

Additional crossing of the Clarence River at Grafton

Route Options Development Report Volume 3 – Technical Papers

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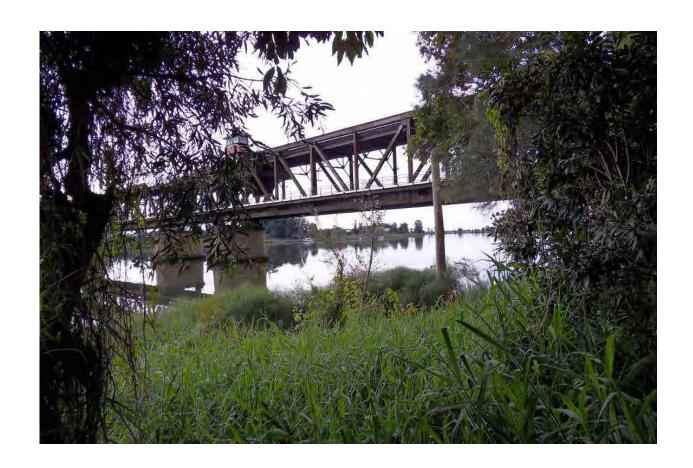


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Route Options Development Report Technical Paper – Ecology

SEPTEMBER 2012





Main Road 83 Summerland Way-Additional Crossing of the Clarence River at Grafton Route Options Development Report

Technical Paper: Ecology

August 2012



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PROJECT	Main Road 83 Summerland Way-Additional Crossing of the Clarence River, Grafton		
BIOSIS PROJECT NO	13967		
REPORT FOR	Arup on behalf of the NSW Roads and Maritime Services – Northern Regional Office		
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AUTHOR(S):	Jennifer Charlton, Monica Campbell, Ben Coddington & Aaron Troy		

EXECUTIVE SUMMARY

Biosis Research was commissioned by Arup, on behalf of NSW Roads and Maritime Services (RMS), 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 six short-listed options. 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.

Terrestrial flora and fauna surveys were conducted within the six short-listed route options (where property access was granted) over five days in February 2012 and two days in April 2012. In addition, flora and fauna surveys were also previously conducted over a broader study area in April and August 2010 and July 2011. Aquatic field surveys were undertaken over three days in August 2010.

No threatened flora species were recorded in the surveys. Two endangered ecological communities (EEC) were identified in the surveyed area, namely freshwater wetlands on coastal floodplains and sub-tropical coastal floodplain forest.

Through a range of survey techniques, seven threatened and five migratory fauna species were recorded with varying degrees of confidence during the route option development surveys. The threatened grey-headed flying-fox was observed foraging within a large fig tree and several thousand individuals were observed leaving their maternity roost at Susan Island on dusk. Four threatened microbats were definitively recorded using ultrasonic call recording with another recorded only as probable. The seventh threatened fauna species, the masked owl, was potentially recorded from regurgitated pellets.

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 vicinity of the six short-listed options 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 wildlife corridor values.

Examples of areas considered to pose an ecological constraint to an additional crossing of the Clarence River at Grafton are: the emergent aquatic vegetation (e.g. *Phragmites australis*) lining the northern bank of the Clarence River in Grafton; drainage soaks and wetlands (including the cattle egret breeding colony located between Prince and North Streets); degraded riparian vegetation (conforming to the sub-tropical coastal floodplain forest EEC) along the banks of the Clarence River; Alipou Creek and associated riparian vegetation; Susan Island; Elizabeth Island; and, hollow-bearing forest red gums (*Eucalyptus tereticornis*).

A summary of the ecological indicator results per route option is shown on the following page.

Potential ecological impacts per route option.

	Route Option					
·	Е	А	С	11	14	15
Plant community/fauna habitat	Approximate area (m²) of plant community/fauna habitat					
Native and exotic plantings	30,000	24,500	32,000	19,000	35,500	34,500
Planted figs	900	-	-	2000	-	50
Reedlands - Freshwater wetlands on coastal floodplain EEC	100	550	600	-	-	-
Native revegetation (Induna Reserve)	-	2400	-	-	-	-
Weeds and exotics	-	400	850	-	-	-
Degraded riparian forest - Sub- tropical coastal floodplain forest EEC	-	-	150	50	-	-
Remnant eucalypts - Sub-tropical coastal floodplain forest EEC	-	-	700	5800	-	-
Drainage soak – Potential Freshwater wetlands on coastal floodplain EEC	-	-	-	8400	10,500	24,500
Drainage soak - Freshwater wetlands on coastal floodplain EEC	-	-	-	-	11,500	13,000
Constructed drainage line with native and exotic vegetation	-	-	-	-	2600	4100
Threatened species record		Kno	own habitat po	tentially impac	ted	
Adjacent Grey-headed flying-fox maternity roost	Breeding (Susan Island)	-	-	-	-	-
20+ Grey-headed flying-foxes foraging in fig	Foraging (figs)	-	-	-	-	-
Cattle egret breeding colony	-	-	-	-	Breeding (wetland)	Breeding (wetland)
Little bentwing-bat	-	Roosting (under bridge)	Roosting (under bridge)	-	-	-
Eastern bentwing-bat	-	Roosting (under bridge)	Roosting (under bridge)	-	-	-
Eastern freetail bat	-	Foraging (riparian zone)	Foraging (riparian zone)	-	-	-
Southern myotis	-	-	Foraging (riparian zone)	-	-	-

The key policy principle of RMS' Biodiversity Guidelines is that "in managing biodiversity, the RMS should aim to:

- 1. Avoid and minimise impacts first.
- 2. Mitigate impacts where avoidance is not possible.
- 3. Offset where residual impacts cannot be avoided" (*Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* NSW RTA 2011).

Where possible important ecological features identified in the local area should be avoided during the route selection stage.

Features of potential ecological importance have been identified below. The above hierarchy of management measures should be considered and applied to these sensitive habitats.

- Reedlands along the banks of the Clarence River and its tributaries that conform to the description of the freshwater wetlands on coastal floodplains' endangered ecological community.
- Drainage soaks that conform to the description of the freshwater wetlands on coastal floodplains' endangered ecological community.
- Degraded riparian vegetation along the banks of the Clarence River that conform to the description of the sub-tropical coastal floodplain forest endangered ecological community.
- Intact patches of other vegetation, including riparian vegetation.
- Hollow-bearing eucalypts.
- The cattle egret breeding colony.

Other considerations are:

- The location of bridge piers or foundations within the main waterway channel.
- Careful selection of lighting in the design of the bridge that may impact on microbat behaviour.
- 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 the twice-daily tidal effects (refer to engineering guidelines (Fairfull and Witheridge 2003; Witheridge 2002)). Low tide approximates between 0.2 and 0.5m and high tide approximates between 1.4 and 1.8m. 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 for the environmental assessment of the preferred route for an additional crossing have been identified. These include:

- 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 (where access could not be obtained during current surveys).
- Assessment of impact of artificial bridge lighting on microbats.

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

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- Josephine Dessmann (Ecologist, Biosis Research)
- Brett Morrisey (Botanist, Biosis Research)

Abbreviations and common terms

AUSRIVAS Australian River Assessment System
CAMBA China-Australia Migratory Bird Agreement

CAV Census of Australian Vertebrates

DECCW NSW Department of Environment, Climate Change and Water (now OEH)

DEWHA Commonwealth Department of the Environment, Water, Heritage and the Arts (now DSEWPaC)

DII NSW Department of Industry and Investment (now DPI)
DPI NSW Department of Primary Industries (formerly DII)

DSEWPaC Commonwealth Department of Sustainability, Environment, Water, Population and Communities

(formerly DEWHA)

EEC Endangered Ecological Community

EP&A Act Environmental Planning and Assessment Act 1979

EPBC Act Environment Protection and Biodiversity Conservation Act 1999

FM Act Fisheries Management Act 1994
HABSCORE Visually-based habitat assessment

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

Proposal area Area of direct impact and any areas subject to potential indirect impacts

RMS NSW Roads and Maritime Services (formerly RTA)

ROKAMBA Republic of Korea-Australia Migratory Bird Agreement

SEPP State Environmental Planning Policy

sp. species (singular)
spp. species (plural)
subsp. subspecies

Threatened species Species listed as migratory, vulnerable, endangered or critically endangered under the relevant

legislation

TSC Act Threatened Species Conservation Act 1995

var. variety

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1.0 INTRODUCTION

1.1 Project background

Roads and Maritime Services (RMS, formerly 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. Arup (on behalf of RMS) has engaged Biosis Research to undertake Ecology investigations.

Since the early 1970s there have been various discussions and studies into an additional crossing of the Clarence River near Grafton. A number of these studies have been carried out during the past ten years and provide the background to the current investigation.

In December 2010, RMS commenced a revised process to work more closely with the community to determine the preferred location for an additional crossing. As part of this revised process, a series of public surveys, community forums and meetings with residents and community groups have been held and various studies and project documents released for public viewing and comment.

In June 2011, RMS released the Feasibility Assessment Report, which describes the assessment undertaken by RMS on the 41 route suggestions identified by the community following the announcement of the revised process in December 2010. The report identified 25 preliminary options within five strategic corridors to go forward for further engineering and environmental investigation.

Between June 2011 and January 2012, RMS carried out investigations in the Grafton area and surrounds to identify constraints relevant to an additional crossing of the Clarence River. The outcomes of these investigations, community comment and a community and stakeholder evaluation workshop provided the inputs to the selection of the short-list of options.

In January 2012, six route options to be investigated further as part of the process to identify a location for the crossing were announced (as shown in Figure 1). The short-listed options were identified in the Preliminary Route Options Report – Final (January 2012) which also provided details of the technical investigations undertaken on the 25 preliminary options and the process to select the short-listed options.

This technical paper builds on the work undertaken for the Preliminary Route Options Report Final (PROR) and is an attachment to the Route Options Development Report. This technical paper will be used to define the ecological constraints for these six short-listed route options. The findings of these investigations will be used as part of the selection of a recommended preferred option.

1.2 The preliminary route options investigation

The following is a summary of the work undertaken by Biosis Research during the preliminary route options investigation as reported in the *Preliminary Route Options Report - Final* (RMS, January 2012), Volume 2 Technical Paper - Ecology:

- Database records were obtained for the Grafton and South Grafton area within a 10km radius of the perimeter of the proposal area (Grafton and South Grafton) for terrestrial species and 30km for aquatic species. Database searches included:
 - NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife.
 - Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters Search Tool.
 - Birds Australia New Atlas of Australian Birds.
 - NSW Department of Primary Industries (formerly DII), Fisheries Database.
 - Clarence Lowlands catchment management authority sub-region.
- Background research involving the review of all relevant literature in relation to the existing ecological environment.
- A preliminary field survey of the Grafton and South Grafton area to broadly identify areas of ecological sensitivity.
- A targeted field survey to map the location of endangered ecological communities (EEC) and other vegetation communities, and to identify threatened and/or migratory fauna species.

- Identify location of opportunities and constraints across Grafton and South Grafton based on the findings of the above investigations.
- Recommendations to minimise or mitigate impacts to threatened and general terrestrial and aquatic biodiversity.
- Assessment of the 25 preliminary route options based on the research and preliminary site surveys described above.

2.0 SHORT-LIST OF ROUTE OPTIONS

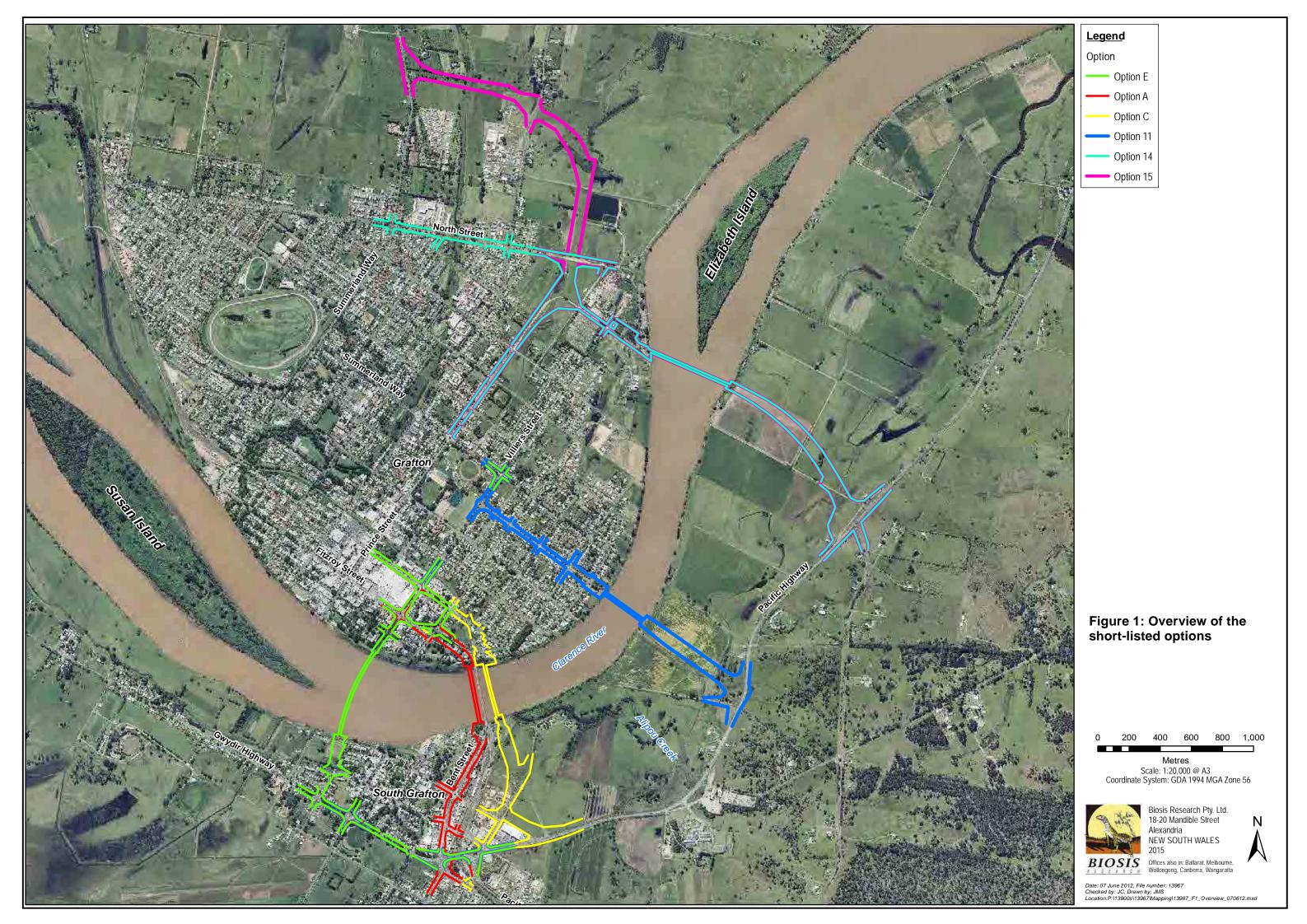
The current investigations assess the six short-listed route options outlined in Table 1 and shown in Figure 1.

Table 1: Six short-listed route options.

OPTION	LOCATION
E	Cowan Street, South Grafton to Villiers Street, Grafton.
А	New bridge parallel to and immediately upstream of the existing bridge connecting Bent Street, South Grafton and Fitzroy Street, Grafton.
С	Junction of Pacific Highway and Gwydir Highway, South Grafton to Pound Street, Grafton.
11	Existing Pacific Highway north of South Grafton to Fry Street, Grafton.
14	Existing Pacific Highway north of South Grafton to North Street, Grafton via Kirchner Street.
15	Existing Pacific Highway north of South Grafton to Summerland Way north of Grafton, via Kirchner Street.

2.1 Aims of route options development investigation

- Identify and assess the condition of EEC potentially impacted by the six short-listed route options.
- Identify and assess the condition of other plant communities potentially impacted by the six short-listed route options.
- Identify the location and extent of threatened plant populations potentially impacted by the six short-listed route options.
- Identify the location of threatened and migratory terrestrial fauna species and their habitats potentially impacted by the six short-listed route options.
- Identify the location of threatened aquatic species and their habitats potentially impacted by the six short-listed route options.



3.0 METHODOLOGY OF ROUTE OPTIONS DEVELOPMENT INVESTIGATION

The current investigation involved three key stages: a desktop study; field surveys; and terrestrial and aquatic biodiversity 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, including updating relevant database searches. Field surveys were undertaken along each of the six short-listed options to identify terrestrial ecological constraints. The combined information from current field, past field (e.g. aquatic surveys) and desktop studies was then used to assess relative conservation significance of the six short-listed options.

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; and consultation with local experts and government agencies.

Database records were obtained for the Grafton and South Grafton area 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 OEH Atlas of NSW Wildlife.
- Records of Matters of National Environmental Significance listed under the provisions of the Commonwealth
 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) obtained from the 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 under the NSW Fisheries Management Act 1994 (FM Act) were obtained from the NSW Department of Primary Industries (formerly DII), Fisheries Database.
- Records of threatened plant and animals recorded within the Clarence Lowlands catchment management authority subregion.

All database searches were updated in January and February 2012.

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

- Aerial photographs of Grafton, South Grafton and surrounds, supplied by RMS.
- 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 Flora survey

Terrestrial flora surveys were conducted within the six short-listed route options (where property access was possible) in February and April 2012. Flora surveys were previously conducted over a broader study area in April and August 2010 and July 2011. Plant species and their habitats were surveyed by undertaking general habitat assessments, targeted searches and plot-based (i.e. quadrat) survey. Survey effort was focused within areas identified as supporting potential habitat for threatened plant species. A description of each of the survey methods is provided below.

Survey data results 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.

3.2.1 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 over a total of twelve days. Current random meander transects were undertaken by two botanists in February 2012 and one botanist in April 2012 traversing the site, focussing on areas of retained native vegetation.

3.2.2 Plot-based survey (quadrats)

Plot-based surveys (quadrats) 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 (quadrats) were not considered appropriate and only one quadrat was undertaken in the riparian vegetation to the east of the mouth of Alipou Creek during the previous surveys. The structure and floristics of this degraded plant community were sampled using one 400m² quadrat (20m x 20m).

3.2.3 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.

3.3 Fauna survey

Terrestrial fauna surveys were conducted within the six short-listed route options (where property access was possible) in February and April 2012. Fauna surveys were previously conducted over a broader study area in April and August 2010 and July 2011. The current terrestrial fauna survey was primarily a habitat-based assessment and trapping for fauna species was not undertaken.

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

- Diurnal bird surveys.
- Active searching for herpetofauna (e.g. turning surface debris or rubbish and fallen timber).
- Active searching and listening for birds and frogs.
- Recording and observing tree hollows.
- Inspecting trees for scratch marks.

- Observing the dusk flight path of flying-foxes from Susan Island.
- Opportunistic spotlighting of flying-foxes (using a 50-watt spotlight).
- Searching for potential roost sites (including full perimeter survey of Elizabeth Island from a boat).
- · Recording incidental observations.

In addition to the above, previous fauna survey effort included:

Ultrasonic call recording (anabats targeting microchiropteran bats were deployed at four sites for one night each).

3.3.1 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.

3.4 Aquatic survey

Aquatic surveys were not undertaken as part of the current investigation. Aquatic surveys were previously undertaken by two qualified aquatic ecologists in August 2010. The aquatic surveys included fyke netting, luminescent bait trapping and habitat-based assessment as detailed below (survey sites shown in Figure 8). Due to the high conductivity levels, excessive depth and macrophyte growth recorded during surveys, backpack electrofishing equipment could not be used. Once a preferred route is selected, bank and boat electrofishing techniques should be used. These surveys should be conducted in spring.

3.4.1 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 16:00hrs each day and retrieved at approximately 8:00hrs 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.

3.4.2 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 16:00hrs each day and retrieved at approximately 8:00hrs the next morning.

3.4.3 Aquatic habitat and condition assessment

Aquatic habitat assessments were conducted at 11 sites, primarily in order to assess the potential to support threatened species. 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 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.

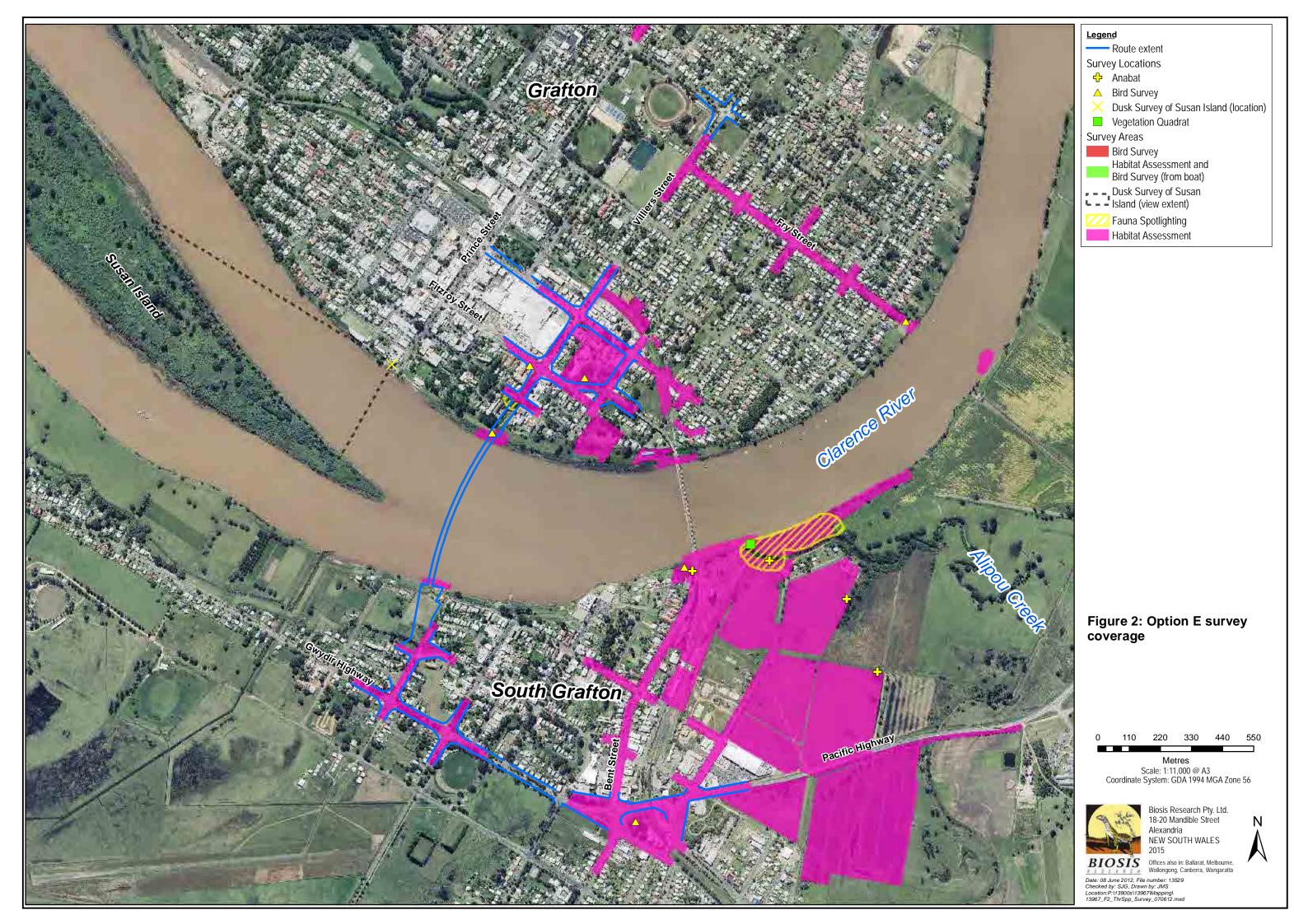
Suboptimal: watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought, although becoming greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.

