

Tweed Shire Council

Ecological impact assessment of Lot 1 DP779817 and Lot 1 DP 408972

Wooyung Road, Wooyung

22 August 2014

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Contents

List of tables

Page number

List of figures

Page number

List of photographs

Page number

List of appendices

Glossary

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity — the variety of genes (or units of heredity) in any population ▪ species diversity — the variety of species ▪ ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. For this study this is the NSW North Coast bioregion as defined in the Interim Biogeographic Regionalisation for Australia.
CMA	Catchment Management Authority
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under either the TSC Act or the EPBC Act and both the state (Department of Environment, Climate Change and Water) and Federal (Department of the Environment, Water, Heritage and the Arts) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant state and Commonwealth legislation.
Department of Sustainability, Environment, Water, Population and Communities (SEWPAC)	The most recent former name of the Commonwealth Department of the Environment (DoE).
Department of the Environment (DoE)	The Commonwealth department responsible for the protection and conservation of Australia's natural environment and cultural heritage. The department develops and implements national policy, programs and legislation including administering the EPBC Act.
Ecological community	An assemblage of species occupying a particular area.
Ecotone	A transitional area between two or more vegetation types. The area where vegetation types meet and integrate. An ecotone may appear on the ground as a gradual blending of vegetation types across a broad area, or it may be a sharp boundary line.
EIS	Environmental Impact Statement.
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GPS	Global Positioning System - a navigational tool that uses radio receivers to pick up signals from four or more special satellites to provide precise

	determination of location.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the TSC Act, the Fisheries Management Act and the EPBC Act. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by Department of Environment and Climate Change (2007).
Locality	The area within a 10 km of the Study Area.
Migratory species	Species listed as Migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the EPBC Act.
MNES	Matters of National Environmental Significance
Noxious weed	An introduced species listed under the Noxious Weeds Act 1993. Under the Act, noxious weeds have specific control measure and reporting requirements.
Office of Environment and Heritage (OEH)	The Office of Environment and Heritage (OEH) is a division of the NSW Department of Premier and Cabinet. Broadly, the OEH works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land and waters: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making. The OEH formed on 4 April 2011 incorporating the former NSW Department of Environment, Climate Change and Water (DECCW) and the Heritage Office, from the Department of Planning, while moving the Office of Water on to Industry and Investment NSW (formerly the Department of Primary Industries).
Patch (vegetation), Patch size	Under the EPBC Act, a patch is defined as a discrete and continuous area of the ecological community. However, a patch may include small-scale disturbances, such as tracks or breaks or small-scale variations in vegetation that do not significantly alter its overall functionality (for instance the movement

	of wildlife or dispersal of plant propagules). The minimum patch size for the Critically Endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia community is 0.1 ha. Where gaps in the canopy exist, they should be in the process of regenerating with the usual suite of rainforest gap species for the site.
Red flag area	An area of land at the development site with high biodiversity conservation values where the impact of the development on biodiversity values cannot be offset by the retirement of biodiversity credits in order to improve or maintain biodiversity values, unless the Director General determines that strict avoidance of the red flag area is unnecessary in the circumstances.
SEPP No. 26 - Littoral Rainforests	State Environmental Planning Policy 26 protects littoral rainforests, a distinct type of rainforest well suited to harsh salt-laden and drying coastal winds. The policy requires that the likely effects of proposed development be thoroughly considered in an environmental impact statement. The policy applies to 'core' areas of littoral rainforest as well as a 100 metre wide 'buffer' area surrounding these core areas, except for residential land and areas to which SEPP No. 14 - Coastal Wetlands applies. Eighteen local government areas with direct frontage to the Pacific Ocean are affected, from Tweed in the north to Eurobodalla in the south.
SEPP No. 44 – Koala Habitat Protection	State Environmental Planning Policy 44 encourages the conservation and management of natural vegetation areas that provide habitat for koalas to ensure permanent free-living populations will be maintained over their present range. The policy applies to 107 local government areas. Local councils cannot approve development in an area affected by the policy without an investigation of core koala habitat. The policy provides the state-wide approach needed to enable appropriate development to continue, while ensuring there is ongoing protection of koalas and their habitat.
Significant, Significant Impact	Important, weighty or more than ordinary as defined by Department of Environment, Climate Change and Water (2007). A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment 2013).
SIS	Species Impact Statement
Study Area	Study area is defined in Figure 1.1 and consists of the land within Lot 1 DP779817 and Lot 1 DP408972.
TEC	Threatened Ecological Community – for the purposes of this report this includes ecological communities listed or nominated under the *Environment Protection and Biodiversity Conservation Act 1999* and ecological communities listed or nominated under the *Threatened Species Conservation Act 1995.*
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the TSC Act or the EPBC Act.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the TSC Act or the EPBC Act. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to

	listing under the relevant state and/or Commonwealth legislation.
TSC Act	NSW *Threatened Species Conservation Act 1995*.
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007).

Executive summary

Wooyung Properties Pty Ltd (Wooyung Properties) have submitted a planning proposal to Tweed Shire Council in relation to Lot 1 DP779817 and Lot 1 DP408972 (the study area) located at Wooyung Road, Wooyung. This report has been prepared for Tweed Shire Council to provide an independent examination of the biodiversity values present within the study area.

The planning proposal consists of 25 dwelling houses and a private heliport, each to be located within an identified building envelope. The study area is also subject to development consent 88/640, granted in 1988, for a 500 bed tourist resort, and it is our understanding the development consent remains current over the study area.

This report provides an understanding of the potential ecological impact of the planning proposal on a site by site basis, cumulatively for each vegetation community, and overall for the project. A comparison of impacts between the planning proposal and the development consent is also provided.

Prior to this survey, the existing vegetation on each of the 25 proposed house sites had been surveyed by representatives of the proponent (Steven Smith Development Community Pty Ltd 2013). To supplement this existing information, a field survey was undertaken over a four day period from 13 to 16 May 2014. The field survey involved an inspection of the ecological values of the study area. Each proposed house site and the helipad were inspected and the proposed access roads were inspected to the fullest extent practical (i.e. where they could be located). To compare the vegetation and habitat quality present within the selected house sites to the broader vegetated areas within the study area, random samples of each vegetation type (and condition class) were selected and surveyed. This allowed for a comparison to be made between the chosen house sites and other randomly available sites within the study area.

The study area contains large areas of native vegetation that are in good condition as defined in the *BioBanking Operation Manual* (Seidel & Briggs 2008). All of the native vegetation within the study area is listed as an Endangered ecological community under the NSW *Threatened Species Conservation Act 1995* (TSC Act). The Littoral Rainforest within the study area is listed as a Critically Endangered ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Two areas of Littoral Rainforest are mapped as SEPP 26 – Littoral Rainforest areas. These communities provide suitable habitat for a number of Threatened plant and animal species listed under the TSC Act. As such, the vegetation and habitats within the study area are sensitive and highly constrained from a housing development perspective.

Minimal avoidance or minimisation strategies to deal with reducing impacts to biodiversity have been utilised in the subdivision design provided in the planning proposal, apart from locating four houses and the helipad in disturbed areas. The majority of houses are proposed to be located in areas of vegetation that are in good condition. Development in the cleared portion of the study area was dismissed solely due to a perceived diminished financial return and the flood prone nature of the land (Steven Smith Development Community Pty Ltd 2013). Avoiding ecological impacts has not been considered. Therefore, there is potential for a high magnitude residual impact to occur in the form of direct vegetation removal, and reduced habitat quality and patch size. These impacts will be irreversible and permanent.

The potential impacts of the planning proposal are potentially significant due to the conservation significance of the vegetation and habitats within the study area. When compared to the potential impacts of the large tourist resort in development consent 88/640, the planning proposal will have a lesser ecological impact as a whole. However, it is worth considering that development consent 88/640 was granted in 1988 before contemporary environmental approval processes had been implemented. As such, the two developments are not directly comparable due to the differing regulatory environments. The planning proposal as described by Steven Smith Development Community Pty Ltd (2013) will still result in significant impacts to TSC Act and

EPBC Act listed Threatened species and ecological communities. The planning proposal would require a SIS and be referred to the Commonwealth Department of the Environment due to potential significant impact on Matters of National Environmental Significance. The planning proposal would likely be considered a 'controlled action' due to impacts to EPBC Act listed Threatened species and ecological communities.

From an ecological perspective, opportunities do exist on site for development as large areas of the study area present little ecological constraint and can be developed with minimal impacts to biodiversity. The main opportunities to avoid ecological impacts are present on the cleared and disturbed land within the study area including the cleared grazing land on the floodplain and the areas of disturbed regrowth vegetation.

1. Introduction

Wooyung Properties Pty Ltd (Wooyung Properties) have submitted a planning proposal to Tweed Shire Council in relation to Lot 1 DP779817 and Lot 1 DP408972 (the study area) located at Wooyung Road, Wooyung (refer Figure 1). The 82.3 hectare property is located approximately 40 km south of Tweed Heads on the southern edge of the Tweed Local Government Area (LGA). The property is bound by the unformed road reserve of Old Coast Road to the east (which separates a narrow coastal Crown reserve and beach), the Billinudgel Nature Reserve to the south, Jones Road to the west, and Wooyung Road to the north. The land is currently owned by Wooyung Properties.

The key objective of the Wooyung Properties' planning proposal is to amend the Table in Schedule 3 of the Tweed Local Environmental Plan 2000 (LEP) so as to enable the land to be used for residential development rather than for the purposes of a tourist development pursuant to a development consent granted in 1988. The following development is proposed by Wooyung Properties:

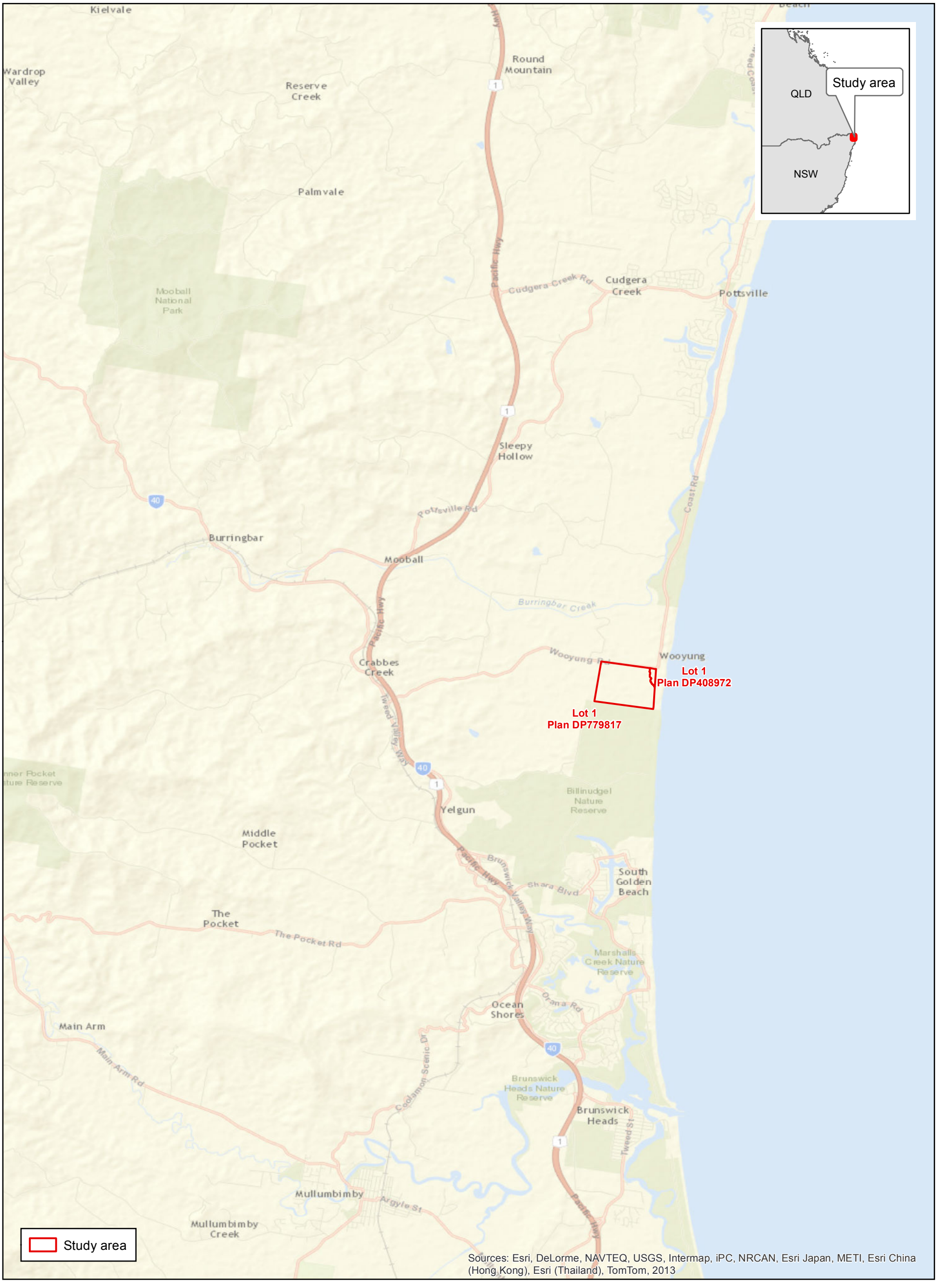
- twenty five dwelling-houses and subdivision (one dwelling-house per allotment) under community title, plus common areas. The subdivision would create:
  - five lots with frontage to the coastal reserve east of Lot 1 DP408972, with lot sizes ranging from 1,240 m^2 to 1,600 m^2
  - seven lots with frontage to the coastal reserve east of Lot 1 DP779817, with lot sizes ranging from 1,050 m^2 to 1,400 m^2
  - thirteen lots west of Billinudgel Creek, with lot sizes ranging from 1,630 m^2 to 2,600 m^2
  - one community lot consolidated from the balance of Lot 1 DP408972 and Lot 1 DP779817, of approximately 78 hectares
- environmental protection works (revegetation of the cleared floodplain area) and environmental facilities.

This report has been prepared for Tweed Shire Council to provide an independent examination of the biodiversity values present within the study area. The objectives of this report are to:

- describe the quality of the existing environment including vegetation and habitats
- identify the potential ecological impacts that may result from the planning proposal in its current form
- describe the ecological constraints and provide recommendations for amendment of the planning proposal to achieve better ecological outcomes
- identify areas on Lot 1 DP779817 and Lot 1 DP408972 where opportunities exist for low impact ecologically sustainable development.

This report provides an understanding of the potential ecological impact of the planning proposal on a site by site basis, cumulatively for each vegetation community, and overall for the project. This report also addresses the following questions listed below:

Question	Section
How the proposed house sites rank against the overall quality of the surrounding vegetation?	3.2
Has Wooyung Properties selected sites for houses that show a degree of lower quality vegetation or not?	3.2 and 5.1
What is the potential impact of the development at each house site, and on the vegetation community immediately adjoining the site taking into account required buffer areas (i.e. bushfire protection)?	4.1
What will be the likely cumulative impact of the development on each vegetation community?	4.1
Can schemes such as BioBanking or biodiversity offsets be applied to the project?	5.3



TWEED SHIRE COUNCIL

Data source: -

esri Partner Network Silver

Map no: 2176503A_GIS_F001_A1

Author: -

Approved by: -

Date: 11/06/2014

0 0.65 1.3 km

1:74,512

Scale ratio correct when printed at A3

Coord sys: GCS GDA 1994

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Ecology Assessment

Figure 1.1 Location of the study area (Lot 1 DP 779817 and Lot 1 DP408972) Wooyung Road, Wooyung

2. Methodology

2.1 Definitions

For the purpose of this report the following definitions apply:

- Development footprint is defined as the design footprint and the direct impacts associated with the construction of the houses, helipad, and all other ancillary infrastructure including access roads, power transmission lines, and sewage (refer Figure 2.1).
- Study area is defined as the entirety of Lot 1 DP779817 and Lot 1 DP408972, Wooyung Road, Wooyung (refer to Figure 1.1 and Figure 2.1).
- Locality is defined as an approximate 10 km radius around the study area.
- Region is a bioregion defined in a national system of bioregionalisation. For this study this is the NSW North Coast bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).

Figure 2.1 **Site plan showing the development footprint for houses and helipad (green shapes) and proposed access roads (yellow lines) Source: (Steven Smith Development Community Pty Ltd 2013)**

2.2 Personnel

The contributors to the preparation of this report, their qualifications and roles are listed in Table 2.1.

Table 2.1 Contributors and their roles

Name	Qualification(s)	Years of experience	Role
Lukas Clews	Bachelor of Science Graduate Certificate in Applied Science Diploma in Conservation and Land Management Master of Scientific Studies	9.5	Lead ecologist, site survey and report preparation
Debbie Landenberger	Bachelor of Science (Honours)	9.5	Senior ecologist, site survey
Alex Cockerill	Bachelor of Science (Honours)	14	Principal ecologist, technical review
David Kretchmann	Bachelor of Regional and Town Planning (Honours)	10	Senior Planner, project manager

2.3 Literature and database review

2.3.1 Database searches

Records of threatened species known or predicted to occur in the locality of the proposal were obtained from a range of databases as detailed in Table 2.2. This research was undertaken to focus the field survey on particular threatened species and ecological communities.

Table 2.2 Database searches

Database	Area searched	Reference
Atlas of NSW Wildlife (BioNet)	10 km buffer around the study area	Office of Environment and Heritage (Office of Environment and Heritage 2014)
PlantNet	Tweed LGA	Royal Botanical Gardens, Sydney (2011)
Protected Matters Search Tool	10 km buffer around the study area	Department of the Environment (2014)

2.3.2 Previous survey and assessment

Prior to this survey, the existing vegetation on each of the 25 proposed house sites had been surveyed by David Fell, an experienced botanist (refer Appendix A for species list detailing vegetation at each house site). As such, the species list is considered appropriate for use in this report. Only a species list has been reviewed as no other documentation from the previous survey was available. According to the planning proposal (Steven Smith Development Community Pty Ltd 2013), the previous survey was undertaken to locate building envelopes that will minimise the impacts of vegetation removal, and to assist with planning for compensatory habitat to be established on the balance lot within the study area.

A further two flora and fauna assessments are relevant to this report and specifically pertain to a proposed single dwelling on Lot 1 DP408972, Wooyung Road, Wooyung; these being:

- Flora and Fauna Assessment Lot 1 DP408972 Wooyung Road, Wooyung (LandPartners 2009).
- Revised Flora and Fauna Assessment, Single Dwelling, Lot 1 DP408972 Wooyung Road, Wooyung (Australian Wetlands Consulting 2013).

LandPartners 2009

Field surveys were completed on Lot 1 DP408972 over four days in October and November 2008 to describe vegetation communities, target some Threatened flora and fauna species, and provide species lists for flora and fauna encountered on site. Field surveys completed on Lot 1 DP408972 comprised:

- one day vegetation and flora survey targeting each vegetation community
- one diurnal bird survey
- two nights spotlighting
- two call playback surveys
- two nights of passive Anabat recording.

Australian Wetlands Consulting 2013

This is a revised ecological assessment relating to two previously unaccepted development proposals regarding the construction of a single dwelling on Lot 1 DP408972. This report sought to identify potential ecological impacts of the proposal as they relate to Threatened species and communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The report also aimed to address legislative and statutory requirements relevant to the proposal and provide ameliorative measures to mitigate impacts of the proposal on biodiversity. Two separate field surveys were completed in Lot 1 DP408972 and comprised:

- Ecological surveys over two days in February 2013:
  - floristic survey of vegetation in in the dwelling footprint, including and inventory of all flora species recorded in the 'vegetation patch'
  - two nights spotlighting
  - two nights Anabat recording
  - opportunistic fauna recordings
- Ecological surveys in October 2013:
  - three nights pitfall trapping (two lines of five buckets)
  - three nights Elliott type A trapping (one line of 25 type A Elliott traps)
  - two nights of passive Anabat recording.

2.4 Desktop analysis of vegetation

Vegetation community boundaries were assessed using aerial photo interpretation and cross referencing with published vegetation mapping for the area. Analysis of the aerial photographs identified past land use practices, disturbance and native vegetation regrowth, changes in vegetation structure and floristics throughout the study area. Examination of the vegetation mapping in the *Tweed Vegetation Management Strategy* (Kingston *et al.* 2004) allowed for a broadscale examination of the likely vegetation communities that existed within the study area. This desktop analysis provided an initial split of vegetation communities into simple structural and disturbance classifications which were then investigated during the field survey.

2.5 Field survey

A field survey was undertaken over a four day period from 13 to 16 May 2014. The field survey involved an inspection of the ecological values of the study area (including ground-truthing of broadscale vegetation mapping and a previous ecological assessment). Each proposed house site and the helipad were inspected. Proposed roads were inspected to the fullest extent practical (i.e. where they could be located). To compare the vegetation and habitat quality present within the selected house sites to the broader vegetated areas within the study area, random samples of each vegetation type (and condition class) were selected and surveyed. This allows for a comparison to be made between the chosen house sites and other randomly available sites within the study area.

No attempt was made at a full floristic survey as this has previously been undertaken by Wooyung Properties at each house site (refer Appendix A for results). A rapid habitat quality assessment was undertaken at each house site to ascertain vegetation and habitat quality. The field survey undertaken for this report was designed to ascertain vegetation quality and search for threatened species. The floristic diversity and possible presence of threatened species was assessed using a combination of random meander and plot-based (quadrat) surveys in accordance with the NSW *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft*) (Department of Environment and Conservation 2004) and the methodology contained in the BioBanking Operation Manual (Seidel & Briggs 2008). The plot-based (quadrat) surveys were undertaken in each vegetation type within the study area outside of the proposed house sites.

