Warrell Creek to Nambucca Heads Upgrade of the Pacific Highway

ROADS AND MARITIME SERVICES

Flying-fox Management Plan

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Warrell Creek to Urunga Upgrade of the Pacific Highway

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V01	16/12/12	Internal practice review	Dr Peggy Eby	18/12/2013	Rachel Vazey
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V12	15/11/17	Update Road Kill Monitoring to increase the relevance of the monitoring program to flying-foxes.	Sean Hardiman	10/11/17	Chris Clark

Acronyms and abbreviations

Acronym	Definition
ABL	Australian Bat Lyssavirus
ACT	Australian Capital Territory
AHD	Australian Height Datum
ANU	Australian National University
BFF	Black Flying-fox
CEMP	Construction Environmental Management Plan
CMS	Construction Method Statement
DECC	Department of Environment and Climate Change NSW
DECCW	Department of Environment, Climate Change and Water NSW
DoEE	(Commonwealth) Department of the Environment and Energy
EEC	Endangered Ecological Community
EMR	Environmental Management Representative
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPA	Environment Protection Authority (NSW)
EWMS	Environmental Work Method Statements
FFMP	Flora and Fauna Management Plan
GHFF	Grey-headed Flying-fox
GIS	Geographical Information Systems
GPS	Global Positioning System
LRFF	Little Red Flying-fox
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	Office of Environment and Heritage (NSW)
P&I	Planning and Infrastructure (NSW)
QLD	Queensland
RTA	Roads and Traffic Authority
SEQ	South-east Queensland
SKM	Sinclair Knight Merz
SMART	Specific, measurable, achievable, results-based, time-based
TSC Act	*Threatened Species Conservation Act 1995*
WIRES	Wildlife Information and Rescue Service

Contents

1. Introduction

1.1 Project overview and background to the plan

The Pacific Highway Upgrade Program is a joint commitment by the Australian and New South Wales (NSW) governments to improve the standard and safety of the Pacific Highway between Hexham and the Queensland border. The Pacific Highway Upgrade Program includes the upgrade of the Pacific Highway between Warrell Creek and Urunga (WC2U) comprised of approximately 42 kilometres of dual carriageway road that would bypass the towns of Warrell Creek, Macksville, Nambucca Heads and Urunga on the Mid North Coast of NSW. The WC2U Project has been divided into two stages and includes the following:

- Stage 1 consisting of the northern 22.5 kilometres of the Project between Nambucca Heads and Urunga (NH2U).
- Stage 2 consisting of the southern 19.5 kilometres of the Project between Warrell Creek and Nambucca Heads (WC2NH) (refer to **Figure 1-1**).

This Management Plan relates to Stage 2 (WC2NH). An Environmental Assessment (EA) was prepared for the WC2U Project by the Roads and Traffic Authority (RTA) in 2010 under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The NSW Minister for Planning and Infrastructure approved the WC2U Pacific Highway Upgrade Project (the Project) under Part 3A (now repealed) of the EP&A Act on 19 July 2011, subject to the Minister's Conditions of Approval (CoA) being met. In accordance with transitional provisions included in Schedule 6A of the EP&A Act, the Project is characterised as a transitional Part 3A Project. It is noted that despite its repeal, Part 3A of the EP&A Act continues to apply in respect of transitional Part 3A Projects. Under section 75C of the EP&A Act, the Minister for Planning declared, by Order dated 5 December 2006 and published in the NSW Government Gazette No. 175, that development for the purposes of upgrading segments of the Pacific Highway is a Project to which Part 3A of the EP&A Act applies (the declared Project). The Minister also declared, by Order dated 8 December 2006 published in Gazette No. 175, that the same development is a critical infrastructure Project under section 75C of the EP&A Act. This was subsequently modified through a further Ministerial Order gazetted on 3 December 2010 (Gazette No. 133).

In late November and early December 2011, subsequent to the WC2U Project approval, Grey-headed Flying-foxes (*Pteropus poliocephalus*) established a camp within the approved alignment of Stage 2 WC2NH of the Project. No flying-fox camps were identified in the study area in the WC2U EA (RTA, 2010) for the Project. The Grey-headed Flying-fox camp (hereafter referred to as the 'Macksville flying-fox camp') is located in a 23.5 hectare (ha) isolated remnant of Swamp Sclerophyll Forest on freehold land 1.9 kilometres south of the Nambucca River and 0.5 kilometres north of Warrell Creek (refer to **Figure 1-2**). The flying-foxes roost in dense stands of permanently inundated Broad-leaved Paperbark (*Melaleuca quinquenervia*) in the central area of the swamp.

Roads and Maritime Services (Roads and Maritime) explored alternative route options to reduce the impact of the alignment on the flying fox colony, and released four alternative options and the original approved alignment for community comment in mid-September 2013. The release of these options triggered media coverage, which was critical of the need to explore alternative route options.

On 26 September 2013, the Premier's Office informed Roads and Maritime it should proceed with planning the new highway on the approved alignment.

The Grey-headed Flying-fox is listed as a 'Vulnerable' species under the NSW Government *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation 1999* (EPBC Act). The colony roosting in the Macksville flying-fox camp is considered to be an 'important population' as defined under the EPBC Act as it is likely to be a key source population for breeding and dispersal. In addition, the Swamp Sclerophyll Forest where the camp is located meets the criteria for Roosting Habitat Critical to Survival of Grey-headed Flying-foxes as defined in the *Draft National Recovery Plan for Grey-headed Flying-foxes* (DECC, 2009). Forest vegetation located within the area to be cleared for the Project meets criteria for Foraging Habitat Critical to Survival of Grey-headed Flying-foxes as defined in DECC (2009).

Following the establishment of the Macksville flying-fox camp within the approved alignment of Stage 2 WC2NH, additional assessments of the impacts on this threatened species were completed by Eby (2012), SKM (2013) and GeoLINK (2013a to 2014r). An Assessment of Significance (EPBC Act) completed by SKM in 2013 found that the Project would likely have a significant impact on the Grey-headed Flying-fox due to the following:

- Direct impacts on foraging habitat considered critical to the survival of the species (DECC, 2009). The loss of critical foraging habitat equates to 106.6 hectares (ha) (including a 10 per cent contingency) (Roads and Maritime 2013) and consists of:
  - Map Unit 1 - Blackbutt Open Forest – 75.2F ha.
  - Map Unit 2 - Mixed Floodplain Forest – 4.0 ha.
  - Map Unit 3 - White Mahogany/Grey Gum/Ironbark Moist Open Forest – 7.3 ha.
  - Map Unit 4 - Flooded Gum Moist Open Forest – 14.8 ha.
  - Map Unit 6 - Swamp Mahogany /Paperbark Swamp Forest – 5.3 ha.
- Direct impacts associated with the removal of 3.1 hectares of roosting habitat considered to be critical to the survival of the species (DECC, 2009) and which is a seasonal camp for an important Grey-headed Flying-Fox population. There would also be indirect impacts to the remaining patch of Swamp Sclerophyll Forest. As such there would be impacts (direct and indirect) to a total of 23.5 hectares of critical roosting habitat as defined in the Draft Recovery Plan (DECC, 2009).
- The Project would likely displace the flying-foxes from their current roosting site, which could lead to stress and reduced fecundity due to potential disruption of the breeding cycle of this important population. The long-term impact on the population would depend on the ability of the flying-foxes to find an alternate camp site. In the event the flying-foxes continue to roost in the surrounding swamp forest, other indirect impacts could include the suppression of the ability to raise young to adulthood and collision with vehicles. It would be possible for some females to lose young when carried in flight, due to a perceived lack of manoeuvrability around highway traffic. Inexperienced young may also be unable to avoid vehicles when learning to fly.
- The Project would also likely interfere substantially with the recovery of the species due to removal of identified critical roosting habitat.

In accordance with Sections 18 and 18A of the EPBC Act, the Grey-headed Flying-fox is a matter of national environmental significance (MNES) and Roads and Maritime has prepared a referral seeking approval from the Australian Government for the Project. The referral was lodged with the Department of the Environment (DoE) on 20 December 2013. For further information refer to http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=current_referral_detail&proposal_id=7101. The referral provides detail on the Project, including a detailed description, proposed construction staging, excluded activities, description of impacts and measures to avoid or manage impacts, for Commonwealth MNES, including Grey-headed Flying-fox. The DoEEhave reviewed the referral (number 2013/7101) on the 23 January 2014 and made the decision under section 75 of the EPBC Act that that the Project is a controlled action and requires approval under the EPBC Act.

Construction of the Project would occur in two stages to facilitate meeting the targeted end of 2016 opening milestone date, in accordance with undertakings by both the NSW and Federal Governments, while ensuring that impacts on the flying-fox camp-site are minimised. This construction schedule would also facilitate access to the crossing of the southern floodplain of the Nambucca River.

The proposed construction stages are:

- **Stage 2.1** - Construction in the vicinity of the flying-fox colony south of Macksville prior to the commencement of construction of the remainder of the Warrell Creek to Nambucca Heads upgrade. Key Stage 2.1 construction activities would include:
  - Construction of the upgrade within the 300 metre and 500 metre buffer zones for the flying-fox colony south of Macksville.
  - Construction of a temporary construction access road from the existing highway to the approved alignment north of the flying fox camp.
  - Establishment and operation of Ancillary facilities, stockpile sites (including associated environmental management measures) for Stage 2.1 south of the Flying fox camp.
- **Stage 2.2** - Construction of the remainder of the Warrell Creek to Nambucca Heads upgrade.

1.2 Purpose and objectives

This management plan identifies the potential impacts of the WC2NH Pacific Highway upgrade on the Macksville flying-fox camp. It outlines the proposed management measures to be implemented for the flying-foxes and a program for monitoring the effectiveness of these measures. The objective of this management plan is to provide measures that minimise impacts to flying-foxes.

1.3 Order of precedence

In the event of any inconsistency, ambiguity or discrepancy between this Management Plan and the Flora and Fauna Management Plan for the Warrell Creek to Nambucca Heads Pacific Highway upgrade Project, the following order of precedence must apply:

(a) This Flying-fox Management Plan.

(b) The Flora and Fauna Management Plan for the Warrell Creek to Nambucca Heads Pacific Highway upgrade Project.

1.4 Management structure and plan updates

The management plan has been presented using an adaptive management approach based on firstly identifying specific goals for management, implementation of management actions followed by monitoring of the performance of these measures against the goals and identified thresholds. As a final step the monitoring would evaluate the effectiveness of the management measures using identified thresholds for performance and implementing corrective actions to improve mitigation where required.

To ensure the success of this approach the management goals presented in the plan have been based on the following SMART principles:

- **S**pecific.
- **M**easurable.
- **A**chievable.
- **R**esults-based.
- **T**ime-based.

Roads and Maritime have prepared this flying-fox management plan in consultation with the Environment Protection Authority (EPA) and the Commonwealth Department of the Environment (DoE). Comments received and Roads and Maritime's responses are documented in **Appendix E**.

General responsibilities for environmental management would be outlined in the Project specific Construction Environment Management Plan (CEMP) and sub-plans, including the Flora and Fauna Management Plan (FFMP). These management plans would be prepared prior to the commencement of construction. Roads and Maritime Service and the contractor engaged to construct the Project would be responsible for implementing the activities in this Flying-fox Management Plan and would include the engagement of suitably qualified specialists to undertake and oversee surveys and monitoring activities.

1.5 Plan authors and expert review

Table 1-1 Qualifications and experience of authors of this flying-fox management plan.