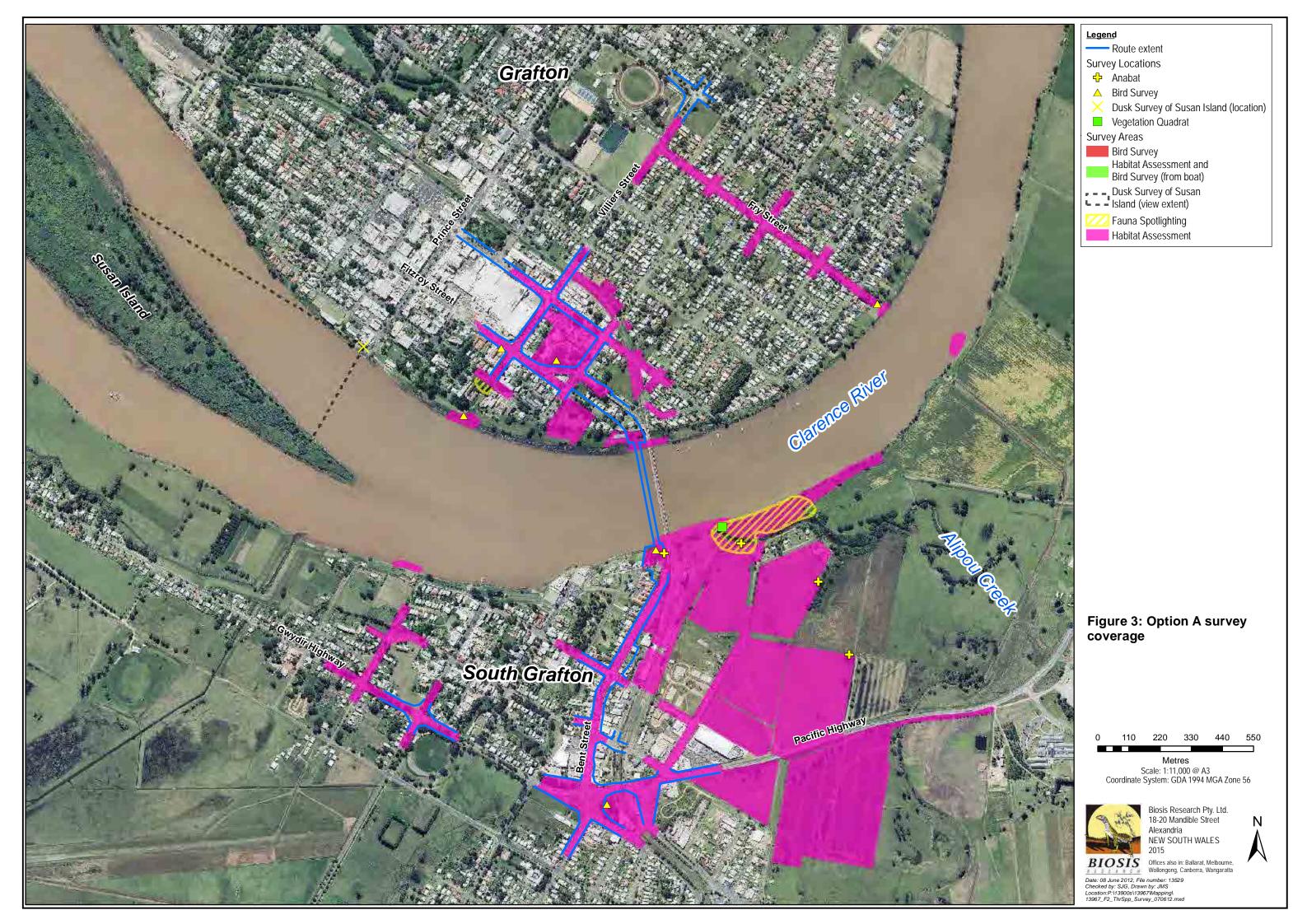
Marginal: watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following high rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and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

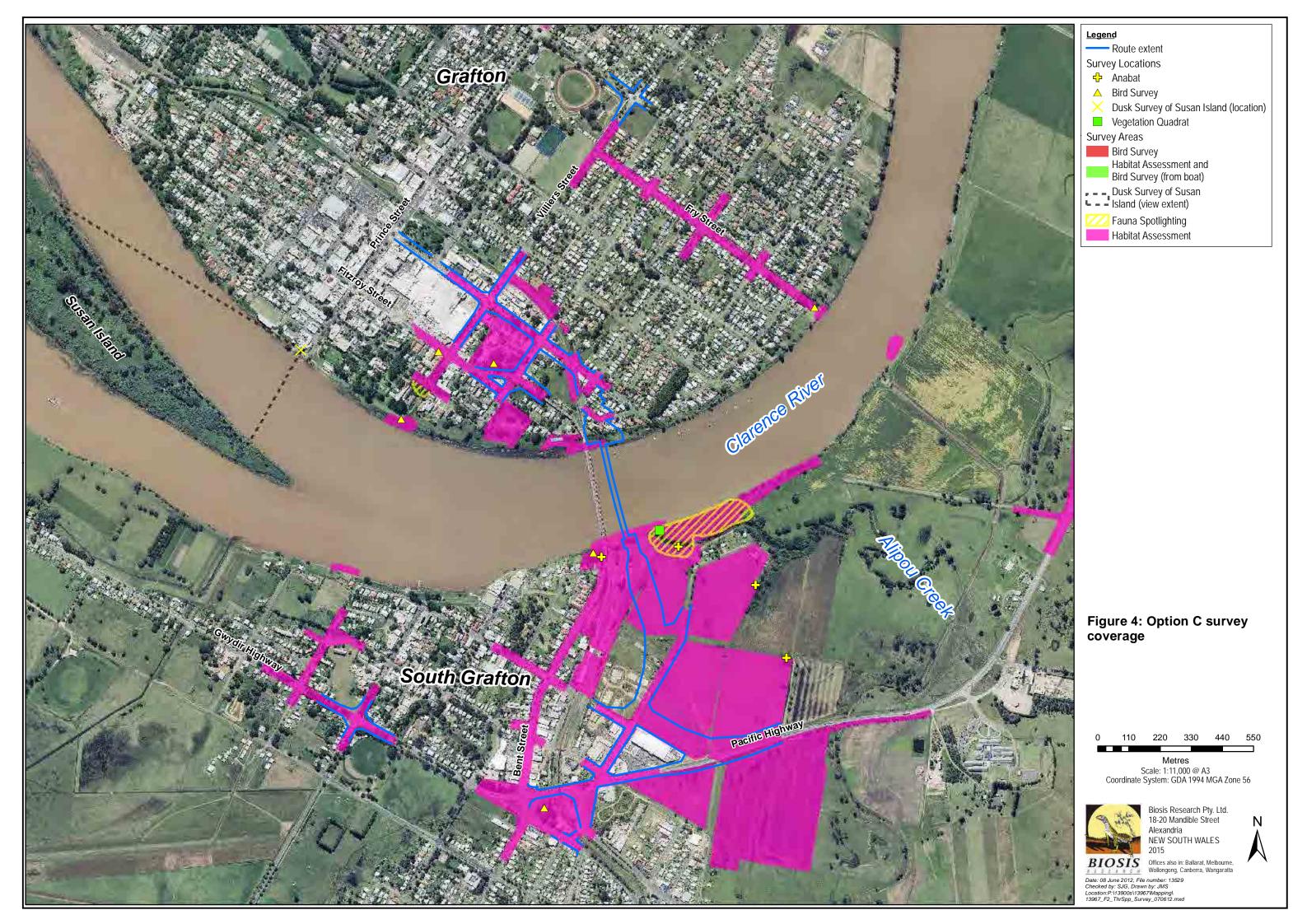
Poor: water courses or drainages that only flow during and immediately after high rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

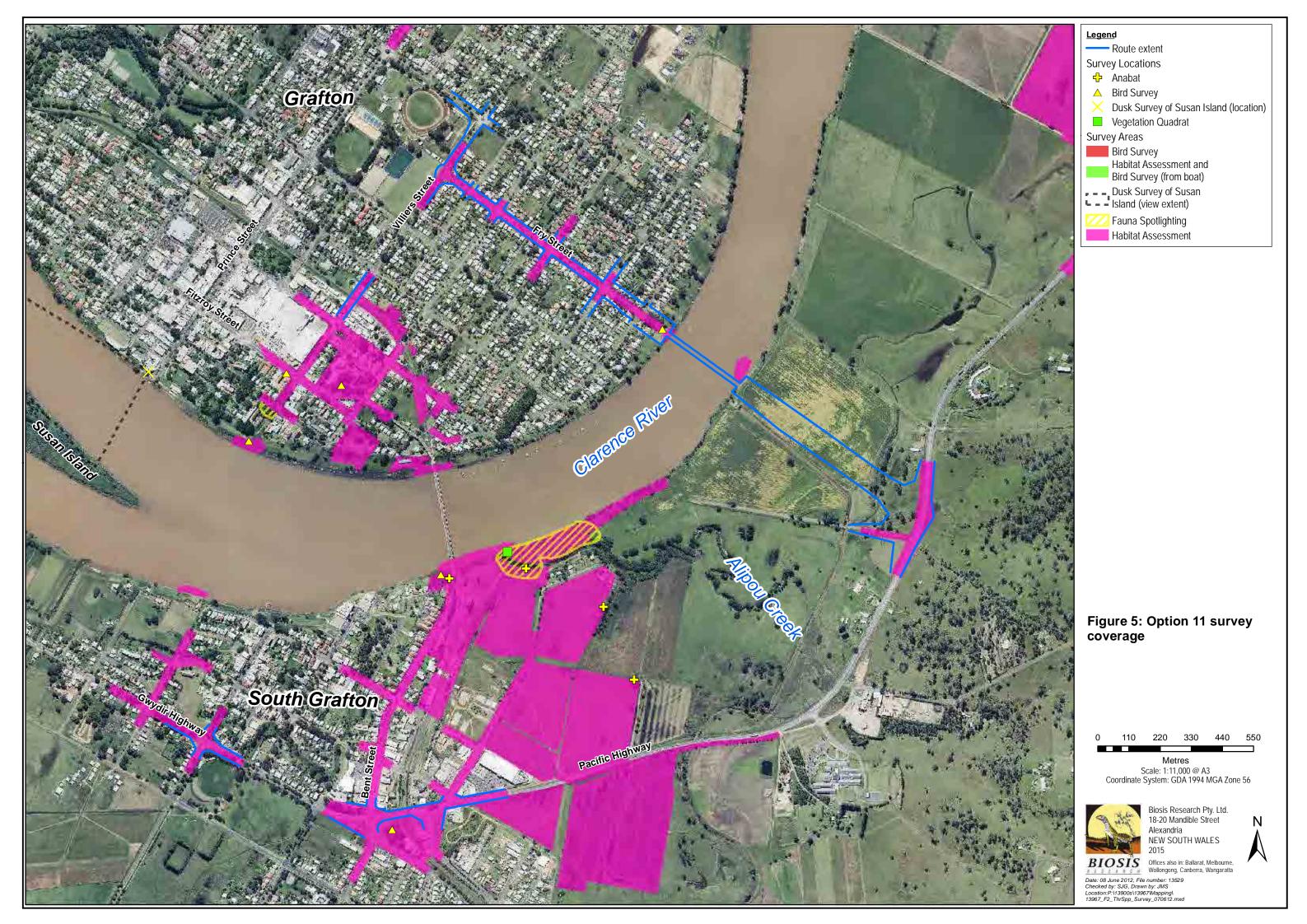
3.4.4 Water quality assessments

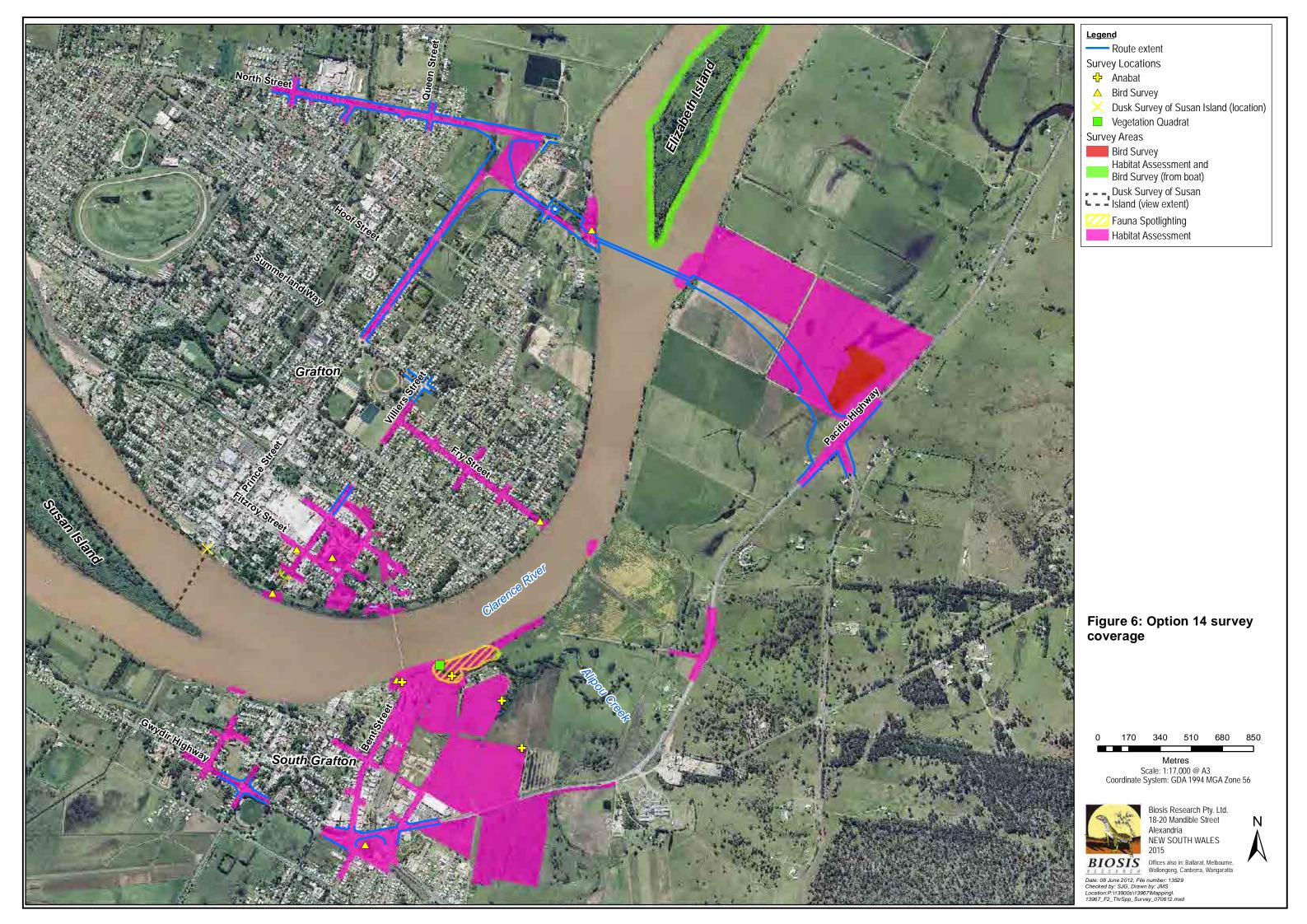
Water quality sampling was undertaken at each site using a Horiba U22-XD Multiparameter Water Probe. Measurements were taken ~30cm below the surface. Variables measured in situ included pH, dissolved oxygen (DO), temperature, turbidity and electrical conductivity (EC). Water quality sampling provides 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.

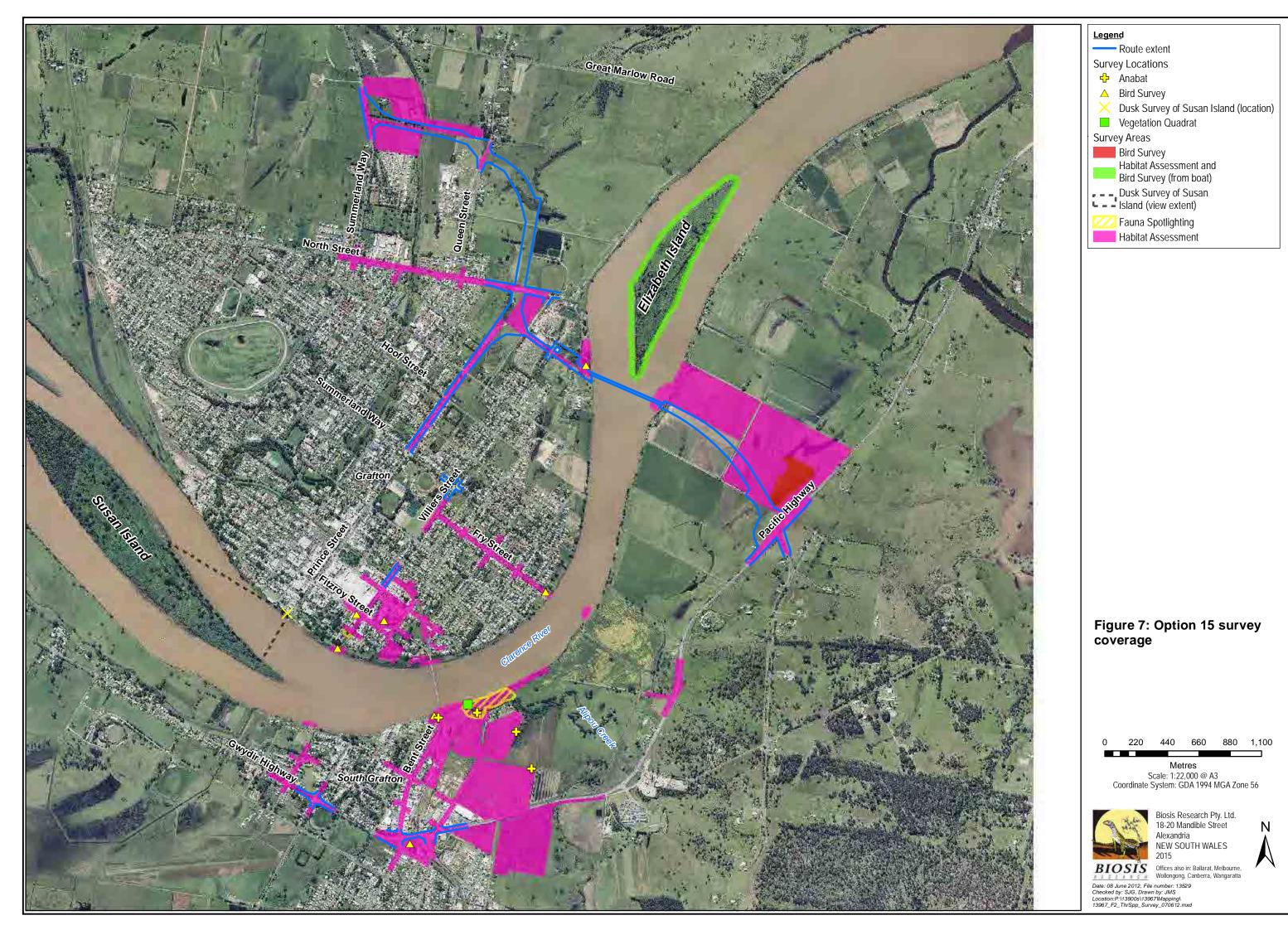


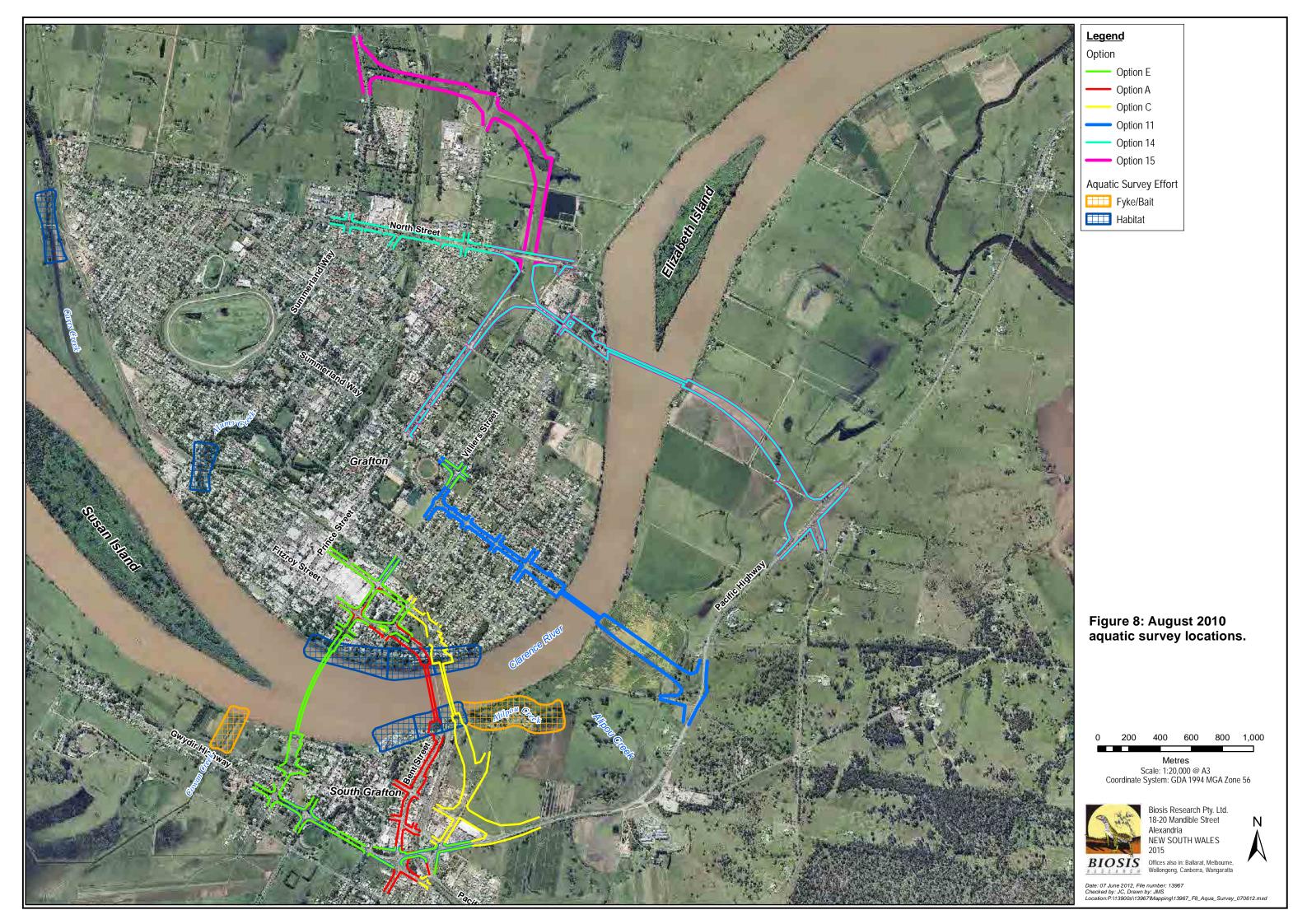












3.5 Assessment criteria and indicators

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 (i.e. biodiversity value) 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 condition of the habitats present and the likelihood that threatened species would utilise or be present in these.
- The presence of EEC and other native 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).