Random meander surveys were completed in each vegetation type within the study area and covered the western and eastern portions of the study area which are proposed for development. Some random meander surveys were also undertaken within the centre of the study area where access was possible. Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random meander throughout the site recording boundaries between vegetation communities, condition of vegetation and searching for Threatened species. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

2.6 Quadrats to determine vegetation quality

Eighteen quantitative (quadrat/transect) site surveys (refer to Appendix C) were completed as outlined in the methodology contained in the BioBanking Operation Manual (Seidel & Briggs 2008) and described below. Figure 2.2 illustrates the plot layout that was used at each site.

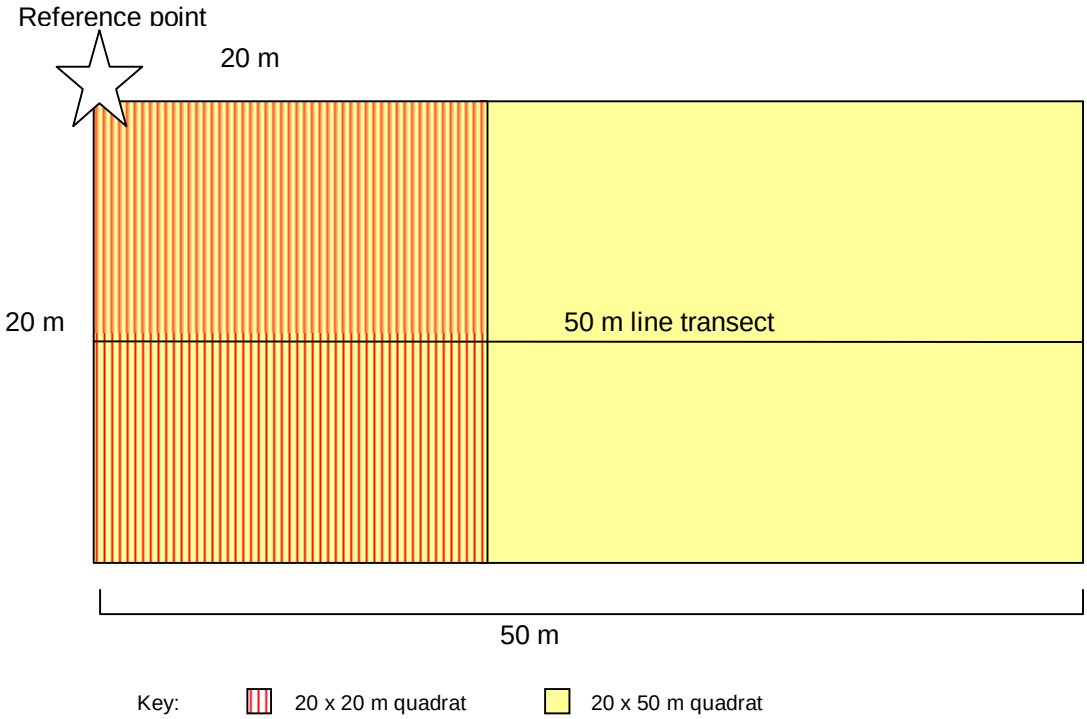


Figure 2.2 Schematic diagram illustrating the layout of the nested 20 x 50 m and 20 x 20 m quadrats used for the assessment of condition attributes at each site

The following site attributes were recorded at each site:

- location (easting – northing grid type MGA 94, Zone 56)
- vegetation structure and dominant species and vegetation condition
- native and exotic species richness (within a 400 m^2 quadrat). This consisted of recording all species by systematically walking through each 20 x 20 m quadrat. The cover abundance of each species was estimated
- number of trees with hollows (1,000 m^2 quadrat). This was the frequency of hollows within living and dead trees within each 50 x 20 m quadrat. A hollow was only recorded if (a) the entrance could be seen: (b) the estimated entrance width was at least 5 cm across: (c) the hollow appeared to have depth: (d) the hollow was at least 1 m above the ground and the (e) the centre of the tree was located within the sampled quadrat
- total length of fallen logs (1,000 m^2 quadrat). This was the cumulative total of logs within each 50 x 20 m quadrat with a diameter of at least 10 cm and a length of at least 0.5 m
- native overstorey cover. This consisted of estimating the percentage cover of the tallest woody stratum present (>1 m and including emergents). The woody stratum included species that were native to NSW and not necessarily those that were locally endemic
- native mid-storey cover. This involved estimating the cover of vegetation between the overstorey stratum and a height of one m (i.e. tall shrubs, under-storey trees and tree regeneration)
- ground cover. This comprised estimating the cover of plants below 1 m in height. The following categories of plants were recorded:
  - native ground cover (grasses): native grasses (Poaceae family native to NSW)
  - native ground cover (shrubs): all woody vegetation below one m in height and native to NSW
  - native ground cover (other): non-woody vegetation (i.e. vascular plants–ferns and herbs) below one m in height and native to NSW

- exotic plant cover: vascular plants not native to Australia.

- evaluation of regeneration. This was estimated as the proportion of overstorey species present at the site that was regenerating (i.e. saplings with a diameter at breast height ≤5 cm). The maximum value for this measure was one.

2.6.1 Condition and quality assessment of vegetation communities

The condition of vegetation was assessed through general observation and comparison against this benchmark data as well as using parameters such as intactness, diversity, history of disturbance, weed invasion and health. Three categories were used to describe the condition of vegetation communities:

- Good: Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers
- Moderate: Vegetation generally still retains its structural integrity, but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants
- Low: Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover, with very few shrubs. Exotic species, such as introduced pasture grasses or weeds, replace much of the indigenous ground cover. Environmental weeds are often co-dominant with the original indigenous species.

Following the biometric methodology (NSW Department of Environment and Conservation 2007), woody vegetation, is considered as low condition vegetation when:

- overstorey per cent foliage cover is <25 per cent of the lower values of the overstorey per cent foliage cover benchmark for that vegetation type, and either:
- less than 50 per cent of vegetation in the ground layer is indigenous species, or
- greater than 90 per cent is ploughed or fallow.

2.7 Limitations

2.7.1 Reliance on externally supplied data

In preparing this study, Parsons Brinckerhoff has relied upon data, surveys, analyses, designs, plans and other information provided by Tweed Shire Council, Wooyung Properties, and other individuals and organisations. Except as otherwise stated in the study, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this study (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

2.7.2 Study for benefit of client

This report has been prepared for the exclusive benefit of Tweed Shire Council and no other party. Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this study (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this

study). Other parties should not rely upon the study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

2.7.3 Field survey limitations

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

Fieldwork for this study was completed during autumn. This may have impacted the activity (and therefore detectability) of some species. However, if suitable habitat was observed, a precautionary approach was taken and it was assumed that the species was present.

2.7.4 Other limitations

To the best of Parsons Brinckerhoff's knowledge, the proposal presented and the facts and matters described in this study reasonably represent the client's intentions at the time of preparation of the study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the proposal and of its possible environmental impact.

Parsons Brinckerhoff will not be liable to update or revise this report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

3. Survey findings

3.1 Landscape context

Tweed Shire Council is the fastest growing area on the NSW Far North Coast, with the population of Tweed Shire Council forecast to exceed 120,000 people by 2025. The majority of this population growth is expected to occur along the coastal strip around Cobaki, Bilambil Heights, South Tweed Heads, Kingscliff, Bogangar and Pottsville. The study area lies to the south of Pottsville.

Over the past 150 years, over 44% of the original vegetation cover within Tweed Shire Council has been cleared or heavily disturbed (Kingston *et al.* 2004). Clearing on the coastal lowlands (where the study area is located) has been particularly extensive leaving only fragmented remnants on the steeper slopes. The study area is composed of three distinct terrain units from east to west. These include a Holocene sand barrier in the east bordering the Pacific Ocean; a low lying inter-barrier floodplain of marine and fluvial sediments in the centre of the study area; and a Pleistocene sand barrier in the west of the study area representing an older beach front. The study area is an example of a relatively intact coastal landscape with remnant vegetation, and wildlife habitat, in a region subject to considerable pressures from rural and urban development.

3.1.1 Surrounding land use

The study area has historically been as a coastal recreation area and for sand mining in the 1960s and 1970s. The central and western portions of the study area have been historically used for agricultural pursuits such as grazing. Cattle grazing continues on site and is the major current land use. Adjoining land uses at the four side boundaries are:

- East: public beach access. A narrow coastal Crown reserve (historically used for sand mining) is present between the eastern edge of the study area and the Pacific Ocean. The Old Coast Road is present here.
- South. The Billinudgel Nature Reserve, a site important for natural and cultural heritage, is located on the southern boundary of the study area.
- West: the study area is bound by Jones Road and agricultural land (grazing and sugar cane)
- North. The study area is bound by Wooyung Road, agricultural land, dwellings, and a motel/caravan park. A strip of coastal vegetation in the east joins the study area to the Wooyung Nature Reserve.

3.1.2 Corridors and connectivity

Wildlife corridors can be defined as ‘retained and/or restored systems of (linear) habitat which, at a minimum enhances connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation’ (Wilson & Lindenmayer 1995). Corridors can provide ecological functions at a variety of spatial and temporal scales from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions.

The native vegetation within the study area provides a link between the large expanses of vegetation within the Billinudgel Nature Reserve in the south to the Wooyung Nature Reserve to the north. The vegetation within the study area is recognised as a Regional Wildlife Corridor and as such is part of a priority wildlife corridor complex that should be maintained and enhanced (Department of Environment Climate Change and Water 2010) (refer Figure 3.1).

The wildlife corridor which the study area forms part of serves an important landscape function in terms of conservation including:

- providing increased foraging area for wide-ranging species
- providing cover for movement between habitat patches and enhancing the movement of animals through sub-optimal habitats
- reducing genetic isolation
- facilitating access to a mix of habitats and successional stages to those species which require them for different activities (for example, foraging or breeding)
- providing refuge from disturbances such as fire
- providing habitat in itself
- linking wildlife populations and maintaining immigration and recolonisation between otherwise isolated patches.

This in turn may help reduce the risk of population extinction in the region for a range of species.

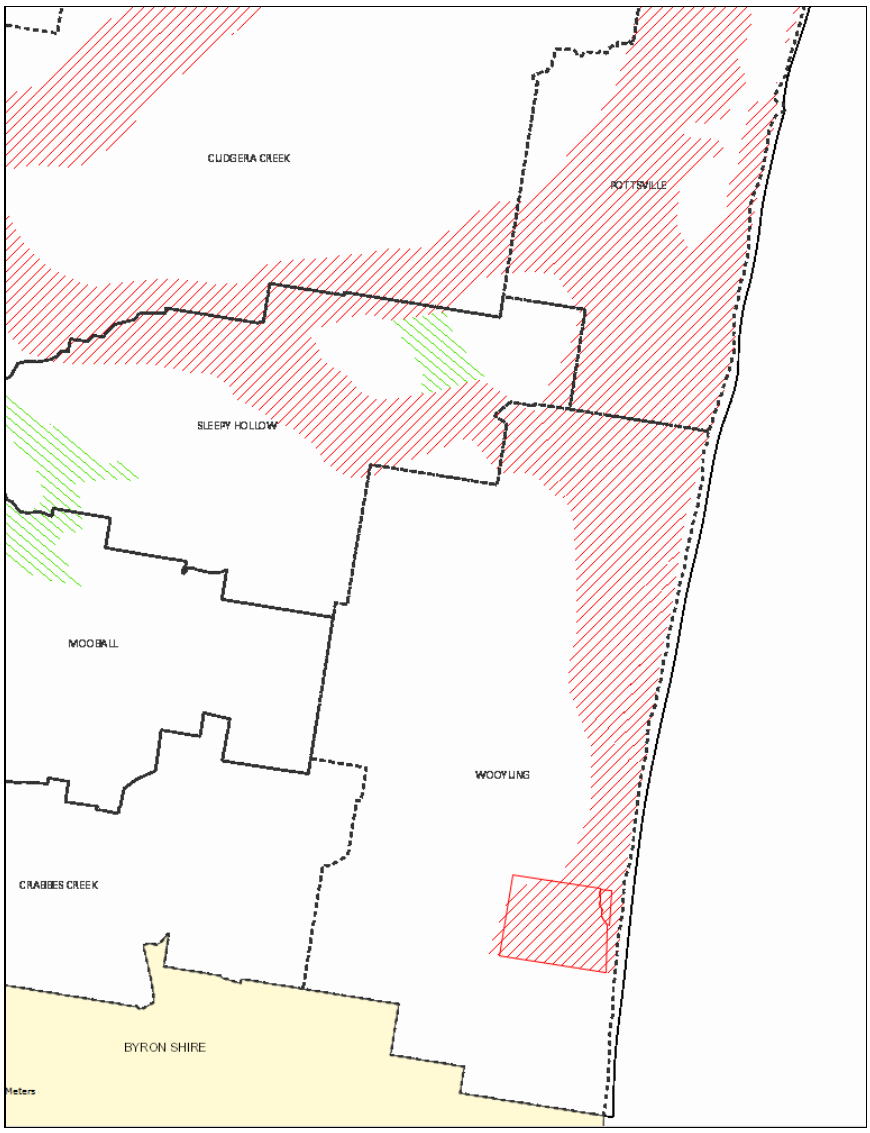


Figure 3.1 Fauna habitat corridors mapping showing the study area as part of a large vegetated regionally significant coastal corridor (study area outlined in red. Red hatching represents the regional wildlife corridor, green hatching are local wildlife corridors)

3.2 Vegetation and habitat quality

3.2.1 Vegetation types

There are six main vegetation types (as described in the BioMetric vegetation type's database for the Northern Rivers region) within the study area (refer Figure 3.2):

- Coast Cypress Pine shrubby open forest of the North Coast Bioregion
- Coastal floodplain sedgelands, rushlands, and forblands
- Paperbark swamp forest of the coastal lowlands of the North Coast
- Swamp Mahogany swamp forest of the coastal lowlands of the North Coast
- Swamp Oak swamp forest of the coastal lowlands of the North Coast
- Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.

The Coast Cypress Pine shrubby open forest of the North Coast Bioregion vegetation type exists in two different condition classes within the study area: Good and Low (refer Figure 3.2 and Section 3.2.2). Cleared and disturbed land is also present (refer Figure 3.2).

Detailed descriptions of each vegetation type within the study area are provided in Appendix D. Figure 3.2 shows the location of each vegetation type within the study area. The location of each vegetation type has been mapped as accurately as possible, however due to the presence of ecotones, overlap of vegetation types occurs and as such the mapping is a representation only.

In Figure 3.2, vegetation patches have been mapped according to the definition of a 'patch' under the EPBC Act. A patch is defined as a discrete and continuous area of the ecological community that may include small-scale disturbances, such as tracks or breaks or small-scale variations in vegetation that do not significantly alter its overall functionality. As such, small scale breaks in vegetation such as gaps in the canopy, do not constitute a separate patch unless they were composed of exotic species, or lacked vegetation. Gaps with native regeneration were considered part of a larger vegetation patch.

3.2.2 Overall vegetation quality within the study area

When compare to the published BioMetric benchmarks for each vegetation type, the vegetation types within the study area fall within established benchmark criteria (refer Appendix E). This suggests that the vegetation types within the study area are in good condition and can be recognised as benchmark examples of these vegetation types within the Northern Rivers region. Indicative photos of each vegetation type within the study area are provided in Appendix D.

Some areas of Coast Cypress Pine shrubby open forest of the North Coast Bioregion within the study area are in low condition. For woody vegetation to be in low condition it must meet the following criteria:

- native over-storey percent foliage cover less than 25% of the lower value of the over-storey percent foliage cover benchmark for that vegetation type, and
  - less than 50% of groundcover vegetation is indigenous species, or
  - greater than 90% of groundcover vegetation is cleared.

The areas of vegetation mapped in Figure 3.2 as Coast Cypress Pine shrubby open forest of the North Coast Bioregion (Low condition) meets this criteria (refer Appendix E for vegetation quality data). This vegetation type is a regrowth community that has low canopy cover and a ground layer dominated by exotic grasses.

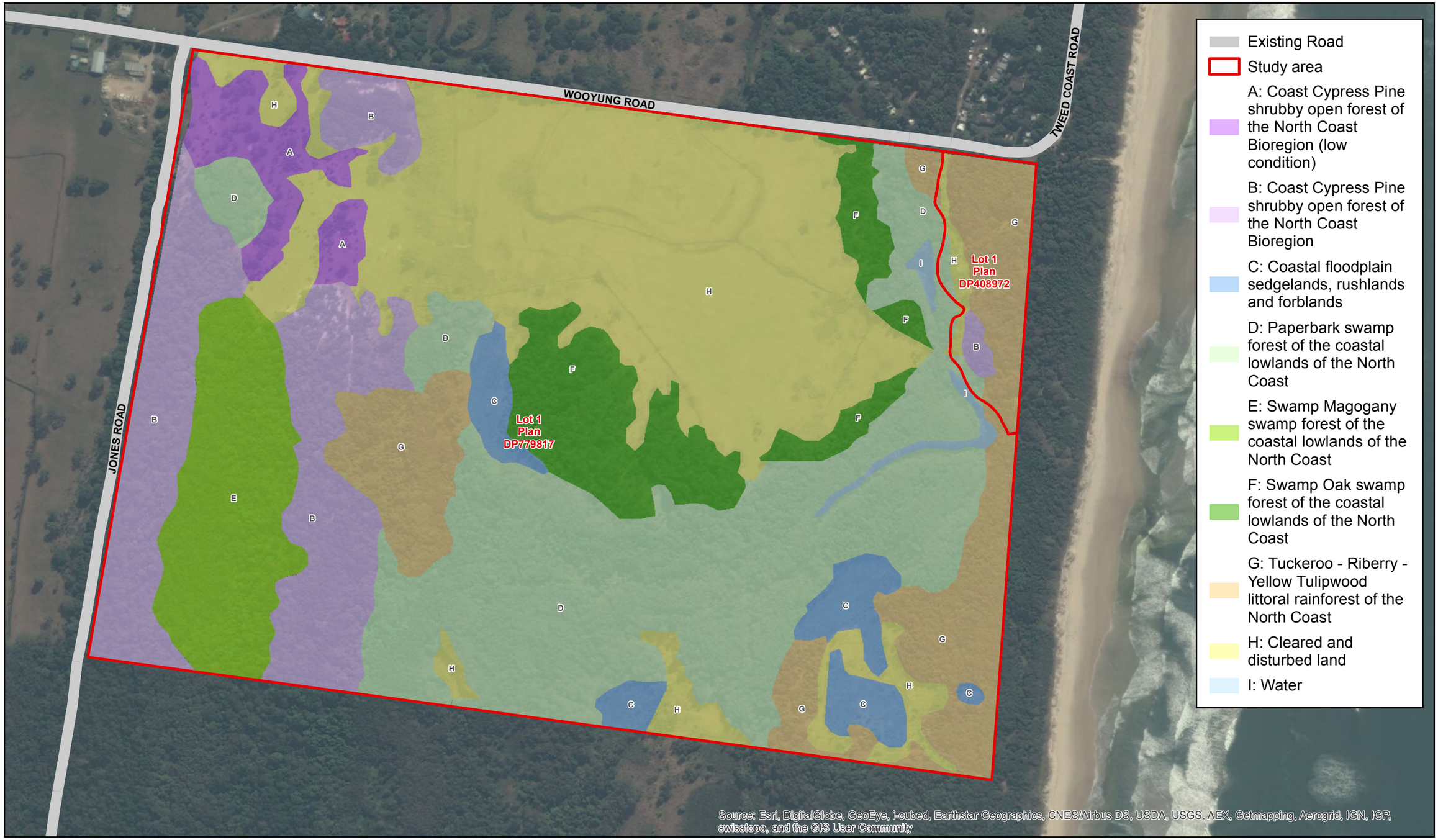
3.2.3 Vegetation quality in the house sites

The vegetation quality within the house sites is good with the exception of house sites 1, 2, 11 and 12 and the helipad. These house sites are located in areas of disturbed regrowth Coast Cypress Pine shrubby open forest of the North Coast Bioregion vegetation that are in low condition. The vegetation in these house sites has low canopy cover (typical of regenerating vegetation) and the ground layer is dominated by exotic grasses.

The remainder of the house sites are located within large patches of native vegetation that are in good condition. While there is some variability in the vegetation on site, the variability is not considered large enough to warrant differing condition categories.

With the exception of house site 14, the vegetation at the house sites is in the same condition as the surrounding vegetation. A portion of house site 14 is located in an area that has been previously disturbed and is currently regenerating. The disturbance is visible from the aerial photos. However, despite the apparent disturbance in this area, the native vegetation is regenerating at this site and a Threatened species listed under the EPBC Act (*Acronychia littoralis*) dominates the vegetation (refer Appendix A for house site 14 species list.

The condition of the vegetation within each house site is illustrated in Appendix B.



TWEED SHIRE COUNCIL

Data source: Ecology assessment by PB, digitised by PB

esri Partner Network Silver

Map no: 2176503A_GIS_F002_C1

Author: AM

Approved by: -

Date: 30/07/2014

0 0.05 0.1 km

1:5,000

Scale ratio correct when printed at A3

Coordinate system: GCS GDA 1994

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Ecology Assessment

Figure 3.2 Vegetation types within the study area
(Lot 1 DP 779817 and Lot 1 DP408972 Wooyung Road, Wooyung)

3.3 Threatened biodiversity and migratory species

3.3.1 Threatened ecological communities

All of the native vegetation within the study area is part of a Threatened ecological community listed under the TSC Act (refer Table 3.1). Additionally, the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia is present which is a Critically Endangered ecological community listed under the EPBC Act.

