



Transport
Roads & Traffic
Authority

An aerial photograph of a town, likely Grafton, showing a busy road with many cars and various buildings, including houses and commercial structures.

Additional crossing of the Clarence River at Grafton

Preliminary Route Options Report - Part One
Volume 2

Technical paper - Ecology

AUGUST 2011





Main Road 83 Summerland Way – Additional Crossing of the Clarence River at Grafton

Preliminary Route Options Report

Technical Paper: Ecology

August 2011

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EXECUTIVE SUMMARY

Biosis Research was commissioned by Arup, on behalf of the NSW Roads and Traffic Authority (RTA), to investigate potential terrestrial and aquatic flora and fauna issues in relation to an additional crossing of the Clarence River at Grafton.

This report details the investigations associated with identification of potential constraints that terrestrial and aquatic flora and fauna of conservation significance may place on the proposal. Flora and fauna of conservation significance include species, populations and ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act), NSW *Fisheries Management Act 1994* (FM Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Relevant statutory requirements including State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44); conservation areas and connectivity were also considered.

Assessment of ecological constraints throughout Grafton and South Grafton has been primarily desktop-based. However, parts of the proposal area were surveyed during a reconnaissance field survey undertaken in April 2010 followed by more detailed surveys undertaken over several days in August 2010 and two days in July 2011. No threatened flora species were recorded in the surveys and only small areas of potential habitat for regionally recorded threatened plants were identified in the Grafton and South Grafton area. Three endangered ecological communities were identified in the proposal area, namely freshwater wetlands on coastal floodplains, lowland rainforest on floodplains and sub-tropical coastal floodplain forest.

Through a range of survey techniques six threatened and five migratory fauna species were recorded with varying degrees of confidence during the current surveys. Four threatened microbats were definitively recorded using ultrasonic call recording with another recorded only as probable. The sixth potential threatened species, the masked owl, was potentially recorded from regurgitated pellets. Habitat surveys across parts of the Grafton and South Grafton area recorded attributes suitable for an additional 52 threatened and/or migratory fauna species.

No aquatic flora or fauna species listed as threatened pursuant to the EPBC Act, TSC Act or the FM Acts were recorded during the surveys. Nine threatened aquatic fauna species are considered to have low to marginal potential habitat within the Grafton and South Grafton area.

Criteria used to identify land within the Grafton and South Grafton area as a potential ecological constraint included information regarding the type of plant community present (particularly whether endangered ecological communities were present), threatened species known or likely to be present, the condition and importance of terrestrial and aquatic flora and fauna habitats present and corridor values. As the assessment of ecological constraints was primarily desktop-based and that limited field surveys predominantly focused around the Clarence River and associated tributaries, not all areas that may pose an ecological constraint have been mapped as such.

Examples of areas considered to pose an ecological constraint to an additional crossing of the Clarence River at Grafton are: Alipou Creek and associated riparian vegetation; the emergent aquatic vegetation (e.g. *Phragmites australis*) lining the northern and southern banks of the Clarence River; the confluence of Alummy Creek with the Clarence River; Susan Island; Elizabeth Island; Swan Creek and associated wetlands; hollow-bearing forest red gums (*Eucalyptus tereticornis*); the northern part of Musk Valley Creek from its confluence with Alipou Creek and the area of wetland between these two creeks; and, two patches of relatively intact forest in the south-east of the proposal area.

The key policy principle of the RTA's road development and impact on habitat amelioration measures is that "in principle, the planning and construction of roads should, in order of consideration endeavour to:

1. Avoid impacts on habitat through the planning process.
2. Minimise impacts on habitat through the planning process.
3. Mitigate impacts on habitat, through the use of a range of amelioration measures" (NSW RTA 2001).

Where possible important ecological features identified in the local area should be avoided during the initial route selection stage. Features of potential ecological importance have been identified below and the above hierarchy of management measures should be considered and applied to these sensitive habitats.

- During the assessment of route options, consideration should be given to the reedlands along the banks of the Clarence River that conform to the description of the freshwater wetlands on coastal floodplains endangered ecological community, Alipou Creek and Susan and Elizabeth islands.
- Intact patches of vegetation, including riparian vegetation.
- Large mature trees, including hollow-bearing trees.
- Drainage lines and low-lying paddock 'soaks' providing ephemeral habitats.
- Other consideration to the location of bridge piers or foundations within the main waterway channel (thalweg: deep, fast-flowing section of a waterway).
- Turbulence or the erosion of the bed and banks of the waterway due to the design and orientation of bridge piers, including those located within overbank areas. This is particularly important for the Clarence River at Grafton due to tidal effects (refer to engineering guidelines (Fairfull and Witheridge 2003; Witheridge 2002)). Consideration needs to be given to potential effects not only downstream of the proposed bridge but also upstream.
- When sizing the waterway area of the bridge, appropriate consideration should be given to fish passage requirements along the floodplains, including locating bridge abutments well away from the channel banks and the possible installation of floodplain culverts adjacent to the main crossing.
- Maximisation of light penetration under the bridge or arch to encourage fish passage.
- Implementation of strict erosion and sediment controls to manage direct and indirect impacts to ecology of water bodies in the proposal area.

In addition to the above recommendations, several studies that will be required to further inform the identification of a preferred location for an additional crossing have been listed below.

- Appropriate seasonal surveys for threatened aquatic fauna using bank and boat electrofishing techniques.
- Seasonal targeted surveys for threatened species identified as having potential habitat in the vicinity of the preferred location.

- AUSRIVAS sampling (to further define relative health of riparian zones).

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- Robert Speirs (Ecologist, Biosis Research)
- Ashleigh Pritchard (GIS, Biosis Research)
- James Shepherd (GIS, Biosis Research)

ABBREVIATIONS / DEFINITIONS

CAMBA	China-Australia Migratory Bird Agreement
DECCW	NSW Department of Environment, Climate Change and Water (now OEH)
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (now DSEWPaC)
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (formerly DEWHA)
I&I NSW	NSW Department of Industry and Investment
EEC	Endangered Ecological Community
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FM Act	<i>Fisheries Management Act 1994</i>
IBRA	Interim Biogeographic Regionalisation of Australia
JAMBA	Japan-Australia Migratory Bird Agreement
KTP	Key Threatening Process
Locality	5km radius of proposal area
NPWS	NSW National Parks and Wildlife Service (now part of OEH)
OEH	NSW Office of Environment and Heritage (formerly DECCW)
PCD	Psittacine circoviral disease
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
Proposal area	Area of direct impact and any areas subject to potential indirect impacts
TSC Act	<i>Threatened Species Conservation Act 1995</i>
sp.	species (singular)
spp.	species (plural)
subsp.	subspecies
var.	variety

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1.0 INTRODUCTION

1.1 Proposal Background

The New South Wales Roads and Traffic Authority (RTA) is currently undertaking investigations to identify an additional crossing of the Clarence River at Grafton to address short-term and long-term transport needs.

The design for the existing bridge over the Clarence River at Grafton commenced in 1915. It comprised a moveable span railway bridge with allowance for pedestrian use. Later in 1922, vehicular traffic was incorporated into the design. The bridge was opened to vehicular traffic in 1932.

Since the early 1970s there have been various discussions and studies into a second crossing of the Clarence River near Grafton. In 1977, the NSW Department of Main Roads (DMR, now the NSW Roads and Traffic Authority) identified that a new bridge should align along Bent Street and Fitzroy Street. It was recognised at that time that the second river crossing proposal was not of immediate priority, but rather a long-term project.

Over the last 10 years, the RTA has carried out a number of studies to identify areas that would be suitable for a second crossing of the Clarence River at Grafton. The most recent comprehensive RTA study was undertaken between 2003 and 2004. It consisted of a feasibility study (February 2003) followed by an environmental overview (January 2004) and a corridor evaluation workshop (April 2004). These studies identified that the most suitable location for a new crossing of the Clarence River would be near the existing Grafton bridge. However, a preferred route was not selected at that time and it was recognised that further investigations were needed to determine a preferred route.

Funding availability for the proposed additional crossing became an issue in 2005 and as a result investigations into a second crossing of the Clarence River were placed on hold.

In 2009, in response to increasing traffic congestion in Grafton and South Grafton, and operational safety issues with the existing bridge, the RTA recommenced investigations. This consisted of a revised traffic analysis that compared previous traffic modelling with updated traffic information. This was undertaken to understand the existing transport demands and traffic patterns within Grafton and the surrounding region. The December 2009 traffic study confirmed that a new bridge, close to the existing bridge, would cater for the traffic needs in the local area.

In February 2010 the RTA displayed four preliminary route options for community comment. These preliminary route options were developed based on traffic modelling only and were all in the vicinity of the existing bridge. This display also defined a proposed additional crossing area for this investigation.

In December 2010 the RTA released a community update announcing a revised process for the identification and preservation of a route for a second crossing. The community update included the route options considered at the April 2004 corridor evaluation workshop, the four preliminary route options publically displayed in February 2010 and options suggested by the community following the February 2010 display.

Between December 2010 and April 2011, the RTA has sought further community input on where the route should be located. This includes telephone surveys and a series of community forums.

This technical paper will be used to define the existing ecological environment and constraints in the Grafton area that may affect the proposed additional crossing.

1.2 Second crossing purpose and objectives

The project purpose is to identify an additional crossing of the Clarence River at Grafton to address short-term and long-term transport needs.

The objectives for the Summerland Way additional crossing of the Clarence River at Grafton are:

- Enhance road safety for all road users over the length of the project.
- Improve traffic efficiency between and within Grafton and South Grafton.
- Support regional and local economic development.
- Involve all stakeholders and consider their interests.
- Provide value for money.
- Minimise impacts on the environment.

These objectives will be used to compare the feasibility of the preliminary route options generated by the community as well as the resulting shortlist of options.

1.3 Report objectives

Biosis Research was commissioned by Arup Pty Ltd, on behalf of the RTA, to investigate potential terrestrial and aquatic flora and fauna issues in relation to the additional crossing of the Clarence River at Grafton. This report details the investigations associated with identification of potential constraints that terrestrial and aquatic flora and fauna of conservation significance may place on the proposal. Its purpose is to provide information that will inform the identification of a preferred location of an additional crossing.

The focus of this technical report is to gather information regarding the flora and fauna in the Grafton and South Grafton area, assess relative ecological values and assess lands within the proposal area in terms of conservation significance.

The specific objectives of this study are to:

- Gather existing information regarding terrestrial and aquatic flora and fauna within the Grafton and South Grafton area, focussing on threatened species, populations and ecological communities.
- Examine the nature, extent and condition of fauna habitats (including aquatic fauna) and vegetation associations within the Grafton and South Grafton area, through a combination of desktop and field studies.
- Determine areas supporting vegetation associations that are, or are likely to be, of conservation significance, or support resources that may be utilised by species or populations of conservation significance.
- Assess the potential occurrence of flora and fauna species or populations of conservation significance, in particular, threatened species, populations and communities.

- Determine areas that may be of importance as habitat corridors.
- Identify areas that are considered to be of ecological constraint to the location of a new river crossing and associated road infrastructure.

1.4 Proposal area

1.4.1 Definitions

NSW threatened species legislation applies particular definitions to the site of a proposed development and the area likely to be impacted by a proposed development. In addition, the present NSW Government and Commonwealth Government approach to biodiversity conservation recognises a system of “bioregions” and “subregions”. In order to provide clarity of reporting and consistency with current legislation and policy, the following definitions apply throughout this document.

Proposal area – in the case of this preliminary constraints investigation, the proposal area includes the suburbs of Grafton and South Grafton, and the Clarence River extending upstream and downstream to account for any potential direct and indirect impacts on threatened species values.

Locality – for the purposes of this report, the locality is defined as the area within a 10km radius of the proposal area.

Region – the region and sub-region in which the proposal would be located, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA). The IBRA is based on Thackway and Cresswell (1995) and Morgan and Terry (1992) and periodically updated by Parks Australia. IBRA version 6.1 (DEH 2004a, b) was current at the time of this study. The current proposal is located in the North Coast Bioregion.

Threatened biota (i.e. species of conservation significance) – threatened species, populations and ecological communities, or their potential habitats, as listed under the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.4.2 Description and extent of the proposal area

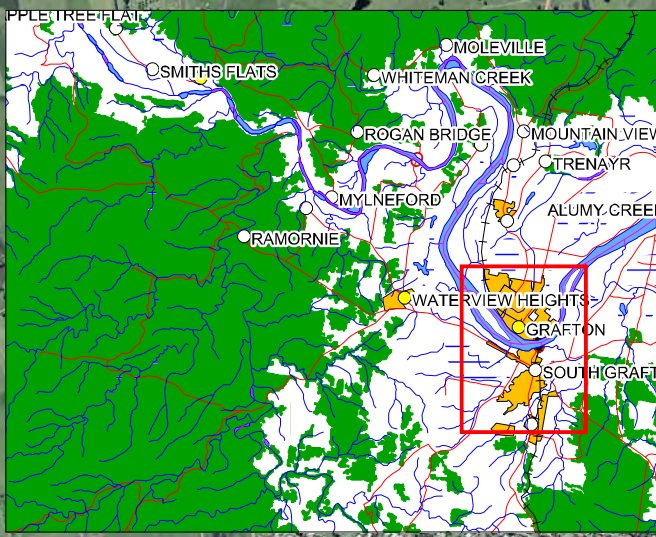
The location of the Grafton and South Grafton area is shown on Figure 1. The proposal area is predominantly cleared of native vegetation with current land uses including public open space, rail infrastructure, industrial and residential areas and agricultural land including areas used for cattle grazing and cropping.

The Clarence River runs through the proposal area flowing from west to east with an average width of approximately 400-600m. Significant tributaries of the Clarence River at Grafton are Alipou Creek (Figure 1; Plate 17), which is located in the south-east of the proposal area and Carrs Creek (Plate 14), which is located north of the proposal area. Alipou and Carrs creeks include substantial areas of permanent water and potential habitat for aquatic fauna. More modified tributaries of the Clarence River at Grafton include Cowan Creek (Plate 15), drainage channels and stormwater outlets which are located at various points in the north and south of the proposal area. An extensive system of flood levees is located in the Grafton and South Grafton area, including on both banks of the Clarence River, Grafton (Grafton Levee and Alipou Basin Levee) extending onto the floodplain in South Grafton (Heber Street Levee).

Susan Island Nature Reserve is located approximately 2km upstream of the existing Grafton bridge and Elizabeth Island is located approximately 3km downstream of the existing Grafton bridge (Figure 1). A number of Council parklands occur in the Grafton and South Grafton area such as Fisher Park, See Park, Westward Park, General Douglas Macarthur Park, Pioneer

Park, Gordon Wingfield Park, Alex Bell Park, McKittrick Park, Beresford Park and Durrington Park. The cover of vegetation varies from park to park.

The Grafton and South Grafton area is in the local government area of Clarence Valley, County of Clarence, Parish of Great Marlow.



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Figure 1: Overview of Grafton & South Grafton Proposal Area

Date: 18 July 2011	Drawn by: ANP/JMS
File number: 13508	Checked by: JC
Location: ...P:\13500s\13508\Mapping\13508_F1_Overview_180511.WOR	

0 200 400 600 800 1000
 Metres

Scale: 1:20,000 at A3
 Map Projection: Universal Transverse Mercator
 Horizontal Datum: Geodetic Datum of Australia 1994
 Map Grid: Map Grid of Australia Zone 56



1.5 Legislative framework

NSW *Environmental Planning and Assessment Act 1979* (EP&A Act)

The EP&A Act and associated EP&A Regulation 2000 provides the statutory context for environmental assessment of the proposal and ultimately planning approval.

One objective of the EP&A Act is to encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats. A second objective is to encourage the principles of ecologically sustainable development, including the precautionary principle as defined under the *Protection of the Environment Administration Act 1991*.

NSW *Threatened Species Conservation Act 1995* (TSC Act)

The TSC Act protects all threatened plants and animals native to NSW (with the exception of fish and marine plants). It provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species.

If a planned development or activity will have an impact on a threatened species, population or ecological community listed under the TSC Act, this must be taken into account in the development approval process. In some cases, the Minister for the Environment will also need to be consulted.

NSW *Fisheries Management Act 1994* (FM Act)

The object of the FM Act is to conserve threatened species, populations and ecological communities of fish and marine vegetation native to NSW and to promote ecologically sustainable development, including the conservation of biological diversity. It also aims to reduce the threats faced by native fish and marine vegetation in NSW.

If a planned development or activity will have an impact on ecological communities, threatened species, populations or their potential habitats as listed under the FM Act, this must be taken into account in the development approval process. In some cases, the Minister for the Environment will also need to be consulted.

Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)

The EPBC Act is a Commonwealth mechanism that requires proposed actions to be assessed in terms of their potential impact upon "Matters of National Environmental Significance". Matters of National Environmental Significance currently listed under the EPBC Act are:

- World Heritage properties.
- Natural heritage places.
- Wetlands of international importance.
- Threatened species and ecological communities.
- Migratory species.

- Commonwealth marine areas.
- Nuclear actions (including uranium mining).

Where a potential impact on a Matter of National Environmental Significance is likely to occur as a result of a proposed action, the significance of that impact must be assessed. Guideline criteria for determining whether an impact is significant is provided under the Act. Where a proposed action will, or is likely to, have a significant impact on a Matter of National Environmental Significance, a Referral to the Commonwealth Environment Minister must be prepared. The purpose of the Referral is to determine whether a proposed action requires approval and/or controls under the EPBC Act.

State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44)

The present known geographic distribution of the koala in NSW is fragmented and most of the populations appear to be small and isolated. A state-wide approach to the issue of declining koala populations is necessary to ensure long term survival over their present range. Thus, SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas. The identification of 'core' koala habitat areas is one of the major aims of this policy.

'Core' koala habitat is defined as an area with a resident population of koalas, as evidenced by attributes such as females with young, recent sightings and historical records of a koala population.

'Potential' koala habitat is defined as areas of native vegetation where koala feed tree species account for at least 15% of the total number of trees in the upper or lower strata of the tree component. The presence of 'potential' koala habitat warrants further investigations into whether there is 'core' koala habitat.

SEPP 44 applies to land within local government areas listed in SEPP 44, Schedule 1 (including Clarence Valley local government area) and Council is the determining authority. SEPP 44 does not apply to land dedicated or reserved under the *National Parks and Wildlife Act 1974* or to land dedicated under the *Forestry Act 1916* as State Forest or flora reserve (SEPP 44, Section 5). Nor does it apply to land where Council is not the determining authority. Thus in instances where state departments such as the RTA undertake Part 5 activities under the EP&A Act (as is likely for this development), SEPP 44 does not apply even if an EIS is required.

While the RTA may not be required to consider the provisions under SEPP 44, it is recommended that a similar approach to that described under SEPP 44 be undertaken as part of the proposal. This will help ensure the longer term survival of koalas, and proper conservation and management of areas of natural vegetation that provide habitat for koalas in the vicinity of the Grafton and South Grafton area.

2.0 PREVIOUS STUDIES AND INVESTIGATIONS

A list of documents used to prepare this report is located in the references section. However previous project studies relevant to the proposed additional crossing of the Clarence River at Grafton are listed below:

- Volumes 1 and 2 of the *Additional crossing of Clarence River Grafton Summerland Way Environmental Overview* (RTA, January 2004).
- *Additional Crossing of the Clarence River, Feasibility Study Report* (RTA, 2003).
- *Ecological Assessment, Clarence River Crossing - Route Selection Stage*. A Report Prepared for the NSW RTA (Kendall & Kendall Ecological Consultants. 2003).

Other note-worthy documents relevant to the Grafton and South Grafton area include:

- *Biodiversity Management Draft Strategy 2010* (Clarence Valley Council, February 2010).
- *Susan Island Nature Research Draft Plan of Management* (DECC, 2009).
- *Acid Sulphate Soil Management Priority Areas in the Lower Clarence Floodplain* (Talau M.J., 1999). Department of Land and Water Conservation, Sydney.

3.0 METHODOLOGY

The investigation involved three key stages: a desktop study; field surveys; and constraints analyses. The desktop study involved gathering and reviewing existing information regarding terrestrial and aquatic flora and fauna of the Grafton and South Grafton area. Field surveys were undertaken for the purpose of ground-truthing information obtained during the desktop study and to gather additional data from parts of the Grafton and South Grafton area selected for further investigation. The combined information from field and desktop studies was then used to assess relative conservation significance across the Grafton and South Grafton area.

3.1 Desktop study

Existing information regarding the flora and fauna of the Grafton and South Grafton area was obtained from a range of sources, including: databases; aerial photographs and maps; previous studies carried out in the vicinity of the proposal area (see Section 3.0); and consultation with local experts and government agencies. A list of documents cited in this report is located in the references section.

Database records were obtained for the Grafton and South Grafton area and the landscape within a 10km radius of the perimeter of the proposal area (Grafton and South Grafton) for terrestrial species and 30km for aquatic species. In addition, species known or predicted to occur within the Clarence Lowlands catchment management authority sub-region, which extends from the Grafton region north along the coastal plain to the Richmond River, were considered. Database searches included:

- Records of threatened flora and fauna species listed on the schedules of the *NSW Threatened Species Conservation Act 1995* (TSC Act) obtained from the then NSW Department of Environment, Climate Change and Water (DECCW) *Atlas of NSW Wildlife*.
- Records of Matters of National Environmental Significance listed under the provisions of the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) obtained from the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) *Protected Matters Search Tool*.
- Records of threatened and migratory bird species obtained from the Birds Australia *New Atlas of Australian Birds*.
- Records of species listed in under the FM Act were obtained from the NSW Department of Industry and Investment (formerly DPI), *Fisheries Database*.
- Records of threatened plant and animals recorded within the Clarence Lowlands catchment management authority sub-region.

All database searches were first conducted in June 2010 and updated in January 2011.

Spatial information from previous studies carried out in the vicinity of the Grafton and South Grafton area that were examined included:

- Aerial photographs of the proposal area and surrounds, supplied by Arup.
- Topographic and orthophoto maps (Land and Property Management Authority, formerly Department of Lands, 1:25,000 map of Grafton).

- Upper North East Forest Ecosystems Mapping (NPWS 1998) (Digital vegetation map layer).

3.2 Survey site selection

A brief reconnaissance survey of the Grafton and South Grafton area was carried out in April 2010 to obtain preliminary information on the current extent and condition of vegetation and identify locations likely to contain potential habitat or resources for threatened species. Survey site selection was also influenced by access limitations, as some land owners could not be contacted or were unwilling to allow access.

A number of sites within the Grafton and South Grafton area were selected for further field investigation following an examination of aerial photographs, topographic maps and nearby threatened species records. Potential survey sites included locations containing stands of tree-dominated vegetation including remnant trees and riparian vegetation along the Clarence River and Alipou Creek.

3.3 Flora survey

Terrestrial flora surveys were conducted throughout parts of the Grafton and South Grafton area on 10, 11 and 12 August 2010 and on 12 and 13 July 2011. Limitations of a winter survey are mentioned in Section 4.8. Plant species and their habitats were surveyed by undertaking general habitat assessments, targeted searches and one plot-based (i.e. quadrat) survey. Survey effort was most rigorous within areas identified as containing potential habitat for threatened plant species (Figure 2). A description of each of the survey methods is provided below.

The flora survey was limited due to the highly modified condition of the vegetation in the Grafton and South Grafton area. Although marginal potential habitat for threatened plant species was identified during the reconnaissance survey and field survey, comprehensive targeted searches for these species were not undertaken due to seasonal survey requirements.

Survey data were compared with existing vegetation maps and Scientific Committee Determinations in order to confirm the identification and extent of plant communities, particularly those that correspond to endangered ecological communities.

3.3.1 Targeted searches

Targeted searches for threatened plant species involved random meander transects as described by Cropper (1993), carried out in selected areas of known or potential habitat. Random meander transects were undertaken by two botanists traversing the site, focussing on areas of retained native vegetation.

During the random meander surveys, an inventory of all observed plant species was recorded (refer Appendix 1).

3.3.2 Plot based survey (quadrats)

Plot-based surveys are used to comprehensively describe the structure and floristics of each sampled plant community, and also provide a concentrated search area for the detection of inconspicuous plant species that may be present at a particular site. Given the fragmentation and modification of native vegetation in the Grafton and South Grafton area, plot-based surveys were not considered appropriate and only one quadrat was undertaken in the riparian vegetation to the east of the mouth of Alipou Creek (Figure 2). The structure and floristics of this degraded plant community were sampled using one 400m² quadrat (20m x 20m). A modified Braun-Blanquet cover abundance scale (Moore 1955) was assigned to each of the species collected within the quadrat. For this assessment a seven-division cover abundance scale was used (refer Table 1).

Table 1: Modified Braun Blanquet cover abundance scale (Moore 1955)

Cover Abundance Score	Cover abundance estimate (% cover of any species within each quadrat)
1	<5% - 3 or less individuals
2	<5% - more than 3 individuals but sparsely scattered consistent throughout plot
3	<5% - many individuals throughout plot and any number less than 5% cover abundance
4	Species covers between 5% and 25% of the plot
5	Species covers between 25% and 50% of the plot
6	Species covers between 50% and 75% of the plot
7	Species covers between 75% and 100% of the plot

3.3.3 Condition assessment

The condition of the vegetation was assessed according to the degree to which it resembled relatively natural, undisturbed vegetation, using the following criteria:

- Species composition (species richness, extent of weed invasion).
- Structure (representation of each of the original layers of vegetation).

Plant community condition was categorised as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and track margins; vegetation community containing original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) intact.

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation modified; vegetation layers (ground, shrub, canopy etc.) largely intact.

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation highly modified; one or more original vegetation layers (ground, shrub, canopy etc) modified or missing.

Unnatural landscape: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition; high input intervention required to revegetate.

3.4 Fauna survey

As this is a preliminary investigation and primarily desktop-based, the terrestrial fauna survey was primarily a habitat-based assessment (see Section 4.4.1 below) and trapping for fauna species was not undertaken. Seasonal and targeted surveys are recommended following identification of a location for an additional river crossing.

However, in addition to the habitat assessment, fauna species and/or their habitat were surveyed by:

- Active searching for herpetofauna (e.g. turning surface debris or rubbish and fallen timber).
- Active searching and listening for birds and frogs.
- Recording tree hollows.
- Inspecting trees for scratch marks.
- Observing the dusk flight path of flying-foxes from Susan Island.
- Searching for potential roost sites.
- Ultrasonic call recording (anabats targeting microchiropteran bats were deployed at four sites within the proposal area (Figure 2) for one night each).
- Spotlighting for nocturnal mammals (1.5 hour spotlight using a 50-watt spotlight was conducted along Alipou Creek from its confluence with the Clarence River).
- Recording incidental observations.

An inventory of all observed terrestrial fauna species was recorded (refer Appendix 2).

3.4.1 Fauna habitat assessment

The habitat assessment was based on the presence of one or more of the following features:

- Vegetation cover.
- Size range and abundance of tree hollows.
- Rock outcrops, overhangs or crevices.
- Freestanding water bodies, ephemeral drainage or seepage areas.
- Disturbances, including weed invasion, clearing, rubbish dumping or fire.
- Potential foraging, nesting or roosting resources.
- Connectivity to off-site habitats.
- Surrounding habitat.

The three categories used to evaluate habitat value were good, moderate or poor, as detailed below:

Good: ground flora containing a high number of indigenous species; plant community structure, ground, log and litter layer intact and undisturbed; a high level of breeding, nesting, feeding and roosting resources available; a high richness and diversity of native fauna species.

Moderate: ground flora containing a moderate number of indigenous species; plant community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna.

Poor: ground flora containing a low number of indigenous species, plant community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native fauna species.

Other habitat features, such as the value of the Grafton and South Grafton area as a habitat corridor, the presence of remnant communities or unusual ecological plant community structures were also used to assess habitat quality.

3.5 Aquatic survey

Aquatic surveys were undertaken by two qualified aquatic ecologists over three days between 2 and 4 August 2010. The aquatic surveys included fyke netting, luminescent bait trapping and habitat-based assessment as detailed below. Due to the high conductivity levels, excessive depth and macrophyte growth recorded during surveys, backpack electrofishing equipment could not be used. Should spring surveys occur, bank and boat electrofishing techniques should be used. Survey sites were located within 8km upstream and downstream of Grafton. Details of each site surveyed are provided in Table 2 and sample site locations are displayed in Figure 3. An inventory of all recorded aquatic species is in Appendix 3.

