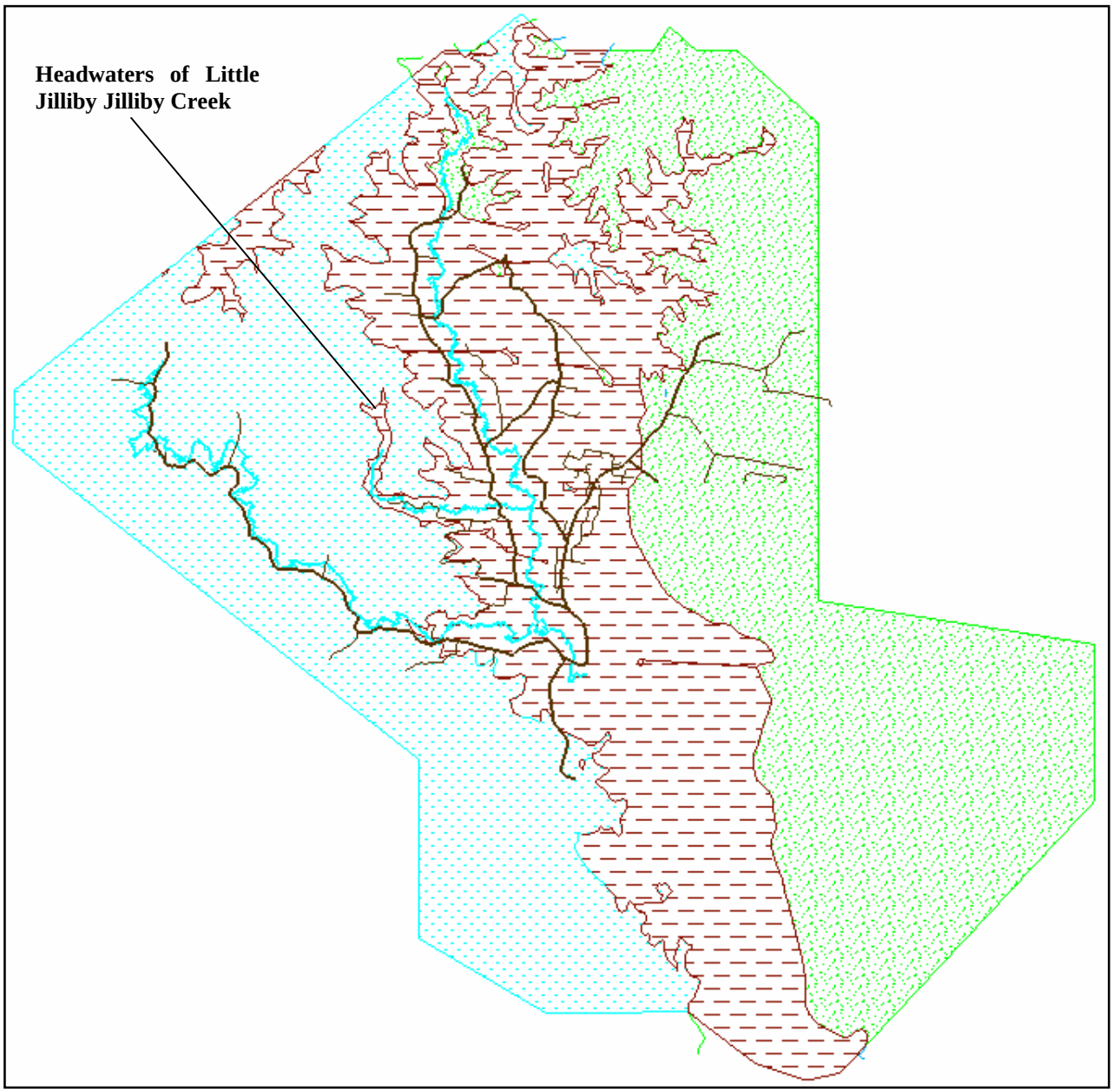


Figure 20: Surface geology showing Jilliby Jilliby Creek and the softer Patonga Claystone (middle) between the more resistant Terrigal (left) and Tuggerah (right) Formations. (Source: WACJV 2007).

The drying of ponds and or creation of new pond areas is associated with many variables. In



relation to this a few notes on subsidence impacts are relevant. While subsidence is a drop in the landscape, where everything on the surface at a given spot changes at the same topographic rate, tilt / strain causes a temporary horizontal change to the ground surface. The effect of tilt within the Dooralong valley floor is understood to be less than 4 mm per metre i.e. for every metre you travel the ground surface would drop by 4 mm. On the ground this would mean that tilt of 4 mm over a 50 m wide dam / water body would result in one side becoming 200 mm (20 cm) lower than the other side. Ecologically speaking a tilt of this degree would not pose a barrier to the movement, migration or re-colonisation of newly created habitat for biota. Tilts can also commonly be temporary effects.

According to ERM (2008) flood behaviour in the Yarramalong Valley will not significantly change as a result of subsidence. The model indicates flood levels generally reduce by 0.01 to 0.08 m in the

vicinity of subsidence areas. Flood depths in the Wyong River area reduce by a similar amount with the exception of a 1.2 km section of the River where depths increase by up to 0.13 m. With the exception of a small backwater between area flood extents vary by less than 5 m. Flow velocities will be unaffected.

Predicted 1:100yr flooding results for the Dooralong Valley are shown in **Figure 15** and involve (ERM 2008):

- while post-subsidence flood levels within the study area were generally up to 1.31 m lower than levels for existing conditions, flood depths increased by up to 1.08 m and inundation extents increased by up to 150 m within the areas directly affected by subsidence;
- changes to flood behaviour in Jilliby Jilliby Creek over approximately 8.7 km of the 9 km upstream of its confluence with the Wyong River;
- an increase of ponding locations of varying extents and depths (up to around 1.2 m) within Jilliby Jilliby Creek itself. Due to the alluvial substrate of the creek, the effect will be self-limiting as the natural bed of alluvium will cause it to vertically re-establish; and
- post-subsidence flow velocities are similar to existing velocities.

In a 1:100 flood event, additional land within the Dooralong Valley becomes flood prone. The major changes are summarised as follows (ERM 2008):

- an increase in flood prone land of 0.8 ha on the right bank and a slight increase in flood prone land of 0.3 ha on the left bank of Jilliby Jilliby Creek upstream of the Durren Road culverts;
- a net increase in flood prone land of 23.3 ha on the right bank and 6.5 ha on the left bank of Jilliby Jilliby Creek between the junction with Little Jilliby Jilliby Creek and Durren Road;
- a net increase in flood prone land of 14.6. ha on the right bank and a net decrease of 0.6 ha on the left bank of Jilliby Jilliby Creek between the Wyong River and Little Jilliby Jilliby Creek;
- flood behaviour in the downstream reaches of Little Jilliby Jilliby Creek is effectively governed by flood levels in Jilliby Jilliby Creek. Following subsidence, flood behaviour in Little Jilliby Jilliby Creek is altered due to flooding of additional low lying areas.

Downstream of the confluence of Jilliby Jilliby Creek and the Wyong River, flood levels reduce by up to 0.06 m with a consequent small reduction in inundation extent and area. This is a result of detention effects in the subsidence area within the Jilliby Jilliby Creek floodplain, which slightly reduces peak flows (ERM 2008).

The literal 'drying' of areas will not occur due to the soils permeability, however, as noted above the extent and duration of inundation will be largely unaffected. A detailed examination of changes in flood behaviours for the Yarramalong and Dooralong Valleys and the potential effects on vegetation are discussed further in Section 6.4.

7.2.2 Impacts to adjoining wetlands

Porters Creek Wetland is not within the mining subsidence area and is at least 2 km away and as such a detrimental change will not affect the wetland. Further, impacts from mining on groundwater

and surface water environments are judged to be low and unlikely to measurably deplete resources of the alluvial lands situated in the Dooralong and Yarramalong Valleys (Mackie (2008). ERM (2008) state that Hue Hue Creek will experience subsidence of up to 0.95 m under the floodplain that will cause reductions in flood levels within or near the subsided areas of 0 to 0.5 m with changes of flood depths of -0.1 to +0.7 m. Based upon the flood study (ERM 2008) it would be theoretically impossible for flows to the wetland to change unless culverts under the F3 freeway were altered. The total volume of water flowing into Porters Creek Wetland will remain the same as it is currently governed by the size of existing culverts.

Similarly, impacts to the Tuggerah Lakes Estuary groundwater and surface water are judged to be low and unlikely to measurably deplete resources of the alluvial lands situated in the Dooralong and Yarramalong Valleys (Mackie 2008) and as such the inference is that no change will occur within the catchment and hence to the Tuggerah Lakes Estuary. Further, ERM (2008) state that no significant changes to flood extents and depths in the Yarramalong Valley (Wyong River) will occur due to predicted mine subsidence. The maximum predicted subsidence under the main channel of the Wyong River will be in the order of 0.15 m. The Dooralong Valley (Jilliby Jilliby Creek and its tributaries) will experience predicted subsidence of up to 1.2 m in parts of the channel and mainly less than 1.6 m within a limited section (5.2 km) of the floodplain. (Greater subsidence of up to 2.4 m is predicted in the forested areas away from floodplain lands). Reductions in flood levels within or near the subsided areas of 0 to 1.85 m and changes of flood depth of -1.1 to +1.1 m will occur. Similarly, the volume of water flowing into the Tuggerah Lakes Estuary will not change, the only effects will be that peak of a flooding event will be reduced due to increased water storage capacity within the subsidence area. The peak flow has been modelled to drop by less than 0.5% and will be delayed between 30 minutes to an hour. The predicted effects of subsidence therefore are unlikely to result in changes in flooding / hydrological activity outside the catchment area that will affect this estuary.

The proposal would have no effect on the Hunter Estuary Wetlands Ramsar site.

Figure 21: Acid sulphate risk map (Source: WACJV).