Table 3.1 Threatened ecological communities within the study area

Vegetation type	Corresponding TEC (TSC Act)	Corresponding TEC (EPBC Act)
Coast Cypress Pine shrubby open forest of the North Coast Bioregion	Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion – Endangered	Not listed
Coastal floodplain sedgelands, rushlands, and forblands	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – Endangered	Not listed
Paperbark swamp forest of the coastal lowlands of the North Coast	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions – Endangered	Not listed
Swamp Mahogany swamp forest of the coastal lowlands of the North Coast		Not listed
Swamp Oak swamp forest of the coastal lowlands of the North Coast	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – Endangered	Not listed
Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions - Endangered	Littoral Rainforest and Coastal Vine Thickets of Eastern Australia – Critically Endangered

3.3.2 Threatened species

The principal habitats within the study area include rainforests, paperbark, swamp mahogany and swamp oak woodlands/forest, wetlands, and dry sclerophyll forests. These habitats are in good condition and are suitable habitat and/or foraging grounds for a suite of Threatened flora and fauna species. Appendix F outlines the likelihood of occurrence assessment for Threatened species.

The study area, including many house sites, is known habitat for Threatened plant species listed under the TSC Act and/or EPBC Act including *Acronychia littoralis* (Scented Acronychia) (Endangered - TSC Act and EPBC Act), *Archidendron hendersonii* (White Lace Flower) (Vulnerable – TSC Act), and *Cryptocarya foetida* (Stinking Cryptocarya) (Vulnerable - TSC Act and EPBC Act). The study area provides large areas of suitable habitat for these plant species. In the case of *Acronychia littoralis*, this species is a dominant component of the Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast vegetation type in the eastern portion of the study area and is also found throughout the Coast Cypress Pine shrubby open forest of the North Coast Bioregion community (refer Figure 3.3). A*rchidendron hendersonii* and *Cryptocarya*

foetida are distributed throughout the study area in the Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast vegetation type (refer Figure 3.3).

A further four Threatened plant species are considered moderately likely to occur in the study area based on the presence of suitable habitat including *Geodorum densiflorum* (Pink Nodding Orchid), *Arthraxon hispidus* (Hairy Joint Grass), *Elyonurus citreus* (Lemon-scented Grass), and *Drynaria rigidula* (Basket Fern) (refer Appendix F).

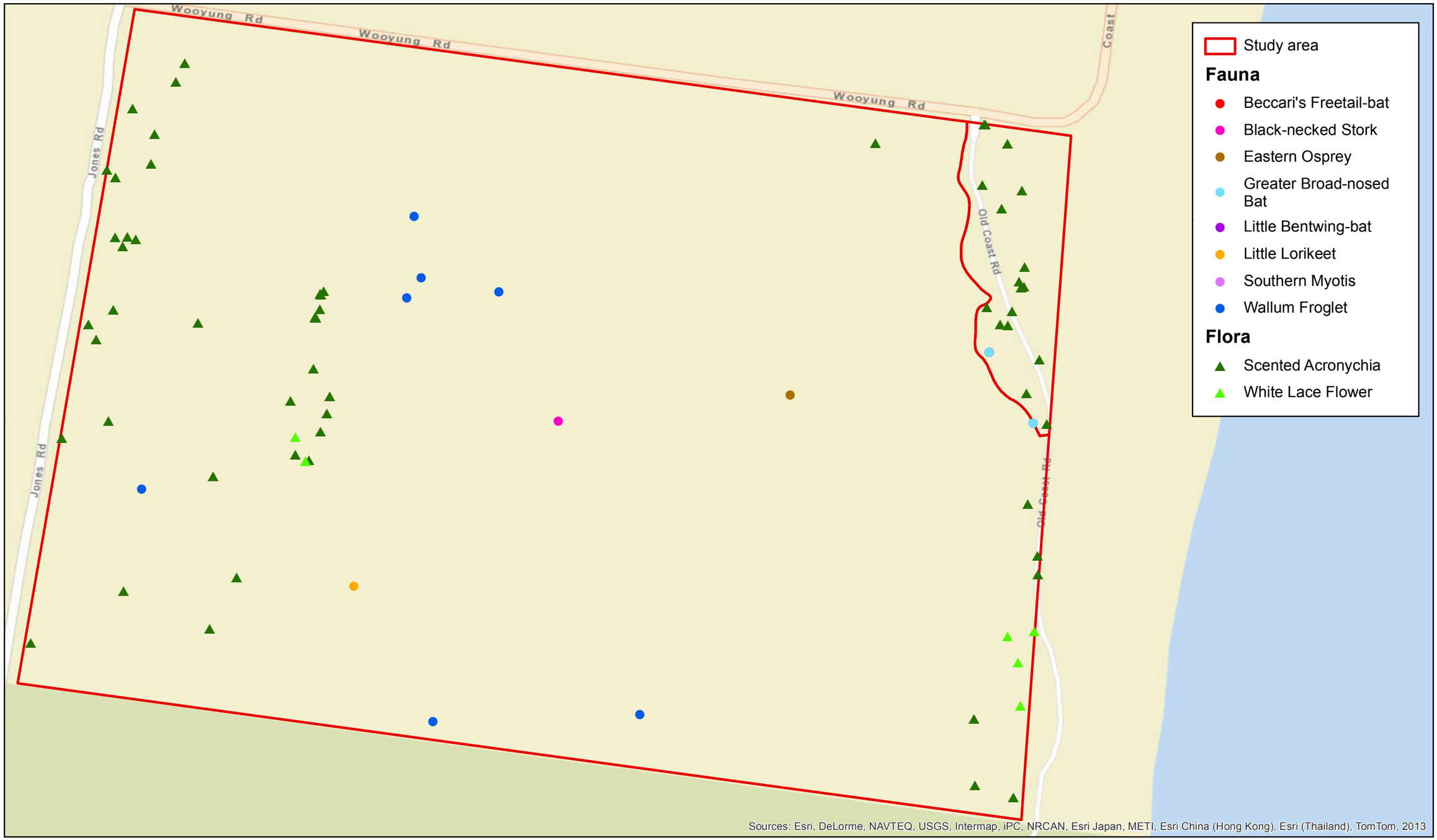
The habitats within the study area are suitable for 17 Threatened bird species (refer Appendix F) due to the presence of substantial foraging resources supplied by the plants in the Littoral Rainforest and swamp forests. Of particular note is the presence of winter flowering tree species including *Eucalyptus robusta* which may provide a foraging resource for the EPBC Act listed Swift Parrot and Regent Honeyeater. The Black-necked Stork has been recorded on the floodplain within the study area and is likely to utilise the study area from time to time for foraging when the floodplain is inundated (refer Appendix F).

Eleven Threatened mammal species are considered likely to utilise the study area as habitat. Suitable habitat exists within the study area for the EPBC Act and TSC Act listed Spotted-Tailed Quoll, Koala (primary feed tree species are present), and Long-nosed Potoroo. Suitable habitat is also present for the TSC Act listed Common Planigale. The EPBC Act and TSC Act listed Grey-headed Flying-fox and the TSC Act listed Common Blossom Bat are considered likely to utilise the study area for foraging due to the abundance of flowering trees within the swamp forests. Five Threatened microbat species listed as Vulnerable under the TSC Act have been previously recorded from the study area near the Old Coast Road including the Greater Broad-nosed Bat, Beccari's Freetail Bat, Southern Myotis, Eastern Bentwing-bat and Little Bentwing-bat. These species are likely to utilise the Littoral Rainforest and adjacent swamp forests. A further five Threatened microbat species listed as Vulnerable under the TSC Act are considered likely to occur within the study area based on the presence of suitable habitats (refer Appendix F).

Two Threatened reptile species, the White-crowned Snake and the Stephen’s Banded Snake are considered moderately likely to occur based on the presence of suitable swamp forest and Littoral Rainforest habitats (refer Appendix F).

The Wallum Froglet, a Vulnerable species listed under the TSC Act is known to inhabit the study area and was recorded during the field survey calling from drainage channels and the swamp forests. It is likely that a relatively large population of the Wallum Froglet occurs within the study area. Another Threatened frog species, the Olongburra Frog, is also considered likely to occur based on the presence of suitable habitat in the form of swamp forests and sedgelands (refer Appendix F).

The swamp forests within the study area, particularly those areas with a rainforest influence, provide suitable habitat for the Mitchell’s Rainforest Snail which is listed as Critically Endangered under the EPBC Act and Endangered under the TSC Act (refer Appendix F).



TWEED SHIRE COUNCIL

Data source: Ecology assessment by PB, imported by PB

esri Partner Network Silver

Map no:	2176503A_GIS_F003_A1
Author:	AM
Approved by:	-
Date:	11/06/2014

0 0.045 0.09 km

1:4,500

Scale ratio correct when printed at A3

Coordinate system: GCS GDA 1994

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Ecology Assessment

Figure 3.3 Threatened species known from the study area (Lot 1 DP 779817 and Lot 1 DP408972 Wooyung Road, Wooyung)

3.3.3 Migratory species

Migratory species listed under the EPBC Act are those protected under international agreements to which Australia is a signatory. These include the *Japan Australia Migratory Bird Agreement* (JAMBA), the *China Australia Migratory Bird Agreement* (CAMBA), the *Republic of Korea Migratory Bird Agreement* (ROKAMBA), and the *Bonn Convention on the Conservation of Migratory Species of Wild Animals*. Migratory species are considered matters of National Environmental Significance under the EPBC Act.

One Migratory species, the Cattle Egret, was observed on site foraging in the cleared paddocks amongst cattle. A further five Migratory species including the Eastern Osprey, Rainbow Bee-eater, White-throated Needletail, White-bellied Sea-Eagle and Regent Honeyeater are considered moderately likely to utilise the study area (refer Appendix F).

While migratory species of bird do use the study area and locality, the study area would not be classed as an 'important habitat' as defined under the EP*BC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment 2013), in that the Project area does not contain:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- habitat utilised by a migratory species which is at the limit of the species range
- habitat within an area where the species is declining.

As such, it is unlikely that the planning proposal would significantly affect migratory species. Consequently, this group is not considered further in this report.

3.3.4 State Environmental Planning Policy 26 (SEPP 26) – Littoral Rainforests

The aim of SEPP 26 is to provide a mechanism for the consideration of applications for development that is likely to damage or destroy littoral rainforest areas with a view to the preservation of those areas in their natural state. SEPP 26 outlines a method for determining the impact of a proposed development on littoral rainforest, with the object of preserving such areas. The area covered by the SEPP includes a 100-metre buffer zone around mapped SEPP 26 areas.

Development consent is required for the following activities in littoral rainforests (and buffer zone):

- erecting a building or carrying out a work
- disturbing, altering or changing any landform
- dumping rubbish or chemicals
- using a littoral rainforest for any purpose
- disturbing native flora (clearing).

These activities are deemed to be designated development (high impact development), which means the development application must be accompanied by an environmental impact statement (EIS) and be placed on public exhibition for public comment. Tweed Shire Council is the consent authority for developments applying to SEPP 26 littoral rainforests and the concurrence of the Director-General of Planning and Environment is required.

Importantly, at the development application stage Council are not permitted to consent to an application made under Clause 7, subclause (1) or (2) of SEPP 26 unless Council is satisfied that there is no place

outside the area to which SEPP 26 applies on which a development might suitably be located or occur. This is an important consideration for the planning proposal.

There are 15 individual patches of SEPP 26 Littoral Rainforest in Tweed Shire Council as follows:

- one at Fingal Head (behind houses on Lagoon Rd)
- two at Tweed Heads South (within the Golf Course)
- one east of Cudgen Lake (opposite Tweed Coast Road)
- one at Cabarita Beach (opposite Towners Ave & Tweed Coast Rd)
- one at Hastings Point (corner Tweed Coast Rd & Yugari Dr)
- nine patches at Wooyung (five along Mooball Creek, two patches within the study area (refer Figure 3.4), and two opposite the beach in the south east of the Council area).

There are only 102 ha of Littoral Rainforest remaining within Tweed Shire Council (Kingston *et al.* 2004).

Figure 3.4 Location of mapped SEPP 26 areas within the study area (Red crosshatched polygons = SEPP 26 areas, purple crosshatched polygons = 100m SEPP 26 buffer areas)

3.3.5 State Environmental Planning Policy 44 (SEPP 44) – Koala Habitat Protection

State Environmental Planning Policy 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range, and to reverse the current trend of koala population decline:

- by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat
- by encouraging the identification of areas of core koala habitat; and
- by encouraging the inclusion of areas of core koala habitat in environmental protection zones.

Under SEPP 44, 'core koala habitat' is defined as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population. 'Potential koala habitat' means areas of native vegetation where the trees of the types listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

The field survey identified areas of native vegetation where the trees of the types listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. *Eucalyptus robusta* (Swamp Mahogany), the dominant canopy tree in the Swamp Mahogany swamp forest of the coastal lowlands of the North Coast vegetation type within the study area, is one of the primary feed tree species for koalas within Tweed Shire Council. Other species that dominate the vegetation of the study area including *Callitris columellaris, Melaleuca quinquenervia, Lophostemon confertus,* and *Casuarina glauca*, are known to be used by koalas within Tweed Shire Council (Biolink Ecological Consultants 2011).

Historically there has been a lack of koala records from the Wooyung area, with few observations made of koalas over the last 20 years, although a koala population is known to have historically been present at Wooyung within the last three koala generations (Biolink Ecological Consultants 2011). While the Wooyung area in general is not currently known to support a koala population, the study area has not been specifically investigated. Potential koala habitat as defined under SEPP 44 exists within the study area and to fully address SEPP 44, a comprehensive survey of the study area for koalas must be undertaken taken to determine if any part of the study area would constitute 'core koala habitat'. If core koala habitat was found, a Koala Plan of Management would be required at a later stage.

4. Potential impacts of the planning proposal

This section identifies key potential impacts that may result from development of the planning proposal in relation to the identified environmental values on site. The potential impacts that may be associated with the planning proposal are considered with respect to the construction and ongoing use of the land for housing. The major potential impacts to ecological values are discussed below in relation to the extent, duration and magnitude of the potential impact.

4.1 Vegetation and habitat clearing

Vegetation clearance and habitat loss are likely to be the largest detrimental impacts to biodiversity that may result from the planning proposal. The impact may be direct in the form of vegetation and habitat removal, or indirect, as fauna may not survive due to shortages in available habitat resources. Even small-scale clearing within largely intact patches of vegetation can cause localised depletion of some species (Kutt *et al.* 2012). The Tweed coastal lowlands exist in a highly modified state and currently possess approximately 52% of the pre-clearing extent of native vegetation (Kingston *et al.* 2004). Consequently, further vegetation clearing in this region is likely to be detrimental to the remaining biodiversity. Vegetation clearing and habitat loss within the study area is likely to result in irreversible and permanent impacts to biodiversity values, including threatened biodiversity.

Clearing of native vegetation is listed as a key threatening process under both the NSW TSC Act and the Commonwealth EPBC Act. Under the TSC Act, native vegetation is made up of plant communities, comprising primarily indigenous species. Clearing is defined as the destruction of a sufficient proportion of one or more strata layers within a stand or stands of native vegetation so as to result in the loss, or long-term modification, of the structure, composition and ecological function of a stand or stands (NSW Scientific Committee 2001).

The overall extent of vegetation removal and habitat loss from the planning proposal is estimated at approximately:

- 4.6 ha for house and helipad construction (assuming all vegetation within the footprints will be cleared and that the footprints include asset protection zones)
- 1.2 ha for access roads (assuming a minimum trafficable width of 4 m and it is assumed that the access roads will be two-wheel drive, all weather roads and will be cleared to a height of 6 m above the road).

Refer to Table 4.1 for the amount of each vegetation type to be removed and Table 4.2 for clearing required for individual houses and access roads.

Bushfire protection implications

Wooyung Properties (2014) have stated the layout has been designed to accommodate the smallest Asset Protection Zones allowable under Planning for Bush Fire Protection. The information submitted by the proponent does not contain specific details on an appropriate Asset Protection Zone for each house site. However, using the site assessment methodology documented in Planning for Bushfire Protection, the maximum width of the Asset Protection Zone, from the edge of each dwelling envelope, will be 20 metres.

- This calculation was derived based on vegetation formations present in the study area, which included Rainforests, Forests, Freshwater Wetlands and Forested Wetlands. Different vegetation formations, fire

danger index and effective slopes, necessarily dictate different minimum specifications for Asset Protection Zones (NSW Rural Fire Service 2006).

- Using a worst case scenario regarding vegetation formations mapped in the study area, the minimum width of an Asset Protection Zone would be 20 metres. This was based on Forest vegetation (commensurate with Coast Cypress Pine shrubby open forest) and Forested Wetland vegetation (commensurate with Paperbark Swamp Forest, Swamp Mahogany Swamp Forest and Swamp Oak Swamp Forest), with a fire danger index of 80 and a slope no greater than 0^{o} – 5^{o}.

The NSW Rural Fires Amendment (Vegetation Clearing) Bill 2014, introduced to Parliament on 29 May 2014, is intended to amend the *Rural Fires Act 1997* to make provision for vegetation clearing work to be carried out in certain areas near residential accommodation or high-risk facilities to reduce bush fire risk. If the Bill is adopted by Parliament in its current form, the provisions that may apply to this development are that vegetation clearing work (removal, destruction other than by fire, or pruning) can be carried out to:

- Any vegetation (including trees or parts of trees) within 10 metres of an external wall of a building containing habitable rooms that comprises or is part of residential accommodation or a high-risk facility, and
- Any vegetation, except for trees or parts of trees, within 50 metres of an external wall of a building containing habitable rooms that comprises or is part of residential accommodation or a high-risk facility.

Importantly, clearing is defined as the destruction of a sufficient proportion of one or more strata within a stand of native vegetation that results in the loss (or long term modification) of the structure, composition and ecological function of the stand (NSW Scientific Committee 2001). Thus, the removal of any vegetation (other than trees) within 50 metres of an external wall of a building would concur with the definition of clearing and has the potential to substantially increase direct impacts to areas of high ecological constraint, including Threatened communities and species.

The applicability of these provisions to the development will be subject to whether the study area is mapped as a 10/50 vegetation clearing entitlement area as mapped by the NSW Rural Fire Service, and whether the clearing is carried out in accordance with a 10/50 Vegetation Clearing Code of Practice. The mapping, and the Code of Practice, are both expected to be products that accompany the amendments to the *Rural Fires Act 1997* if the Bill is adopted in its current form.

For the purpose of quantifying the implications of the Bill (i.e., clearing 50 metres from the external wall of a building), the estimated edge effects of 50 metres (as quantified in section 4.2.1) would be a conservative amount.

Direct impacts of habitat removal

The greatest impact from vegetation removal will occur to the Littoral Rainforest vegetation type which is listed as a Critically Endangered ecological community under the TSC Act and EPBC Act. Coastal Cypress Pine and Swamp Sclerophyll Forest, listed as Endangered ecological communities under the TSC Act, will also be affected (refer Section 4.8 for a discussion on Threatened species impacts).

The study area has had a history of disturbance from land clearing associated with farming and sand mining (refer Appendix G for historical aerial photos). However, the vegetation within the study area has recovered from these disturbances and now exists in a near natural state. While the amount of vegetation removal predicted from the planning proposal appears to be relatively minor in the context of the broadscale clearing that has historically occurred within the Tweed lowlands, the conservation significance of the vegetation to be removed is high. The impact from vegetation and habitat clearing will be long term and permanent. As such the magnitude of this impact is considered high.

The quality of the vegetation to be removed is shown in Photos 4.1 to 4.6.

Table 4.1 Estimated vegetation clearing required for the house sites by vegetation type

Vegetation type	Clearing required (ha)	Extent remaining in Tweed Shire Council (ha)	% of extent in Tweed Shire Council to be cleared
Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.9	Unknown (regrowth is not mapped)	Unknown (regrowth is not mapped)
Coast Cypress Pine shrubby open forest of the North Coast Bioregion	1.2	29	4.1%
Paperbark swamp forest of the coastal lowlands of the North Coast	0.2	1,131	0.02%
Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	0.8	170	0.5%
Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	1.5	102	1.5%
Totals	**4.6**	**1,432**	**0.3%**

Table 4.2 Estimated vegetation and habitat clearing required based on the proposed plan of subdivision in the Planning Proposal

Clearing area	Vegetation community / habitat type	Clearing footprint (ha)
Helipad	Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.131
House site 1	Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.163
House site 2	Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.189
House site 3	Paperbark swamp forest of the coastal lowlands of the North Coast	0.230
House site 4	Coast Cypress Pine shrubby open forest of the North Coast Bioregion	0.240
House site 5	Coast Cypress Pine shrubby open forest of the North Coast Bioregion	0.259
House site 6	Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	0.259
House site 7	Coast Cypress Pine shrubby open forest of the North Coast Bioregion	0.259
House site 8	Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	0.259
House site 9	Coast Cypress Pine shrubby open forest of the North Coast Bioregion	0.260

Clearing area	Vegetation community / habitat type	Clearing footprint (ha)
House site 10	Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	0.260
House site 11	Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.260
House site 12	Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.259
House site 13	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.170
House site 14	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.127
House site 15	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.127
House site 16	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.129
House site 17	Coast Cypress Pine shrubby open forest of the North Coast Bioregion	0.160
House site 18	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.124
House site 19	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.117
House site 20	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.116
House site 21	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.129
House site 22	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.139
House site 23	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.105
House site 24	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.105
House site 25	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	0.129
Access roads	Coastal Cypress Pine and Littoral Rainforest	1.2
Total cumulative impact		**5.8**

Photo 4.1 **Coast Cypress Pine shrubby open forest in the western portion of Lot 1 DP779817**

Photo 4.2 **Swamp Mahogany swamp forest in the western portion of Lot 1 DP779817**

Photo 4.3 **Paperbark swamp forest in the western portion of Lot 1 DP779817**

Photo 4.4 **Littoral Rainforest in the eastern portion of Lot 1 DP408972**

Photo 4.5 **Disturbed area with Coastal Cypress Pine regrowth in the north western portion of Lot 1 DP779817**

Photo 4.6 **The Old Coast Road in the south east corner of Lot 1 DP779817**

4.2 Reduction of habitat quality and patch size

The direct removal of vegetation and habitat that may result from the planning proposal is likely to be relatively small at approximately 4.6 ha for housing footprints and approximately 1.2 ha for access roads. However, greater impacts are predicted due to the reduction of habitat quality and patch size. Reduction of habitat quality and patch size may be an important impact that may ultimately lead to habitat loss within the remaining vegetation of the study area over time.