RMS in collaboration with the project team and Biosis Research have developed the following indicators to assist in the assessment of the six short-listed route options.

Table 2: Quantitative indicators for assessment of the route options.

Indicator	Unit	Description
Potential direct impact on known threatened flora species	Species and description	This is an indicator of the comparative potential direct impacts on known threatened flora species. It identifies whether the option potentially impacts known threatened flora species listed in the NSW Threatened Species Conservation Act 1995 or the Environment Protection and Biodiversity Conservation Act 1999. A route option affecting known threatened flora species is considered to have a comparatively greater impact on the natural environment.
Potential direct impact on identified endangered ecological communities (EEC)	Total area (square metres) per EEC	This is an indicator of the comparative potential direct impacts on EEC. It measures the area of each option through ecological communities considered endangered by the NSW Threatened Species Conservation Act 1995 or the Environment Protection and Biodiversity Conservation Act 1999. For the purposes of this assessment, the area has been measured within the indicative road boundary. Endangered ecological communities in the Grafton area include sub-tropical coastal floodplain (riparian forest and remnant eucalyptus), lowland rainforest on floodplains and freshwater wetlands on coastal floodplains (reedlands and drainage soaks). It also describes the condition of such vegetation (e.g. poor/degraded, fair, etc). Comparatively, the greater the area, the greater the potential impact.
Potential direct impact on other vegetation and habitat	Total area (square metres) per plant community	This is an indicator of the comparative potential direct impacts on other vegetation and habitat. It measures the area of each option through potential threatened flora and fauna habitat and other plant community (i.e. not EEC) and flora and fauna habitat. For the purposes of this assessment, the area has been measured within the indicative road boundary. Comparatively, the greater the area of native plant community, the greater the potential impact.
Potential direct impact on known habitat for threatened fauna species	Species and description	This is an indicator of the comparative potential direct impacts on known habitat for threatened fauna species. It identifies whether the option affects areas with known nesting, roosting and/or foraging habitat for threatened fauna species listed in the NSW Threatened Species Conservation Act 1995 or the Environment Protection and Biodiversity Conservation Act 1999. A route option affecting an area with known habitat for threatened fauna species is considered to have a comparatively greater impact on the natural environment.

3.6 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.

3.7 Suitability of methodology used

The study effort, combined with information available from other sources and previous field investigations, is considered suitable for a comparative assessment of the six short-listed route options. As a result, there is no substantial limitation to the study. However, the following limitations and assumptions apply:

- It is not the purpose of this report to undertake an impact assessment (no Assessments of Significance have been undertaken), and each option has not been ranked against another based on their respective levels of potential impact. The purpose of this report is to identify potential ecological constraints. This has been done by addressing the four indicators shown in Table 2 and providing a measurable unit (e.g. area in square metres) for each of the six short-listed route options to allow a quantitative comparison of ecological constraints present.
- Access to some properties potentially affected by the six short-listed options was not possible. In such cases, flora and
 fauna field surveys were conducted from adjacent publicly accessible areas and/or adjoining properties where access
 was possible. In some cases, properties could not be surveyed in the field at all and were assessed via desktop
 analysis.
- A survey for hollow-bearing trees within the vicinity of the six short-listed options was conducted. However, due to property access limitations, not all potentially affected trees were surveyed for hollows.
- 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 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 at certain times of the year.
- 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 OEH 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 high 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 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, surveys should be completed in spring once a preferred option has been selected.
- To date, aquatic survey has 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 aquatic 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.

4.0 EXISTING ECOLOGICAL CONDITIONS AND CONSTRAINTS

Lists of the terrestrial and aquatic flora and fauna recorded during the previous and current surveys are provided in Appendices 1, 2 and 3.

4.1 Flora

4.1.1 Overview

Table 3 summarises the existing flora conditions along the alignment of each short-listed route option. Further details are provided in the sections below.

Table 3: Summary of flora and flora habitat identified for each option.

Option	South Grafton	Grafton
E	Native and exotic plantings (e.g. Plate 4)	Reedlands - Freshwater wetlands on coastal floodplain EEC (e.g. Plate 13)
		Native and exotic plantings
		Planted figs (e.g. Plate 17)
А	Reedlands - Freshwater wetlands on coastal floodplain EEC	Reedlands - Freshwater wetlands on coastal floodplain EEC
	Native and exotic plantings	Native and exotic plantings
	Native revegetation (Induna Reserve; Plate 15)	
	Weeds and exotics	
С	Degraded riparian forest - Sub-tropical coastal floodplain forest EEC (e.g. Plate 12)	Reedlands - Freshwater wetlands on coastal floodplain EEC
	Reedlands - Freshwater wetlands on coastal floodplain	Native and exotic plantings
	EEC	Weeds and exotics
	Remnant eucalypts - Sub-tropical coastal floodplain forest EEC (e.g. Plate 16)	
	Native and exotic plantings	
11	Remnant eucalypts - Sub-tropical coastal floodplain	Native and exotic plantings
	forest EEC	Planted figs
	Drainage soak – Potential Freshwater wetlands on coastal floodplain EEC (e.g. Plate 10)	
	Degraded riparian forest - Sub-tropical coastal floodplain forest EEC	
14	Drainage soak - Freshwater wetlands on coastal floodplain EEC	Drainage soak - Potential Freshwater wetlands on coastal floodplain EEC
	Native and exotic plantings	Constructed drainage line with native and exotic vegetation (e.g. Plate 21)
		Native and exotic plantings
15	Drainage soak - Freshwater wetlands on coastal floodplain EEC	Drainage soak - Freshwater wetlands on coastal floodplain EEC
	Native and exotic plantings	Drainage soak - Potential Freshwater wetlands on coastal floodplain EEC
		Constructed drainage line with native and exotic vegetation
		Native and exotic plantings
		Planted figs

All accessible occurrences of degraded riparian forest, drainage soaks, reedlands, remnant eucalypts and constructed drainage lines were determined to be in a poor condition. The native revegetation (i.e. Induna Reserve) was determined to be in a moderate condition. Native and exotic plantings, including planted figs, are an unnatural landscape and therefore their condition as a plant community cannot be assessed.

4.1.2 Vegetation mapping

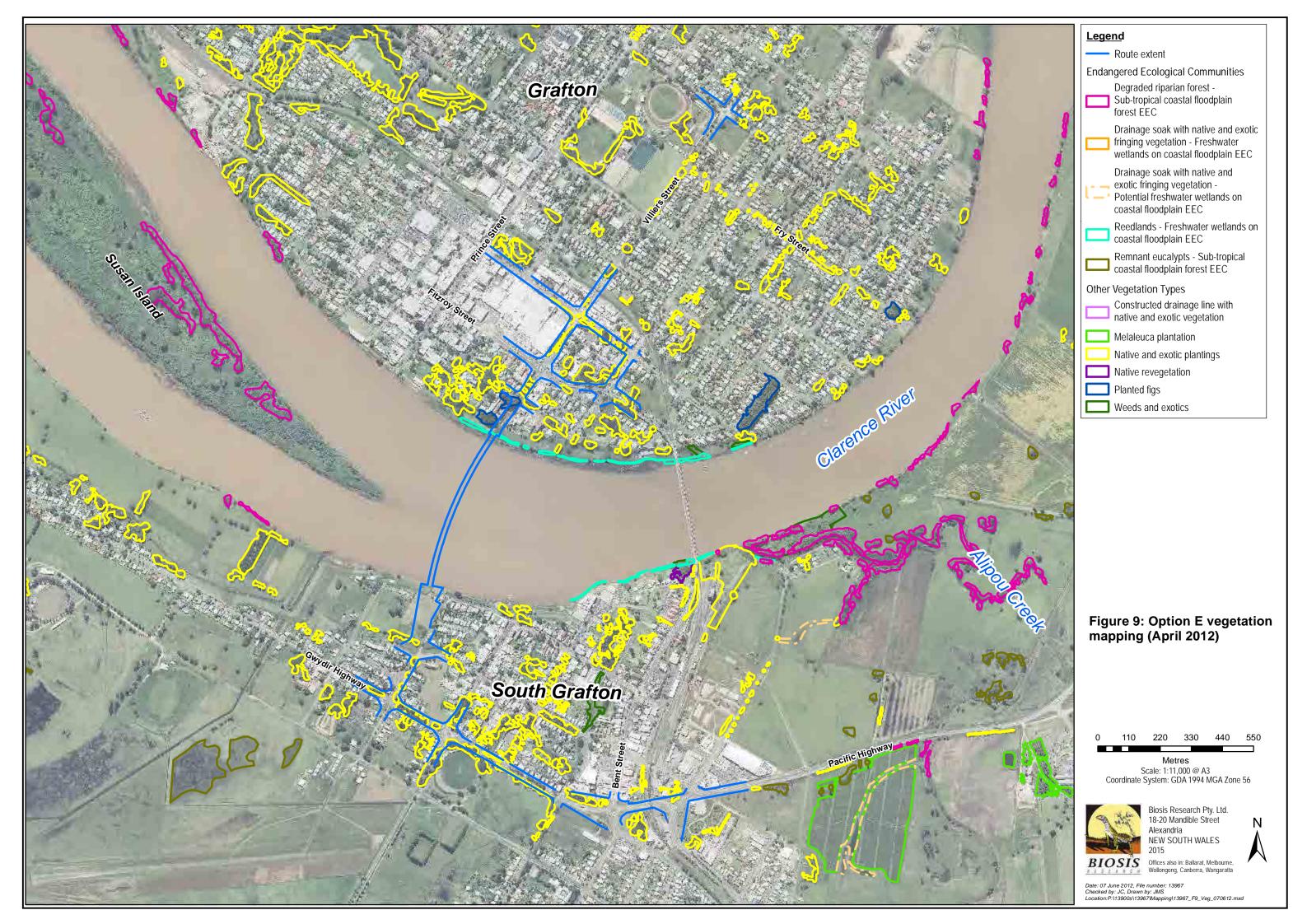
The Upper North East Forest Ecosystems Mapping (NPWS 1998) classifies some patches of native vegetation on Susan Island only. The NPWS mapping is not of a sufficient scale to identify all small patches of native vegetation present in the Grafton and South Grafton area. Broad vegetation classification 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).

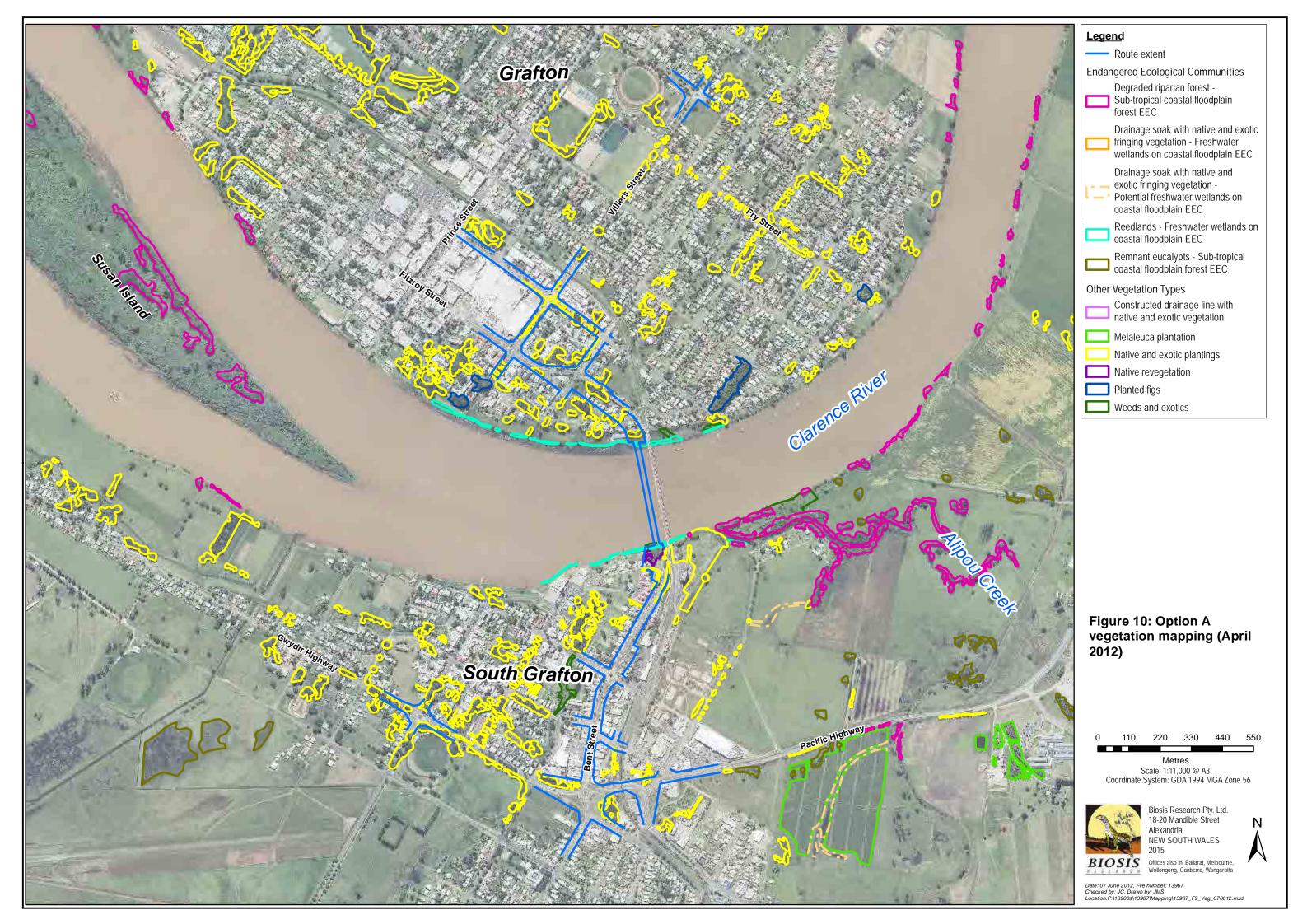
The vegetation classification by Kendall and Kendall (2003) is in general concordance with the results of the route options development surveys in Section 4.1.3.

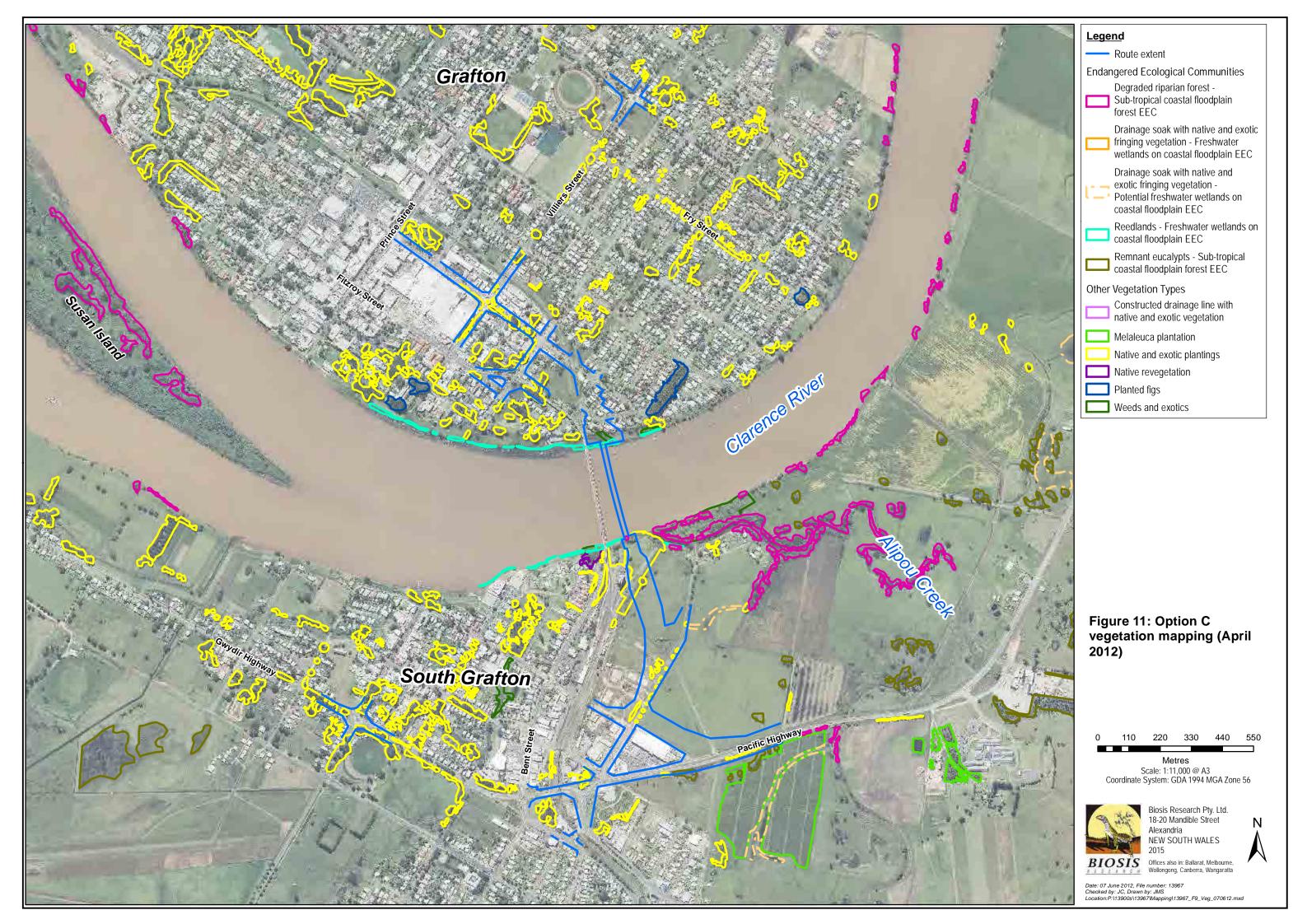
4.1.3 Current vegetation survey

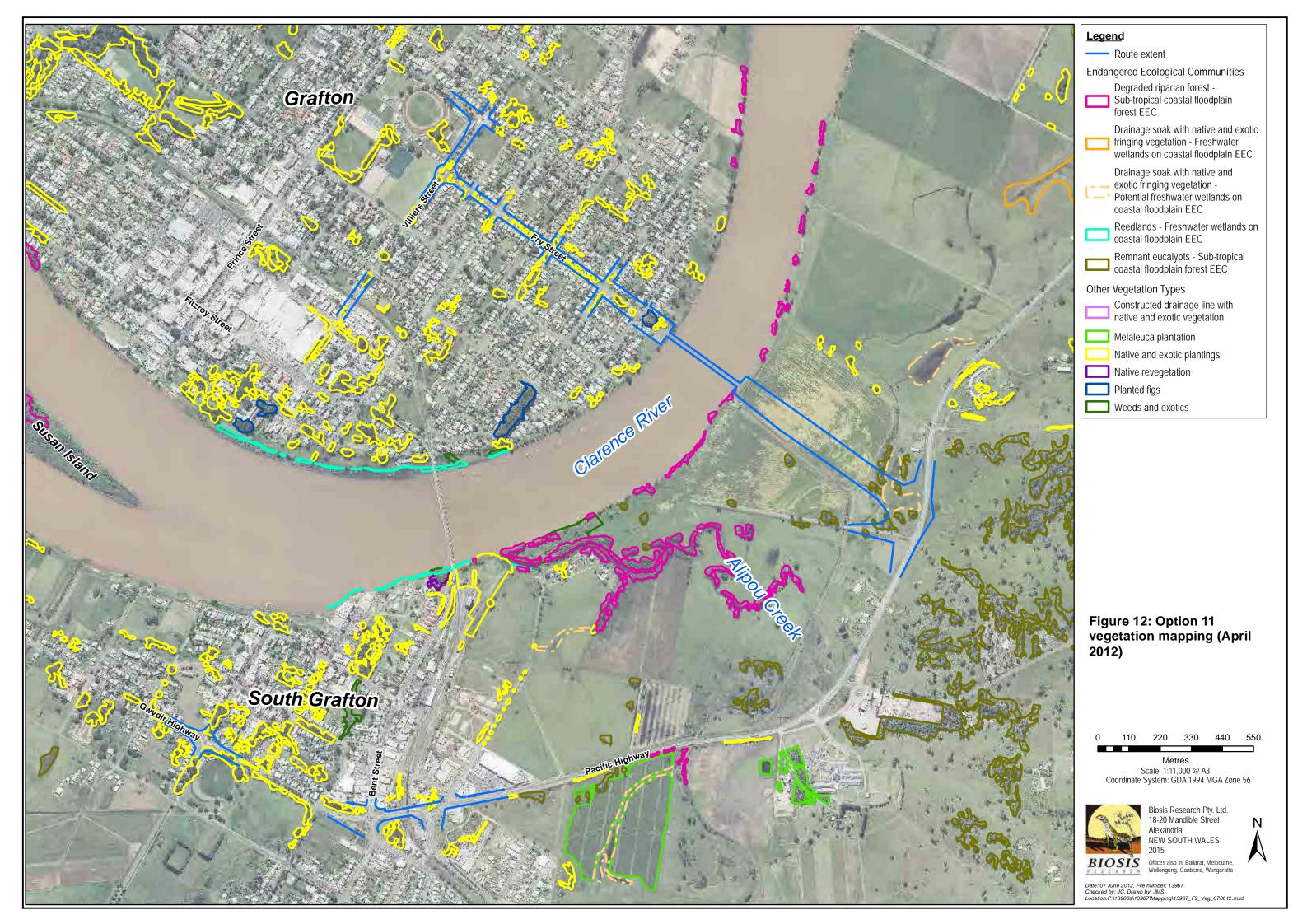
Broad scale mapping of the vegetation throughout the Grafton and South Grafton area was previously undertaken based on desktop research, high resolution aerial photography interpretation, and preliminary field surveys. The current field surveys targeted vegetation within the six short-listed route options. Figures 9 to 14 show the areas of each vegetation type that occur within the vicinity of each short-listed option. These vegetation types are described below.