Table 2: Habitat assessment and targeted fish survey sites (2-4 August 2010)

Site code	Site location description
U1NC	Directly upstream of Grafton Bridge on the northern bank of the Clarence River
D1NC	Directly downstream of Grafton Bridge on the northern bank of the Clarence River
U1SC	Directly upstream of Grafton Bridge on the southern bank of the Clarence River
D1SC	Directly downstream of Grafton Bridge on the southern bank of the Clarence River
U2NC	Upstream of Grafton Bridge at Fitzroy Street on the northern bank of the Clarence River
D2SC	Upstream of Grafton Bridge at Wharf Street on the southern bank of the Clarence River
ACDG	Alipou Creek downstream of Grafton Bridge
CCUG	Cowan Creek upstream of Grafton Bridge
C1UG	Carrs Creek 1 upstream of Grafton Bridge
C2UG	Carrs Creek 2 upstream of Grafton Bridge
ACUG	Alumy Creek upstream of Grafton Bridge

3.5.1 Fyke netting

Fyke nets are a long sock of mesh with two internal throats and set up either attached above the waterline to the bank or a stake in the river bed. Fyke nets are effective at sampling a wide variety of fish sizes and species. Four fyke nets were set at approximately 16:00 each day and retrieved at approximately 8:00 the next morning. At each site two large dual wing fyke nets with 10mm mesh size were set in addition to two single wing fyke nets with 6mm mesh size targeting smaller fish species. The location of the fyke nets are shown in Figure 3.

3.5.2 Luminescent bait trapping

Luminescent bait traps are baited with a glow stick and attached to the bank or float. The number of traps set at each site is dependant upon the habitat and target species expected. Glow sticks are placed inside each bait trap to serve as an attractant. Six bait traps were set at approximately 16:00 each day and retrieved at approximately 8:00 the next morning. The location of the luminescent bait traps are shown in Figure 3.

3.5.3 Aquatic habitat and condition assessment

Aquatic habitat assessments were conducted at all 11 sites, primarily in order to assess the potential to support threatened species (refer Appendix 8 for results).

The aquatic habitat assessment utilised standardised methods including the allocation of HABSCORE indices. Barbour *et al.* (1999) describes HABSCORE as a 'visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community'.

HABSCORE assessments utilise visually based habitat characteristics to classify the quality of the water resource and the condition of the resident aquatic community. HABSCORES range from poor to optimal condition and reflect the current category condition of the water resource. Categories are derived from the sum of scores divided by the sum of the characters assessed.

The descriptors and categories for the HABSCORE assessment used in this survey are provided in Appendix 9.

HABSCORE assessments are based on the presence and condition of the following features:

- Pool substrate characterisation.
- Pool variability.
- Channel flow status.
- Bank vegetation (score for each bank).
- Bank stability (score for each bank).
- Width of riparian zone (score for each bank).
- Epifaunal substrate / available cover.

The aquatic habitat within the Grafton and South Grafton area was described in terms of four category types (Fairfull and Witheridge 2003; Barbour *et al.* 1999). The four categories used to evaluate habitat value were optimal, suboptimal, marginal or poor, as detailed below:

Optimal: watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.

Suboptimal: watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought, although becoming greatly reduced in extent. These watercourses should support a relatively diverse array

of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.

Marginal: watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.

Poor: water courses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

3.5.4 Water quality assessments

Water quality sampling was undertaken at each site using a Horiba U22-XD Multiparameter Water Probe. Measurements were taken ~30cm below the surface. Variables measured in situ included pH, dissolved oxygen (DO), temperature, turbidity and electrical conductivity (EC). Water quality sampling provides an insight into current baseline conditions of aquatic habitats within the Grafton and South Grafton area and assists in determining suitability of targeted fish survey techniques (refer Appendix 7 for results).



Legend

Targeted Survey Effort





-  Flora and Fauna Habitat Assessments
-  Vegetation Quadrat
-  Fauna Spotlighting
-  Anabat

Figure 2: Targeted flora and fauna survey locations.

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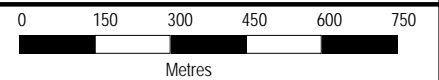
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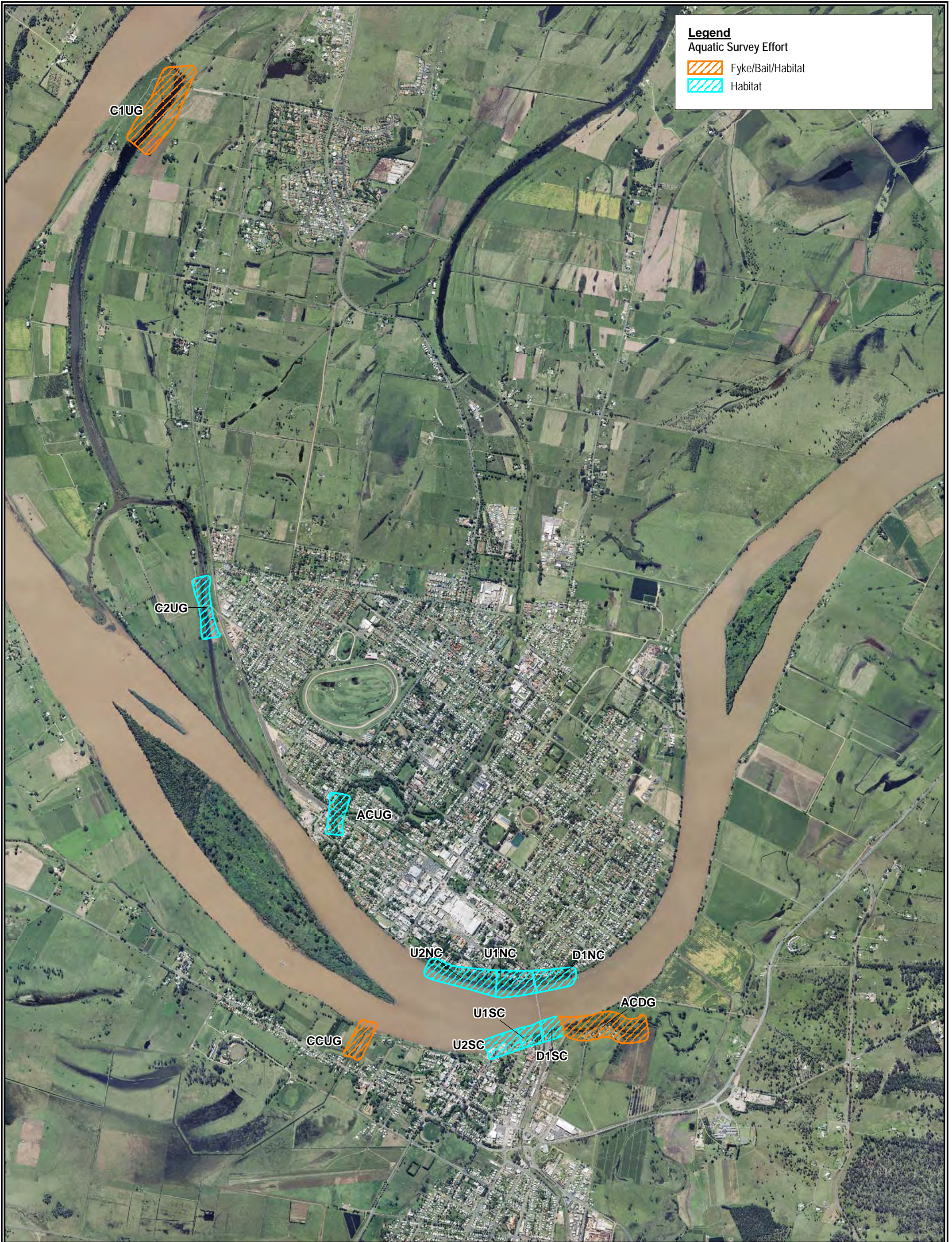
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Checked by: JC



Scale: 1:15,000 at A3
 Map Projection: Universal Transverse Mercator
 Horizontal Datum: Geodetic Datum of Australia 1994
 Map Grid: Map Grid of Australia Zone 56





Legend
 Aquatic Survey Effort

- Fyke/Bait/Habitat
- Habitat

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Figure 3: Aquatic survey locations.

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Scale: 1:25,000 at A3
 Map Projection: Universal Transverse Mercator
 Horizontal Datum: Geodetic Datum of Australia 1994
 Map Grid: Map Grid of Australia Zone 56



3.6 Ecological constraints assessment

The conservation significance of flora and fauna within the Grafton and South Grafton area was primarily assessed according to Commonwealth (EPBC Act) and NSW (TSC Act and FM Act) legislation and other relevant policies. In this report the term “threatened species” refers to species listed as migratory, vulnerable, endangered or critically endangered under the relevant legislation.

Areas of known and potential habitat for threatened flora and fauna species, populations and ecological communities were considered to be of conservation significance and therefore potential ecological constraints. The following factors were considered in identifying areas of potential ecological constraint:

- Areas of known habitats for threatened species (based on current and previous records).
- Areas that contained potential habitat for threatened species.
- The extent and nature of the resources present and the likelihood that threatened species would occur.
- The presence of endangered ecological communities and other plant communities of state or national significance.
- Areas that were considered to be part of a regional or local habitat or movement corridor.
- Areas declared as critical habitat.
- Riparian zone vegetation including emergent and submergent macrophyte beds.
- Areas of isolated or degraded native or exotic vegetation (although such areas are likely to pose less of an ecological constraint than areas described above).

3.7 Taxonomy

The plant taxonomy (method of classification) used in this report follows Harden (1990, 1992, 1993, 2002) and subsequent advice from the National Herbarium of NSW. In the body of this report, plant species are generally referred to by their common names (where available) and scientific names. All plant common names and scientific names have been included in threatened species tables and the complete flora list in Appendix 1.

The aquatic taxonomy (classification) used in this report follows the most recent *Waterplants in Australia* (Harden 1990; Harden 1992; Harden 1993; Harden 2002), *Freshwater Fishes of South-Eastern Australia* (McDowall 1996) and *Field Guide to the Freshwater Fishes of Australia* (Allen *et al.* 2002).

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by DSEWPaC (DEWHA 2009). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

3.8 Limitations

The study effort, combined with information available from other sources, is considered suitable for a preliminary assessment of the overall ecological values of the Grafton and South Grafton area. As a result, there is no significant limitation to the study. However, the following qualifications apply:

- Preliminary vegetation mapping of the Grafton and South Grafton area was undertaken based on desktop research, high resolution aerial photography interpretation, and preliminary field surveys. Comprehensive on-ground surveys would be required in order to accurately ground-truth the broad scale vegetation mapping prepared and presented herein.
- The field survey focused on the habitats of the Clarence River, associated drainages and nearby stands of vegetation and habitats. The field survey did not cover the entire Grafton and South Grafton area and therefore assessment of habitat and constraints outside of the areas surveyed in the field are based on desktop studies.
- Fine-scale vegetation mapping does not exist for the entire Grafton and South Grafton area and therefore the existence of significant communities and/or habitats outside the area surveyed in the field cannot be entirely ruled out.
- Some plant species that occur in the local area are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year and would not be detectable during July and August surveys.
- Some species do not appear or flower consistently each season or from one year to the next. Other plant species are perennial, but are inconspicuous unless flowering or in fruit and may not be detectable during July and August surveys.
- Some fauna species (including aquatic species) are only detectable or more readily detectable at certain times of the year. Therefore, given that seasonal surveys were not undertaken, it is possible that some species that are present on the site or that utilise the site seasonally were not detected.
- This assessment has relied on threatened species data provided by then DECCW and publicly available data from DSEWPaC. The limitations of the collection, processing, management, presentation and distribution of the data sourced from these parties are relevant to the current assessment.
- The NSW DPI *Fisheries Database* data and records are not comprehensive. The DPI *Fisheries Database* only contains information owned by Department of Industry and Investment NSW. Therefore the use of expected distributions of threatened species is a better measure of the potential occurrence of threatened species utilising the Grafton and South Grafton area.
- The water quality parameters measured provide a snapshot of conditions at a given point in time. Some of these parameters typically exhibit a high degree of temporal variation and can change substantially over small periods of time such as weeks, days and even hours, particularly in response to significant rainfall events. This is especially relevant to the Clarence River, given the inherent shifting nature in composition due to the proximity to the saline coastal waters, receiving brackish estuarine waters, and tidal influences.
- The shallow depth on the northern foreshore of the Clarence River and tidal effects precluded the use of fyke netting and bait trapping, however an additional site at Carrs Creek was established to supplement the species list.
- Backpack electrofishing was not conducted within the Grafton and South Grafton area due to excessive depth/conductivity/macrophyte growth. To effectively electrofish within the Grafton and South Grafton area, appropriate seasonal surveys using bank and boat electrofishing techniques would need to be undertaken.
- The Grafton and South Grafton area was largely defined by property boundaries and there was limited access to some areas. As a result survey effort was concentrated in accessible areas.

- The current aquatic surveys took place in August 2010 during winter when fish activity and movement is at its lowest. In order to complete a thorough investigation of the aquatic environs within the Grafton and South Grafton area in regards to aquatic fauna, surveys should be completed in spring.
- The present investigation included a targeted survey of aquatic fauna using fyke netting and luminescent bait traps only.
- Fyke netting of the northern and southern banks did not occur due to excessive depth, flow and tidal influences.
- The surveys conducted provide a snapshot of the aquatic fauna communities at the time and season of assessment. Other aquatic fauna species may have occurred at the site in the past and may again occur in the future. Failure to detect a species does not necessarily imply that the species is not present, but may imply low abundance of that species (provided appropriate survey techniques and survey effort was applied for detection of that species) and as such, additional species that we did not detect may occur within the Grafton and South Grafton area.
- Mapping is conducted using hand-held (uncorrected) GPS units and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally +/- 7 metres) and dependent on the limitations of aerial photo rectification and registration. As such, these points should not be relied on for design purposes.

Despite these limitations, the assessment of potential constraints is based on the presence or absence of suitable habitat for threatened flora and fauna, and as such, species are taken into account during the assessment even though they may not have been detected during the survey.

4.0 EXISTING ENVIRONMENT & CONSTRAINTS

Lists of the terrestrial and aquatic flora and fauna recorded during the ecological survey of the Grafton and South Grafton area are provided in Appendices 1, 2 and 3.

4.1 Topography and soils

The landscapes of NSW were mapped at a broad scale (1: 250,000) using land systems, geology, geomorphology and elevation data (DECCW 2003). The proposal area lies within the Clarence-Moreton Basin and has been identified to have two landscape types present:

Clarence - Richmond alluvial plains

Wide valleys, channels, floodplains, terraces and estuaries of the Clarence and Richmond Rivers and other coastal streams on Quaternary alluvium, which have a general elevation of 0m to 50m Australian Height Datum (AHD), with a local relief 15m. The alluvium in the Clarence River at Grafton is estimated to be about 40m thick (Department of Primary Industries 1970). These alluvial soils (structure loams) are characterised as being deep brown earths and structured brown clays on floodplains. These soils are fertile having a high organic content and are generally not considered to have high erosion potential.

Soils within the Grafton and South Grafton area have been substantially disturbed through sub-urban, agricultural and industrial land uses. Severe floods in the 1940s and 1950s prompted the development of an extensive levee and drainage network to mitigate the effects of major flooding events. The levee system was completed in the 1970s with levees present on both sides of the bank of the Clarence River and extending across the floodplains in South Grafton.

Less disturbed portions of the Grafton and South Grafton area where topsoils remain at least partially intact include isolated patches of native vegetation that is typical floodplain vegetation of the lower Clarence.

Grafton formation (cretaceous) - sandstone, siltstone, claystone and minor coal

The land surrounding Grafton (other than the floodplains, described above) is identified as 'Grafton formation (cretaceous) - sandstone, siltstone, claystone and minor coal' (Pogson 1973).

4.2 Flora

4.2.1 Vegetation mapping

The Upper North East Forest Ecosystems Mapping (NPWS 1998) classifies some patches of native vegetation on Susan Island only. The NPWS mapping is not of a sufficient scale to identify all small patches of native vegetation present in the Grafton and South Grafton area. Broad vegetation classification and mapping for the Grafton and South Grafton area was previously undertaken as part of an earlier ecological assessment in relation to Clarence River crossing options (Kendall & Kendall Ecological Consultants 2003).

The vegetation classification by Kendall and Kendall (2003) is in general concordance with the results of the current surveys (see below).

4.2.2 Current vegetation survey

Broad scale mapping of the vegetation throughout the Grafton and South Grafton area was undertaken based on desktop research, high resolution aerial photography interpretation, and preliminary field surveys. Comprehensive on-ground surveys would be required in order to accurately ground-truth the broad scale vegetation mapping prepared and presented herein. Figure 4 shows the areas of each broad vegetation type that occur within the the Grafton and South Grafton area. These broad vegetation types are described below.

With regard to the above, it must be noted that the majority of the Grafton and South Grafton area is represented by a highly modified landscape in poor condition with little or no native remnant vegetation remaining (Plate 3). The majority of the Grafton and South Grafton area has been subject to historic and ongoing urbanisation, grazing and cropping.

Degraded riparian forest

The forest vegetation adjoining Alipou Creek is highly degraded and dominated by exotic species (Plate 17). The creek and adjoining lands have been highly disturbed by previous flood mitigation activities and agricultural clearing. Observations of the 1954 aerial photograph of Grafton show the banks of Alipou Creek and the Clarence River almost completely cleared of trees, with a few scattered tree crowns visible. Few components of the original vegetation remain. The condition of this vegetation was assessed as being poor.

There were mature *Casuarina cunninghamiana* (river sheoak) and *C. glauca* (swamp sheoak) present in the canopy of the riparian forest adjoining Alipou Creek and the Clarence River to the east of the mouth of Alipou Creek. There was also sporadic occurrence of *Eucalyptus tereticornis* (forest red gum), with one stand recorded to the east of the mouth of Alipou Creek (sampled in Quadrat 1) and a few scattered individuals observed adjoining the tributary of Alipou Creek. Exotic trees frequently recorded include *Cinnamomum camphora* (camphor laurel), *Morus alba* (white mulberry), *Erythrina crista-galli* (cockspur coral tree) and *Salix* spp. (willows).

The midstorey of the riparian forest was dominated by exotic species including *Ligustrum sinense* (small-leaved privet), which formed dense thickets, shading out the understorey and suppressing growth of other plant species.

The ground layer in the riparian forest was generally either shaded out by dense cover of woody weed shrubs such as *Ligustrum sinense* and *Lantana camara* (lantana); dominated by exotic or cosmopolitan native pasture grasses such as *Cynodon dactylon* (couch); or by weedy herbs including *Ageratum houstonianum* (blue billy goat weed) and *Tradescantia fluminensis* (wandering jew).

Quadrat 1, which sampled the riparian forest to the east of the mouth of Alipou Creek, provides a representative species list for this vegetation type (Table 3).

Table 3: Species recorded in Quadrat 1

Scientific name	Common name	Cover abundance score
* <i>Ageratum houstonianum</i>	Blue billy goat weed	5
* <i>Araujia sericifera</i>	Moth vine	3
<i>Casuarina glauca</i>	Swamp oak	4
* <i>Cinnamomum camphora</i>	Camphor laurel	1
* <i>Conyza sp.</i>	Fleabane	3
* <i>Cryptostegia grandiflora</i>	Rubber vine	1

Scientific name	Common name	Cover abundance score
* <i>Cynodon dactylon</i>	Common couch	5
<i>Einadia trigonos</i>	Fishweed	1
<i>Eucalyptus tereticornis</i>	Forest red gum	4
* <i>Ipomoea cairica</i>		3
* <i>Lantana camara</i>	Lantana	4
* <i>Ligustrum sinense</i>	Small-leaved privet	4
* <i>Macfadyena unguis-cati</i>	Cat's claw creeper	1
<i>Microlaena stipoides</i>	Weeping grass	2
<i>Oxalis sp.</i>		1
* <i>Panicum maximum</i>	Guinea grass	4
* <i>Senecio madagascariensis</i>	Fireweed	3
* <i>Solanum mauritianum</i>	Wild tobacco bush	2
* <i>Tradescantia fluminensis</i>	Wandering jew	2
* <i>Verbena sp.</i>		1

Note: * indicates exotic species. See Table 1 for cover abundance scale.

Reedlands

The reedlands adjoining the Clarence River and a small section near the mouth of Alipou Creek consist mainly of stands of the native aquatic grass *Phragmites australis* (common reed), with *Typha orientalis* (broad-leaved cumbungi) and *Eleocharis sphacelata* (tall spikerush) also common (Plate 4). The reedlands adjoined mown grass on the river foreshore, with mowing generally extending to the water's edge, leaving a thin strip of mainly emergent aquatic plants. The exotic grass *Megathyrsus maximus* (guinea grass) was often interspersed with *Phragmites australis*.

The aquatic vegetation on the north bank of the Clarence River to the west of the existing bridge was the most diverse sampled during the current survey, with a range of native and exotic species recorded including *Bolboschoenus fluviatilis*, *Schoenoplectus mucronulatus*, *Schoenoplectus validus*, *Persicaria hydropiper* (water pepper) and *Nymphoides indica* (water snowflake).

On the south bank of the Clarence River the aquatic vegetation was mainly comprised of monostands of *Phragmites australis*. There was also a large patch of the exotic *Cyperus papyrus* (papyrus) to the west of the existing bridge.

Upstream of the floodgate in Alipou Creek, the surface of the creek was choked with *Eichhornia crassipes* (water hyacinth), with *Azolla sp.* also present.

Although the reedlands were generally small in size, fragmented and subject to exotic species incursion, these areas do loosely meet the criteria for freshwater wetlands on coastal floodplains, an endangered ecological community under the TSC Act. The Office of Environment and Heritage (OEH) identification guidelines for freshwater wetlands on coastal floodplains (DECC 2008) list a number of degraded variants of the endangered ecological community including "large monocultures of reed species such as common reed and/or cumbungi" and "water bodies invaded with floating weeds such as water hyacinth (*Eichhornia crassipes*)".

Native and Exotic Plantings

To the north and south of the Clarence River, the proposal area is characterised by residential and commercial development with vegetation limited to street trees and cultivated gardens and verges. The street trees consisted mainly of exotic and non-

local native species, including *Jacaranda mimosifolia* (jacaranda), *Cinnamomum camphora*, *Melaleuca leucodendron* (weeping paperbark), *Mangifera indica* (mango) and *Archontophoenix alexandrae* (alexandra palm) (Plate 5).

Cultivated gardens in the Grafton and South Grafton area were generally not surveyed due to access constraints. The road verges and parklands supported scattered planted native and exotic trees with an understorey of mown grass, usually widespread exotic species such as *Pennisetum clandestinum* (kikuyu), *Axonopus fissifolius* (narrow-leafed carpet grass) or the cosmopolitan native *Cynodon dactylon*.

Native Revegetation

Induna Reserve, west of the existing bridge on the south bank of the Clarence River, supported a canopy of even-aged trees including *Eucalyptus saligna* (blue gum) and a range of typical coastal floodplain and rainforest species including *Casuarina cunninghamiana*, *Brachychiton acerifolia* (illawarra flame tree), *Elaeocarpus obovatus* (hard quandong), *Melaleuca quinquenervia* (broad-leaved paperbark) and *Syzygium australe* (brush cherry). The ground layer was sparse and dominated by leaf litter, with scattered occurrence weed species such as *Bidens pilosa* (cobblers pegs), *Cardiospermum grandiflorum* and *Asparagus aethiopicus*.

Agricultural paddocks and plantations

The majority of the land in the south-east of the proposal area is either industrial or agricultural in land use. There are some large grazing paddocks dominated by *Cynodon dactylon* (couch), *Pennisetum clandestinum* (kikuyu) and *Trifolium repens* (white clover). A drainage soak traverses the centre of one of the paddocks, occasionally fringed with *Juncus usitatus* and *Eleocharis acuta*.

A few large remnant trees of *Eucalyptus tereticornis* are scattered around the paddocks in the south and east of the proposal area (Plate 2). These trees were up to 2m in diameter and are likely to be the only remaining component of the floodplain forest that would formerly have occupied the area.

A number of large plantations of *Melaleuca alternifolia* (tea tree) occur in the south of the proposal area. The tea trees were planted in rows and were approximately 1m in height at the time of survey. There were a few weeds such as *Senecio madagascariensis*, *Cyperus eragrostis* and *Coryza* sp. interspersed with the tea trees.

Areas adjoining the plantation support pasture dominated by *Cynodon dactylon*. A large drain traverses the centre of the tea tree plantation, fringed with *Juncus usitatus* and *Eleocharis acuta*.

4.2.3 Endangered Ecological Communities

Three endangered ecological communities listed on the *Threatened Species and Conservation Act 1995* (TSC Act) are known to occur within the Grafton and South Grafton area, namely freshwater wetlands on coastal floodplains, lowland rainforest on floodplains and sub-tropical coastal floodplain forest.

Freshwater wetlands on coastal floodplains (TSC Act)

The reedlands adjoining the Clarence River and more patchily along Alipou Creek consist mainly of stands dominated by *Phragmites australis*, with other native aquatic macrophytes including *Schoenoplectus mucronulatus* and *Typha orientalis* also present. The fringing reedland in the Grafton and South Grafton area along the Clarence River is broadly consistent with the

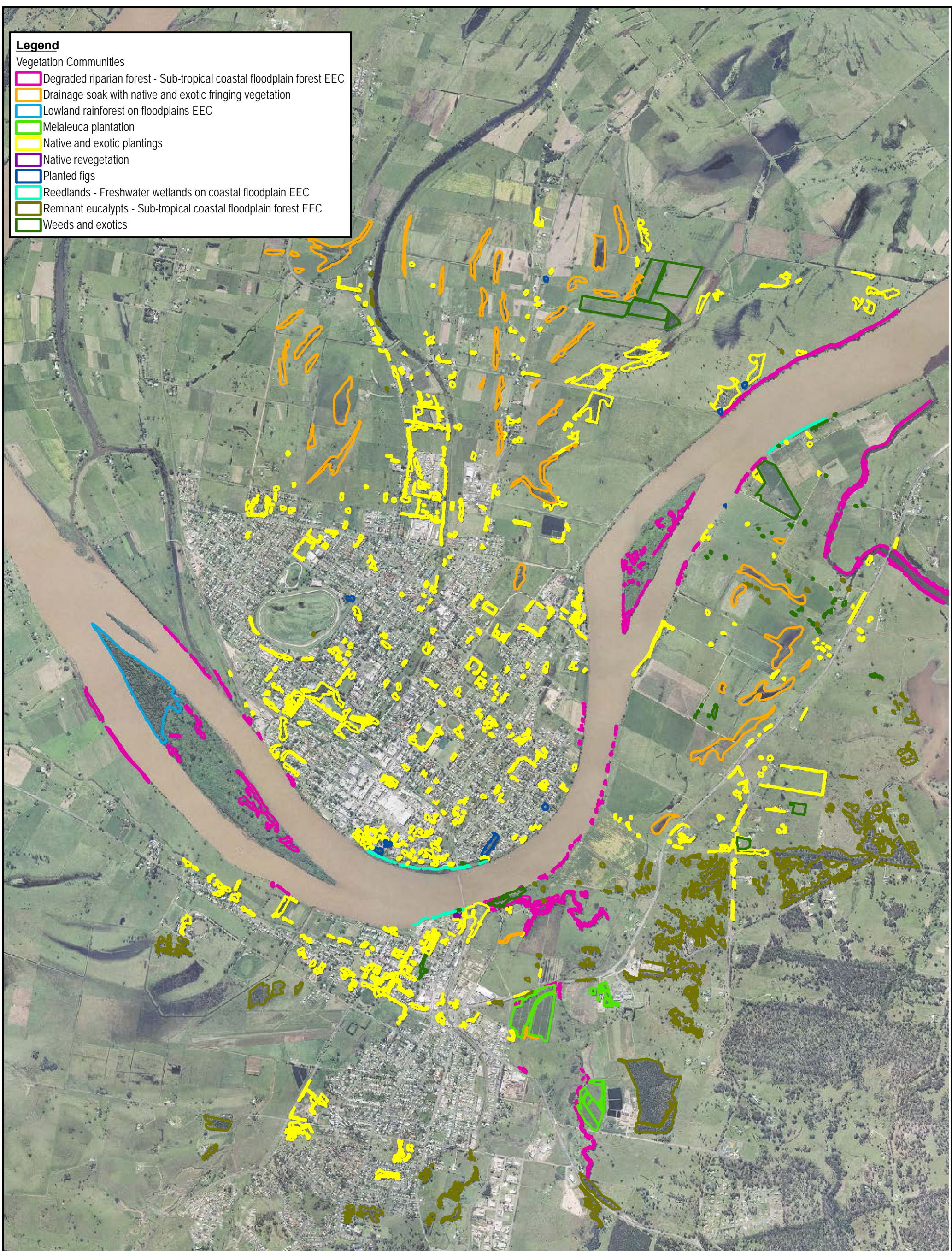
endangered ecological community, freshwater wetlands on coastal floodplains. Ground-truthing surveys would be required to determine whether this endangered ecological community also occurs along other areas of the Clarence River banks.