Reduction of habitat quality and patch size is a direct and cumulative impact. The planning proposal will directly reduce habitat quality and habitat patch size and each house (and ancillary infrastructure) will act together to produce synergistic effects. The potential alteration of habitat mosaics and alteration of relatively large and long unmodified habitats from the planning proposal is likely to result in edge effects, habitat fragmentation, and barrier effects which can cause habitat degradation and simplification.

Reduction of habitat quality and patch size will occur during the construction and occupation of the houses. While the houses will result in the reduction of habitat quality and patch size, the installation of infrastructure (i.e. access roads, and the water, gas, power, telecommunications network and on site effluent) is likely to create a greater disturbance in terms of reducing habitat quality and patch size. There is a high potential for edge effects, habitat fragmentation and barrier effects associated with this development due to the impact footprint and perimeter. Threatened species, endangered vegetation, and a regional fauna corridor will be impacted most from this impact pathway due to the importance of habitat quality and patch size for these aspects of biodiversity at a local scale and the cumulative impacts at a regional landscape scale.

The planning proposal (Steven Smith Development Community Pty Ltd 2013) suggests that the construction of dwellings is not expected to be a significant impediment to wildlife movement. However, considerable habitat degradation and removal of habitat in large core inner habitat areas to build houses and access roads will occur. This will result in a suite of impacts including edge effects, fragmentation and barrier effects which will have an impact on wildlife movement. No avoidance or minimisation strategies to deal with reducing impacts associated with reduction of habitat quality and patch size appear to have been utilised in the subdivision design provided in the planning proposal. Therefore, there is potential for a high magnitude residual impact to occur in the form of reduced habitat quality and patch size, which is irreversible and permanent.

4.2.1 Edge effects

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along the habitat edges can promote the growth of different vegetation types (including weeds), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident animals (Moenting & Morris 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators. The distance of edge effect influence can vary, with the extent of edge effects having been recorded greater than 1 km from an edge (Forman et al. 2000) and stopping as little as 50 m from an edge (Bali 2000, 2005).

While the vegetation within the study area is composed of various types, the vegetation exists as a large continuous block running from the beach in the east to Jones Road in the west, and is contiguous with the large expanse of vegetation comprising the Billinudgel Nature Reserve to the south. Large core areas of vegetation and habitat exist with low edge to area ratios (i.e. vegetation patches have a large perimeter). Some smaller areas of vegetation are also present and some disturbances do exist within the study area. Cleared areas exist within the vegetation and the Old Coast Road (in the eastern portion of the study area), perimeter tracks around the property, and old access tracks are present through the vegetation. Many of the old access tracks have now overgrown with vegetation. The Old Coast Road, perimeter tracks and old access tracks are narrow and are sand based dry weather only roads.

Due to the large size of the vegetated area, and minimal disturbance over the last 20 years, edge effects are minimal as evidenced by the lack of weeds in the vegetation. However, some edge effects are evident in smaller more disturbed vegetation patches, and where vegetation meets cleared areas and Old Coast Road. Weed invasion for grass and herbaceous weeds (the most obvious form of edge effect within the study area), is most prominent at the edges of Old Coast Road and does not penetrate the core of the Littoral Rainforest. The Coastal Cypress Pine forest and Paperbark Swamp forest adjacent to the Old Coast Road are however subject to weed invasion in the ground layer. The remainder of native vegetation within the study area is relatively weed free with some small areas of weeds such as Lantana and Asparagus fern occurring sparsely.

With the construction of the houses and ancillary infrastructure, it is likely that the planning proposal will increase the amount of edge effects within the remaining vegetation considerably, resulting in habitat degradation and a reduction of the core habitat available for a range of species. Taking a precautionary approach and estimating a minimum 50 m width for an edge effect zone, the likely area of native vegetation that would be impacted by edge effects is approximately 20 ha (refer Figure 4.1).

Edge effects have the potential to impact on the range of flora and fauna species identified as occurring or potentially occurring in the study area and the more sensitive species that have specific micro-habitat requirements and which are less tolerant to disturbance, will be effected the most (e.g. ground-dwelling reptiles and mammals, smaller birds and some plants).

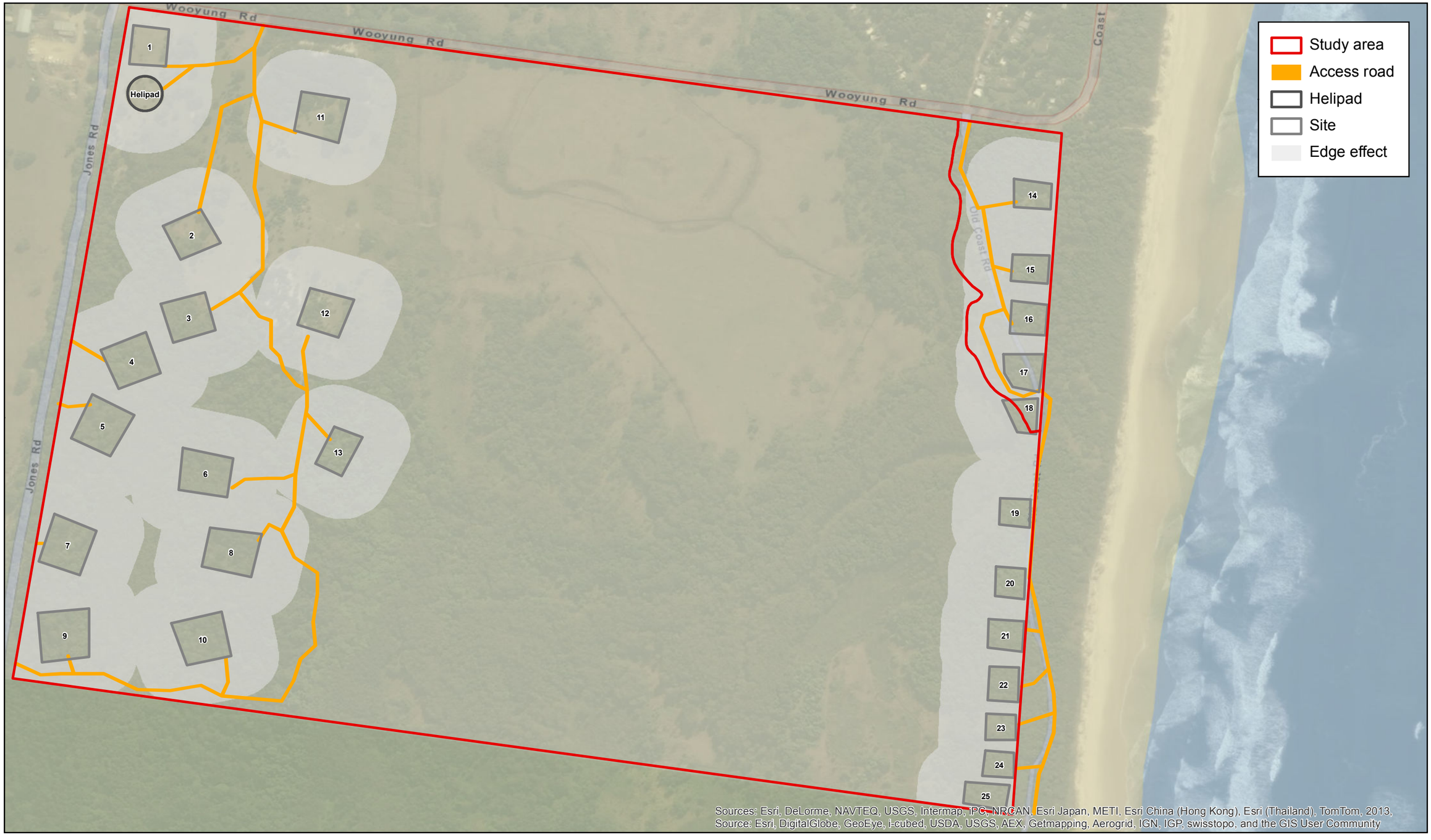
4.2.2 Habitat fragmentation

Habitat fragmentation *per se* relates to the physical dividing up of once continuous habitats into separate smaller ‘fragments’ (Fahrig 2002). The habitat fragments created by fragmentation tend to be smaller and separated from each other by a matrix of less suitable habitat. The new dividing habitat type between fragments is often artificial and less suitable to the species remaining within these newly created fragments (Bennett 1990, 1993; Lindenmayer & Fischer 2006; MacNally 1999) or is generally only used by adaptive and aggressive generalist species (e.g. Noisy Miners, Loyn *et al.* 1983) which further decreases population levels of other species remaining in the fragments.

The planning proposal will result in fragmentation of the vegetation within the study area and landscape scale fragmentation of a regional fauna corridor. The coastal area of Tweed Shire Council and the coast of the Northern Rivers region in general, are already highly fragmented. Therefore, the remaining large blocks of vegetation within the coastal zone, particularly those areas that are connected to other areas of vegetation, are important landscape features for biodiversity. The planning proposal will result in the removal of areas of vegetation for the construction of houses and strips of vegetation for construction of access roads. The current subdivision design will result in fragmentation of habitats from east to west within the study area and will also fragment the regional north south fauna corridor that connects the Billinudgel Nature Reserve to the Wooyung Nature Reserve.

Threatened species, endangered ecological communities, and fauna corridors will be impacted most from habitat fragmentation due to the importance of connectivity, dispersal opportunities and habitat quality, for species at a local scale and the cumulative impacts at a regional landscape scale. Fragmentation within the study area will be detrimental to the dispersal of relatively sedentary species such as small mammals, frogs, and reptiles which can lead to crowding effects and increased competition within remaining habitat patches. Mobile species such as birds and bats may not be affected by this fragmentation as the predicted level of fragmentation would not likely be enough to restrict their dispersal between habitat patches.

The predicted level of habitat fragmentation from the planning proposal may prevent the breeding and dispersal of some plant pollinators or the dispersal of plant propagules (reproductive material) between habitat patches. Functional connectivity for many species (e.g. bats and birds) will likely remain in the study area. However, division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability may result from the planning proposal.



TWEED SHIRE COUNCIL

Data source: Ecology assessment by PB, imported by PB

esri Partner Network Silver

Map no: 2176503A_GIS_F004_A1

Author: AM

Approved by: -

Date: 11/06/2014

0 0.045 0.09 km

1:4,500

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Scale ratio correct when printed at A3

Coordinate system: GCS GDA 1994

Ecology Assessment

Figure 4.3 Predicted impacts from edge effects, habitat fragmentation and barrier effects as a result of the planning proposal

4.2.3 Barrier effects

Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a 'barrier' (e.g. a newly created inhospitable habitat type or physical barrier such as a fence or road). Species most vulnerable to barrier effects include uncommon species, smaller ground-dwelling species, and relatively sessile species with smaller home ranges.

Houses and roads may create a hard barrier that restricts fauna movement and this impact is likely to be most obvious for fauna groups including small mammals, frogs, and reptiles. Mobile species such as larger mammals, birds, and bats may not be affected to the same extent.

Human activity and infrastructure are likely to create a barrier as many species are known to avoid areas of human activity resulting in indirect habitat loss (Caro 2005;Rogala et al. 2011Whittaker & Knight 1998). Some species display avoidance behaviour while others may habituate and become attracted to areas of human activity (Caro 2005). Predators and prey may respond differentially to human activity, causing a disruption of community interaction and potentially disrupting ecological processes (Caro 2005). Where animals cannot leave a disturbed habitat, they may change the timing of activities (Buckley 2004). Human presence and activity is likely to produce avoidance responses in larger mammalian predators that are sensitive to disturbance while species such as macropods and smaller amphibian and reptile species are more likely to habituate to human presence.

Barrier effects may be experienced by native animals in the form of increased patrolling and predation by pest animals (including pets such as cats and dogs) along barriers, such as roads. Foxes, cats and dogs target these barrier areas as prey becomes more exposed and easier to detect and catch.

4.3 Proliferation of weed and pest species

Weed and pest species pose some of the greatest threats to biodiversity as these species displace native species through predation and competition, and damage vegetation by grazing and trampling (Adair & Groves 1998; Clarke *et al.* 2000; Thorp & Lynch 2011). Consequently, proliferation of weed and pest species due to the planning proposal will be a key impact to biodiversity.

Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of planning proposal) that may have cumulative effects. Proliferation of weed and pest species is likely to occur during construction and occupation of the houses. The effects of proliferation of weed and pest species may not be experienced immediately or even in the short-term. However, these impacts will likely commence a few months after construction and gradually increase over months and seasons. Proliferation of weed and pest species has the potential to impact on the quality and integrity of the native vegetation within the study area including habitat for threatened species.

The study area contains some weed species, particularly in disturbed areas. Bitou Bush, Camphor Laurel, and Lantana are present. However, these species are sparsely distributed throughout the study area and are not a dominant component of the vegetation. Weed invasion within the study area is minimal and is limited to vegetation edges, cleared land, and the sides of roads and access tracks.

Without appropriate management strategies, construction activities have the potential to disperse weeds into areas of undisturbed native vegetation where weed species are currently limited or in low density. Construction activities also have the potential to import new weed species into the study area. The most likely causes of weed dispersal and importation associated with the planning proposal include earthworks, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery. Weed dispersal by vehicles along roads and access tracks is a key source of weed invasion (Birdsall et al. 2012). Once house construction is finished, further weed invasion may result from inappropriate landscaping and garden plantings around the houses with invasive plant species that may escape into the surrounding

vegetation and modify habitats. Weed invasion is recognised as an indirect impact that may degrade the quality of remaining vegetation and habitats within the study area resulting in habitat loss.

The study area is likely to provide habitat for a range of pest species including foxes and cane toads. Construction activities have the potential to disperse pest species out of the study area across the surrounding landscape and increase the ability of pest species to utilise habitats due to habitat removal, noise, and human presence during construction and operation of the Project. Access roads will also provide an easy access pathway for pest species into areas of core habitats. Construction of access tracks and other linear infrastructure through large patches of intact vegetation may result in the establishment of pest species (particularly predators such as foxes and cats) into areas where they are currently absent or in low numbers.

Where vegetation clearing, particularly for access roads, takes place in medium and large tracts of vegetation, the impacts of pest species dispersing into these new areas to a greater extent will likely have a high impact on native habitat and wildlife.

4.4 Direct physical trauma to fauna

Direct physical trauma to fauna is a direct impact that reduces local population numbers and has the greatest potential to occur during vegetation clearing, earthworks, and trenching as the houses and other elements of the planning proposal are built. This impact will be proportionate to the extent of vegetation that is cleared and has the potential to impact threatened species listed under the TSC Act and EPBC Act.

Some diurnal (day active) and mobile species, such as birds, may be able to move away from the path of vegetation removal and may not be greatly affected unless they are nesting. However, other species that are less mobile (i.e. ground dwelling reptiles and mammals), or those that are nocturnal and nest or roost in trees or tree hollows during the day (i.e. arboreal mammals such as possums, koalas, and microchiropteran bat species), may find it difficult to escape.

There is a high chance of fauna mortality through vehicle collision. Roadkill is a direct impact that reduces local population numbers and is a common occurrence in Australia (Coffin 2007; Rowden et al. 2008). The creation of an access road network to the houses will introduce vehicle presence and movements into the habitats that may cause injury or death to fauna by vehicle strike. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly those common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roadways for movement pathways or as foraging habitat.

Entrapment of wildlife in excavations is another potential cause of direct physical trauma to fauna that may result from the planning proposal. Open trenches, for example for underground pipeline or telephone line construction, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality (Ayers & Wallace 1997; Doody *et al.* 2003; Woinarski *et al.* 2000). Species most likely to become trapped in pits or other excavations during construction are ground dwelling species such as mammals, amphibians, and reptiles.

Direct physical trauma to fauna can generally be managed through implementation of principles of avoidance, (i.e. avoiding disturbance to preferred habitat areas), and mitigation techniques involving managing trenching activities, protocols around vehicle movement so that the overall magnitude of the impact is low. However, even with mitigation such as pre-clearing fauna removal and fauna salvage during construction, there will be a risk of physical trauma to fauna. Ongoing roadkill during the lifetime that the houses are occupied will be a considerable cumulative impact.

4.5 Noise, dust, light and contaminant pollution

Noise, dust, light and contaminant pollution are direct impacts that are likely to have cumulative effects. Noise, dust, light and contaminant pollution will occur during construction and occupation of the houses and

will be an ongoing impact. Threatened species and endangered ecological communities listed under the TSC Act and/or the EPBC Act will be impacted by noise, dust, light and contaminant pollution. The magnitude of noise, dust, light, and contaminant pollution is likely to be high as the study area is currently not developed or urbanised.

4.5.1 Noise pollution

Anthropogenic noise can alter the behaviour of animals or interfere with their normal functioning (Bowles 1997). During construction and occupation of the houses there will be increased noise levels in the study area and immediate surrounds due to vegetation clearing, ground disturbance, machinery and vehicle movements, drilling, and general human activity and presence. The noise from activities associated with the planning proposal will potentially disturb fauna and may disrupt foraging, reproductive, or movement behaviours.

Noise from occupation of the houses is likely to have a significant, long-term, impact on wildlife populations. Some sensitive species (including threatened species) may avoid the noise and some more tolerant species, including small mammals, will habituate over the longer-term (Byrnes *et al.* 2012).

4.5.2 Dust pollution

Elevated levels of dust may be deposited onto the foliage of vegetation adjacent to the construction activities. This has the potential to reduce photosynthesis and transpiration and cause abrasion and radioactive heating resulting in reduced growth rates and decreases in overall health of the vegetation (Grantz *et al.* 2003). Consequently, changes in the structure and composition of plant communities and consequently the grazing patterns of fauna may occur (Auerbach *et al.* 1997; Walker & Everett 1987).

Dust is likely to be generated throughout the construction period, although dust pollution is likely to be greatest during periods of substantial earthworks, vegetation clearing, vehicle movements for construction activities, and during adverse weather conditions. Deposition of dust on foliage is likely to be localised, intermittent, and temporary and is therefore not considered likely to be a major impact of the planning proposal. However, dust may impact on endangered ecological communities and threatened plant species directly adjacent to the construction activities.

4.5.3 Light pollution

Ecological light pollution is the descriptive term for light pollution that includes direct glare, chronic or periodic increased illumination, and temporary unexpected fluctuations in lighting (including lights from a passing vehicles), that can have potentially adverse effects on wildlife (Longcore & Rich 2004).

The occupation of houses within the vegetation will result in light pollution. The access roads through the vegetation to each house will also require lighting which will essentially create permanent ‘daylight’ conditions through the vegetation. Ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle. Some species (i.e. light tolerant microchiropteran bats) may benefit from the lighting due to increased food availability from insects attracted to lights. Due to the frequency and sustained nature of the lighting, particularly along access roads, it is unlikely that animals will habituate to the light disturbance and a long-term impact in the area of lighting is likely.

4.5.4 Contaminant pollution

During the construction of the houses, accidental discharge of contaminants from machinery (e.g. hydraulic fluids, oils) into the surrounding environment may accidentally occur. Once the houses are built and occupied, household contaminants in storm water runoff, sewage or water systems may be released into the surrounding environment. Pesticides and herbicides used around the houses also provide a potential source

of impact to the surrounding vegetation. This may be an important impact due to the presence of forested wetlands and Billinudgel Creek within the study area directly adjacent to houses and access roads.

Accidental spills of contaminants may result in damage to the local environment, which may in turn detrimentally affect the habitat of flora and fauna.

4.6 Hydrological changes

There are currently no paved roadways or impervious surfaces within the study area. The Old Coast Road and perimeter and internal access tracks are unpaved and sand based and water can freely penetrate into the soil. With the construction of impervious paved access roads, the roofs of houses, and other concrete areas around the houses, a considerable increase in stormwater runoff will occur. The current water regime of the habitats will be altered to the detriment of vegetation and habitats. Water filtration will be altered and the quality of water in Billinudgel Creek may be affected through sedimentation and increased nutrient loads.

4.7 Ongoing impacts after development

While the greatest ecological impacts will occur during construction of the houses and access roads (e.g. vegetation clearing), there will be ongoing ecological impacts from human use once the houses are occupied.

The extent of vegetation removal assessed in Section 4.1 can be considered the minimum likely vegetation removal that will occur. It is likely that once houses are occupied, incremental clearing of surrounding vegetation will occur as residents look to establish, or expand an existing lawn or garden and/or improve the view from their houses. This is a particular risk for houses 14 to 25 which are located close to the beach front. Some residents are likely to undertake illegal vegetation removal in these areas to improve views of the ocean and construct access tracks to the beachfront from their properties. While this type of impact cannot be quantified, this incremental vegetation removal will add to the cumulative impacts of the planning proposal.