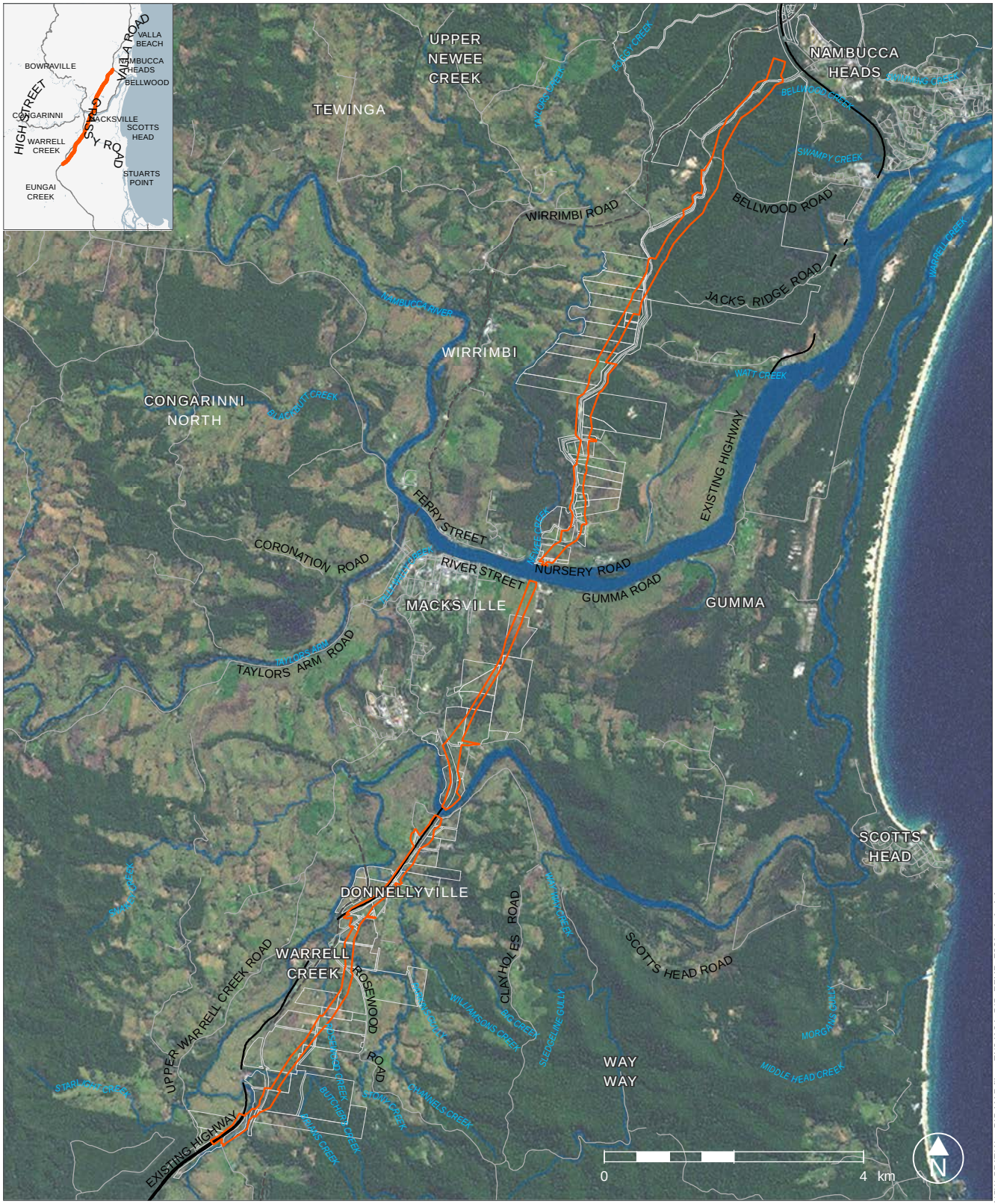
Personnel	Qualifications	Experience
Vanessa Gorecki	Masters of Science with Honours, Macquarie University Bachelor of Applied Science (Ecology and Environmental Science), University of Canberra	Vanessa is an ecologist with seven years of research and consultancy experience. Vanessa is experienced in ecological survey and monitoring, ecological assessment, management and approvals, and Project management. Vanessa is competent in conducting baseline flora and fauna surveys, vegetation mapping, assessing impacts on ecological values, developing management plans and monitoring strategies for threatened species, ecological communities, weeds and pest animals and rehabilitation. Vanessa is also an experienced spotter catcher and wildlife rehabilitator.
Rachel Vazey	Bachelor of Science (Honours) Earth Science – University of Newcastle	Rachel Vazey is an Environmental Planner and Geographical Information Systems (GIS) Analyst. Rachel has an in depth understanding of NSW and Commonwealth environmental planning legislation and is particularly familiar with the preparation of environmental assessments under Part 5 of the *Environmental Planning and Assessment Act (1979)* (EP&A Act) and the preparation of referrals under the *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act). Rachel has worked extensively with government agencies in the Project management of environmental assessments of public infrastructure Projects including upgrades of major highways and intersections for Roads and Maritime and upgrades of water supply systems and sewage treatment works for Hunter Water.
Chris Thomson	Bachelor of Applied Science and Graduate Certificate in Natural Resources	Chris is a group practice leader for ecology with a Bachelor of Applied Science and Graduate Certificate in Natural Resources and seventeen years professional experience managing biodiversity assessments and scientific reporting. He is a highly experienced field ecologist with extensive experience on major road Projects with the Roads and Maritime, having worked widely throughout NSW as the technical lead on a range of environmental assessments including several Pacific Highway upgrades, the Hume Highway, Great Western Highway, Princes Highway and New England Highway along with numerous large and small arterial road Projects including the M5, M4, Westlink M7 and Westconnex. Chris has comprehensive knowledge of Commonwealth and NSW threatened species legislation, policies and guidelines and has extensive experience in the design of avoidance and mitigation measures for minimising impacts on threatened species with a high level of experience on infrastructure Projects including the development of compensatory habitat and offset strategies, biodiversity connectivity strategies, mitigation and monitoring strategies and threatened species management plans.

Expert review of the plan

An expert review of the plan was undertaken by Dr Peggy Eby. Dr Eby is recognised as one of Australia's leading flying-fox ecologists having completed her PhD on the interaction between Grey-headed Flying-foxes, seasonal movements in relation to dietary requirements and their role in seed dispersal. She prepared the Draft National Recovery Plan for the Greg-Headed Flying-fox and has published numerous scientific articles on various aspects of flying-fox ecology.

Recommendations provided by Dr Eby have been incorporated into the final management plan.

Figure 1-1 Overview of locality

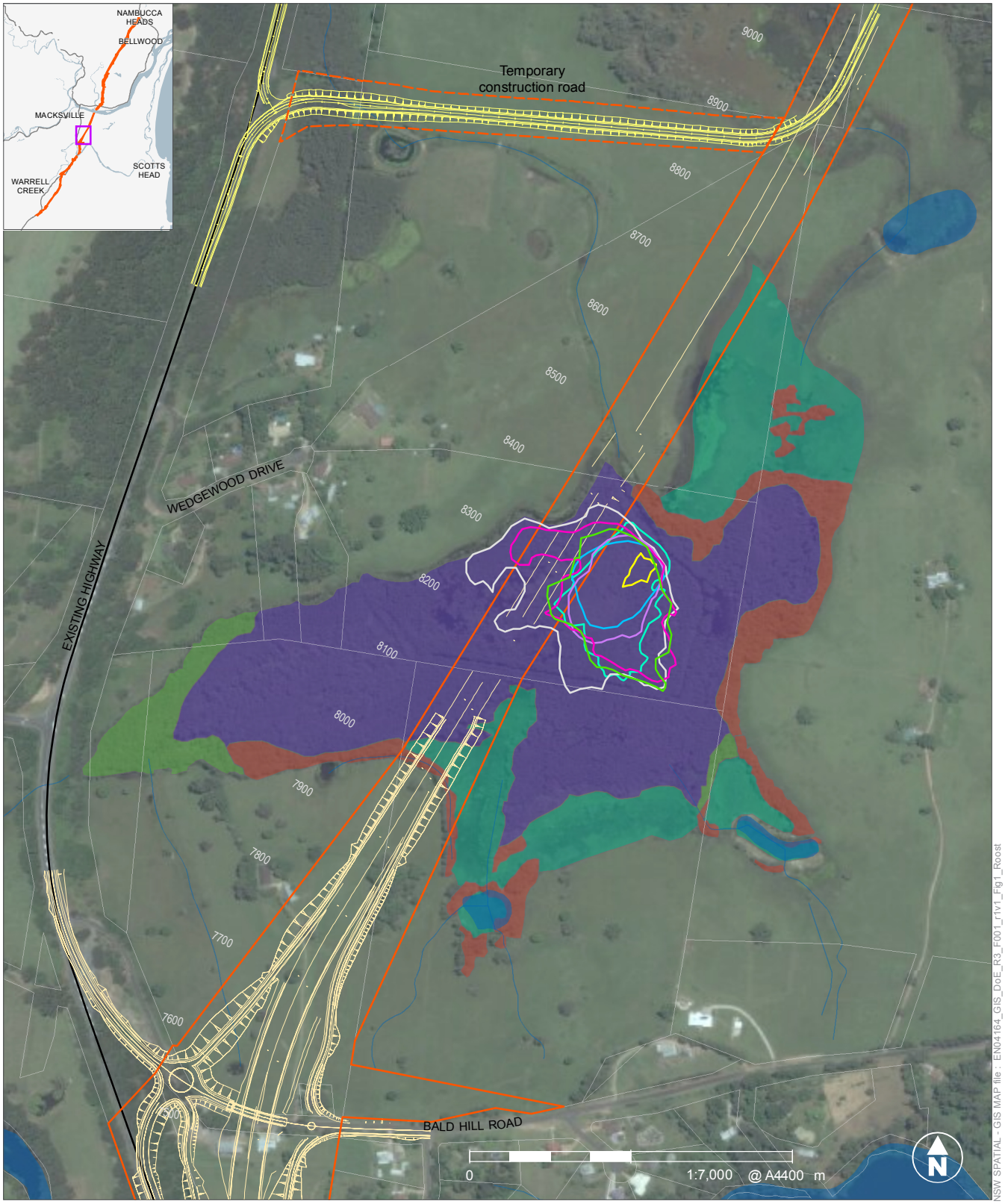


Road boundary
Existing highway
Railway
Waterway

DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010

NSW SPATIAL - GIS MAP file : EN04164_GIS_FFMP_F001_r1v1_A1

Figure 1-2 Location of the Flying-fox camp



Road boundary
Road design
Temporary construction road boundary
Temporary construction road design
Existing highway
Railway
Waterway

April 2013 Flying-fox camp footprint
September 2013 Flying-fox camp footprint
November 2013 Flying-fox camp footprint
January 2014 Flying-fox camp footprint
February 2014 Flying-fox camp footprint
March 2014 Flying-fox camp footprint
April 2014 Flying-fox camp footprint

Vegetation type

Broad-leaved Paperbark Swamp Forest
Freshwater Wetland
Swamp Mahogany / Broad-leaved Paperbark Swamp Forest
Swamp Oak Swamp Forest

DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, Streetworks 2001, SKM 2010, OEH 2013

2. Flying-fox populations

2.1 General knowledge

2.1.1 Flying-fox populations within the region

Three species of flying foxes occupy the mid north coast region of NSW: the Grey-headed Flying-fox (GHFF) (*Pteropus poliocephalus*), the Black Flying-fox (BFF) (*Pteropus alecto*) and the Little Red Flying-fox (LRFF) (*Pteropus scapulatus*). All three species are migratory. Individuals move long distances in response to variations in the abundance of food, primarily nectar secretion from eucalypts (*Eucalyptus, Corymbia, Angophora*) but also fleshy fruits (Eby 1991 and 1996, Hall and Richards 2000; Roberts *et al.* 2012). Eucalypt flowering is notably erratic. Most species do not flower every year in a local area and flowering intensity is highly variable (Eby and Law 2008). Therefore, the size of local flying-fox populations varies substantially both from season to season and from year to year.

The GHFF is the most common in the region and is the predominant species in the Macksville flying-fox camp. The BFF occurs in lower numbers than the GHFF and has been recorded in the Macksville flying-fox camp. LRFFs occupy the mid north coast irregularly, but are occasionally present in large numbers. Small numbers were present in the Macksville flying-fox camp in autumn of 2014.

2.1.2 Roosting habitat

The Grey-headed Flying-fox roosts in camps, usually in dense riparian habitats, during the day and disperses at dusk in search of preferred food sources comprised mainly of eucalypt blossom and rainforest fruits. Camps provide resting habitat within foraging distance of food sources, sites of significant behaviours such as mating, birth and lactation and night refuge for flightless young.

Habitat associated with camps have been characterised by the following (Roberts 2005):

- Vegetation with closed canopy (on the mid north coast, camps typically occur in rainforest or swamp forest dominated by *Melaleuca quinquenervia*).
- Continuous canopy area >1 hectare.
- Canopy height >8 metres.
- Close proximity to waterways (<500 metres), commonly rivers or creeks.
- Level topography, <5 degree incline.
- Positioned within nightly commuting distance of sufficient food resources to support the population of a communal roost.

While these characteristics can be used to describe roosting habitat, they are insufficient to predict the specific locations of camps, suggesting additional habitat characteristics that are important to flying-foxes are yet to be identified.

Twenty camp sites were recorded within a 50 kilometre radius of the Macksville camp, including the site itself (Eby 2012). Thirteen of the 20 camp sites meet at least one of the criteria for Roosting Habitat Critical to Survival of Grey-headed Flying-foxes as defined in the DECC (2009) (Eby 2012), refer to **Figure 2-1**.

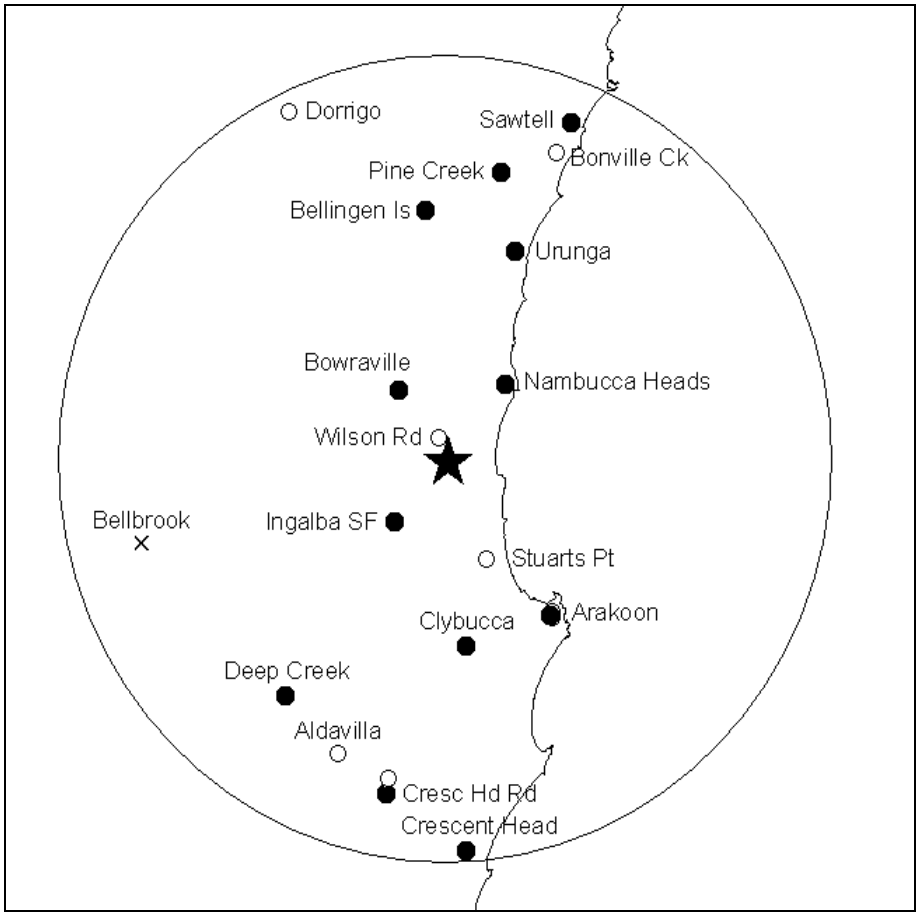


Figure 2-1 : The distribution of flying fox camp sites located within 50 kilometres of the Macksville camp (black star) as defined by Eby (2012)

Legend:

- **Black circles - camps that meet criteria for habitat critical to the survival of Grey-headed flying foxes (DECC, 2009).**
- **Open circles - camps that were not assessed due to insufficient information.**
- **Black cross – The approximate location of the Bellbrook camp (Eby, 2012).**

2.1.3 Foraging habitat

Flying-foxes are canopy-feeding frugivores and nectarivores, which use diverse vegetation types including rainforest, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. The Grey-headed Flying-fox is highly mobile and commutes to foraging areas, which are typically located within 15 kilometres of day roosts. Flights of more than 50 kilometres from their roost to feeding areas may also occur.