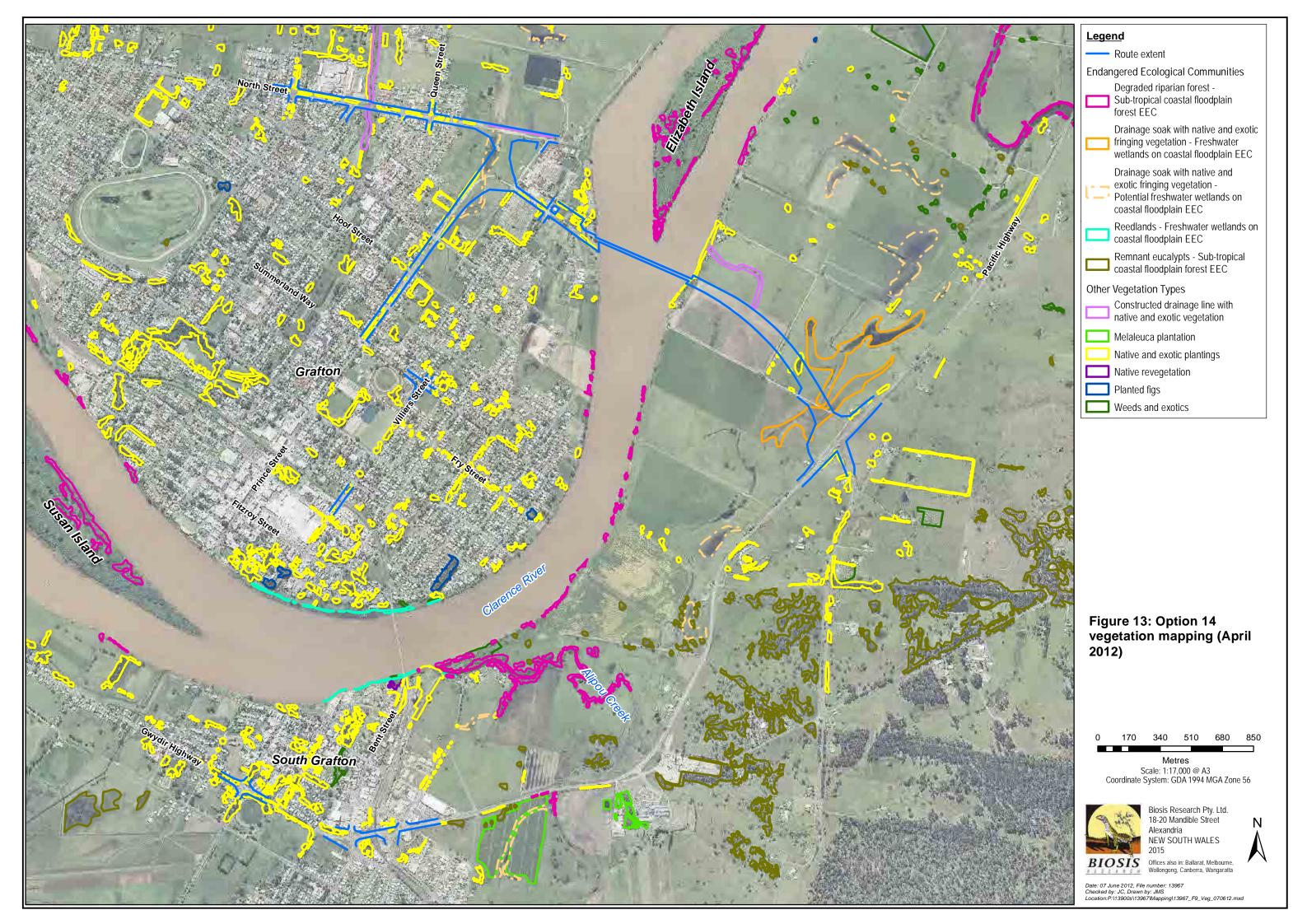
With regard to the above, it must be noted that the majority of the Grafton and South Grafton area is represented by a highly modified landscape in poor condition with little native remnant vegetation remaining. The majority of the Grafton and South Grafton area has been subject to historic and ongoing urbanisation, grazing and cropping.

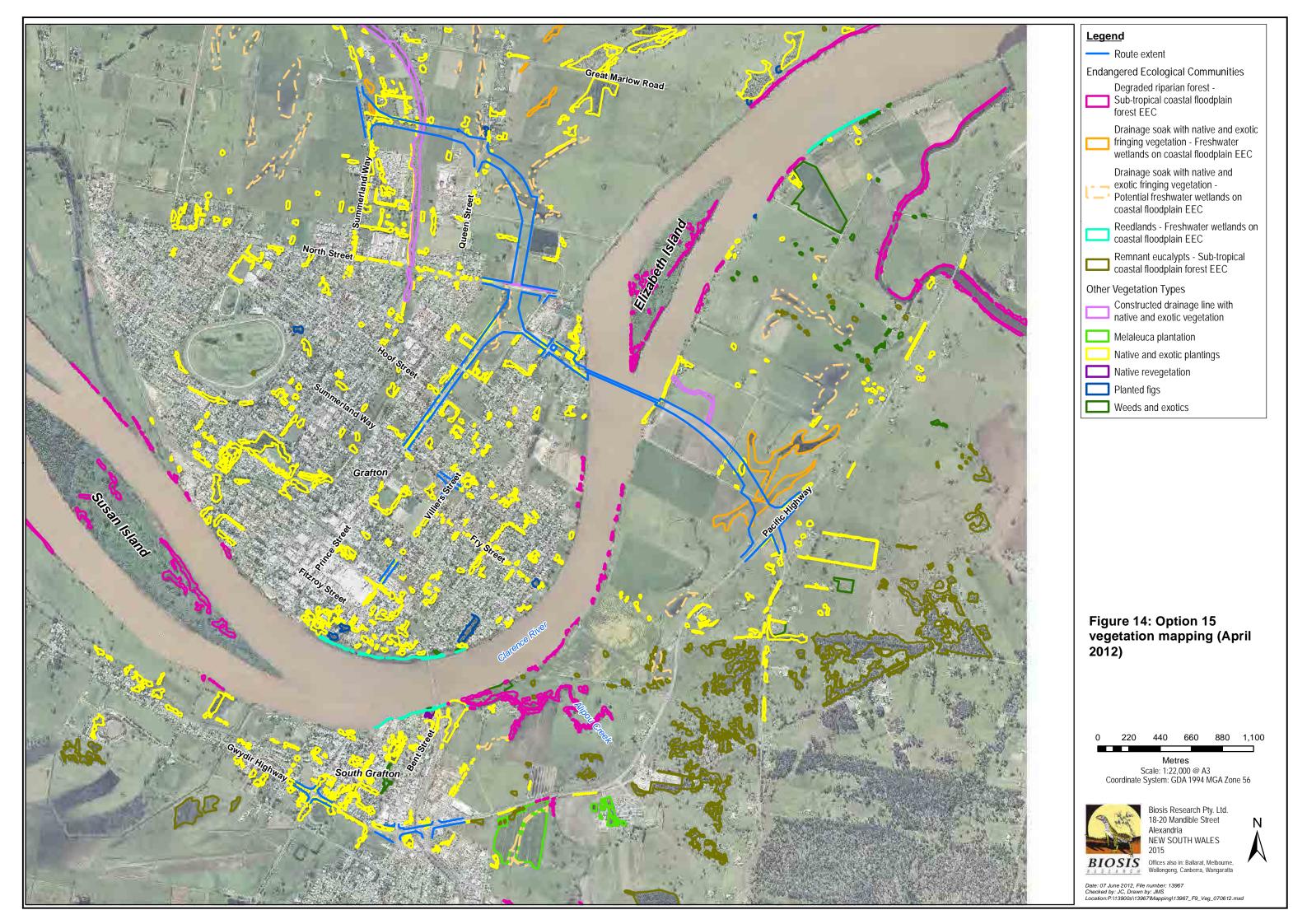












Native and exotic plantings

The native and exotic plantings community is the most predominant vegetation community within the Grafton and South Grafton area and is the only community traversed by all six short-listed options. This community is associated with local streets and roads that support residential, commercial and recreational development. In these areas vegetation is limited to street trees and cultivated gardens and maintained road verges. The most common street trees were exotic and native species, including jacaranda (*Jacaranda mimosifolia*), camphor laurel (*Cinnamomum camphora*), Moreton Bay fig (*Ficus macrophylla*), weeping fig (*F. benjamina*), poinciana (*Delonix regia*), leopard tree (*Caesalpinia ferrea*), cocos palm (*Syagrus romanzoffiana*), tallowwood (*Eucaylptus microcorys*), golden shower tree (*Cassia fistula*), weeping paperbark (*Melaleuca leucodendron*), brush box (*Lophostemon confertus*), mango (*Mangifera indica*) and alexandra palm (*Archontophoenix alexandrae*).

The road verges and parklands supported scattered planted native and exotic trees with an understorey of mown grass, usually widespread exotic grasses, sedges and/or cultivated lawn species such as paspalum (*Paspalum dilatatum*), kikuyu (*Pennisetum clandestinum*), narrow-leaved carpet grass (*Axonopus fissifolius*), mullumbimby couch (*Cyperus brevifolius*), *C. sesquiflorus* and green couch (*Cynodon dactylon*).

This community also encompasses a small degraded patch of river sheoak (*Casuarina cuninghamiana*) forest in Corcoran Park. This patch of vegetation supports a relatively even-aged stand of river sheoak with an understorey dominated by weed species such as guinea grass (*Megathyrsus maximus*), coastal morning glory (*Ipomoea cairica*), moth vine (*Araujia sericifera*), wild tobacco (*Solanum mauritianum*), climbing nightshade (*S. seaforthianum*), cobbler's pegs (*Bidens poliosa*), purple-top verbena (*Verbena bonariensis*), castor oil plant (*Ricinus communis*), fleabane (*Conyza bonariensis*) and lantana (*Lantana camara*).

Alex Bell Park in South Grafton is also included in the native and exotic planting community. This public park adjoins Through Street which is traversed by Option A. In the vicinity of Through Street, Alex Bell Park supports a storm water drainage line that has been planted out with native species including bangalow palm (*Archontophoenix cunninghamiana*), bumpy ash (*Flindersia schottiana*), blue quandong (*Elaeocarpus grandis*), red pear fruit (*Mischocarpus australis*), sweet pittosporum (*Pittosporum undulatum*), river sheoak and spiny-headed matt rush (*Lomandra longifolia*).

Examples of native and exotic plantings within the vicinity of the six short-listed options are provided as Plates 1 to 6.

The native and exotic plantings community does not possess the floristic or structural components described for any EEC listed under the TSC and/or EPBC Acts. Given that this community consists of species that have been planted in road reserves and public parks, its condition is rated as unnatural landscape.

It is noted two plantings of Wallangarra white gum (*Eucalyptus scoparia*) were recorded during the route options development survey; one on the access road leading into Corcoran Park and one within Jacaranda Park along Prince Street (refer Plates 7 and 8). This species is currently listed as endangered under the provisions of the TSC Act and as vulnerable under the EPBC Act, but is commonly used in landscape plantings. Given that Grafton is not within the natural distribution range for this species (i.e. the New England Tablelands) and the specimens encountered were clearly part of a landscaped garden, they will not be treated as threatened species for the purposes of this assessment.

Drainage soaks

Drainage soak vegetation communities are generally located in low-lying areas that are associated with permanent drainage features and are frequently saturated either as a result of surface water runoff or groundwater seepage. These communities are dominated by herbaceous plants, with the occasional tree or shrub typically restricted to the drier edges. Dominant species recorded during the current survey include swamp rice grass (*Leersia hexandra*), water couch (*Paspalum distichum*), *Juncus usiatus*, water pepper (*Persicaria hydropiper*), *P. decipiens*, giant Parramatta grass (*Sporobolus fertilis*) and umbrella sedge (*Cyperus eragrostis*). Woody species include swamp box (*Lophostemon suaveolens*), forest red gum (*Eucalyptus tereticornis*) and crack willow (*Salix fragilis*).

Not all drainage soaks were accessible during the route options development survey. Where access was possible, field observations confirmed that while the majority of drainage soaks have a relatively low floristic diversity and are subject to degrading processes such as cattle grazing, they satisfy the key criteria for the classification of the Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC.

The drainage soak to the south of North Street that is traversed by Options 14 and 15, was assessed during the route options development survey as being too degraded and dominated by non-native species to be classified as an EEC. However, it is noted that this community may at present be in a degraded state owing to the high-rainfall that preceded the route options

development survey. If either Option 14 or 15 is selected as the preferred option, it is recommended that the soak is surveyed again to take into account for changes in floristic structure and composition as the community recovers from recent flooding. Field surveys are required to verify the EEC status of other drainage soaks that were not assessable during the current investigation.

The drainage soak communities provide habitat suitable for three flora species of conservation significance namely tall knotweed (*Persicaria elatior*) (vulnerable), hairy joint grass (*Arthraxon hispidus*) (vulnerable) and square-stemmed spike rush (*Eleocharis tetraquetra*) (endangered). Targeted, seasonal surveys were undertaken for these species. These species were not recorded from the drainage soaks that were accessible during the route options development surveys. Nonetheless, the soaks that were not subject to detailed surveys are being treated as potential habitat until field surveys are able to confirm presence/absence of threatened flora species.

Examples of drainage soaks traversed by Options 14 and 15 are provided as Plates 9, 10 and 11. All drainage soaks that were accessible during the current survey were determined to be in a poor condition.

Degraded riparian forest

Isolated patches of degraded riparian vegetation associated with the north and south bank of the Clarence River will be traversed by Options C and 11. These patches support river sheoak and swamp sheoak (*C. glauca*) with the occasional forest red gum. Weed species are common including small-leaved privet (*Ligustrum sinense*), camphor laurel, white mulberry (*Morus alba*), cockspur coral tree (*Erythrina crista-galli*) and willows (*Salix* spp.) (Plate 12).

The understorey is highly disturbed, degraded and generally dominated by weed species such as lantana, guinea grass, blue billy goat weed (*Ageratum houstonianum*) and wandering Jew (*Tradescantia fluminensis*).

Owing to its degraded and fragmented state this community is in a poor condition. Nonetheless these degraded patches satisfy the key criteria for classification as Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion EEC.

Reedlands

The reedlands community occurs in fragmented patches along the north and south banks of the Clarence River in the vicinity of Options A, C and E. Owing to extended periods of high rainfall and river flooding prior to the current survey, many areas of reedlands that had been identified in previous field surveys were in a degraded state. As such, information relating to this community collected during previous surveys is being relied upon for the purposes of this report.

The reedlands consist mainly of stands of the native aquatic grass common reed (*Phragmites australis*), with broad leaved cumbungi (*Typha orientalis*) and tall spikerush (*Eleocharis sphacelata*) also common (Plates 13 and 14). 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 guinea grass was often interspersed with common reed.

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 marsh club rush (*Bolboschoenus fluviatilis*), triangular club rush (*Schoenoplectus mucronatus*), *S. validus*, water pepper and water snowflake (*Nymphoides indica*). On the south bank of the Clarence River the aquatic vegetation was mainly comprised of monocultures of common reed. There was also a large patch of the exotic papyrus (*Cyperus papyrus*) to the west of the existing bridge.

Although the reedlands were generally small in size, fragmented and subject to exotic species incursion, these areas could be considered to meet the criteria for Freshwater Wetlands on Coastal Floodplains EEC. All representations of the reedland community are in a poor condition.

Native revegetation

The Induna Reserve, west of the existing bridge on the south bank of the Clarence River, was a revegetation project supported by Grafton Shire Council that will be traversed by Option A (Plate 15). The reserve supports a range of canopy species including flooded gum (*Eucalyptus grandis*), river sheoak, Illawarra flame tree (*Brachychiton acerifolius*), broad-leaved paperbark (*Melaleuca quinquenervia*) and brush cherry (*Syzygium australe*). The ground layer was sparse and dominated by leaf litter, with scattered infestations of weed species such as cobblers pegs, balloon vine (*Cardiospermum grandiflorum*) and basket asparagus (*Asparagus aethiopicus*).

This community does not satisfy the key criteria for any EEC described under the TSC and/or EPBC Acts. However, the revegetation project has been well-maintained and this community is currently in a moderate condition.

Remnant eucalypts

Remnant eucalypts are scattered throughout agricultural paddocks in the broader study area. Option 11 could have an impact on a small area of remnant eucalypts where it connects to the Pacific Highway in South Grafton. This area supports relic forest red gum and rough barked apple (*Angophora floribunda*) in a paddock that also supports a drainage soak. There is also a stand of mature forest red gum at the edges of the mapped melaleuca plantation along the Pacific Highway adjacent to Option C. The midstorey in these areas is generally absent and the groundstorey is dominated by pasture grasses (Plate 16).

While this community is highly disturbed owing to past land management practices, it could be considered to satisfy the key criteria for classification as Subtropical Coast Floodplain Forest EEC. However, due to its fragmented and modified nature, this community is currently in a poor condition.

Planted figs

The planted fig community is restricted to local streets in north Grafton and integrates with the planted native and exotics community. This community encompasses large, impressive examples of planted fig trees, typically Moreton Bay fig (Plate 17).

This community does not satisfy the key criteria for any EEC described under the TSC and/or EPBC Acts. Given the figs trees are likely to have been planted for landscaping purposes, this community is a non-native landscape.

Constructed drainage lines

Options 14 and 15 traverse constructed drainage lines that support native and exotic species including water couch, guinea grass, balloon cotton bush (*Gomphocarpus physocarpus*), cockspur coral tree, spiny headed mat rush (*Lomandra longifolia*), crack willow, green couch, triangular club rush and broad-leaved cumbungi (Plates 18, 19 and 20).

The large constructed drainage line that is traversed by Options 14 and 15 is heavily infested in some areas with the noxious weed water hyacinth (*Eichhornia crassipes*) (Plate 21).

These drainage lines have been constructed in order to manage and convey storm water flows and as such, have not been classified as the Freshwater Wetlands on Coastal Floodplains EEC. The drainage lines are generally in a degraded state owing to receiving run-off from adjoining agricultural and urban landscapes, erosion of the banks and infestation by weed species (i.e. guinea grass, willow and water hyacinth in particular). All representatives of this community were assessed as being in a poor condition.

Agricultural paddocks and plantations

The remaining areas traversed by the six short-listed route options support either industrial or agricultural land use. There are some large grazing paddocks dominated by green couch, kikuyu and white clover with scattered trees such as forest red gum, poplar, camphor laurel, Moreton Bay fig and cadaghi.

For the purposes of this report this community has not been mapped and does not satisfy any of the key criteria for any of the EEC described under the TSC and/or EPBC Acts.

4.1.4 Endangered Ecological Communities

The Office of Environment and Heritage (OEH) states that on the coastal floodplain of New South Wales, all the remaining native vegetation has been identified to be threatened and each distinct ecological community has been listed as Endangered under the TSC Act (OEH 2005).

The Grafton and South Grafton area is within the modified floodplain of the Clarence River, therefore all native vegetation within this area forms part of an Endangered Ecological Community (EEC). Three distinct EEC listed under the provisions of the TSC Act are known to occur within the Grafton and South Grafton area, namely:

- Freshwater wetlands on coastal floodplains.
- Lowland rainforest on floodplains.
- Sub-tropical coastal floodplain forest.

The six short-listed route options were found to traverse vegetation communities that satisfy the key criteria for two of these EEC (freshwater wetlands on coastal floodplains and sub-tropical coastal floodplain forest).

No EEC listed under the provisions of the Commonwealth EPBC Act were recorded during this survey.

Freshwater wetlands on coastal floodplains

The OEH identification guidelines for freshwater wetlands on coastal floodplains (DECC 2008) list a number of degraded variants of the EEC including:

- Damp depressions with low grass structure due to grazing or slashing (wetland species will often recover if this disturbance is removed).
- Large monocultures of reed species such as common reed and/or cumbungi.
- Water bodies invaded with floating weeds such as water hyacinth (Eichhornia crassipes).

On this basis the reedlands associated with the Clarence River and the majority of the drainage soaks that were assessed during this survey have been classified as representatives of this EEC. However, it should be noted that in all cases these reedlands and drainage soaks are in a poor condition owing to fragmentation, weed invasion and/or livestock grazing.

Artificial wetlands created on previously dry land for purposes such as sewerage treatment, stormwater management and farm production, are not regarded as part of this community (DECC 2008). As such, none of the constructed drainage line communities encountered during this survey have been classified as forming part of this EEC.

Sub-tropical coastal floodplain forest

Less than 30 per cent of the original distribution of sub-tropical coastal floodplain forest remains and these areas are often highly fragmented and threatened by clearing for urban and agricultural purposes, pollution from urban runoff and weed invasion (DECC 2007). There are some patches of remnant and regrowth native trees characteristic of this community present within the Grafton and South Grafton area, including:

- Fragmented patches of forest red gum (*Eucalyptus tereticornis*) and river sheoak (*Casuarina cunninghamiana*) along the banks of Clarence River.
- Relic paddock trees.

Options C and 11 traverse examples of this community associated with the banks of Clarence River. The extent of historic clearing along the Clarence River has reduced representatives of this EEC to small isolated patches of remnant trees over weed infested understorey in heavily modified landscape.

Option 11 traverses an area of relic paddock trees that loosely fit the criteria for this EEC. This patch of relic paddock trees has relatively low ecological value owing to its small size, modified nature and isolation from similar patches of vegetation by surrounding areas of cleared paddocks, cropping land, and the Pacific Highway. Nonetheless this community offers stepping-stone habitat for highly mobile fauna species as they move throughout the broader locality.

4.1.5 Plant species

A total of 173 vascular plant species were recorded from the sites surveyed, as shown in Figures 2 to 7, comprising 80 (46 per cent) locally indigenous species and 93 (54 per cent) exotic species. A list of plant species recorded is provided in Appendix 1.