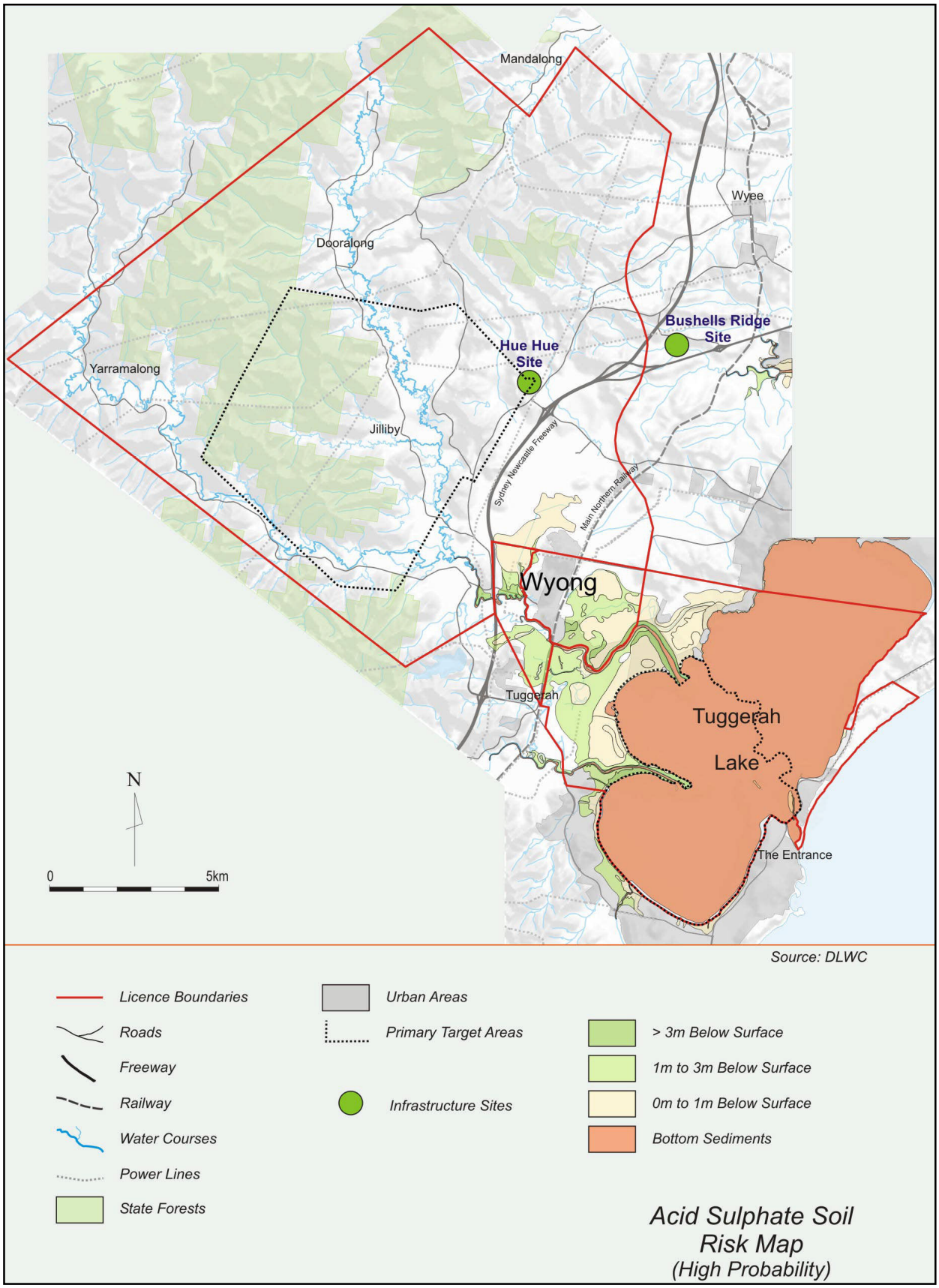


Figure 22: Rivers, creeks and dams within the subsidence area.

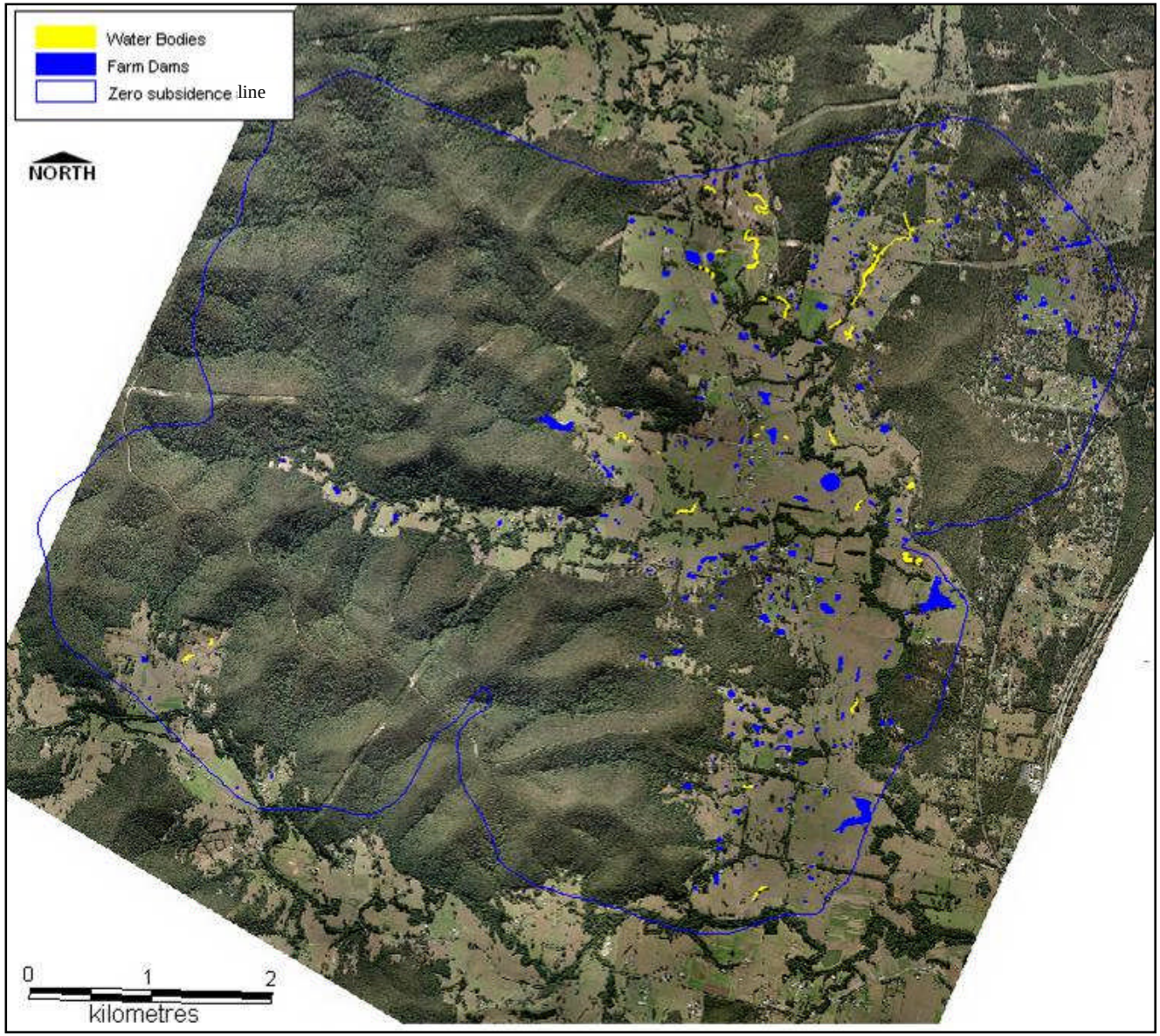


Figure 23: Laser imaging of the grounds surface showing existing and former of waterways in the subsidence area

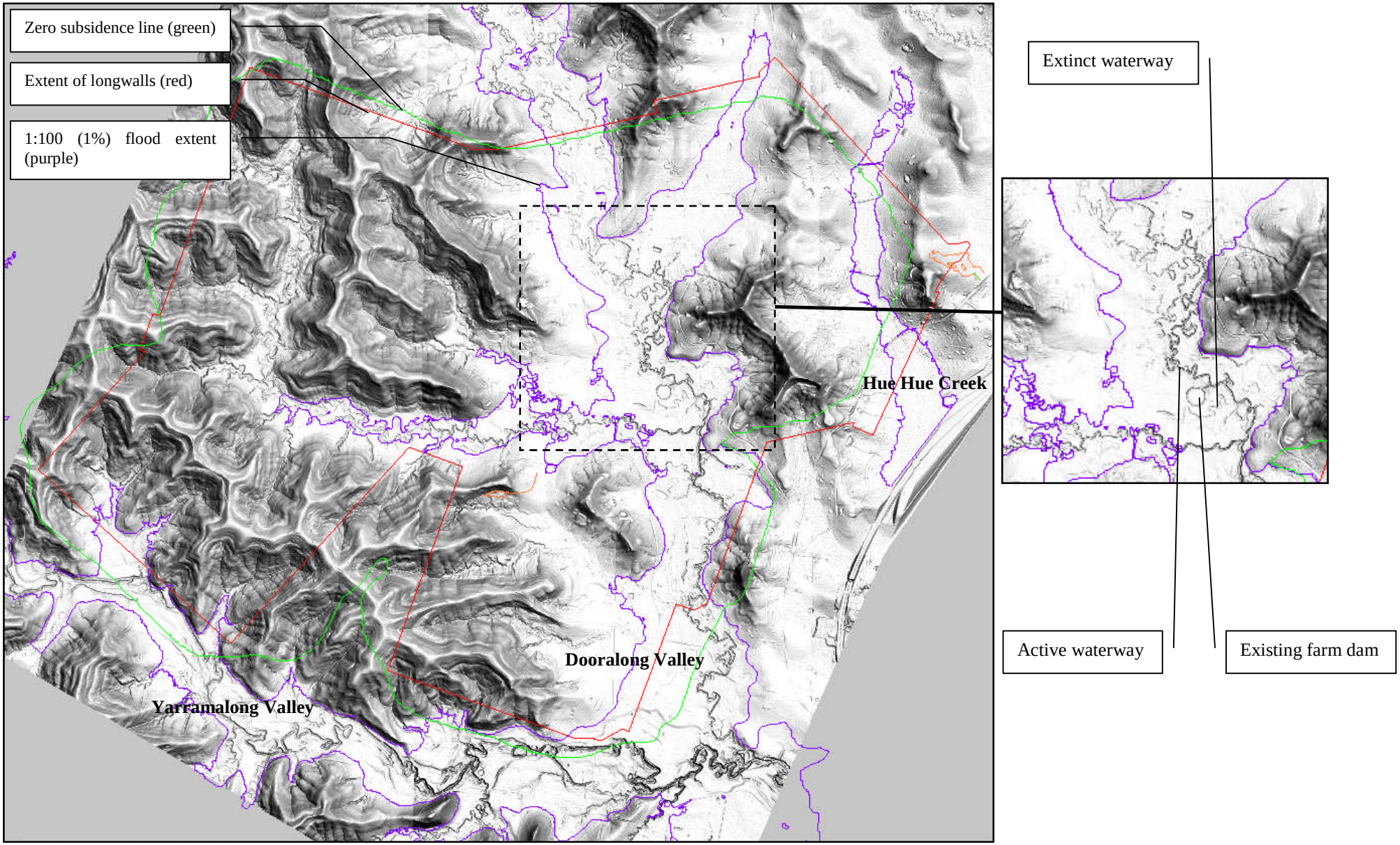


Figure 24: Predicted changes to 1:100 year (1% AEP) flooding patterns (Source: WACJV).