GHFFs are likely to forage on flowering eucalypts and fruit trees throughout the locality of the Macksville flying-fox camp, refer to **Figure 2-2**. The following vegetation types within the locality are known to provide suitable foraging habitat for the species (Eby, 2012):

- Blackbutt Open Forest.
- Mixed Floodplain Forest.
- White Mahogany/Grey Gum/Ironbark Moist Open Forest.
- Flooded Gum Moist Open Forest.
- Swamp Mahogany/Paperbark Swamp Forest
- Lowland Rainforest.

Highly productive plants in the blossom diet of flying-foxes are dominant in five of the habitat types listed above. These species include *Corymbia intermedia, Eucalyptus pilularis, E. robusta, E. siderophloia* and *Melaleuca quinquenervia*. A diverse range of fruit-producing diet species dominate the sixth type, Lowland rainforest, with *Eucalyptus grandis* and *Lophostemon confertus* emergents (Eby, 2012). Potential foraging habitat has been mapped by Eby (2012), refer to **Figure 2-2**. **Table 2-1** summarises the number and area of vegetation within 50 kilometres of the Project which meet the criteria for foraging habitat critical to flying-foxes (DECC, 2009).

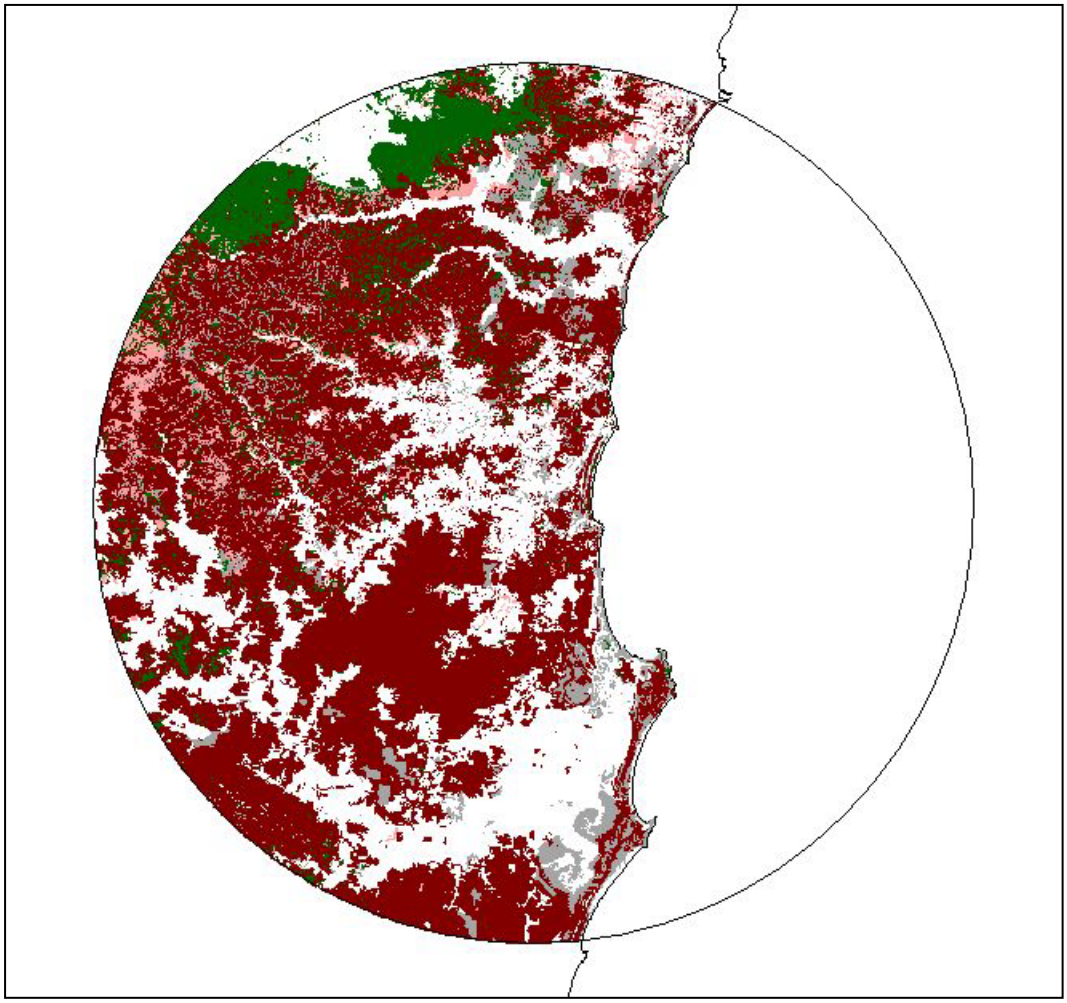


Figure 2-2 The distribution of native vegetation within 50 kilometres of the Macksville flying fox camp (black star). Deep red polygons indicate vegetation containing blossom diet species and identified as critical foraging habitat. Green polygons indicate rainforest vegetation identified as critical foraging habitat. Light red polygons indicate foraging habitat with low levels of productivity and not included in assessments (ranks 3 & 4, Eby and Law 2008). Grey polygons indicate native vegetation that does not contain flying fox diet species. White areas are cleared land or water bodies.

Table 2-1 Summary of the number and area of vegetation types in the study area that meet criteria for foraging habitat critical to flying foxes, from Eby (2012).

DECC 2009 critical foraging habitat criteria	Vegetation types (n)	Area (ha)
Criterion 1. productive during resource bottlenecks	45	249,300
Criterion 2. supports large populations	24	179,400
Criterion 3. productive during key reproductive periods	77	327,800
Criterion 4. supports commercial fruit industries	45	224,100
Total	77	327,800

2.1.4 Regional presence

Numerous previous records of flying-foxes on the NSW Wildlife Atlas database exist from within the locality of the study area, including 90 records within five kilometres of the Project footprint and 326 records from within 10 kilometres of the Project (Office of Environment and Heritage (OEH), 2013).

There are a number of known camps for the Grey-headed Flying-fox in the region of the Project as described in **Section 2.1**.

2.2 Flying-fox population, camp and habitat within the Project footprint

2.2.1 Data collection - Macksville flying-fox camp

Data describing the Macksville flying-fox camp and its inhabitants has been acquired from a range of sources. In 2012 a history of use of the site was compiled from pre-existing information as part of an initial assessment that aimed to document the characteristics of the camp consistent with requirements of the *NSW Flying fox Camp Management Policy* (DECC 2009); and assess the potential likely impact of construction and operation of the adjoining Nambucca Heads to Urunga upgrade on the camp (Eby 2012). This information was supplemented by field work conducted in the following year and from satellite telemetry records of animals captured at the Royal Botanic Gardens Sydney in June 2012 (John Martin, Royal Botanic Garden and Domain Trust, Sydney). A systematic program of monthly monitoring was introduced in winter 2013 which focused on the seasonality of occupation of the camp site, the species and number of flying-foxes present, the camp footprint and likely importance as a maternity site. The frequency of monitoring was increased to fortnightly monitoring in January 2014 (SKM data; GeoLINK 2013a-g and 2014a-t, refer **Section 6**). A table of results to date is presented in **Appendix B** and summarised below.

Population size

The size of the Macksville colony has fluctuated from 0 to around 40,000 – 50,000 animals over the monitoring period, for further details, refer to **Appendix B**. Population size has varied between years with relatively high numbers recorded in summer 2012, autumn 2013, early spring 2013 and autumn 2014; and relatively low numbers recorded in late spring / summer 2013. The camp was empty in winter 2013 and 2014. This variation is in keeping with fluctuations recorded at other sites.

Species present

Grey-headed Flying-foxes, Black Flying-foxes and Little Red Flying-foxes have been recorded at the site. Grey-headed Flying-foxes predominate and make up 80-95% of the population.

Age and persistence of the camp

The Macksville flying-fox camp was established in late spring 2011. It is too early in its history to predict its long-term status (Eby, 2012). The formation of new flying-fox camps is generally associated with either a period of food scarcity when flying foxes disperse into small aggregations close to feeding areas (Eby *et al.* 2012), or abandonment of a near-by site (Hall 2002, Roberts *et al.* 2011). There is no evidence that food for flying foxes in south-east Australia was scarce at the time the Macksville camp was formed in late spring / summer 2011. However, the timing was associated with a notable shift in occupation of the camp at Bowraville (Eby, 2012).

It is likely that the Macksville camp formed in response to the abandonment of the Bowraville camp in 2011. Indications include the timing of abandonment of Bowraville relative to the establishment of Macksville, the proximity of the two sites, seasonal trends in population size and spatial associations in foraging areas accessed from the two camps. Flying-foxes returned to the Bowraville camp in October 2013 after an unprecedented absence of two years (GeoLINK 2013d). It is not possible to predict whether animals will continue to use the site.

Timing of when the camp is occupied

Combined survey and telemetry records confirmed occupation of the Macksville camp in December 2011; January, March and June 2012; each month from October 2012 to May 2013; and irregularly from September to April 2014. The bats were absent at the time of June, July and August 2013 surveys and the May through to September 2014 surveys, indicating seasonal use of the site (GeoLINK 2013a – 2013g and GeoLINK 2014a – 2014t).

Populations in excess of 10,000 including reproductive adults were recorded in the birth period (2011 and 2013), during lactation (2012 and 2014) and at the time of conception (2013 and 2014). Dependent young were recorded at the site in each year of monitoring. Thus the population is considered to be an 'important population' as defined under the EPBC Act as it is likely to be a key source population for breeding and dispersal. Numbers varied between October 2013 to mid-April 2014 and the site was occupied irregularly in these months, this is in keeping with expected inter-annual variations. For further details of the timing and numbers of when the camp is occupied refer to **Appendix B**.

Proximity of the camp to the Project

The proposed road corridor traverses the western edge of the perimeter of the Macksville flying-fox camp (refer to **Figure 1-2**). There is potential for the camp footprint to occupy much of this area during peak periods.

Condition of the vegetation where the flying-fox is currently roosting within the Project boundary

A habitat assessment was completed as part of a survey completed on 23 – 24 July 2013. Vegetation was assessed as predominantly in good condition, although localised areas around the edges of the remnant were in low or moderate condition due to edge effects, historic clearing and/ or livestock disturbances. Stands of mostly treeless Freshwater Wetland vegetation communities occur to the north-east and south-east of the forested areas. These wetland areas are listed under the TSC Act as the Endangered Ecological Community (EEC) - Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.

GeoLINK noted that there was a substantial *Salvina molesta* infestation that covered approximately 40 per cent of the water in the Swamp Sclerophyll Forest. This species is listed as a noxious species and weed of national significance and it was noted that care should be taken by all personnel visiting the site to avoid spread of this highly invasive species.

3. Key threats and potential impacts of the Project

3.1 Key threats to the species

3.1.1 Loss of habitat including loss of potential roosting sites and foraging opportunities

Flying-foxes require a continuous sequence of productive foraging habitats, the migration corridors or stopover habitats that link them, and suitable roosting habitat within nightly commuting distance of foraging areas (Fleming and Eby 2003). The clearing of vegetation results in the loss of foraging habitat, roosting sites and migration corridors and this is recognised as a threatening process to the Grey-headed Flying-fox (DECC, 2009).

The loss of roosting habitat is recognised as a threatening process to the Grey-headed Flying-fox (DECC, 2009). The degradation of vegetation in small remnants threatens longevity and may also reduce the suitability of sites as camps.

The loss of foraging habitat is recognised as a primary threat to Grey-headed Flying-foxes (DECC, 2009). Flying-foxes feed primarily on blossoms and fruit and supplement this diet with leaves. The majority of animals feed on nectar and pollen from Eucalypts, Melaleucas and Banksias. Loss of winter and spring forage is of particular concern as food bottlenecks occur in these seasons. Food shortages during late gestation, birth and early lactation can result in rapid weight loss in adults, poor reproductive success and high rates of mortality (Roberts, 2006, DECC, 2009).

Within 50 kilometres of the Project there are approximately 327,800 hectares of critical foraging habitat available, refer to **Figure 2-2** and **Table 2-1**.

3.1.2 Fragmentation of habitat and impacts to connectivity

Camps are used as day refuges by animals that forage in surrounding areas over several weeks, and as short-term stopover sites by migrating animals (DECC, 2009). Flying-foxes are proficient at foraging in fragmented landscapes. They are however reliant on corridors and landscape linkages to gain access to food. Their mobility enables them to move freely across fragmented, degraded and urban landscapes. Flying-foxes have been recorded flying large distances from their roost to different feeding areas (Roberts *et. al*, 2012). A reduction in roosting and foraging habitat reduces connectivity across the landscape.

3.1.3 Disturbance of roosting sites

Roosting flying-foxes are readily disturbed by various stimuli such as loud noise, smoke, dust and alterations to roosting vegetation (Roberts et al. 2011). Prolonged or intensive disturbances cause the animals to take flight for lengthy periods during the day, to repeatedly move between roost trees and may eventually cause animals to abandon camp sites. Disturbances to colonies potentially have adverse effects on the life cycle of flying-foxes, particularly if the disturbance occurs when females are heavily pregnant or have dependant young. Disturbance is particularly detrimental during the last weeks of pregnancy when females can spontaneously abort (Garnett et al. 1998, Luly et al, 2010). Additionally, disturbance of a maternity roost during the breeding season can result in the death of dependent young as females can be forced to fly off leaving dependent young behind (Garnett et al. 1998, Roberts, 2006).