Lowland rainforest on floodplains (TSC Act)

According to previous studies the western end of Susan Island Nature Reserve includes a stand of the endangered ecological community, lowland rainforest on floodplains (NSW RTA 2004; DECCW 2009). Ground-truthing surveys would be required to determine whether other vegetation in the proposal area (other than Susan Island) is consistent with this endangered ecological community.

Sub-tropical coastal floodplain forest (TSC Act)

All remaining native vegetation on coastal floodplains in NSW falls under the definition of one or more endangered ecological communities under the TSC Act. The Grafton and South Grafton area is within the modified floodplain of the Clarence River, therefore all native vegetation within this area is part of an endangered ecological community. There are some patches of remnant and regrowth native trees characteristic of this community present within the Grafton and South Grafton area, including *Eucalyptus tereticornis* and *Casuarina cunninghamiana*. These patches are predominantly located on the floodplains adjoining and to the south of Alipou Creek. The stands of native trees adjoining Alipou Creek are interspersed with exotic species including *Cinnamomum camphora* and *Ligustrum sinense* and the understorey of these areas is densely covered with predominantly exotic species. These areas are considered too degraded to meet the criteria for the endangered ecological community. There are also some large remnant *Eucalyptus tereticornis* present as isolated trees in the paddocks to the south of Alipou Creek. These trees are remnant components of the sub-tropical coastal floodplain forest that would formerly have dominated the Grafton and South Grafton area. Ground-truthing surveys would be required to determine whether other vegetation in the proposal area is consistent with this endangered ecological community.



- Legend**
- Vegetation Communities
- Degraded riparian forest - Sub-tropical coastal floodplain forest EEC
 - Drainage soak with native and exotic fringing vegetation
 - Lowland rainforest on floodplains EEC
 - Melaleuca plantation
 - Native and exotic plantings
 - Native revegetation
 - Planted figs
 - Reedlands - Freshwater wetlands on coastal floodplain EEC
 - Remnant eucalypts - Sub-tropical coastal floodplain forest EEC
 - Weeds and exotics

Figure 4: Preliminary vegetation map of Grafton and south Grafton proposal area

Date: 18 July 2011	Drawn by: JMS
File number: 13508	Checked by: JC
Location: P:\13500s\13508\Mapping\13508_F4_Veg.mxd	

0 245 490 980 1,470

Metres

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



Figure 4


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 18-20 Mandible Street
 Alexandria
 NEW SOUTH WALES
 2015

4.2.4 Plant species

A total of 136 vascular plant species were recorded from the sites surveyed, as shown in Figure 2, comprising 61 (45 per cent) locally indigenous species and 75 (55 per cent) exotic species. A list of plant species recorded is provided in Appendix 1.

Ten of the exotic species recorded are listed as noxious weeds in the Clarence Valley local government area (Table 4).

Table 4: Noxious Weeds recorded in the Grafton and South Grafton area

Weed species	Common Name	Noxious Weed Class
<i>Ageratina adenophora</i>	Crofton weed	4
<i>Cestrum parqui</i>	Green cestrum	3
<i>Cinnamomum camphora</i>	Camphor laurel	4
<i>Cryptostegia grandiflora</i>	Rubbervine	1
<i>Eichhornia crassipes</i>	Water hyacinth	4
<i>Lantana camara</i>	Lantana	4
<i>Ligustrum lucidum</i>	Broad-leaved privet	4
<i>Ligustrum sinense</i>	Small-leaved privet	4
<i>Opuntia stricta</i>	Prickly pear	4
<i>Salix</i> sp.	Willow	5

The legal requirements of these noxious weed classes include:

- Class 1 - The plant must be eradicated from the land and the land must be kept free of the plant.
- Class 3 - The plant must be fully and continuously suppressed and destroyed.
- Class 4 - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
- Class 5 - The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

4.2.5 Significant flora

No threatened flora species were recorded during the current surveys. Eight threatened plant species and the habitat of a further seven threatened plants have been recorded within 10km of the Grafton and South Grafton area (DECCW *Atlas of NSW Wildlife* and DSEWPaC *Protected Matters Search Tool*). A further 63 threatened plant species are known or predicted to occur within the Clarence Lowlands catchment management authority sub-region. The complete list of species along with a description of potential habitats is provided in Appendix 4.

Based on preliminary investigations and subsequent field survey, 10 threatened plants are considered to have potential habitat within the Grafton and South Grafton area (refer Table 5). It should be noted that while potential habitat may be present in the proposal area, existing habitats are considered highly marginal due to the long history of disturbance and relatively poor condition of remaining native vegetation.

Table 5: Threatened flora with potential habitat in the Grafton and South Grafton area

Key: 1) Listed on the EPBC Act as Endangered (E) or Vulnerable (V)
2) Listed on the TSC Act as Endangered (E1) or Vulnerable (V)

Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Potential habitat in proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Arthraxon hispidus</i> Hairy-joint grass	V	V	Yes Marginal potential habitat only	Possibly on low-lying areas on paddocks draining to Alipou Creek.	Moderate	Targeted surveys for this species would be required and must be completed between January and May.
<i>Dendrobium melaleucaphilum</i> Spider orchid	-	E1	Yes Marginal potential habitat only	This species is epiphytic on <i>Melaleuca styphelioides</i> , recorded in Induna Reserve – however unlikely to support this species.	Very Low	Targeted search for this species on habitat trees would be required if potential habitat to be impacted. The survey should be completed during the flowering season July to October.
<i>Eleocharis tetraquetra</i> Square-stemmed spike-rush	-	E1	Yes Marginal potential habitat only	Possibly on low-lying areas on paddocks draining to Alipou Creek.	Moderate	Targeted surveys for this species would be required and must be completed between November and March. It would be most efficient to complete these surveys concurrently with those for Hairy-joint Grass.
<i>Eucalyptus tetrapleura</i> Square-fruited ironbark	V	V	Yes Marginal potential habitat only	It is possible that this species persists as a remnant or regrowth tree however it was not recorded during the survey.	Very Low	Any 'ironbark' trees located within potential impact areas should be identified to species level to ascertain whether they are Square-fruited ironbark. The buds and fruit of this species are distinct and surveys could be completed at any time of year.
<i>Hydrocharis dubia</i> Frogbit	V	-	Yes Marginal potential habitat only	Possibly in some sections of fringing reedlands.	Very Low	Ensure preferred option has adequate setbacks from bank of Clarence River. Implement controls during construction to minimise impacts on reedland habitats. If reedlands are to be impacted upon, targeted surveys for this species should be conducted during the flowering season September to February.

Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Potential habitat in proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Myrsine richmondensis</i> Ripple-leaf muttonwood	-	E1	Yes Marginal potential habitat only	May occur in degraded riparian forest along Alipou Creek and/or remnant rainforest patches.	Very Low	A targeted survey for this species throughout potential habitat would be required if potential habitat is to be impacted. The survey should be completed during the flowering season September to February.
<i>Ochrosia moorei</i> Southern ochrosia	E	E1	Yes Marginal potential habitat only	May occur in degraded riparian forest along Alipou Creek and/or remnant rainforest patches.	Low	A targeted survey for this species throughout potential habitat would be required if potential habitat is to be impacted. The survey should be completed during the flowering season December to February.
<i>Parsonsia dorrigoensis</i> Milky silkpod	E	V	Yes Marginal potential habitat only	May occur in degraded riparian forest along Alipou Creek and/or remnant rainforest patches.	Very Low	A targeted survey for this species throughout potential habitat would be required if potential habitat is to be impacted. The survey should be completed during the flowering season December to February.
<i>Persicaria elatior</i> Tall knotweed	V	V	Yes Marginal potential habitat only	Possibly in some sections of fringing reedlands.	Low-Moderate	Ensure preferred option has adequate setbacks from bank of Clarence River. Implement controls during construction to minimise impacts on reedland habitats. If reedlands are to be impacted upon, targeted surveys for this species should be conducted during the flowering season December to April.

Main Road 83 Summerland Way - Additional Crossing of the Clarence River at Grafton
Preliminary Route Options Report: Technical Paper - Ecology

Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Potential habitat in proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Rotala tripartita</i>	-	E1	Yes Marginal potential habitat only	Possibly in some sections of fringing reedlands.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River. Implement controls during construction to minimise impacts on reedland habitats. If reedlands are to be impacted upon, targeted surveys for this species should be conducted two to four months after substantial rainfall as the species only persists as soil seed-bank during dry times.

4.3 Fauna

4.3.1 Fauna habitat

Fauna habitats within the Grafton and South Grafton area broadly correspond to the vegetation types and conditions described in Section 4.2.2.

Suitability, size and configuration of vertebrate fauna habitats broadly correlate to the structure, connectivity and quality of local and regional vegetation types. The Grafton and South Grafton area contained a range of microhabitat features including tree hollows, leaf litter, understorey shrubs, fallen logs and debris, surface water and riparian vegetation.

Each of the major fauna habitats that are present within the Grafton and South Grafton area are described below. The fauna species recorded from within the proposal area are discussed in the following section.

Residential areas

Grafton and South Grafton townships are urban environments with a mixture of residential housing, shops and roads. The main tree plantings throughout the towns are of introduced *Jacaranda mimosifolia*, *Cinnamomum camphora* and *Ficus* spp.. These planted street trees provide feeding resources for a range of bird and mammal species including the black flying-fox (*Pteropus alecto*) and grey-headed flying-fox (*Pteropus poliocephalus*) (colonies of these species roost on Susan Island). The large established street trees also provide roosting and sheltering habitat for several fauna species. A few *J. mimosifolia* trees were also observed to be hollow-bearing (Plate 7), providing habitat for hollow-dependent fauna such as the common brushtail possum (*Trichosurus vulpecula*). Some planted eucalypt species occur along the Clarence River foreshore which lorikeets and honeyeaters were observed to forage in. The remains of fairy martin (*Hirundo ariel*) nests were observed beneath the raised railway duct running through Grafton.

The central townships of Grafton and South Grafton are highly modified urban environments, providing foraging and breeding habitat predominantly in the form of introduced tree species (*C. camphora* and *J. mimosifolia* are listed as weeds) and man-made structures.

Riparian and fringing vegetation

Along the Clarence River there are varying densities of fringing vegetation with *Typha* sp. and *Phragmites australis* lining the banks (Plate 4). This vegetation type provides habitat for several species including the Australian reed-warbler (*Acrocephalus stentoreus*), dusky moorhen (*Gallinula tenebrosa*) and nankeen night heron (*Nycticorax caledonicus*). Threatened microbats will forage for insects and frogs over the open water of the Clarence River and Alipou Creek (e.g. eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), greater broad-nosed bat (*Scoteanax rueppellii*) and southern myotis (*Myotis macropus*). The Australian wood duck (*Chenonetta jubata*) was commonly found foraging along the grassy foreshore and within the fringing *P.australis* vegetation.

South-eastern Clarence River bank

Most of the dense vegetation along the southern bank is a mixture of the introduced small-leaved privet, camphor laurel, wild lemons and rubber vine. High incidences of bandicoot diggings were observed throughout the privet thickets and along the south-eastern bank of the Clarence River. Remnant stumps and stags were also found to be scattered along the bank of the Clarence River which contained hollows, splits, fissures or cracks of various sizes that provided suitable shelter and breeding

habitat for a range of hollow-dependent mammals, birds and reptiles (Plate 1). These microhabitat features would provide habitat for threatened hollow-dependent microbats (e.g. greater broad-nosed bat). Dilapidated man-made structures present amongst the small-leaved privet also provide sheltering and roosting habitat for threatened microbats (e.g. eastern bentwing-bat). Self propagated wild lemons were present along the Clarence River south-east bank. These fruit trees provide food for several mammal species including the black flying-fox and grey-headed flying-fox.

Soaks and ephemeral flooded pastures

Unnamed minor drainage lines and ephemeral flooding areas form soaks (Plate 6) within some grassy pastureland and treeless areas to the south-east of the proposal area. These form ephemeral habitats for many bird species including the intermediate egret, cattle egret and perhaps infrequently the glossy ibis and black-necked stork. Within these flood prone drainage areas common frog species such as spotted grass frog (*Lymnodynastes tasmaniensis*) may be found.

Grassland with remnant red gums

The grassland habitat consisted of areas mostly devoid of canopy cover and was predominantly featured in the south-eastern section of the proposal area (Plate 3). These areas support foraging and browsing habitat for large native mammals including the eastern grey kangaroo (*Macropus giganteus*) and common wombat (*Vombatus ursinus*). This habitat was also found to support introduced species including the european rabbit (*Oryctolagus cuniculus*) and red fox (*Vulpes vulpes*). Several large remnant forest red gums (*Eucalyptus tereticornis*) were scattered within the grassy paddocks (Plate 2) or within the tea tree plantation. These large, old eucalypts contain many hollows of variable sizes which provide habitat for a range of fauna such as the brushtail possum, galah (*Cacatua roseicapilla*), red-rumped parrot (*Psephotus haematonotus*) and little bentwing-bat (*Miniopterus australis*). Larger tree-hollows, required by threatened species such as the masked owl (*Tyto novaehollandiae*), were also present.

This habitat was highly disturbed from many decades of farming practices and cultivation but provides important roosting, nesting and sheltering habitat in the form of hollow-bearing trees for many fauna species.

4.3.2 SEPP 44 Koala Habitat

No core koala habitat was present within the Grafton and South Grafton area. *Eucalyptus tereticornis*, a listed preferred feed tree of the koala under SEPP 44 was present within the proposal area, however only as scattered trees within open paddocks. Due to the low number of trees and their isolation from other stands of eucalypts they are not considered to be suitable habitat to support breeding or foraging activities of a population of koalas.

4.3.3 Fauna species

A list of fauna recorded within the Grafton and South Grafton area is provided in Appendix 2 and includes 64 species of bird (including four introduced species), 14 mammals (including one introduced species), four reptiles (e.g. Plate 8 and Plate 9) and one frog species.

The fauna surveys generally focused on habitats with a greater potential to contain native species, e.g. remnant native vegetation and waterbodies (Clarence River, Alipou Creek and unnamed tributaries, wetlands, farm dams). Less effort was expended on highly modified areas such as cropped pastures, suburban streets and residential housing.

Four microchiropteran bats listed on the NSW *Threatened Species Conservation Act 1995* (TSC Act) were recorded foraging primarily along the water ways of the proposal area, with a fifth species recorded with probable certainty. A sixth threatened species, the masked owl, was potentially recorded from a regurgitated pellet. Additionally five species listed as migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded within the proposal area. These species were the Australian reed-warbler (*Acrocephalus stenoreus*), white-bellied sea-eagle (*Haliaeetus leucoga*), cattle egret (*Ardea ibis*), common tern (*Sterna hirundo*) and rainbow bee-eater (*Merops ornatus*).

Threatened and migratory fauna recorded during the August 2010 and July 2011 surveys are shown on Figure 5.

4.3.4 Significant fauna

Sixty-two threatened and/or migratory fauna species and the habitat of a further 13 threatened and/or migratory fauna have been recorded within 10km of the Grafton and South Grafton area (DECCW *Atlas of NSW Wildlife*; Birds Australia *Atlas of Australian Birds*; and, DSEWPaC *Protected Matters Search Tool*). In addition, individuals of the endangered emu (*Dromaius novaehollandiae*) population in the New South Wales North Coast Bioregion and Port Stephens local government area have been recorded within 10km of the Grafton and South Grafton area. A further 47 threatened fauna species are known or predicted to occur within the Clarence Lowlands catchment management authority sub-region. The complete list of species along with a description of potential habitats is provided in Appendix 5.

Based on preliminary investigations and subsequent field survey, 63 threatened and/or migratory fauna species are considered to have potential habitat within the Grafton and South Grafton area (refer Table 6). It should be noted that while potential habitat may be present in the proposal area, many existing habitats are considered only marginal due to the long history of disturbance and relatively poor condition of remaining native vegetation.

Table 6: Threatened or migratory fauna with potential habitat in the Grafton and South Grafton area

Key: 1) Listed on the EPBC Act as Endangered (E), Critically Endangered (Z), Vulnerable (V) or covered under migratory provisions (M) of the Act
2) Listed on the TSC Act as Endangered (E1), Critically Endangered (C1) or Vulnerable (V)

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Acrocephalus australis</i> Australian reed-warbler	M	-	Yes	Recorded during current survey. Potential habitat exists along the Clarence River, within riparian vegetation and habitat along Alipou Creek, and wetlands. An additional crossing of the Clarence River has the potential to impact riparian vegetation.	High (recorded during Aug 2010 survey)	Ensure preferred option has adequate setbacks from bank of Clarence River and avoids impacts to the riparian vegetation along Alipou Creek. Implement controls during construction to minimise impacts on reedland habitats. Sedentary in the north; migratory in the south, moving south to breed. Best detected between August and April.
<i>Amaurornis olivaceus</i> Bush-hen	-	V	Yes	May forage within flooded grasslands and rainforest fringes.	Low	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Avoid impacts to rainforest patches. Detectable all year.
<i>Anseranas semipalmata</i> Magpie goose	-	V	Yes	May forage within shallow ephemeral flooded paddocks in the south-east of the proposal area.	High (previously recorded within proposal area)	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Detectable all year.
<i>Apus pacificus</i> Fork-tailed swift	M	-	Yes	None, aerial forager.	Moderate-High (previously recorded above proposal area)	Summer migrant to Australia. Best detected between October and April.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Ardea alba</i> Great egret	M	-	Yes	May forage within shallow ephemeral flooded paddocks in the south-east of the proposal area.	Moderate-High	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Undertakes some regular seasonal movements, mostly to and from breeding colonies. Detectable all year.
<i>Ardea ibis</i> Cattle egret	M	-	Yes	This species was observed foraging in paddocks in the south-east of the proposal area. However, foraging habitat is not considered limiting so this species' presence is considered a low constraint.	High (recorded during Aug 2010 and July 2011 surveys)	Detectable all year (although may be in lower numbers during winter).
<i>Botaurus poiciloptilus</i> Australasian bittern	-	V	Yes	Marginal potential habitat exists along the Clarence River, within riparian vegetation and habitat along Alipou Creek. An additional crossing of the Clarence River has the potential to impact riparian vegetation.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River and avoids impacts to the riparian vegetation along Alipou Creek. Implement controls during construction to minimise impacts on reedland habitats. Potentially detectable all year but semi-nomadic.
<i>Burhinus grallarius</i> Bush stone-curlew	-	E1	Yes	May forage within lightly timbered farmlands with remnants of woodland.	Moderate (previously recorded within proposal area)	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Detectable all year (requires nocturnal survey).
<i>Calyptorhynchus lathami</i> Glossy black-cockatoo	-	V	Yes	The highest value habitats within the proposal area include any Allocasuarina trees (foraging resource) and hollow-bearing trees (nesting resource).	Low-Moderate	Retain Allocasuarina trees and hollow-bearing trees (alive or dead). Detectable all year.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Chalinolobus dwyeri</i> Large-eared pied bat	V	V	Yes	The highest value habitats within the proposal area include the riparian vegetation along Alipou Creek and fringes of rainforest patches.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek and rainforest patches. Best detected mid spring to mid autumn (requires nocturnal surveys).
<i>Chalinolobus nigrogriseus</i> Hoary wattled bat	-	V	Yes	The highest value habitat within the proposal area includes the riparian vegetation along Alipou Creek.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek. Best detected during warm months October to March (requires nocturnal surveys). Not active in winter or wet/windy/cold weather.
<i>Climacteris picumnus victoriae</i> Brown Treecreeper (eastern subspecies)	-	V	Yes	May forage within lightly timbered farmlands with remnants of woodland and nest in tree hollows.	Low-Moderate (more likely in southern part of proposal area)	Hollow-bearing trees alive and dead should be retained where possible. Ensure preferred option minimises habitat fragmentation. Detectable all year.
<i>Circus assimilis</i> Spotted harrier	-	V	Yes	Nest trees.	Moderate	Avoid impact to nest trees. Detectable all year.
<i>Coeranoscincus reticulatus</i> Three-toed snake-tooth skink	V	V	Yes	May occur within rainforest patches.	Low (hasn't been recorded within proposal area since 1992)	Avoid impact to rainforest patches. Any disturbance to rainforest will likely require targeted searches for this species. Best detected mid spring to mid autumn.
<i>Coracina lineate</i> Barred cuckoo-shrike	-	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Detectable all year.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Cuculus saturatus</i> Oriental cuckoo	M	-	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Best detected September to May.
<i>Daphoenositta chrysoptera</i> Varied sittella	-	V	Yes	No stringy-barks were observed within the proposal area. Species likely to be of low constraint.	Low	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Best detected July to April.
<i>Dasyurus maculatus maculatus</i> Spotted-tailed quoll (south-eastern mainland)	E	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek, and tree hollows.	Moderate	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Hollow-bearing trees alive and dead, and hollow logs, should be retained where possible. Detectable all year.
<i>Ephippiorhynchus asiaticus</i> Black-necked stork	-	E1	Yes	May forage within shallow ephemeral flooded paddocks in the proposal area.	High (previously recorded within proposal area)	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Detectable all year.
<i>Erythrotriorchis radiatus</i> Red goshawk	V	C1	Yes	Nest trees.	Low	Avoid impact to nest trees. Detectable all year.
<i>Falsistrellus tasmaniensis</i> Eastern false pipistrelle	-	V	Yes	The highest value habitat within the proposal area includes the riparian vegetation along Alipou Creek.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek. Best detected mid-spring to mid-autumn.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Gallinago hardwickii</i> Latham's snipe	M	-	Yes	May forage within shallow ephemeral flooded paddocks in the proposal area.	Low	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Best detected between August and January on migration from northern Australia. Arrive in Japan in April and in Russia in April/May.
<i>Glossopsitta pusilla</i> Little lorikeet	-	V	Yes	Several remnant <i>Eucalyptus tereticornis</i> paddock trees provide potential nesting hollows for this species. Sub-optimal foraging habitat exists in the form of scattered eucalypts within the proposal area.	Moderate	Hollow-bearing trees alive and dead should be retained where possible. Detectable all year.
<i>Grus rubicunda</i> Brolga	-	V	Yes	May forage within shallow ephemeral flooded or dry paddocks in the proposal area.	Low	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Implement controls during construction to minimise impacts on reedland habitats. Detectable all year.
<i>Haematopus longirostris</i> Pied oystercatcher	-	E1	Yes	Potential habitat exists along the Clarence River and within paddocks.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River. Detectable all year.
<i>Haliaeetus leucogaster</i> White-bellied sea-eagle	M		Yes	This species was observed foraging along the Clarence River. Nest trees may occur along the Clarence River.	High (recorded during Aug 2010 and July 2011 surveys)	Avoid impact to nest trees. Detectable all year.
<i>Hieraaetus morphnoides</i> Little eagle	-	V	Yes	Nest trees.	Moderate	Avoid impact to nest trees. Detectable all year.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Hirundapus caudacutus</i> White-throated needletail	M		Yes	None, aerial forager.	High (previously recorded above proposal area)	None. Usually arrive over the Torres Strait during September and October and migrate to southern parts of its range (Victoria and Tasmania) from November to February.
<i>Irediparra gallinacea</i> Comb-crested jacana	-	V	Yes	May forage within wetlands/flooded paddocks where floating aquatic vegetation occurs.	Low	Avoid wetlands with floating aquatic vegetation. Detectable all year.
<i>Ixobrychus flavicollis</i> Black bittern	-	V	Yes	Marginal potential habitat exists along the Clarence River, within riparian vegetation and habitat along Alipou Creek. An additional crossing of the Clarence River has the potential to impact riparian vegetation.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River and avoids impacts to the riparian vegetation along Alipou Creek. Implement controls during construction to minimise impacts on reedland habitats. Any loss of emergent vegetation should be reinstated following construction. Species is nomadic and potentially detectable all year.
<i>Lophoictinia isura</i> Square-tailed kite	-	V	Yes	Nest trees.	Moderate-High (previously recorded within proposal area)	Avoid impact to nest trees. Detectable all year.
<i>Merops ornatus</i> Rainbow bee-eater	M	-	Yes	This species was recorded along the bank of the Clarence River. An additional crossing of the Clarence River has the potential to the banks of the Clarence River.	High (recorded during Aug 2010 survey)	Ensure preferred option has adequate setbacks from bank of Clarence River and avoids impacts to the bank of Alipou Creek. May be detected year round in both breeding and non-breeding seasons, however most likely to be best detected in breeding season from August to early November.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Miniopterus australis</i> Little bentwing-bat	-	V	Yes	This species was recorded along Alipou Creek and beneath the Grafton Bridge. The highest value habitat within the proposal area includes potential roost sites (e.g. bridges, culverts and tree hollows), rainforest patches and the riparian vegetation along Alipou Creek.	High (recorded during Aug 2010 survey)	Avoid impact to roost sites. Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Best detected mid-spring to mid-autumn.
<i>Miniopterus schreibersii oceanensis</i> Eastern bentwing-bat	-	V	Yes	This species was recorded along Alipou Creek and beneath the Grafton Bridge. The highest value habitat within the proposal area includes potential roost sites (e.g. bridges, culverts), rainforest patches and the riparian vegetation along Alipou Creek.	High (recorded during Aug 2010 survey)	Avoid impact to roost sites. Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Best detected mid-spring to mid-autumn.
<i>Monarcha leucotis</i> White-eared monarch	-	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Detectable all year.
<i>Monarcha melanopsis</i> Black-faced monarch	M	-	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek. Species likely to be of low constraint.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Summer breeding migrant to coastal south-eastern Australia. Best detected between September and March.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Monarcha trivirgatus</i> Spectacled monarch	M	-	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek. Species likely to be of low constraint.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Resident in Queensland to Rockhampton, summer breeding migrant further south. Best detected between September and March.
<i>Mormopterus beccarii</i> Beccari's freetail bat	-	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek, and tree hollows. Species may also forage over grasslands.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Hollow-bearing trees alive and dead should be retained where possible. Detectable all year.
<i>Mormopterus norfolkensis</i> Eastern freetail-bat	-	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek, and tree hollows.	High (recorded during Aug 2010 survey)	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Hollow-bearing trees alive and dead should be retained where possible. Detectable all year.
<i>Myiagra cyanoleuca</i> Satin flycatcher	M		Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek. Species likely to be of low constraint.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Migrates northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring. Best detected March to May.