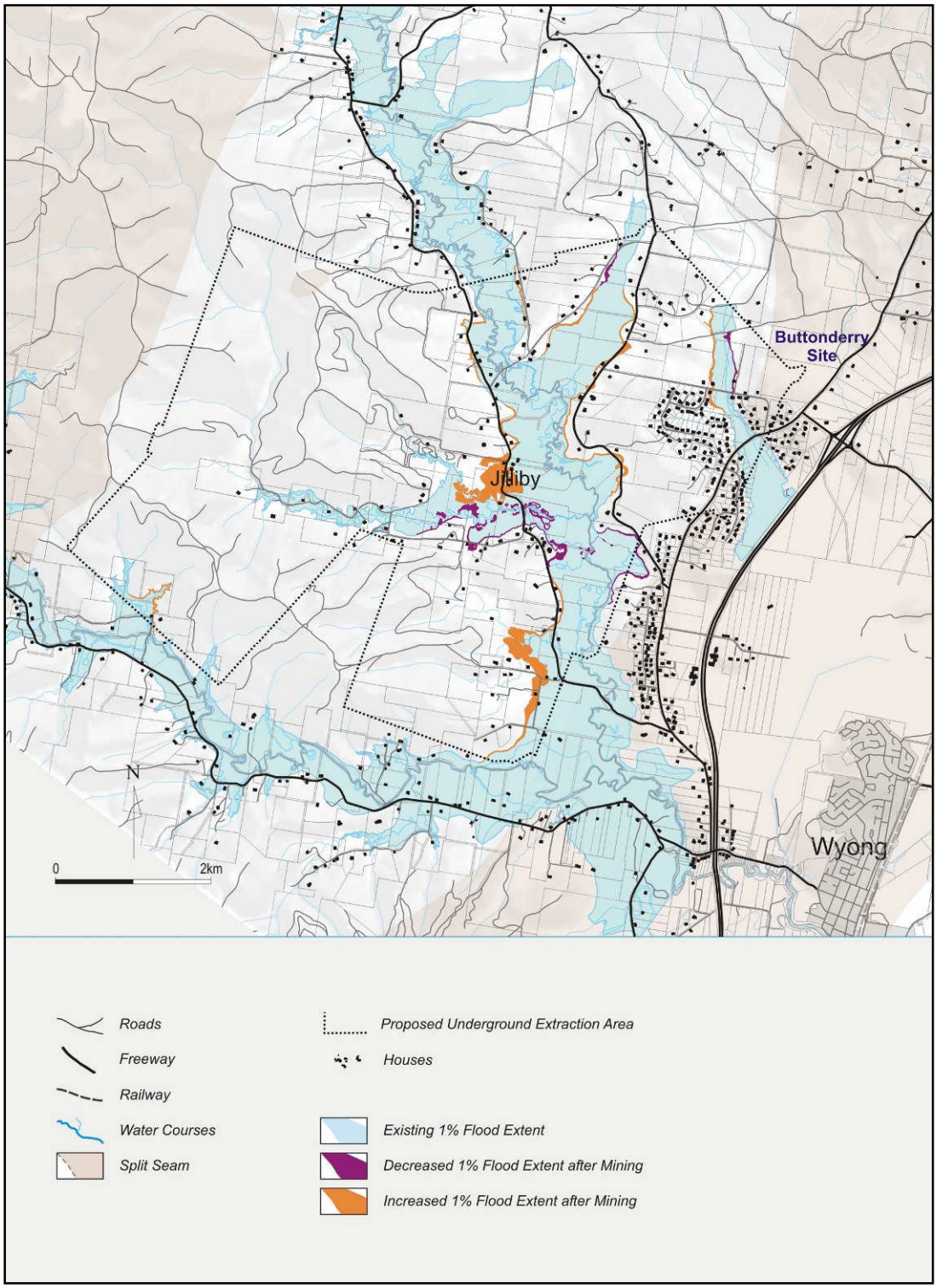


Figure 25: Predicted changes to 5:100 year (5% AEP) flooding patterns (Source: WACJV).

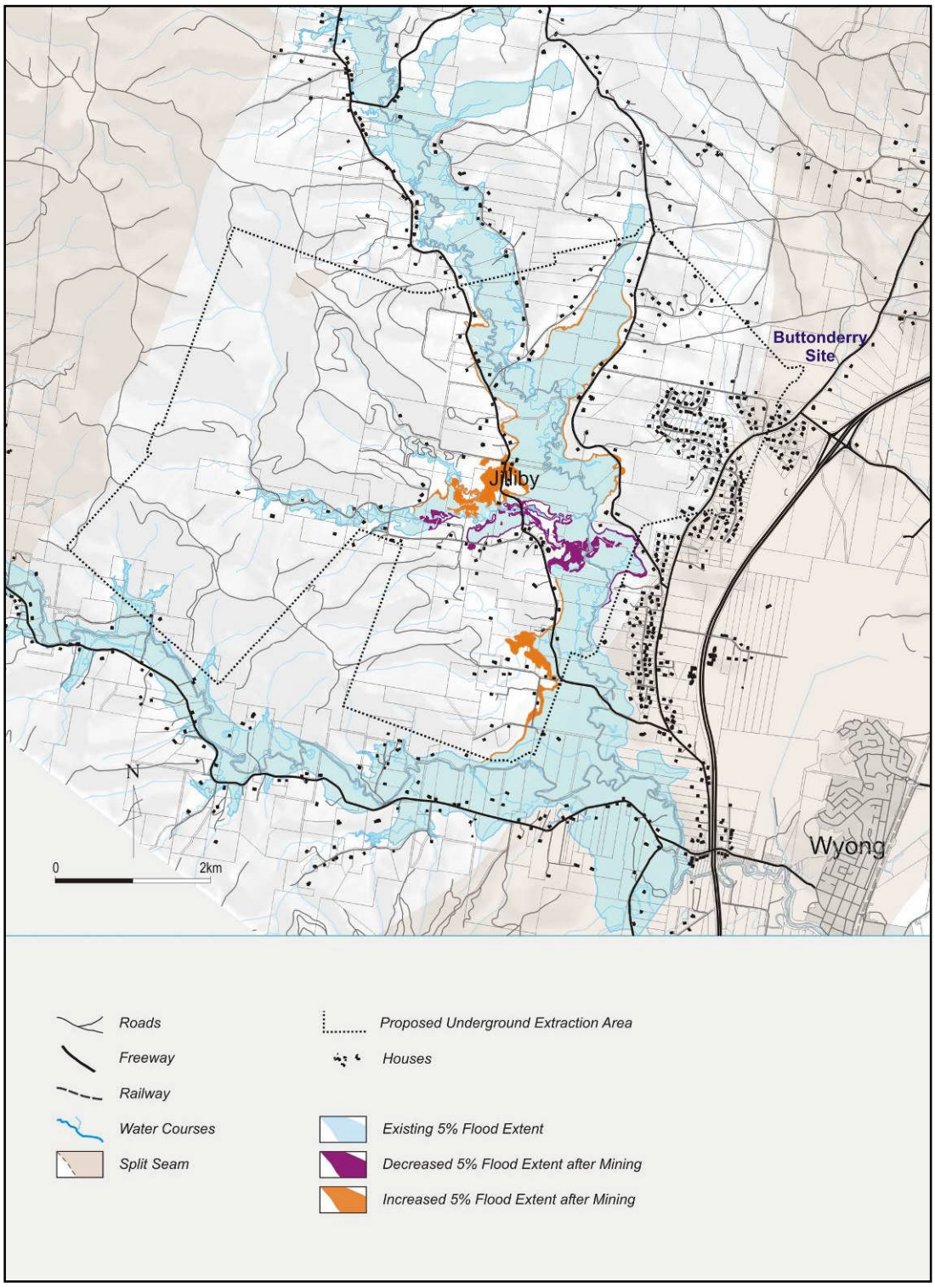
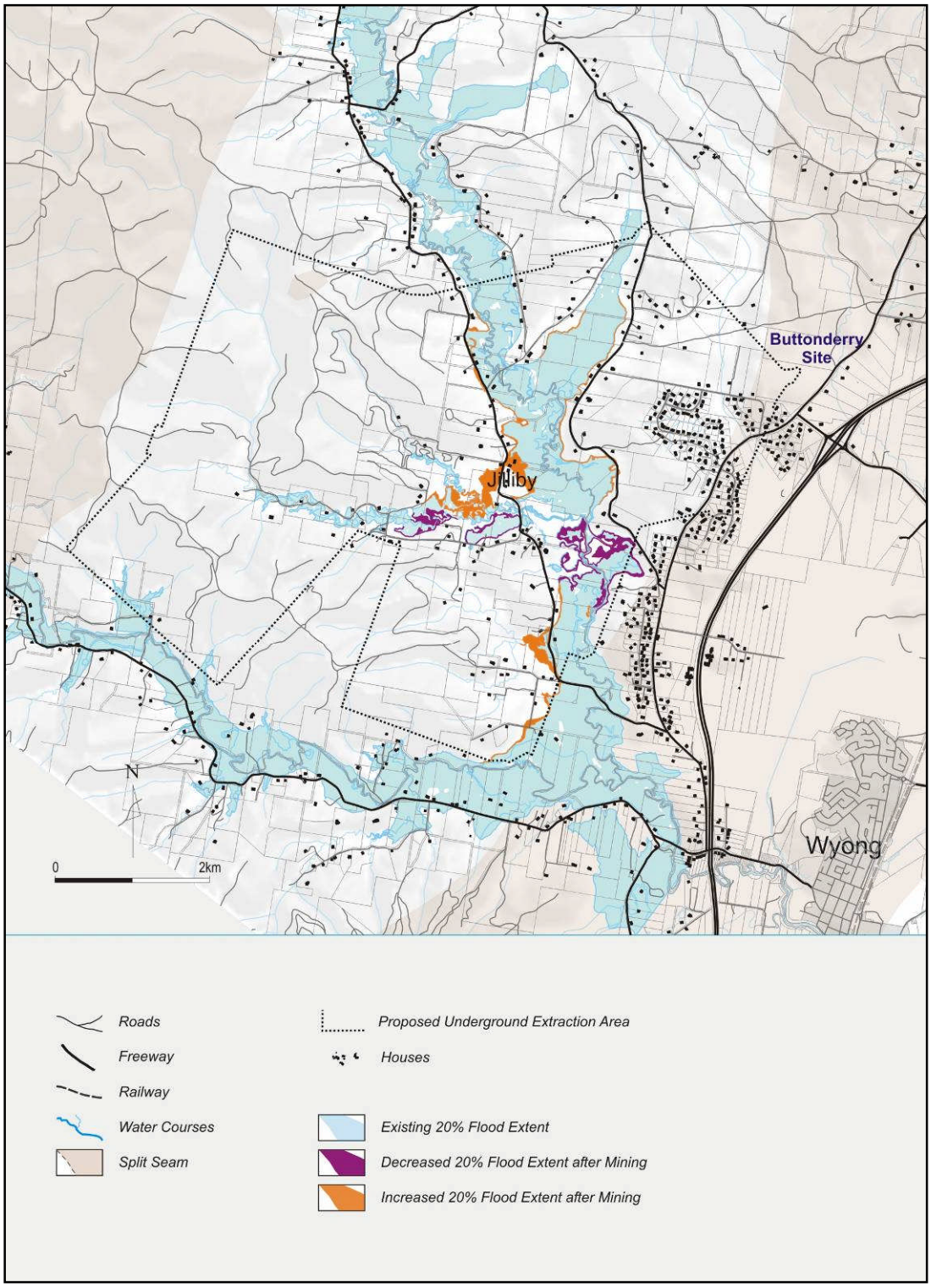