Thirteen 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
Ageratina adenophora	Crofton weed	4
Alternanthera philoxeroides	Alligator weed	2
Cestrum parqui	Green cestrum	3
Cinnamomum camphora	Camphor laurel	4
Cryptostegia grandiflora	Rubber vine	1
Eichhornia crassipes	Water hyacinth	4
Lantana camara	Lantana	4
Leptospermum petersonii	Lemon-scented tea tree	4
Ligustrum lucidum	Broad-leaved privet	4
Ligustrum sinense	Small-leaved privet	4
Opuntia stricta	Prickly pear	4
Salix fragilis	Crack willow	5
Sporobolus fertilis	Giant Parramatta grass	4

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 2 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.

4.1.6 Significant flora

No threatened terrestrial or aquatic flora species were recorded during the previous or current surveys. Six threatened terrestrial plant species and the habitat of a further eight threatened terrestrial plants have been recorded within 10km of the Grafton and South Grafton area (OEH Atlas of NSW Wildlife and DSEWPaC Protected Matters Search Tool). A further 64 threatened terrestrial plant species are known or predicted to occur within the Clarence Lowlands catchment management authority subregion. The study area is not considered to provide habitat for any threatened aquatic plants.

4.2 Fauna

4.2.1 Overview

Table 5 summarises the existing fauna conditions along the alignment of each short-listed route option.

Table 5: Summary of fauna and fauna habitat identified for each option.

Option	South Grafton	Grafton
Е	Fauna habitat in the form of native and exotic plantings	Fauna habitat in the form of reedlands - Freshwater
	Grey-headed flying-fox	wetlands on coastal floodplain EEC
	One hollow-bearing tree	Fauna habitat in the form of native and exotic plantings
		Fauna habitat in the form of planted figs
		Grey-headed flying-fox
		Ten hollow-bearing trees
А	Fauna habitat in the form of reedlands - Freshwater wetlands on coastal floodplain EEC	Fauna habitat in the form of reedlands - Freshwater wetlands on coastal floodplain EEC
	Fauna habitat in the form of native and exotic plantings	Fauna habitat in the form of native and exotic plantings
	Fauna habitat in the form of native revegetation (Induna Reserve)	Nine hollow-bearing trees
	Fauna habitat in the form of weeds and exotics	

Option	South Grafton	Grafton
	Little bentwing-bat	
	Eastern bentwing-bat	
	Eastern freetail bat	
	One hollow-bearing tree	
С	Fauna habitat in the form of degraded riparian forest - Sub-tropical coastal floodplain forest EEC	Fauna habitat in the form of reedlands - Freshwater wetlands on coastal floodplain EEC
	Fauna habitat in the form of reedlands - Freshwater wetlands on coastal floodplain EEC	Fauna habitat in the form of native and exotic plantings Fauna habitat in the form of weeds and exotics
	Fauna habitat in the form of remnant eucalypts - Subtropical coastal floodplain forest EEC	Six hollow-bearing trees
	Fauna habitat in the form of native and exotic plantings	
	Little bentwing-bat	
	Eastern bentwing-bat	
	Eastern freetail bat	
	Southern myotis	
	Two hollow-bearing trees	
11	Fauna habitat in the form of remnant eucalypts - Subtropical coastal floodplain forest EEC	Fauna habitat in the form of native and exotic plantings Fauna habitat in the form of planted figs
	Fauna habitat in the form of drainage soaks – Potential Freshwater wetlands on coastal floodplain EEC	·
	Fauna habitat in the form of degraded riparian forest - Sub-tropical coastal floodplain forest EEC	
	At least four hollow-bearing trees	
14	Fauna habitat in the form of drainage soaks - Freshwater wetlands on coastal floodplain EEC	Fauna habitat in the form of drainage soaks - Potential Freshwater wetlands on coastal floodplain EEC
	Fauna habitat in the form of native and exotic plantings One hollow-bearing tree	Fauna habitat in the form of a constructed drainage line with native and exotic vegetation
	Cho hollow bearing tree	Fauna habitat in the form of native and exotic plantings
		Cattle egret breeding colony (Plate 23)
		One hollow-bearing tree
15	Fauna habitat in the form of drainage soaks - Freshwater wetlands on coastal floodplain EEC	Fauna habitat in the form of drainage soaks - Freshwater wetlands on coastal floodplain EEC
	Fauna habitat in the form of native and exotic plantings	Fauna habitat in the form of drainage soaks - Potential Freshwater wetlands on coastal floodplain EEC
		Fauna habitat in the form of a constructed drainage line with native and exotic vegetation
		Fauna habitat in the form of native and exotic plantings
		Fauna habitat in the form of planted figs
		Cattle egret breeding colony (Plate 23)
		Nine hollow-bearing trees

4.2.2 Fauna habitat

Fauna habitats within the Grafton and South Grafton area broadly correspond to the vegetation types and conditions described in Section 4.1.3.

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 (refer Figures 15 to 20), 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, and that may be affected by the six short-listed route options, are described below. The fauna species recorded during previous and current surveys 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 (*Jacaranda mimosifolia*), camphor laurel (*Cinnamomum camphora*) and fig trees (*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 threatened grey-headed flying-fox (*Pteropus poliocephalus*). Colonies of these species roost on Susan Island (Eby 1991 and personal observation). A few hollow-bearing trees were observed (Plate 22), providing habitat for hollow-dependent fauna such as the common brushtail possum (*Trichosurus vulpecula*) and microbats. 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 manmade structures.

Generally, fauna habitat within residential areas was assessed as being in poor condition however, the planted street trees are a known foraging resource for the threatened grey-headed flying-fox (as observed during the current surveys).

Riparian and fringing vegetation

Along the Clarence River there are varying densities of fringing vegetation with broad-leaved cumbungi (*Typha orientalis*) and common reed (*Phragmites australis*) lining the banks (Plate 13). 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. Riparian trees lining the banks of the Clarence River and Elizabeth and Susan Islands, provide nest and perch sites for birds of prey (e.g. brahminy kite (*Haliastur indus*)). Remnant stumps and stags were also found to be scattered along the banks 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.

Generally, riparian and fringing vegetation was assessed as being in poor condition however, the reedlands are a known habitat resource for the migratory Australian reed-warbler (as observed during previous and current surveys).

Soaks and ephemeral flooded pastures

Unnamed minor drainage lines and ephemeral flooding areas form soaks (Plates 9 and 10) within some grassy pastureland and treeless areas within the vicinity of the six short-listed options. These form ephemeral habitats for many bird species including the intermediate egret (*Ardea intermedia*), cattle egret (*Ardea ibis*), royal spoonbill (*Platalea regia*), straw-necked ibis (*Threskiornis spinicollis*) and perhaps infrequently the migratory glossy ibis (*Plegadis falcinellus*) and threatened black-necked stork (*Ephippiorhynchus asiaticus*). Within these flood-prone drainage areas common frog species such as spotted grass frog (*Lymnodynastes tasmaniensis*) may occur.

Generally, soaks and flooded pastures have been assessed as being in poor condition however, they do provide an important resource for wetland birds, including migratory species. One wetland in particular, located within Options 14 and 15, supports a breeding colony of the migratory cattle egret. Several hundred cattle egrets in breeding plumage, occupying and constructing nests, were observed within this wetland during the current surveys (Plate 23).

Grassland with remnant red gums

The grassland habitat consists of areas mostly devoid of canopy cover and is predominantly featured to the east and south-east of the Clarence River, and north of Grafton. 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 16) and 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 threatened 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 (and therefore considered to be in poor condition) but provides important roosting, nesting and sheltering habitat in the form of hollow-bearing trees for many fauna species.

4.2.3 SEPP 44 Koala Habitat

No core koala (*Phascolarctos cinereus*) habitat was observed within the Grafton and South Grafton area. Forest red gum (*Eucalyptus tereticornis*), a listed preferred feed tree of the koala under SEPP 44 was recorded, 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. A koala has been previously recorded along the Gwydir Highway in the vicinity of Option E (OEH record dated 2010). No other options are located in the vicinity of a koala record.

4.2.4 Fauna species

A list of fauna recorded within the Grafton and South Grafton area is provided in Appendix 2 and includes 80 species of bird (including four introduced species), 15 mammals (including one introduced species), six reptiles and two frog species.

The current fauna surveys included all publicly accessible and private properties where access was possible. Generally, survey effort was most focused on habitats with a greater potential to contain native species, e.g. remnant native vegetation and waterbodies (Clarence River, wetlands, soaks). Less effort was expended on highly modified areas such as cropped pastures, suburban streets and residential housing.

The following threatened and migratory fauna species were recorded during the previous and current surveys (and are mapped in Figures 21 to 26):

Threatened species

- Grey-headed flying-fox (including maternity camp).
- Eastern bentwing-bat.
- Little bentwing-bat.
- Southern myotis.
- Eastern freetail bat.
- Greater broad-nosed bat (only 'possible').
- Masked owl (only 'possible').

The little bentwing-bat, eastern bentwing-bat and eastern freetail bat were recorded beneath the existing bridge. These species may have been roosting beneath the bridge within small cavities and/or foraging within the riparian vegetation of the Clarence River.

Migratory species

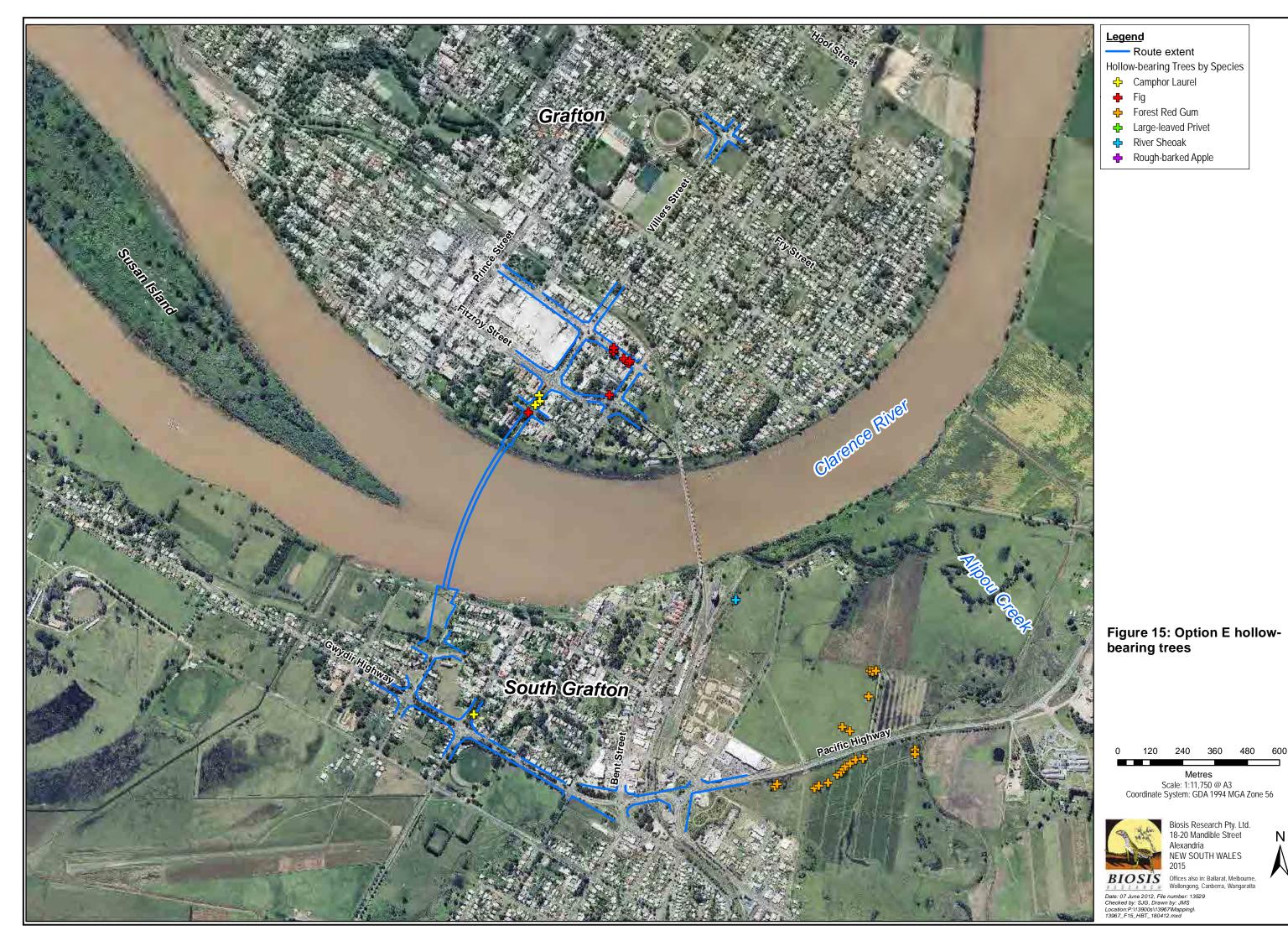
- Cattle egret (including a breeding colony).
- Australian reed-warbler.
- White-bellied sea-eagle.
- Rainbow bee-eater.
- Common tern.

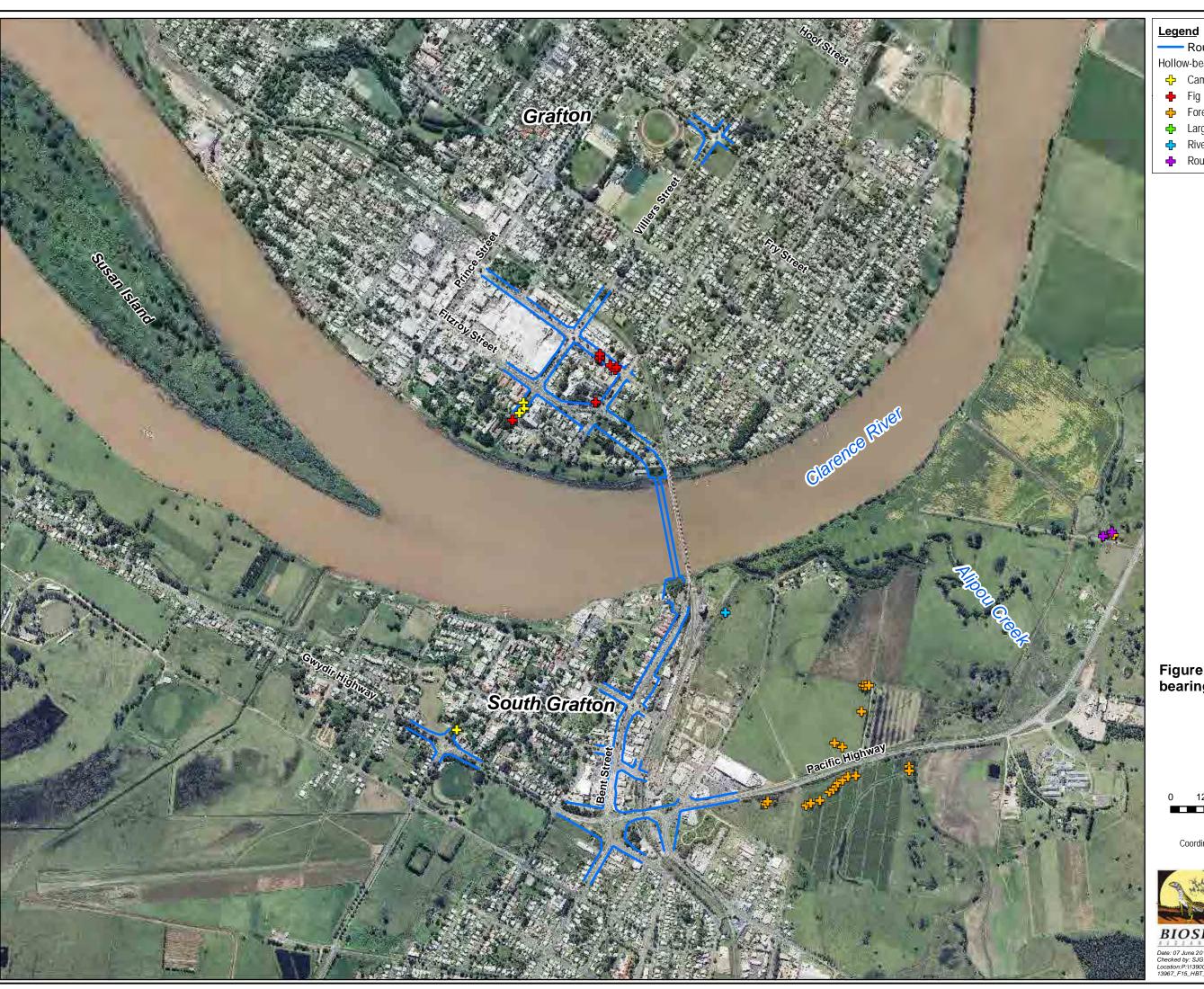
The cattle egret breeding colony is located between Prince Street and North Street, along the western edge of route options 14 and 15. Further studies would be required to determine if the cattle egret uses this site permanently or seasonally.

4.2.5 Significant fauna

Sixty-one 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 (OEH 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 (as listed on the TSC Act) have been recorded within 10km of the Grafton and South Grafton area. A further 50 threatened fauna species are known or predicted to occur within the Clarence Lowlands catchment management authority sub-region.

Of the above species, 83, 14 and four species are listed as vulnerable, endangered and critically endangered on the TSC Act, respectively. Further, of the above species, 28, 14, four and one are listed as migratory, vulnerable, endangered and critically endangered on the EPBC Act, respectively. A species may be listed under one or both Acts, as well as both threatened and migratory.





Route extent

Hollow-bearing Trees by Species

- ♣ Camphor Laurel
- Forest Red Gum
- ♣ Large-leaved Privet
- River Sheoak
- Rough-barked Apple

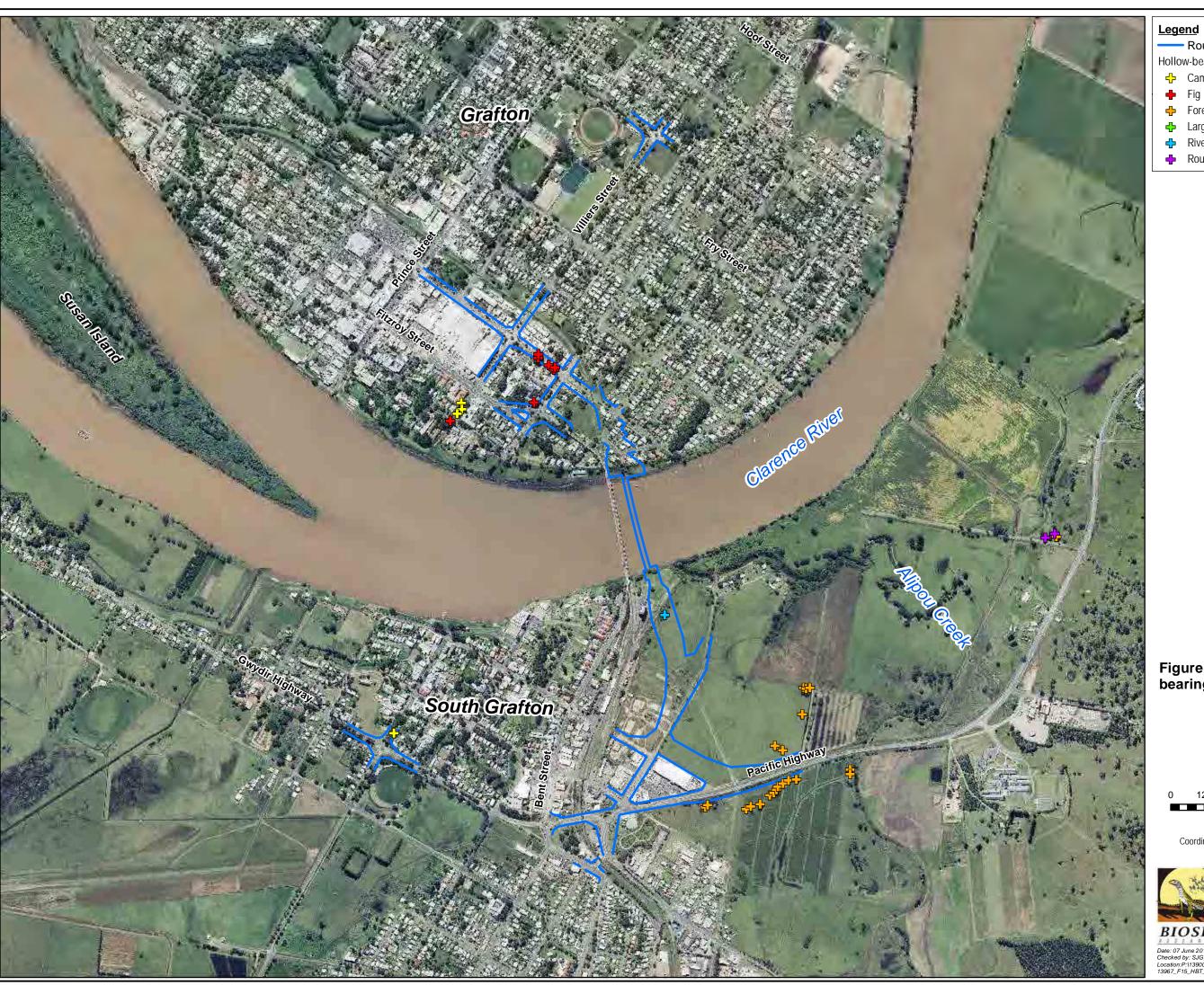
Figure 16: Option A hollow-bearing trees

Metres Scale: 1:12,280 @ A3 Coordinate System: GDA 1994 MGA Zone 56



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Route extent

Hollow-bearing Trees by Species

- ♣ Camphor Laurel
- Forest Red Gum
- Large-leaved Privet
- River Sheoak
- Rough-barked Apple