Disturbance of colonies located in proximity to food resources during periods of food shortages (ie winter) can also have an adverse impact on the life cycle of flying-foxes. Disturbance has the potential to cause flying-foxes to become fatigued as they are forced to fly around, especially if there is limited alternative roosting habitat close by (Roberts, 2006). This issue is exacerbated when there are pregnant females or lactating females with dependent young present in the camp. The potential impacts may be amplified due to cumulative effects of ongoing dispersal activities at other flying-fox camps in NSW and Queensland (Roberts *et al.* 2011).

3.1.4 Noise, vibration and light impacts

Noise and vibration from machinery and associated activities can disturb flying-foxes in a camp (SEQ Catchments, 2012). Abandonment of a camp could lead to a significant impact to roosting populations during critical periods in their reproductive cycle i.e. when there are pregnant females or lactating females with dependent young present in the camp.

3.1.5 Impacts to groundwater/ponded surface water within flying-fox habitat

Research indicates that flying-foxes in coastal lowlands of SEQ and NSW choose to roost in vegetation that contains a closed canopy, a complex vegetation structure and is located within 500 metres of a waterway. The mid-storey vegetation within a camp site is considered critical for maintaining a cool, humid and sheltered environment to alleviate stress during drought and extreme temperatures and a dense understorey is believed to contribute to the provision of a desirable microclimate (SEQ Catchments, 2012).

Modification to groundwater and surface water hydrological regimes has the potential to:

1) Cause a change in vegetation structure with implications for a particular camp's viability as a flying-fox roosting site (a common method used to disperse flying-fox camps is camp modification, which includes modifying the vegetation structure of a camp (Roberts, 2006)).

2) Substantially alter the microclimate of the roost, particularly levels of humidity which can be important in defining roost locations (Snoyman and Brown 2010).

3.1.6 Electrocution on power lines, entanglement in netting and on barbed wire fencing

Flying-foxes are prone to accidental injury and death from various obstacles. They are prone to electrocution on power lines (Tidemann 1999, K. Parry-Jones, University of Sydney unpublished data); they can become entangled in netting that is intended to protect backyard fruit trees; and they can become entangled on barbed-wire fencing, particularly in rural areas (Halpin et al. 1999, van der Ree 1999, DECC, 2009). Such traumas can cause injuries resulting in death and can also cause pregnant females to spontaneously abort (Halpin et al. 1999). Trauma caused to lactating females can result in the death of dependent young left at the camp at night while females forage.

3.2 Potential impacts from the Project

This section identifies potential impacts from the Project. Measures to avoid, minimise and/or mitigate these potential impacts are addressed in **Sections 4, 5 and 6**. A monitoring program is discussed in **Section 7**.

3.2.1 Direct impacts of clearing work

The perimeter of the flying-fox camp overlaps the Project footprint and zone identified for vegetation clearing at its western edge. If flying-foxes were present at the time there would be potential for animals roosting in the camp to be injured or killed during clearing works through disturbance during the daytime, disorientation and/or increased susceptibility to predators.

The level of disturbance in and immediately adjacent to the camp area would likely displace the flying-foxes from their current roosting site, which may lead to stress and reduced fecundity for this population.

3.2.2 Loss of habitat including loss of potential roosting sites and foraging opportunities

The assessment of the area of habitat affected by direct clearing and damage to vegetation during construction of the Warrell Creek to Nambucca Heads Pacific Highway upgrade was based on the following:

- Concept design with 15 metre buffer.
- Construction/ operational water quality basins with 10 metre buffer.

- Adjustments to access roads within Nambucca State Forest with 10 metre buffer.
- Utility adjustments with clearing requirements of utility authorities.
- Three metre clearing width for boundary fencing - excluding within Nambucca State Forest and swamp forest where flying fox camp is located.

The area identified for clearing includes a 10 per cent contingency which allows provision for clearing construction phase water quality basins, accesses to ancillary facilities, stockpile sites and design refinements.

Clearing required for construction would remove 3.1 hectares of Swamp Mahogany /Paperbark Swamp Forest at the roost location. The total clearing of this community is 5.3 hectares, with the additional area located in another part of the corridor away from the camp site. The clearing will bisect the 23.5 ha remnant of Swamp Sclerophyll forest which contains the Macksville flying-fox camp. The current camp footprint lies partly within the road corridor hence there would be a direct impact associated with the removal of critical flying-fox roosting habitat. The entire area of Swamp Sclerophyll Forest (23.5 hectares) could potentially be used for roosting during peak periods. There would also be indirect impacts to the remaining patch of Swamp Sclerophyll Forest. As such there would be impacts (direct and indirect) to a total of 23.5 hectares of critical roosting habitat as defined in the Recovery Plan (DECC, 2009).

Five vegetation types which provide critical foraging habitat for the Grey-headed Flying-fox occur within the construction footprint of the Project (Eby, 2012) and highly productive plants in the blossom diet of Flying-foxes dominant in these habitat types include *Corymbia intermedia*, *Eucalyptus pilularis*, *E. robusta*, *E. siderophloia* and *Melaleuca quinquenervia*. The loss of foraging habitat for these key vegetation types equates to 106.6 hectares and consists of:

- Blackbutt Open Forest – 75.2 ha.
- Mixed Floodplain Forest – 4.0 ha.
- White Mahogany/Grey Gum/Ironbark Moist Open Forest – 7.3 ha.
- Flooded Gum Moist Open Forest – 14.8 ha.
- Swamp Mahogany /Paperbark Swamp Forest – 5.3 ha.

The area of each vegetation type that would be cleared represents <1 per cent of the total extent of the type within a 50 kilometre radius of the Macksville camp (Eby, 2012). It is considered that the presence of foraging habitat within the region would maintain connectivity and food resources for flying-foxes. The most substantial impact would be from the loss of a relatively small area of Swamp Forest - Swamp Mahogany / Paperbark (Map Unit 6). Approximately 5.3 hectares of this unit would be lost from the study area from the Project. This vegetation unit is of particular importance to flying-foxes as it contains two key diet species and hence foraging habitat, *Eucalyptus robusta* and *Melaleuca quinquenervia*, which are productive during winter when feeding options are highly restricted and food scarcities are common (DECC 2009, Eby et al., 2012).

3.2.3 Fragmentation of habitat and impacts to connectivity

Impacts to flying-foxes from habitat fragmentation would occur at two scales: the scale of the remnant containing the flying-fox camp and the scale of the Project area. The linear area to be cleared bisects the remnant in an area used by roosting animals. The fragmentation of the roosting habitat may cause the animals to abandon the camp site.

Removal of vegetation beyond the remnant will result in fragmentation of foraging habitat. However, flying-fox are highly mobile species and are proficient at moving across fragmented landscapes. As noted above, foraging habitat is widely available within a 50 kilometre radius of the Macksville camp.

3.2.4 Disturbance of roosting sites

Clearing of the line of vegetation through the remnant Swamp Forest would substantially alter the vegetation and microclimate of the current camp area. The remnant will be bisected and new edges exposed to sun, wind

and dry (rather than inundated) substrates will be introduced as will the potential for degradation of the vegetation along the edges.

Recent satellite telemetry work has clearly demonstrated that the animals roosting at the Macksville camp are part of the migratory population and move between various camps distributed over large distances from Macksville (J. Martin, RBGT Sydney, unpublished data). These animals are potentially exposed to dispersal actions that occur beyond the Macksville area, many of which are intentional. The long-term impact on the population is unknown and will depend on the ability of the flying-foxes to find a suitable alternate camp site. Twenty camp sites were recorded within a 50 kilometre radius of the Macksville camp, including the site itself (Eby 2012). Thirteen of the 20 camp sites meet at least one of the criteria for Roosting Habitat Critical to Survival of Grey-headed Flying-foxes as defined in the DECC (2009) (Eby 2012), refer to **Figure 2-1**.

3.2.5 Noise, vibration, dust and light impacts

The present roost site lies partly within the road corridor hence there will be a direct disturbance to the flying-fox roost site by construction activities. This is unavoidable due to the alignment of the State approved critical infrastructure project. The main construction impact from noise, vibration, dust and light would be associated with vehicles and machinery such as excavators, dozers, trucks, graders pile drivers and other machinery, rock fall etc during filling operations and ancillary noise associated with vegetation clearance. The area affected by disturbance from noise, vibration and dust would be defined as the area of habitat required to be removed for the construction of the Project plus a zone of 100 metres into the edge of the vegetation along the new edges. Some out of hours construction work would be required for health/safety, programming and engineering reasons which would require lighting. This would be discussed further with regulatory authorities and the adjacent community.

Opening of the section of the Project, in the vicinity of the flying-fox colony to highway traffic when the population of the roost is at or near its greatest may result in the abandonment of the roost, at least temporarily. The flying-fox camp may potentially be abandoned due to disturbance from noise, vibration, dust and light during construction. The most common method for intentionally dispersing flying-foxes from a roost is repeated exposure to loud noise (Roberts et al. 2011). The likely impact of noise during construction is, therefore, a particularly important consideration. The potential impact of vibration is not known. Richards (2004) reported that during the construction of the Southeast Freeway, the long term maternity colony at Slacks Creek in Brisbane vacated the site and did not return for 20 years. No mitigation measures were in place to reduce the impact of construction on the colony. Due to the timing of the desertion, it was concluded that the construction work caused the camp dispersal.

Eby (2013) summarised the conditions and outcomes of five construction projects of comparable magnitude to the WC2U Project and one smaller project, conducted in close proximity to flying-fox roosts (refer to **Table 3-1**). All construction works occurred whilst a flying-fox colony was in occupancy at the adjacent roost sites. Four of the roost sites were abandoned during construction and not re-established; and one roost site was abandoned but re-established 20 years later. It should be noted that whilst substantial construction activities were occurring around 240 metres from the Kurnell roost, the timing of roost abandonment at that site was additionally associated with drawdown of surface waters during severe drought conditions. As such it is not conclusive that the abandonment of the Kurnell roost could be attributed to adjacent construction activities.

In addition, the temporary roost that formed near the township of Tarcutta, NSW was established during a uniquely long and widespread food shortage for flying-foxes in south east Australia. The animals departed the site at a time when other temporary camps in the regional area also emptied. This also coincided with pile driving during construction of a bridge 250 metres from the roost. It is therefore not clear whether departure from the site was associated with the pile driving.

Table 3-1 A summary of the conditions and outcomes of five construction projects of comparable magnitude to the WC2U Project and one smaller project, conducted in close proximity to flying-fox roosts. This information is provided to assist in predicting the potential for flying-foxes to abandon the Macksville roost as an outcome of construction.

ROOST	PROJECT	WORKS NEAR ROOST SITE*	ROOST OCCUPANCY	APPROXIMATE DISTANCE ROOST TO WORKS	OUTCOME	NEW ROOST SITE & DIST
Kempsey Crescent Head Road	Pacific Highway Kempsey bypass	Crushing and screening facility, bridge piling	Annual - seasonal / long history of use	Around 200 metres from crushing plant and 500 metres from bridge piling activities	Roost present for the first two years of construction with ancillary facilities in operation as well as bridge piling activities. Roost abandoned after 2 years of construction commencing and has not re-established	Rudders Park, 2 km
Moorland	Pacific Highway Moorland to Herons Creek upgrade	Widen to 4 lane dual carriageway	Irregular / long history of use	Abuts: some roost site vegetation removed	Roost abandoned, not re-established	Lansdowne State Forest, 7 km
Kurnell**	Sydney Desalination Plant	Construction of extensive plant; 5 km pipeline; tunnelling; trenching	Annual – seasonal / long history of use	240 metres nearest above ground works, 450 metres nearest below ground works	Roost abandoned during construction, not re-established	Kareela, 10 km
Slacks Creek	Southeast Freeway (Qld)	Construct dual carriageway, interchange, bridge	Continuous / long history of use	175 metres to highway; 200 metres to the bridge	Roost abandoned during construction re-established after 20 years	Unknown
Tarcutta***	Hume Highway Tarcutta bypass	Construct 4 lane dual carriageway; bridge	Temporary (food shortage)	230 metres to highway; 250 metres to the bridge	Roost abandoned during construction, not re-established**	None, temporary site
Campbelltown	Access road	Construct 2 lane road; bridge piling	Annual – seasonal / new roost	80 metres to the road; 300 metres to the bridge	Roost remained through construction	Not applicable

* All construction works occurred whilst a flying-fox colony was in occupancy at the adjacent roost sites.

** Whilst substantial construction activities were occurring around 240 metres from the Kurnell roost, the timing of roost abandonment at that site was additionally associated with drawdown of surface waters during severe drought conditions. As such it is not conclusive that the abandonment of the Kurnell roost could be attributed to adjacent construction activities.

*** A temporary roost formed near the township of Tarcutta, NSW during a uniquely long and widespread food shortage for flying-foxes in south east Australia. The animals departed the site at a time when other temporary camps in the regional area also emptied. This also coincided with pile driving during construction of a bridge 250m from the roost. It is not clear whether departure from the site was associated with the pile driving.

Sources of information: http://www.rta.nsw.gov.au/roadProjects/index.html; A. Wyatt (OEH); C. Slade (Forests NSW); Eby (2009); Hall (2002); K. Whiting (EMM); A. Taylor (Campbelltown CC)

The roost associated with the smaller Campbelltown project was occupied throughout the construction period, despite works occurring 80 metres away. New roost sites were formed within 10 kilometres of three of the five abandoned sites.

3.2.6 Electrocution on power lines, entanglement in netting and on barbed wire fencing

No impact from electrocution would be anticipated. At its nearest point, the existing 11kV power line along the northern side of Bald Hill Road occurs approximately 600 metres south of the flying-fox camp. This power line would be relocated underground as part of the Project, thereby eliminating this potential risk to flying-foxes.

No impact from barbed wire fencing would be anticipated. Fauna exclusion fencing would be erected within the zone of cleared land five metres outside the footprint of the proposed activity. This fence would be connected to boundary fencing outside the forest to avoid the need to clear for and erect fencing, including barbed wire fencing, along the corridor boundary through the forest.

No netting would be installed as part of the Project.