Figure 26: Predicted changes to 20:100 year (20% AEP) flooding patterns



(Source: WACJV).

8. FAUNA WITH POTENTIAL TO BE AFFECTED BY SUBSIDENCE

8.1 Background

8.1.1 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 CMA (Appendix 1). 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 online 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 1).

The DEWHA online database (protected matters report) shows that there are 46 threatened species and 31 migratory species in the Wyong LGA (Appendix 1). Of the threatened species 33 are animals (13 birds, 5 frogs, 7 mammals, 2 fish, 3 reptiles and 3 sharks). 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 that 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.

8.1.2 Sensitivity of local fauna to subsidence

Threatened species that occur within vegetation communities most likely to be impacted by subsidence are by default at greatest risk. Aquatic and semi aquatic environments have received the most attention due to the nature of habitat alteration that can occur sometimes as a result of subsidence, especially in sandstone geologies.

Hanging swamps or high altitude swamps on sandstone are often provided as examples of ecological communities placed at most risk from subsidence, however the W2CP mining area contains no examples of these types of communities.

Within the subsidence area there are four basic types of habitats:

- Aquatic habitats (creeks, dams and the rivers) with permanent water;
- Semi-aquatic habitats (areas which become temporarily inundated) that may provide feeding or breeding resources for particular species or populations. These may be regular (seasonal) or irregular (1:20 years) in nature and experience a wide difference in duration of inundation;
- Valley floor terrestrial habitats; and
- Hilly landform habitats.

The above habitat types are listed in order of sensitivity for a worst case scenario subsidence related impact as changes in hydrology have a rapid effect on ecological communities and hence the species supported by them.

As concluded in Chapter 7 there are no significant impacts to water quality or quantity as a result of subsidence and therefore any aquatic species currently dependant on a permanent water body ecosystem are likely to remain unaffected as a result of the W2CP project.

Semi-aquatic habitats are the most sensitive to habitat alteration given the local conditions. Although one of the constraints of this study has been the inability to directly access the fauna dependent on these ecosystems, the DECCW database suggests that several species of threatened frogs able to tolerate, high nutrient levels, stocking rates, and trampling and indeed thrive in extensively cleared agricultural land have the potential to occur within the W2CP study area. An abundance of calling frogs within the area was noted during the reconnoitre, and although none were immediately noted as threatened species, there nonetheless remains potential for them to occur. Secondly, several of the DEWHA and DECCW wetland and migratory wetland species have potential to seasonally utilise feeding resources provided by these environments.

8.2 Methods

Fauna surveys were limited due to access issues associated with private land. A large body of previous literature focussed on the immediate environs of the current study areas was drawn upon, enabling tailored searches for key habitat elements for threatened species identified as likely to occur, but not previously recorded. Simply putting it, a list of DECCW and DEWHA species was reviewed for the area and the question asked in the field at various locations ‘what could occur here based upon the current habitat and disturbance levels?’ Followed by ‘If a given species has potential to occur, what impacts are likely to occur to it after predicted subsidence?’

Reconnoitre of the area occurred on the 28th of June 2007 which was cool and continuously wet (raining) whilst the 29th was warm, clear and sunny. The Wyong area had been receiving heavy rainfall over the past month and the majority of the valley floors were still affected by a small degree of inundation. Understandably not

all farm dams, creeks and other waterways could be observed with binoculars from public roads. A conscious effort was made to look at a temporary water bodies (resulting from low areas / former natural drainage features filling from heavy rains the week prior), permanent water bodies such as dams and creek crossing at road intersections.

8.3 Results

The existing semi-aquatic environments, which were inundated at the time of assessment, provided habitat for a number of wetland bird species including:

- White-faced Heron (*Egretta novaehollandiae*) – commonly recorded through the valley floor in a variety of habitats. This species feeds on a variety of animals that include insects, fish and amphibians;
- White-necked Heron (*Adrea pacifica*) – only one pair seen in recently inundated grassland in the locality of Jilliby. This species has a similar diet to the White-faced heron;
- Purple Swamphen (*Porphyrio porphyrio*) – one pair sighted at large permanent dam, perched on a small (1 x 6 m) island. Near the intersection of Dickson and Dooralong Rds. Appeared to be utilising grassy vegetation on the island for shelter which was inaccessible to livestock. This species eats the soft shoots of reeds and rushes but will also opportunistically eat ducklings;
- Australian White Ibis (*Threskironis molucca*) – the most abundant wetland species noted occurring in flocks of more than 200 in several locations through the Dooralong Valley. The diet of this species includes a broad range of items, hence their success in the environment, including terrestrial and aquatic invertebrates and any anthropomorphic scraps. The long beak has been known to be used to dig for muscles and crayfish;
- Glossy Ibis (*Plegadis falcinellus*) – found in association with Straw-necked and Australian White Ibis, together being collectively the second most common species of bird encountered at all sites, occurring in large flocks of between 100 to 200 birds at each location. Diet is similar to that listed above;
- Straw-necked Ibis (*Threskiornis spinicollis*) as above;
- Pied Cormorant (*Phalacrocorax varius*) – only observed in one location, same area as the purple swamp hen. Sitting on a fence post. This species also feeds on a wide variety of aquatic animals ranging from insects (including yabbies) to fish;
- Grey Teal (*Anas gracilis*) – only observed once on deep water at the same location (a modified billabong , large dam) as the purple swamp hen. Feed on dry land plants, aquatic plants, seeds, crustaceans, and insects and their larvae;
- Pacific Black Duck (*Anas superciliosa*) – common on all waterways, permanent to temporary. This species is mainly vegetarian but will also eat small crustaceans, molluscs and aquatic insects.
- Maned Duck (*Chenonetta jubata*) – occasionally seen in areas with more ground cover (less intensively grazed) in association with permanent water. This species feed on seeds and green shoots of various grasses;

- Cattle Egret (*Ardea ibis*) - associated with cattle and shallow or recently inundated pastures throughout the valley. Frequently observed, approximately 15 to 20 individuals noted. Feeds on insects such as grasshoppers, frogs, cane toads, lizards and some small mammals. This species is a listed Migratory Wetland Bird under the EPBC Act 1999;
- Intermediate Egret (*Ardea intermedia*) – commonly seen throughout the study area on recently inundated pastures up to 50 individuals noted. Similar diet to that listed above; and
- Masked Lapwing (*Vanellus miles*) - two pairs seen within the study area, both surrounding recently inundated grasslands. Diet consists of insects and their larvae, and earthworms.

8.4 Discussion

Terrestrial habitats on the valley floor have been heavily impacted by agriculture and settlement. What remains is associated with small pockets of remnant vegetation that will remain largely unaffected by subsidence. Water chemistry will also remain the same. Similarly, the majority of species within hilly landform habitats in the Wyong State Forest and Jilliby State Conservation Area are not very susceptible to subsidence and the habitat values of the vegetation it supports will remain the same.

With respect to changes to the abundance of potential habitat for threatened species; 55.8 ha that was not previously inundated during a 1:100 flood event (prior to subsidence) will be inundated to a shallow degree, while c. 10 ha that is currently inundated (prior to subsidence), will not be flooded during the same event (after subsidence has occurred, ERM 2008). As these changes will occur in like for like habitat (predominantly cleared, grazed or farmed agricultural land) there will be no net loss of potential habitat that would place any threatened species at risk of local extinction.

The presence of wetland birds within the Dooralong Valley led the author to assume that a healthy macroinvertebrate population existed in the area but interestingly, no small waders such as snipes, crakes, sandpipers etc were observed. Understandably, some species would not be expected, i.e. Latham's Snipe (*Gallinago hardwickii*) which are not likely to be observed until the summer months. Other influencing factors include the level of inundation and flooding of suitable mudflats on dam banks, however, an overarching factor appeared to be the effect of domestic livestock on edge vegetation at water bodies.