As houses are occupied, it is likely that residents will bring in exotic garden plants to decorate their houses and gardens. While this may appear to be a minor impact, invasive exotic plants can impact on ecosystem structure and function, reducing native species richness, altering hydrological or fire regimes, changing soil nutrient status and modifying habitat. If residents were to plant invasive species in the gardens around their home where they adjoin native vegetation, there is a high risk of habitat degradation occurring. This is particularly important for houses situated in Littoral Rainforest. The loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants is listed as a key threatening process sunder the TSC Act.

Although the development is likely to be pet free, residents of the houses may still keep household pets. Domestic animals can have a considerable impact on biodiversity as dogs will harass kill native animals and cats will instinctively hunt birds and small ground dwelling animals.

The houses are to be built within a series of coastal ecosystems separated by a floodplain housing vegetated wetlands. Consequently, mosquitos are common. It is likely that insecticides will be used to control mosquitos as the mosquitos will have an impact on the health and lifestyle of residents. Mosquito control will have flow on effects through the food chain which may impact biodiversity including Threatened species.

4.8 Significance of impacts to threatened biodiversity

If the planning proposal were to proceed, a development application would require assessment under Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). The EP&A Act requires that a ‘7 part

test' is undertaken to assess the likelihood of significant impact upon threat-listed species, populations or ecological communities listed under the TSC Act (Department of Environment and Climate Change 2007).

For threat-listed biodiversity listed under the EPBC Act, significance assessments will need to be completed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment 2013). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment, 2013).

The criteria that must be used to assess the impacts of the planning proposal on Threatened species are outlined in Appendix H. Significance assessments for Threatened species have not been completed in this report as detailed ecological surveys have not been completed within the study area and the planning proposal has not been finalised. However, based on the field survey undertaken for this report a preliminary assessment can be made (refer Table 4.3). Detailed significance assessments would be required as part of a detailed ecological investigation that would be required for the planning proposal.

From a preliminary assessment, it is considered that a significant impact to TSC Act and EPBC Act listed Threatened species and ecological communities would likely result from the planning proposal due to the high magnitude of the following impacts:

- adverse impact to species lifecycles
- reduction in the area of occupancy of a species
- disruption of the breeding cycle of a population
- adverse effects (i.e. reduction) on the extent of ecological communities such that its local occurrence is likely to be placed at risk of extinction
- likelihood to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction
- removal and modification of Threatened species habitats
- fragmentation of habitat
- direct contribution to Key Threatening Processes (refer Section 4.9).
- modification and/or destruction of abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including substantial alteration of surface water drainage patterns
- change in the species composition of an occurrence of an ecological community,
- a substantial reduction in the quality or integrity of an occurrence of an ecological community
- interference with the recovery of an ecological community (i.e. through direct removal and habitat degradation).

It is likely that a species impact statement (SIS) and referral of the development to the Commonwealth Department of the Environment would be necessary. The development would likely be a controlled action under the EPBC Act due to potential impacts on Matters of National Environmental Significance.

Table 4.3 Potential impacts to threatened biodiversity

Species / ecological community	Threatened category		Is a significant impact likely?
	TSC Act	EPBC Act	
Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion	Endangered	Not listed	Yes
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Endangered	Not listed	No
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (EPBC Act listing name)	Endangered	Critically Endangered	Yes
Archidendron hendersonii	Vulnerable	Not listed	Potential
Cryptocarya foetida	Vulnerable	Vulnerable	Potential
Geodorum densiflorum	Endangered	Not listed	Unknown
Arthraxon hispidus	Vulnerable	Vulnerable	Unknown
Elyonurus citreus	Endangered	Not listed	Unknown
Drynaria rigidula	Endangered	Not listed	Unknown
Acronychia littoralis	Endangered	Endangered	Potential
Pale-vented Bush-hen	Vulnerable	Not listed	Unknown
Regent Honeyeater	Critically Endangered	Endangered	Unknown
Australasian Bittern	Endangered	Endangered	Unknown
Bush Stone-curlew	Endangered	Not listed	Unknown
Glossy Black-Cockatoo	Vulnerable	Not listed	Unknown
Black-necked Stork	Endangered	Not listed	Unknown
Little Lorikeet	Vulnerable	Not listed	Unknown
Black Bittern	Vulnerable	Not listed	Unknown
Swift Parrot	Endangered	Endangered	Unknown
Square-tailed Kite	Vulnerable	Not listed	Unknown
White-eared Monarch	Vulnerable	Not listed	Unknown
Powerful Owl	Vulnerable	Not listed	Unknown
Eastern Osprey	Vulnerable	Not listed	Unknown
Wompoo Fruit-Dove	Vulnerable	Not listed	Unknown
Rose-crowned Fruit-Dove	Vulnerable	Not listed	Unknown
Superb Fruit-Dove	Vulnerable	Not listed	Unknown
Eastern Grass Owl	Vulnerable	Not listed	Unknown
Masked Owl (southern mainland)	Vulnerable	Not listed	Unknown

Species / ecological community	Threatened category		Is a significant impact likely?
	TSC Act	EPBC Act	
Mitchell's Rainforest Snail	Endangered	Critically Endangered	Unknown
Hoary Wattled Bat	Vulnerable	Not listed	Unknown
Spotted-Tailed Quoll (Southern Subspecies)	Vulnerable	Endangered	Unknown
Golden-tipped Bat	Vulnerable	Not listed	Unknown
Little Bent-wing Bat	Vulnerable	Not listed	Unknown
Eastern Bent-wing Bat	Vulnerable	Not listed	Unknown
Beccari's Freetail Bat	Vulnerable	Not listed	Unknown
Eastern Free-tail bat	Vulnerable	Not listed	Unknown
Southern Myotis	Vulnerable	Not listed	Unknown
Eastern Long-eared Bat	Vulnerable	Vulnerable	Unknown
Koala (NSW, ACT & QLD - excluding SE QLD)	Vulnerable	Vulnerable	Unknown
Common Planigale	Vulnerable	Not listed	Unknown
Long-nosed Potoroo (SE mainland)	Vulnerable	Not listed	Unknown
Grey-headed Flying-fox	Vulnerable	Vulnerable	Unknown
Yellow-bellied Sheathtail-bat	Vulnerable	Not listed	Unknown
Greater Broad-nosed Bat	Vulnerable	Not listed	Unknown
Common Blossom-bat	Vulnerable	Not listed	Unknown
White-crowned Snake	Vulnerable	Not listed	Unknown
Stephen's Banded Snake	Vulnerable	Not listed	Unknown
Wallum Froglet	Vulnerable	Not listed	Potential.
Olongburra Frog	Vulnerable	Vulnerable	Unknown

Notes: Where a significant impact is unknown, further detailed ecological survey and assessment work is required to enable an accurate prediction of likely impacts.

4.9 Key threatening processes

Key threatening processes are listed under Schedule 3 of the NSW TSC Act, NSW Fisheries Management Act and also under the Commonwealth EPBC Act. The key threatening processes that are likely to be relevant to the planning proposal are outlined in Table 4.4. The planning proposal has the potential to increase the impact of several key threatening processes.

Table 4.4 Key Threatening Processes likely to be occurring in the study area and their relevance to the planning proposal

Listed Key Threatening Process EPBC Act	TSC Act	Will the planning proposal affect this threat?
Pest animal		

Listed Key Threatening Process EPBC Act	TSC Act	Will the planning proposal affect this threat?
Competition and land degradation by rabbits	Competition and grazing by the feral European rabbit	No. The planning proposal is unlikely to increase this threat any more than that currently occurring in the study area.
Predation by European red fox	Predation by the European Red Fox	Possible. The planning proposal may increase the Foxes ability to penetrate habitats through the access road network. This may cause an increase in predation within the study area.
–	Predation by feral cats	Possible. Project unlikely to increase predation by feral cats. However, predation by domestic cats kept as pets is likely to occur.
–	Competition from feral honeybees	Possible. The planning proposal could increase competition for tree hollows through displacement of bees in hollows cleared and a reduction in hollow availability.
Weeds		
–	Invasion and establishment of exotic vines and scramblers	Yes. Exotic vines and scramblers are present within the study area and construction work may spread this species throughout the study area.
–	Invasion, establishment and spread of *Lantana camara*	Yes. Lantana is present within the study area and construction work may spread this species throughout the study area.
–	Invasion of native plant communities by bitou bush & boneseed (*Chrysanthemoides monilifera*)	Yes. Bitou Bush is present within the study area and construction work may spread this species throughout the study area.
–	Invasion of native plant communities by exotic perennial grasses	Yes. Exotic perennial grasses are prevalent within the cleared areas and edges of vegetation within the study area. Construction work may spread exotic grasses throughout the study area.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Yes. Escaped garden plants are known to exist within the study area already and residents are likely to plant exotic species around the houses.
Habitat loss or change		
Land clearance	Clearing of native vegetation.	Yes. The planning proposal intends to clear native vegetation.
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	Human-caused climate change	Possible. Vegetation removal will contribute to this key threatening process.
–	Loss of hollow-bearing trees	Yes. Hollow trees were recorded in the study area and some of these may be removed.
–	Removal of dead wood and dead trees	Yes. Dead wood and dead trees were recorded in the study area and some of these would be removed.

Listed Key Threatening Process EPBC Act	TSC Act	Will the planning proposal affect this threat?
–	Ecological consequences of high frequency fires	Potential. There is no evidence of high frequency fire regimes in the study area and given the dominance of rainforest and wetland vegetation, high frequency fire is unlikely. However, the presence of people may increase the risk of arson.
–	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.	Potential. The planning proposal will alter the current catchment around Billinudgel creek by introducing impervious surfaces and increasing storm water runoff. This may have an impact on the flow regime of Billinudgel Creek.
Disease		
Disease affecting endangered psittacine species	Infection by Psittacine circoviral (beak & feather) disease affecting endangered psittacine species.	No. The planning proposal is unlikely to increase frequency of infection or spread of Psittacine circoviral disease
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis.	Potential. Construction activities associated with the planning proposal may introduce or spread the chytrid fungus within the study area.
Dieback caused by the root-rot fungus (Phytophthora cinnamomi)	Infection of native plants by *Phytophthora cinnamomi*.	Potential. Construction activities associated with the planning proposal may introduce or spread Phytophthora.
–	Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Potential. Construction activities associated with the planning proposal may introduce or spread Exotic Rust Fungi.

4.10 Comparison of ecological impacts between the development consent and the planning proposal

Development consent 88/640 approves a large tourist resort to be constructed within the study area that has a footprint of approximately 45 ha. The approved development is centred around utilising the cleared portions of the study area for creating dwellings on islands within a lake (refer Figure 4.2). The lake would be constructed in the cleared portion of the study area and will encroach into the native vegetation (refer Figure 4.2). A golf course is planned to be constructed within the native vegetation in the western and southern portions of the study area (refer Figure 4.2).

Development consent 88/640 was granted in 1988, before contemporary environmental approval processes had been implemented. The likely ecological impacts of development consent 88/640 will be considerable and greater than the planning proposal. A comparison of potential ecological impacts between the planning proposal and development consent 88/640 is provided in Table 4.5.

Development consent 88/640 would result in the removal of approximately 32 ha of native vegetation which is considerably more than the planning proposal which will remove approximately 4.6 ha (5.8 ha including estimated clearing for access roads) of native vegetation. Development consent 88/640 would result in greater impacts to every vegetation type within the study area and will result in greater ecological impacts on the whole when compared to the planning proposal (refer Table 4.5). However, the planning proposal is likely to result in greater habitat degradation from edge effects.

Figure 4.2 The site plan for the approved development consent 88/640

Table 4.5 Comparison of ecological impacts between Development consent 88/640 and the planning proposal (houses)

Impact type		Planning proposal (houses)	Development consent 88/640
Vegetation and habitat clearing	Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	0.9 ha	2.2 ha
	Coast Cypress Pine shrubby open forest of the North Coast Bioregion	1.2 ha	4.6 ha
	Coastal floodplain sedgelands, rushlands, and forblands	0 ha	2 ha
	Paperbark swamp forest of the coastal lowlands of the North Coast	0.2 ha	11 ha
	Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	0.8 ha	3 ha
	Swamp Oak swamp forest of the coastal lowlands of the North Coast	0 ha	5.3 ha
	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast.	1.5 ha	4 ha
Total vegetation removal		4.6 ha	32.1 ha
SEPP 26 – Littoral Rainforest (not including 100 metre buffer)		0.53	0.69

Impact type	Planning proposal (houses)	Development consent 88/640
Habitat degradation (edge effects)	20 ha	16.6 ha

5. Opportunities and constraints for development

The areas of ecological constraint are outlined in Figure 5.1.

From an ecological perspective, some parts of the study area are more suitable for development than other areas. The main constraints to development within the study area are the large patches of native vegetation that are in good condition. The native vegetation provides an ecological constraint for the following reasons:

- All native vegetation within the study area is part of an Endangered ecological community listed under the TSC Act.
- The Littoral Rainforest within the study area is listed as a Critically Endangered ecological community under the EPBC Act
- The vegetation provides habitat for a range of Threatened animal species listed under the TSC Act and EPBC Act.
- Habitat for a range of Threatened plant species listed under the TSC Act and/or EPBC Act are present.
- Mapped areas of SEPP 26 Littoral Rainforest and buffer zones are present.
- Development in the vegetated areas would require a SIS to accompany the development application.
- Development in the SEPP 26 areas would trigger an EIS for the planning proposal.

Despite the highly constrained nature of the study area from an ecological perspective, opportunities do exist on site for development (refer Figure 5.1). Large areas of the study area present little ecological constraint and can be developed with minimal impacts to biodiversity. The main opportunities to avoid ecological impacts are present on the cleared and disturbed land within the study area including:

- the cleared grazing land on the floodplain
- the areas of Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition) in north west.

5.1 Location of houses and vegetation quality

The previous ecological survey undertaken in the study area was undertaken to locate building envelopes intended to minimise the impacts of vegetation removal, and to assist with planning for compensatory habitat to be established on the large neighbourhood lot within the study area (Steven Smith Development Community Pty Ltd 2013). The planning proposal states that tree removal has been minimised and Threatened flora species have been avoided (Steven Smith Development Community Pty Ltd 2013). However, from the field survey undertaken for this report little evidence was observed of sensitive positioning of house locations to avoid ecological impacts. The only houses located in disturbed areas are house sites 1, 2, 11 and 12 and the helipad.

The native vegetation within the study area is in good condition throughout with the exception of the regrowth patches of the Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition). House sites 1, 2, 11, 12, and the helipad have been situated appropriately to minimise ecological impacts. However, the remainder of the house sites have been situated in the middle of good condition native vegetation and no avoidance measures appear to have been used to position these houses. House sites 3 to 10 and 13 are situated in the middle of good condition Endangered ecological communities that are listed under the TSC Act. In the case of houses 4, 5, 7, 8, 9, and 10, these houses are located directly within the TSC Act listed Endangered ecological community Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion which is an extremely restricted community only found on the NSW North Coast. No measures to avoid directly impacting this Endangered ecological community have been made.

More importantly, houses 14 to 25 are situated directly in the middle of a large patch of the EPBC Act listed Critically Endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia. Additionally, (according to the proposed plans) house site 18 is situated on a steep slope that is unsuitable for building on that overhangs Billinudgel Creek. House site 14 is the only house site in this area that has been positioned to consider past disturbances. However, this site contains regenerating Littoral Rainforest and Threatened plant species listed under the TSC Act and EPBC Act. House sites 19 - 25 appear to have been positioned on the top of the sand dune to move the houses out of the flood zone and afford better views of the ocean. Avoidance of impacts to the Critically Endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia has not been undertaken as evidenced by the direct positioning of house sites within this community.

No avoidance or minimisation strategies to deal with reducing impacts associated with reduction of habitat quality and patch size appear to have been utilised in the design provided in the planning proposal. The positioning of houses appears to have been driven by the need to avoid areas of flood prone land. Development in the cleared portion of the study area was dismissed solely due to perceived diminished financial return and the flood prone nature of the land (Steven Smith Development Community Pty Ltd 2013). Avoiding ecological impacts has not been considered. Therefore, there is potential for a high magnitude residual impact to occur in the form of direct vegetation removal, and reduced habitat quality and patch size. These impacts will be irreversible and permanent. The potential impacts are amplified when the cumulative impacts of coastal development in Tweed Shire Council are taken into account.

While most house sites have not avoided impacts to native vegetation, the access roads appear to have been positioned based on the location of existing tracks through the study area (i.e. Old Coast Road, access from Jones Road, and farm tracks). However, these access tracks will require upgrades and new access roads will need to be created through vegetation which will result in direct impacts to Threatened ecological communities.

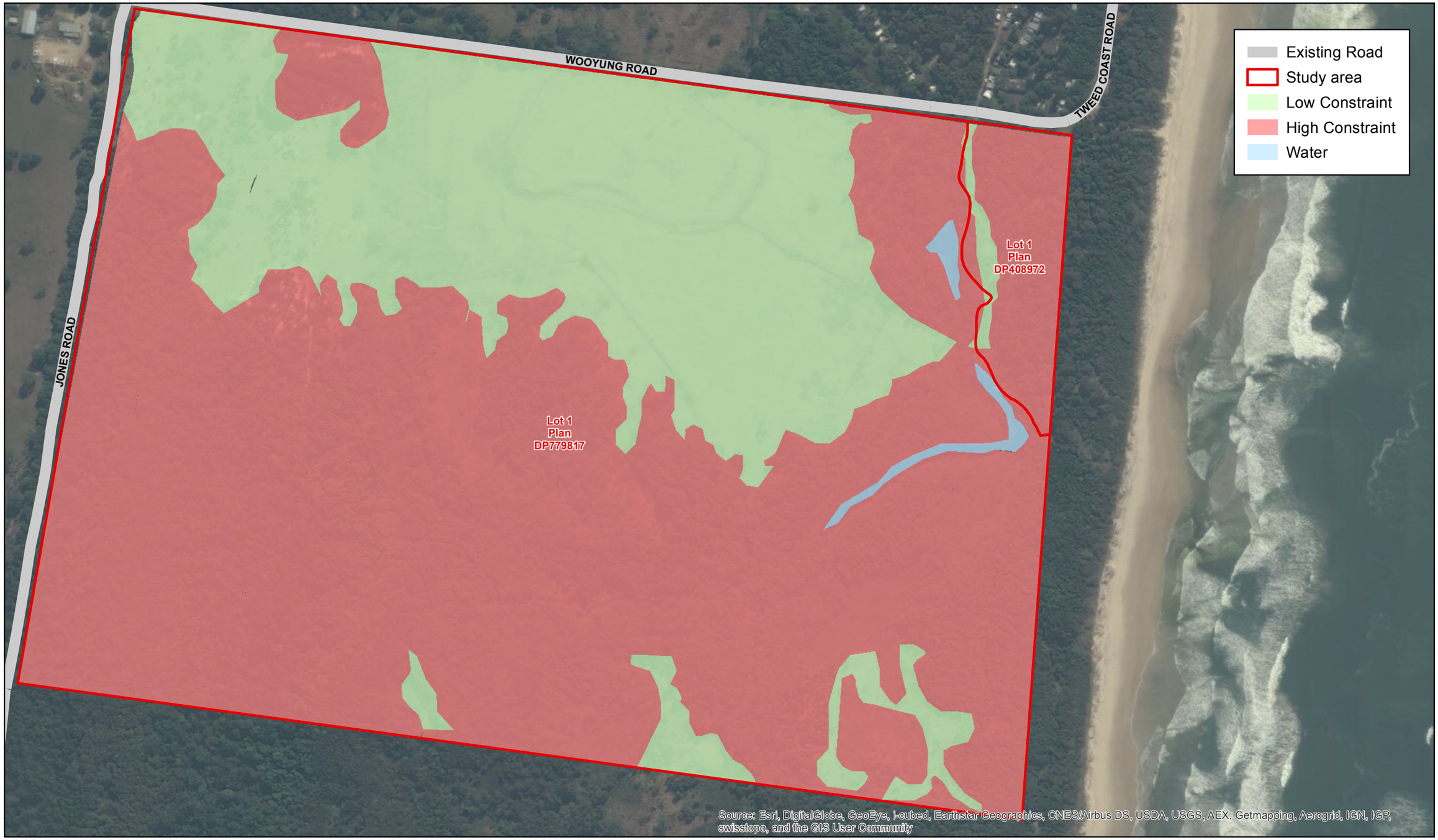
5.2 Proposed revegetation area

The planning proposal acknowledges that significant ecological impacts are likely to result from the development. A key component of the planning proposal is the revegetation on the large neighbourhood lot within the study area to establish compensatory habitat. The planning proposal states that the community will benefit from significant revegetation and regeneration of coastal wetlands and littoral rainforest, that the proposed development will expand the area of littoral rainforest as part of the revegetation program (with the area of habitat having qualities worthy of protection under SEPP 26) (Steven Smith Development Community Pty Ltd 2013).

While the inclusion of revegetation areas within the planning proposal is a beneficial point, proposed revegetation does not provide justification to remove Threatened ecological communities. Priority should be given to avoiding impacts in the first instance then implementing a suite of mitigation measures to reduce impacts to within acceptable limits. Compensation measures such as revegetation should be used as a supplementary measure once avoidance and minimisation have been undertaken. In the case of the

planning proposal, compensatory revegetation appears to be the only measure considered for environmental management.