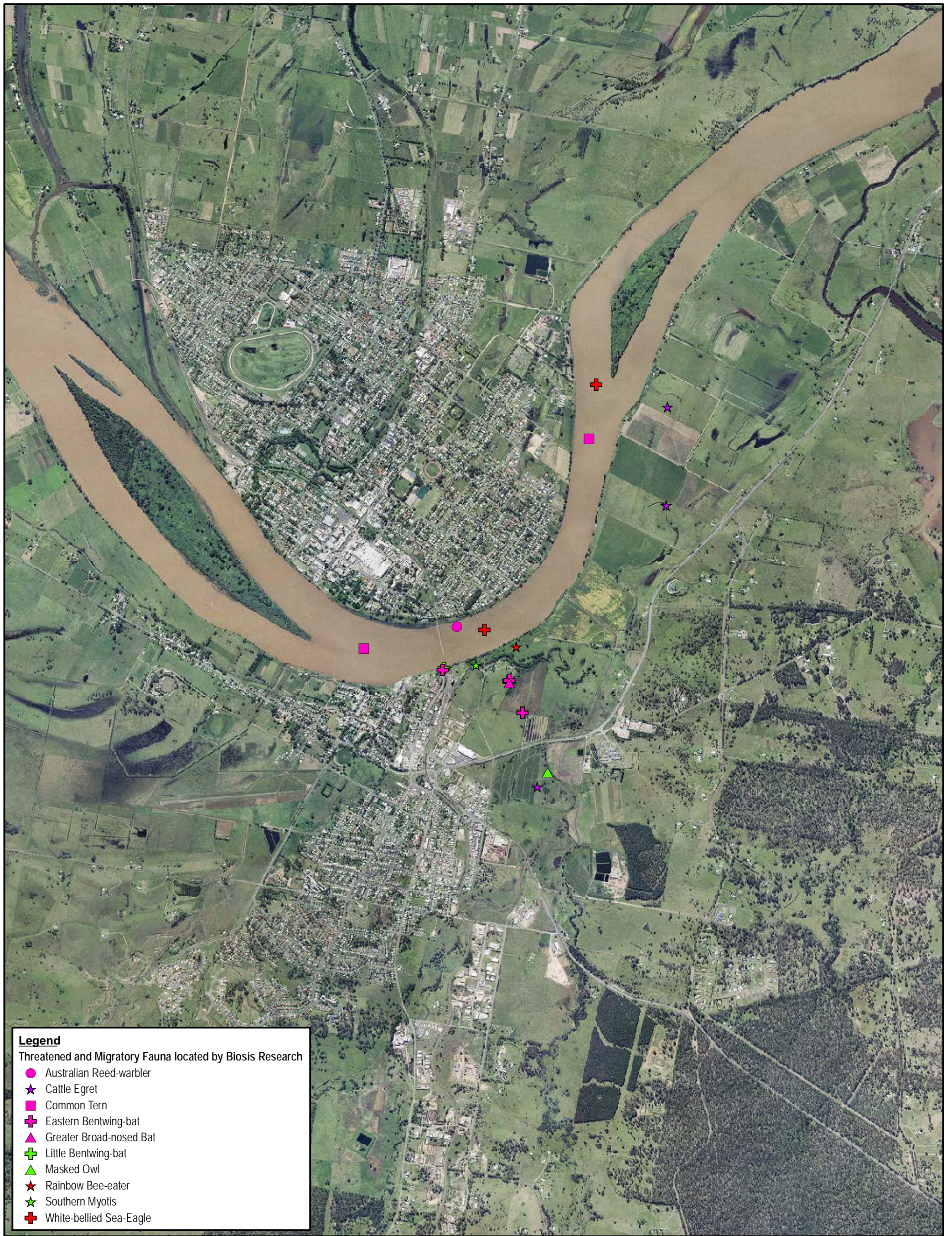
Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Myotis macropus</i> Southern myotis	-	V	Yes	This species was recorded along Alipou Creek. The highest value habitat within the proposal area includes potential roost sites (e.g. bridges, culverts), rainforest patches and the riparian vegetation along Alipou Creek.	High (recorded during Aug 2010 survey)	Avoid impact to roost sites. Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Detectable all year.
<i>Nyctophilus bifax</i> Eastern long-eared bat	V	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek, and tree hollows.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Hollow-bearing trees alive and dead should be retained where possible. Detectable all year.
<i>Oxyura australis</i> Blue-billed duck	-	V	Yes	Potential habitat exists along the Clarence River. An additional crossing of the Clarence River has the potential to impact riparian vegetation.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River and avoids impacts to the riparian vegetation along Alipou Creek. Implement controls during construction to minimise impacts on reedland habitats. Detectable all year.
<i>Pandion haliaetus</i> Osprey	M	V	Yes	Recorded nesting on Susan Island. May forage along the Clarence River.	High	Avoid impact to nest trees. Detectable all year.
<i>Petroica boodang</i> Scarlet robin	-	V	Yes	Species likely to be of low constraint.	Low	Detectable all year.
<i>Petroica phoenicea</i> Flame robin	-	V	Yes	Species likely to be of low constraint.	Low	Detectable all year.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Plegadis falcinellus</i> Glossy ibis	M		Yes	May forage within shallow ephemeral flooded paddocks.	Moderate	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Both migratory and nomadic. Main breeding areas in the Murray-Darling Basin of New South Wales and Victoria, the Macquarie Marshes in New South Wales, and in southern Queensland. Best detected in spring and summer.
<i>Pomatostomus temporalis temporalis</i> Grey-crowned babbler (eastern subspecies)	-	V	Yes	May forage within lightly timbered farmlands with remnants of woodland.	Moderate-High (previously recorded within proposal area)	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Detectable all year.
<i>Pteropus poliocephalus</i> Grey-headed flying-fox	V	V	Yes	Colony exists on Susan Island. Forages on fruits and blossoms of street trees, cultivated and wild species.	High	No impact to colony on Susan Island. Minimise the removal of fruit-bearing trees such as Figs and Mangoes. Best detected when forage habitat is fruiting and/or flowering. Look in known camps.
<i>Rhipidura rufifrons</i> Rufous fantail	M	-	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek. Species likely to be of low constraint.	Low-Moderate	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Best detected between September and March. Virtually disappears from Victoria and New South Wales during winter.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Rostratula australis</i> Australian painted snipe	VM	E1	Yes	May forage within shallow ephemeral flooded paddocks.	Low	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Nomadic and potentially detectable all year. Not generally active during day.
<i>Saccolaimus flaviventris</i> Yellow-bellied sheath-tail bat	-	V	Yes	The highest value habitat within the proposal area includes the riparian vegetation along Alipou Creek and tree hollows.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek. Hollow-bearing trees alive and dead should be retained where possible. Detectable all year.
<i>Scoteanax rueppellii</i> Greater broad-nosed bat	-	V	Yes	The highest value habitats within the proposal area include rainforest patches and the riparian vegetation along Alipou Creek, and tree hollows.	Moderate-High (recorded with probable certainty during Aug 2010 survey)	Ensure preferred option minimises habitat fragmentation and avoids impacts to rainforest patches and the riparian vegetation along Alipou Creek. Hollow-bearing trees alive and dead should be retained where possible. Best detected mid-spring to mid-autumn.
<i>Stagonopleura guttata</i> Diamond firetail	-	V	Yes	The highest value habitat within the proposal area includes the riparian vegetation along Alipou Creek.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek. Detectable all year.
<i>Sterna caspia</i> Caspian tern	M	-	Yes	Potential habitat exists along the Clarence River. An additional crossing of the Clarence River has the potential to impact riparian vegetation.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River. Mainly sedentary but numbers fluctuate seasonally in many areas. From Tasmania they go north in winter to NSW waters. Potentially detectable all year.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Sterna hirundo</i> Common tern	M	-	Yes	This species was recorded during the current survey. Potential habitat exists along the Clarence River. An additional crossing of the Clarence River has the potential to impact riparian vegetation.	High (recorded during Aug 2010 and July 2011 surveys)	Ensure preferred option has adequate setbacks from bank of Clarence River. Best detected in spring and summer. Migrates northwards, May to August, for breeding.
<i>Stictonetta naevosa</i> Freckled duck	-	V	Yes	Marginal potential habitat exists along the Clarence River, within riparian vegetation and habitat along Alipou Creek. The proposed crossing of the Clarence River has the potential to impact riparian vegetation.	Low	Ensure preferred option has adequate setbacks from bank of Clarence River and avoids impacts to the riparian vegetation along Alipou Creek. Implement controls during construction to minimise impacts on reedland habitats. Potentially detectable all year.
<i>Thersites michellae</i> Mitchell's rainforest snail	Z	E1	Yes	May occur within rainforest patches.	Low	Avoid impact to rainforest patches. Any disturbance to rainforest will likely require targeted searches for this species. Detectable all year.
<i>Tringa stagnatilis</i> Marsh sandpiper	M	-	Yes	May forage within shallow ephemeral flooded paddocks.	Low	Ensure preferred option minimises habitat fragmentation and considers potential indirect impacts such as increased risks of fauna road mortalities. Best detected in summer between August and April.
<i>Turnix maculosa</i> Red-backed button-quail	-	V	Yes	May occur within grasslands and reedlands near water.	Low	Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek and wetlands. Implement controls during construction to minimise impacts on reedland habitats. Detectable all year.
<i>Turnix melanogaster</i> Black-breasted button-quail	V	C1	Yes	May occur within rainforest patches.	Low	Avoid impact to rainforest patches. Detectable all year.

Latin name / Common name	EPBC Act ¹	TSC Act ²	Potential habitat within proposal area	Potential constraint areas/habitats	Likelihood of occurrence	Recommendations
<i>Tyto novaehollandiae</i> Masked owl	-	V	Yes	Active nest tree recorded during field surveys approximately 200m south of the Pacific Hwy.	High (potentially recorded during Aug 2010 survey from regurgitated pellet)	No impact to nest tree. If works are proposed for this area that they be undertaken outside of the peak breeding season March - July to minimise disturbances, which may prompt abandonment of the nest. Detectable all year.
<i>Vespadelus troughtoni</i> Eastern cave bat	-	V	Yes	The highest value habitat within the proposal area includes potential roost sites (e.g. bridges, culverts) and the riparian vegetation along Alipou Creek.	Low	Avoid impact to roost sites. Ensure preferred option minimises habitat fragmentation and avoids impacts to the riparian vegetation along Alipou Creek. Detectable all year.



Legend

Threatened and Migratory Fauna located by Biosis Research

- Australian Reed-warbler
- ★ Cattle Egret
- Common Tern
- ⊕ Eastern Bentwing-bat
- ▲ Greater Broad-nosed Bat
- ⊕ Little Bentwing-bat
- ▲ Masked Owl
- ★ Rainbow Bee-eater
- ★ Southern Myotis
- ⊕ White-bellied Sea-Eagle

Figure 5: Threatened and migratory fauna recorded by Biosis Research

Date: 18 July 2011

Drawn by: JMS

File number: 13508

Checked by: JC

Location: P:\13500s\13508\Mapping\13508_F5_Thr_Fauna.mxd

0 250 500 1,000 1,500

Metres
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

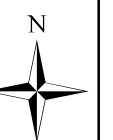


Figure 5

4.4 Aquatic fauna

4.4.1 Database search results

Aquatic threatened species database searches were conducted in June 2010 and then repeated in January 2011 and included the NSW DPI *Fisheries Database*, then DECCW (now OEH) *Atlas of NSW Wildlife* and DSEWPac EPBC online *Protected Matters Search Tool*. Allowing for the mobility of aquatic fauna within riverine systems and limited number of local records, NSW *Fisheries Database* searches were conducted based on the recorded occurrences of species within the entire Northern Rivers catchment management authority and the Clarence Valley local government area; and DECCW and DSEWPac searches included records within 30km of the Grafton and South Grafton area.

These searches identified 16 threatened aquatic flora and fauna species listed under the TSC Act, EPBC Act and/or FM Act that have previously been recorded or may potentially occur in the vicinity of the Clarence River at Grafton.

A total of nine threatened aquatic fauna species have low to marginal potential habitat within 10km of the Grafton and South Grafton area. The complete list of species along with a description of potential habitats is provided in Appendix 6.

4.4.2 Aquatic habitats

Aquatic flora within the Grafton and South Grafton area broadly correspond to the vegetation types and conditions described in Section 4.2.2. Each of the major aquatic fauna habitats that are present within the Grafton and South Grafton area are described below.

Clarence River

The Clarence River at Grafton flows from west to east within the proposal area. The Clarence River Basin covers an area of approximately 22,700km² and is located in the far north coast of New South Wales. Tidal influences extend to the town of Copmanhurst approximately 30km upstream of Grafton. The river rises near the Queensland border and flows south and north-east for 394km before emptying into the Pacific Ocean at Yamba.

Current and previous land uses have altered the natural hydrological regimes of the Clarence River, due to the construction of levees on the north and south banks at Grafton. The riparian vegetation of the Clarence River in the vicinity of Grafton is substantially modified (Plate 11 and Plate 13), having been cleared for pasture/grazing. Whilst some patches of native ground cover species appear to remain, the riparian vegetation appears to be dominated by exotic species. However, the instream vegetation, particularly within the proposal area, is predominantly native and appears relatively diverse (Plate 12).

Alipou Creek

Alipou Creek is a tributary of the Clarence River at Grafton and flows from east to west within proposal area. Alipou Creek is influenced by the tidal influences that affect the Clarence River. A causeway located on Alipou Creek is a significant barrier to fish movement effectively limiting the available aquatic fauna habitat to the first 200m of Alipou Creek.

Current and previous land uses have altered the natural hydrological regimes of Alipou Creek (Plate 18), due to the construction of a causeway and agriculture practices nearby. The riparian vegetation of Alipou Creek is substantially modified, having been cleared for pasture/grazing. Whilst some patches of native ground cover species appear to remain, the riparian vegetation appears to be dominated by exotic species (Plate 17). However, the instream vegetation, particularly within the proposal area, is predominantly native and appears relatively diverse.

Cowan Creek

Cowan Creek is a tributary of the Clarence River at Grafton and flows from south to north within the proposal area. Cowan Creek is influenced by the tidal influences that affect the Clarence River. Cowan Creek has been heavily modified as part of an irrigation system and floodgates.

Current and previous land uses have altered the natural hydrological regimes of Cowan Creek, due to the construction of floodgates and alteration into an irrigation channel (Plate 15). The riparian vegetation of Cowan Creek is substantially modified, having been cleared for the construction of the irrigation channel and floodgates. The riparian vegetation appears to be dominated by exotic species however the instream vegetation, particularly within the proposal area, is predominantly native and appears relatively diverse (Plate 16).

Carrs Creek

Carrs Creek is a tributary of the Clarence River upstream of Grafton and flows from north to south within the proposal area. Carrs Creek was sampled to supplement the recorded species due to the inability to complete backpack electrofishing, fyke netting and bait trapping on the northern and southern banks of the Clarence River at Grafton. Carrs Creek has been heavily modified as part of an irrigation system for the surrounding pasture/grazing (Plate 14).

Current and previous land uses have altered the natural hydrological regimes of Carrs Creek, with the northern section being drastically altered to disconnect it from the Clarence River and further alteration into an irrigation channel. The riparian vegetation of Carrs Creek is substantially modified, having been cleared for the construction of the irrigation channel for the surrounding pasture/grazing. The riparian vegetation appears to be dominated by exotic species, however the instream vegetation, particularly where sampling occurred, is predominantly native and appears relatively diverse.

Flood history

The Clarence River has experienced regular floods with records indicating that since 1839 the Clarence River has experienced 74 major and moderate floods; the most recent being in January 2011 (peaking at 7.64m). The previous major flood was in May 2009 when the river peaked at 7.37m (Clarence Valley Council website). The floods typically occur from relatively low rainfall events upstream, lasting for several days or weeks, rather than high intensity rains. Long periods of dry followed by flooding events are normal environmental conditions given the size of the catchment and rainfall for the region.

The aquatic habitats within the Grafton and South Grafton area are in marginal to suboptimal condition based on a modified HABSCORE assessment and in general are considered to provide significant feeding and resting habitats for aquatic fauna. The presence of submerged vegetation, large woody debris and trailing bank vegetation provide ideal habitat for aquatic fauna. The river and creek beds and banks of the Grafton and South Grafton area were generally clay/silt substrates with some sections of rocky substrates. In addition, mobile eroded sediments and some sands were present. These habitats provide ideal habitat for aquatic fauna within the Grafton and South Grafton area.

4.4.3 Aquatic fauna

A list of aquatic fauna recorded within the Grafton and South Grafton area is provided in Appendix 3 and includes nine species of fish (including two introduced species), one marbled eel, one Clarence River turtle and one prawn species. The aquatic surveys generally focused on habitats with a greater potential to contain native species, e.g. remnant native vegetation and waterbodies (Clarence River, Alipou Creek, Cowan Creek and Carrs Creek).

Of the 16 threatened aquatic flora or fauna species (as listed on the EPBC Act, TSC Act or FM Acts) with the potential to occur in the vicinity of the Clarence River at Grafton, none were recorded during the surveys.

Eel-tailed catfish (*Tandanus tandanus*) and olive perchlet (*Ambassis agassizii*) were recorded within the proposal area. The Murray-Darling Basin population of the eel-tailed catfish and the western population of the olive perchlet are listed as endangered populations under the FM Act. However, the Clarence River at Grafton is outside the expected distribution of these populations and therefore the individuals recorded within the proposal area are not considered to be part of the listed endangered populations.

The endangered eastern freshwater cod (*Maccullochella ikei*) (FM Act and EPBC Act) is known within the Clarence River system, however this species is expected to be absent in the vicinity of the Grafton and South Grafton area due to degraded nature of the riparian vegetation along the Clarence River at Grafton and due to limited anecdotal records placing them within the proposal area. Australian bass (*Macquaria novemaculeata*) were observed within the proposal area, although not listed under the EPBC or FM Acts are under significant decline and are an important angling species within the vicinity of the Grafton and South Grafton area.

Nine threatened aquatic fauna species were considered to have low to marginal potential habitat within the Grafton and South Grafton area (refer Appendix 6). Despite the failure to record any of these threatened aquatic fauna species, low to marginal potential habitat exists for these species at all sites. Appropriate seasonal surveys are recommended to further the confirmation of absence or presence within the Grafton and South Grafton area.

4.5 Corridors and connectivity

This is a preliminary discussion of connectivity issues based on aerial photo interpretation and field surveys. It is recommended that further discussions, consultation and surveys are carried out when a preferred location has been identified, so as to better assess the nature of the connectivity issues associated with the preferred option.

It was considered possible that an additional river crossing may interfere with the flight path of flying-foxes dispersing from their day roosts on Susan Island to feeding resources on dusk. Observations were made during the field survey to determine the likely indirect impact of an additional bridge on the black and grey-headed flying-fox colonies which roost on Susan Island. Potential indirect impacts on this colony were considered to include interruption to flight paths and an increased potential for collision risk or road strike. It was determined via observation of the Susan Island roost at dusk that the flying-foxes disperse from the roost in all directions in search of feeding sites.

4.6 Critical habitat

Critical habitat can be declared under both the EPBC and TSC Acts. Under the EPBC Act, it is an offence for a person to take an action that the person knows will significantly damage the critical habitat of a listed threatened species. Under the TSC Act, the declaration of critical habitat serves primarily as a guide for planning under Part 3 of the EP&A Act and a trigger which ensures a rigorous environmental assessment of all activities and developments proposed, and any other action that has the potential to damage the species or its habitat (NPWS 2002b).

No areas of critical habitat for flora or fauna have been declared within the locality.

4.7 Constraints assessment

Assessment of ecological constraints throughout Grafton and South Grafton has been primarily desktop-based. Field surveys were conducted in parts of the Grafton and South Grafton area, and were predominantly focused around the Clarence River and associated tributaries as well as stands of trees.

All of the factors considered in identifying potential ecological constraints of the Grafton and South Grafton area are listed below (and described in more detail in Section 4.6).

- Endangered ecological communities.
- Significant flora and fauna species records.
- Known and/or potential habitat for threatened terrestrial and aquatic flora and fauna.
- Areas of critical habitat.
- Habitat connectivity.
- Wildlife corridors (local or regional).

4.7.1 Ecological constraints

Clarence River, Alipou Creek & Alummy Creek

The reedlands adjoining the Clarence River and more patchily along Alipou Creek consist mainly of stands dominated by *Phragmites australis*, with other native aquatic macrophytes including *Schoenoplectus mucronulatus* and *Typha orientalis* also present. The fringing reedland in the proposal area along the Clarence River is broadly consistent with the endangered ecological community, freshwater wetlands on coastal floodplains. Parts of Alummy Creek are consistent within this community. These reedlands also form potential marginal habitat for two threatened plant species, *Hydrocharis dubia* and *Persicaria elatior*, and threatened fauna species such as blue-billed duck, freckled duck, black bittern and Australasian bittern. The additional crossing of the Clarence River should have sufficient set-backs on both banks to avoid and/or minimise impacts to the reedlands.

The freshwater wetlands on coastal floodplains also provide habitat for aquatic fauna within the Grafton and South Grafton area and impacts associated with the construction of the bridge abutment may adversely impact on this important aquatic habitat. Construction of the piers within the Clarence River has the potential to impact downstream, causing degradation of water quality and aquatic habitat of the Clarence River and Alipou Creek through increased sedimentation, pollutants and altered hydrology. Pollution could potentially enter waterways via runoff, airborne transport of spray or dust, or a spillage event and could result in physical or chemical changes in water quality.

Sedimentation is of primary concern during the construction of the bridge piers and abutments as it can have detrimental ecological effects, including a reduction in substrate and depth heterogeneity, smothering and killing of demersal eggs, smothering of macroinvertebrates, smothering of food sources, smothering of vegetation, impacts on fish respiration (gills become clogged), reduced feeding ability, transportation of pollutants attached to sediment and reduced light penetration for aquatic vegetation.

Susan Island and Elizabeth Island

According to previous studies the western end of Susan Island Nature Reserve includes a stand of the endangered ecological community, lowland rainforest on floodplains (NSW RTA 2004; DECCW 2009). The rainforest may provide potential habitat for the threatened plant *Parsonsia dorrigoensis* and the threatened Mitchell's rainforest snail, threatened microbats and the migratory black-faced monarch and rufous fantail. In addition, a colony of the threatened grey-headed flying-fox is known to occur on Susan Island.

Elizabeth Island provides known and potential habitat for threatened and migratory fauna such as the black-necked stork and rainbow bee-eater (previously recorded on the island). Due to the lack of adequate vegetation mapping and only a preliminary field survey viewing the island from across the Clarence River, the vegetation of the island has only been broadly described as degraded riparian forest.

Swan Creek and associated wetlands

Swan Creek occurs to the north-east of the existing Grafton Bridge. Swan Creek and its associated wetlands support a high number of black-necked stork records and provide habitat connectivity to Alipou Creek.

Hollow-bearing forest red gums

There are some patches of remnant and regrowth native trees characteristic of the endangered ecological community, sub-tropical coastal floodplain forest present within the Grafton and South Grafton area, including *Eucalyptus tereticornis*. The isolated forest red gums in the Grafton and South Grafton area are the only remnant components of the original floodplain community which originally occurred throughout the area.

Tree hollows within the forest red gums provide a significant resource for hollow-dwelling fauna such as threatened microbats (e.g. little bentwing-bat, eastern bentwing-bat, southern myotis and greater broad-nosed bat) and the little lorikeet. A nest tree forest red gum, probably that of the threatened masked owl, was recorded approximately 200m south of Charles Street / Pacific Highway.

Confluence of Musk Valley Creek and Alipou Creek

Based on aerial photograph interpretation and threatened fauna mapping, the confluence of Musk Valley Creek with Alipou Creek surrounds an area of wetland. A number of black-necked stork records occur here and along both creeks, which provides local to sub-regional connectivity for mobile waterbirds.

Intact forest patches

Two large, relatively intact forest patches occur to the south-east of the existing bridge. The available vegetation mapping does not classify these patches so the plant community is unknown. It is likely these patches provide potential habitat for a number of threatened animals and possibly plants as well. Hollow-bearing trees may be present.

The patches of forest vegetation also act as stepping stones in an otherwise fragmented landscape for mobile fauna.

Induna Reserve

Induna Reserve occurs on the southern bank of the Clarence River beneath the existing bridge. The reserve contains planted native trees. While there are no legislative constraints on clearing this vegetation, it does represent some of the native species that would formerly have occurred in the area. This vegetation includes a few trees of *Melaleuca styphelioides*, a species which potentially forms habitat for the threatened orchid *Dendrobium melaleucaphilum* (spider orchid). It is considered highly unlikely this species occurs here as the trees were planted within the last 20-30 years and there is no proximate natural *Melaleuca* forest, however it cannot be completely ruled out.

Fragmented freshwater wetland endangered ecological community

Large sections of the northern and southern banks of the Clarence River contain fragmented patches of *Phragmites australis* reedlands. These reedlands may provide limited potential habitat for two threatened plant species, *Hydrocharis dubia* and *Persicaria elatior*, and threatened fauna species such as blue-billed duck, freckled duck, black bittern and Australasian bittern. An additional crossing of the Clarence River should have sufficient set-backs on both banks to avoid and/or minimise impacts to the reedlands.

Waterlogged paddocks/wetlands/dams

Flood-prone paddocks, wetlands and farm dams may be used from time to time by threatened and migratory species such as black-necked stork, glossy ibis, cattle egret, great egret, magpie goose, latham's snipe, Australian painted snipe and marsh sandpiper. These areas also provide potential habitat for the threatened plant square-stemmed spike-rush (*Eleocharis tetraquetra*).

Scattered trees on farmland in the east

A large area of scattered trees on farmland occurs to the east of the southern bank of the Clarence River. The available vegetation mapping does not classify this area so the plant community that it may have previously resembled (before disturbance) is unknown. The threatened grey-crowned babbler and bush stone-curlew have been previously recorded in this area. It is likely this patch provides potential habitat for other threatened animals and possibly plants as well. Hollow-bearing trees may be present.

The scattered trees also provide interspersed linkages in an otherwise fragmented landscape for mobile fauna.

Alumy Creek upstream of the railway

The section of Alumy Creek upstream of the railway is in poorer condition than the downstream end due to the degraded nature of the vegetation and lack of connectivity for aquatic species. Although modified, the upstream section may provide local habitat connectivity for terrestrial fauna.

Alipou and Musk Valley creeks

Sections of Alipou and Musk Valley creeks not already described above provide known and potential habitat for threatened fauna (e.g. black-necked stork and magpie goose) as well as provide a local to sub-regional level of habitat connectivity throughout the Grafton and South Grafton area.

Tea tree plantation

A large plantation of *Melaleuca alternifolia* (tea tree) occurs in the south of the proposal area. The tea trees were planted in rows and were approximately 1m in height at the time of survey. There were a few weeds such as *Senecio madagascariensis*, *Cyperus eragrostis* and *Conyza* sp. interspersed with the tea trees.

Areas adjoining the plantation support pasture dominated by *Cynodon dactylon*. A large drain traverses the centre of the tea tree plantation, fringed with *Juncus usitatus* and *Eleocharis acuta*.

The plantation may provide resources for common fauna however is considered unlikely to contain potential habitat for threatened species.

Street trees

A number of planted street trees occur within Grafton and South Grafton. Fruit-bearing trees (e.g. fig trees) provide feeding resources for the threatened grey-headed flying-fox. Although the grey-headed flying-fox is known to roost on Susan Island, and therefore forage regularly within the Grafton and South Grafton area, it is a highly mobile species capable of travelling up to 50km to forage (DEC 2005CE). Given the species' high mobility and wide range in diet (e.g. feeds on the nectar and pollen of native trees, in particular eucalypts, melaleuca and banksia, and fruits of rainforest trees and vines), foraging resources within the proposal area (excluding Susan Island) are not considered to be limiting.

Bare banks of Clarence River

Some banks of the Clarence River are highly modified and lack any native vegetation (e.g. where private properties back onto the river). These areas are unlikely to provide habitat for threatened species and therefore pose a low ecological constraint to development.