As previously stated ponding or surface swale effects will not be an issue given the topography and drainage patterns of the land. The following information has been provided as a worst case scenario:

All semi-aquatic habitats for terrestrial species on the valley floors were recorded as 'fragmented' or 'isolated' in their current state. Given that the average depth of subsidence in the valley floor is in the order of 1 m over each panel width (150 m to 175 m) and each panel is separated by 50 m it would not be unreasonable to assume that if small, cryptic species were located in the middle of an unsubsided area, it would be able to make it 25 m to find the edge of a lower (more moist) or higher (drier) area that had been subsided if temporary changes to local soil moisture

conditions occurred. Given the nature of semi-aquatic environments on the valley floor, it is not unreasonable to assume that the subsided areas would, at an ecological level, function the same as semi-aquatic areas prior to subsidence, as the microflora and fauna would remain within the area, presumably remain unaffected by the process, at best slightly altering their distributions. The only macroscopic difference may be that the duration of water logging may be slightly longer in a worst case local situation.

The only species sensitive to change could be Giant Barred Frog (*Mixophyes iteratus,* Stuttering Frog (*Mixophyes balbus),* both listed in the TSC and EPBC Acts as vulnerable that are known to occur in the subsidence area at the headwaters to Little Jilliby Jilliby Creek in Narrabeen Warm Temperate-Subtropical Rainforest predominantly on Patonga Claystones in the lower gully sections of the hilly landform. The Littlejohn's Tree Frog (*Litoria littlejohni)* a species listed in the TSC Act is also considered likely to occur. These species breed around shallow, flowing rocky streams. The females lay eggs onto moist creek banks or rocks above water level or in a foam on that water where the tadpoles latter grow into larger frogs. The frog species would be susceptible to changes in pools or creeks if altered hydrology affected surface water in the area.

Impacts to other species of legislative interest listed by DECCW and DEWHA have been listed on **Table 5** (note species added to the EPBC list since this report was originally finalised have been addressed in context **Appendix 1)**.

8.4.1 Case study Latham's Snipe

The potential for the presence of Latham's Snipe (also referred to as Japanese Snipe) a species listed as Endangered in the TSC and Vulnerable in the EPBC Act, in the study area is probably a good analogue for the evaluation of suitable habitat a range of threatened wetland bird species, additionally there is an old record on BioNet of one having been recorded in the subsidence area during the 1980s. Due to the associated constraints, the only way of assessing potential habitat for species of legislative interest was by observation of the environment and recording any species utilising it (see 8.3). The major considerations, albeit subjective under the circumstances, were habitat complexity, key habitat elements available (i.e. likely food resources, suitable vegetation etc.) and types of disturbance that may influence the potential for a particular body of water to provide habitat for species of legislative interest. The observations were undertaken on the 28th and 29th of June 2007 and the findings in Todd (2000) were the most useful guide and supplemented information published in the EPBC website (2007).

Todd (2002) documented results of a Latham's Snipe feeding ecology study at Cedar Hill Swamp, Shortland Wetlands, Markey Swamp, Newcastle Wetlands Reserve and Birmingham Gardens (all within easy flying distance from the W2CP study area and comprise known habitat for the species). The study showed feeding habitat consisted of mud flats with *Eleocharis* (spike rushes that grow to sprawling sedges from deep to ephemeral waters) or *Juncas* (relatively short, grow as edge vegetation) at 71% of all sites. The birds were seen most often in remnant swamp / wetland vegetation on mudflats with sparse densities of in-water *Eleocharis* during the day and around clumps of Water Couch *Paspalum distichum* and *Juncus* at night at 69% of sites (Todd 2000: 134).

Another useful study was undertaken in 2001 (Lindegarth & Chapman). This study aimed test a hypothesis about enhancing habitat for feeding birds in a freshwater wetland through habitat manipulation. The most important consideration prior to 'enhancing' the site, (draining to expose mud flats) was that it was known, by previous sightings, to provide suitable habitat (and thus feeding resources) for Latham's Snipe. Ultimately, the intention was to partially drain a wetland at a suitable time period to enhance suitable habitat for Latham's Snipe (*Gallinago hardwickii*) at Wharf Marsh, NSW. The study estimated habitat potential for the species by undertaking a detailed assessment of chironomid and oligochate abundances (invertebrate food items) at two sites, a control and treatment. Unfortunately, when compared to the control wetland at Benolong Point, NSW, the management action at Wharf Marsh did not achieve the desired goal, abundances and diversity of benthic animals decreased dramatically in the sediments that were exposed after draining (resulting in a reduced biomass of potential food). As an aside there were many constraints and limitations associated with this study i.e. only having one control and one treatment site and no pre draining population census was undertaken.

The current study area is not known to be utilised as habitat for this species however it is within a region with recognised quality habitat with good patch sizes for the species.

Relating these findings to predicted subsidence and changes in inundation, there is no extrapolation that creation of new potential habitat for threatened wetland bird species through changes in local hydrology will occur as a result of the W2CP. A low potential will exist for there to be more hectares of similar habitat created for commonly occurring local species to utilise.

Habitat within the study area is interpreted to at best, to support occasional, transient, individual threatened wetland birds, yet provides almost continuous habitat for the more common of the DEWHA listed wetland species, which are not listed as threatened by the DECCW. Porters Creek Wetland, Tuggerah Lakes, Cedar Hill Swamp, Shortland Wetlands, Markey Swamp, New Castle Wetlands Reserve and Birmingham Gardens provide better quality habitat for wetland species purely due to the absence of grazing livestock, size of the remnant and presence of more suitable edge vegetation and microhabitat. These areas are also managed to maintain important wetland bird habitat. On a regional perspective these habitats have at least, or for the most part, documented Plans of Management, whereas the private landholders of the Dooralong and Yarramalong Valleys, irrespective of the current project, will likely continue to be managed without special consideration for wetland bird species.

In essence, it's possible that wetland / migratory species of conservation concern may use the study area during suitable periods however the fact remains that there are far better local and regional habitats in close proximity that wetland species of legislative interest are more likely to use that are currently protected (i.e. by DCP's or being listed as a EEC's). This statement is reflected by mapping the recorded sighting of wetland species with conservation concern on the BioNet website.

Table 5: Likely impacts to species of legislative interest from longwall mining in the subsidence area.

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*	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. Key habitat elements will not be altered as a result of longwall mining subsidence for this species. **Further assessment is not required.**
Australasian Bittern *Botaurus poiciloptilus* *TSC Act*	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 under surface 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. 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, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are	Low. Predicated subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area (densely timbered creek lines). Areas to undergo altered flooding hydrology are within cleared grazing land. **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**
	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*	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. 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. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area (densely timbered creek lines). Areas to undergo altered flooding hydrology are within cleared grazing land. **Further assessment is not required.**
Square-tailed Kite *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	Low. Very unlikely to occur in the area. 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 species ability to utilise the areas will be affected. **Further assessment not required.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	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.	
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. **Habitat and ecology** 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 has the potential to utilise resources within the study areas hand has been historically recorded within the zero subsidence line. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area (stands of casuarina along riparian corridors and the timbered hills). Areas to undergo altered flooding hydrology are within cleared grazing land. **Further assessment is not required.**
Black-necked Stork *Ephippiorhynchus asiaticus* *TSC Act*	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 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 alive or dead tree, in or near a freshwater swamp. Two to four eggs are laid; incubation is by both parents.	Low. This species has the potential to utilise resources within the study areas hand has been historically recorded within the subsidence area (in 1984). Predicted subsidence and change in flooding behaviour would not reduce the potential for this species to occur in the area as there will be an increase in potential habitat for the species post-subsidence. **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**
Brown treecreeper *Climacteris picumnus* *TSC Act*	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. Highly likely to occur in the timbered hills but as yet remains extant. Predicted subsidence will not detrimentally alter habitat (timbered hills) that this species could potentially use within the subsidence area. **Further assessment is not required.**
Diamond Firetail Finch *Stagonopleura guttata* *TSC Act*	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. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
Painted Honeyeater *Grantiella picta* *TSC Act*	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, foraging opportunities will also remain the same. F**urther assessment is not required.**
Black-chinned Honeyeater *Melithreptus gularis gularis* *TSC Act*	Occupies mostly upper levels of drier open forests or woodlands dominated by box and 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	Low. Predicated subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **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**
	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 .	
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. **Habitat and ecology** 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. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
Grey-crowned Babbler *Pomatostomus temporalis temporalis* *TSC Act*	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 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. **Habitat and ecology** 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	Low. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **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**
	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. **Habitat and ecology** 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. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
Powerful owl *Ninox strenua* *TSC Act*	The powerful owl occupies an extensive home range of up to 1000 hectares, generally within 200 kilometres of the coast in south-eastern Australia. **Habitat and ecology** Habitat preferences include mountain forests; gullies and forest margins; sparser hilly woodlands; coastal forests, 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.	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. **Further assessment is not required.**
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 and ecology** 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. **Further assessment is not required.**
Masked Owl *Tyto novaehollandiae*	The masked owl occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002a).	Low. There is potential for this species to

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TSC Act	**Habitat and ecology** 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).	use habitat within the study area. The impact would not affect the likelihood of this species to occur. **Further assessment is not required.**
Tyto tenebricosa Sooty Owl *TSC Act*	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. 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 (*Pseudocheirus peregrines*) or Sugar Glider (*Petaurus breviceps*). Nests in very large tree-hollows.	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. **Further assessment is not required.**
Regent Honeyeater *Xanthomyza phrygia* *TSC Act* *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. Eucalypt species preferred by this species will remain unaffected by the proposal. **No further assessment is required.**
Australian Painted Snipe *Rostratula benghalensis* *TSC Act* *EPBC Act*	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. 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. **Further assessment is currently not warranted, however if transient individuals were to be recorded, regular population monitoring should occur.**
Swift Parrot	Inhabits forests, woodlands, plantations, banksias and also street trees, parks and gardens.	Low.