Figure 17: Option C hollow-bearing trees

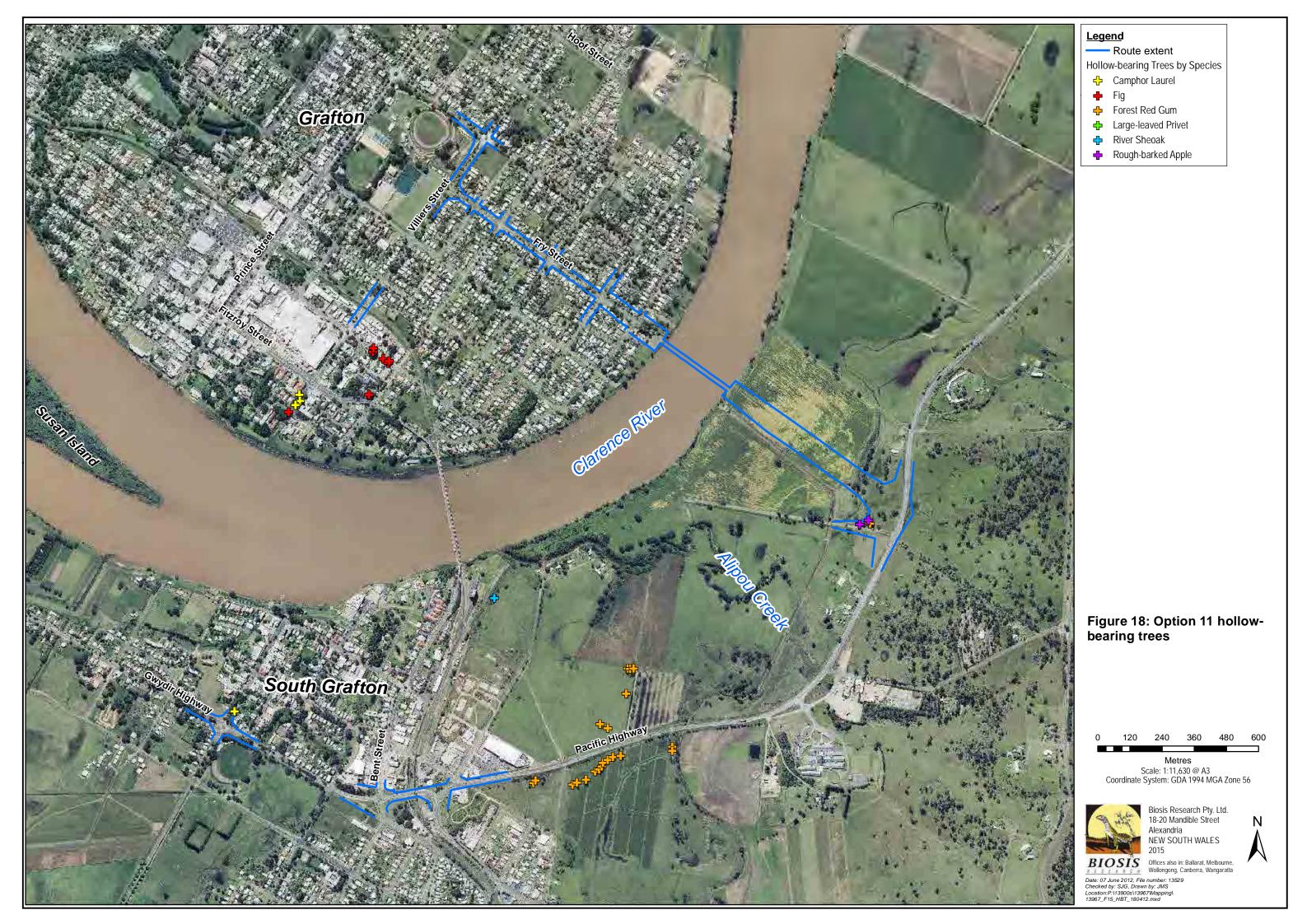
120 240 360 480 600

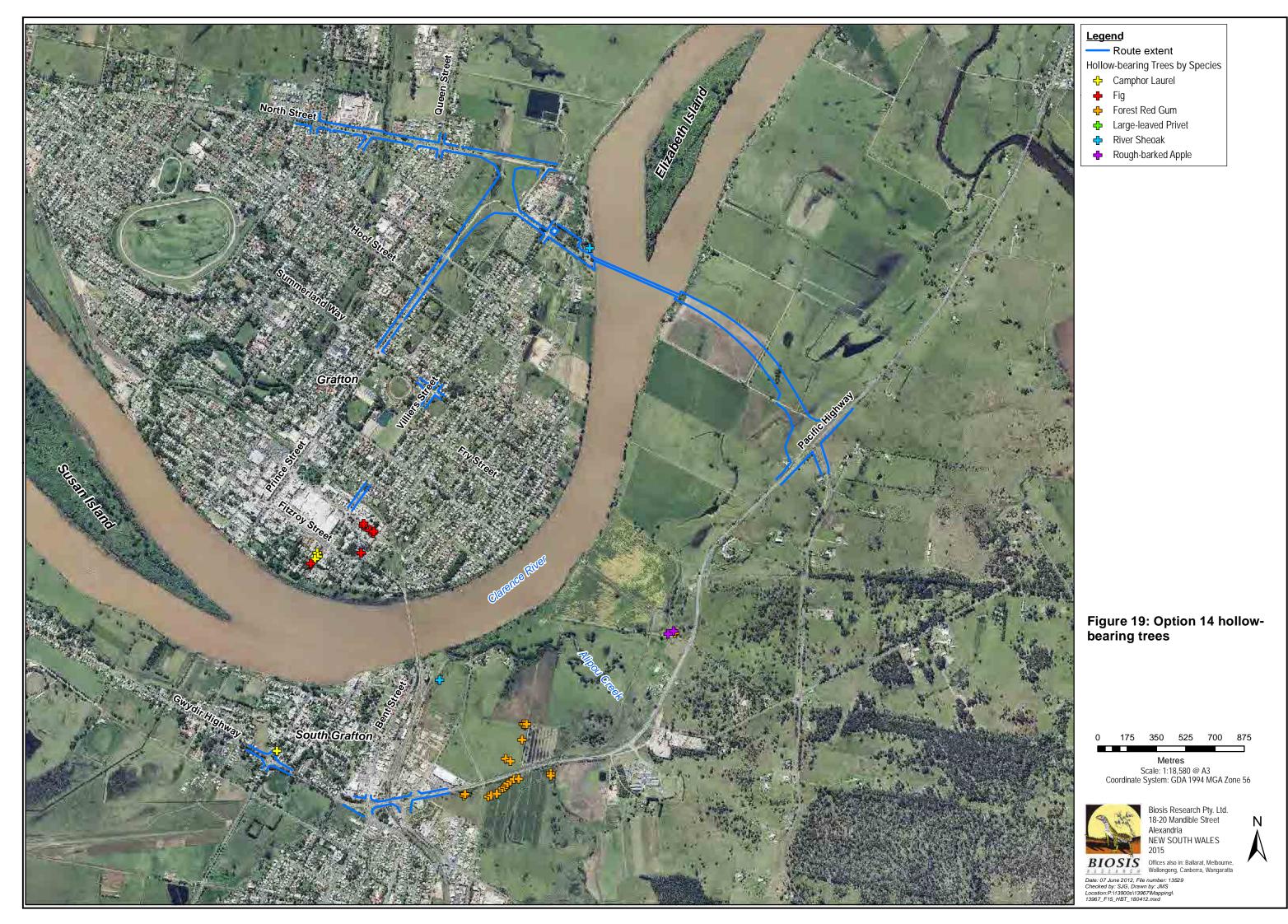
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<u>Legend</u>

- Route extent

Hollow-bearing Trees by Species

- ♣ Camphor Laurel
- 🕂 Fig
- Forest Red Gum
- ♣ Large-leaved Privet
- River Sheoak
- Rough-barked Apple

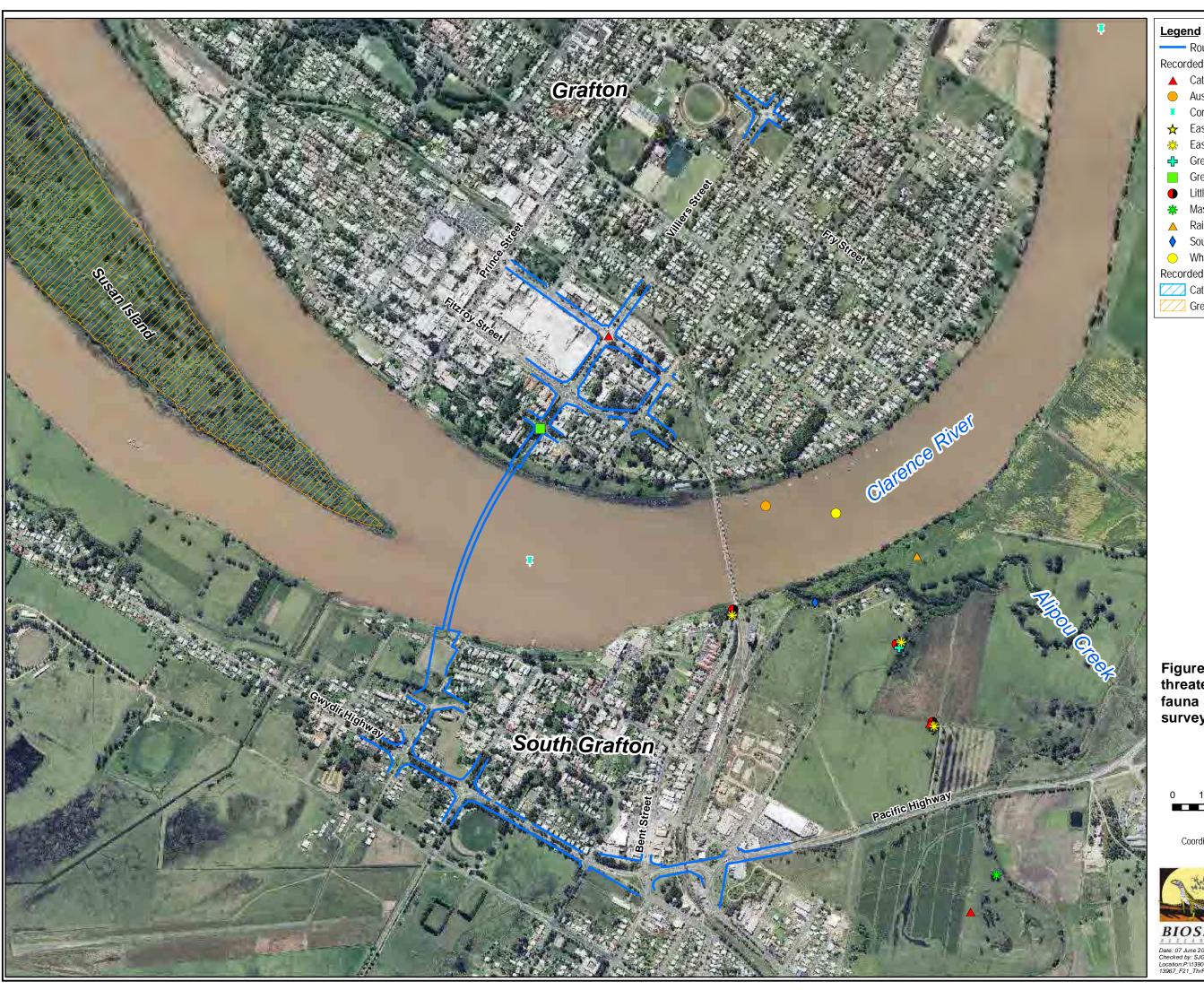
Figure 20: Option 15 hollow-bearing trees

Metres Scale: 1:23,580 @ A3 Coordinate System: GDA 1994 MGA Zone 56



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Route extent

Recorded Threatened Species

▲ Cattle Egret

Australian Reed-warbler

Common Tern

★ Eastern Bentwing Bat

Eastern Freetail Bat

Greater Broad-nosed Bat

Grey-headed Flying-fox (20+)

Little Bentwing Bat

Masked Owl

Rainbow Bee-eater

Southern Myotis

White-bellied Sea-Eagle

Recorded Threatened Species Areas

Cattle Egret (breeding colony)

Grey-headed Flying-fox Colony

Figure 21: Option E threatened and migratory fauna recorded during surveys (2010, 2011, 2012)

110 220

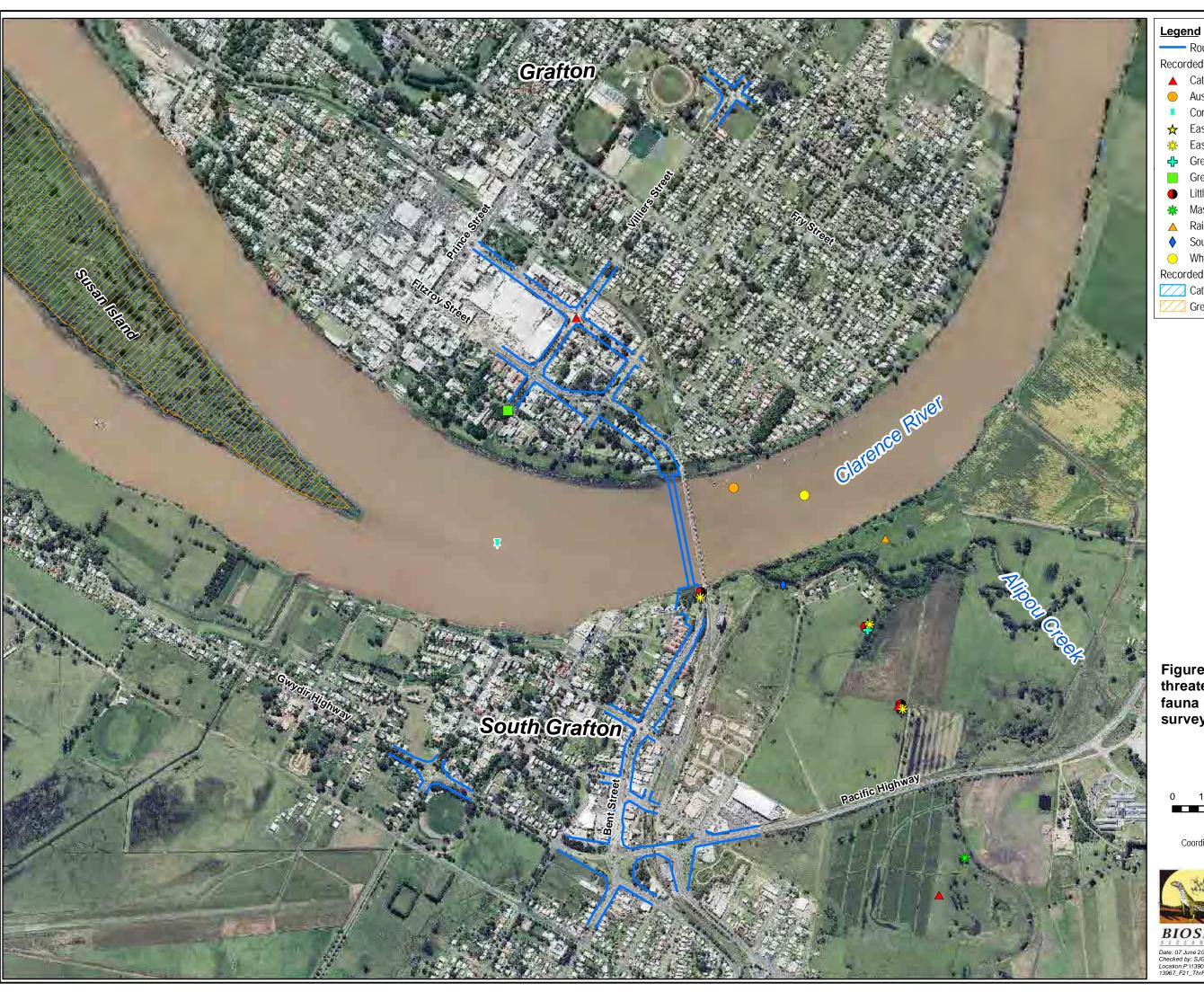
Metres Scale: 1:11,000 @ A3 Coordinate System: GDA 1994 MGA Zone 56



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- Route extent

Recorded Threatened Species

▲ Cattle Egret

Australian Reed-warbler

Common Tern

★ Eastern Bentwing Bat

Eastern Freetail Bat

♣ Greater Broad-nosed Bat

Grey-headed Flying-fox (20+)

Little Bentwing Bat

Masked Owl

Rainbow Bee-eater

Southern Myotis

White-bellied Sea-Eagle

Recorded Threatened Species Areas

Cattle Egret (breeding colony)

Grey-headed Flying-fox Colony

Figure 22: Option A threatened and migratory fauna recorded during surveys (2010, 2011, 2012)

110 220

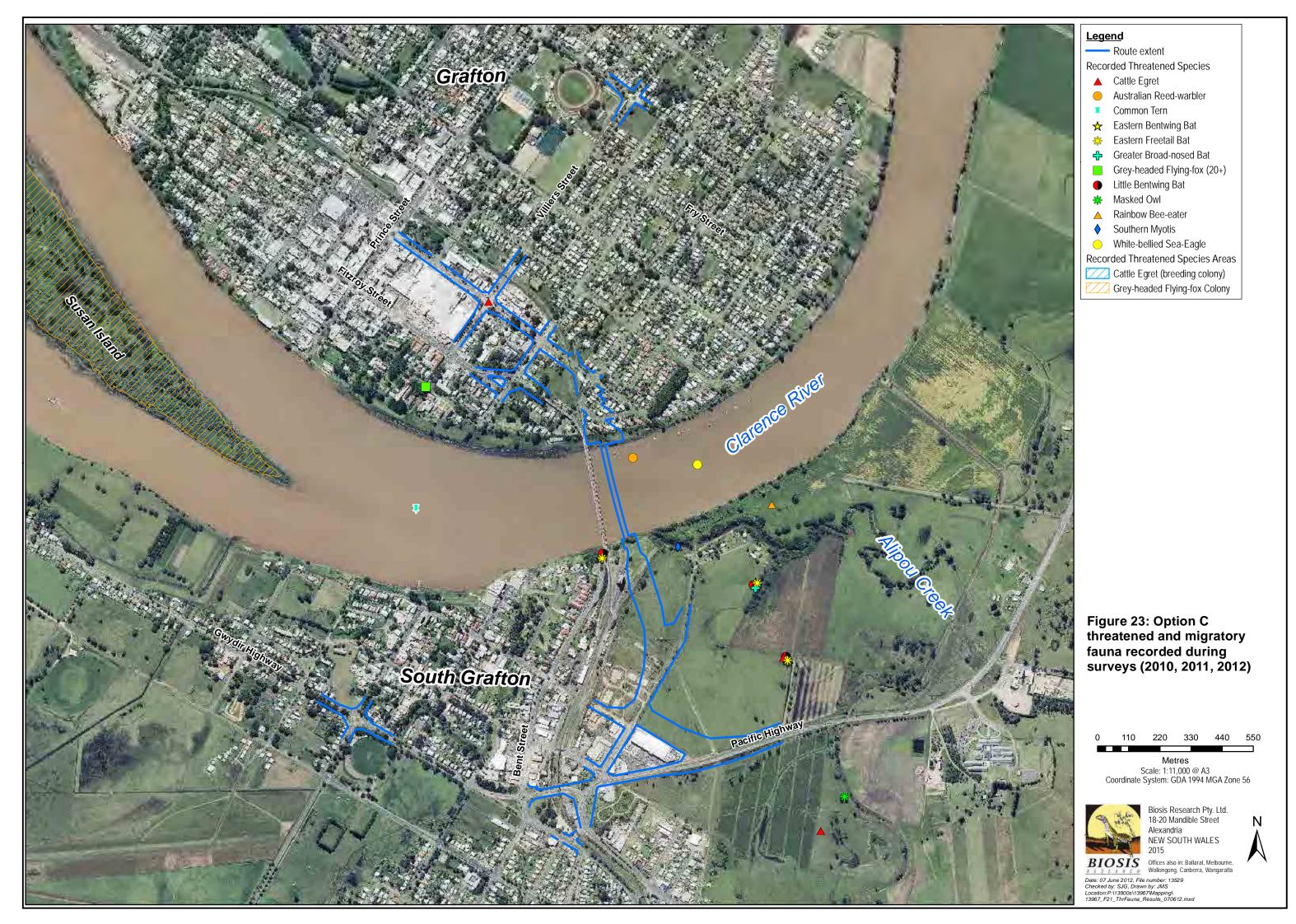
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Route extent

Recorded Threatened Species

▲ Cattle Egret

Australian Reed-warbler

Common Tern

★ Eastern Bentwing Bat

Eastern Freetail Bat

Greater Broad-nosed Bat

Grey-headed Flying-fox (20+)

Little Bentwing Bat

Masked Owl

Rainbow Bee-eater

Southern Myotis

White-bellied Sea-Eagle

Recorded Threatened Species Areas

Cattle Egret (breeding colony)

Grey-headed Flying-fox Colony

Figure 24: Option 11 threatened and migratory fauna recorded during surveys (2010, 2011, 2012)

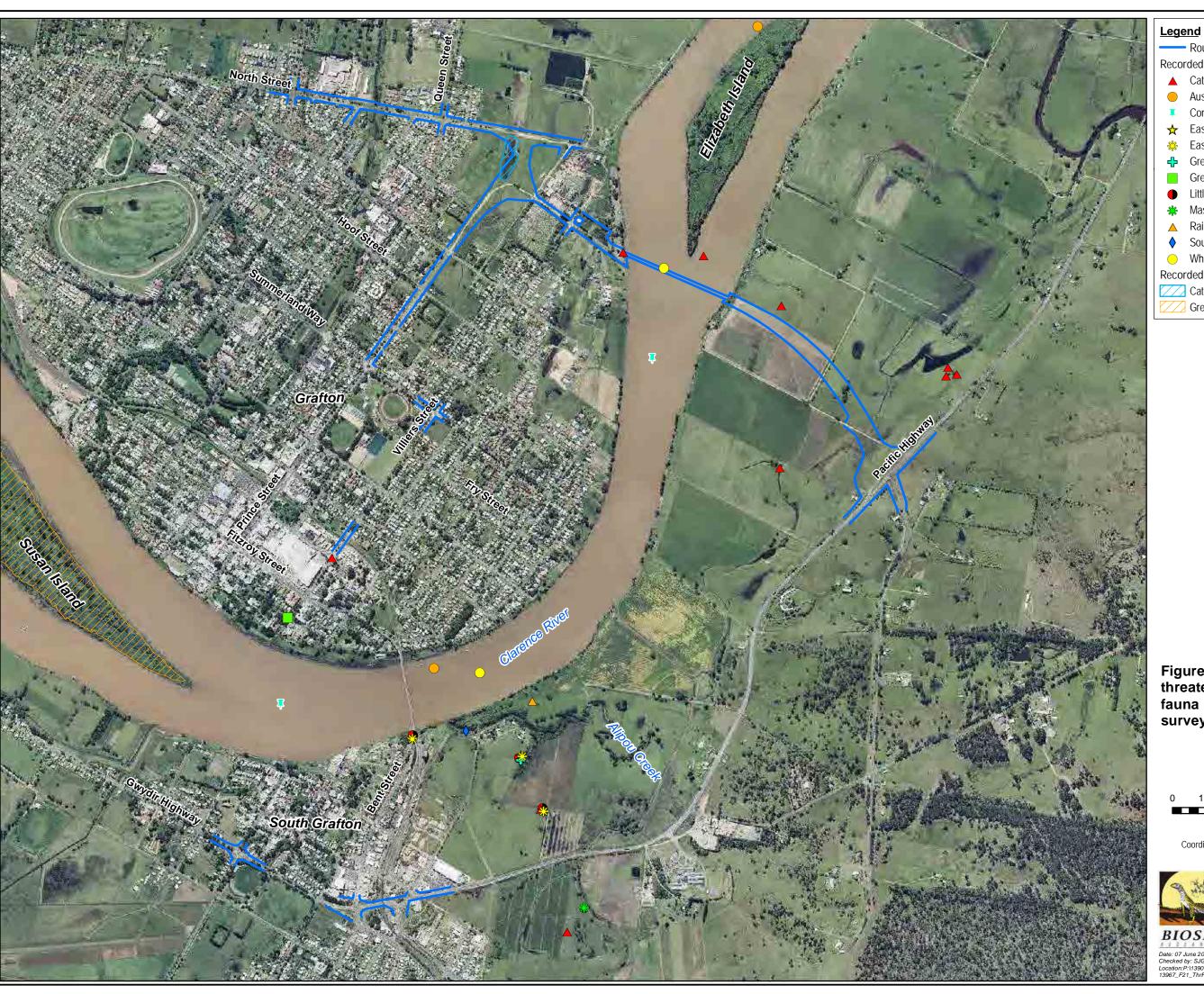
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Route extent