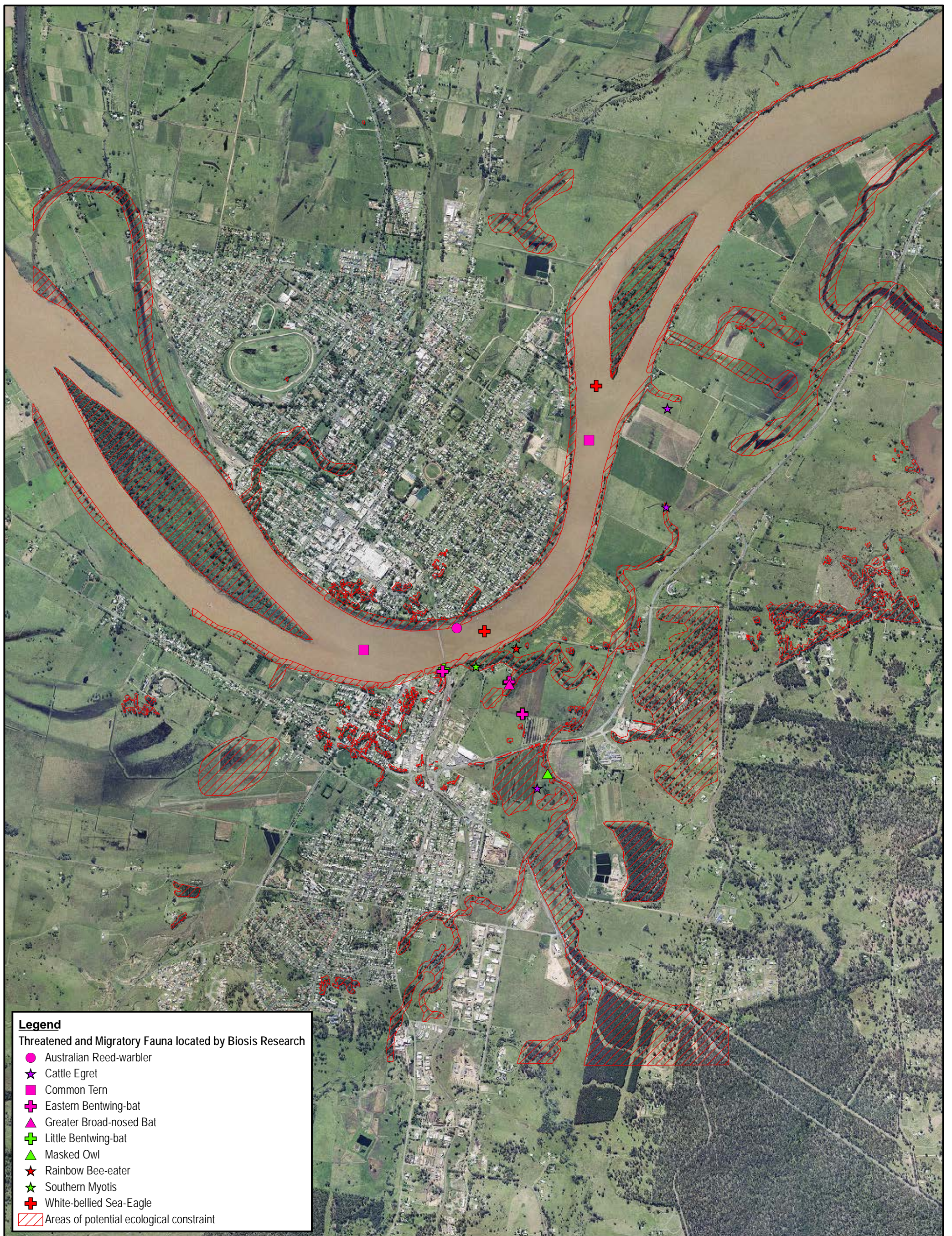
Highly modified environments

This includes town centres, suburban development, industrial areas and dry exotic paddocks. These areas are unlikely to provide habitat for threatened species and therefore pose a low ecological constraint to development.

4.8 Constraints mapping

Criteria used to identify land within the Grafton and South Grafton area in terms of potential ecological constraint included information regarding the type of plant community present (particularly whether endangered ecological communities were present), threatened species known or likely to be present, the condition and importance of terrestrial and aquatic flora and fauna habitats present and, corridor values. Figure 6 shows habitat areas identified as potential ecological constraints as well as threatened and migratory fauna records across the Grafton and South Grafton area.

Assessment of ecological constraints throughout Grafton and South Grafton has been primarily desktop-based. Field surveys were conducted in parts of the proposal area, and were predominantly focused around the Clarence River and associated tributaries as well as stands of trees. Therefore, not all areas that may pose an ecological constraint have been mapped as such.



Legend

Threatened and Migratory Fauna located by Biosis Research

- Australian Reed-warbler
- ★ Cattle Egret
- Common Tern
- ⊕ Eastern Bentwing-bat
- ▲ Greater Broad-nosed Bat
- ⊕ Little Bentwing-bat
- ▲ Masked Owl
- ★ Rainbow Bee-eater
- ★ Southern Myotis
- ⊕ White-bellied Sea-Eagle
- ▨ Areas of potential ecological constraint

Figure 6: Ecological constraints mapping of the Grafton and South Grafton proposal area

Date: 18 July 2011

Drawn by: JMS

File number: 13508

Checked by: JC

Location: P:\13500s\13508\Mapping\13508_F6_Constraints.mxd

0 230 460 920 1,380

Metres
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

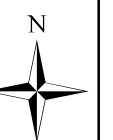


Figure 6

5.0 CONCLUSION

The NSW RTA is currently undertaking investigations to identify a preferred location for an additional crossing of the Clarence River at Grafton. This report details the investigations associated with identification of potential constraints that terrestrial and aquatic flora and fauna of conservation significance may place on the proposal. Its purpose is to provide information that will inform the route selection process.

Criteria used to identify land within the Grafton and South Grafton area in terms of potential ecological constraint included information regarding the type of plant community present (particularly whether endangered ecological communities were present), threatened species known or likely to be present, the condition and importance of terrestrial and aquatic flora and fauna habitats present and, corridor values.

Assessment of ecological constraints throughout Grafton and South Grafton has been primarily desktop-based. Field surveys were conducted in parts of the proposal area, and were predominantly focused around the Clarence River and associated tributaries as well as stands of trees. Therefore, not all areas that may pose an ecological constraint have been mapped as such.

No areas of critical habitat for flora or fauna have been declared within the locality.

Three endangered ecological communities are known to occur within the Grafton and South Grafton area, namely freshwater wetlands on coastal floodplains, lowland rainforest on floodplains and sub-tropical coastal floodplain forest.

No threatened plants were recorded during the current field surveys however 10 threatened plant species are considered to have potential habitat within the Grafton and South Grafton area (refer Table 5). It should be noted that while potential habitat may be present in the proposal area, existing habitats are considered highly marginal due to the long history of disturbance and relatively poor condition of remaining native vegetation.

Four microchiropteran bats listed on the NSW TSC Act were recorded foraging primarily along the water ways of the proposal area, with a fifth species recorded with probable certainty. A sixth threatened species, the masked owl, was potentially recorded from a regurgitated pellet. Additionally five species listed as migratory under the Commonwealth EPBC Act were recorded within the Grafton and South Grafton area. These species were the Australian reed-warbler, white-bellied sea-eagle, cattle egret, common tern and rainbow bee-eater.

An additional 52 threatened and/or migratory fauna species are considered to have potential habitat within the Grafton and South Grafton area (refer Table 6). It should be noted that while potential habitat may be present in the proposal area, many existing habitats are considered only marginal due to the long history of disturbance and relatively poor condition of remaining native vegetation.

No aquatic flora or fauna species listed as threatened pursuant to the EPBC Act, TSC Act or the FM Acts were recorded during the surveys. Nine threatened aquatic fauna species are considered to have low to marginal potential habitat within the Grafton and South Grafton area (refer Appendix 6).

It was considered possible that an additional river crossing may interfere with the flight path of flying-foxes dispersing from their day roosts on Susan Island to feeding resources on dusk. Observations were made during the field survey to determine the likely indirect impact of an additional bridge on the black and grey-headed flying-fox colonies which roost on Susan Island. Potential indirect impacts on this colony were considered to include interruption to flight paths and an increased potential for

collision risk or road strike. It was determined via observation of the Susan Island roost at dusk that the flying-foxes disperse from the roost in all directions in search of feeding sites.

Examples of areas considered to pose ecological constraint to an additional crossing of the Clarence River at Grafton are: Alipou Creek and associated riparian vegetation; the emergent aquatic vegetation (e.g. *Phragmites australis*) lining the northern and southern banks of the Clarence River; the confluence of Alummy Creek with the Clarence River; Susan Island; Elizabeth Island; Swan Creek and associated wetlands; hollow-bearing forest red gums (*Eucalyptus tereticornis*); the northern part of Musk Valley Creek from its confluence with Alipou Creek and the area of wetland between these two creeks; and, two patches of relatively intact forest in the south-east of the proposal area.

5.1.1 Recommendations

The key policy principle of the RTA's road development and impact on habitat amelioration measures is that "in principle, the planning and construction of roads should, in order of consideration endeavour to:

1. Avoid impacts on habitat through the planning process.
2. Minimise impacts on habitat through the planning process.
3. Mitigate impacts on habitat, through the use of a range of amelioration measures" (NSW RTA 2001).

Where possible important ecological features identified in the local area should be avoided during the initial route selection stage. Features of potential ecological importance have been identified below and the above hierarchy of management measures should be considered and applied to these sensitive habitats.

- During the assessment of route options, consideration should be given to the reedlands along the banks of the Clarence River that conform to the description of the freshwater wetlands on coastal floodplains endangered ecological community, Alipou Creek and Susan and Elizabeth islands.
- Intact patches of vegetation, including riparian vegetation.
- Large mature trees, including hollow-bearing trees.
- Drainage lines and low-lying paddock 'soaks' providing ephemeral habitats.
- Other consideration to the location of bridge piers or foundations within the main waterway channel (thalweg: deep, fast-flowing section of a waterway).
- Turbulence or the erosion of the bed and banks of the waterway due to the design and orientation of bridge piers, including those located within overbank areas. This is particularly important for the Clarence River at Grafton due to tidal affects (refer to engineering guidelines (Fairfull and Witheridge 2003; Witheridge 2002)). Consideration needs to be given to potential affects not only downstream of the proposed bridge but also upstream.
- When sizing the waterway area of the bridge, appropriate consideration should be given to fish passage requirements along the floodplains, including locating bridge abutments well away from the channel banks and the possible installation of floodplain culverts adjacent to the main crossing.

- Maximisation of light penetration under the bridge or arch to encourage fish passage.
- Implementation of strict erosion and sediment controls to manage direct and indirect impacts to ecology of water bodies in the proposal area.

In addition to the above recommendations, several studies that will be required to further inform the identification of a preferred location for an additional crossing have been listed below.

- Appropriate seasonal surveys for threatened aquatic fauna using bank and boat electrofishing techniques.
- Seasonal targeted surveys for threatened species identified as having potential habitat in the vicinity of the preferred location.
- AUSRIVAS sampling (to further define relative health of riparian zones).

PLATES



Plate 1: Facing north-west towards Grafton Bridge. Splintered stump in foreground providing potential habitat for microbats.



Plate 2: Facing east overlooking disturbed pastureland with remnant Eucalypts, along the southern bank of the Clarence River.



Plate 3: Facing south over disturbed pastureland south of Clarence River.



Plate 4: *Phragmites australis* and emergent vegetation habitat along northern bank of the Clarence River.



Plate 5: Large mango trees near the intersection of Clarence and Fitzroy Streets, Grafton.



Plate 6: Drainage 'soak' present within the Tea tree plantation property to the south-east of the proposal area.



Plate 7: Hollow-bearing Jacaranda street tree on Clarence Street, Grafton.



Plate 8: Three-toed skink *Saiphos equalis* found beneath debris on southern bank of Clarence River.



Plate 9: Eastern water skink *Eulamprus quoyii* found along drainage line within the Tea tree plantation.



Plate 10: Anabat set-up along unnamed tributary of Alipou Creek.



Plate 11: Looking downstream on the northern bank of the Clarence River.



Plate 12: Looking downstream on the southern bank of the Clarence River.



Plate 13: Looking downstream on the southern bank of the Clarence River toward Wharf Street, South Grafton, and the Grafton Bridge.



Plate 14: Carrs Creek located north-west of Grafton Bridge.



Plate 15: Looking upstream at Cowan Creek a tributary of the Clarence River.



Plate 16: Confluence of Cowan Creek and the Clarence River.



Plate 17: Looking upstream at Alipou Creek, a tributary of the Clarence River.



Plate 18: Anabat set-up along unnamed tributary of Alipou Creek.

APPENDICES

APPENDIX 1

Flora Results

Table 7: Plant species recorded in the proposal area during current surveys

* Denotes exotic species

Family	Scientific name	Common name
Alliaceae	* <i>Agapanthus praecox</i>	Agapanthus
Amaranthaceae	<i>Alternanthera sp.</i>	
Amygdalaceae	* <i>Prunus sp.</i>	Flowering cherry
Anacardiaceae	* <i>Mangifera indica</i>	Mango
Apiaceae	<i>Centella asiatica</i>	Pennywort
Apocynaceae	* <i>Cryptostegia grandiflora</i>	Rubber vine
	* <i>Nerium oleander</i>	Oleander
	<i>Parsonsia straminea</i>	Common silkpod
Aquifoliaceae	* <i>Ilex aquifolium</i>	Holly
Araucariaceae	* <i>Agathis robusta</i>	Queensland kauri pine
	* <i>Araucaria heterophylla</i>	Norfolk Island pine
Arecaceae	* <i>Archontophoenix alexandrae</i>	Alexandra palm
Asclepiadaceae	* <i>Araujia sericifera</i>	Moth vine
Asparagaceae	* <i>Asparagus aethiopicus</i>	Asparagus fern
Asteliaceae	<i>Cordyline stricta</i>	Narrow-leaved palm lily
Asteraceae	* <i>Ageratina adenophora</i>	Crofton weed
	* <i>Ageratum houstonianum</i>	Blue billy goat weed
	* <i>Bidens pilosa</i>	Cobbler's pegs
	<i>Calotis sp.</i>	
	* <i>Cirsium vulgare</i>	Spear thistle
	* <i>Conyza sp.</i>	Fleabane
	* <i>Senecio madagascariensis</i>	Fireweed
	* <i>Sonchus oleraceus</i>	Common sowthistle
	* <i>Taraxacum officinale</i>	Dandelion
Azollaceae	<i>Azolla sp.</i>	
Basellaceae	* <i>Anredera cordifolia</i>	Madeira vine
Bignoniaceae	* <i>Jacaranda mimosifolia</i>	Jacaranda
	* <i>Macfadyena unguis-cati</i>	Cat's claw creeper
Brassicaceae	* <i>Brassica napus</i>	Rape
Cactaceae	* <i>Opuntia stricta</i>	Prickly pear
Cannaceae	* <i>Canna indica</i>	Indian shot
Casuarinaceae	<i>Allocasuarina torulosa</i>	Forest oak
	<i>Casuarina cunninghamiana</i>	River oak
	<i>Casuarina glauca</i>	Swamp oak
Chenopodiaceae	<i>Einadia trigonos</i>	Fishweed
Commelinaceae	* <i>Tradescantia fluminensis</i>	Wandering jew
Convolvulaceae	<i>Dichondra repens</i>	Kidney weed
	* <i>Ipomoea cairica</i>	
Cyperaceae	<i>Bolboschoenus fluviatilis</i>	
	* <i>Cyperus eragrostis</i>	Umbrella sedge
	* <i>Cyperus papyrus</i>	Papyrus
	<i>Eleocharis sphacelata</i>	
	<i>Schoenoplectus mucronatus</i>	
	<i>Schoenoplectus validus</i>	
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken

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Family	Scientific name	Common name
Elaeocarpaceae	<i>Elaeocarpus obovatus</i>	Hard quandong
Euphorbiaceae	* <i>Ricinus communis</i>	Castor oil plant
Fabaceae - Caesalpinioideae	* <i>Caesalpinia ferrea</i>	Leopard tree
	<i>Cassia brewsteri</i>	Native laburnum
	* <i>Delonix regia</i>	Royal poinciana
Fabaceae (Faboideae)	<i>Castanospermum australe</i>	Black bean
	<i>Desmodium rhytidophyllum</i>	
	* <i>Erythrina crista-galli</i>	Cockspur coral tree
	<i>Medicago sp.</i>	
	* <i>Trifolium repens</i>	White clover
	* <i>Vicia sativa</i>	
Fabaceae (Mimosoideae)	<i>Acacia irrorata</i>	Green wattle
Fumariaceae	* <i>Fumaria bastardii</i>	Bastards fumitory
Geraniaceae	<i>Geranium solanderi</i>	Native geranium
Haloragaceae	* <i>Myriophyllum aquaticum</i>	Parrots feathers
Juncaceae	<i>Juncus usitatus</i>	
Juncaginaceae	<i>Triglochin multifructa</i>	
Lauraceae	* <i>Cinnamomum camphora</i>	Camphor laurel
Lemnaceae	<i>Lemna trisulca</i>	Duckweed
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed mat-rush
Loranthaceae	<i>Amyema congener</i>	
Malvaceae	* <i>Hibiscus sp.</i>	
	* <i>Modiola caroliniana</i>	Red-flowered mallow
	* <i>Sida rhombifolia</i>	Paddy's lucerne
Meliaceae	<i>Melia azedarach</i>	White cedar
Menyanthaceae	<i>Nymphoides indica</i>	Water snowflake
Moraceae	<i>Ficus macrophylla</i>	Motreton bay fig
	<i>Ficus microcarpa</i>	Small-fruited fig
	<i>Ficus obliqua</i>	DeciduousFig
	* <i>Morus alba</i>	White mulberry
Myrtaceae	<i>Callistemon viminalis</i>	Weeping bottlebrush
	* <i>Corymbia citriodora</i>	Lemon-scented gum
	<i>Corymbia maculata</i>	Spotted gum
	* <i>Corymbia torelliana</i>	Cadaghi
	<i>Eucalyptus saligna</i>	Sydney blue gum
	<i>Eucalyptus sp.</i>	
	<i>Eucalyptus tereticornis</i>	Forest red gum
	<i>Lophostemon confertus</i>	Brush box
	<i>Melaleuca alternifolia</i>	Tea tree
	* <i>Melaleuca leucadendra</i>	Weeping paperbark
	<i>Melaleuca quinquenervia</i>	Paperbark
	<i>Melaleuca styphelioides</i>	Prickly-leaved tea tree
	<i>Syzygium australe</i>	Brush cherry
Nyctaginaceae	* <i>Bougainvillea glabra</i>	
Oleaceae	* <i>Ligustrum lucidum</i>	Large-leaved privet
	* <i>Ligustrum sinense</i>	Small-leaved privet
	* <i>Olea europaea ssp. cuspidata</i>	African olive
Oxalidaceae	<i>Oxalis sp.</i>	
Papaveraceae	* <i>Argemone ochroleuca</i>	Mexican poppy

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Family	Scientific name	Common name
Passifloraceae	* <i>Passiflora suberosa</i>	Cork passionfruit
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet pittosporum
Plantaginaceae	* <i>Plantago lanceolata</i>	Lamb's tongues
Platanaceae	* <i>Platanus x acerifolia</i>	Plane tree
Poaceae	* <i>Arundo donax</i>	Giant reed
	* <i>Axonopus fissifolius</i>	Narrow-leaved carpet grass
	* <i>Bromus catharticus</i>	Prairie grass
	* <i>Chloris gayana</i>	Rhodes grass
	* <i>Cynodon dactylon</i>	Common couch
	* <i>Holcus lanatus</i>	Yorkshire fog
	<i>Microlaena stipoides</i>	Weeping grass
	<i>Oplismenus aemulus</i>	
	* <i>Panicum maximum</i>	Guinea grass
	* <i>Paspalum urvillei</i>	Vasey grass
	* <i>Pennisetum clandestinum</i>	Kikuyu grass
	<i>Phragmites australis</i>	Common reed
	* <i>Setaria gracilis</i>	Slender pigeon grass
Polygonaceae	<i>Persicaria hydropiper</i>	Water pepper
	<i>Persicaria sp.</i>	
	<i>Rumex brownii</i>	Swamp dock
	<i>Rumex sp.</i>	
Pontederiaceae	* <i>Eichhornia crassipes</i>	Water hyacinth
Proteaceae	<i>Banksia integrifolia</i>	Coast banksia
	* <i>Grevillea baileyana</i>	White oak
	<i>Grevillea robusta</i>	Silky oak
	* <i>Macadamia integrifolia</i>	Macadamia nut
Rutaceae	* <i>Citrus limonia</i>	Rough lemon
Salicaceae	* <i>Salix sp.</i>	Willow
Sapindaceae	* <i>Cardiospermum grandiflorum</i>	Balloon vine
	<i>Cupaniopsis anacardioides</i>	Tuckeroo
	<i>Harpullia pendula</i>	Tulipwood
	* <i>Koelreuteria paniculata</i>	Golden rain tree
Solanaceae	* <i>Cestrum parqui</i>	Green cestrum
	* <i>Lycopersicon esculentum</i>	Tomato
	* <i>Solanum mauritianum</i>	Wild tobacco bush
	<i>Solanum sp.</i>	
Sterculiaceae	<i>Brachychiton acerifolius</i>	Illawarra flame tree
Tropaeolaceae	* <i>Tropaeolum majus</i>	Nasturtium
Typhaceae	<i>Typha orientalis</i>	Broad-leaved cumbungi
Verbenaceae	* <i>Lantana camara</i>	Lantana
	<i>Verbena sp.</i>	
Violaceae	<i>Viola caleyana</i>	Swamp violet

APPENDIX 2

Fauna Results

Table 8: Fauna species recorded in the proposal area during current surveys

Latin name	Common name	EPBC Act ¹	TSC Act ²	Observation	Anabat survey			
					Tributary of Alipou Creek	Beneath Grafton Bridge	Property 40 paddock	Property 48 Alipou Creek
Amphibians								
<i>Litoria fallax</i>	Eastern dwarf tree frog			W				
Reptiles								
<i>Physignathus lesueurii</i>	Eastern water dragon			O				
<i>Eulamprus quoyii</i>	Eastern water skink			O				
<i>Lampropholis guichenoti</i>	Garden skink			O				
<i>Saiphos equalis</i>	Three-toed skink			O				
Birds								
<i>Columba livia</i>	Rock dove*		U	O				
<i>Streptopelia chinensis</i>	Spotted turtle-dove*		U	O				
<i>Passer domesticus</i>	House sparrow*		U	O				
<i>Acridotheres tristis</i>	Common myna*		U	O				
<i>Acrocephalus stenoreus</i>	Australian reed-warbler	M		OW				
<i>Accipiter cirrhocephalus</i>	Collared sparrowhawk			O				
<i>Aquila audax</i>	Wedge-tailed eagle			O				
<i>Accipiter fasciatus</i>	Brown goshawk			O				
<i>Elanus axillaris</i>	Black-shouldered kite			O				
<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle	M		O				
<i>Haliastur indus</i>	Brahminy kite			O				
<i>Haliastur sphenurus</i>	Whistling kite			O				
<i>Anas superciliosa</i>	Pacific black duck			O				
<i>Chenonetta jubata</i>	Australian wood duck			O				
<i>Ardea ibis</i>	Cattle egret	M		O				
<i>Ardea intermedia</i>	Intermediate egret			O				
<i>Ardea pacifica</i>	White-necked heron			O				
<i>Egretta novaehollandiae</i>	White-faced heron			O				
<i>Artamus leucorhynchus</i>	White-breasted woodswallow			O				

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Latin name	Common name	EPBC Act ¹	TSC Act ²	Observation	Anabat survey			
					Tributary of Alipou Creek	Beneath Grafton Bridge	Property 40 paddock	Property 48 Alipou Creek
<i>Cracticus nigrogularis</i>	Pied butcherbird			O				
<i>Cracticus torquatus</i>	Grey butcherbird			O				
<i>Grallina cyanoleuca</i>	Magpie-lark			OW				
<i>Gymnorhina tibicen</i>	Australian magpie			OW				
<i>Strepera graculina</i>	Pied currawong			O				
<i>Cacatua roseicapilla</i>	Galah			O				
<i>Cacatua sanguinea</i>	Little corella			OW				
<i>Coracina novaehollandiae</i>	Black-faced cuckoo-shrike			O				
<i>Vanellus miles</i>	Masked lapwing			OW				
<i>Columba leucomela</i>	White-headed pigeon			O				
<i>Geopelia humeralis</i>	Bar-shouldered dove			O				
<i>Ocyphaps lophotes</i>	Crested pigeon			O				
<i>Phaps chalcoptera</i>	Common bronzewing			O				
<i>Corvus coronoides</i>	Australian raven			OW				
<i>Corvus orru</i>	Torresian crow			OW				
<i>Rhipidura albiscapa</i>	Grey fantail			OW				
<i>Rhipidura leucophrys</i>	Willie wagtail			OW				
<i>Falco berigora</i>	Brown falcon			O				
<i>Falco cenchroides</i>	Nankeen kestrel			O				
<i>Dacelo novaeguineae</i>	Laughing kookaburra			OW				
<i>Hirundo neoxena</i>	Welcome swallow			O				
<i>Larus novaehollandiae</i>	Silver gull			O				
<i>Sterna hirundo</i>	Common tern	M		O				
<i>Malurus cyaneus</i>	Superb fairy-wren			OW				
<i>Entomyzon cyanotis</i>	Blue-faced honeyeater			OW				
<i>Lichmera indistincta</i>	Brown honeyeater			O				
<i>Manorina melanocephala</i>	Noisy miner			O				

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Latin name	Common name	EPBC Act ¹	TSC Act ²	Observation	Anabat survey			
					Tributary of Alipou Creek	Beneath Grafton Bridge	Property 40 paddock	Property 48 Alipou Creek
<i>Myzomela sanguinolenta</i>	Scarlet honeyeater			O				
<i>Merops ornatus</i>	Rainbow bee-eater	M		OW				
<i>Anthus novaeseelandiae</i>	Richard's pipit			O				
<i>Cisticola exilis</i>	Golden-headed cisticloa			OW				
<i>Sphecotheres viridis</i>	Figbird			O				
<i>Acanthiza lineata</i>	Striated thornbill			O				
<i>Neochmia temporalis</i>	Red-browed finch			OW				
<i>Taeniopygia bichenovii</i>	Double-barred finch			OW				
<i>Pelecanus conspicillatus</i>	Australian Pelican			O				
<i>Phalacrocorax sulcirostris</i>	Little black cormorant			O				
<i>Phalacrocorax varius</i>	Pied cormorant			O				
<i>Platycercus eximius</i>	Eastern rosella			O				
<i>Trichoglossus haematodus</i>	Rainbow lorikeet			OW				
<i>Gallinula tenebrosa</i>	Dusky moorhen			O				
<i>Porphyrio porphyrio</i>	Purple swamphen			OW				
<i>Threskiornis molucca</i>	Australian white ibis			O				
<i>Threskiornis spinicollis</i>	Straw-necked ibis			O				
<i>Tyto novaehollandiae</i>	Masked owl		V	Z*				
<i>Zosterops lateralis</i>	Silvereye			OW				
Mammals								
<i>Vulpes vulpes</i>	Fox*		U	I				
<i>Macropus giganteus</i>	Eastern grey kangaroo			O				
<i>Mormopterus norfolkensis</i>	Eastern freetail bat		V		AD	AM	AP	
<i>Isodon macrourus</i>	Northern brown bandicoot			O				
<i>Trichosurus sp.</i>	Brush-tail possum			I				

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Latin name	Common name	EPBC Act ¹	TSC Act ²	Observation	Anabat survey			
					Tributary of Alipou Creek	Beneath Grafton Bridge	Property 40 paddock	Property 48 Alipou Creek
<i>Pteropus alecto</i>	Black flying-fox			OW				
<i>Chalinolobus gouldii</i>	Gould's wattled bat				AP	AM	AP	AP
<i>Miniopterus australis</i>	Little bentwing-bat		V		AD	AD	AD	
<i>Miniopterus schreibersii oceanensis</i>	Eastern bentwing-bat		V		AD	AM	AP	
<i>Myotis macropus</i>	Southern myotis		V		AD			AM
<i>Nyctophilus sp.</i>	long-eared bat							AM
<i>Scoteanax rueppellii</i>	Greater broad-nosed bat		V		AP			
<i>Scotorepens sp.</i>	broad-nosed bat				AP		AD	AP
<i>Vespadelus vulturnus</i>	Little forest bat				AD	AD		

Key:

V = Listed as Vulnerable under the TSC and/or EPBC Act.

U = Unprotected species.

* = Introduced species.

O = Observed.

W = Heard.

I = Indirect evidence (e.g. scats, skull, burrows).

Z* = Owl pellet, only a probable result, other more common species also probable.

AD = Definite Anabat result.

AP = Probable Anabat result.