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Lathamus discolour *TSC Act* *EPBC Act*	**Habitat and ecology** 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.	Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
Black-tailed Godwit *Limosa limosa* *TSC 1995* *EPBC Act*	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 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. 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. 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.	Low. There is only a very limited potential for this species to use habitat within the study area. The impact would not affect the likelihood of this species to occur. **Further assessment is not required.**
Bush stone-curlew		Low.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Burhinus grallarius *TSC 1995*	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 patch. Two eggs are laid in spring and early summer . Utilises open forests and savannah woodlands, sometimes dune scrub, savannah and mangrove fringes.	Presence of foxes and dogs within the subsidence area make it very unlikely that species would occur. The proposed impacts will not affect the potential for this species to occur in the area **No further assessment is required.**
Japanese Snipe or Latham's Snipe *Gallinago hardwickii* *EPBC Act*	Latham's Snipe is a medium sized wader and the largest snipe in Australia (c. 33 cm in length) with a wingspan of 50 to 54 cm, weighing around 150 to 230g. It has a long straight bill, short broad pointed wings, long tail and short legs. Plumage in intricately barred and has chevrons of buff, black and brown (various shades). Black / brown stripes occur across the crown and cream striped down the back. Belly and portions of the head are white, tail is rufous with a white tip. It has large black / brown eyes, bill is pale brown / yellow that is distally black / olive yellow at the base. Similarly legs are pale brown / olive and blackish at the distal third and olive yellow at the base. Sexes are similar and there is no season variation in the plumage. Juveniles cab be differentiated by the patterning on the upper wings. When flushed non-breeding pairs flee with a distinctive and rapid zigzagging flight. Occurs in temperate and tropical regions of Australia. Its altitudinal range extends from sea-level (i.e. the coast) or possibly below. For example, there are records from near Lake Eyre to approximately 2000 m above sea-level. **Habitat and ecology** Occur signally or in small lose groups of less than a dozen birds. Occasionally observed in larger groups of several dozen birds or more. Migrating flocks arriving in Australia have been known to contain 200 pairs. Occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. Usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies) Can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. In Australia, Latham's Snipe occurs in a wide variety of permanent and ephemeral wetlands. They usually occur in open, freshwater wetlands that have some form of shelter (usually low and dense vegetation) nearby. They generally occupy flooded meadows, seasonal or semi-permanent swamps, or open waters, but various other freshwater habitats can be used including bogs, waterholes, billabongs, lagoons, lakes, creek or river margins, river pools and floodplains. The structure and composition of the vegetation that occurs around these wetlands is not important in determining the suitability of habitat. As such, snipe may be found in a variety of vegetation types or communities including tussock grasslands with rushes, reeds and sedges, coastal and	Low. Has potential to occur at Porters Creek Wetland and Tuggerah Lakes Estuary. Slight potential for isolated individuals to be recorded within the subsidence area. The proposed impacts will not affect the potential for this species to occur in the area. **Further assessment is not required unless it is subsequently recorded in the area.**

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	alpine heathlands, lignum or tea-tree scrub, button-grass plains, alpine herbfields and open forest. Latham's Snipe sometimes occur in habitats that have saline or brackish water, such as saltmarsh, mangrove creeks, around bays and beaches, and at tidal rivers. These habitats are most commonly used when the birds are on migration. They are regularly recorded in or around modified or artificial habitats including pasture, ploughed paddocks, irrigation channels and drainage ditches, ricefields, orchards, saltworks, and sewage and dairy farms. They can also occur in various sites close to humans or human activity (e.g. near roads, railways, airfields, commercial or industrial complexes) The foraging habitats of Latham's Snipe are characterized by areas of mud (either exposed or beneath a very shallow covering of water) and some form of cover (e.g. low, dense vegetation) (Frith et al. 1977; Todd 2000). The snipe roost on the ground near (or sometimes in) their foraging areas, usually in sites that provide some degree of shelter, e.g. beside or under clumps of vegetation, among dense tea-tree, in forests, in drainage ditches or plough marks, among boulders, or in shallow water if cover is unavailable. Latham's Snipe can occur coincidentally with the Painted Snipe *Rostratula benghalensis* (i.e. both species occupy similar habitats and may sometimes come into close proximity with one another). (Source: EPBC website 2007).	
Fork-tailed Swift *Apus pacificus* *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 coast's in Oct. and leaves in Apr., summer visitor only to Torres Strait islands, rarely over-winters on Cape York Peninsula (DEH webpage 2005)	Low. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
Cattle Egret *Ardea ibis* *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 has been observed within the subsidence area. It will not be affected by a net decrease in habitat. **Further assessment is not required. There may be a slight net benefit for this species.**
White Egret *Ardea alba* *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 is likely to be observed within the subsidence area. This species will not be affected by a net decrease in habitat. **Further**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
		assessment is not required. There may be a slight net benefit for this species.
White-bellied Sea-Eagle *Haliaeetus leucogaster* *EPBC Act*	**Habitat and ecology** 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). 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 (Victorian Dept of Environment & Sustainability web page 2005).	Low. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
White-throated Needletail *Hirundapus caudacutus* *EPBC Act*	**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. Predicted subsidence will not detrimentally alter habitat that this species could potentially use within the subsidence area. **Further assessment is not required.**
Rainbow Bee-eater *Merops ornatus* *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**

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		required.
Black-faced Monarch *Monarch melanopsis* *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 occur therefore **further assessment is not required.**
Satin Flycatcher *Myiagra cyanoleuca* *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* *EPBC Act*	**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* *EPBC Act*	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. The Greater Sand Plover breeds in central Asia from Armenia to Mongolia, moving further south for	Low. There is very 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.**

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	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 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* *TSC Act*	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. 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 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 biology have not been well-studied.	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.**
Terek Sandpiper *Xenus cinereus* *TSC Act*	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.	Low. There is limited potential for this species to use habitat within the study area. The impact would not

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EPBC Act	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.	affect the likelihood of this species to occur therefore **further assessment is not required.**
Pied Oystercatcher *Haematopus longirostris* *TSC Act*	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. 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.	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**
Blue-billed Duck *Oxyura australis* *TSC Act*	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. 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 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.	Low. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
Great Knot *Calidris tenuirostris* *TSC Act* *EPBC Act*	**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**	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**
	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	
Broad-billed Sandpiper *Limicola falcinellus* *TSC Act* *EPBC Act*	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 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. 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, embayment's, 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	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**
Comb-crested Jacana *Irediparra gallinacae* *TSC Act*	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. 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 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.	Low. There is potential for this species to use habitat within the study area, however trampling and a missing layer of edge vegetation, and a general lack of visible waterlilies make it unlikely to breed in the area. The impact would not affect the likelihood of this species to occur. **Further assessment may be required if this species is recorded to regularly use the study area.**
Cotton Pygmy-goose *Nettapus coromandelianus* *TSC Act*	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. 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 (primarily due to distribution and its rarity). The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Magpie Goose *Anseranas semipalmata* *TSC Act*	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. The Magpie Goose is still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the	Low. This species has potential to occur within the study area. This species will not be affected by a net decrease in habitat. **Further assessment may be required if**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	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	**this species is recorded to regularly use the study area.**
Osprey *Pandion haliaetus* *TSC Act*	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. 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.**
Sooty Oystercatcher *Haematopus fuliginous* *TSC Act*	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.	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**
	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.	**assessment is not required.**
Rose-crowned Fruit Dove *Ptilinopus regina* *TSC 1995*	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'. 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 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.	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.**
Gang-Gang Cockatoo *Callocephalon fimbriatum* *TSC 1995*	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. 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**	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.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	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.	
Superb Fruit Dove *Ptilinopus superbus* *TSC 1995*	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 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. 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.	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.**
Lesser Sand Plover *Charadrius mongolus* *TSC 1995*	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	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

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
EPBC Act	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. 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 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.	to occur therefore **further assessment is not required.**
Little Tern *Sterna albifrons* *TSC 1995* *EPBC Act*	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. 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.	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**
	The nest is a scrape in the sand, which may be lined with shell grit, seaweed or small 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*	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 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 seasonal trends in births.	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Red-legged Pademelon *Thyogale stigmatica* *TSC 1995*	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. 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**	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

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	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.	to occur therefore **further assessment is not required.**
Parma Wallaby *Macropus parma* *TSC 1995*	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. 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* *EPBC Act*	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, 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. 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.	Low. This species is more than likely inhabiting areas within the state forest and SCA. The impact would not affect key habitat elements for this species nor would it affect its potential tom occur. **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**
	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 creek lines. Average litter size is five; both sexes mature at about one year of age.	
Eastern Chestnut Mouse *Pseudomys gracilicaudatus* *TSC 1995*	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. 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. **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.	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 Planigale *Planigale maculata* *TSC 1995*	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. 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	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**
	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.	
Large-footed Myotis *Myotis adversus* *TSC 1995*	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 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).	Low. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
The Yellow–bellied sheath Bat *Saccolaimus flaviventris* *TSC 1995*	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.	Low. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
Golden-tipped Bat *Kerivoula papuensis* *TSC 1995*	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. 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. This species will not be affected by a net decrease in habitat. **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**
Eastern Freetail-bat *Mormopterus norfolkensis* *TSC Act*	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. The Eastern Freetail-bat is found along the east coast from south Queensland to southern 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.	Low. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
Large-eared Pied Bat *Chalinolobus dwyeri* *TSC Act* *EPBC Act*	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. 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. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
Eastern False Pipistrelle *Falsistrellus tasmaniensis* *TSC Act*	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. The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from 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.	Low. This species will not be affected by a net decrease in habitat. **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**
	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 Common Bentwing Bat *Miniopterus australis* *TSC Act*	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. 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.	Low. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
Eastern Bentwing-bat / Large Bentwing-bat *Miniopterus schreibersii oceanensis* *TSC Act*	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. 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, 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.	Low. This species will not be affected by a net decrease in habitat. **Further assessment is not required**.
Greater Broad-nosed Bat –	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	Low. This species will not be affected by

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Scoteanax rueppellii *TSC Act*	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. **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.	a net decrease in habitat. **Further assessment is not required**.
Eastern Cave Bat *Vespadelus troughtoni* *TSC Act*	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 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 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.	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required**.
Grey-headed Flying-fox	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	Low. The impact would not affect the