3.2.7 Negative public attitude, conflict with humans and health risks

Conflict between humans and flying-foxes is an ongoing and increasing issue, particularly affecting camps located near developed areas. Conflict and negative perceptions of flying-foxes can affect the species directly through harassment and deliberate destruction (DECC, 2009). Should flying-foxes abandon the camp at Macksville, they would be likely to establish a new roost site in the local area rather than join an existing site (Roberts et al. 2011). Vegetation that meets known descriptive characteristics as roosting habitat is widely available. However, as critical roost selection criteria are not defined, it would not be possible to predict or control the location of a new site. A new camp could prove a source of conflict for people living in the surrounding area.

Flying-foxes can carry diseases of significance to humans. These diseases include Australian Bat Lyssavirus (ABL) and Hendra virus. ABL can only be contracted from being bitten or scratched by an animal infected with ABL. Hendra virus can only be contracted by contact with an infected horse. The colony would be tested for the presence of Hendra virus when the site is occupied by a sufficient population of flying-foxes. An ecologist, experienced with flying-foxes, would supervise vegetation clearing and habitat removal activities in the vicinity of the camp. A fauna handling protocol is discussed in **Section 5.3.7**.

3.2.8 Noise, vibration and light impacts

Operational impacts associated with noise and light will include general traffic noise and lighting from vehicles. Roadside lighting would be limited to lighting required for the interchange at Bald Hill Road south of the camp. Disturbance due to noise, vibration and light will be continual once the highway is operational. Noise, vibration and light impacts from vehicles will be greatest during peak traffic times. Due to the disturbance from noise, vibration and light being a permanent impact this impact will extend through all seasons.

Disturbance due to noise, vibration and light is expected to penetrate approximately 100 metres into the vegetation on either side of the highway.

3.2.9 Proximity of the camp from the disturbance

The present camp footprint lies partly within the road corridor. There will be a direct disturbance to the flying-fox camp site by the operation of the highway. This is unavoidable due to the alignment of the State approved critical infrastructure Project.

3.2.10 Mortality due to vehicle strike during take-off from roosting/foraging sites

Richards (2004) reported that flying-foxes are likely to die or be injured from collision with vehicles when exiting roosts near construction zones.

Flying-fox camp abandonment, at least temporarily, is expected to occur due to disturbance during construction (noise, dust) and during operation (noise, landscape alteration). In the event flying-foxes continue to forage in the surrounding swamp forest, there may be collisions between flying-foxes and vehicles due to the proximity of the camp to highway traffic. Collisions would be particularly likely at times when the flying-foxes are experiencing a shortage of food, are weaker and as such, are flying lower (Eby, 2013). Collisions can occur at a range of distances from roosts.

If females remain at the camp there is a likelihood of reduced ability to manoeuvre around traffic when carrying heavy, dependent young. Additionally, inexperienced young may also suffer vehicle strike due to an inability to avoid vehicles when learning to fly (Richards, 2004). In a banding study conducted between 1988 and 1999, Tidemann (1999) identified that 3 per cent of Grey-headed Flying-foxes died as a result of collision with motor vehicles.

3.2.11 Impacts to groundwater/ponded surface water within flying-fox habitat

During the April 2013 survey, the camp was located in the areas of deepest inundation in the swamp (water depths of 1-1.5 metres). There is a potential that changes to the groundwater/ponded surface water regime would occur as a result of local drawdown. Impacts on the dynamics of the ground and ponded surface water in the Project area could indirectly impact the flying-fox colony and result in the abandonment of the camp. Eby (2013) states that changes to the groundwater regime have the potential to substantially alter the microclimate of a camp site, particularly levels of humidity which can be important in defining roost locations (Snoyman and Brown 2010).

The Project would require cuttings through Bald Hill Road (to the south of the wetland) to be excavated to an approximate relative level of 10 metres Australian Height Datum (AHD) (some 15 to 17 metres depth). Groundwater levels in the areas of the cuttings are likely to be three to eight metres below the surface and thus groundwater seepages are anticipated into the cuttings, leading to a local drawdown in the groundwater level either side of the cutting beneath the Bald Hill Road ridgeline. An assessment by Coffey Geotechnics (2013) found, that on the basis of the supplied information, the drawdown of the groundwater level beneath the ridgeline is unlikely to have an environmental impact on surface ecosystems or existing groundwater usage on the ridgeline. Furthermore it is considered by Coffey to be highly unlikely that the Project would result in long term draw down of the groundwater table in the wetland area and the Nambucca River floodplain. Any surface water flows in the cutting/s would be captured and transported to the wetland area through drainage measures (with possible treatment if required).

Accordingly, the Project would not reduce the supply of groundwater that may currently flow towards to the wetland area and would be unlikely to result in long term draw down of the groundwater table in the section of Swamp Sclerophyll Forest where the flying-fox colony has a roosting camp. Further information regarding the hydrologic regime and management measures is provided in Section 16 of Volume 1 of the WC2U EA (RTA, 2010a).

However, modifications to the hydrological regime have the potential to impact on microclimates within vegetation communities by creating greater fluctuation in temperature and humidity (Catterall, Lynch and Jansen, 2007). Runoff from the highway has the potential to contain pollutants and fine sediment which can also modify vegetation communities by causing infilling of channels and alterations to water chemistry. This can also exacerbate the growth of aquatic weeds. This degradation of habitat can further reduce the amount of roosting and/or foraging resources available to flying-foxes.

The Project includes transverse drainage culverts to maintain the hydrological regime (and hence the microclimates within vegetation communities) during the operational phase. The Project also includes a range of water quality management measures, including sediment basins and drainage swales, to manage runoff from the highway and minimise the risk of pollutants and fine sediment entering the waterways.

4. Pre-construction management measures

4.1 Potential pre-construction impacts

Location of infrastructure within ancillary facility sites may impact on flying-fox habitat, movements, foraging and behaviour.

4.2 Main goals for management

The main goals for management are as follows:

- No damage to flying-fox habitat outside road corridor.
- No damage to flying-fox habitat outside designated ancillary facility areas.
- No mortality of flying-foxes due to the ancillary facilities.

4.3 Detailed design considerations

The alignment of the Project within the State approved corridor in the vicinity of the colony has been refined to maximise the separation from the camp. The refined alignment would involve locating the northbound carriageway as close as practical to the western boundary of the approved corridor and reducing the width of the median between the two carriageways from 12 metres to 5 metres.

A number of additional factors would be addressed in the detailed design phase to minimise the impacts of the Project. The factors to be considered which would be particularly relevant for the minimisation of impacts to the Macksville camp include:

- Avoiding and minimising vegetation removal.
- Consideration of the placement of ancillary facilities. These are required to be placed outside the 500 metres buffer distance from the camp.
- Consideration of potential long term changes to the hydrological regime within the Swamp Sclerophyll Forest.
- Consideration of the timing and staging of works.

4.4 Mitigation measures

4.4.1 Timing of activities

Clearing within the section of Swamp Sclerophyll forest south of Macksville in which the flying-fox colony became established in October 2011 would be undertaken when the camp is empty or at its lowest occupancy. Clearing would commence at the outer edges of the Swamp Sclerophyll forest and work in towards to the centre of the swamp along the clearing corridor alignment, in order to encourage any roosting flying-foxes to temporarily move out of the swamp forest during clearing activities. Monitoring of the colony to assist with management of impacts during construction and operation of the Project impacts undertaken to date indicates this is between 1 May and mid-September (refer **Appendix B**). These periods would be further informed by future survey information.

4.4.2 Identify habitat exclusion zones and construction buffers

The boundaries of habitat exclusion zones as documented in the approved CEMP and construction buffer zones required for measures to mitigate impacts during construction (see **Section 4.3**), would be identified pre-construction and marked or fenced.

An exclusion zone is a designated ‘no-go’ area that is clearly identified and appropriately marked or fenced to prevent damage to native vegetation and fauna habitat. This would be documented in the Flora and Fauna Management Plan (FFMP) and based on the recorded footprint of the flying-fox camp. A buffer zone refers to

the area of separation between the flying fox camp and construction activities and /or ancillary facilities. The extent of buffer zones around the flying-fox camp would be measured from the combined mapped extent of the 2013-2014 surveys. The location of the buffer zones may be modified based on monitoring results of the camp.

A buffer zone of 300 metres would be imposed between the perimeter of the camp and major construction activities (e.g. clearing, earthworks, bridgeworks and pavement construction) undertaken between mid-September and the end of April the following year when the population of the camp is likely to be at or near its maximum. The existing highway, the temporary construction connection between the existing highway and the alignment and the Bald Hill Road interchange / cutting would be excluded from the 300 metres construction buffer zone. Fortnightly monitoring of the camp will be undertaken between 1 August and the end of April the following year. Clearing of vegetation within the buffer zone would halt if there are heavily pregnant GHFF or female GHFF with dependant young present. Construction activities within 300 metres of the perimeter of the camp may be undertaken before 1 May or after 15 September each year if monitoring demonstrates that no GHFF are present.

Subject to the above, activities within the 300 metre buffer zone between mid-September and the end of April the following year would be restricted to low noise/ low disturbance construction activities required for monitoring, maintenance and incident response purposes. Observational monitoring would be undertaken to ensure that the activities undertaken are causing minimal disturbance to any flying-foxes in the camp.

A timeline showing the implementation of the 300 metre construction buffer relative to the anticipated vacancy and occupancy of the Macksville flying-fox camp is included; refer to **Figure 4-1**.

Due to the nature of the activities undertaken at ancillary sites and the duration of their operation, ancillary sites have the potential to generate greater levels of disturbance than road construction activities. Accordingly, a buffer of 500 metres would be imposed between the perimeter of the camp and any ancillary sites throughout the period of construction of the Project.

4.4.3 Procedures for human interaction with flying-foxes and management of occupational health and safety risks

The best prevention of an interaction between a human and a flying-fox is to avoid contact with flying-foxes. If an injured or trapped flying-fox is identified, the Wildlife Information and Rescue Service (WIRES) will be telephoned for assistance.

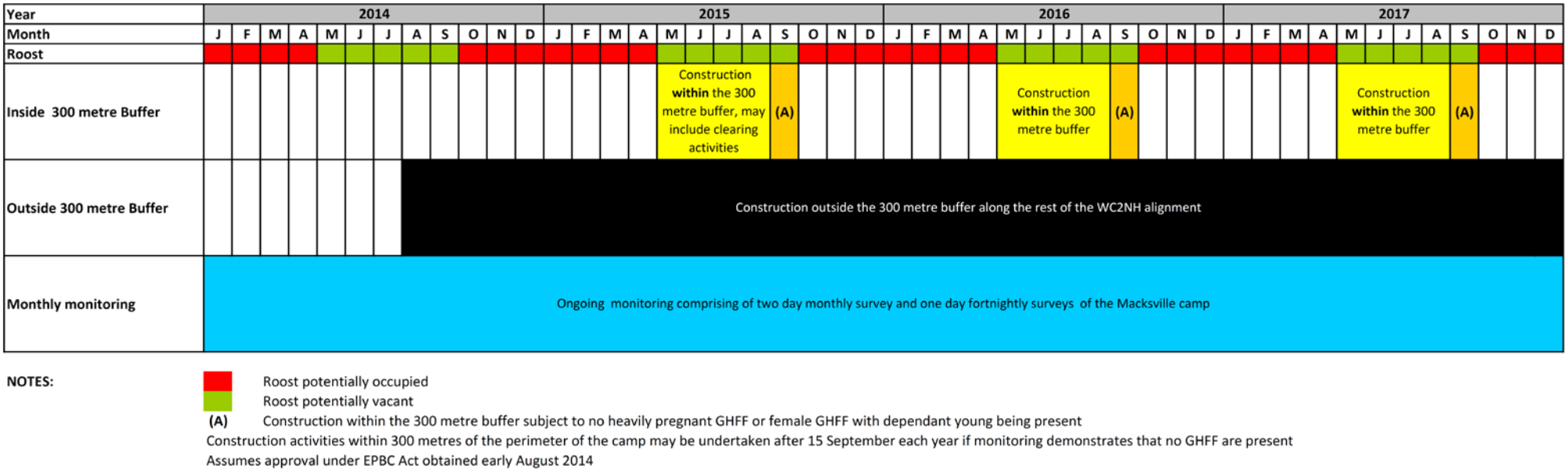
If an individual is bitten or scratched, the health and safety procedure is to thoroughly wash the wound, apply an antiseptic solution such as povidone-iodine and contact a local doctor immediately. If the individual is at risk, a doctor may provide a post-exposure Rabies vaccine. Note that even if an individual has been vaccinated beforehand, they will need to be revaccinated (Office of Environment and Heritage (OEH), 2013). This information would be incorporated into the CEMP, induction and toolbox talks.

4.5 Pre-construction monitoring

4.5.1 Baseline monitoring

Baseline monitoring at the Macksville camp would continue to be undertaken through pre-construction to confirm flying-fox presence and determine population size, species abundance and diversity, demographics and camp footprint. Methods, timing, frequency and duration are outlined in **Section 6**. This data would inform mitigation measures and monitoring activities during construction and operation (refer to **Section 4.3**).

The pre-construction monitoring program would be important for developing a baseline of population condition prior to road construction. This would provide a point of comparison to assess the impacts of the road on the population of flying-foxes and monitor the effectiveness of mitigation measures.



NOTES:

Roost potentially occupied

Roost potentially vacant

(A) Construction within the 300 metre buffer subject to no heavily pregnant GHFF or female GHFF with dependant young being present

Construction activities within 300 metres of the perimeter of the camp may be undertaken after 15 September each year if monitoring demonstrates that no GHFF are present

Assumes approval under EPBC Act obtained early August 2014

Figure 4-1 Summary timeline figure displaying construction buffer timing in relation to the occupancy of the Macksville roost

Note: Subject to (A) above and noise levels being less than the Operational Noise levels at this location once the Project opens to traffic (Leq 15hr = 56.5 dB(A) as predicted 100 m from the centre of carriageway), activities within the 300 metre buffer zone between 15 September and the end of April the following year would be restricted to haulage of materials (no construction works including no loading and unloading) and low noise / low disturbance construction activities required for monitoring, maintenance and incident response purposes if monitoring demonstrates that GHFF are present. (refer to Section 5.3.3).