AM = Possible Anabat result.

APPENDIX 3

Aquatic Results

Table 9: Fish Survey Results (August 2010)

Waterbody		Carrs Creek		Alipou Creek		Cowan Creek	
		Bait Traps	Fyke Nets	Bait Traps	Fyke Nets	Bait Traps	Fyke Nets
Gear Type							
Native Fish Species							
Pacific blue eye	<i>Pseudomugil signifer</i>	8	36	0	0	0	0
Flathead gudgeon	<i>Philypnodon grandiceps</i> (Adult)	17	50	0	0	2	10
Flathead gudgeon	<i>Philypnodon grandiceps</i> (Juvenile/Dwarf)	3	2	3	20	0	0
Olive perchlet	<i>Ambassis agassizii</i>	7	89	0	2	1	0
Striped gudgeon	<i>Gobiomorphus australis</i>	22	43	10	55	5	5
Empire/Firetail gudgeon	<i>Hypseleotris compressa/galii</i> (Adult)	11	0	11	323	0	0
Empire gudgeon	<i>Hypseleotris compressa</i> (Adult)	0	0	0	0	10	60
Firetail gudgeon	<i>Hypseleotris galii</i> (Adult)	0	0	0	0	5	50
Empire/Firetail gudgeon	<i>Hypseleotris compressa/galii</i> (Juvenile)	0	0	0	1	10	50
Eel-tailed catfish	<i>Tandanus tandanus</i>	0	0	0	0	0	1
Introduced Fish Species							
Plague minnow	<i>Gambusia holbrooki</i>	3	0	0	0	5	0
Rainbow mish	<i>Perca fluviatilis</i>	0	0	0	1	0	0
Other Native Vertebrate Species							
Marbled eel	<i>Anguilla reinhardtii</i>	0	3	0	0	1	4
Clarence River turtle	<i>Emydura macquarii binjing</i>	0	0	0	0	0	2
Native Invertebrate Species							
Prawn	Family: Palaemonidae	5	30	0	0	2	10

APPENDIX 4

Threatened Flora Habitat Descriptions

Table 10: Threatened Flora Habitat Table

Key: 1) Listed on the EPBC Act as Endangered (E) or Vulnerable (V)
2) Listed on the TSC Act as Endangered (E1) or Vulnerable (V)

Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
Species (or habitat) recorded within 10 km of the proposal area				
<i>Allocasuarina defungens</i> Dwarf heath casuarina	E	E1	<i>Allocasuarina defungens</i> is found only in the Hunter/Central Rivers, and Northern Rivers Catchments, ranging from the Nahiack area, north-west of Forster, to Byron Bay on the NSW north coast (DEC 2005e). <i>Allocasuarina defungens</i> grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains. Vegetation communities associated with the species, includes: Dry Sclerophyll Forests, Forested Wetlands, Grassy Woodlands, and Heathlands (DEC 2005e).	No
<i>Angophora robur</i> Sandstone rough-barked apple	V	V	Occurs in a band from around Glenreagh, north-west of Coffs Harbour, to the Coaldale area north-west of Grafton, with an isolated occurrence farther west near Nymboida. It can be locally common. Dry open forest in sandy or skeletal soils on sandstone, or occasionally granite, with frequent outcrops of rock (DEC 2005g).	No
<i>Arthraxon hispidus</i> Hairy-joint grass	V	V	Occurs over a wide area in south-east Queensland, and on the northern tablelands and north coast of NSW, but is never common. Also found from Japan to central Eurasia. Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps (DEC 2005i). Often recorded in cleared and disturbed paddocks subject to moderate levels of grazing. According to the OEH species profile, this species is predicted to occur within the Clarence Lowlands sub-region.	Yes Marginal potential habitat within proposal area
<i>Cryptostylis hunteriana</i> Leafless tongue orchid	V	V	This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996). Within the Central Coast bioregion, this species has been recorded within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland (Bell 2001). This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by <i>Eucalyptus sclerophylla</i> , <i>E. sieberi</i> , <i>Corymbia gummifera</i> and <i>Allocasuarina littoralis</i> ; appears to prefer open areas in the understorey of this community and is often found in association with the <i>Cryptostylis subulata</i> (DEC 2005s). It occurs in the following Catchment Management Regions Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers and Southern Rivers.	No

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Eucalyptus tetrapleura</i> Square-fruited ironbark	V	V	Restricted to the coastal lowlands and foothills of northern NSW around Casino and Grafton. Dry or moist eucalypt forest on moderately fertile soil, often in low areas with poor drainage (DEC 2005).	Yes Marginal potential habitat within proposal area
<i>Hydrocharis dubia</i> Frogbit	V		Aquatic perennial with emergent and floating leaves; stolons rooted in shallow water, floating across deeper water. Grows in small shallow freshwater bodies or swamps. It is known from north of Kempsey, in New South Wales, to Fletcher River, near Charters Towers, and south-east Queensland. The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities: Swamp tea-tree (<i>Melaleuca irybana</i>) forest in south-east Queensland, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, and Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) (DEWHA 2010a).	Yes Marginal potential habitat within proposal area
<i>Marsdenia longiloba</i> Slender marsdenia	V	E1	Scattered sites on the north coast of NSW north from Barrington Tops. Also occurs in south-east Queensland. Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops (DEC 2005•).	No
<i>Melaleuca irybana</i> Weeping paperbark		E1	Found in only a few places in north-east NSW, including near Coraki, Casino and Coutts Crossing south of Grafton. Also occurs in near Ipswich south-east Queensland. Open eucalypt forest in poorly drained, usually clay, soils (DEC 2005~).	No
<i>Niemeyera whitei</i> Syn. <i>Amorphospermum whitei</i> Rusty plum		V	Found in littoral and warm-temperate rainforest (Harden 1993) and the adjacent understorey of moist eucalypt forest. Rusty plum occurs in the coast and adjacent ranges of northern NSW from the Macleay River into southern Queensland. Its distributional stronghold is on the mid north coast around Coffs Harbour (DEC 2005f).	No - the two records from within the locality are dated from 1918
<i>Phyllanthus microcladus</i> Brush sauropus		E1	In NSW confined to a few locations in the Tweed, Brunswick, Richmond and Wilson River Valleys with an outlying population near Grafton. Also occurs in south-east Queensland. Usually found on banks of creeks and rivers, in streamside rainforest (DEC 2005£).	No
<i>Polygala linariifolia</i> Native milkwort		E1	North from Copeton Dam and the Warialda area to southern Queensland. Also found on the NSW north coast near Casino and Kyogle and in Western Australia. Sandy soils in dry eucalypt forest and woodland with a sparse understorey (DEC 2005¤).	No

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Prostanthera spinosa</i> Spiny mint-bush		V	<i>Prostanthera spinosa</i> occurs in NSW, Victoria and South Australia. In NSW it is located within a small area to the north of Grafton in the NSW North Coast bioregion. The NSW occurrence of <i>P. spinosa</i> is very restricted and disjunct, separated by more than 1000 km from other occurrences in Victoria and South Australia, and may represent a distinct taxon. There are five populations of <i>Prostanthera spinosa</i> known from confirmed records, and possibly several other small populations from anecdotal sightings in Banyabba Nature Reserve. The confirmed records include locations within Fortis Creek National Park and Banyabba Nature Reserve. All known populations are within a linear range of 16-20 km.	No
<i>Taeniophyllum muelleri</i>	V	P13	Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges, from sea level to 250 m alt., north from the Bellinger R (Harden 1993).	No
<i>Triplarina imbricata</i>	E	E1	Found only in a few locations in the ranges south-west of Glenreagh and near Tabulam in north-east NSW. Also dubiously recorded from Parramatta (before 1810). Habitat is along watercourses in low open forest with Water Gum (<i>Tristaniopsis laurina</i>) (DEC 2005 ³).	No
<i>Tylophora woollsii</i> Cryptic forest twiner	E	E1	Found in wet sclerophyll forest and rainforest (Harden 1991). Co-occurring species include <i>Acacia melanoxylon</i> , <i>A. binervata</i> , <i>Caldcluvia paniculata</i> , <i>Ehretica acuminata</i> , <i>Eucalyptus microcorys</i> , <i>E. saligna</i> , <i>Schizomeria ovata</i> and <i>Syncarpia</i> spp. (NPWS 1999l).	No
Species known or predicted to occur within the Clarence Lowlands catchment management authority sub-region (not already listed above)				
<i>Acacia ruppilii</i> Rupp's wattle	E	E1	Occurs at altitudes of 50 - 150 m in the Banyabba - Coaldale area to the north-west of Grafton. Although plentiful in some locations it is restricted to a small area. Occurs in dry open forest and shrubland in sandstone areas, often near creeks and on roadsides. Grows in the understorey below Needlebark stringybark (<i>Eucalyptus planchoniana</i>), Red bloodwood (<i>Corymbia gummifera</i>) and Smudgy apple (<i>Angophora woodsiana</i>) (DEC 2005b).	No
<i>Acalypha eremorum</i> Acalypha	-	E1	Though widespread and moderately common in south-east Queensland, in NSW it occurs in only a few localities, including the Chaelundi, Lismore and Burringbar areas. It is found in subtropical rainforest, dry rainforest and vine thickets (DEC 2005c).	No
<i>Acronychia littoralis</i> Scented acronychia	E	E1	Found in littoral rainforest on sand. Scented acronychia is found between Fraser Island in Queensland and Port Macquarie on the north coast of NSW (Horton 1997).	No
<i>Aldrovanda vesiculosa</i> Waterwheel plant		E1	This aquatic herb grows in freshwater (Harden 1990). Also found near-coastal shallow freshwater ponds and wetlands poor in lime and rich in organic matter. The species is more commonly found in northern Australia and tropical regions of Asia and Africa. Known in NSW only from wetlands in the Moruya area and the Evans Head area in the north-east (DEC 2005d). Within the Clarence Lowlands catchment management authority sub-region, this species is restricted to within 5 km of the coast.	No
<i>Archidendron hendersonii</i> White lace flower		V	From north Queensland south to the Richmond River in north-east NSW. It is found on a variety of soils including coastal sands and those derived from basalt and metasediments. Riverine and lowland subtropical rainforest and littoral rainforest (DEC 2005h).	No

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Belvisia mucronata</i> Needle-leaf fern		E1	In Australia, this species is restricted to Queensland and NSW. In NSW, it is known from only five locations on the far north coast, north from Evans Head. The southern distributional limit for this species is north east of Grafton. Forms small clumps on trees or rocks in dry rainforest or along creeks in moist open forest. Occurs in low numbers at all sites (DEC 2005k).	No
<i>Boronia umbellata</i>	V	V	This species occurs on the coastal ranges between Athol Glen & Coramba, north of Coffs Harbour, north-eastern NSW. Twelve populations are known, one of which is conserved in Madmans Ck Flora Reserve. This plant has also been collected from Wedding Bells State Forest. This species occurs in coastal ranges, in sclerophyll forest on sandstone & metasediments at 100-600 m alt. It also occurs in heath, mainly at low to medium altitudes. Variable geology and soils are favoured. Flowering occurs June-Nov (DEWHA 2010b).	No
<i>Centranthera cochinchinensis</i> Swamp foxglove		E1	Occurs in northern Australia and south-east Asia and known from NSW north from Wooli. Recorded in swampy areas and other moist sites (DEC 2005n). Predicted to occur within Swamp Oak swamp forest of the coastal lowlands of the North Coast and Forest Red Gum - Swamp Box of the Clarence Valley lowlands of the North Coast	No
<i>Chamaesyce psammogeton</i> Sand spurge		E1	Found sparsely along the coast from south of Jervis Bay to Queensland, in the following catchment regions - Hunter/central rivers, Hawkesbury/Nepean, Northern Rivers, Southern Rivers, Sydney Metropolitan. Populations have been recorded in Wamberal Lagoon Nature Reserve, Myall Lakes National Park and Bundjalung National Park. Grows on fore-dunes and exposed headlands, often with <i>Spinifex sericeus</i> . Flowering occurs in summer, with plant growth occurring in spring and summer (DEC 2005o). Likes disturbed edges of tracks leading through fore dunes (N.Smith pers. Comm.).	No
<i>Clematis fawcettii</i> Stream clematis	V	V	Found in widely dispersed areas in southern Queensland and in north-east NSW north from Lismore. Drier rainforest, usually near streams (DEC 2005a)	No
<i>Corynocarpus rupestris</i> ssp. <i>Rupestris</i> Glenugie karaka	V	V	This tree is known only from Glenugie Peak Flora Reserve, south-east of Grafton. Dry rainforest on steep basalt boulder slopes. Soil is scarce but relatively high in nutrients and very well-drained. Fire is generally excluded by the rocky terrain and absence of ground litter (DEC 2005q).	No
<i>Cryptocarya foetida</i> Stinking cryptocarya	V	V	Coastal south-east Queensland and north-east NSW south to Iluka. Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils. The seeds are readily dispersed by fruit-eating birds, and seedlings and saplings have been recorded from other habitats where they are unlikely to develop to maturity. Though seedlings can be fairly numerous, few mature trees are known (DEC 2005r).	No

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Cynanchum elegans</i> White-flowered wax plant	E	E1	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005 ²). <i>Cynanchum elegans</i> usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; <i>Leptospermum laevigatum</i> , <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> ; <i>Eucalyptus tereticornis</i> open forest and woodland; <i>Eucalyptus maculata</i> open forest and woodland; and <i>Melaleuca armillaris</i> scrub to open scrub (DEC 2005 ²). Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific (DEC 2005 ²).	No
<i>Cyperus aquatilis</i> Water nutgrass		E1	In NSW, known only from a few sites north from Grafton. Also occurs in Queensland, Northern Territory, Western Australia and New Guinea. Grows in ephemerally wet sites, such as roadside ditches and seepage areas from small cliffs, in sandstone areas (DEC 2005t).	No
<i>Davidsonia jerseyana</i> Davidson's plum	E	E1	Restricted to south-east Queensland and north-east NSW to as far south as Wardell. The Davidson's Plum is found in coastal and lowland subtropical rainforest and wet sclerophyll forest, often with an overstorey including <i>Lophostemon confertus</i> (Brush Box), <i>Araucaria cunninghamii</i> (Hoop Pine) and/or eucalypt species. Species commonly occurring at Davidson's plum sites include <i>Acacia bakeri</i> (Marblewood), <i>Cupaniopsis newmanii</i> (Longleaved tuckeroo), <i>Endiandra globosa</i> (Black walnut), <i>Eucalyptus microcorys</i> (Tallowwood), <i>Flindersia bennettiana</i> (Bennett's ash), <i>Flindersia schottiana</i> (Cudgerie), <i>Pentaceras australe</i> (Crow's ash), <i>Synoum glandulosum</i> (Scentless rosewood) and the introduced <i>Cinnamomum camphora</i> (Camphor laurel). Many trees are isolated in paddocks and on roadsides in former rainforest habitats (DEC 2004).	No
<i>Davidsonia johnsonii</i> Smooth davidson's plum	E	E1	Restricted distribution in south-east Queensland and north-east NSW south to Tintenbar. This species is found in lowland subtropical rainforest and wet eucalypt forest at low altitudes (below 300m). Many trees are isolated in paddocks and on roadsides in cleared land (NPWS 1999d).	No
<i>Dendrobium melaleucaphilum</i> Spider orchid		E1	Occurs in coastal districts and nearby ranges, extending from Queensland to its southern distributional limit in the lower Blue Mountains. In NSW, it is currently known from seven recent collections. There has been no subsequent confirmation from the locations of three earlier (pre-1922) collections and it is possible that these are now extinct. Grows frequently on <i>Melaleuca styphelioides</i> , less commonly on rainforest trees or on rocks in coastal districts. Flowers July – October (DEC 2005u).	Yes Marginal potential habitat within proposal area
<i>Desmodium acanthocladum</i> Thorny pea	V	V	Occurs only in north-east NSW. It is found in the Lismore area, and there are also records from near Grafton, Coraki, Casino and the Mount Warning area. Occurs in dry rainforest and fringes of riverine subtropical rainforest on basalt-derived soils and at low elevations (DEC 2005v).	No

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<i>Diploglottis campbelli</i> Small-leave tamarind	E	E1	Recorded from the coastal lowlands between Richmond River on the Far North Coast of NSW and Mudgeeraba Creek on the Gold Coast hinterland, Queensland. Confined to the warm subtropical rainforests of the NSW-Queensland border lowlands and adjacent low ranges. The forest types in which the species occurs vary from lowland subtropical rainforest to drier subtropical rainforest with a Brush Box open overstorey. Occurs on basalt-derived soils and also on poorer soils such as those derived from quartz monzonite. Flowering times vary across its range depending on latitude and to some extent annual seasonal variations. Ripe fruits are generally present from January to early April, with peak fruiting during the last week of February and early March (DEC 2005w).	No
<i>Drynaria rigidula</i> Basket fern		E1	Occurs widely in eastern Queensland as well as islands of the Pacific and parts of south-east Asia. In NSW it is only found north of the Clarence River, in a few locations at Maclean, Bogangar, Byron Bay, Mullumbimby, in the Tweed Valley and at Woodenbong. Grows on plants, rocks or on the ground. Usually found in rainforest but also in moist eucalypt and Swamp Oak forest (DEC 2005x).	No
<i>Eleocharis tetraquetra</i> Square-stemmed spike-rush		E1	Thought to be extinct in NSW until it was rediscovered in 1997 at Boambee near Coffs Harbour. It has since been found in other north coast localities near Grafton and Murwillumbah. The species also occurs in south-east Queensland. Found in damp locations on stream edges and in and on the margins of freshwater swamps (DEC 2005z).	Yes Marginal potential habitat within proposal area
<i>Elyonurus citreus</i> Lemon-scented grass		E1	Lemon-scented Grass occurs north from Grafton in NSW. It is only known from localities south of Casino, north-west of Grafton, near Cudgen Lake on the Tweed coast and in Yuraygir National Park. It also occurs in Queensland, NT, WA and New Guinea. Lemon-scented Grass grows in sandy soils near rivers or along the coast in wallum areas or sand dunes. At the NSW locations, the species has been found growing in infertile white sands (DEC 2005{).	No
<i>Endiandra floydii</i> Floyd's walnut	E	E1	Confined to the Tweed and Brunswick Valleys and Byron Bay area of north-east NSW, and to one or two locations in south-east Queensland. Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest (DEC 2005j).	No
<i>Endiandra hayesii</i> Rusty rose walnut	V	V	A restricted distribution from Burleigh Heads in Queensland to the Richmond River in north-east NSW. It is locally abundant in some parts of its range in NSW. Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils (DEC 2005}).	No
<i>Endiandra muelleri</i> ssp. <i>Bracteata</i> Green-leaved rose walnut		E1	Occurs in Queensland and in north-east NSW south to Maclean. It is sparsely distributed within this range. Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes (DEC 2005~).	No
<i>Eucalyptus glaucina</i> Slaty red gum	V	V	Occurs near Casino and from Taree to Broke where it is locally common but very sporadic. Found in grassy woodland on deep, moderately fertile and well watered soil (Harden 2002). Previously recorded within Central Hunter Riparian Forest (mu13) (NPWS 2004). Within the Clarence Lowlands catchment management authority sub-region this species restricted areas north of Grafton.	No

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<i>Fontainea oraria</i> Coastal fontainea	E	E1	Restricted to a small number of trees at Lennox Head in north-east NSW. Coastal fontainea occurs in remnant regrowth littoral rainforest on highly fertile red-brown krasnozems derived from the basalt. These remnants occur on stony slopes within 1km of the sea and at about 50 m above sea level (DEC 2005).	No
<i>Geijera peniculata</i> Axe-breaker		E1	Moderately common in restricted habitat in Queensland between the Brisbane River and the central Queensland coast, but very rare in north-east NSW, where it is known from the Tweed, Lismore and Wardell areas. Axebreaker is found in dry subtropical rainforest and vine scrub, often along rivers (DEC 2005).	No
<i>Geodorum densiflorum</i> Pink nodding orchid		E1	There are thought to be less than 20 populations of Pink nodding orchid in NSW, all north of Bundjalung National Park, and including Tweed Shire. The species also occurs in Queensland. Occurs in dry eucalypt forest and coastal swamp forest at lower altitudes, often on sand (DEC 2005).	No
<i>Gossia frangrantissima</i> Sweet myrtle	E	E1	Occurs in south-east Queensland and in north-east NSW south to the Richmond River. Within the Clarence Lowlands CMW sub-region this species is restricted to areas north of Evans Head. Mostly found on basalt-derived soils. Dry subtropical and riverine rainforest. As it can coppice from roots left in the ground when rainforest is cleared, it is found at several sites as isolated plants in paddocks or regrowth (DEC 2005...).	No
<i>Grammitis stenophylla</i> Narrow-leaf finger fern		E1	Occurs in eastern NSW in the Sydney Metropolitan, Hawkesbury/Nepean, and Northern Rivers Catchment. It has been found on the south, central and north coasts and as far west as Mount Kaputar National Park near Narrabri (DEC 2005†). Grows in small colonies in moist places, usually on rocks or trees near streams in rainforest and moist eucalypt forest (DEC 2005†).	No
<i>Grevillea banyabba</i>	V	V	Restricted to the Fortis Creek–Coaldale area between Grafton and Whiporie. Most plants are in one population in the Banyabba Nature Reserve. Habitat is shrubby open eucalypt forest growing on low ridges and slopes with poor sandy soil. Often growing in association with Bastard white mahogany <i>Eucalyptus psammitica</i> , Sandstone rough-barked apple <i>Angophora robur</i> and Pink bloodwood <i>Corymbia intermedia</i> . (DEC 2005%).	No
<i>Grevillea masonii</i> Mason's grevillea	E	E1	Occurs in only a few locations between Grafton and Casino in north-eastern NSW. Occurs on gravelly loam soils and in sand in open eucalypt woodland (DEC 2005§).	No
<i>Grevillea quadricauda</i>		V	In NSW it is found to the north-west of Whiporie in Mount Belmore State Forest and Mount Neville Nature Reserve, and at Tucabia east of Grafton. It also occurs near Toowoomba in south-east Queensland. Grows in gravelly loam, in the understorey of dry eucalypt forest, usually along or near creeks (DEC 2005).	No
<i>Hedyotis galiodes</i> Sweet false galium		E1	In north-east NSW, known from Whiporie State Forest south of Casino and one location in the Tweed district. Also occurs on the north-west plains of NSW and in Queensland, Northern Territory and Western Australia. Habitat is margins of seasonally inundated wetlands in paperbark swamps and Forest red gum <i>Eucalyptus tereticornis</i> woodlands (DEC 2005).	No

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<i>Hibbertia marginata</i> Bordered Guinea Flower	V	V	Occurs only in north-east NSW, where it is restricted to the southern Richmond Range between Casino and Grafton. Most often found in grassy or shrubby dry open eucalypt forest at low altitudes on sandstone(DEC 2005Ž).	No
<i>Lindernia alsinoides</i> Noah's false chickweed		E1	North from Buladelah. Currently known from Shannon Creek (south west of Grafton). Pre-1925 records from Buladelah and Coopernook. Grows in swampy sites in sclerophyll forest and coastal heath. At Shannon Creek, occurs in damp paperbark swamp with <i>Melaleuca alternifolia</i> and <i>Melaleuca quinquinervia</i> (DEC 2005').	No
<i>Lindsaea incisa</i> Slender screw fern		E1	In NSW it is known only from a few locations between Woombah and just south of Coffs Harbour. Also occurs in north and south-east Queensland. Occurs in dry eucalypt forest on sandstone and moist shrubby eucalypt forest on metasediments. It is usually found in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly (DEC 2005').	No
<i>Macadamia tetraphylla</i> Rough-leaved Queensland nut	V	V	Confined chiefly to the Richmond and Tweed Rivers in north-east NSW, extending just across the border into Queensland. This species is found in subtropical rainforest, usually near the coast (DEC 2005").	No
<i>Maundia triglochinosides</i>		V	<i>Maundia triglochinosides</i> is restricted to Coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct. Catchment Regions include Hunter/Central Rivers, Northern Rivers and Sydney Metropolitan (DEC 2005—). Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. It is associated with wetland species e.g. <i>Triglochin procerum</i> and vegetation communities such as Dry Sclerophyll Forests, Forested wetlands, and Freshwater wetlands (DEC 2005—). Flowering occurs during warmer months. Flowers November-January (DEC 2005—).	No
<i>Melichrus hirsutus</i>		E1	Restricted to a few locations near Grafton in north-east NSW. Prefers Dry eucalypt forest with a shrubby understorey on sandy infertile soils with rock outcrops. Found in the Northern Rivers Catchment (DEC 2005™).	No
<i>Melichrus sp. 'Gibberagee'</i> Narrow-leaf melichrus	E	E1	Restricted to north-east NSW. Known only from a single population in Gibberagee State Forest and adjacent private property, about 40 km south of Casino. Occurs in low-altitude dry eucalypt forest on gentle slopes(DEC 2005§).	No
<i>Myrsine richmondensis</i> Ripple-leaf muttonwood		E1	Subtropical and dry rainforest and swamp forest on creek flats and slopes on basalt derived soil (DEC 2005›).	Yes Marginal potential habitat within proposal area
<i>Oberonia titania</i> Red-flowered king of the fairies		V	Red-flowered king of the fairies occurs on the NSW north coast north from Kendall, and also in Queensland and Norfolk Island. It is known from 10 locations in NSW, two of which occur within Dorrigo National Park and Washpool National Park. Occurs in littoral and subtropical rainforest and paperbark swamps, but it can also occur in eucalypt-forested gorges and in mangroves (DEC 2005œ).	No

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<i>Ochrosia moorei</i> Southern ochrosia	E	E1	Southern ochrosia is found in north-east NSW north from the Richmond River, and in south-east Queensland. It is very sparsely distributed within this range. Southern ochrosia is found in riverine and lowland subtropical rainforest (DEC 2005).	Yes Marginal potential habitat within proposal area
<i>Oldenlandia galioides</i> Sweet false galium		E1	In north-east NSW, known from Whiporie State Forest south of Casino and one location in the Tweed district. Also occurs on the north-west plains of NSW and in Queensland, Northern Territory and Western Australia. Occurs on the margins of seasonally inundated wetlands in paperbark swamps and Forest Red Gum <i>Eucalyptus tereticornis</i> woodlands (DEC 2005ž).	No
<i>Parsonsia dorrigoensis</i> Milky silkpod	E	V	<i>Parsonsia dorrigoensis</i> is found only within NSW, with scattered populations in the north coast region between Kendall and Woolgoolga (Hunter/Central Rivers and Northern Rivers Catchment) (DEC 2005Ÿ). <i>P. dorrigoensis</i> is found in subtropical and warm-temperate rainforests, especially in more open parts and on rainforest margins, and in wet sclerophyll forests (tall open forests) on brown clays overlying metasediments (NPWS 1999a). Associated species include <i>Lophostemon confertus</i> , <i>Eucalyptus campanulata</i> , <i>E.microcorys</i> , <i>E. pilularis</i> , <i>E. saligna</i> , <i>Schizomeria ovata</i> , <i>Acmena smithii</i> , <i>Trochocarpa laurina</i> , and <i>Tristaniopsis collina</i> (NPWS 1999a). Flowers in summer. Appears to be able to withstand, and maybe even favour, light to moderate physical disturbance (DEC 2005Ÿ).	Yes Marginal potential habitat within proposal area
<i>Peristeranthus hillii</i> Brown fairy-chain orchid	-	V1	Found in north-eastern NSW, north from Port Macquarie, extending to north-eastern Queensland as far as the Bloomfield River. Restricted to coastal and near-coastal environments, particularly Littoral Rainforest and the threatened ecological community Lowland Rainforest on Floodplain. The species is an epiphyte, growing in clumps on tree trunks and thick vines. Flowers appear during September and October (DEC 2005).	No
<i>Persicaria elatior</i> Tall knotweed	V	V	Tall knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace and the Grafton area (Cherry Tree and Gibberagee State Forests). The species also occurs in Queensland. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance (DEC 2005j).	Yes Marginal potential habitat within proposal area
<i>Phaius australis</i> Lesser swamp-orchid	E	E1	Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie. Found in swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas (DEC 2005ø).	No