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Pteropus poliocephalus *TSC Act* *EPBC Act*	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. 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. 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.	likelihood of this species to occur therefore **further assessment is not required.**
Eastern Pygmy-possum *Cercartetus nanus* *TSC 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 extends 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 peregrines) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to	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**
	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.	
Squirrel Glider *Petaurus norfolcensis* *TSC Act*	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. **Habitat and ecology** 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 .	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Yellow-bellied Glider *Petaurus australis* *TSC Act*	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. 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.	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**
	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.	
Brush-tailed Phascogale- *Phascogale tapoatafa* *TSC Act*	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. 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. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
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. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Long-nosed Potoroo *Potorous tridactylus Tridactylus* *EPBC Act* *TSC Act*	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*	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. 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.	Unknown. (Likely low to Medium) Known to occur under one of the TransGrid easements in Narrabeen Warm Temperate-Subtropical Rainforest. **Further assessment should be undertaken so that information on the local population can be used to mitigate any future impacts.**
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.**
Green Thighed Frog *Litoria brevipalmata* *TSC Act*	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. 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	Low. This species has been recorded in farm dams in the region and therefore has potential to be recorded in the study area. It is unlikely that subsidence will affect the potential for this species to occur. **Further targeted assessment to identify if this**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	semi-permanent ponds and flood-prone grassy areas. The frogs are thought to forage in leaf-litter.	**species is located within agricultural land should be undertaken in future such that monitoring and mitigation of impacts to any extant population can occur.**
Green and Golden Bell Frog *Litoria aurea* *TSC Act*	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. 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* 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.	Low. This species has the potential to be recorded in the study area. It is unlikely that subsidence will affect the potential for this species to occur. **Further targeted assessment to identify if this species is located within agricultural land should be undertaken in future such that monitoring and mitigation of impacts to any extant population can occur.**
Giant Burrowing Frog *Heleioporus australiacus* *TSC Act*	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.	Low. Key habitat elements will not be affected such that populations of this species would be affected. **Targeted assessment for this species in the Wyong State**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	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.	**Forests should occur so that 'hot spots' for population monitoring can be identified such that mine plans etc can be alerted if required in future.**
Wallum Froglet *Crinia tinnula* *TSC Act*	Wallum Froglets 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. 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. 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.	Low. Has potential to be recorded in remnant paperbark swamps in the zero subsidence line. Remnants will not be affected by subsidence and the hence the habitat for any extant population will remain secure. **Further targeted assessment to identify if this species is located within agricultural land should be undertaken in future such that monitoring and mitigation of impacts to any extant population can occur.**
Stuttering Frog *Mixophyes balbus* *EPBC, TSC Act*	The Stuttering Barred Frog is relatively large and muscular, growing to about 8 cm in length. It has large, black eyes and vertical pupils, webbed feet, barred hind legs and a black line from the snout, through the eye and above the 'ear'. The body colour is brown to olive-green and may be broken into irregular blotches. The underside is creamy-white. The adult has a pale-blue crescent across the upper half of the eye; this, and the call - a stuttering 'ugh' or 'op', distinguishes the species from other barred frogs. The tadpole is dark brown to black and grows to 6.5 cm in length. Stuttering Barred Frogs occur along the east coast of Australia from southern Queensland to the north-eastern Victoria. The species has suffered a marked decline in distribution and abundance, particularly in south-east NSW. It is the only *Mixophyes* species that occurs in south-east NSW and in recent surveys it has only been recorded at three locations south of Sydney.	Unknown .(Likely Low to Medium) Known to occur under one of the TransGrid easements in Narrabeen Warm Temperate-Subtropical Rainforest. . **Further assessment should be undertaken so that information on the local population can be used to mitigate any future impacts.**

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
	Habitat and ecology Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Feed on insects and smaller frogs. Breed in streams during summer after heavy rain. Eggs are laid on rock shelves or shallow riffles in small, flowing streams. As the tadpoles grow they move to deep permanent pools and take approximately 12 months to metamorphose.	
Littlejohn's Tree Frog *Litoria littlejohni* *TSC Act* *EPBC Act*	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". 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. 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.	Unknown. (Likely Low to Medium) Known to occur in the region. Has potential to be recorded in the study area. **Further targeted assessment should occur for this species whilst studying the population of threatened frogs under the TransGrid easement.**
Reptilia Broad-headed Snake - *Hoplocephalus bungaroides*	**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	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**
TSC Act *EPBC Act*	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.	
Pale-headed snake *Hoplocephalus bitorquatus* *TSC Act*	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. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Stephens Banded Snake *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. This species occurs from 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.	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Little Whip Snake *Suta flagellum* *TSC Act*	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.	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**
	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.	
Pink-tailed Worm-lizard *Aprasia parapulchella* *TSC Act* *EPBC Act*	The Pink-tailed Worm-lizard is worm-like, with a dark-brown head and nape, gradually 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. 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.	Low. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Rosenberg's Goanna *Varanus rosenbergi* *TSC Act*	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.	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**
	Juveniles are brighter in colour, having an orange wash on the sides of the face and body. 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 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* *EP&BC Act*	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. 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. The impact would not affect the likelihood of this species to occur therefore **further assessment is not required.**
Loggerhead turtle *Caretta Caretta* *TSC Act*	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. 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 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.	Low. No suitable habitat on site. **No further assessment is required.**
Leathery Turtle	A very large sea-turtle up to 3 m long with heavy paddle-shaped limbs lacking claws. Adults are dark	Low.

Common and *scientific* name Act providing leg. protection	**Preferred Habitat (Source: DECCW threatened species and DPI website)**	**Likelihood of impact**
Dermochelys coriacae *TSC Act*	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. 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.	No suitable habitat on site. **No further assessment is required.**
Australian Grayling *Prototroctes maraena* *TSC Act*	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 grayish or straw coloured fins (Allen 1989; McDowall 1996) **Habitat and Ecology** 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 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 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	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**
	1978a). 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). 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 DEH threatened species profile website.	
Macquarie 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 *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. Adam's emerald dragonflies (*Archaeophya 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.	**Low.** Unlikely to occur but if it did the impact would not affect its potential to occur. **No further assessment is required.**

9. 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. Wetland in the vicinity of the project site would remain unaffected by the Proposal, similarly the Hunter Estuary Wetlands Ramsar site would not be impacted by the project;
- Three Commonwealth listed flora species are known to occur in the subsidence area (*Grevillea parviflora subsp. parviflora, Melaleuca biconvexa and Tetratheca juncea,* **Figure 8**). These species are all recorded within the valley floor within the project site (c. 0.02 to 1.0 m predicted subsidence, **Figure 4).** Flooding and groundwater studies assess probability for hydrological changes on the general stream and alluvial systems as low. The main effects to these species will potential (slight) earth movement that would not place any of these species at risk. The greatest risk to these species is their current management as they occur on private land subject to grazing and mowing. Further flora assessments commissioned as part of the SMP will (allowing for access to private land) determine if any additional Commonwealth listed vulnerable or endangered flora species observed 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;
- Three listed species of Commonwealth listed vulnerable or endangered fauna species (spotted tail quoll, giant burrowing frog and stuttering frog) are known to be in the study area or have portions of their life cycle dependant on the study area. With the current breadth of knowledge (subsidence and hydrology studies) it is considered unlikely that the frogs would be placed at risk by the proposal however, further targeted assessment has been recommended as part of the SMP. The quoll is a historic record, further subsidence and altered hydrology will not affect this species as the greatest threats are existing agriculture and urbanisation. 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 (Fork-tailed Swift, Latham's Snipe, Cattle Egret, Rufous fantail and Black-faced Monarch) have all been previously recorded within the zero subsidence line. 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.
- Commonwealth marine areas do not occur within the study areas; and
- nuclear actions (including uranium mining) are not associated with the proposal.

10. SUMMARY AND CONCLUSIONS

The effects of subsidence to native fauna and flora are unlikely to be significant. Current impacts of agriculture and land management practices and road usage (vehicle trauma) in the Yarramalong and Dooralong valleys are considered to represent ongoing highest risks to biodiversity. There are no species of concern at risk from local extinction with respect to planning approvals. This overarching statement is made with the body of knowledge currently at hand.

Effective management of potential impacts to species of concern, if planning approval is granted, would be through a Fauna and Flora Management Plan implemented through overarching Subsidence Management Plan. This process would allow:

- Monitoring of areas of environmental concern identified within this report (aquatic habitats, water dependant vegetation communities, specific populations of threatened species) pre, during and post mining. The scientific data obtained would document adverse impacts and allow for a program of mitigation, amelioration, restoration or reconstruction of habitats to occur and thus be an effective and transparent management tool.
- Specific environmental measures including avoidance or compensation could be planned for in areas known to be of environmental concern.
- Plans of Management could be produced for areas or items of environmental concern.
- Revegetation, habitat maintenance and monitoring programs would be documented for areas or items of environmental concern.

The majority of effects associated with the predicted W2CP subsidence will occur in currently cleared and disturbed land in the Dooralong valley floor where changes to flood inundation are likely to occur or where it is unlikely to be significant from an ecological point of view. **Figures 15 and 16** shows the native vegetation communities mapped for the study that will be potentially impacted upon by changes in flooding regimes resulting from mine subsidence. Modelling completed by WACJV for 1:100yr (1%), 5:100yr (5%) and 20:100yr (20%) flooding regimes shows that minor increased flooding depths (but not frequency) will potentially impact primarily upon Riverine Alluvial Gallery Rainforest-Moist Forest, with minor impact on Alluvial Floodplain Shrub Swamp Forest, Alluvial Woollybutt-Melaleuca Sedge Forest and Alluvial Footslopes Redgum Forest. All four of these communities occur on already highly flood-prone areas within floodplain alluvium and equate to existing EEC's.

Other communities occupy negligible or none of the land surface within the existing or future flood zones.

Of the vegetation communities listed above only one, Riverine Alluvial Gallery Rainforest-Moist Forest is reliant on deep alluvium in close proximity to a permanent water source and in this context may be considered a Groundwater Dependent Ecosystem. Increasing the potential for flooding due to subsidence has the potential to affect between 66 and 72% of the extant distribution of this community within the study area. The risk of detrimental changes to this EEC, however, is considered low with the body of information available. To ensure due diligence, the SMP should include the establishment of several monitoring points within the community to measure and document the health and status of the EEC's. This body of credible data may be drawn upon at a later date to establish if potential impacts to the EEC are due to subsidence or other external processes and to provide appropriate mitigative measures with improvement of future mining technologies for those areas that are not undermined.