Recorded Threatened Species

▲ Cattle Egret

Australian Reed-warbler

Common Tern

★ Eastern Bentwing Bat

Eastern Freetail Bat

Greater Broad-nosed Bat

Grey-headed Flying-fox (20+)

Little Bentwing Bat

Masked Owl

Rainbow Bee-eater

Southern Myotis

White-bellied Sea-Eagle

Recorded Threatened Species Areas

Cattle Egret (breeding colony)

Grey-headed Flying-fox Colony

Figure 25: Option 14 threatened and migratory fauna recorded during surveys (2010, 2011, 2012)

170 340 510 680 850

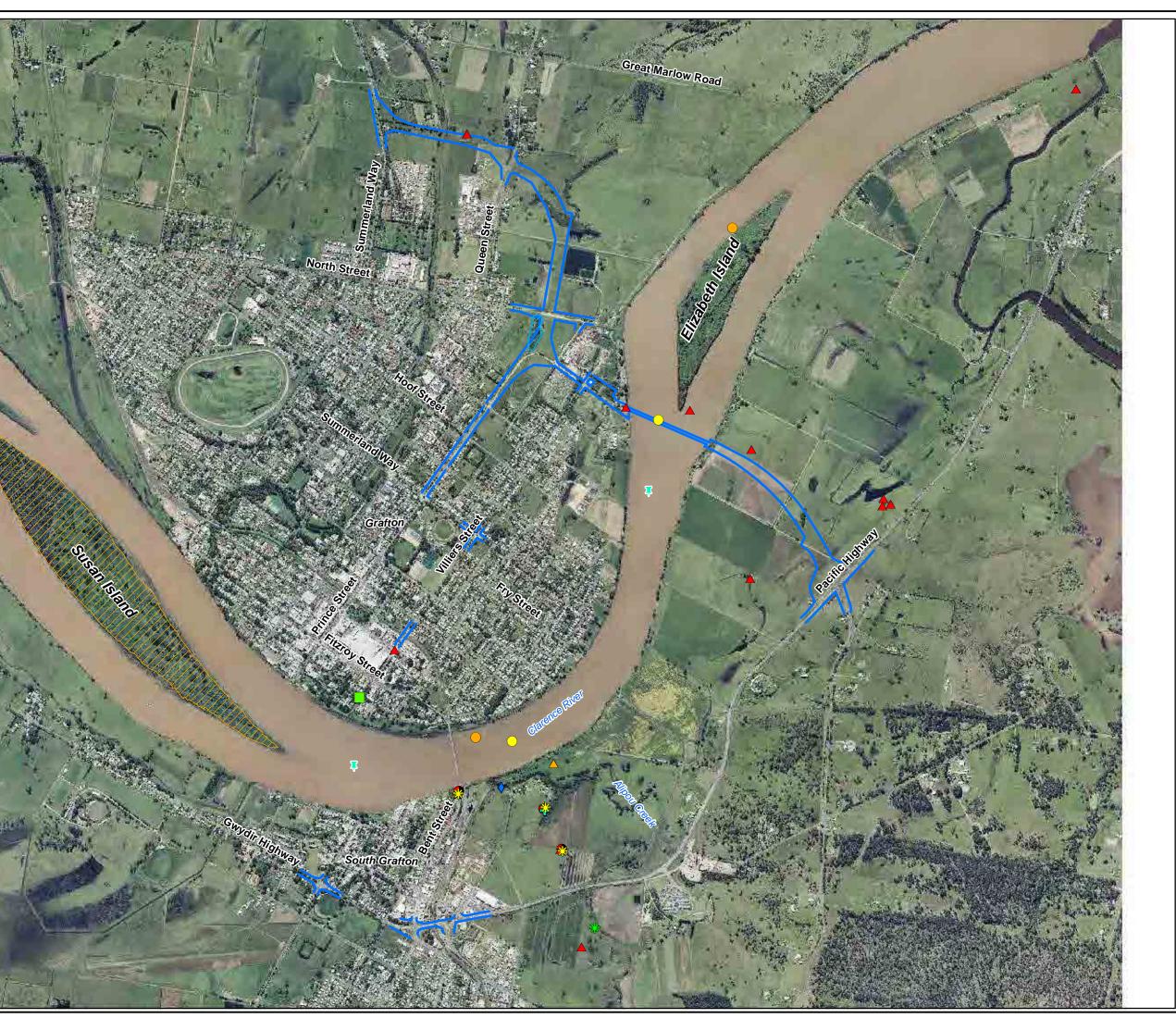
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Legend

Route extent

Recorded Threatened Species

▲ Cattle Egret

Australian Reed-warbler

Common Tern

★ Eastern Bentwing Bat

Eastern Freetail Bat

Greater Broad-nosed Bat

Grey-headed Flying-fox (20+)

Little Bentwing Bat

Masked Owl

Rainbow Bee-eater

Southern Myotis

White-bellied Sea-Eagle

Recorded Threatened Species Areas

Cattle Egret (breeding colony)

Grey-headed Flying-fox Colony

Figure 26: Option 15 threatened and migratory fauna recorded during surveys (2010, 2011, 2012)

Metres Scale: 1:22,000 @ A3 Coordinate System: GDA 1994 MGA Zone 56



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4.3 Aquatic fauna

4.3.1 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.

4.3.2 Aquatic habitats

Aquatic flora within the Grafton and South Grafton area broadly correspond to the vegetation types and conditions described in Section 4.1.3. 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, and lies within the Clarence Lowlands catchment management authority sub-region. 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, 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.

Alipou Creek

Alipou Creek is a tributary of the Clarence River at Grafton and flows from east to west within the proposal area (Figure 8). Alipou Creek is influenced by the tidal influences that affect the Clarence River. A causeway located on Alipou Creek is a restrictive 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 24), 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. However, the instream vegetation 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 (Figure 8). 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 a floodgate and alteration into an irrigation channel. 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.

Carrs Creek

Carrs Creek is a tributary of the Clarence River upstream of Grafton and flows from north to south within the proposal area (Figure 8). 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.

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 75 major and moderate floods; the most recent being in January 2012 (peaking at 5.53m). The previous major flood was in January 2011 when the river peaked at 7.64m (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 important 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.

4.3.3 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. Despite the failure to record any of these threatened aquatic fauna species, low to marginal potential habitat exists for nine of these species at all sites. Appropriate seasonal surveys are recommended to further the confirmation of absence or presence within the preferred route option, once chosen.

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.

4.4 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 for an additional crossing 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 previous and current field surveys 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.

4.5 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.

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

5.0 ROUTE OPTIONS ASSESSMENT

The following sections identify and describe existing ecological constraints per short-listed route option, in accordance with the quantitative indicators defined in Section 3.5.

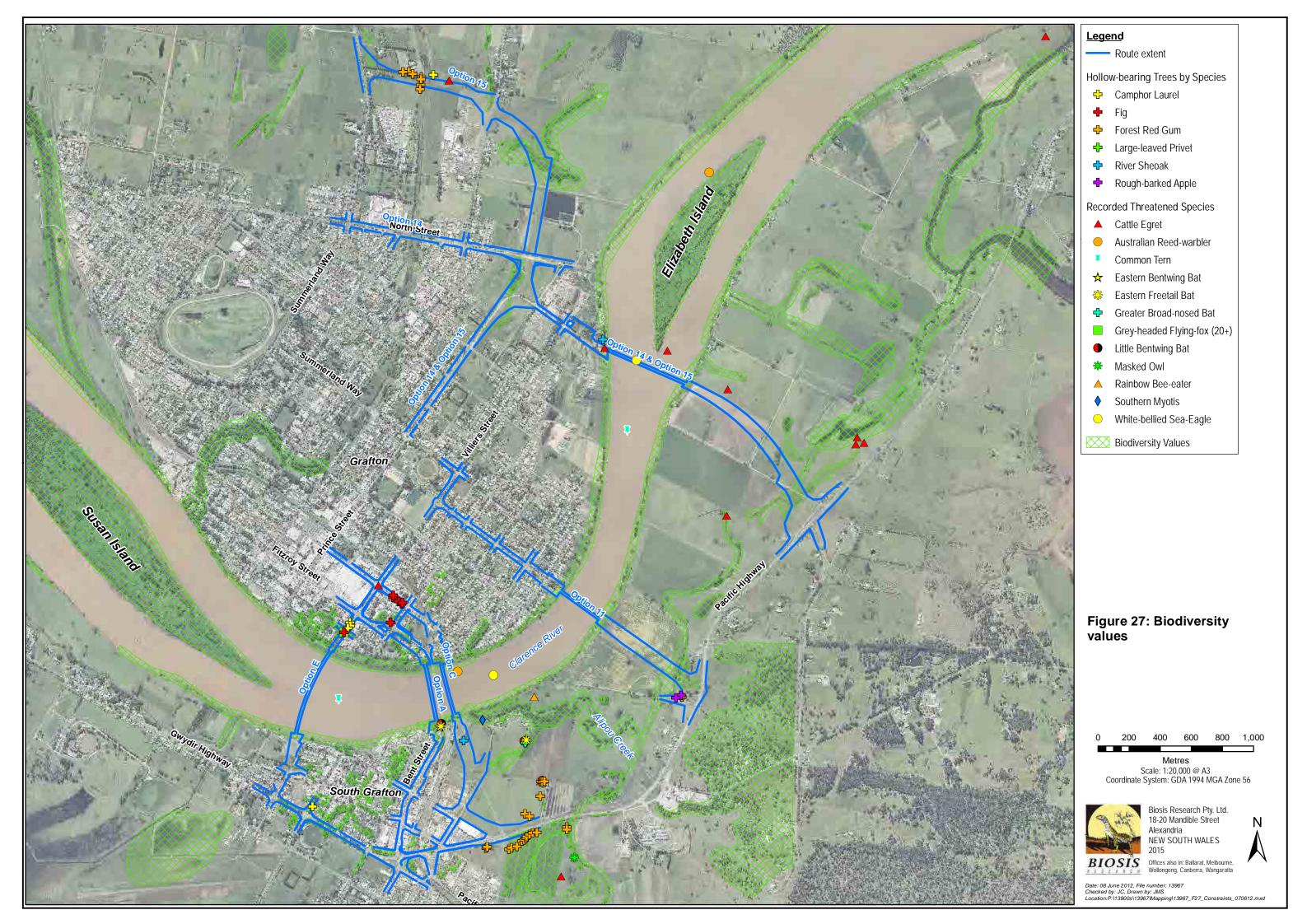
5.1 Identification of ecological constraints

Field surveys were conducted in the vicinity of the six short-listed route options to identify ecological constraints. All of the factors considered to determine areas of biodiversity value (and therefore ecological constraint) are listed below (and described in more detail in Section 3.5).

- 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).

5.1.1 Biodiversity value mapping

Figure 27 shows habitat areas identified as containing 'biodiversity value' as well as individual hollow-bearing trees and threatened and migratory fauna records (as recorded during previous and current field surveys) across the Grafton and South Grafton area.



5.1.2 Potential ecological impacts per route option

The location of mapped plant communities in relation to each of the six short-listed route options is shown in Figures 9 to 14. The location of threatened species records in relation to each of the six route options (as recorded during previous and current surveys) is shown in Figures 21 to 26.

Table 6 below summarises the plant communities/fauna habitats and threatened species that may be impacted by each route option.

Table 6: Potential ecological impacts per route option.

	Route Option					
	Е	А	С	11	14	15
Plant community/fauna habitat	Approximate area (m²) of plant community/fauna habitat					
Native and exotic plantings	30,000	24,500	32,000	19,000	35,500	34,500
Planted figs	900	-	-	2000	-	50
Reedlands - Freshwater wetlands on coastal floodplain EEC	100	550	600	-	-	-
Native revegetation (Induna Reserve)	-	2400	-	-	-	-
Weeds and exotics	-	400	850	-	-	-
Degraded riparian forest - Sub- tropical coastal floodplain forest EEC	-	-	150	50	-	-
Remnant eucalypts - Sub-tropical coastal floodplain forest EEC	-	-	700	5800	-	-
Drainage soak – Potential Freshwater wetlands on coastal floodplain EEC	-	-	-	8400	10,500	24,500
Drainage soak - Freshwater wetlands on coastal floodplain EEC	-	-	-	-	11,500	13,000
Constructed drainage line with native and exotic vegetation	-	-	-	-	2600	4100
Threatened species record		Kno	own habitat po	tentially impa	cted	
Adjacent Grey-headed flying-fox maternity roost	Breeding (Susan Island)	-	-	-	-	-
20+ Grey-headed flying-foxes foraging in fig	Foraging (figs)	-	-	-	-	-
Cattle egret breeding colony	-	-	-	-	Breeding (wetland)	Breeding (wetland)
Little bentwing-bat	-	Roosting (under bridge)	Roosting (under bridge)	-	-	-
Eastern bentwing-bat	-	Roosting (under bridge)	Roosting (under bridge)	-	-	-
Eastern freetail bat	-	Foraging (riparian zone)	Foraging (riparian zone)	-	-	-
Southern myotis	-	-	Foraging (riparian zone)	-	-	-

Other individual threatened species recorded during the Biosis Research field surveys, but with no known habitat relationship with a particular route option, include: cattle egret, common tern, Australian reed-warbler and white-bellied sea-eagle.

5.2 Indicator results

The quantitative ecological indicator results per route option are shown below.

5.2.1 Option E

Option E traverses areas mapped as biodiversity value including one EEC (in poor condition) and two other plant communities/fauna habitats (both regarded as an unnatural landscape); known habitat for the threatened grey-headed flying-fox; and, 11 hollow-bearing trees. Details are provided below.

Table 7: Option E ecological indicator results.

Indicator	Unit	Result
Potential direct impact on known threatened flora species	Species and description	Nil identified
Potential direct impact on identified endangered ecological communities (EEC)	Total area (square metres) per EEC	Reedlands - Freshwater wetlands on coastal floodplain EEC: 100
Potential direct impact on other vegetation and habitat	Total area (square metres) per plant community	Native and exotic plantings: 30,000 Planted figs: 900
Potential direct impact on known habitat for threatened fauna species	Species and description	Grey-headed flying-fox: loss of known foraging resource in the form of fig trees on Villiers Street. Route within one flight path of the species from Susan Island where breeding colony occurs – potential for bridge or vehicle strike.

5.2.2 Option A

Option A traverses areas mapped as biodiversity value including one EEC (in poor condition) and three other plant communities/fauna habitats (one in moderate condition, the others regarded as an unnatural landscape); known habitat for three threatened microbats; and, 10 hollow-bearing trees. Details are provided below.

Table 8: Option A ecological indicator results.

Indicator	Unit	Result
Potential direct impact on known threatened flora species	Species and description	Nil identified
Potential direct impact on identified endangered ecological communities (EEC)	Total area (square metres) per EEC	Reedlands - Freshwater wetlands on coastal floodplain EEC: 550
Potential direct impact on other vegetation and habitat	Total area (square metres) per plant community	Native and exotic plantings: 24,500 Native revegetation (Induna Reserve): 2400 Weeds and exotics: 400
Potential direct impact on known habitat for threatened fauna species	Species and description	Little bentwing-bat: roosting habitat beneath existing bridge. Eastern bentwing-bat: roosting habitat beneath existing bridge. Eastern freetail bat: foraging habitat within riparian zone of Clarence River.

5.2.3 Option C

Option C traverses areas mapped as biodiversity value including three EEC (in poor condition) and two other plant communities/fauna habitats (both regarded as an unnatural landscape); known habitat for four threatened microbats; and, eight hollow-bearing trees. Details are provided below.

Table 9: Option C ecological indicator results.

Indicator	Unit	Result
Potential direct impact on known	Species and description	Nil identified
threatened flora species		
Potential direct impact on identified	Total area (square	Reedlands - Freshwater wetlands on coastal floodplain EEC:
endangered ecological	metres) per EEC	600
communities (EEC)		Degraded riparian forest - Sub-tropical coastal floodplain forest
		EEC: 150
		Remnant eucalypts - Sub-tropical coastal floodplain forest
		EEC: 700
Potential direct impact on other	Total area (square	Native and exotic plantings: 32,000
vegetation and habitat	metres) per plant	Weeds and exotics: 850
	community	
Potential direct impact on known	Species and description	Little bentwing-bat: roosting habitat beneath existing bridge.
habitat for threatened fauna		Eastern bentwing-bat: roosting habitat beneath existing bridge.
species		Eastern freetail bat: foraging habitat within riparian zone of
		Clarence River.
		Southern myotis: foraging and potentially roosting habitat
		within riparian zone of Alipou Creek.

5.2.4 Option 11

Option 11 traverses areas mapped as biodiversity value including three EEC (in poor condition) and two other plant communities/fauna habitats (both regarded as an unnatural landscape); and, at least four hollow-bearing trees (high likelihood of more than four hollow-bearing trees based on visual assessment from outside property boundaries). Details are provided below.

Table 10: Option 11 ecological indicator results.

Indicator	Unit	Result
Potential direct impact on known threatened flora species	Species and description	Nil identified
Potential direct impact on identified endangered ecological communities (EEC)	Total area (square metres) per EEC	Drainage soak – Potential Freshwater wetlands on coastal floodplain EEC: 8400 Degraded riparian forest - Sub-tropical coastal floodplain forest EEC: 50 Remnant eucalypts - Sub-tropical coastal floodplain forest EEC: 5800
Potential direct impact on other vegetation and habitat	Total area (square metres) per plant community	Native and exotic plantings: 19,000 Planted figs: 2000
Potential direct impact on known habitat for threatened fauna species	Species and description	Nil identified

5.2.5 Option 14

Option 14 traverses areas mapped as biodiversity value including one EEC (in poor condition) and two other plant communities/fauna habitats (one in poor condition and the other regarded as an unnatural landscape); known habitat for the migratory cattle egret; and, two hollow-bearing trees. Details are provided below.

Table 11: Option 14 ecological indicator results.

Indicator	Unit	Result
Potential direct impact on known threatened flora species	Species and description	Nil identified
		
Potential direct impact on identified	Total area (square	Drainage soak – Potential Freshwater wetlands on coastal
endangered ecological	metres) per EEC	floodplain EEC: 10,500
communities (EEC)		Drainage soak - Freshwater wetlands on coastal floodplain
		EEC: 11,500

Indicator	Unit	Result
Potential direct impact on other vegetation and habitat	Total area (square metres) per plant community	Constructed drainage line with native and exotic vegetation: 2600 Native and exotic plantings: 35,500
Potential direct impact on known habitat for threatened fauna species	Species and description	Cattle egret: breeding colony located on western edge of route option between Prince and North Streets.

5.2.6 Option 15

Option 15 traverses areas mapped as biodiversity value including one EEC (in poor condition) and three other plant communities/fauna habitats (one in poor condition, the others regarded as an unnatural landscape); known habitat for the migratory cattle egret; and, nine hollow-bearing trees. Details are provided below.

Table 12: Option 15 ecological indicator results.

Indicator	Unit	Result
Potential direct impact on known threatened flora species	Species and description	Nil identified
Potential direct impact on identified endangered ecological communities (EEC)	Total area (square metres) per EEC	Drainage soak – Potential Freshwater wetlands on coastal floodplain EEC: 24,500 Drainage soak - Freshwater wetlands on coastal floodplain EEC: 13,000
Potential direct impact on other vegetation and habitat	Total area (square metres) per plant community	Constructed drainage line with native and exotic vegetation: 4100 Native and exotic plantings: 34,500 Planted figs: 50
Potential direct impact on known habitat for threatened fauna species	Species and description	Cattle egret: breeding colony located on western edge of route option between Prince and North Streets.

6.0 RECOMMENDATIONS

The key policy principle of RMS' Biodiversity Guidelines is that "in managing biodiversity, the RMS should aim to:

- 1. Avoid and minimise impacts first.
- 2. Mitigate impacts where avoidance is not possible.
- 3. Offset where residual impacts cannot be avoided" (*Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* NSW RTA 2011).

Where possible important ecological features identified in the local area should be avoided during the route selection stage.

Features of potential ecological importance have been identified below. The above hierarchy of management measures should be considered and applied to these sensitive habitats.

- Reedlands along the banks of the Clarence River and its tributaries that conform to the description of the freshwater wetlands on coastal floodplains' endangered ecological community.
- Drainage soaks that conform to the description of the freshwater wetlands on coastal floodplains' endangered ecological community.
- Degraded riparian vegetation along the banks of the Clarence River that conform to the description of the sub-tropical coastal floodplain forest endangered ecological community.
- Intact patches of other vegetation, including riparian vegetation.
- Hollow-bearing eucalypts.
- The cattle egret breeding colony.

Other considerations are:

- The location of bridge piers or foundations within the main waterway channel.
- Careful selection of lighting in the design of the bridge that may impact on microbat behaviour.
- 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 the twice-daily tidal effects (refer to engineering guidelines (Fairfull and Witheridge 2003; Witheridge 2002)). Low tide approximates between 0.2 and 0.5m and high tide approximates between 1.4 and 1.8m. 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 for the environmental assessment of the preferred route for an additional crossing have been identified. These include:

- 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 (where access could not be obtained during current surveys).
- Assessment of impact of artificial bridge lighting on microbats.
- AUSRIVAS sampling (to further define relative health of riparian zones).