No revegetation of the Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion is proposed despite this community being directly removed by house sites and access roads.



TWEED SHIRE COUNCIL

Data source: Ecology assessment by PB, digitised by PB

esri Partner Network Silver

Map no: 2176503A_GIS_F005_C1

Author: AM

Approved by: -

Date: 30/07/2014

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Ecology Assessment

Figure 5.1 Opportunities and constraints to development from an ecological perspective (Lot 1 DP 779817 and Lot 1 DP408972 located at Wooyung Road, Wooyung)

The required method to revegetate Littoral Rainforest is to rebuild the soil on the site (if required), plant pioneer species (i.e. *Acacia* spp. and *Banksia integrifolia*) to build up soil nutrients, then plant primary rainforest species 10 to 15 years later (Peel 2010). It is unlikely that the planning proposal has considered this timeframe and there is a high chance that any revegetation attempts would fail. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat (Department of Environment and Climate Change 2008).

A key component of successful revegetation is that the vegetation type to be planted should reflect the original vegetation community that was in that position in the landscape (Seidel & Briggs 2008). Littoral Rainforest cannot be successfully recreated on the cleared floodplain within the study area as it did not exist in this area in the past (refer Appendix G for aerial photos of the study area). The vegetation that used to be present on the cleared floodplain would have been the Swamp Oak swamp forest of the coastal lowlands of the North Coast. Littoral Rainforest is a vegetation type that exists on coastal headlands, sea cliffs, and beach dunes, not a low lying coastal floodplain that previously contained Swamp Oak swamp forest of the coastal lowlands of the North Coast. The planning proposal will result in a net loss of Littoral Rainforest not expansion of this community. Time lags in development of the revegetation area mean that fauna habitat will be lost for 20 – 100 years until the vegetation reaches a comparable state to the vegetation that is proposed to be removed.

5.3 Applicability of biodiversity offsets

5.3.1 Principles of biodiversity offsets

The principles for the use of biodiversity offsets in NSW (Department of Environment and Climate Change 2008) provide a useful framework when considering biodiversity impacts and appropriate offset requirements. The 13 principles for the use of biodiversity offsets in NSW are as follows:

1. Impacts must be avoided first by using prevention and mitigation measures.
2. All regulatory requirements must be met.
3. Offsets must never reward ongoing poor performance.
4. Offsets will complement other government programs.
5. Offsets must be underpinned by sound ecological principles.
6. Offsets should aim to result in a net improvement in biodiversity over time.
7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.
8. Offsets should be agreed prior to the impact occurring.
9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.
10. Offsets must be targeted (they must offset impacts on the basis of like-for-like or better conservation outcomes).
11. Offsets must be located appropriately.
12. Offsets must be supplementary.
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or contracts.

5.3.2 The planning proposal

The planning proposal has not attempted to avoid impacts by using prevention and mitigation measures. Positioning of houses has been driven by economic reasons and desire to avoid the flood prone land with the study area. For offsets to be used, the planning proposal must clearly demonstrate how avoidance has been implemented. A court case decided in 2013 (Bulga Milbrodale Progress Association v Minister for Planning and Infrastructure and Warkworth Mining Limited [2013] NSWLEC 48) confirms that offsets are not to be preferred over avoidance and mitigation strategies. Importantly for the planning proposal, all of the native vegetation within the study area is defined as a 'red flag' (a red flag is an area of land that has high biodiversity conservation values) under the BioBanking Assessment Methodology. As such, a biobanking statement cannot be issued for the planning proposal as it will not improve or maintain biodiversity values.

The *EPBC Act Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012) outlines the Australian Government's approach to the use of environmental offsets ('offsets') under the EPBC Act. The *EPBC Act Environmental Offsets Policy* only applies to 'controlled actions' and offsets are not considered at the referral stage.

The planning proposal is likely to be a controlled action under the EPBC Act due to impacts to the Critically Endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community. Impacts to the Critically Endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community have not been avoided or mitigated and there are likely to be significant residual impacts. Therefore, the use of offsets under the EPBC Act cannot be considered (refer Figure 5.2).

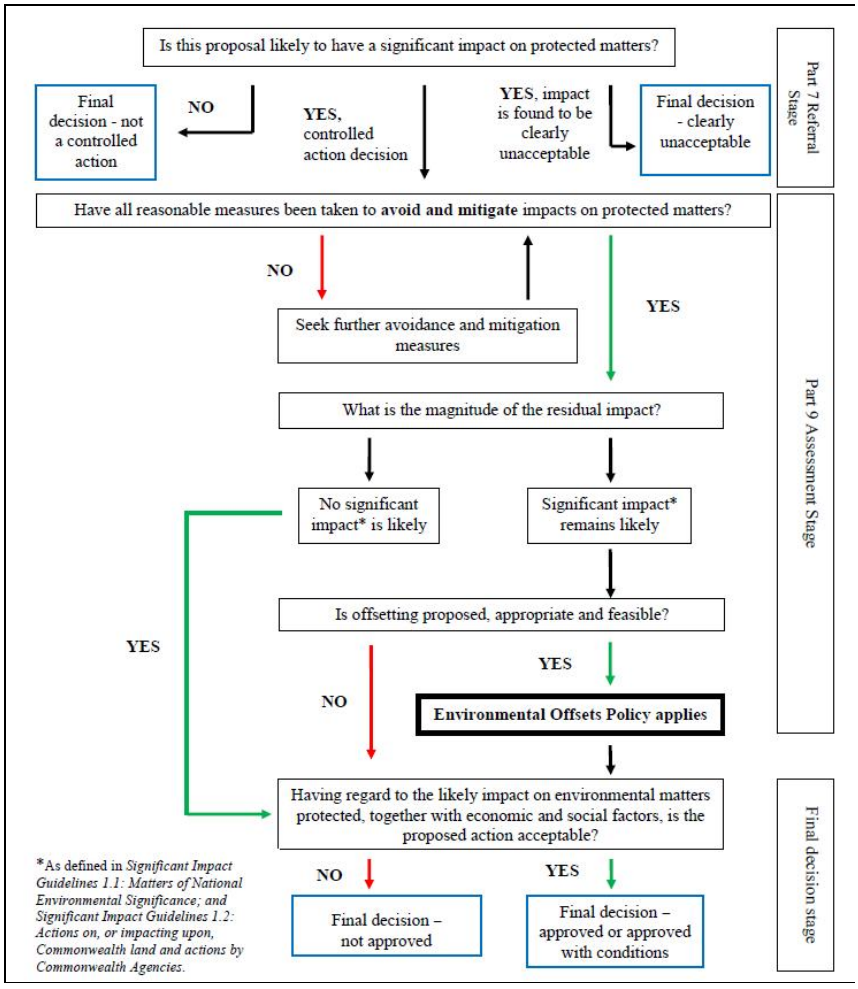

Figure 5.2 The role of offsets within the broader environmental impact assessment process under the EPBC Act (Department of Sustainability Environment Water Population and Communities 2012)

5.3.3 Potential changes to the planning proposal

Offsets will be an acceptable outcome if impacts to the Critically Endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community are avoided.

If OEH have indicated that they will accept a ratio of 5:1, this will likely be an appropriate condition of approval. However it is unlikely the proposed revegetation alone will be sufficient as an offset. In addition, the only vegetation type that can be created on the floodplain area of the site is Swamp Oak Forest, however this vegetation type is currently not impacted by the planning proposal.

The proponent will need to offset the vegetation types that are being lost. In the case of Coast Cypress Pine forest (which is the largest vegetation type to be removed on site), offsetting this type of vegetation on the site will be difficult to achieve as there is only 29 ha of this type of vegetation remaining within Tweed Shire Council to start with. As a consequence, an off-site offset is likely to be required for Coast Cypress Pine in addition to any revegetation attempted by the proponent on the site.

6. Conclusions and recommendations

6.1 Conclusions

1. The study area contains large areas of native vegetation that are in good condition as defined in the *BioBanking Operation Manual* (Seidel & Briggs 2008).
2. All of the native vegetation within the study area is listed as an Endangered ecological community under the TSC Act.
3. The Littoral Rainforest within the study area is listed as a Critically Endangered ecological community under the EPBC Act.
4. Two areas of Littoral Rainforest are mapped as SEPP 26 – Littoral Rainforest areas.
5. Vegetation communities in the study area provide suitable habitat for a number of Threatened plant and animal species listed under the TSC Act. As such, the vegetation and habitats within the study area are sensitive and highly constrained from a housing development perspective.
6. Few avoidance or minimisation strategies to deal with reducing impacts to biodiversity have been utilised in the subdivision design provided in the planning proposal.
7. Development in the cleared portion of the study area was dismissed solely due to perceived diminished financial return and the flood prone nature of the land (Steven Smith Development Community Pty Ltd 2013). However, house sites 1, 2, 11 and 12 and the helipad are situated appropriately in disturbed areas. The remainder of the house sites have not been situated to avoid ecological impacts.
8. There is potential for a high magnitude residual impact to occur in the form of direct vegetation removal, and reduced habitat quality and patch size. These impacts will be irreversible and permanent. The potential impacts are amplified when the cumulative impacts of coastal development in the Tweed LGA are taken into account.
9. The potential impacts of the planning proposal are potentially significant due to the conservation significance of the vegetation and habitats within the study area.
10. When compared to the potential impacts of the large tourist resort in development consent 88/640, the planning proposal will have a lesser ecological impact as a whole. However, it is worth considering that development consent 88/640 was granted in 1988 before contemporary environmental approval processes had been implemented. As such, the two developments are not directly comparable due to the differing regulatory environments.
11. The planning proposal as described by Steven Smith Development Community Pty Ltd (2013) will still result in significant impacts to TSC Act and EPBC Act listed Threatened species and ecological communities.
12. The planning proposal would require a SIS and be referred to the Commonwealth Department of the Environment due to potential significant impact on Matters of National Environmental Significance. The planning proposal would likely be considered a ‘controlled action’ due to impacts to EPBC Act listed Threatened species and ecological communities.
13. Opportunities do exist on site for development as large areas of the study area present little ecological constraint and can be developed with minimal impacts to biodiversity. The main opportunities to avoid ecological impacts are present on the cleared and disturbed land within the study area including the cleared grazing land on the floodplain and the areas of Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition) in the north west of the study area.

14. The floodplain should not pose a constraint to development as engineering solutions can be used to rectify flooding issues.
15. The proposed revegetation area cannot be used as a solution to permit the development of houses in Threatened ecological communities. It is unlikely that Littoral Rainforest could be successfully recreated on the floodplain. Despite the proposed revegetation, the planning proposal will result in a net loss of Littoral Rainforest not expansion of this community.
16. Time lags in development of the revegetation area mean that fauna habitat will be lost.
17. Based on the current planning proposal, biodiversity offsets are not an appropriate avenue for investigation at this stage as the planning proposal has not fully considered avoidance and mitigation of ecological impacts.
18. Biodiversity offsets will be an acceptable outcome if impacts to the Critically Endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community are avoided.

6.2 Recommendations

Recommendations for reducing ecological impacts of the planning proposal are as follows:

- Permit housing development to the cleared areas as development in these areas will have little ecological impacts.
- Permit housing development within the areas of Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition) that are located in the north west of the study area.
- Greater avoidance of native vegetation, and Threatened species, must be attempted in the subdivision design and a detailed case that is not just based on financial gain or flooding issues needs to be put forward as to why native vegetation cannot be avoided.
- Wooyung Properties should be encouraged to pursue engineering solutions to enable development on the cleared floodplain area in the north of the study area.
- Access roads must avoid removing canopy trees where possible and should utilise existing access tracks within the study area to the fullest degree possible.
- The development should be pet free and koala friendly design features should be included
- To minimise impacts from introduced weeds, landscaping must only include species native to the vegetation types within the study area and all plants should preferentially be grown from seed collected from the site.
- Where access roads will cut connectivity between habitat patches, fauna crossing structures should be installed to reintroduce some habitat connectivity between patches.
- Internal access roads must be speed limited (i.e. 20 km/h) to reduce the risks of road kill.
- A detailed revegetation plan must be prepared and implemented with revegetation completed before house construction begins to reduce time lags in vegetation establishment and to ensure revegetation is undertaken.

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Appendix A

Flora species list for each proposed house site



Appendix B

Representative photos of each proposed house site

House site 1 showing cleared land with regrowth Coastal Cypress Pine (low condition)

House site 4 showing Coastal Cypress Pine EEC (good condition)

House site 2 showing cleared land with regrowth Coastal Cypress Pine (low condition)

House site 5 showing Coastal Cypress Pine EEC (good condition)

House site 3 showing Swamp Sclerophyll Forest EEC (good condition)

House site 6 showing Swamp Sclerophyll Forest EEC (good condition)

House site 7 showing Coastal Cypress Pine EEC (good condition)

House site 10 showing Coastal Cypress Pine EEC (good condition)

House site 8 showing Coastal Cypress Pine EEC (good condition)

House site 11 showing cleared land at the edge of Coastal Cypress Pine (low condition)

House site 9 showing Coastal Cypress Pine EEC (good condition)

House site 12 showing cleared land with regrowth Coastal Cypress Pine (low condition)

House site 13 showing regenerating Littoral Rainforest EEC (good condition)

House site 16 showing Littoral Rainforest EEC (good condition)

House site 14 showing disturbed ground and regrowth of *Acronychia littoralis* (moderate condition)

House site 17 showing Coastal Cypress Pine EEC (good condition)

House site 15 showing Littoral Rainforest EEC (good condition)

House site 18 showing Littoral Rainforest EEC on steep slope down to Billinudgel Creek (good condition)

House site 19 showing Littoral Rainforest EEC (good condition)

House site 22 showing Littoral Rainforest EEC (good condition)

House site 21 showing Littoral Rainforest EEC (good condition)

House site 23 showing Littoral Rainforest EEC (good condition)

House site 21 showing Littoral Rainforest EEC (good condition)

House site 24 showing Littoral Rainforest EEC (good condition)

House site 25 showing Littoral Rainforest EEC (good condition)



Appendix C

Location of survey effort

Table C.1 Location of vegetation condition quadrats

Site ID	Vegetation community	Easting	Northing
Site 1	Littoral Rainforest	153.553	-28.464
Site 2	Littoral Rainforest	153.553	-28.460
Site 3	Littoral Rainforest	153.552	-28.457
Site 4	Paperbark	153.343	-28.458
Site 5	Swamp Mahogany	153.543	-28.463
Site 6	Callitris Pine	153.543	-28.459
Site 7	Callitris Pine	153.545	-28.457
Site 8	Callitris Pine (low condition)	153.543	-28.456
Site 9	Callitris Pine (low condition)	153.544	-28.458
Site 10	Callitris Pine	153.542	-28.458
Site 11	Swamp Mahogany	153.543	-28.462
Site 12	Swamp Mahogany / Paperbark	153.545	-28.459
Site 13	Swamp Oak	153.548	-28.459
Site 14	Littoral Rainforest	153.552	-28.464
Site 15	Sedgeland	153.550	-28.462
Site 16	Callitris Pine	153.552	-28.459
Site 17	Paperbark	153.551	-28.458
Site 18	Swamp Oak	153.550	-28.457

(1) Note: GDA 94: Zone 56.



Appendix D

Descriptions of vegetation types within the study area

D1. Vegetation types within the study area

D1.1 Coast Cypress Pine shrubby open forest of the North Coast Bioregion

Located on the coastal sand plain on a low rise above the floodplain of Billinudgel Creek, Coastal Cypress Pine forest was predominantly present in the western portion of the site adjacent to Jones Road with a smaller area in the east adjacent to the Old Coast Road. This vegetation type exists in two condition classes within the study area: good (photo D1) and low (photo D2).

This vegetation is an open forest of *Callitris columellaris* with *Banksia integrifolia* and *Corymbia intermedia*. *Eucalyptus robusta* and *Melaleuca quinquenervia present* are at the ecotone of community. *Acacia disparrima* subsp*. disparrima* trees and a rainforest midstorey were present. The large size and dominance of *Callitris columellaris* in the canopy suggest that this vegetation is in a mature and relatively undisturbed state and has not been subject to a large scale disturbance such as fire or clearing for many years. A very dense shrub layer of *Austromyrtus dulcis, Leucopogon margarodes, Monotoca elliptica, Acacia ulicifolia, Leptospermum polygalifolium, Persoonia stradbrokensis,* and *Zieria smithii* was present. The ground layer was in good condition and composed of *Pomax umbellata, Dianella caerulea, Baloskion tetraphyllum* subsp*. meiostachyum, Commelina cyanea, Lomandra longifolia, Pteridium esculentum* and *Imperata cylindrica* var. *major.* Some weeds including *Lantana camara, Asparagus asparagoides* and *Ochna serrulata* were occasionally present but did not form a dominant component of the vegetation.

Photo D.1 **Coast Cypress Pine shrubby open forest (good condition)**

Photo D.2 **Coast Cypress Pine shrubby open forest (low condition)**

D1.2 Swamp Mahogany swamp forest of the coastal lowlands of the North Coast

The Swamp Mahogany swamp forest of the coastal lowlands of the North Coast vegetation type is located in the western portion of the study area in a depression between stands of Coastal Cypress Pine Forest. This vegetation type is associated with humic and sandy loam soils that are periodically inundated. This vegetation type is in good condition (refer Photo D3).

This vegetation is an open forest of *Eucalyptus robusta* with *Melaleuca quinquenervia* as a co-dominant to sub-dominant species in the canopy layer. *Corymbia intermedia* and *Lophostemon confertus* were also occasionally present in the canopy. Canopy trees showed evidence of fire. However, this vegetation is in a mature and relatively undisturbed state and has not been subject to a large scale disturbance for many years. Midstorey trees including *Glochidion ferdinandi, Melicope elleryana,* and *Acacia maidenii* were occasionally present as was the vine *Parsonsia straminea*. A shrub layer of *Austromyrtus dulcis, Leucopogon margarodes, Monotoca elliptica, Acacia ulicifolia, Leptospermum polygalifolium, Persoonia stradbrokensis,* and *Zieria smithii* was present at the edges where this vegetation type intergraded with the Coastal Cypress Pine forest. The ground layer was in good condition and largely dominated by *Baloskion tetraphyllum*, *Blechnum* spp., *Hypolepis muelleri*, and *Gahnia* spp. Some weeds including *Lantana camara, Asparagus asparagoides* and *Ochna serrulata* were occasionally present but did not form a dominant component of the vegetation.

Photo D.3 Swamp Mahogany swamp forest in the western portion of Lot 1 DP779817

D1.3 Paperbark swamp forest of the coastal lowlands of the North Coast

The Paperbark swamp forest of the coastal lowlands of the North Coast vegetation type is located in the central portion of the study area on the floodplain of Billinudgel Creek. This vegetation type is associated with humic and sandy loam soils that are periodically inundated when Billinudgel Creek floods. This vegetation type is in good condition (refer Photo D4).

This vegetation is an open forest of *Melaleuca quinquenervia* with occasional *Eucalyptus robusta* and *Casuarina glauca* trees in the canopy. This vegetation is in a mature and relatively undisturbed state and has not been subject to a large scale disturbance for many years. Similar to the Swamp Mahogany forest, midstorey trees including *Glochidion ferdinandi, Melicope elleryana,* and *Acacia maidenii* were occasionally present as was the vine *Parsonsia straminea*. A shrub layer was generally absent. The ground layer was generally in good condition and largely dominated by *Blechnum indicum*, *Hypolepis muelleri*, and *Gahnia* spp. A patch of this vegetation type adjacent to the old coast road is suffering from invasion from the weedy grasses *Megathyrsus maximus*, *Axonopus fissifolius* and *Digitaria didactyla*. Some weeds including *Lantana camara, Asparagus asparagoides* and *Ochna serrulata* were occasionally present but did not form a dominant component of the vegetation.

Photo D.4 Paperbark swamp forest in the western portion of Lot 1 DP779817

D1.4 Swamp Oak swamp forest of the coastal lowlands of the North Coast

The Swamp Oak swamp forest of the coastal lowlands of the North Coast vegetation type is located in the central portion of the study area on the floodplain of Billinudgel Creek in between the cleared grazing land and the Paperbark swamp forest vegetation type. This vegetation type is associated with humic and sandy loam soils that are periodically inundated when Billinudgel Creek floods. This vegetation type is in good condition (refer Photo D5).

This vegetation is an open forest dominated by a canopy of *Casuarina glauca*. This vegetation exists in a relatively disturbed state as it exists at the interface of grazing land and is frequently used by cattle and is heavily grazed. Similar to the Swamp Mahogany forest and Paperbark swamp forests, midstorey trees including *Glochidion ferdinandi, Melicope elleryana,* and *Acacia maidenii* were occasionally present as was the vine *Parsonsia straminea*. A shrub layer was generally absent. The ground layer was in good to poor condition and largely dominated by *Imperata cylindrica* and the weedy grasses *Axonopus fissifolius* and *Digitaria didactyla*.

Photo D.5 Swamp Oak swamp forest in the central portion of Lot 1 DP779817

D1.5 Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast

The Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast vegetation type is located along the eastern edge of the study area and in a section in the east. This vegetation type is associated with the sand dunes either side of Billinudgel Creek. This vegetation type is in good condition (refer Photo D6).