4.5.2 Radio-tracking/satellite tracking

Practical/ cost effective radio-tracking/satellite tracking flying-foxes roosting in the Macksville camp prior to the start of construction may provide an opportunity to obtain data on the distribution and migratory patterns of flying-foxes in the area and the potential impacts of disturbance of the colony. The potential opportunities, benefits and impacts of radio-tracking/satellite tracking of flying-foxes roosting in the Macksville camp have been further investigated by Roads and Maritime. Advice from Dr Peggy Eby indicates that radio-tracking/satellite tracking flying-foxes would be of marginal value for the following reasons:

1) As per **Section 4.4.1**, it is highly likely that all tagged animals would depart the Macksville camp prior to disturbance commencing at the site.
2) The highly variable nature of flying-fox movements would make it difficult to interpret the impact of the disturbance on subsequent migration and feeding patterns.

Based on this advice there is no intent to pursue radio-tracking/satellite tracking of the Macksville camp flying-foxes during pre-construction monitoring.

4.6 Performance thresholds and corrective actions

Table 4-1 presents the main goals of management for pre-construction activities as described in **Section 4.2** and includes a summary of the relevant mitigation measures for flying-foxes that are to be completed prior to the commencement of construction. The table also describes how the identified mitigation measures are to be monitored, the timing and frequency of monitoring, who is responsible for implementing the measures, the performance thresholds that each goal is measured against and the corrective actions if deviation from the performance criteria occurs. A full description of the pre-construction management mitigation measures is included in **Section 4.4**.

Table 4-1 Summary of pre-construction management goals, mitigation measures, performance thresholds and corrective actions.

Main goal	Mitigation / control measure	Monitoring / timing frequency	Responsibility	Performance threshold	Corrective actions if deviation from performance criteria
• No damage to flying-fox habitat outside the road corridor or within identified exclusion areas.	• Identify exclusion zones and install exclusion fencing or marking. Exclusion fencing or marking is intended to exclude construction activities from occurring in flying-fox habitat. • Minimise through detailed design the incidence of clearing vegetation containing Swamp Mahogany, *Melaleuca quinquenervia*, *Banksia integrifolia* and *Eucalyptus tereticornis* that contribute to foraging habitat during known food bottle necks (i.e. winter period).	• Identify clearing limits prior to construction to mark and flag exclusion zones. • Follow-up inspection after surveying the Project area to ensure correct areas has been marked out prior to construction.	• Design and Construction (D&C) contractor. • D&C contractor.	• Exclusions zones identified and approved as part of the CEMP prior to construction being undertaken.	• Construction within or adjacent to areas of flying-fox habitat delayed and clearing works would not commence until exclusion zones have been approved as part of the CEMP.
• No damage to flying-fox habitat outside designated ancillary facilities. • No mortality of flying-foxes due to the ancillary facilities and pre-clearing activities.	• Minimise through detailed design the incidence of clearing vegetation containing Swamp Mahogany, *Melaleuca quinquenervia*, *Banksia integrifolia* and *Eucalyptus tereticornis* that contribute to foraging habitat during known food bottle necks (i.e. winter period). • Construction related infrastructure to be planned	• Detailed plans to be prepared showing the proposed location of construction related infrastructure and approved prior to the commencement of construction.	• D&C contractor	• Exclusions zones identified and approved as part of the CEMP prior to construction and clearing works being undertaken.	• Construction within or adjacent to areas of flying-fox habitat delayed until ancillary facility locations have been approved.

Main goal	Mitigation / control measure	Monitoring / timing frequency	Responsibility	Performance threshold	Corrective actions if deviation from performance criteria
	and sited within cleared or disturbed areas of the ancillary site. Particularly away from water sources and flying-fox movements areas.				

5. Construction management measures

5.1 Summary of potential impacts

- Direct impacts of clearing work.
- Loss of habitat including loss of potential roosting sites and foraging opportunities.
- Fragmentation of habitat and impacts to connectivity.
- Disturbance of roosting site.
- Noise, vibration, dust and light impacts.
- Impacts to groundwater/ponded surface water within flying-fox habitat.

5.2 Main goals for management

- No injury or mortality to flying-foxes as a result of vegetation clearance or construction of the Project.
- Minimise removal of roosting and foraging habitat outside the boundaries of the Project or within identified exclusion zones.
- Minimise removal of threatened flying-fox habitat outside designated ancillary facility areas.
- Minimise disturbance to the flying-fox camp from vegetation removal, surface water drawdown, noise, vibration and lighting.
- Impacts to flying-foxes during clearing managed in accordance to fauna handling protocol.
- No contamination or isolation of water supplies.

5.3 Mitigation measures

A program of measures to mitigate impacts of construction of the Project on flying-foxes would be implemented. The main strategy would be to avoid exposing animals to potentially harmful work whenever practicable through careful timing and definition of permissible activities within buffer zones around the perimeter of the camp.

5.3.1 Timing of activities

Survey work undertaken at the flying- fox camp has indicated that the camp would be empty or at its lowest occupancy between May and mid-September. Accordingly, it is proposed that construction activities along the approved alignment within the vicinity of the flying fox camp would be restricted if and when GHFF are present between 15 September and 1 May the following year. The period would be further informed by future survey information.

As discussed in **Section 3.2** above, opening of the section of the Project in the vicinity of the flying-fox colony to highway traffic when the population of the roost is at or near its greatest may result in the abandonment of the roost, at least temporarily. To minimise the risk of abandonment of the roost, Roads and Maritime has investigated opportunities to open the section of the Project in the vicinity of the camp to highway traffic when the roost is either empty or at its lowest. Subject to favourable weather during the construction period, opening of the section of the Project in the vicinity of the camp to highway traffic may be able to be achieved in the winter period prior to mid-September 2018. Extended working hours, potentially including all night work, would increase the likelihood of opening this section of the Project at this time. The potential extension of working hours to enable the section of the Project to be opened to traffic in the winter period prior to mid-September 2018 would be discussed further with regulatory authorities and the adjacent community.

5.3.2 Construction work method statements

Specific environmental work method statements (EWMS) would be prepared for specific works to ensure sound environmental practices have been implemented and to minimise the risk of environmental incidents or system failures, in accordance with the CEMP and to address flying fox issues. These would be prepared for works in the vicinity of the flying fox roost and for clearing of flying-fox habitat along the Project in consultation with relevant agencies, Roads and Maritime and the relevant Project environmental manager prior to the commencement of identified activities.

General responsibilities for environmental management are outlined in the approved construction environmental management plan (CEMP).

Roads and Maritime finalised this Flying-fox Management Plan in consultation with the Commonwealth DoE, NSW DP&I and EPA in December 2014 for the second stage of the WC2U project (WC2NH). DoEEacceptance of the plan and staging priorities was received in January 2015. Roads and Maritime, the construction contractor and the contractor's ecologist engaged for the WC2NH Project, the section relevant to the Macksville Flying-fox camp, are responsible to oversee the implementation of the plan.

5.3.3 Buffers zones and permissible construction activities

A buffer zone refers to the area of separation between the flying fox camp and construction activities. The extent of buffer zones around the flying-fox camp will be measured from the combined mapped extent of the 2013-2014 surveys. The location of the buffer zones may be modified based on monitoring results of the camp.

Based on the fact that the existing Pacific Highway, which is the main source of noise in the subject area, is located within approximately 330 metres of the mapped edge of the flying-fox camp survey in 2012, it is proposed that a buffer of 300 metres is appropriate between the perimeter of the camp and major construction activities (eg clearing, earthworks, bridgeworks and pavement construction) undertaken between mid-September and the end of April the following year when the population of the camp is likely to be at or near its maximum. The existing highway, the temporary construction connection between the existing highway and the alignment and the Bald Hill Road interchange / cutting would be excluded from the 300 metre construction buffer zone.

The systematic program of monthly monitoring introduced in winter 2013 (as discussed in Section 2.2) will continue through to 12 months after the opening of the Project to traffic. Fortnightly monitoring of the flying-fox camp will be undertaken from 1 August 2014 until clearing is complete. When construction is being undertaken within the buffer zone, daily walk through inspections will be undertaken prior to works commencing.

Subject to the following, construction activities within the 300 metre construction buffer zone will be restricted to the period 1 May to 15 September each year. Clearing of vegetation within the buffer zone will halt if heavily pregnant GHFF or female GHFF with dependant young are present as verified by the project ecologist. Construction activities within the buffer zone may be undertaken before 1 May or after 15 September each year if monitoring demonstrates that no GHFF are present.

The likely impacts associated with these activities would be reviewed with input and advice from Dr Eby or another suitably qualified and experienced GhFF expert. Observational monitoring of the camp for a-typical behavioural responses would be undertaken during the execution of these activities to assess any impacts on the flying-foxes. Noise monitoring of the haulage operations will be undertaken to substantiate that the activity is of no greater impact than predicted to occur post opening at dawn and dusk if GhFF are present. If noise levels exceed post opening levels haulage activities will cease.

It is recognised that activities occurring at ancillary sites would operate through the year. Accordingly a buffer of 500 metres would be imposed between the camp and any ancillary sites. A summary of the construction buffer zones and permissible activities allowed during construction are summarised in **Table 5-1**.

The flying fox camp would be monitored prior to and throughout construction. The population size, roosting location and demographics of the colony would be assessed as would key behaviours (e.g. reproductive behaviours). The methods employed would be consistent with those established in the pre-construction monitoring program. The methods would enable repeat measures to be compared statistically and would allow comparisons to be drawn with other camps (control sites). The frequency of monitoring sessions would vary according to the phase of the annual cycle of flying-foxes. Details of the monitoring program are provided in **Section 6** and a decision flow chart that is to be followed regarding permissible construction activities within the 300 metre buffer zone based on the results of monitoring of the Macksville flying-fox camp is summarised in **Figure 5-1**.

For the purposes of this plan, low noise / low disturbance construction activities required for monitoring,

maintenance and incident response purposes include the following:

- monthly GhFF population and presence monitoring,
- daily pre construction GhFF presence inspections,
- noise monitoring during haulage operations,
- monthly and post rainfall surface and ground water sample collection,
- inspection and repair of erosion and sediment controls, and
- environmental incident response and management.

Table 5-1 Summary of mitigation measures during construction

Construction works would be managed to accommodate the following mitigation measures:

- A buffer of 300 metres would be imposed around the perimeter of the camp. The extent of buffer zones around the flying-fox camp would be measured from the combined mapped extent of the 2013-2014 surveys. The location of the buffer zones may be modified based on monitoring results of the camp.
- Construction activities within the 300 metre buffer zone would halt if monitoring demonstrates that heavily pregnant GHFF or female GHFF with dependant young were present.
- Construction activities within the buffer zone would be undertaken between 1 May and 15 September and if flying-fox are present in the clearing corridor the contingency strategy would be implemented.
- Construction activities within the buffer zone may be undertaken after 15 September each year if monitoring demonstrates that no GHFF are present.
- Subject to the above, and noise levels being less than the Operational Noise levels (at this location once the Project opens to traffic (Leq 15hr = 56.5 dB(A) as predicted 100 m from the centre of carriageway), activities within the 300 metre buffer zone between mid-September and the end of April the following year would be restricted to haulage of materials (no construction works including loading or unloading) and low noise/ low disturbance construction activities required for monitoring, maintenance and incident response purposes if monitoring demonstrates that GHFF are present. Observational monitoring on a daily basis along with noise monitoring during haulage operations in the morning and afternoon will be undertaken to ensure that the haulage of materials and low level noise/disturbance activities are in fact meeting those criteria.
- A buffer of 500 metres would be imposed around the perimeter of the camp for ancillary facilities. Ancillary sites would be excluded from this area throughout the period of construction of the Project.
- To minimise the extent of clearing of the Swamp Sclerophyll Forest within which the flying-fox colony is located, clearing of the forest would be limited to five metres outside the footprint of the proposed activity.
- The impact of construction activities on the flying fox colony would be monitored during construction. Fortnightly monitoring of the camp to be undertaken from 1 August 2014 clearing is complete Once clearing is complete monitoring is to be monthly in association with daily pre-dawn walk through inspections prior to works commencing.
- Clearing of vegetation would halt if there are heavily pregnant GHFF or female GHFF with dependant young present noting that an ecologist, experienced with flying-foxes would be on site during removal of vegetation in the vicinity of the flying-fox camp.
- Other construction activities would halt if there are heavily pregnant GHFF or female GHFF with dependant young present after 31 August.
- Construction activities within the buffer zone may be undertaken prior to 1 May or after 15 September each year if monitoring demonstrates that no GHFF are present.
- Measures would be implemented to ensure that the proposed activity does not result in long term changes to the natural surface water levels in the vicinity of the camp. Monitoring would be carried out to identify any changes to water levels using appropriate expertise where practicable.
- A temporary construction access road may be constructed from the existing highway to the proposed activity to the north of the flying fox camp to reduce potential impacts on the colony by providing access to the critical works on the Nambucca River floodplain and bridge over the Nambucca River. At its closest, the temporary construction access would be about 500 metres from the perimeter of the camp. The existing highway, the temporary construction connection between the existing highway and the alignment and the Bald Hill Road interchange / cutting would be excluded from the 300 metre construction buffer zone.
- The alignment of the Project within the State approved corridor in the vicinity of the colony would be refined to maximise separation from the camp.
- Measures may be implemented to facilitate opening of the section of the Project in the vicinity of the flying-fox camp-site to highway traffic when the population is at or near its minimum.