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PLATES



Plate 1. Planted street trees along North Street - Option 14



Plate 2. Planted Street Trees along Villiers Street – Options C, E and A



Plate 3. Planted street trees along Summerland Way – Option



Plate 4. Planted trees along Skinner Street – Option E



Plate 5. Small patch of River Sheoak in Corcoran Park



Plate 6. Planted native trees in Alex Bell Park - Option A



Plate 7. Planted *Eucalyptus scoparia* along access road to Corcoran Park – Options 14 and 15



Plate 8. Planted *Eucalyptus scoparia* in Jacaranda Park, Prince Street – Options 14 and 15



Plate 9. Drainage Soak/Freshwater Wetland EEC on private land adjacent to Summerland Way – Option 15



Plate 10. Drainage Soak/Freshwater Wetland EEC on private land adjacent to Eggins Lane – Option 14 and 15



Plate 11. Highly degraded drainage Soak to south of North Street – Options 14 and 15

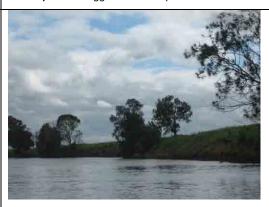


Plate 12. Degraded riparian forest associated with Clarence River



Plate 13. Example of Reedland/Freshwater Wetland EEC along the banks of the Clarence River



Plate 14. Example of Reedland/Freshwater Wetland EEC along the banks of the Clarence River at Corcoran Park



Plate 15. Induna Reserve native revegtation – Option A



Plate 16. Remnant eucalypts/Subtropical Coastal Forest EEC – Option 11



Plate 17. Large planted fig tree in Grafton



Plate 18. Degraded stormwater drain along North Street – Option 14



Plate 19. Degraded stormwater drain along North Street – Options 14 and 15



Plate 20. Constructed stormwater drain along Prince Street – Option 14 and 15



Plate 21. Large constructed drainage line infested with Water Hyacinth – Options 14 and 15



Plate 22. Hollows in large planted fig tree



Plate 23. Breeding colony of cattle egrets – Options 14 and 15



Plate 24. Alipou Creek, tributary of the Clarence River

APPENDICES

APPENDIX 1

Flora Results

Table 13: Plant species recorded during previous and current surveys

* Denotes exotic species

Family	Scientific name	Common name	2010-2011	2012
Alliaceae	* Agapanthus praecox	Agapanthus	Υ	Υ
Altingiaceae	* Liquidambar styraciflua	Liquid amber	-	Υ
Amaranthaceae	* Alternanthera philoxeroides	Alligator weed	-	Υ
	Alternanthera sp.		Υ	-
Amygdalaceae	* Prunus sp.	Flowering cherry	Υ	-
Anacardiaceae	* Mangifera indica	Mango	Y	Υ
	* Pistacia chinensis		-	Υ
Apiaceae	Centella asiatica	Pennywort	Υ	Υ
•	Hydrocotyle peduncularis	,	-	Υ
Apocynaceae	* Cryptostegia grandiflora	Rubber vine	Υ	-
, ,	* Nerium oleander	Oleander	Υ	-
	Parsonsia straminea	Common silkpod	Y	-
Aquifoliaceae	* Ilex aquifolium	Holly	Υ	-
Araucariaceae	* Agathis robusta	Queensland kauri pine	Y	-
7 11 44 4 4 4 1 4 4 4 4 4 4 4 4 4 4 4 4	* Araucaria heterophylla	Norfolk Island pine	Y	-
Araliaceae	Schefflera actinophylla	Umbrella tree		Υ
Arecaceae	* Archontophoenix	Alexandra palm	Y	Y
, 110000000	alexandrae	πιολατιστά μαιτι		<u> </u>
	Archontophoenix	Bangalow palm	-	Υ
	cunninghamiana			
	Livistona australis	Cabbage palm	-	Υ
	* Syagrus romanzoffiana	Cocos palm	-	Υ
Asclepiadaceae	* Araujia sericifera	Moth vine	Y	Υ
	* Gomphocarpus physocarpus	Balloon cotton bush	-	Y
Asparagaceae	* Asparagus aethiopicus	Asparagus fern	Y	Υ
Asteliaceae	Cordyline stricta	Narrow-leaved palm lily	Y	
Asteraceae	* Ageratina adenophora	Crofton weed	Υ	-
	* Ageratum houstonianum	Blue billy goat weed	Y	Υ
	* Bidens pilosa	Cobbler's pegs	Y	Y
	Calotis sp.	Consider a page	Y	 -
	* Cirsium vulgare	Spear thistle	Y	_
	* Conyza bonariensis	Fleabane	<u> </u>	Υ
	* Conyza sp.	Fleabane	Y	 '
	* Gazania rigens	ricabane	<u>'</u>	Υ
	* Hypochaeris radicata	Catsear		Y
	* Onopordum acanthium	Calseal		Y
	* Senecio madagascariensis	Fireweed	Y	T
	* Sonchus oleraceus	Common sowthistle	Y	Y
A = a a = a = a	Taraxacum omcinale	Dandelion	Y	-
Azollaceae	* Aprodora conditolia	Mandalanada		-
Basellaceae	Arriedera cordiiolia	Madeira vine	Y	-
Bignoniaceae	Jacaranua miimosiiolia	Jacaranda	Y	Υ
	Macradyeria drigdis-cati	Cat's claw creeper	Y	-
Brassicaceae	* Brassica napus	Rape	Y	-
Cactaceae	* Opuntia stricta	Prickly pear	Y	-
Cannaceae	* Canna indica	Indian shot	Y	-
Casuarinaceae	Allocasuarina torulosa	Forest oak	Y	Υ
	Casuarina cunninghamiana	River oak	Y	Υ
	Casuarina glauca	Swamp oak	Y	Υ

Family	Scientific name	Common name	2010-2011	2012	
Chenopodiaceae	Einadia hastata	Berry saltbush	-	Υ	
	Einadia trigonos	Fishweed	Y	-	
Commelinaceae	* Tradescantia fluminensis	Wandering jew	Υ	Υ	
Convolvulaceae	Dichondra repens	Kidney weed	Y	Υ	
	* Ipomoea cairica	Coastal morning glory	Y	Υ	
Cupressaceae	* Cupressus leylandii		-	Υ	
Cyperaceae	Bolboschoenus fluviatilis	Marsh club rush	Y	Υ	
	* Cyperus brevifolius	Mullumbimby couch	-	Υ	
	* Cyperus eragrostis	Umbrella sedge	Y	Υ	
	Cyperus exaltatus		-	Υ	
	* Cyperus papyrus	Papyrus	Y	Υ	
	Cyperus sesquiflorus		-	Υ	
	Eleocharis sphacelata	Tall spike rush	Υ	Υ	
	Schoenoplectus mucronatus	Triangular club rush	Y	Υ	
	Schoenoplectus validus		Υ	Υ	
Dennstaedtiaceae	Pteridium esculentum	Bracken	Y	-	
Elaeocarpaceae	Elaeocarpus grandis	Blue quandong	-	Υ	
	Elaeocarpus obovatus	Hard quandong	Y	-	
Euphorbiaceae	* Ricinus communis	Castor oil plant	Y	Υ	
Fabaceae -	* Caesalpinia ferrea	Leopard tree	Y	Y	
Caesalpinioideae	Cassia brewsteri	Native laburnum	Y	' -	
·	* Delonix regia	Royal poinciana	Y	Υ	
Fabaceae	Castanospermum australe	Black bean	Y	' -	
(Faboideae)	Desmodium rhytidophyllum	Black bealt	Y	_	
(. 220.202)		Cookenur corel tree	Y	- Y	
	* Erythrina crista-galli	Cockspur coral tree	Y		
	Medicago sp.	White clover	Y	-	
	* Trifolium repens	vvnite clover		Υ	
	vicia sativa) NA (1) (1)	Υ	-	
Fabaceae (Mimosoideae)	Acacia floribunda	White sally	-	Υ	
	Acacia irrorata	Green wattle	Υ	-	
Fumariaceae	* Fumaria bastardii	Bastards fumitory	Y	-	
Geraniaceae	Geranium solanderi	Native geranium	Y	Υ	
Haloragaceae	* Myriophyllum aquaticum	Parrots feathers	Y	-	
Juncaceae	Juncus usitatus		Y	Υ	
Juncaginaceae	Triglochin multifructa		Υ	-	
Lauraceae	* Cinnamomum camphora	Camphor laurel	Υ	Υ	
Lemnaceae	Lemna trisulca	Duckweed	Y	-	
Lomandraceae	Lomandra longifolia	Spiny-headed mat-rush	Y	Υ	
Loranthaceae	Amyema congener		Y	-	
Malvaceae	* Hibiscus sp.		Υ	-	
	* Modiola caroliniana	Red-flowered mallow	Υ	Υ	
	* Sida rhombifolia	Paddy's lucerne	Y	Υ	
Meliaceae	Melia azedarach	White cedar	Υ	-	
Menyanthaceae	Nymphoides indica	Water snowflake	Υ	Υ	
Moraceae	Ficus benjamina	Weeping fig	-	Υ	
	Ficus macrophylla	Moreton Bay fig	Y	Υ	
	Ficus microcarpa	Small-fruited fig	Y	Υ	
	Ficus obliqua	Deciduous fig	Y	-	
	Ficus rubiginosa	Port Jackson fig, rusty fig	-	Υ	
	* Morus alba	White mulberry	Y	Υ	
Myrtaceae	Acmena smithii	Lilly pilly	-	Υ	

Family	So	cientific name	Common name	2010-2011	2012
		Angophora floribunda	Rough-barked apple	-	Υ
		Callistemon viminalis	Weeping bottlebrush	Y	Υ
	*	Corymbia citriodora	Lemon-scented gum	Y	Υ
	Corymbia ma		Spotted gum	Y	-
	*	Corymbia torelliana	Cadaghi	Y	Υ
		Eucalyptus grandis	Flooded gum	-	Υ
		Eucalyptus saligna	Sydney blue gum	Y	-
		Eucalyptus scoparia	Wallangarra white gum	-	Υ
		Eucalyptus sp.		Υ	-
		Eucalyptus tereticornis	Forest red gum	Υ	Υ
		Leptospermum petersonii	Lemon-scented tea tree	-	Υ
		Lophostemon confertus	Brush box	Y	Υ
		Lophostemon suaveolens	Black tea tree	-	Υ
		Melaleuca alternifolia	Tea tree	Υ	-
		Melaleuca bracteata		-	Υ
	*	Melaleuca leucadendra	Weeping paperbark	Υ	-
		Melaleuca leucadendron		-	Υ
		Melaleuca quinquenervia	Broad leaved paperbark	Υ	Υ
		Melaleuca styphelioides	Prickly-leaved tea tree	Υ	Υ
		Syzygium australe	Brush cherry	Υ	Υ
		Syzygium luehmannii	Riberry	-	Υ
		Waterhousea floribunda	Weeping lilly pilly	-	Υ
Nyctaginaceae	*	Bougainvillea glabra		Υ	-
Oleaceae	*	Fraxinus excelsior	European Ash	-	Υ
	*	Ligustrum lucidum	Large-leaved privet	Υ	Υ
	*	Ligustrum sinense	Small-leaved privet	Υ	-
	*	Olea europaea ssp. cuspidata	African olive	Y	-
Oxalidaceae		Oxalis sp.		Υ	-
Papaveraceae	*	Argemone ochroleuca	Mexican poppy	Υ	-
Passifloraceae	*	Passiflora suberosa	Cork passionfruit	Υ	-
Pittosporaceae	ļ.,	Pittosporum undulatum	Sweet pittosporum	Y	Υ
Plantaginaceae	*	Plantago lanceolata	Lamb's tongues	Y	-
Platanaceae	*	Platanus x acerifolia	Plane tree	Υ	Υ
Poaceae	*	Arundo donax	Giant reed	Υ	-
		Axonopus compressus	Broad-leaved carpet grass	-	Υ
	*	Axonopus fissifolius	Narrow-leafed carpet grass	Υ	-
	*	Bromus catharticus	Prairie grass	Y	-
	*	Chloris gayana	Rhodes grass	Υ	Υ
	*	Cynodon dactylon	Common couch	Υ	Υ
	*	Digitaria ciliaris		-	Υ
	*	Holcus lanatus	Yorkshire fog	Υ	-
	<u> </u>	Leersia hexandra	Swamp ricegrass	-	Υ
	*	Megathyrsus maximus	Guinea grass	-	Υ
		Microlaena stipoides	Weeping grass	Υ	-
		Oplismenus aemulus		Y	-
	*	Panicum maximum	Guinea grass	Υ	-
	*	Paspalum dilatatum	Paspalum	-	Υ
	*	Paspalum distichum	Water couch	-	Υ
	*	Paspalum urvillei	Vasey grass	Y	-
	*	Pennisetum clandestinum	Kikuyu grass	Υ	-
	ŕ	Pennisetum purpureum	Elephant grass	-	Υ

Family	Scientific name	Common name	2010-2011	2012
	Phragmites australis	Common reed	Υ	Υ
	* Setaria gracilis	Slender pigeon grass	Υ	-
	* Sporobolus africanus	Parramatta grass	-	Υ
	* Sporobolus fertilis	Giant Parramatta grass	-	Υ
Polygonaceae	Persicaria decipiens	Slender knotweed	-	Υ
	Persicaria hydropiper	Water pepper	Υ	Υ
	Persicaria sp.		Υ	-
	Rumex brownii	Swamp dock	Υ	Υ
	Rumex sp.		Υ	-
Pontederiaceae	* Eichhornia crassipes	Water hyacinth	Υ	Υ
Proteaceae	Banksia integrifolia	Coast banksia	Υ	-
	Banksia robur	Swamp banksia	-	Υ
	* Grevillea baileyana	White oak	Υ	-
	Grevillea robusta	Silky oak	Υ	Υ
	* Macadamia integrifolia	Macadamia nut	Υ	-
	Stenocarpus sinuatus	Firewheel tree	-	Υ
Rutaceae	* Citrus limonia	Rough lemon	Υ	
	Flindersia schottiana	Cudgerie	-	Υ
Salicaceae	Populus sp.	Poplar	-	Υ
	* Salix fragilis	Crack willow	-	Υ
	* Salix sp.	Willow	Υ	-
Sapindaceae	* Cardiospermum grandiflorum	Balloon vine	Υ	Y
	Cupaniopsis anacardioides	Tuckeroo	Υ	Υ
	Harpullia pendula	Tulipwood	Y	-
	Jagera pseudorhus	Foam bark	-	Υ
	* Koelreuteria paniculata	Golden rain tree	Υ	-
	Mischocarpus australis	Red pear fruit	-	Υ
Solanaceae	* Cestrum parqui	Green cestrum	Υ	-
	* Lycopersicon esculentum	Tomato	Υ	-
	* Solanum mauritianum	Wild tobacco bush	Y	Υ
	* Solanum seaforthianum	Climbing nightshade	-	Υ
	Solanum sp.		Υ	-
Sterculiaceae	Brachychiton acerifolius	Illawarra flame tree	Υ	Υ
Tropaeolaceae	* Tropaeolum majus	Nasturtium	Y	-
Typhaceae	Typha orientalis	Broad-leaved cumbungi	Y	Υ
Verbenaceae	* Lantana camara	Lantana	Υ	Υ
	Verbena bonariensis	Purpletop	-	Υ
	Verbena sp.		Y	-
Violaceae	Viola caleyana	Swamp violet	Υ	-

APPENDIX 2

Fauna Results

Table 14: Fauna species recorded during previous and current surveys

				Observation		Anabat su	rvey (2010)		Observation
Latin name	Common name	EPBC Act	TSC Act	(2010-11)	Tributary of Alipou Creek	Beneath Grafton Bridge	Alipou Lane paddock	Alipou Creek	(2012)
Amphibians		1		1	1				
Litoria fallax	Eastern dwarf tree frog			W					W
Limnodynastes peronii	Striped marsh frog			-					W
Reptiles					,				,
Physignathus lesueurii	Eastern water dragon			0					0
Cryptoblepharus virgatus	Wall lizard			-					0
Eulamprus quoyii	Eastern water skink			0					0
Lampropholis guichenoti	Garden skink			0					-
Saiphos equalis	Three-toed skink			0					-
Saproscincus sp.	Shade skink			-					0
Birds									
Columba livia	Rock dove		U	0					0
Streptopelia chinensis	Spotted turtle-dove		U	0					OW
Passer domesticus	House sparrow		U	0					OW
Acridotheres tristis	Common myna		U	0					0
Acrocephalus stenoreus	Australian reed-warbler	M		ow					W
Accipiter cirrhocephalus	Collared sparrowhawk			0					-
Accipiter fasciatus	Brown goshawk			0					-
Aquila audax	Wedge-tailed eagle			0					-
Aviceda subcristata	Pacific baza			-					0
Elanus axillaris	Black-shouldered kite			0					0
Haliaeetus leucogaster	White-bellied sea-eagle	M		0					-
Haliastur indus	Brahminy kite			0					0
Haliastur sphenurus	Whistling kite			0					-
Alcedo azurea	Azure kingfisher			-					OW
Anas superciliosa	Pacific black duck			0					OW
Chenonetta jubata	Australian wood duck			0					OW
Cygnus atratus	Black swan			-					0
Anhinga novaehollandiae	Australasian darter			-					0
Ardea ibis	Cattle egret	М		0					OW
Ardea intermedia	Intermediate egret			0					0

Latin name	Common name		Observation (2010-11)			Observation		
		EPBC Act		Tributary of Alipou Creek	Beneath Grafton Bridge	Alipou Lane paddock	Alipou Creek	(2012)
Ardea pacifica	White-necked heron		0					0
Egretta novaehollandiae	White-faced heron		0					0
Artamus leucorhynchus	White-breasted woodswallow		0					-
Cracticus nigrogularis	Pied butcherbird		0					OW
Cracticus torquatus	Grey butcherbird		0					W
Grallina cyanoleuca	Magpie-lark		OW					OW
Gymnorhina tibicen	Australian magpie		OW					OW
Strepera graculina	Pied currawong		0					-
Cacatua galerita	Sulphur-crested cockatoo		-					0
Cacatua roseicapilla	Galah		0					OW
Cacatua sanguinea	Little corella		OW					-
Coracina novaehollandiae	Black-faced cuckoo- shrike		0					OW
Vanellus miles	Masked lapwing		OW					OW
Columba leucomela	White-headed pigeon		0					0
Geopelia humeralis	Bar-shouldered dove		0					-
Ocyphaps lophotes	Crested pigeon		0					OW
Phaps chalcoptera	Common bronzewing		0					-
Eurystomus orientalis	Dollarbird		-					0
Corvus coronoides	Australian raven		OW					-
Corvus orru	Torresian crow		OW					OW
Scythrops novaehollandiae	Channel-billed cuckoo		-					0
Dicaeum hirundinaceum	Mistletoebird		-					W
Rhipidura albiscapa	Grey fantail		OW					W
Rhipidura leucophrys	Willie wagtail		OW					OW
Falco berigora	Brown falcon		0					-
Falco cenchroides	Nankeen kestrel		0					0
Dacelo novaeguineae	Laughing kookaburra		OW					0
Todiramphus sanctus	Sacred kingfisher		-					OW
Hirundo neoxena	Welcome swallow		0					OW
Hirundo nigricans	Tree martin		-					0

				Observation (2010-11)		Observation			
Latin name	Common name	EPBC Act	TSC Act		Tributary of Alipou Creek	Beneath Grafton Bridge	Alipou Lane paddock	Alipou Creek	(2012)
Larus novaehollandiae	Silver gull			0					0
Sterna hirundo	Common tern	М		0					-
Malurus cyaneus	Superb fairy-wren			OW					OW
Entomyzon cyanotis	Blue-faced honeyeater			OW					OW
Lichmera indistincta	Brown honeyeater			0					-
Manorina melanocephala	Noisy miner			0					OW
Myzomela sanguinolenta	Scarlet honeyeater			0					-
Philemon citreogularis	Little friarbird			-					OW
Merops ornatus	Rainbow bee-eater	М		OW					-
Anthus novaeseelandiae	Richard's pipit			0					-
Cisticola exilis	Golden-headed cisticloa			OW					OW
Sphecotheres viridis	Figbird			0					OW
Acanthiza chrysorrhoa	Yellow-rumped thornbill			-					0
Acanthiza lineata	Striated thornbill			0					-
Acanthiza pusilla	Brown thornbill			-					W
Neochmia temporalis	Red-browed finch			OW					W
Taeniopygia bichenovii	Double-barred finch			OW					-
Pelecanus conspicillatus	Australian Pelican			0					-
Phalacrocorax sulcirostris	Little black cormorant			0					-
Phalacrocorax varius	Pied cormorant			0					0
Platycercus eximius	Eastern rosella			0					-
Trichoglossus chlorolepidotus	Scaly-breasted lorikeet			-					W
Trichoglossus haematodus	Rainbow lorikeet			OW					OW
Gallinula tenebrosa	Dusky moorhen			0					0
Platalea regia	Royal spoonbill			-					0
Porphyrio porphyrio	Purple swamphen			OW					-
Threskiornis molucca	Australian white ibis			0					0

Latin name			TSC Act	Observation (2010-11)		Observation			
	Common name	EPBC Act			Tributary of Alipou Creek	Beneath Grafton Bridge	Alipou Lane paddock	Alipou Creek	(2012)
Threskiornis spinicollis	Straw-necked ibis			0					0
Tyto novaehollandiae	Masked owl		V	Z*					-
Zosterops lateralis	Silvereye			OW					OW
Mammals									
Vulpes vulpes	Fox		U	I					-
Macropus giganteus	Eastern grey kangaroo			0					-
Mormopterus norfolkensis	Eastern freetail bat		v		AD	АМ	AP		-
Isoodon macrourus	Northern brown bandicoot			0					-
Trichosurus sp.	Brushtail possum			I					-
Pteropus alecto	Black flying-fox			OW					OW
Pteropus poliocephalus	Grey-headed flying-fox	٧	V	-					OW
Chalinolobus gouldii	Gould's wattled bat				AP	AM	AP	AP	-
Miniopterus australis	Little bentwing-bat		V		AD	AD	AD		-
Miniopterus schreibersii oceanensis	Eastern bentwing-bat		v		AD	АМ	AP		-
Myotis macropus	Southern myotis		V		AD			AM	-
Nyctophilus sp.	long-eared bat							AM	-
Scoteanax rueppellii	Greater broad-nosed bat		v		AP				-
Scotorepens sp.	broad-nosed bat				AP		AD	AP	-
Vespadelus vulturnus	Little forest bat				AD	AD			-

Key:

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

U = Listed as Unprotected species under the TSC Act (i.e. introduced species).

M = Listed as Migratory under the EPBC Act.

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 15: Fish Survey Results (August 2010)

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