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<i>Phaius tankervilleae</i> Greater swamp-orchid	E	E1	This terrestrial orchid is found in coastal districts where it grows in <i>Melaleuca quinquinerva</i> swamps near sea level (Harden 1993). It may be extinct in north-east NSW.	No
<i>Prostanthera palustris</i> Swamp mint-bush	V	V	Only known from the Jerusalem Creek area in the north of Bundjalung National Park, near Evans Head. Grows in poorly drained sandy soils, subject to extended waterlogging, in wet shrubland to heathland (DEC 2005i).	No
<i>Pultenaea maritime</i> Coast headland pea		V1	Occurs in New South Wales and Queensland. Within NSW, the species has been recorded from Newcastle north to Byron Bay on 16 headlands, within the Hunter/Central Rivers and Northern Rivers Catchment. The number of individuals at each of these sites is unknown. Five sites occur within conservation reserves (DEC 2005§). The species occurs in grasslands, shrublands and heath on exposed coastal headlands. Vegetation Communities include: Grasslands, Heathlands and Sydney Coastal Heaths (DEC 2005§).	No
<i>Quassia sp. 'Moonee Creek'</i> Moonee quassia	E	E1	Scattered distribution from the Moonee Creek area north of Coffs Harbour to north-east of Grafton. Found in the shrub layer below tall moist eucalypt forest and tall dry eucalypt forest, including forest edges, mostly at lower altitudes (DEC 2005").	No
<i>Rapanea sp. Richmond River</i> Ripple-leaf muttonwood	E	E1	Known only from a few populations at Coraki, Boatharbour near Lismore, and the Cherry tree area west of Casino. Subtropical and dry rainforest and swamp forest on creek flats and slopes on basalt derived soil (DEC 2005©).	No
<i>Rotala tripartita</i> Rotala tripartita		E1	<i>Rotala tripartita</i> occurs in New South Wales, Queensland and the Northern Territory. In New South Wales the species is currently known from only two locations, one in the Casino district and one in the South Grafton area, in the northern part of the North Coast bioregion. These locations are separated by a distance of less than c. 100 km. The geographic distribution of the species in New South Wales is therefore highly restricted. There are no records in any reserve or State Forest. <i>Rotala tripartita</i> is a riparian species that grows in free-standing water with sedges. There appear to be extreme fluctuations in abundance of the species, with plants observed to germinate prolifically and establish in large numbers after substantial rainfall. Individuals disappear above-ground during dry periods and may only persist during these times in the soil seed-bank. Previous surveys in the South Grafton area located two populations of <i>Rotala tripartita</i> growing in exposed silty clay on the edges of farm dams that were about 150 m apart. Also known from Melaleuca freshwater coastal wetlands.	Yes Marginal potential habitat within proposal area

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<i>Rutidosia heterogama</i> Heath wrinklewort	V	V	<i>Rutidosia heterogama</i> is confined to the North Coast and Northern Tablelands regions of NSW. It occurs within the Border Rivers Gwydir, Hunter/Central Rivers and Northern Rivers (NSW) Natural Resource Management Regions. The species mostly inhabits heath, and is often found along disturbed roadsides (Harden 1992). It occurs on moist sites in open forest and in sedgeland/heathland within shrubby open forest and woodland (DEWHA 2008). The inland populations in the Torrington area occur on leuco-granitic geology, in heath, open forest and woodland. The coastal populations from Woolli to Evans Head occur on clay soil in grassland, heath, open forest and woodland (RACAC, undated) (DEWHA 2008). The distribution of the species overlaps with the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act-listed ecological community (DEWHA 2008).	No
<i>Sarcochilus hartmannii</i> Waxy sarcochilus	V	V	This terrestrial or epilithic orchid is found in sclerophyll forests or in exposed sites where it usually grows on volcanic rocks in shallow soils. Restricted to altitudes of 500-1000 m (Harden 1993). Favours cliff faces but also found occasionally at the bases of fibrous trunks of trees, including cycads and grass-trees. Occurs on the Richmond River in northern NSW to Gympie in south-east Queensland (DEC 2005«).	No
<i>Senna acclinis</i> Rainforest cassia		E1	Found in coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland. Grows in or on the edges of subtropical and dry rainforest (DEC 2005-).	No
<i>Sophora fraseri</i> Brush sophora	V	V	Occurs north from the Casino district in north-east NSW, where it is very rare. Also in south-east Queensland where it is widespread but not common. Brush Sophora is usually found in moist situations, often near rainforest (DEC 2005-).	No
<i>Sophora tomentosa</i> ssp. <i>Australis</i> Silverbush		E1	Silverbush occurs in coastal areas in Queensland and northern NSW. It was previously common north from Port Stephens but is now uncommon and found only north of Old Bar, near Taree. The largest known population, at Port Macquarie, is estimated at up to 500 plants, other populations are of less than 20 plants. Silverbush occurs on coastal dunes (DEC 2005@).	No
<i>Syzygium hodgkinsoniae</i> Red lilly pilly	V	V	A restricted range from the Richmond River in north-east NSW to Gympie in Queensland. Locally common in some parts of its range, but otherwise sparsely distributed. Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils (DEC 2005°).	No
<i>Thesium australe</i> Austral toad-flax	V	V	Found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. <i>Thesium australe</i> is a root parasite that takes water and some nutrient from other plants, especially Kangaroo grass (DEC 2005±). It is often found in damp sites in association with <i>Themeda australe</i> , but also found on other grass species at inland sites (G. Leonard pers. obs.). Occurs on clay soils in grassy woodlands or coastal headlands (James <i>et al.</i> 1999).	No
<i>Tinospora tinosporoides</i> Arrow-head vine	V	V	North from the Richmond River in north-east NSW, where it is locally common in some parts of its range. Also recorded from a single location in south-east Queensland. Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils (DEC 2005´).	No

APPENDIX 5

Threatened Fauna Habitat Descriptions

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Table 11: Threatened Fauna Habitat Table

Key: 1) Listed on the EPBC Act as Endangered (E), Critically Endangered (Z), Vulnerable (V) or Migratory (M)
2) Listed on the TSC Act as Endangered (E1), Endangered Population (E2), Critically Endangered (C1) or Vulnerable (V)

Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
Amphibians				
<i>Litoria aurea</i> Green and golden bell frog	V	E1	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC (NSW Government 2009). The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999g; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 6 weeks to develop, feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DEC 2005‡).	No (not previously recorded within 10km)
<i>Litoria brevipalmata</i> Green thighed frog		V	The majority of records for the species are in the NSW North Coast. There are disjunct records near Bulahdelah and in the ranges behind the Central Coast. Populations in NSW have declined over the last century (DEC 2005*). The Green Thighed Frog occurs within wet forests (swamp forests, wet sclerophyll forest and rainforest) (Cogger 2000; Robinson 1998; Barker <i>et al.</i> 1995), although records from dry sclerophyll forest have been reported within the northern part of its range (Nattrass and Ingram 1993; Aridis 1997). Habitat of the species is poorly known however, the species is thought to forage and shelter in areas of deep leaf litter, dense low vegetation, or both, during non-breeding times. Breeding occurs in flooded paddocks or waterholes next to forest (Barker, 1995 272 /id). The Green thighed frog is also considered to be partially arboreal, where it is thought to utilise trees and vegetation within only a few metres of the ground (Lemckert and Slatyer 2002).	No (not previously recorded within 10km)
<i>Litoria olongburensis</i> Wallum sedge frog	V	V	The Olongburra frog (Wallum sedge frog) is only known from well vegetated acid swamps and streams on coastal sand masses (Tyler and Australia. 1997).	No (not previously recorded within 10km)
<i>Crinia tinnula</i> Wallum froglet		V	The Wallum froglet is a coastal species, confined to acid, paperbark swamps and sedge swamps of the "wallum" country. The species occurs from near Noosa in southern Queensland south to the central coast of NSW, with a disjunct population on Kurnell Peninsula (Cogger 2000; DECC 2005d). The species is a late winter breeder and males call in choruses from within sedge tussocks or at the water edge (DECC 2005d).	No (not previously recorded within 10km)
<i>Mixophyes balbus</i> Stuttering frog	V	E1	This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker <i>et al.</i> 1995). It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker <i>et al.</i> 1995).	No (not previously recorded within 10km)

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<i>Mixophyes iterates</i> Giant barred frog	E	E1	Occurs along coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. Found in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m, often hiding in leaf litter near permanent fast-flowing streams. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. When not breeding the frogs disperse hundreds of metres away from streams (DEC 2005f).	No (not previously recorded within 10km)
Birds				
<i>Circus assimilis</i> Spotted harrier		V	The Spotted harrier is found throughout Australia but rarely in densely forested and wooded habitat of the escarpment and coast (NSW Scientific Committee 2010b). Preferred habitat consists of open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, acacia and mallee remnants, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation (NSW Scientific Committee 2010b). The Spotted harrier is more common in drier inland areas, nomadic part migratory and dispersive, with movements linked to the abundance of prey species. Nesting occurs in open or remnant woodland and unlike other harriers, the Spotted harrier nests in trees (Marchant and Higgins 1993).	Yes
<i>Erythrotriorchis radiatus</i> Red goshawk	V	C1	Occur in forest and woodland habitat near permanent water. In NSW prefer Melaleuca swamp forest and open eucalypt woodland (Marchant and Higgins 1993). Require greater than 20 m tall trees for nesting (Marchant and Higgins 1993).	Yes
<i>Haliaeetus leucogaster</i> White-bellied sea-eagle	M		A migratory species that is generally sedentary in Australia, although immature individuals and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees (Marchant and Higgins 1993).	Yes, recorded during Aug 2010 and July 2011 surveys
<i>Hieraaetus morphnoides</i> Little eagle		V	The Little eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species (NSW Scientific Committee 2009b). It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests (Marchant and Higgins 1993).	Yes
<i>Lophoictinia isura</i> Square-tailed kite		V	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by <i>Eucalyptus longifolia</i> , <i>Corymbia maculata</i> , <i>E. elata</i> or <i>E. smithii</i> (NPWS 1999k). Individuals appear to occupy large hunting ranges of more than 100 km ² . They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993).	Yes

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<i>Pandion haliaetus</i> Osprey	M	V	Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers (Pizzey and Knight 1997). It is water-dependent, hunting for fish in clear, open water. The Osprey occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea (Marchant and Higgins 1993).	Yes
<i>Nettapus coromandelianus</i> Cotton pygmy-goose		E1	The Cotton pygmy-goose is found along the coast from Northern Queensland extending south into Victoria. It is considered a vagrant throughout the southern extent of its range (Morcombe 2003). The Cotton Pygmy-goose is rarely seen on land, preferring deep permanent water including freshwater swamps, lagoons, dams, with water lilies and other semi-emergent water plants (Pizzey and Knight 2007). In the north it will move onto the floodplains following the wet season rain.	No (not previously recorded within 10km)
<i>Oxyura australis</i> Blue-billed duck		V	Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990).	Yes, potential habitat along Clarence River
<i>Stictonetta naevosa</i> Freckled duck		V	The Freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).	Yes, potential habitat along Clarence River
<i>Anseranas semipalmata</i> Magpie goose		V	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges. They are often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes (DEC 2005"). Breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level. Nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW (DEC 2005"). Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation (DEC 2005").	Yes
<i>Apus pacificus</i> Fork-tailed swift	M		Almost exclusively aerial (foraging). The Fork-tailed swift breeds in Asia but migrates to Australia from September to April (Higgins 1999). Individuals or flocks can be observed hawking for insects at varying heights from only a few metres from the ground and up to 300 metres high (Boehm 1944).	Yes
<i>Hirundapus caudacutus</i> White-throated Needletail	M		An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breed in Asia (Pizzey and Knight 1997).	Yes
<i>Ardea alba</i> Great egret	M		Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare salt pans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	Yes

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<i>Ardea ibis</i> Cattle egret	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).	Yes, recorded during Aug 2010 and July 2011 surveys
<i>Botaurus poiciloptilus</i> Australasian bittern		V	The Australasian bittern is distributed across south-eastern Australia. Often found in terrestrial and estuarine wetlands, generally where there is permanent water with tall, dense vegetation including <i>Typha</i> spp. and <i>Eleocharis</i> spp. (DECC 2005a; NPWS 1999b). Typically this bird forages at night on frogs, fish and invertebrates, and remains inconspicuous during the day. The breeding season extends from October to January with nests being built amongst dense vegetation on a flattened platform of reeds (DECC 2005a).	Yes, marginal potential habitat
<i>Ixobrychus flavicollis</i> Black bittern		V	The Black bittern is found along the coastal plains within NSW, although individuals have rarely been recorded south of Sydney or inland. It inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation (DEC 2005l; NPWS 1999c). The Black Bittern typically roosts on the ground or in trees during the day and forages at night on frogs, reptiles, fish and invertebrates (DEC 2005l). The breeding season extends from December to March. Nests are constructed of reeds and sticks in branches overhanging the water.	Yes, marginal potential habitat
<i>Burhinus grallarius</i> Bush stone-curlew		E1	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993).	Yes, marginal potential habitat
<i>Esacus neglectus</i> Beach stone-curlew		C1	Occurs on open, undisturbed beaches, islands, reefs and estuarine intertidal sand and mudflats (Marchant and Higgins 1993).	No (not previously recorded within 10km)
<i>Calyptorhynchus banksii banksii</i> Red-tailed black-cockatoo (coastal)		C1	Occur in a wide variety of habitats, but prefer eucalypt forest and woodland, and often in adjacent Acacia or casuarina woodland or proteaceous woodland or shrubland, especially if recently burnt (Higgins 1999). Fertile riparian flats and floodplains	No (not previously recorded within 10km)
<i>Calyptorhynchus lathami</i> Glossy black-cockatoo		V	Inhabits forest with low nutrients, characteristically with key <i>Allocasuarina</i> species. Tends to prefer drier forest types (NPWS 1999e). Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	Yes, marginal potential habitat
<i>Coracina lineate</i> Barred cuckoo-shrike		V	Found in rainforests, vine thickets and their margins. Also found in eucalypt forests and clearing in secondary growth forests (Pizzey and Knight 1997).	Yes
<i>Dromaius novaehollandiae</i> Emu (endangered population)		E2	Emu population in the NSW North Coast Bioregion and Port Stephens Local Government Area occurs in open forest, woodland, coastal heath, coastal dunes, wetland areas, tea tree plantations and open farmland, and occasionally in littoral rainforest (NPWS 2002).	No (one record 12 km north-east of the existing bridge, on the edge of the Clarence River)

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<i>Charadrius leschenaultia</i> Greater sand plover	M	V	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries and roosting during high tide on sandy beaches or rocky shores. Individuals have been recorded on inshore reefs, rock platforms, small rocky islands and sand cays on coral reefs, within Australia. Occasional sightings have also occurred on near-coast saltlakes, brackish swamps, shallow freshwater wetlands and grassed paddocks (NPWS 1999f).	No (not previously recorded within 10km)
<i>Charadrius mongolus</i> Lesser sand plover	M	V	In Australia, the species is known to favour coastal environs including beaches, mudflats and mangroves. Within NSW, individuals have been observed on intertidal sand and mudflats in estuaries or roosting on sandy beaches or rocky shores at high tide (NPWS 1999h).	No (not previously recorded within 10km)
<i>Ephippiorhynchus asiaticus</i> Black-necked stork		E1	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997).	Yes
<i>Climacteris picumnus victoriae</i> Brown treecreeper (eastern subspecies)		V	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	Yes, marginal potential habitat
<i>Ptilinopus magnificus</i> Wompoo fruit-dove		V	Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Ptilinopus regina</i> Rose-crowned fruit-dove		V	Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Ptilinopus superbus</i> Superb fruit-dove		V	The Superb Fruit Dove's NSW distribution ranges from northern NSW to as far south as Moruya (DEC 2005 ⁻). It is found in rainforests, closed forests (including mesophyll vine forests) and sometimes in eucalypt and acacia woodlands where there are fruit-bearing trees (Higgins and Davies 1996). It forages in the canopy of fruiting trees such as figs and palms. Nests are constructed high in the canopy throughout September to January (DEC 2005 ⁻).	No (not previously recorded within 10km)
<i>Cuculus saturatus</i> Oriental cuckoo	M		Canopy or shrub layer of monsoon rainforest, vine thickets, wet sclerophyll forest, or open casuarina, Acacia or Eucalyptus woodland (Higgins 1999).	Yes
<i>Monarcha leucotis</i> White-eared monarch		V	Restricted to eastern Queensland and the NSW north coast from Cape York south to Iluka at the mouth of the Clarence River and occur west only as far as the Richmond Range. Occasionally found further south in the vicinity of Coffs Harbour and Port Macquarie. In NSW this species occurs primarily in coastal rainforest, swamp forest and wet eucalypt forest. It appears to favour rainforest edges where trees are frequently covered with vines and through the canopy of more extensive patches of rainforest. Occurs in rainforest, sometimes mangroves and paperbark swamps (DEC 2005 ^μ).	Yes
<i>Monarcha melanopsis</i> Black-faced monarch	M		A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).	Yes

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<i>Monarcha trivirgatus</i> Spectacled monarch	M		Found in darker parts of mountain and lowland rainforest, adjacent to thickly wooded gullies (Pizzey and Knight 1997).	Yes
<i>Myiagra cyanoleuca</i> Satin flycatcher	M		Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).	Yes
<i>Rhipidura rufifrons</i> Rufous fantail	M		Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).	Yes
<i>Grus rubicunda</i> Brolga		V	The Brolga has been recorded on open wetlands, shallow swamps, floodplains, paddocks, farmland and salt flats (NPWS 1996). This species nest in shallow wetlands where there is shelter such as canegrass, lignum or sedge swamp. They feed in or near water and have often been observed foraging in grassland, dry wetlands and cultivated areas (NPWS 1996).	Yes, marginal potential habitat
<i>Haematopus fuliginosus</i> Sooty oystercatcher		V	The Sooty Oystercatcher is found on undisturbed tidal rocks on ocean shores and islands. Occasionally it is observed on sandspits and mudflats (Pizzey and Knight 1997). It forages on exposed rock or coral at low tide for limpets and mussels. The Sooty Oystercatcher breeds in spring and summer almost exclusively offshore or on isolated promontories (DECCW 2005).	No (not previously recorded within 10km)
<i>Haematopus longirostris</i> Pied oystercatcher		E1	An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Its food supply (beach macroinvertebrates) have been negatively affected by human impacts (NSW Scientific Committee 2010a). The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. A pair will re-nest in the same spot each year, rarely shifting their territory (NSW Scientific Committee 2010a). Occasionally the Pied Oystercatcher is found in paddocks near the coast (Pizzey and Knight 1997).	Yes, marginal potential habitat
<i>Todiramphus chloris</i> Collared kingfisher		V	Occurs in mangroves and coastal areas (Simpson and Day 1996).	No (not previously recorded within 10km)
<i>Irediparra gallinacean</i> Comb-crested jacana		V	Occurs in freshwater wetlands, lagoons, Billabongs, swamps, lakes, rivers and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1993).	Yes
<i>Gygis alba</i> White tern		V	The extreme west of this species' range touches the mid-east coast of Australia, where it may be occasionally observed during the breeding season foraging over reefs (Morcombe 2003). Otherwise this pelagic species only comes to land to breed which occurs exclusively on Lord Howe and Norfolk Islands (Pizzey and Knight 2007).	No
<i>Sterna albifrons</i> Little tern	M	E1	The Little tern favours sheltered coasts, harbours, bays, lakes, inlets, estuaries, coastal lagoons and ocean beaches especially with sand-spits and sand islets (Higgins and Davies 1996; Morcombe 2003). It forages over shallow waters close inshore or over sandbars and reefs (Morcombe 2003).	No (not previously recorded within 10km)
<i>Sterna caspia</i> Caspian tern	M		Usually coastal, with a preference for sheltered estuaries, inlets, bays, harbours, lagoons with muddy or sandy shores. Keeps close inshore, not out beyond reef line. Also extends well inland on fresh or salt lakes, temporary floodwaters, large rivers, reservoirs, sewage ponds (Morcombe 2003).	Yes

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<i>Sterna fuscata</i> Sooty tern		V	The Sooty tern is a pelagic species found over tropical waters where it feeds offshore far away from land. It breeds off the coast of WA and QLD rarely venturing to the south-east of Australia (Morcombe 2003; Higgins and Davies 1996).	No
<i>Sterna hirundo</i> Common tern	M		Marine, typically well offshore, but also in coastal waters, sheltered bays, estuaries, and on ocean beaches (Morcombe 2003).	Yes, recorded during Aug 2010 and July 2011 surveys
<i>Anthochaera phrygia</i> Regent honeyeater	E	E1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999i; Pizzey and Knight 1997). Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: <i>E. microcarpa</i> , <i>E. punctata</i> , <i>E. polyanthemos</i> , <i>E. mollucana</i> , <i>Corymbia robusta</i> , <i>E. crebra</i> , <i>E. caleyi</i> , <i>C. maculata</i> , <i>E. mckieana</i> , <i>E. macrorhyncha</i> , <i>E. laevopinea</i> , and <i>Angophora floribunda</i> . Nectar and fruit from the mistletoes <i>A. miquelii</i> , <i>A. pendula</i> , <i>A. cambagei</i> are also eaten during the breeding season (DEC 2005 ^a). Regent honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DEC 2005 ^a).	No (not previously recorded within 10km)
<i>Lichenostomus fasciogularis</i> Mangrove honeyeater		V	The Mangrove honeyeater is confined to the coastal fringe and offshore islands of eastern Australia from the Townsville area, Queensland south to the NSW north coast. It is common in Queensland but rare in NSW, where a few colonies exist at scattered localities, including the Tweed, Richmond and Clarence River estuaries and Stuarts Point south of Macksville. Its primary habitat is mangrove forest but the species also occurs in other near-coastal forests and woodlands, including casuarina and paperbark swamp forests. It sometimes frequents adjacent shrublands and woodlands dominated by banksias and eucalypts. It sometimes visits gardens in coastal towns (NPWS 2001b).	No (not previously recorded within 10km)
<i>Melithreptus gularis gularis</i> Black-chinned honeyeater (eastern subspecies)		V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins <i>et al.</i> 2001). It is rarely recorded east of the Great Dividing Range (Higgins <i>et al.</i> 2001).	No (potential habitat surrounding proposal area, but unlikely within it)
<i>Menura alberti</i> Albert's lyrebird		V	This species is restricted to the south-east corner of Queensland and far north-east NSW. In NSW it occurs west to the Acacia Plateau in the Border Ranges and reaches its eastern and southern limits in the coastal range south west of Ballina. It occurs in mixed rainforest and wet open forest, frequently dominated by Brush Box. In winter birds commonly forage in moist forest on ridges between wetter forest (NPWS 2001a).	No (not previously recorded within 10km)

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<i>Merops ornatus</i> Rainbow bee-eater	M		Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999).	Yes, recorded during Aug 2010 survey
<i>Acrocephalus australis</i> Australian reed-warbler	M		This species lives singly or in pairs usually in wetlands with reeds. It feeds on insects (Blakers <i>et al.</i> 1984).	Yes, recorded during Aug 2010 survey
<i>Daphoenositta chrysoptera</i> Varied sittella		V	The Varied sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts (Higgins and Peter 2002; NSW Scientific Committee 2010c). The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (NSW Scientific Committee 2010c).	Yes
<i>Chthonicola sagittata</i> Speckled warbler		V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers <i>et al.</i> 1984; NSW Scientific Committee 2008a). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers <i>et al.</i> 1984; NSW Scientific Committee 2008a). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2008a).	No (most records from 1980s and 90s; one record from 2006 7km south-west of existing bridge)
<i>Stagonopleura guttata</i> Diamond firetail		V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins <i>et al.</i> 2006).	Yes
<i>Melanodryas cucullata cucullata</i> Hooded robin (south-eastern form)		V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	No (not previously recorded within 10km)
<i>Petroica boodang</i> Scarlet robin		V	During the breeding season the Scarlet robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet robin forages amongst logs and woody debris for insects which make up the majority of its diet (NSW Scientific Committee 2009c). The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (NSW Scientific Committee 2009c). It is conspicuous in open and suburban habitats (Morcombe 2003).	Yes

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<i>Petroica phoenicea</i> Flame robin		V	Flame robins are found in a broad coastal band from southern Queensland to just west of the South Australian border (Australian Museum 2009). The species is also found in Tasmania. The preferred habitat in summer includes moist eucalyptus forests and open woodlands, whilst in winter prefers open woodlands and farmlands (NSW Scientific Committee 2009a). It is considered migratory. The Flame robin breeds from about August to January (Morcombe 2003).	Yes
<i>Podargus ocellatus</i> Marbled frogmouth		V	Inhabits tropical and subtropical rainforest, usually with luxuriant epiphytic growth (Higgins 1999). In south-east Qld and north-east NSW, mostly restricted to moist lowland mesophyll vine forest, including remnant pockets, especially along creeks and gullies with understorey of palms or ferns, and often surrounded by wet sclerophyll forest (Higgins 1999).	No (not previously recorded within 10km)
<i>Pomatostomus temporalis temporalis</i> Grey-crowned babbler (eastern subsp)		V	The Grey-crowned babbler is found in dry, open forests, scrubby woodlands, trees bordering roads and farmland with isolated trees (Simpson and Day 1996).	Yes, marginal potential habitat
<i>Glossopsitta pusilla</i> Little lorikeet		V1	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008b).	Yes
<i>Lathamus discolor</i> Swift parrot	E	E1	The Swift parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	No (not previously recorded within 10km)
<i>Neophema pulchella</i> Turquoise parrot		V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	No (not previously recorded within 10km)
<i>Pezoporus wallicus wallicus</i> Eastern ground parrot		V	Mainly found in heathland, sedgeland or buttongrass plains providing medium to dense cover (Higgins 1999).	No
<i>Amaurornis olivaceus</i> Bush-hen		V	Occurs in swamps, flooded grasslands and rainforest fringes (Simpson and Day 1996).	Yes (although not previously recorded within 10km)
<i>Rostratula australis</i> Australian painted snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	Yes

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<i>Calidris acuminata</i> Sharp-tailed sandpiper	M		Inland waters, coastal (Simpson and Day 1996).	No (no recent records)
<i>Calidris alba</i> Sanderling	M	V	Occurs on the coast mostly on open sand beaches exposed to open sea-swells (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Calidris tenuirostris</i> Great knot	M	V	Mainly found on intertidal mudflats, sandflats and sandy beaches (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Gallinago hardwickii</i> Latham's snipe	M		Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	Yes
<i>Limicola falcinellus</i> Broad-billed sandpiper	M	V	Occurs in sheltered parts of coasts, such as estuaries, harbours, embayments and lagoons, which have shell or sandbanks nearby (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Limosa limosa</i> Black-tailed godwit	M	V	Mainly coastal, usually in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Tringa stagnatilis</i> Marsh sandpiper	M		Inhabits permanent or ephemeral wetlands, including swamps, billabongs, lagoons, saltmarshes and estuaries. Forages at the edge of wetlands in shallow water (Higgins and Davies 1996).	Yes, potential habitat along Clarence River
<i>Xenus cinereus</i> Terek sandpiper	M	V	Mainly found on saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons (Higgins and Davies 1996).	No (not previously recorded within 10km)
<i>Ninox connivens</i> Barking owl		V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997). Territories range from 30 to 200 ha (DEC 2005j).	No (potential habitat surrounding proposal area, but unlikely within it; one record within 10km occurs 7km north-east of existing bridge, recorded 2010)