This vegetation is a closed forest dominated by a canopy of *Cupaniopsis anacardioides*, *Acmena smithii*, and *Syzygium oleosum* with *Acronychia imperforata, Acronychia littoralis, Elaeodendron australe* var. *australe*, and *Litsea australis*. The mid layer was dense and composed of species including *Notelaea longifolia, Pittosporum undulatum, Notelaea longifolia, Alyxia ruscifolia, Cissus antarctica* and *Pyrrosia confluens.* The ground cover was generally sparse due to a dense leaf litter layer but was composed of species including *Pellaea falcata, Oplismenus imbecillis, Commelina cyanea, Dianella caerulea* and *Lomandra longifolia.*

Photo D.6 **Tuckeroo – Riberry – Yellow Tulipwood littoral rainforest in the eastern portion of Lot 1 DP408972**

D1.6 Coastal floodplain sedgelands, rushlands, and forblands

The Coastal floodplain sedgelands, rushlands, and forblands vegetation type is located in several locations throughout the study area in association with the Billinudgel Creek floodplain. However, this vegetation type is most common in the south eastern corner of the study area. This vegetation type is in good condition (refer Photo D7).

This vegetation is a closed sedgeland dominated by *Baumea rubiginosa, Lepironia articulata*, *Gahnia clarkei, Baloskion tetraphyllum*, and *Eleocharis* spp. Occasional *Melaleuca quinquenervia* and *Casuarina glauca* trees were present. This vegetation type does not suffer from significant weed invasion.

Photo D.7 Coastal floodplain sedgeland in the eastern portion of Lot 1 DP779817

D1.7 Cleared and disturbed land

Cleared and disturbed land is present in the northern area of the Billinudgel Creek floodplain. This area is used for cattle grazing and is drained by drainage channels that have been cut into the earth (refer Photo D8). The vegetation is dominated by *Imperata cylindrica* and the weedy grasses *Axonopus fissifolius* and *Digitaria didactyla*. Regrowth trees of *Melaleuca quinquenervia* and *Casuarina glauca* are occasionally present.

This vegetation is in poor condition and represents the greatest opportunity for development in the study area.

Photo D.8 Cleared land on the floodplain in the central north portion of Lot 1 DP779817



Appendix E

BioMetric vegetation types benchmarks

Table E.1 BioMetric vegetation condition benchmarks for vegetation types within the study area

Veg Type Name	Native plant species richness	Native over-storey cover		Native mid-storey cover		Native ground cover (grasses)		Native ground cover (shrubs)		Native ground cover (other)		Number of trees with hollows	Total length of fallen logs
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper		
Coast Cypress Pine shrubby open forest of the North Coast Bioregion	37	10	50	0	60	5	60	5	60	5	60	1.5	7
Coastal floodplain sedgelands, rushlands, and forblands	13	10	50	5	70	1	70	0	10	1	80	1	0
Paperbark swamp forest of the coastal lowlands of the North Coast	6	10	70	0	80	0	50	0	60	5	60	0.1	5
Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	6	10	70	0	80	0	50	0	60	5	60	0.1	5
Swamp Oak swamp forest of the coastal lowlands of the North Coast	13	10	50	5	70	1	70	0	10	1	80	1	0
Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast	45	40	100	10	100	0	10	5	15	5	50	0	0.5

Table E.2 Condition of vegetation types within the study area

Veg Type Name	Native plant species richness	Native over-storey cover		Native mid-storey cover		Native ground cover (grasses)		Native ground cover (shrubs)		Native ground cover (other)		Number of trees with hollows	Total length of fallen logs
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper		
Coast Cypress Pine shrubby open forest of the North Coast Bioregion (low condition)	10 - 22	0	2	0	0	0	0	0	0	0	8	0	0
Coast Cypress Pine shrubby open forest of the North Coast Bioregion	31 - 42	24	48	9	41	10	16	12	46	32	44	0 - 2	15 - 42
Coastal floodplain sedgelands, rushlands, and forblands	12	0	-	0.5	-	14	-	0	-	86	-	0	0
Paperbark swamp forest of the coastal lowlands of the North Coast	14 - 35	22.5	43	0	38	0	22	0	10	6	68	0 - 1	8.5 - 10
Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	17 - 22	30.5	31	0	12	0	0	0	0	82	100	2 - 5	10 - 25
Swamp Oak swamp forest of the coastal lowlands of the North Coast	15 - 34	19.5	26.5	1.5	10.5	12	68	0	12	20	76	0 - 1	0 - 28
Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast	29 - 53	19	67	22	30	6	10	20	30	44	70	1 - 2	10 - 62

Note: Only one plot was completed in the Coastal floodplain sedgelands, rushlands, and forblands vegetation type.

Vegetation in **low condition** means:

1 **woody native vegetation** with:

- native over-storey percent foliage cover less than 25% of the lower value of the over-storey percent foliage cover benchmark for that vegetation type, and
  - — less than 50% of groundcover vegetation is indigenous species, or
  - — greater than 90% of groundcover vegetation is cleared.

2 **native grassland**, **wetland** or **herbfield** where:

- less than 50% of groundcover vegetation is indigenous species[1], or
- more than 90% of groundcover vegetation is cleared.

If native vegetation is not in low condition, it is in **moderate** to **good condition**.



Appendix F

Likelihood of occurrence assessment for threatened species

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Plants						
Argophyllaceae	*Corokia whiteana*	-	Vulnerable	Vulnerable	Three distinct populations are known: one in the Nightcap Range, one in the Tweed Valley, and the other close to the coast near Brunswick Heads. The inland popualtions occur in warm-temperate rainforest on poorer soil and at the boundaries between wet Eucalyptus forest and warm temperate rainforest below 800m altitude. On the coast it is found in Brush Box forest associated with littoral rainforest species (Harden 1992; NSW National Parks and Wildlife Service 2002b).	Low. Restricted to warm temperate rainforest & wet sclerophyll forest. No suitable habitat in the study area.
Davidsoniaceae	*Davidsonia jerseyana*	Davidsons Plum	Endangered	Endangered	Occurs in coastal areas from Brunswick River to the Tweed Valley where it is confined to subtropical rainforest and wet eucalypt forest at low altitudes (less than 300 m). Fruits are produced from April to October (Harden 2000; NSW National Parks and Wildlife Service 2002b).	Low. Confined to subtropical rainforest and wet eucalypt forest. No suitable habitat in the study area.
Davidsoniaceae	*Davidsonia Johnsonian*	Smooth Davidsons Plum	-	Endangered	Occurs between Tintenbar - Broken Head districts, NSW, in the south and Tallebudgera and Numinbah valleys, Qld, in the north. Known from as far inland as Nimbin. Found mainly in wet sclerophyll forests and subtropical rainforest (complex notophyll vine forest) below 300m altitude, including disturbed lowland subtropical rainforest or on the margin with wet sclerophyll forest. Also occurs as isolated trees in paddocks and on roadsides in cleared land (Harden 2000).	Low. Found mainly in wet sclerophyll forests and subtropical rainforest (complex notophyll vine forest). No suitable habitat in the study area.
Euphorbiaceae	*Acalypha eremorum*	Acalypha	-	Endangered	Occurs north of Lismore where it grows in subtropical rainforest, dry rainforest and vine thickets. (Harden 2000; NPWS 2002). Distribution: Limpinwood NR, near Lismore, Mooball SF, Nullum. Likely habitat: Dry rainforest, margins of sub-tropical rainforest (NSW National Parks and Wildlife Service 1999d).	Low. Littoral Rainforest within the study area may provide suitable habitat for this species. However, it has not been recorded within the study area.
Euphorbiaceae	*Fontainea australis*	-	Vulnerable	-	Distribution: North of Lismore, e.g. Wanganui, Goonengerry, upper Couchy and Crystal Creeks, and Tyalgum. Likely habitat: Lowland subtropical rainforest. Additional known habitat details: Associated species include *Argyrodendron trifoliolatum, Diospyros mabacea, Toona australis,* and *Dendrocnide excelsa*. On basaltic alluvial flats (NSW National Parks and Wildlife Service 1999d; Royal Botanic Gardens 2005).	Low. No suitable habitat in the study area. Restricted to Lowland subtropical rainforest on basaltic alluvial flats.
Fabaceae (Caesalpinioideae)	*Cassia brewsteri* var. *marksiana*	-	-	Endangered	Occurs north from Brunswick Heads, around Murwillumbah, and north into south-east Queensland as far as Beenleigh. Found in littoral and riverine rainforest, and in regrowth vegetation on farmland and along roadsides. It prefers more fertile soil-types and is often found in low and flat sites (Department of Environment and Conservation 2006b).	Low. Littoral Rainforest within the study area may provide suitable habitat for this species. However, it has not been recorded within the study area.
Fabaceae (Mimosoideae)	*Acacia bakeri*	Marblewood	-	Vulnerable	Occurs north of Mullumbimby where it grows in or near lowland subtropical rainforest, in adjacent wet sclerophyll eucalypt forest and in regrowth (Harden 2002; NSW National Parks and Wildlife Service 2002b; NSW Scientific Committee 2000).	Low. No suitable habitat in the study area. Restricted to Lowland subtropical rainforest.
Fabaceae (Mimosoideae)	*Archidendron hendersonii*	White Lace Flower	-	Vulnerable	Occurs north of Alstonville where it grows in riverine and lowland subtropical rainforest and littoral rainforest (Harden 2000; NSW National Parks and Wildlife Service 2002b).	Recorded within the study area. *Archidendron hendersonii* is known from the study area and is present in house site 20, 21 and 22. *Archidendron hendersonii* is also present along Jones Road and scattered throughout the Littoral Rainforest within the study area.
Lauraceae	*Cryptocarya foetida*	Stinking Cryptocarya	Vulnerable	Vulnerable	Scattered occurrence from Illuka NR north to Fraser Is. Usually found in littoral rainforest on old sand dunes, and subtropical rainforest over slate, but mature trees have also been recorded occasionally on basalt soils. Associated species include: *Acmena hemilampra, Acronychia imperforata, Cryptocarya triplinervis, Cupaniopsis anacardioides, Flindersia bennettiana, Lophostemon confertus, Syzygium luehmanii*. The seeds are readily dispersed by birds resulting in seedling and saplings growing within other habitats where they are unlikely to develop to maturity (Harden 2000; NSW National Parks and Wildlife Service 1999d, 2002b).	Recorded within the study area. *Cryptocarya foetida* is known from the study area and is present in house site 23. *Cryptocarya foetida* was also found in several other locations within the Littoral Rainforest in the study area.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Lauraceae	*Endiandra hayesii*	Rusty Rose Walnut	Vulnerable	Vulnerable	Distribution: North from the Clarence River, e.g. Big Scrub FR, Broken Head FR, Minyon Falls FR, Nightcap NP, Snows Gully FR, Mebbin, Mooball, Nullum, Whian Whian & Wollumbin SFs. Known to be locally abundant in lowland subtropical rainforest on sedimentary, basaltic soils and alluvium in cool, moist sheltered valleys. Likely habitat: Subtropical & littoral rainforest, & wet sclerophyll forest (Harden 2000; NSW National Parks and Wildlife Service 1999d, 2002b).	Low. Littoral Rainforest within the study area may provide suitable habitat for this species. However, it has not been recorded within the study area.
Lauraceae	*Endiandra muelleri* subsp. *bracteata*	-	-	Endangered	Occurs north from Maclean where it grows in subtropical rainforest, mostly at lower altitudes (Harden 2000).	Low. No suitable habitat in the study area. Restricted to Lowland subtropical rainforest.
Myrtaceae	*Syzygium hodgkinsoniae*	Red Lilly Pilly	Vulnerable	Vulnerable	Distribution: North from the Richmond River, e.g. Big Scrub FR, Boomerang Falls FR, Brunswick Heads NR, Inner Pocket NR, Limpinwood NR, Minyon Falls FR, Mt Warning NP, Nightcap NP, Numinbah NR. Grows in subtropical rainforest or gallery forest on rich alluvial or basaltic soils. Likely habitat: Rainforest & rainforest with Lophostemon overstorey. (Harden 2000; NSW National Parks and Wildlife Service 1999d, 2002b).	Low. No suitable habitat in the study area. Restricted to Lowland subtropical rainforest.
Myrtaceae	*Syzygium moorei*	Coolamon	Vulnerable	Vulnerable	Occurs north of the Richmond River, e.g. Brunswick Heads NR, Stotts Island NR, Binna Burra, Mullumbimby. Known from subtropical riverine & gully rainforests at low altitude. Also often occurs as isolated paddock trees (Harden 2002; NSW National Parks and Wildlife Service 1999d, 2002b).	Low. No suitable habitat in the study area. Restricted to subtropical riverine & gully rainforests.
Orchidaceae	*Geodorum densiflorum*	Pink Nodding Orchid	-	Endangered	There are thought to be less than 20 populations of Pink Nodding Orchid in NSW, all occur north of Bundjalung National Park and the Macleay River. The species also occurs in Queensland. It Grows in open dry eucalypt forest, heathland and coastal swamp forest at lower altitudes, often on coastal sand. Often occurs on grassy hillsides in loose colonies (Bishop 2000).	Moderate. Suitable habitat for *Geodorum densiflorum* is present in the swamp forests and Coastal Cypress Pine forests within the study area.
Poaceae	*Arthraxon hispidus*	Hairy Joint Grass	Vulnerable	Vulnerable	Occurs north from Gibraltar Range where it grows on the edges of rainforest and in wet sclerophyll forest. It prefers moist shady sites and is often found near creeks or swamps (Harden 1993; NSW National Parks and Wildlife Service 2002b).	Moderate. Suitable habitat for *Arthraxon hispidus* is present in the swamp forests and Littoral Rainforests within the study area.
Poaceae	*Elyonurus citreus*	-	-	Endangered	Grows in sandy soils near rivers or along the coast; north from Grafton (Royal Botanic Gardens 2005)	Moderate. Suitable habitat for *Elyonurus citreus* is present in the Coastal Cypress Pine forests within the study area.
Polypodiaceae	*Drynaria rigidula*	Basket Fern	-	Endangered	Occurs north of the Clarence River where it grows predominantly in rainforest but also in moist eucalypt forest on plants, rocks or on the ground (Harden 2000; NSW National Parks and Wildlife Service 2002b).	Moderate. Suitable habitat for *Drynaria rigidula* is present in the swamp forests and Littoral Rainforests within the study area.
Proteaceae	*Floydia praealta*	Ball Nut	Vulnerable	Vulnerable	Distribution: North from the Clarence River, e.g. Boatharbour NR, Broken Hd NR, Johnstons Scrub NR, Limpinwood NR, Mt Warning NP, Nightcap NP, Numinbah NP, Victoria Park NR. Whian Whian & Wollumbin SFs. Known habitat: Chiefly riverine and subtropical rainforest, usually on basaltic soils. Likely habitat: Rainforest. (Harden 2002; NSW National Parks and Wildlife Service 1999d, 2002b).	Low. No suitable habitat in the study area. Restricted to subtropical rainforests.
Proteaceae	*Grevillea hilliana*	White Silky Oak/Yiel Yiel	-	Endangered	Occurs north of Brunswick River and the only populations known in NSW occur in small remnant patches in the Brunswick Heads and Tweed Heads areas. It grows in subtropical rainforest, often on basic igneous substrates (basalt-derived soils) (Harden 2002; NSW National Parks and Wildlife Service 2002b).	Low. No suitable habitat in the study area. Restricted to subtropical rainforests.
Proteaceae	*Hicksbeachia pinnatifolia*	Red Boppel Nut	Vulnerable	Vulnerable	Known habitat is subtropical rainforest on basaltic derived soils, moist open forest & regrowth rainforest, and Brush Box forest. Often on floodplain edge on lower slopes. Often regenerates by suckering in disturbed sites. Northern Metapopulation Unit: Distribution: North of Lismore, e.g. Whian Whian SF, Nullum SF, Mooball SF. High probability habitat: Rainforest, wet eucalypt forest with rainforest understorey. Additional known habitat details: Recorded on basalt-derived soils in association with Lop*hostemon confertus, Eucalyptus grandis, E. microcorys, Ceratopetalum apetalum, Schizomeria ovata, Flindersia schottiana, Heritiera trifoliolata, Geissois benthamii.* (Harden 2002; NSW National Parks and Wildlife Service 1999d, 2002b).	Low. No suitable habitat in the study area. Restricted to subtropical rainforests on basaltic derived soils.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Proteaceae	*Macadamia tetraphylla*	Rough-leaved Queensland Nut	Vulnerable	Vulnerable	Distribution: north of the Clarence River, chiefly in the Richmond & Tweed Rivers extending into the Numinbah Valley & Coomera River, Qld, e.g. Goonengerry and Whian Whian SF, Davis Scrub NR, Limpinwood NR, Minyon Falls FR, Mt Warning NP, Nightcap NP, Numinbah NR, Victoria Park NR. Known habitat details: Subtropical rainforest, usually near the coast. Likely habitat: Rainforest. (Harden 2002; NSW National Parks and Wildlife Service 1999d, 2002b).	Low. No suitable habitat in the study area. Restricted to subtropical rainforests.
Rubiaceae	*Randia moorei*	Spiny Gardenia	Endangered	Endangered	Occurs north of Lismore where it grows in subtropical, riverine, littoral and dry rainforest commonly with a Hoop Pine and Brush Box canopy (Harden 1992; NSW National Parks and Wildlife Service 2002b).	Low. Littoral Rainforest within the study area may provide suitable habitat for this species. However, it has not been recorded within the study area.
Rutaceae	*Acronychia littoralis*	Scented Acronychia	Endangered	Endangered	Occurs north of Port Macquarie where it grows in littoral rainforest on sand (Harden 2002; NSW National Parks and Wildlife Service 2002b).	Recorded within the study area. *Acronychia littoralis* is known from the study area and is present in 13 house sites. *Acronychia littoralis* is a dominant component of the Littoral Rainforest within the study area and is also present along Jones Road and scattered throughout the Coastal Cypress Pine forests and swamp forests within the study area.
Rutaceae	*Bosistoa transversa*	Three-leaved Bosistoa	Vulnerable	Vulnerable	Occurs north of Tweed River where it grows in lowland subtropical rainforest up to 300m in altitude (Harden 2002; NSW National Parks and Wildlife Service 2002b).	Low. Littoral Rainforest within the study area may provide suitable habitat for this species. However, it has not been recorded within the study area.
Sapindaceae	*Lepiderema pulchella*	Fine-leaved Tuckeroo	-	Vulnerable	Found on the NSW north coast north of Brunswick Heads, and in Queensland. Most records in NSW are from the Tweed Valley, and the majority of known populations are on private land. Found in lowland subtropical rainforest in NSW and on infertile metasediments and on fertile basalts in the Tweed Valley (Department of Environment and Conservation 2006a).	Low. Littoral Rainforest within the study area may provide suitable habitat for this species. However, it has not been recorded within the study area.
Animals						
Birds	*Amaurornis moluccana*	Pale-vented Bush-hen	-	Vulnerable	Occurs in rainforest fringes, swamp-forests, low scrub in flooded areas, roadside vegetation, tall grass, lantana thickets, canefields and gardens (Pizzey & Knight 1997).	Moderate. The sedgeland, swamp forests and Littoral Rainforests within the study area provide suitable habitat for this species.
Birds	*Anseranas semipalmata*	Magpie Goose	-	Vulnerable	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry season this species migrates hundreds of kilometres to perennial swamps (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002a).	Low. The study area does not provide high quality habitat for the Magpie Goose.
Birds	*Anthochaera phrygia (*syn*. Xanthomyza phrygia)*	Regent Honeyeater	Endangered Migratory	Critically Endangered	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with Casuarina cunninghamiana and Amyema cambagei are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include Eucalyptus sideroxylon (Mugga Ironbark), E. albens (White Box), E. melliodora (Yellow Box) and E. leucoxylon (Yellow Gum) (Garnett & Crowley 2000).	Moderate. The Swamp Mahogany forest within the study area may provide a seasonal (winter) foraging resource for the Regent Honeyeater.
Birds	*Ardea ibis*	Cattle Egret	Migratory	-	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands and very rarely in arid and semi-arid regions. High numbers may occur in moist, poorly drained pastures with high grass; it avoids low grass pastures but has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora (Marchant & Higgins 1990; Morton *et al.* 1989).	Recorded within the study area. Cattle Egrets were recorded in the study area and surrounds foraging in grazing paddocks amongst cows.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Birds	*Botaurus poiciloptilus*	Australasian Bittern	Endangered	Endangered	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002a).	Moderate. The sedgelands and swamp forests within the study area provide suitable habitat for the Australasian Bittern.
Birds	*Burhinus grallarius*	Bush Stone-curlew	-	Endangered	In coastal areas tidal and estuarine communities (Casuarina woodlands, saltmarsh and mangroves) provide suitable habitat (Price 2004). Nesting sites are frequently located in relatively open areas, where ground cover is extremely low and/or sparse including native vegetation and mown lawns, ploughed paddocks and paddocks cut for hay, dirt and gravel roads, seaweed on sand beach, playing fields, vacant lots (Department of Environment and Conservation NSW 2006).	Moderate. The Coastal Cypress Pine forests and swamp forests within the study area provide suitable habitat for the Bush Stone-curlew.
Birds	*Calyptorhynchus lathami*	Glossy Black-Cockatoo		Vulnerable	Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 1999a).	Moderate. The Swamp Oak forests within the study area provide suitable foraging habitat for the Glossy Black-Cockatoo.
Birds	*Ephippiorhynchus asiaticus*	Black-necked Stork	-	Endangered	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett & Crowley 2000).	Known from the study area. The Black-necked Stork was recorded from the centre of the study area in 1987. The Black-necked Stork is likely to inhabit the floodplain in the centre of the study area from time to time.
Birds	*Erythrotriorchis radiatus*	Red Goshawk	Vulnerable Migratory	Critically Endangered	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 meters which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest (Garnett & Crowley 2000).	Low. The study area may form part of the home range for a Red Goshawk but the study area is unlikely to provide permanent habitat.
Birds	*Glossopsitta pusilla*	Little Lorikeet	-	Vulnerable	The Little Lorikeet is a small green lorikeet with black bill and red patch on forehead and throat. The underside is yellow-green. Immatures are duller with less red on face and brown bill. Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins 1999).	Moderate. The Swamp Mahogany forest within the study area may provide a seasonal (winter) foraging resource for the Little Lorikeet.
Birds	*Grus rubicunda*	Brolga	-	Vulnerable	Occurs in well vegetated shallow freshwater wetlands, small isolated swamps in eucalypt forests, floodplains, grasslands, paddocks, ploughed fields, irrigated pastures, stubbles, crops, desert claypans, bore drains, tidal areas, mangroves, beach wastes. Roosts in shallow, bare swamps and nests on small islands in wetland or standing in shallow water, eggs are occasionally laid on bare ground (Pizzey & Knight 1997).	Low. The Brolga may inhabit the floodplain in the centre of the study area from time to time.
Birds	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	Migratory	-	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 1997).	Moderate. The study area may form part of the home range for a White-bellied Sea-Eagle.
Birds	*Hirundapus caudacutus*	White-throated Needletail	Migratory	-	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 1997).	Moderate. The White-throated Needletail is likely to fly over and use the airspace over the study area from time to time.
Birds	*Ixobrychus flavicollis*	Black Bittern	-	Vulnerable	Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002a).	Moderate. The sedgelands and swamp forests within the study area provide suitable habitat for the Black Bittern.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Birds	*Lathamus discolor*	Swift Parrot	Endangered	Endangered	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).	Moderate. The Swamp Mahogany forest within the study area may provide a seasonal (winter) foraging resource for the Swift Parrot.
Birds	*Lophoictinia isura*	Square-tailed Kite		Vulnerable	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes (Garnett & Crowley 2000).	Moderate. The study area may form part of the home range for a Square-tailed Kite.
Birds	*Merops ornatus*	Rainbow Bee-eater	Migratory	-	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins 1999).	Moderate. The Rainbow Bee-eater may utilise the study area from time to time for foraging.
Birds	*Monarcha leucotis*	White-eared Monarch	-	Vulnerable	Occurs in rainforest margins or regrowth, dense scrubs on streams, paperbarks, mangroves, and adjacent eucalypt forest. Thought to migrate from highlands to coastal lowlands in autumn-winter (Pizzey & Knight 1997).	Moderate. The Littoral Rainforest and swamp forests within the study area provides suitable habitat for the White-eared Monarch.
Birds	*Ninox strenua*	Powerful Owl	-	Vulnerable	A sedentary species with a home range of approximately 1,000 hectares it occurs within open eucalypt, Casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett & Crowley 2000).	Moderate. The study area may form part of the home range for a Powerful Owl.
Birds	*Pandion cristatus (syn. P. haliaetus)*	Eastern Osprey	Migratory	Vulnerable	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish (Pizzey & Knight 1997).	Moderate. The study area may form part of the home range for an Eastern Osprey.
Birds	*Ptilinopus magnificus*	Wompoo Fruit-Dove	-	Vulnerable	Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country (Garnett & Crowley 2000).	Moderate. The Littoral Rainforest and swamp forests within the study area provides suitable habitat for the Wompoo Fruit-Dove.
Birds	*Ptilinopus regina*	Rose-crowned Fruit-Dove	-	Vulnerable	Occurs in subtropical and dry rainforests and occasionally in moist eucalypt forests and swamp forests where fruit is plentiful. They are thought to move locally as they follow the ripening fruit (NSW National Parks and Wildlife Service 2002a).	Moderate. The Littoral Rainforest and swamp forests within the study area provides suitable habitat for the Rose-crowned Fruit-Dove.
Birds	*Ptilinopus superbus*	Superb Fruit-Dove	-	Vulnerable	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lily pillies and blackberries (Pizzey & Knight 1997).	Moderate. The Littoral Rainforest and swamp forests within the study area provides suitable habitat for the Superb Fruit-Dove.
Birds	*Tyto longimembris longimembris*	Eastern Grass Owl	-	Vulnerable	Typically found in tussock-grasslands but also occur in heathland, swamps, coastal dunes, tree-lined creeks, treeless plains, grassy gaps between trees and crops. Nest on the ground generally under tussocks. They generally feed on rodents but will also eat insects (Pizzey & Knight 1997).	Moderate. The sedgelands within the study area provide suitable habitat for the Eastern Grass Owl.
Birds	*Tyto novaehollandiae novaehollandiae*	Masked Owl (southern mainland)	-	Vulnerable	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves (Garnett & Crowley 2000).	Moderate. The Coastal Cypress Pine forests and swamp forests within the study area provide suitable habitat for the Masked Owl.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Invertebrates	*Thersites mitchellae*	Mitchell's Rainforest Snail	Critically Endangered	Endangered	Restricted to lowland subtropical rainforest and swamp sclerophyll forest with a rainforest understorey, typically on alluvial soils with a basaltic influence. It is apparently absent from other rainforest types in the area, such as littoral rainforest (NSW National Parks and Wildlife Service 2001b).	Moderate. The swamp forests within the study area provide suitable habitat for the Mitchell's Rainforest Snail
Mammals	*Chalinolobus nigrogriseus*	Hoary Wattled Bat	-	Vulnerable	Wide range of habitats from wet sclerophyll to open woodland and even over scrub on sand-dunes (Strahan 1995).	Moderate. The Coastal Cypress Pine forests and swamp forests within the study area provide suitable habitat for the Hoary Wattled Bat.
Mammals	*Dasyurus maculatus maculatus*	Spotted-Tailed Quoll (Southern Subspecies)	Endangered	Vulnerable	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999d). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999c, 1999d).	Moderate. The Spotted-Tailed Quoll has been recorded from near the study area at Burringbar Creek as recently as 2006. The large areas of rainforest, Coastal Cypress Pine forests and swamp forest within the study area provides suitable habitat for this species.
Mammals	*Kerivoula papuensis*	Golden-tipped Bat	-	Vulnerable	Predominantly distributed throughout Indonesia, New Guinea and the Philippines, the species has been observed on the east coast of NSW and Victoria. Prefers moist dense vegetation in coastal forests, near to where wet and dry forests meet and often in the vicinity of creeks. Possibly prefers ecotonal habitats (such as creek lines) for feeding and passage and an ability to manoeuvre in dense vegetation (Strahan 1995).	Moderate. The Littoral Rainforest and adjacent swamp forests within the study area provide suitable habitat for the Golden-tipped Bat.
Mammals	*Miniopterus australis*	Little Bent-wing Bat	-	Vulnerable	Feeds on small insects beneath the canopy of well-timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred (Strahan 1995).	Known from the study area. The Little Bent-wing Bat has been recorded in the study area near the Old Coast Road and is likely to use the Littoral Rainforest and swamp forests within the study area as habitat.
Mammals	*Miniopterus schreibersii oceanensis*	Eastern Bent-wing Bat	-	Vulnerable	This species is found along the east coast of Australia from Cape York in Queensland to Castlemaine in Victoria. Habitat includes rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands. Roosts in caves, old mines, stormwater channels and sometimes buildings with populations centred on maternity caves that are used annually for the birth and development of young (Churchill 2008).	Known from the study area. The Eastern Bent-wing Bat has been recorded in the study area; specifically in Lot 1 DP408972.
Mammals	*Mormopterus beccarii*	Beccari's Freetail Bat	-	Vulnerable	This species is widely distributed across northern Australia from Western Australia to Queensland, extending south to the north-east corner of NSW. The only confirmed record in NSW is of a colony found in the roof of a house in Murwillumbah; however, calls have been detected from a few other locations in the far north east of the State. Found in a range of vegetation types in northern Australia, from rainforests to open forests and woodlands, and are often recorded along watercourses. They can also occur in towns and cities. Roost mainly in tree hollows but relatively large colonies have been found under house roofs in urban areas in Queensland.	Known from the study area. Beccari's Freetail Bat has been recorded in the study area near the Old Coast Road and is likely to use the Littoral Rainforest and swamp forests within the study area as habitat.
Mammals	*Mormopterus norfolkensis*	Eastern Free-tail bat	-	Vulnerable	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008).	Moderate. The Eastern Free-tail bat is likely to utilise most of the habitats present within the study area.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Mammals	*Myotis macropus*	Southern Myotis	-	Vulnerable	Found in most habitat types in association with streams and permanent waterways usually at low elevations in flat or undulating landscapes from northern areas of Western Australia, and the Northern Territory, down the entire east coast and the southern coast of Australia to just west of the Victoria/South Australia border and inland along the Murray River. Roosts in caves, tree hollows, in clumps of dense vegetation (e.g. Pandanus), mines, tunnels, under bridges, road culverts and stormwater drains often in abandoned, intact Fairy Martin nests. Roost sites are strongly associated with bodies of water where this species commonly feeds on aquatic insects, shrimp and small fish at the water surface, however, aerial foraging for other insects is also known(Churchill 2008). Breeding habitat likely to coincide with roosting habitat (Office of Environment and Heritage 2011).	Known from the study area. The Southern Myotis has been recorded in the study area near the Old Coast Road and is likely to use the Littoral Rainforest and swamp forests within the study area as habitat. The Southern Myotis is likely to forage in Billinudgel Creek.
Mammals	*Nyctophilus bifax*	Eastern Long-eared Bat	Vulnerable	Vulnerable	Occurs in a range of tropical habitats from rainforest to dry sclerophyll woodland and is often found in riparian vegetation. It catches prey in the air and also takes insects from foliage and the ground or other hard surfaces. It roosts in tree hollows and in the roofs of buildings (Strahan 1995).	Moderate. The Eastern Long-eared Bat is known from the adjacent Billinudgel Nature Reserve and is likely to utilise the habitats within the study area, particularly Littoral Rainforest.
Mammals	*Phascolarctos cinereus*	Koala (NSW, ACT & QLD - excluding SE QLD)	Vulnerable	Vulnerable	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum Eucalyptus tereticornis, Grey Gum E. punctata, Monkey Gum E. cypellocarpa and Ribbon Gum E. viminalis. In coastal areas, Tallowwood E. microcorys and Swamp Mahogany E. robusta are important food species, while in inland areas White Box E. albens, Bimble Box E. populnea and River Red Gum E. camaldulensis are favoured (NSW National Parks and Wildlife Service 1999b, 2003). Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW TSC Act.	Moderate. The Koala is known from the Wooyung area; however, recent records have been scarce. Suitable habitat, including the primary feed tree species *Eucalyptus robusta*, is present within the study area. As such, the western areas of the study area are considered as potential koala habitat.
Mammals	*Planigale maculata*	Common Planigale	-	Vulnerable	Occurs in a range of habitats from rainforest, sclerophyll forest, grasslands, marshlands and rocky areas, usually where there is ground cover and close to water (NSW National Parks and Wildlife Service 2002a). Builds small saucer-shaped nests of grass and bark (Strahan 1995).	Moderate. The Common Planigale is known from the adjacent Billinudgel Nature Reserve and is likely to utilise all habitats within the study area.
Mammals	*Potorous tridactylus tridactylus*	Long-nosed Potoroo (SE mainland)	Vulnerable	Vulnerable	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense healthy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available (Johnston 1995; NSW National Parks and Wildlife Service 1999d).	Moderate. The Long-nosed Potoroo is known from the adjacent Billinudgel Nature Reserve and is likely to utilise all habitats within the study area. The Littoral Rainforest within the study area may provide suitable breeding habitat for this species.
Mammals	*Pteropus poliocephalus*	Grey-headed Flying-fox	Vulnerable	Vulnerable	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001a).	Moderate. The study area supports large areas of suitable habitat for the Grey-headed Flying-fox in the form of Littoral Rainforest and the swamp forests. The paperbark and swamp mahogany trees would provide a good food source for this species, as would fruiting trees in the Littoral Rainforest.