Three species of TSC and EPBC listed flora (*Grevillea parviflora subsp. parviflora, Melaleuca biconvexa and Tetratheca juncea*) are known to occur within the subsidence area (**Figure 8**). These species are all recorded within the valley floor which is subject to the least movement within the project site (c. 0.02 to 1.0 m, **Figure 4).** Flooding and groundwater studies assess probability for hydrological changes on the general stream and alluvial systems as low. The main effects to these species will potential (slight) earth movement that would not place any of these species at risk. The greatest risk to these species is their current management as they occur on private land subject to grazing and mowing.

The effects of subsidence on native fauna are not likely to be significant and as such there are no species of concern with respect to planning approvals. Native fauna are currently impacted by agriculture and land management practices in the Yarramalong and Dooralong Valleys. Changes to flood inundation is unlikely to affect threatened species known to occur in the area or threatened species remaining undetected, yet having the potential to occur. In specific relation to migratory wetland birds, there will be no net loss of potential habitat, those species adapted to agricultural areas will remain secure and those species adapted to more natural settings i.e. Porters Creek Wetland and the Tuggerah Lakes Estuary will continue to have the same potential to be recorded in those locations.

It is unknown if several species of threatened frogs occur within the area, therefore targeted, surveys for Giant Barred Frog, Green Thighed Frog, Green and Golden Bell Frog, Wallum Froglet and Little Johns Tree Frog should occur as part of the SMP if access to privately owned land is allowed in future. Although a net increase in potentially flood-prone areas inundated by a 1 in 100 year flood will occur after subsidence it would be pertinent to try and study any changes to these potentially occurring populations prior to and as a result of subsidence.

Two species of threatened frogs (Giant Barred Frog and Stuttering Frog) are known to occur within the Wyong State Forest within a TransGrid easement in a moist layered / warm, temperate, subtropical rainforest environment which is predominantly on Patonga Claystone. This area will not be undermined for up to 30 years or more; however these species should be included as an item of concern in the SMP. Further

study on the population of this species should occur in this and similar locations, such that the ecological niches in the area and security of the local populations are transparent. This process will assist future mine managers to mitigate impacts with improvements to mining technologies.

Wetlands, though in the vicinity of the proposal, will not be impacted. The Hunter Estuary Wetlands Ramsar site (comprising Koorang Nature Reserve and Shortland Wetlands) will not be impacted by the project.

11. RECOMMENDATIONS

1. When a SMP is developed for the W2CP project, it should include the establishment of several monitoring points within Riverine Alluvial Gallery Rainforest-Moist Forest to measure and document the health and status of the EEC's as it has potential, albeit low, to be impacted by the proposal. The data generated should establish if potential impacts to the EEC are related to subsidence or other external processes. The data should also be a resource from which to develop mitigative measures with improvement of future mining technologies for those areas that would be undermined in future.

2. It is unlikely that the potential for migratory birds to utilise available habitat will be affected by subsidence. When the SMP is developed it should, at regular intervals, review the Schedules of the TSC and EPBC Acts, NPWS Wildlife Atlas or BioNet database and consider impacts to ecological niches of those species known to occur within the zero subsidence line.

3. It is unknown if several species of threatened frogs occur within the area therefore, targeted opportunistic surveys for Giant Barred Frog, Green Thighed Frog, Green and Golden Bell Frog, Wallum Froglet and Little Johns Tree Frog should be undertaken as part of the SMP if access to privately owned land is allowed in future. Although a net increase in inundated areas will occur after subsidence it would be pertinent to try and study any changes to these potentially occurring populations prior to and as a result of subsidence.

4. Two species of threatened frogs (Giant Barred Frog and Stuttering Frog) are known to occur within the Wyong State Forest under a TransGrid easement in a moist layered / warm temperate subtropical rainforest environment. Although this area will not be undermined for up to 30 years or more, these populations should be included as an item of concern in the SMP. Further study / monitoring on the population for species should occur in this and similar locations such that the ecological niches in the area and security of the locals populations are transparent. This process will assist future mine managers to mitigate impacts with improvements to mining technologies.

5. If offsets are required they should be developed in accordance with the NSW DECCW '*Principles for the use of biodiversity offsets in NSW*' and the DEWNA's draft policy statement: '*Use of environmental offsets under the EPBC Act 1999'*.

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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 Desktop 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 Woodland in the Sydney Basin Bioregion	Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion	Endangered Ecological 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 (Ramsar Sites) [Dataset Information]	
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 Australian Painted Snipe		Vulnerable	Species or species habitat may occur within 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 (south-eastern 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	Migratory	Breeding likely to occur within area

Satin Flycatcher			
Rhipidura Rufous Fantail	*rufifrons*	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
Numinous 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	*glareola*	Migratory	Roosting likely to occur within area

Wood Sandpiper			
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 Common Sandpiper	*hypoleucos*	Listed	Roosting known to occur within area
Apus Fork-tailed Swift	*pacificus*	Listed - overfly marine area	Species or species habitat may occur within area
Ardea Great Egret, White Egret	*alba*	Listed - overfly marine area	Species or species habitat may occur within area
Ardea Cattle Egret	*ibis*	Listed - overfly marine area	Species or species habitat may occur within area
Arenaria Ruddy Turnstone	*interpres*	Listed	Roosting known to occur within area
Calidris Sharp-tailed Sandpiper	*acuminata*	Listed	Roosting known to occur within area
Calidris Sanderling	*alba*	Listed	Roosting known to occur within area
Calidris Red Knot, Knot	*canutus*	Listed - overfly marine area	Roosting known to occur within area
Calidris Curlew Sandpiper	*ferruginea*	Listed - overfly marine area	Roosting known to occur within area
Calidris Pectoral Sandpiper	*melanotos*	Listed - overfly marine area	Roosting known to occur within area
Calidris Red-necked Stint	*ruficollis*	Listed - overfly marine area	Roosting known to occur within area
Calidris Long-toed Stint	*subminuta*	Listed - overfly marine area	Roosting likely to occur within area
Calidris Great Knot	*tenuirostris*	Listed - overfly marine area	Roosting known to occur within area
Charadrius Double-banded Plover	*bicinctus*	Listed - overfly marine area	Roosting known to occur within area
Charadrius Little Ringed Plover	*dubius*	Listed - overfly marine area	Roosting likely to occur within area
Charadrius Greater Sand Plover, Large Sand Plover	*leschenaultii*	Listed	Roosting likely to occur within area
Charadrius Lesser Sand Plover, Mongolian Plover	*mongolus*	Listed	Roosting known to occur within area
Charadrius Red-capped Plover	*ruficapillus*	Listed - overfly marine area	Roosting known to occur within area
Diomedea Antipodean Albatross	*antipodensis*	Listed	Species or species habitat may occur within area
Diomedea Gibson's Albatross	*gibsoni*	Listed	Species or species habitat may occur within area
Gallinago Latham's Snipe, Japanese Snipe	*hardwickii*	Listed - overfly marine area	Roosting known to occur within area
Gallinago Swinhoe's Snipe	*megala*	Listed - overfly marine area	Roosting likely to occur within area
Gallinago	*stenura*	Listed - overfly	Roosting likely to occur within area

Pin-tailed Snipe		marine area	
Glareola Oriental Pratincole	*maldivarum*	Listed - overfly marine area	Roosting likely to occur within area
Haliaeetus White-bellied Sea-Eagle	*leucogaster*	Listed	Species or species habitat likely to occur within area
Heteroscelus Grey-tailed Tattler	*brevipes*	Listed	Roosting known to occur within area
Heteroscelus Wandering Tattler	*incanus*	Listed	Roosting likely to occur within area
Himantopus Black-winged Stilt	*himantopus*	Listed - overfly marine area	Roosting known to occur within area
Hirundapus White-throated Needletail	*caudacutus*	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus Swift Parrot	*discolor*	Listed - overfly marine area	Species or species habitat likely to occur within area
Limicola Broad-billed Sandpiper	*falcinellus*	Listed - overfly marine area	Roosting likely to occur within area
Limnodromus Asian Dowitcher	*semipalmatus*	Listed - overfly marine area	Roosting likely to occur within area
Limosa Black-tailed Godwit	*limosa*	Listed - overfly marine area	Roosting known to occur within area
Macronectes Southern Giant-Petrel	*giganteus*	Listed	Species or species habitat may occur within area
Macronectes Northern Giant-Petrel	*halli*	Listed	Species or species habitat may occur within area
Merops Rainbow Bee-eater	*ornatus*	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha Black-faced Monarch	*melanopsis*	Listed - overfly marine area	Breeding may occur within area
Myiagra Satin Flycatcher	*cyanoleuca*	Listed - overfly marine area	Breeding likely to occur within area
Numenius Eastern Curlew	*madagascariensis*	Listed	Roosting known to occur within area
Numenius Little Curlew, Little Whimbrel	*minutus*	Listed - overfly marine area	Roosting likely to occur within area
Numenius Whimbrel	*phaeopus*	Listed	Roosting known to occur within area
Phalaropus Red-necked Phalarope	*lobatus*	Listed	Roosting likely to occur within area
Philomachus Ruff (Reeve)	*pugnax*	Listed - overfly marine area	Roosting likely to occur within area
Pluvialis Pacific Golden Plover	*fulva*	Listed	Roosting known to occur within area
Pluvialis Grey Plover	*squatarola*	Listed - overfly marine area	Roosting known to occur within area
Recurvirostra Red-necked Avocet	*novaehollandiae*	Listed - overfly marine area	Roosting likely to occur within area
Rhipidura Rufous Fantail	*rufifrons*	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis Painted Snipe	*s. lat.*	Listed - overfly marine area	Species or species habitat may occur within area
Sterna Little Tern	*albifrons*	Listed	Breeding likely to occur within area
Stiltia Australian Pratincole	*isabella*	Listed - overfly marine area	Roosting likely to occur within area
Thalassarche	*bulleri*	Listed	Species or species habitat may occur within

Buller's Albatross		area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross	Listed	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross	Listed	Species or species habitat may occur within 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 Pipefish	Listed	Species or species habitat may occur within area
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