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<i>Ninox strenua</i> Powerful owl		V	The Powerful owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both unlogged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). It has a large home range of between 450 and 1450 ha (DEC 2005).	No (potential habitat surrounding proposal area, but unlikely within it)
<i>Plegadis falcinellus</i> Glossy ibis	M		Terrestrial wetlands, and occasionally wet grasslands and sheltered marine habitats. Forage in shallow water over soft substrate or on grassy or muddy verges of wetlands, preferring those providing variety of water depths; avoid dry ground (Marchant and Higgins 1990).	Yes, potential habitat along Clarence River and in open grassy paddocks
<i>Turnix maculosa</i> Red-backed button-quail		V	Red-backed button-quail inhabit grasslands, woodlands and cropped lands of warm temperate areas that annually receive 400 mm or more of summer rain (Marchant and Higgins 1993). Observations of populations in other parts of its range suggest the species prefers sites near water, including grasslands and sedgelands near creeks, swamps and springs, and wetlands. Red-backed Button-quail usually breed in dense grass near water, and nests are made in a shallow depression sparsely lined with grass and ground litter (Marchant and Higgins 1993).	Yes (although not previously recorded within 10km)
<i>Turnix melanogaster</i> Black-breasted button-quail	V	C1	Within NSW, the species inhabits areas with an elevation of 200 to 700m, in dry or subtropical rainforests which contain brigalow, belah, bottletrees, hoop pine, lantana, ironbark, wattle, spotted gum, wallaby grass or rhodes grass (DEC 2005m).	Yes, marginal potential habitat (although not previously recorded within 10km)
<i>Tyto capensis</i> Grass owl		V	Occurs mainly in open tussock grassland, usually in treeless areas. Can also occur in marshy areas with tall dense tussocks of grass. Occasionally occurs in densely vegetated agricultural lands such as sugarcane fields (Higgins 1999).	No (not previously recorded within 10km)
<i>Tyto novaehollandiae</i> Masked owl		V	The Masked owl may be found across a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). It has mostly been recorded in open forests and woodlands adjacent to cleared lands. They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). The nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997; Higgins 1999). It has a large home range of between 500 to 1000 ha (DEC 2005-).	Yes (pellet collected within the proposal area likely to be from a Masked owl)

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<i>Tyto tenebricosa</i> Sooty owl		V	The Sooty owl is often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude <500 m. The Sooty Owl nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 cm in diameter (Gibbons and Lindenmayer 1997).	No (not previously recorded within 10km)
Invertebrates				
<i>Thersites michellae</i> Mitchell's rainforest snail	Z	E1	Mitchell's rainforest snail occurs in coastal areas of undisturbed moist forest, rainforest, and wet sclerophyll forest. It is semi-arboreal and can be found under bark on tree trunks and in the base of palm fronds (NPWS 2001c).	Yes, marginal potential habitat
<i>Argyreus hyperbius</i> Laced fritillary		E1	A butterfly species which occurs in open swampy coastal habitat. Eggs are laid singly on a leaf of the caterpillar's food plant a native Violet, <i>Viola betonicifolia</i> . The food plant occurs in ground level vegetation in swampy areas beneath grasses and Lomandra (DEC 2005).	No (not previously recorded within 10km)
Mammals				
<i>Cercartetus nanus</i> Eastern pygmy-possum		V	Patchily distributed from the coast to the Great Dividing Range, and as far as Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes. Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Soft fruits are eaten when flowers are unavailable and it also feeds on insects (DEC 2005y; Ward and Turner 2008). Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period (Ward 1990). It is mainly solitary, and each individual uses several nests. Home ranges of males are generally less than 0.75 ha, and those of females are smaller (Ward and Turner 2008).	No
<i>Dasyurus maculatus maculates</i> Spotted-tailed quoll (south-eastern mainland)	E	V	Occurs along the east coast of Australia and the Great Dividing Range (Belcher <i>et al.</i> 2008). Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999k). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). 70% of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999j). The home range of a female is between 180 – 1000 ha, while males have larger home ranges of between 2000 – 5000 ha. Breeding occurs from May to August (Belcher <i>et al.</i> 2008).	Yes, marginal potential habitat

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Phascogale tapoatafa</i> Brush-tailed phascogale		V	The Brush-tailed phascogale had a scattered distribution centred around the Great Dividing Range. It prefers open forests with a sparse ground cover, but also inhabits mallee and rainforests. It feeds on insects and nectar, particularly in rough-barked trees. The Brush-tailed Phascogale will nest and shelter in tree hollows, tree stumps and occasionally birds nests, and can use more than 40 nests in a year (Soderquist and Rhind 2008). Suitable tree hollows have entrances 25-40 mm wide (Soderquist 1995). Females have exclusive territories of approximately 20 - 60 ha, while males have overlapping territories of up to 100 ha. Breeding occurs from May to July, after which all the males die (Soderquist and Rhind 2008).	No (no recent records within proposal area; potential habitat may surround proposal area)
<i>Planigale maculata</i> Common planigale		V	Occurs from the Queensland border and south to the Upper Hunter River (Menkhorst and Knight 2001). The southernmost record is from Gosford ((Burnett 2008)). The Common Planigale is known to occur in a variety of habitats from weed-infested urban reserves to cool mountain forests (Burnett 2008), from sea level up to 400 m (Redhead 1995). Habitat selection is considered to be dependant on an adequate surface cover of grasses, hollow logs, rocks and leaf litter. It feeds on insects, spiders and small lizards. This species shelters under rocks, timber, rubbish (e.g. sheet iron) and in termite mounds. There is nothing known of its home range. Breeding occurs during spring and summer (Burnett 2008).	No (one record from 1982 lies 6km north-west of existing bridge)
<i>Saccolaimus flaviventris</i> Yellow-bellied sheathtail bat		V	Found throughout NSW (Richards 2008). They have been reported from southern Australia between January and June (Churchill 1998). Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert (Churchill 1998). They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (Churchill 2008; Richards 2008).	Yes
<i>Petrogale penicillata</i> Brush-tailed rock-wallaby	V	E1	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2-30 ha (Eldridge and Close 1995).	No
<i>Thylogale stigmatica</i> Red-legged pademelon		V	The Red-legged pademelon is patchily distributed along coastal and subcoastal eastern Australia from Cape York to the Hunter Valley in NSW. It is also found in New Guinea. It inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub. It also inhabits wet gullies with dense, shrubby ground cover provide shelter from predators. In NSW, rarely found outside forested habitat. They disperse from dense shelter areas to feed from late afternoon to early morning, favouring native grasses and herbs on the edge of the forest. The Red-legged Pademelon is also known to feed on fruits, young seedling leaves and stems, fungi and ferns (NPWS 2001d).	No (not previously recorded within 10km)

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Mormopterus beccarii</i> Beccari's freetail bat		V	Beccari's freetail bat inhabits a range of vegetation types including rainforest, river flood plains, tall open forest, savanna woodlands, arid shrublands and grasslands (Churchill 2008). They are often recorded along water courses and in towns and cities (DECC 2005b). This species commonly roosts in tree hollows but colonies have been recorded under house roofs in Queensland (DECC 2005b).	Yes (although not previously recorded within 10km)
<i>Mormopterus norfolkensis</i> Eastern freetail-bat		V	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney (Churchill 1998). Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoyer <i>et al.</i> 2008).	Yes, recorded during Aug 2010 survey
<i>Pseudomys gracilicaudatus</i> Eastern chestnut mouse		V	Occurs from Queensland to Jervis Bay. In NSW the Eastern Chestnut Mouse is mostly found in heathland and is most common in dense, wet heath and swamps, but also occurs in open woodlands and dry sclerophyll forests with a grassy understorey. Density of the ground layer is a determining factor (Fox 2008), and it is often found in areas burnt within the last four years (DECC 2005c). The species is sedentary, with home ranges of less than 0.5 ha (Fox 2008). It relies on a variety of food sources, including fungi, seeds, insects and stems (Luo <i>et al.</i> 1994).	No (not previously recorded within 10km)
<i>Pseudomys novaehollandiae</i> New holland mouse	V		The New holland mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The home range of the New Holland Mouse can range from 0.44 ha to 1.4 ha. The New holland mouse is a social animal, living predominantly in burrows shared with other individuals. The species is nocturnal and omnivorous, feeding on seeds, insects, leaves, flowers and fungi, and is therefore likely to play an important role in seed dispersal and fungal spore dispersal. It is likely that the species spends considerable time foraging above-ground for food, predisposing it to predation by native predators and introduced species. Breeding typically occurs between August and January, but can extend into autumn (Threatened Species Scientific Committee 2010).	No (not previously recorded within 10km)
<i>Petaurus australis</i> Yellow-bellied glider		V	Restricted to tall native forests in regions of high rainfall along the coast of NSW. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999m). Live in family groups of 2-6 individuals which commonly share a number of tree hollows. Family groups are territorial with exclusive home ranges of 30-60 ha. Very large expanses of forest (>15,000 ha) are required to conserve viable populations (Goldingay 2008).	No

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Petaurus norfolcensis</i> Squirrel glider		V	Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran in the northern part of the state (DEC 1999) and as far west as Tocumwal along the southern border of the state (NSW Government 2009). Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Require abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Van der Ree and Suckling 2008). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst <i>et al.</i> 1988). They live in family groups of 2-10 individuals and maintain home ranges of 0.65 and 10.5 ha, varying according to habitat quality and food resource availability (Quin 1995; Goldingay and Jackson 2004). Family groups occupy multiple hollows over time (Van der Ree and Suckling 2008).	No
<i>Phascolarctos cinereus</i> Koala		V	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin <i>et al.</i> 2008). Primary feed trees include <i>Eucalyptus robusta</i> , <i>E. tereticornis</i> , <i>E. punctata</i> , <i>E. haemostoma</i> and <i>E. signata</i> (DoP 1995). They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100 ha (Martin <i>et al.</i> 2008).	No (isolated feed tree species present however not expected to support breeding or foraging activities)
<i>Aepyprymnus rufescens</i> Rufous bettong		V	Occurs in a variety of habitats from coastal eucalypt forest, through tall, wet sclerophyll, to low, dry open woodland. Only occurs in areas with a sparse or grassy understorey, adjacent to areas of dense undergrowth (Dennis and Johnson 1995).	No (although known and potential habitat occurs within 10km)
<i>Potorous tridactylus</i> Long-nosed potoroo	V	V	Occurs from Queensland to Victoria, normally within 50 km of the coast (Claridge <i>et al.</i> 2007). Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue. It is solitary and sedentary, but tends to aggregate in small groups. It has two breeding seasons, one in late winter-early spring and the other in late summer (Johnston 2008). This species appears to benefit from a lack of recent disturbance (Claridge <i>et al.</i> 2007).	No (not previously recorded within 10km)
<i>Pteropus poliocephalus</i> Grey-headed flying-fox	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	Yes
<i>Syconycteris australis</i> Common blossom-bat		V	Require a combination of heathland and coastal rainforest. In northern Queensland they occur in rainforest and paperbark forest (Churchill 1998).	No (not previously recorded within 10km)

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Chalinolobus dwyeri</i> Large-eared pied bat	V	V	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley (van dyck and Strahan 2008). Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months (Churchill 2008). The only known existing maternity roost is in a sandstone cave near Coonabarabran (Pennay 2008).	Yes
<i>Chalinolobus nigrogriseus</i> Hoary wattled bat		V	Predominantly a northern species, but occurs in north-eastern NSW to the lower Clarence and Richmond River areas in dry open eucalypt forests, particularly those dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common. Prefers open habitat types and roosts mainly in tree hollows, but sometimes in rock crevices or buildings (van dyck and Strahan 2008).	Yes
<i>Kerivoula papuensis</i> Golden-tipped bat		V	Occurs in a narrow band down the coast from Cape York to Eden, in moist, closed forest that receives high rainfall (Law and Chidel 2004). Important habitat features includes forest ecotones, streams and an abundance of vines (van dyck and Strahan 2008). Primarily feeds on web-building spiders. Most nightly movements occur within 2km of the roost. Roosts in the nests of Yellow-throated Scrubwren and Brown Gerygone, as well as in tree hollows, foliage and roofs of houses (van dyck and Strahan 2008).	No (not previously recorded within 10km)
<i>Falsistrellus tasmaniensis</i> Eastern false pipistrelle		V	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill 2008). Apparently hibernates in winter. Roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals. Often change roosts every night. Forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails (Law <i>et al.</i> 2008). Has a large foraging range, up to 136 ha (Churchill 2008; Law <i>et al.</i> 2008). Records show movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).	Yes
<i>Miniopterus australis</i> Little bentwing-bat		V	Occurs from Northern Queensland to the Hawkesbury River near Sydney. Roost sites encompass a range of structures including caves, tunnels and stormwater drains (van dyck and Strahan 2008). Young are raised by the females in large maternity colonies in caves in summer. Shows a preference for well timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. The Little Bentwing bat forages for small insects (such as moths, wasps and ants) beneath the canopy of densely vegetated habitats (Churchill 2008; Hoye and Hall 2008b).	Yes, recorded during Aug 2010 survey

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Miniopterus schreibersii oceanensis</i> Eastern bentwing-bat		V	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoyer and Hall 2008a).	Yes, recorded during Aug 2010 survey
<i>Myotis macropus</i> Southern myotis		V	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards <i>et al.</i> 2008).	Yes, recorded during Aug 2010 survey
<i>Nyctophilus bifax</i> Eastern long-eared bat	V	V	Occurs across northern Australia in habitats ranging from rainforests to riparian woodlands (van dyck and Strahan 2008). It frequently roosts communally in foliage and tree hollows and under exfoliated bark (van dyck and Strahan 2008). They change roosts seasonally, from rainforest edges in winter to the centre of rainforest patches in summer (van dyck and Strahan 2008).	Yes
<i>Scoteanax rueppellii</i> Greater broad-nosed bat		V	Occurs along the Great Dividing Range, generally at 500 m but up to 1200 m, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches (Churchill 2008; Richards <i>et al.</i> 2008).	Yes, recorded with probable certainty during Aug 2010 survey
<i>Vespadelus trougtoni</i> Eastern cave bat		V	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. It roosts in small groups, often in well-lit overhangs and caves, mine tunnels, road culverts, and occasionally in buildings (van dyck and Strahan 2008).	Yes
Reptiles				
<i>Cacophis harriettae</i> White-crowned snake		V	Distributed from coastal and near-coastal areas from central eastern Queensland south to the vicinity of Coffs Harbour in north-east NSW. The White-crowned Snake favours low to mid-elevation dry eucalypt forest and woodland, particularly areas with a varied and well-developed litter layer, where their prey of small lizards may be more abundant. It is also occasionally found in moist eucalypt forest and coastal heathland (NPWS 2001f).	No
<i>Hoplocephalus bitorquatus</i> Pale-headed snake		V	Found in a variety of habitats from wet sclerophyll forest to dry eucalypt forest on the western slopes of NSW (Cogger 2000) (Wilson and Swan 2003). Feeds largely on frogs and lizards (Cogger 2000).	No
<i>Hoplocephalus stephensii</i> Stephen's banded snake		V	This nocturnal species is partly arboreal and is usually found in wet sclerophyll forest or rainforest. It feeds on lizards, birds and small mammals (Cogger, 1992 346 /id).	No (not previously recorded within 10km)

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Latin Name / Common Name	EPBC Act ¹	TSC Act ²	Habitat	Potential Habitat?
<i>Delma torquata</i> Collared delma	V		The Collared delma is the smallest of the legless lizards, growing to a total length of 15cm and is coloured reddish-brownish on top with a bluish grey flush to the tail. The core range of the Collared Delma is within south-east Queensland, however, a few records occur in northern NSW. This species is often found in rocky terrain within eucalypt woodlands dominated by ironbarks, spotted gum, white cypress pine and smooth-barked apple. The ground layer often contains kangaroo grass. It has also been recorded in woodlands of river red gum, poplar box and brigalow with no significant rock component, and adjacent to semi-evergreen vine thickets.	No (not previously recorded within 10km)
<i>Coeranoscincus reticulatus</i> Three-toed snake-tooth skink	V	V	The Three-toed snake-tooth skink occurs in the coast and ranges from the Macleay valley in NSW to south-eastern Queensland. It is very uncommon south of Grafton. Its habitat includes rainforest and occasionally moist eucalypt forest, on loamy or sandy soils. The Three-toed Snake-tooth Skink lives in loose soil, leaf litter and rotting logs, and feeds on earthworms and beetle grubs (NPWS 2001e).	Yes (although no recent records; records from 1980s and 90s)

APPENDIX 6

Aquatic Fauna Habitat Descriptions

Table 12: Threatened Aquatic Species Habitat Table

Key: 1) Listed on the EPBC Act as Endangered (E), Critically Endangered (Z), Vulnerable (V) or Migratory (M)
2) Listed on the FM Act as Endangered (E1), Endangered Population (E2), Vulnerable (V) or Protected (P)
3) Listed on the TSC Act as Endangered (E1) or Vulnerable (V)

Latin Name / Common Name	EPBC Act ¹	FM Act ²	TSC Act ³	Habitat	Potential habitat in proposal area?
<i>Bidyanus bidyanus</i> Silver perch	-	V	-	Rivers, lakes and reservoirs, preferring areas of rapid flow (Allen <i>et al.</i> 2002). Originally widespread throughout the Murray Darling drainage system is now restricted to one self sustaining population in the Murray Darling Basin downstream of Yarrowonga Weir. Has been translocated to many localities, including coastal streams of south-eastern Queensland and New South Wales (DPI 2010).	Yes Marginal potential habitat within proposal area
<i>Carcharias taurus</i> Greynurse shark	Z	-	-	East and west coast populations of Australia in subtropical to cool temperate waters (Kuitert 2000).	No Pelagic with no potential habitat within proposal area
<i>Caretta caretta</i> Loggerhead turtle	EM	-	E1	Occurs in tropical and temperate waters off the Australian coast, only occasionally entering southern Australian waters (Cogger 1992).	Yes Low potential habitat within proposal area
<i>Chaetodontoplus ballinae</i> Arrow-backed angel fish	-	P	-	Northern NSW around Coffs Harbour, Ballina and North Solitary Islands, and around the Balls Pyramid area of Lord Howe Island (DPI 2010).	No Pelagic with no potential habitat within proposal area
<i>Dermochelys coriacea</i> Leathery turtle	VM	-	V	Marine species usually sighted along the eastern seaboard often in bays, estuaries and rivers (Cogger 1992).	No Pelagic with no potential habitat within proposal area
<i>Epinephelus coioides</i> Brown-spotted grouper	-	P	-	In tropical and warm temperate marine waters in Queensland, the Northern Territory and Western Australia (DPI 2010).	No Pelagic with no potential habitat within proposal area
<i>Epinephelus daemeli</i> Black cod	-	V	-	Warm temperate and subtropical parts of the south-western Pacific (DPI 2010).	No Pelagic with no potential habitat within proposal area
<i>Epinephelus lanceolatus</i> Queensland groper	-	P	-	Tropical and warm temperate coasts of Australia but rarely found in cooler waters to the south (DPI 2010).	No Pelagic with no potential habitat within proposal area

Latin Name / Common Name	EPBC Act ¹	FM Act ²	TSC Act ³	Habitat	Potential habitat in proposal area?
<i>Maccullochella ikei</i> Eastern freshwater cod	E	E	-	Clarence and Richmond River systems downstream of tablelands waterfalls often found in clear, flowing streams with rocky beds and deep holes (DPI 2010). Now occurs in the upper Clarence (Guy Fawkes, Mann and Nymboida rivers) system (Allen <i>et al.</i> 2002).	Yes Marginal potential habitat within proposal area
<i>Mogurnda adspersa</i> Purple spotted gudgeon	-	E	-	Murray Darling Basin and eastern streams and rivers from northern NSW to north QLD (Allen <i>et al.</i> 2002).	Yes Low potential habitat within proposal area
<i>Nannoperca oxleyana</i> Oxleyan pygmy perch	E	E	-	Endemic to the coastal region of eastern Australia, from northern NSW to south-eastern Queensland (DPI 2010).	Yes Low potential habitat within proposal area
<i>Notopala sublineata</i> River snail	-	E	-	Murray Darling Basin within irrigation pipelines in southern NSW (DPI 2010).	Yes Low potential habitat within proposal area
<i>Paraplesiops bleekeri</i> Bleekers devil fish	-	P	-	In caves, crevices and under ledges on inshore reefs and estuaries from southern Queensland to Montague Island on the NSW south coast (DPI 2010).	No Pelagic with no potential habitat within proposal area
<i>Petalura gigantea</i> Giant dragonfly	-	-	E1	Found along the east coast of NSW from the Victorian border to northern NSW and known in the Clarence River catchment. Live in permanent swamps and bogs with some free water and open vegetation (DEC 2005,,).	Yes Low potential habitat within proposal area
<i>Petalura litorea</i> Coastal petaltail	-	-	E1	In NSW known populations are restricted to coastal and near coastal lowlands between Coffs Harbour and Ballina. Live in permanent swamps and bogs with some free water and open vegetation (DEC 2005p).	Yes Low potential habitat within proposal area
<i>Pristis zijsron</i> Green sawfish	-	E	-	Coastal waters off Broome, Western Australia, around northern Australia and down the east coast as far as Jervis Bay, NSW (DPI 2010).	Yes Marginal potential habitat within proposal area

APPENDIX 7

Water Quality Results

Table 13: Water quality measurements for August 2010

	Clarence River	Alipou Creek	Cowan Creek	Carrs Creek	Alumy Creek
Temp °C	17.27	16.94	17.28	16.8	NS
pH	5.01	4.95	4.95	5.2	NS
Conductivity µS/cm	770	650	690	685	NS
D.O. ppm	18.18	15.7	16.61	13.2	NS
Saturation %	175	167	175	150	NS
Turbidity NTU	8.8	20.9	10.3	23	NS
TDS g/L	0.048	0.042	0.045	0.032	NS

APPENDIX 8

Aquatic Habitat Assessment Results

Table 14: HABSCORE Results (August 2010)

	U1NC	D1NC	U1SC	D1SC	U2NC	D2SC	ACDG	CCUG	C1UG	C2UG	ACUG
	4/08/2010	4/08/2010	4/08/2010	4/08/2010	4/08/2010	4/08/2010	2/08/2010	2/08/2010	3/08/2010	3/08/2010	2/08/2010
High Gradient											
Riffle Quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Embeddedness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Velocity-depth regime	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Low Gradient											
Pool substrate characterisation	15	11	8	12	11	15	9	12	13	13	5
Pool variability	11	12	12	11	11	11	9	11	12	12	5
High and Low Gradient											
Channel Flow Status	20	20	20	20	20	20	10	12	14	14	5
Bank vegetation - LB	2	1	2	8	1	3	9	6	7	5	5
Bank vegetation - RB	2	5	5	8	1	3	9	6	7	5	5
Bank Stability - LB	8	8	7	10	9	10	7	6	7	7	7
Bank Stability - RB	8	8	7	10	7	10	7	6	7	7	7
Width of riparian zone - LB	1	1	1	3	1	1	7	1	4	2	5
Width of riparian zone - RB	1	5	6	3	1	1	7	1	4	2	5
Epifaunal substrate / available cover	5	3	5	4	2	7	10	15	16	16	1
	52	53	52	64	46	58	60	54	65	59	36
	S	S	S	S	M	S	S	S	S	S	M
0-25 = Poor											
26 - 50 = Marginal											
51 - 75 = Suboptimal											
76 - 100 = Optimal											
Not Applicable = N/A											

APPENDIX 9

HABSCORE Data Sheet

Modified HABSCORE Assessment. Modified from (Barbour et al. 1999; Fairfull and Witheridge 2003) used for aquatic habitat assessments.

Table 15: HABSCORE Assessment Data Sheet

RIVER	DATE.....	LOCATION CODE
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HIGH and LOW GRADIENT STREAMS

1. If you are in a steep valley.....do HIGH GRADIENT STREAMS sections
If you are in a plain.....do LOW GRADIENT STREAMS sections
If you are in a broad valley.....go to #2.
2. If >50% of the substrate in the reach is larger than gravel.....do HIGH GRADIENT STREAMS sections
If >50% of the substrate in the reach is gravel or smaller.....do LOW GRADIENT STREAMS sections

Habitat Parameter	HIGH GRADIENT STREAMS ONLY			
	Optimal	Suboptimal	Marginal	Poor
Riffle quality	Well developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; abundance of cobble (boulders prevalent in headwater streams).	Riffle as wide as stream but length is less than 2 times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or bedrock prevalent; some cobbles present.	Riffles or runs virtually nonexistent; bedrock prevalent, cobbles lacking.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Embedd- edness	Pebble, cobble and boulder particles are 0-25% surrounded by fine sediment (eg. sand, silt or clay).	Pebble, cobble and boulder particles are 25-50% surrounded by fine sediment (eg. sand, silt or clay).	Pebble, cobble and boulder particles are 50-75% surrounded by fine sediment (eg. sand, silt or clay).	Pebble, cobble and boulder particles are >75% surrounded by fine sediment. (Include sites dominated by sand particles or smaller here.)
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Velocity- depth regime	All 4 velocity-depth regimes present. Velocity-depth regimes : slow-deep (<3m/s,>.5m) slow-shallow fast-deep fast-shallow	Only 3 of the 4 velocity-depth regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 depth-velocity regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity-depth regime (usually slow-deep).
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	LOW GRADIENT STREAMS ONLY			
	Optimal	Suboptimal	Marginal	Poor
Pool substrate character- isation	Mixture of substrate materials, with gravel and firm sand prevalent; tree roots and/or submerged vegetation common. (Do NOT include willow roots.)	Mixture of soft sand, mud or clay; mud may be dominant; some tree roots and/or submerged vegetation present.	All mud or clay or sand bottom; little submerged vegetation present.	Hard-pan clay or bedrock; no submerged vegetation present.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Pool variability	Even mix of large/shallow, large/deep, small/shallow and small/deep pools.	Majority of pools large/deep; very few shallow pools.	Shallow pools much more prevalent than deep pools.	Majority of pools small/shallow or pools absent.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

RIVER..... DATE..... LOCATION CODE.....
HIGH and LOW GRADIENT STREAMS: Do this page for BOTH stream types.

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
Channel flow status	Water reaches base of both lower banks, and minimal amount of channel substrate exposed.	Water fills >75% of available channel or <25% of channel substrate exposed.	Water fills 25-75% of available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Bank vegetation (score each bank)	More than 90% of stream- bank surfaces covered by native vegetation; high structural diversity (large & small trees and under-storey shrubs); vegetative disruption through grazing or mowing minimal or not evident. (Undisturbed alpine sites score high.)	50-90% of stream bank surfaces covered by native vegetation, or one structural class of plants not well represented; disruption of vegetation evident but not affecting full plant growth potential to any great extent.	10-50% of stream bank surfaces covered by native vegetation; disruption of vegetation obvious, with patches of bare soil or closely cropped vegetation common.	Less than 10% of the stream bank surfaces covered by native vegetation, or stream bank surfaces dominated by exotic vegetation (eg, willows); disruption of vegetation is very high (eg, vegetation has been removed to 5 cm or less).
Score	Left bank 10 9	8 7 6	5 4 3	2 1 0
Score	Right bank 10 9	8 7 6	5 4 3	2 1 0
Bank stability (score each bank)	Banks naturally stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected by erosion.	Moderately stable; infrequent small areas of erosion mostly healed over; 5-30% of bank in reach has areas of erosion or stabilised banks e.g. rip rap/gabion	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
Score	Left bank 10 9	8 7 6	5 4 3	2 1 0
Score	Right bank 10 9	8 7 6	5 4 3	2 1 0
Width of riparian zone (score each bank)	Width of riparian zone >30 m.	Width of riparian zone 10-30 m.	Width of riparian zone 5-10 m.	Width of riparian zone <5 m.
Score	Left bank 10 9	8 7 6	5 4 3	2 1 0
Score	Right bank 10 9	8 7 6	5 4 3	2 1 0

NOTE DIFFERENT PERCENTILES FOR HIGH AND LOW GRADIENT STREAMS FOR THIS PARAMETER:

Epifaunal substrate/ available cover	Greater than 70% (>50% for low gradient streams) of substrate favourable for epifaunal colonisation and fish cover; can include mix of "seasoned" snags (i.e. <u>not</u> newly fallen or transient), submerged logs, undercut banks, cobble or other stable habitat.	40-70% (30-50% for low gradient streams) of substrate favourable for epifaunal colonisation and fish cover; still contains a reasonable mix of stable habitat, can include substrate in the form of newly fallen, but not yet "seasoned", logs.	20-40% (10-30% for low gradient streams) of substrate favourable for epifaunal colonisation and fish cover; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (>10% for low gradient streams) substrate favourable for epifaunal colonisation and fish cover; lack of suitable epifaunal habitat obvious; substrate highly unstable.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

ARE ALL SPACES FILLED IN ON ALL SHEETS? Yes [] No [] Checked by.....

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