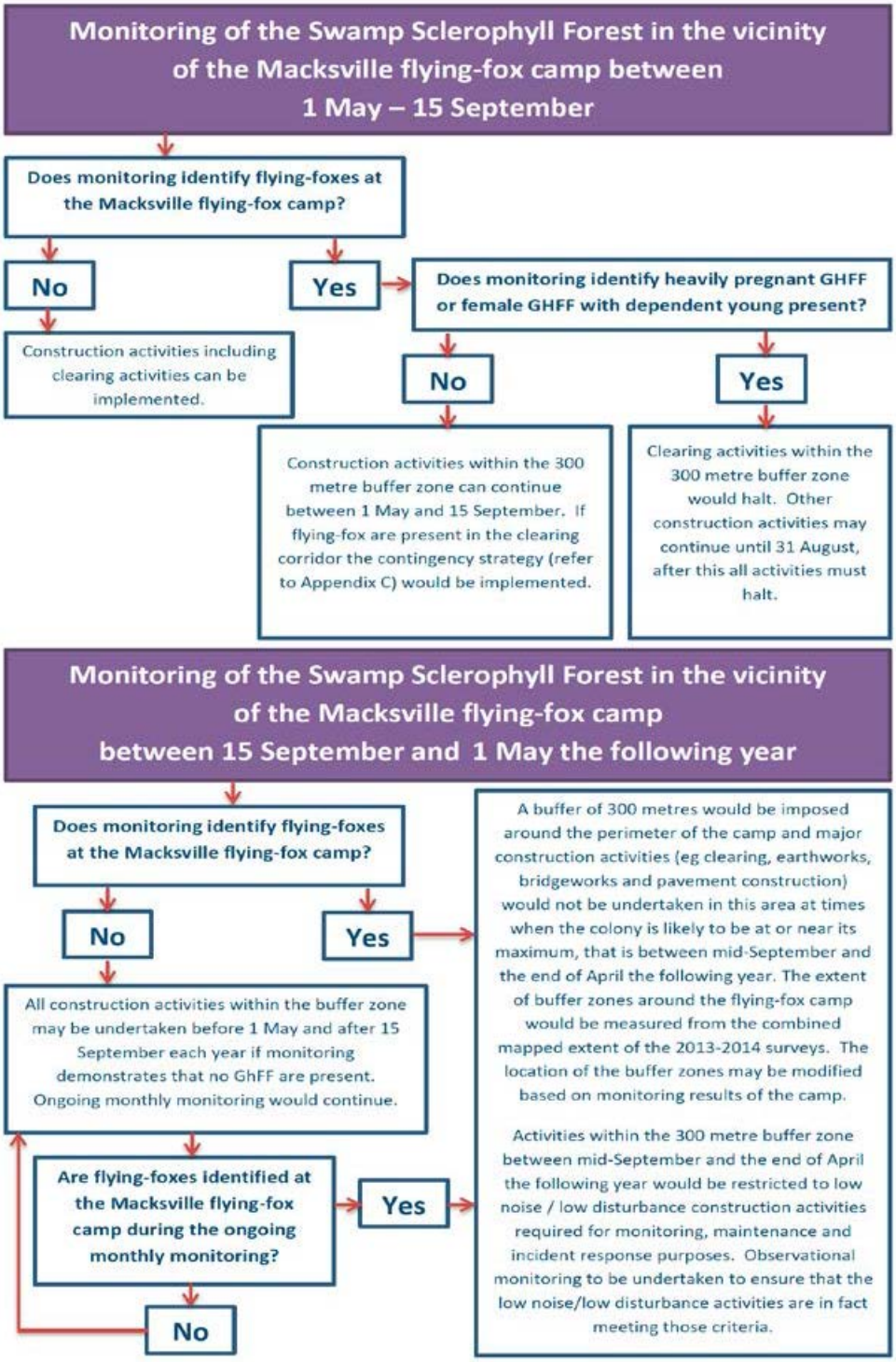


Figure 5-1 Flow chart that is to be followed regarding permissible construction activities within the 300 metre buffer zone based on the results of monitoring of the Macksville flying-fox camp

Note: Subject to the above and noise levels being less than the Operational Noise levels at this location once the Project opens to traffic (Leq 15hr = 56.5 dB(A) as predicted 100 m from the centre of carriageway), activities within the 300 metre buffer zone between 15 September and the end of April the following year would be restricted to haulage of materials (no construction works including no loading and unloading) and low noise / low disturbance construction activities required for monitoring, maintenance and incident response purposes if monitoring demonstrates that GHFF are present.

5.3.4 Construction induction and training

All contractors and other staff that would be working in the area of the flying-fox camp south of Macksville would be given tool box talks and training as part of the WC2NH Project specific induction regarding the Grey-headed Flying-fox and management of impacts to the species. This training would identify the two species of flying-fox recorded at the Macksville camp with particular emphasis on the threatened Grey-headed Flying-fox, their habitats, distribution and key threats, and all personnel would be trained to identify the species. The importance of following the clearing protocols would be made clear for all personnel that require access to the site.

5.3.5 Pre-clearing and clearing procedures

Pre-clearing and clearing procedures would be outlined in the approved Flora and Fauna Management Plan (FFMP), and would be undertaken in accordance with *Biodiversity Guidelines: Protecting and managing biodiversity on RTA Projects* (RTA 2011). In summary, prior to the commencement of clearing operations, the Project ecologist would identify all areas that contain vegetation and habitat to be retained, including exclusion zones. Targeted surveys for flying-foxes would also be undertaken.

If a flying-fox is identified within the construction clearing zone, all clearing works will cease within 100 metres of the observed individual, or the edge of the group if a number of individuals are identified. Clearing will not commence in the area where the flying-foxes were identified until clearance is given by the Project ecologist. This is to enable the animal to move off its own volition or to be relocated in accordance with the *NSW Code of Practice for Injured, Sick and Orphaned Flying-foxes* (OEH 2012).

The ecologist would manage any injured or displaced flying-foxes with assistance from a wildlife carer or vet for rehabilitating injured wildlife. The ecologist or wildlife carer would relocate and release displaced flying-foxes upon confirmation of the animal's health.

5.3.6 Contingency strategy for moving flying-foxes out of the highway corridor during clearing operations between the period 1 May – 15 September.

Should a flying-fox (or group of flying-foxes) be identified within the construction clearing zone and within 100 metres of clearing activities during the pre-clearing ecology surveys outlined above, the contractor may need to move the flying-foxes out of the construction clearing zone using the contingency strategy included in **Appendix C**.

The contingency strategy for moving the flying-fox has been prepared as a precautionary measure should flying-foxes remain in the camp during the 1 May to 15 September period when clearing work is proposed to be undertaken within the 300 metre construction buffer. Concurrence from EPA and DoEEwould be obtained prior to implementation of the contingency strategy included in **Appendix C**.

The contingency strategy aims to move flying-foxes from vegetation proposed to be removed during clearing activities and 100 metres beyond this in order to prevent stress, injuries or mortality to the animals. The aim of the contingency strategy is to herd the animals through the contiguous tract of Swamp Sclerophyll Forest until they reach vegetation not proposed to be removed during the clearing activities. This strategy is a temporary contingency to minimise impacts on flying-foxes should animals be roosting in vegetation proposed to be removed and is not a long term dispersal/relocation strategy. No disturbances to the flying-foxes would occur during high wind, heavy rain or other adverse environmental conditions. Pre-clearance ecology surveys would occur daily prior to any clearing works commencing.

The contingency strategy for moving the flying-foxes out of vegetation proposed to be removed during clearing activities would be undertaken as a series of separate steps. Each individual step would only be implemented if the previous step was not successful in moving all flying-foxes out of vegetation proposed to be removed. Refer to Appendix C for further detail. The 100m offset from the construction corridor is also adopted for noise monitoring during haulage operations if GhFF are present.

5.3.7 Fauna handling protocol

An ecologist would be present on site during all vegetation clearing activities in the vicinity of the Macksville camp to monitor the behaviour of any flying-foxes that may be present. Licensed wildlife carers would be identified prior to commencement of works to ensure that personnel are available on-site as required. Any injured, sick or orphaned flying-foxes will be cared for by a licensed wildlife carer. A daily fauna incident log will be maintained during clearing activities.

5.3.8 Management of construction noise, vibration and light impacts

Impacts to the flying-fox camp from construction noise, vibration and light would be managed through maintaining a works buffer of 300 metres between the perimeter of the camp and major construction activities (e.g. clearing, earthworks, bridgeworks and pavement construction) if GhFF are present between mid-September and the end of April the following year when the population of the camp is likely to be at or near its maximum. The existing highway, the temporary construction connection between the existing highway and the alignment (if required) and the Bald Hill Road interchange / cutting would be excluded from the 300 metre construction buffer zone. Fortnightly monitoring of the camp would be undertaken from 1 August 2014 to clearing is complete. Clearing of vegetation within the buffer zone would halt if there are heavily pregnant GHFF or female GHFF with dependant young present. Other construction activities would halt if there are heavily pregnant GHFF or female GHFF with dependant young present after 31 August. Construction activities within the buffer zone may be undertaken prior to 1 May or after 15 September each year if monitoring demonstrates that no GHFF are present.

Subject to the above and noise levels being less than the Operational Noise levels at this location once the Project opens to traffic (Leq 15hr = 56.5 dB(A) as predicted 100 m from the centre of carriageway), within the 300 metre buffer zone between 15 September and the end of April the following year would be restricted to haulage of materials (no construction works including no loading and unloading) and low noise / low disturbance construction activities required for monitoring, maintenance and incident response purposes if monitoring demonstrates that GHFF are present. Observational monitoring of the camp for a-typical behavioural responses would be undertaken during the execution of these activities on a daily basis to assess any impacts on the flying-foxes. Construction activities within 300 metre of the perimeter of the camp may be undertaken after 15 September each year if monitoring demonstrates that no GHFF are present.

A buffer of 500 metres would also be imposed between the camp and any ancillary sites throughout the period of construction of the Project.

5.3.9 Management of construction impacts to groundwater/ponded surface water levels

It is acknowledged that the dynamics of the ground and ponded surface water in the area could indirectly impact on the camp and result in the potential abandonment of the camp. Management of this potential impact would include cross drainage and the provision of a permeable, free draining rock platform to ensure that the proposed activity does not result in long term changes to the natural surface water levels in the vicinity of the camp. It is noted that drought and rainfall may alter water levels and Roads and Maritime would have no influence on changes on these variables, nor any freehold works outside the corridor.

Short term modifications to the level of the ponded surface water in the area may be required during the 1 May to 15 September period during which construction activities along the approved alignment within the vicinity of the flying fox camp would be undertaken. Any short term modifications to the level of the ponded surface water in the area would be undertaken to facilitate construction of this section of the Project within the available 1 May to 15 September period. Any short term modifications to the level of the ponded surface water in the area would be implemented for the minimum time required to facilitate construction of this section of the Project.

Monitoring within, upstream of and downstream of the construction corridor would be carried out to identify any changes to water levels.

5.3.10 Management of construction impacts to water quality

The Project has the potential to change the ground water and surface water hydrological functioning of the surrounding habitat due to dewatering of the swamp during construction, increased runoff containing pollutants and fine sediment and weed invasion. These changes may have impacts on the suitability of the habitat as a foraging site and the suitability of remaining vegetation as roosting habitat for flying-foxes.

Rainfall in the area would be monitored in association with drainage performance to identify if the hydrology and water quality has been adversely impacted by the Project. Procedures, including erosion and sediment control measures included in the approved CEMP, would be implemented to maintain water quality during construction. These measures would be important in maintaining the current condition of flying-fox habitat retained within and adjacent to the Project and include:

- Controlled access to watercourses by construction workers and vehicles.
- Storage of chemicals, fuel and lubricants in suitably located and bunded areas to minimise the impact of any spillage or contamination on the Construction Site and adjoining areas. No location of these storage areas within 50 metres of any aquatic habitat, flood prone areas, or on slopes steeper than 1:10.
- No refuelling or maintenance of plant and equipment, mixing cutting oil with bitumen, or carrying out any other activity which may result in spillage of a chemical, fuel or lubricant at any location which drains directly to a waterway or environmentally sensitive areas, without the appropriate temporary bunding being provided. No unattended refuelling operations.
- Specific measures for construction and operational phase water quality management, including pollution and discharge controls, construction and operational phase water quality basins and swales.

5.3.11 Management of construction vehicles

All construction vehicles would be required to comply with the speed limits set out in the CEMP and to remain out of exclusion areas. Low noise reversing beepers (quakers) on vehicles will be used on vehicles.

5.3.12 Strategies for minimising flying-fox vehicle strike during take-off from roosting/foraging

Construction within 300 metres of the flying-fox roost will be restricted to the period 1 May to 15 September when the camp is vacated or at its lowest occupancy. These periods would be further informed by future survey information. Construction activities within 300 metres of the perimeter of the camp may be undertaken after 15 September each year if monitoring demonstrates that no GHFF are present.

To minimise the risk of flying-fox vehicle strike during take-off from roosting/foraging, road corridor revegetation and ornamental planting is not to include plants that flower prolifically and produce nectar food sources likely to attract flying-foxes.

5.3.13 Procedures for human interaction with flying foxes and management of occupational health and safety risks

A procedure for the management of human interaction with flying-foxes would be included in a communication and media strategy which would be prepared prior to the commencement of construction. The strategy would include, but not be limited to:

- A mechanism for people to make reports of new GHFF camps or increases in numbers.
- A series of press releases, targeted communications and/or media releases for potentially impacted communities, particularly for residents/receivers adjacent to existing camp sites.
- A mechanism for dispute resolution.

The strategy will be included in the Community Communication Strategy required under MCoA B28 which would be prepared by Roads and Maritime in consultation with EPA.