Family Name	*Species Name*	Common Name	EPBC Act Listing	TSC Act Listing	Habitat	Likelihood of Occurrence
Mammals	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	-	Vulnerable	This species is widespread through tropical Australia and migrates to southern Australia in summer. Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts and breeds in tree hollows but has also been recorded roosting under exfoliating bark, in burrows of terrestrial mammals, in soil cracks and under slabs of rock and in the nests of bird and sugar gliders (Churchill 2008).	Moderate. The Yellow-bellied Sheathtail-bat has been previously recorded approximately 3km to the south west of the study area. This mobile species is likely to utilise habitats within the study area.
Mammals	*Scoteanax rueppellii*	Greater Broad-nosed Bat	-	Vulnerable	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 2008).	Known from the study area. The Greater Broad-nosed Bat has been recorded in the study area near the Old Coast Road and is likely to use the Littoral Rainforest and swamp forests within the study area as habitat.
Mammals	*Syconycteris australis*	Common Blossom-bat	-	Vulnerable	Often roosts in littoral rainforests and feed on flowers in adjacent heathland and paperbark swamps. They roost individually in foliage of the subcanopy (NSW National Parks and Wildlife Service 2002a).	Moderate. The study area supports large areas of suitable habitat for the Common Blossom-bat in the form of Littoral Rainforest and the swamp forests. The paperbark and swamp mahogany trees would provide a good food source for this species. The Littoral Rainforest may provide suitable breeding habitat.
Reptiles	*Cacophis harriettae*	White-crowned Snake	-	Vulnerable	Occurs in coastal and near coastal areas from the Tropic of Capricorn to north-eastern NSW. A nocturnal species, during the day it is generally found under leaf litter and fallen timber. It feeds mostly on small lizards (Cogger 2000).	Moderate. The study area supports large areas of suitable habitat for the White-crowned Snake in the form of swamp forests and Coastal Cypress Pine forest.
Reptiles	*Hoplocephalus stephensii*	Stephen's Banded Snake	-	Vulnerable	Found in coastal areas from Gosford district to southern QLD. Arboreal snake usually encountered in the wetter sclerophyll or rainforests which occur within its range (Cogger 2000).	Moderate. The Littoral Rainforest within the study area provides suitable habitat for the Stephen's Banded Snake.
Amphibians	*Crinia tinnula*	Wallum Froglet	-	Vulnerable	Occurs along coast from south-eastern Queensland to Sydney. Mostly associated with swamps, dams and flooded roadside ditches, usually in heathland, where it is confined to acid, paperbark swamps and sedge swamps of the 'wallum' country. Males call any time of year. Breed in late winter (Anstis 2002; NSW National Parks and Wildlife Service 2002a).	Known from the study area. The Wallum Froglet has been recorded within the study area in several locations associated with the drainage channels, swamp forests and Billinudgel Creek. The Wallum Froglet was heard calling in several locations within drainage channels and swamp forests during the field survey. A relatively large population of Wallum Froglet is likely to be present within the study area.
Amphibians	*Litoria olongburensis*	Olongburra Frog	Vulnerable	Vulnerable	Occurs in creeks and in marshy or swampy lowland habitats amongst emergent vegetation and reeds (Cogger 2000), in particular in the paperbark swamps and sedge swamps of the coastal 'wallum' country (NSW National Parks and Wildlife Service 2002a).	Moderate. The sedgelands and swamp forests within the study area provide suitable habitat for the Olongburra Frog.



Appendix G

Historical aerial photographs of the study area

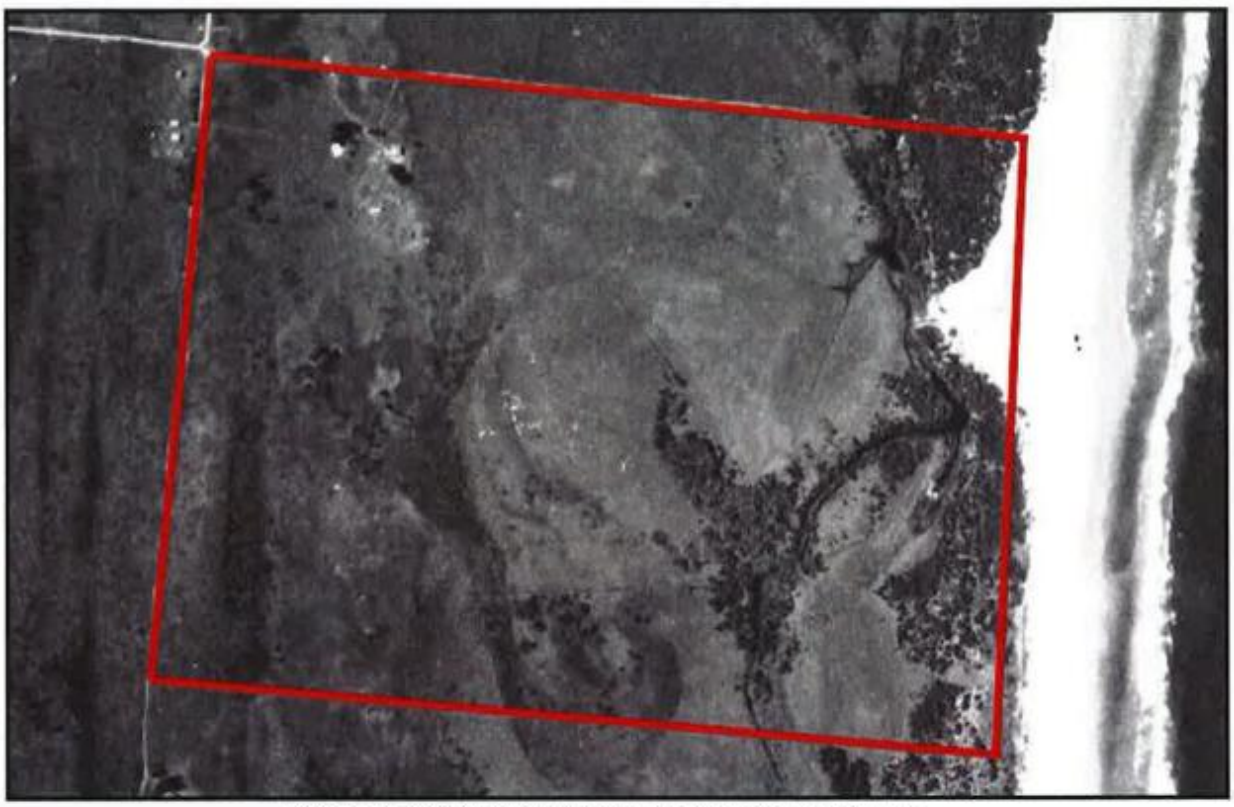

Figure 21: 1944 Aerial photograph of the Subject Lands

Figure 22: 1962 Aerial photograph of the Subject Lands

Figure 23: 1977 Aerial photograph of the Subject Lands

Figure 24: 1991 Aerial photograph of the Subject Lands

Recent aerial photograph of the study area



Appendix H Significance assessment criteria for threatened species and ecological communities

H1. TSC Act significance Assessments

H1.1 Factors for consideration

The factors to be considered when determining whether an action, development or activity is likely to significantly affect Threatened species, populations or ecological communities, or their habitats are outlined below:

1. In the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction
2. In the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction
3. In the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:
    a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction
    b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction
4. In relation to the habitat of a Threatened species, population or ecological community:
    a) the extent to which habitat is likely to be removed or modified as a result of the action proposed
    b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
    c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.
5. Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)
6. Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan
7. Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

H2. EPBC Act significance assessments

H2.1 Significant impact criteria for Critically Endangered or Endangered ecological communities

An action is likely to have a significant impact on a Critically Endangered or Endangered ecological community if there is a real chance or possibility that it will:

1. reduce the **extent** of an ecological community
2. **fragment** or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
3. adversely affect **habitat critical to the survival** of an ecological community
4. modify or destroy **abiotic (non-living) factors** (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
5. cause a substantial change in the **species composition** of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
6. cause a substantial reduction in the **quality or integrity of an occurrence** of an ecological community, including, but not limited to:
    a) assisting **invasive species**, that are harmful to the listed ecological community, to become established
    b) causing regular mobilisation of fertilisers, herbicides or other **chemicals or pollutants** into the ecological community which kill or inhibit the growth of species in the ecological community
7. interfere with the **recovery** of an ecological community.

H2.2 Significant impact criteria for Critically Endangered or Endangered species

An action is likely to have a significant impact on a Critically Endangered or Endangered species if there is a real chance or possibility that it will:

1. lead to a long-term decrease in the **size of a population**
2. reduce the **area of occupancy** of the species
3. **fragment** an existing population into two or more populations
4. adversely affect **habitat critical to the survival** of a species
5. disrupt the **breeding cycle** of a population
6. modify, destroy, remove, isolate or decrease the **availability or quality of habitat** to the extent that the species is likely to decline

7. result in **invasive species** that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat
8. introduce **disease** that may cause the species to decline, or
9. interfere with the **recovery** of the species.

H2.3 Significant impact criteria for Vulnerable species

An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:

1. lead to a long-term decrease in the size of an important population of a species
2. reduce the area of occupancy of an important population
3. fragment an existing important population into two or more populations
4. adversely affect habitat critical to the survival of a species
5. disrupt the breeding cycle of an important population
6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
7. result in invasive species that are harmful to a vulnerable species becoming established in the Vulnerable species' habitat
8. introduce disease that may cause the species to decline, or
9. interfere substantially with the recovery of the species.

H2.4 Significant impact criteria for Migratory species

An action is likely to have a significant impact on a Migratory species if there is a real chance or possibility that it will:

1. substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a Migratory species
2. result in an invasive species that is harmful to the Migratory species becoming established in an area of important habitat for the Migratory species, or
3. seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a Migratory species.