5.3.14 Procedures for managing the loss of roosting and foraging habitat

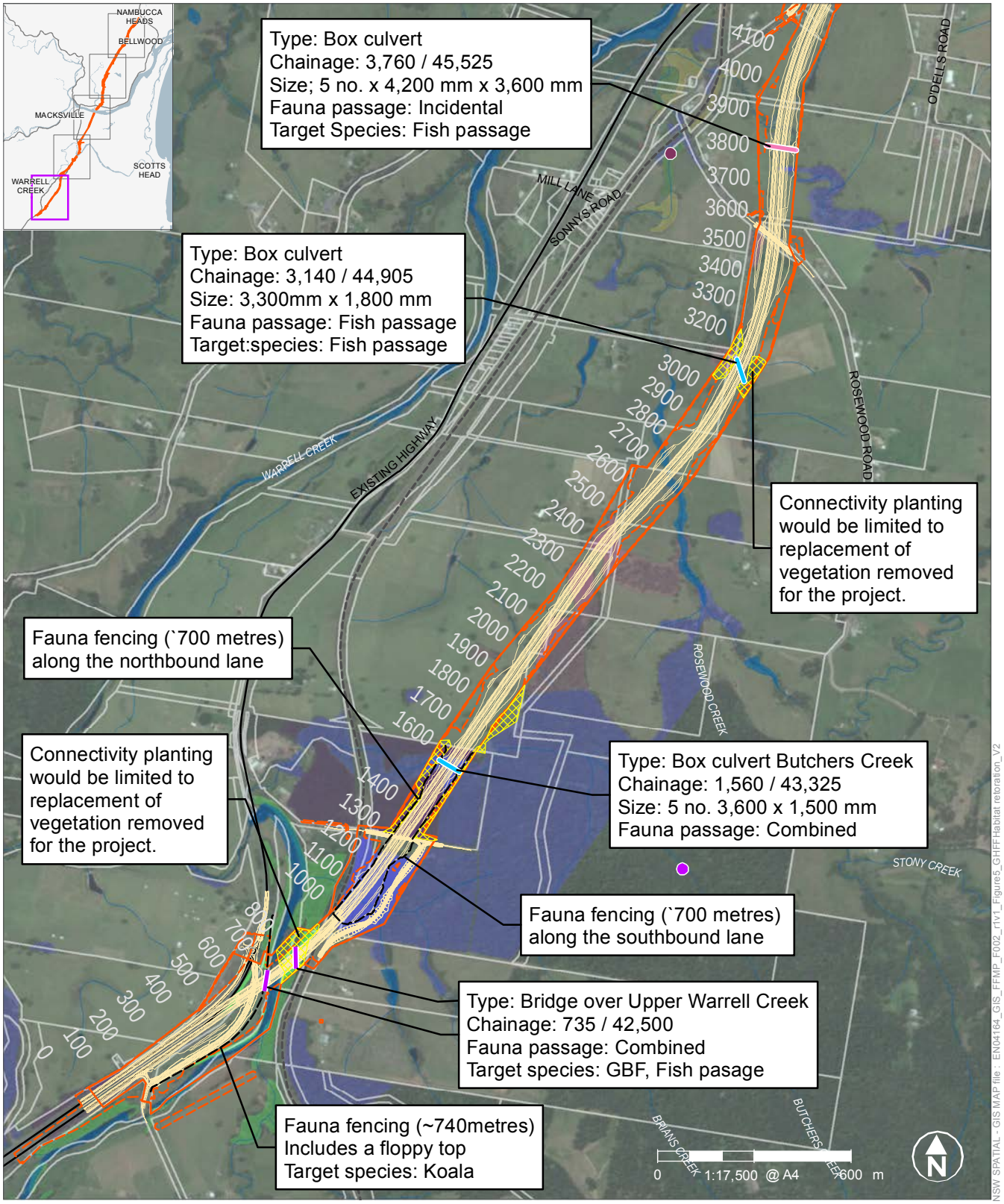
Habitat restoration would occur in areas of flying-fox habitat identified along the edges of the highway alignment that have been directly or indirectly impacted as part of the Project and would include temporary ancillary facilities, access tracks, watercourse crossings, etc (refer to the maps series included as **Figure 5-2**). These areas would be actively rehabilitated, regenerated and/ or revegetated to promote biodiversity outcomes and visual integration. Key rehabilitation measures would include:

- Progressive revegetation/rehabilitation during the construction phase using collected topsoil and seed at specific sites and to develop different successional stages of rehabilitation.
- Planting and seeding of preferred food trees for the GHFF which includes winter-flowering trees to supplement seasonal foraging habitat (refer to **Appendix D**).
- Monitoring revegetation/rehabilitation areas to ensure the establishment/restoration of seedlings and plants.
- Management and control of noxious and environmental weeds.

These measures would be implemented as part of the CEMP for the Project.

Roads and Maritime is developing a biodiversity offset package in accordance with the EPBC Act offsets policy for the residual impacts to the GHFF habitat. For the GHFF, the proposed offsets allow for impacts on both foraging and roosting habitat. As a precautionary approach, the proposed offsets assume that all of the 23.5 hectare patch of Swamp Sclerophyll Forest within which the camp site is located could be used for roosting during peak periods and that the Project could have direct or indirect impacts on entire patch of forest.

As part of the offset package, Roads and Maritime would also provide funding to enable the implementation of the *Bowraville flying-fox camp Plan of Management* adopted by Nambucca Heads Shire Council following consultation with the affected community. Roads and Maritime funding would be up to the lesser of $100,000 or 50 per cent of the cost of implementing the Management Plan.



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Legend

- Proposed areas of connectivity and habitat restoration
- Road boundary
- Road design
- Service Road - Old Coast Road
- Clearing boundary
- State Forest boundary
- Lot (survey)
- Combined culvert with fauna underpass
- Dedicated fauna underpass
- Fauna fence
- Bridge with fauna passage
- Incidental fauna passage

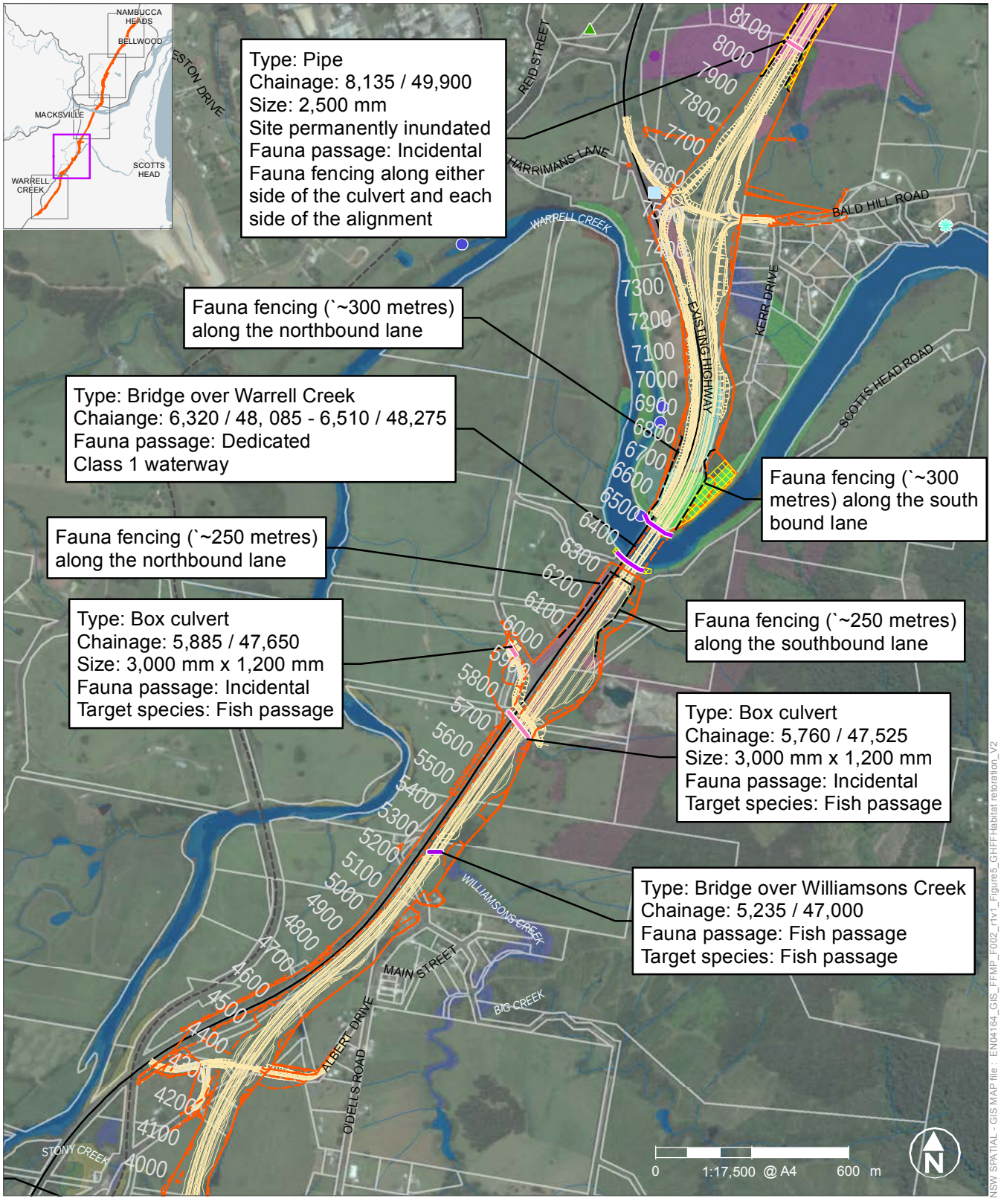
Vegetation map units (WC2U EA, RTA

- Map Unit 1: Open Forest - Blackbutt
- Map Unit 2: Mixed Floodplain Forest (Subtropical Coastal Floodplain Forest (EEC – TSC Act)
- Map Unit 3: Moist Open Forest - White Mahogany/Grey Gum/Ironbark
- Map Unit 4: Moist Open Forest - Flooded Gum
- Map Unit 5: Lowland Rainforest (EEC – EPBC Act and the TSC Act)
- Map Unit 6: Swamp Forest - Swamp Mahogany/Paperbark (Swamp Sclerophyll Forest (EEC – TSC Act)
- Map Unit 7: Swamp Forest - Swamp Oak (Swamp Oak Floodplain Forest (EEC – TSC Act)
- Map Unit 8: Freshwater Wetlands (TEC – TSC Act)
- Map Unit 9: Mangrove Forest
- Map Unit 10: Coastal Saltmarsh (VEC – EPBC Act and TSC Act)
- Map Unit 11: Open Forest - Scribbly Gum
- Map Unit 12: Hardwood plantation
- Map Unit 13: Softwood plantation

NOTES

- The chainages in this figure reflect the WC2U EA chainages. To convert these to the referral chainages add 41765.
- The locations of the fauna crossings and fauna fences are indicative only.

DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
This mapping is current as at December 2013 and could be refined with updated survey information



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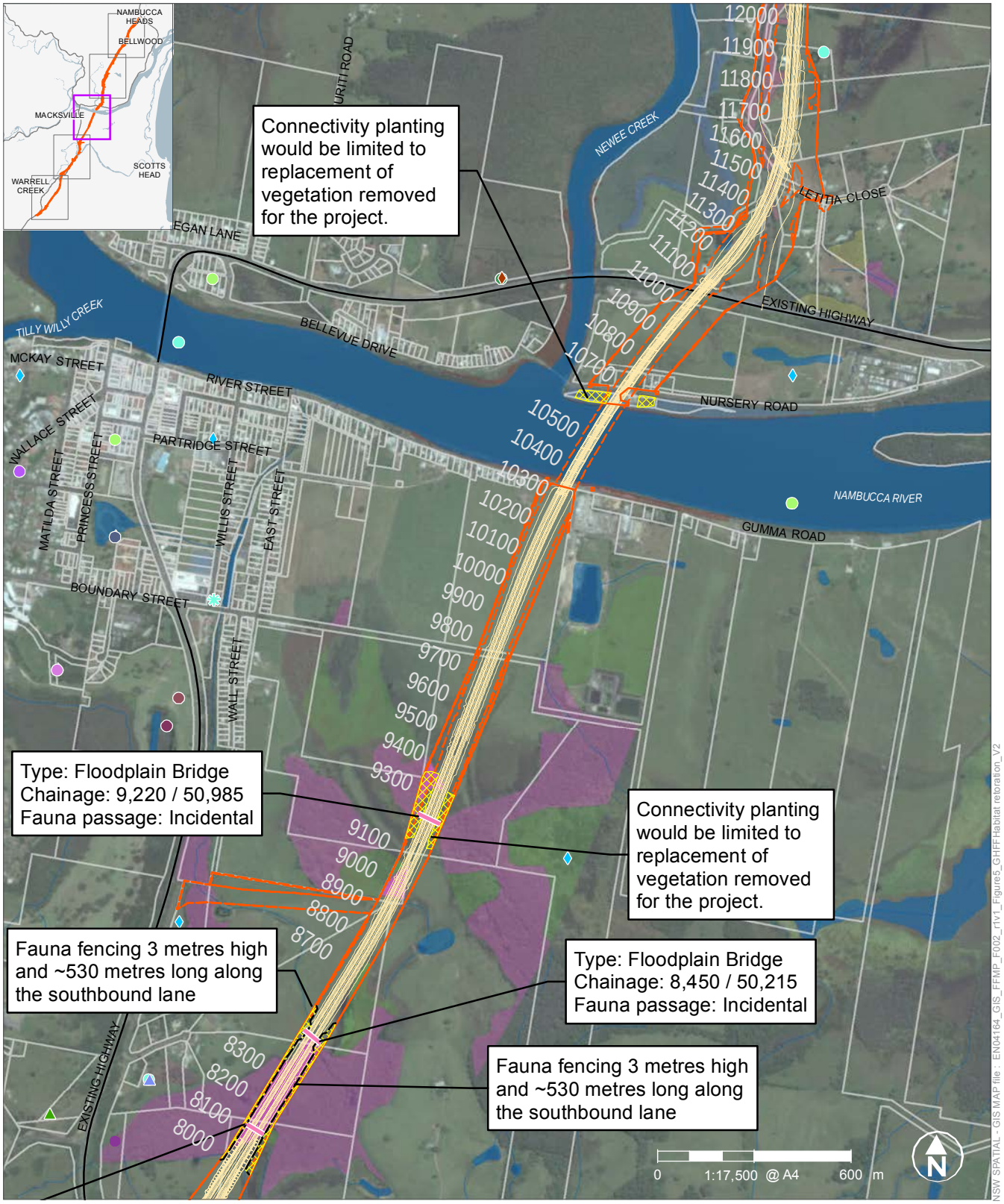
This mapping is current as at December 2013 and could be refined with updated survey information

Figure 5-3 | Fauna connectivity and habitat restoration



Legend

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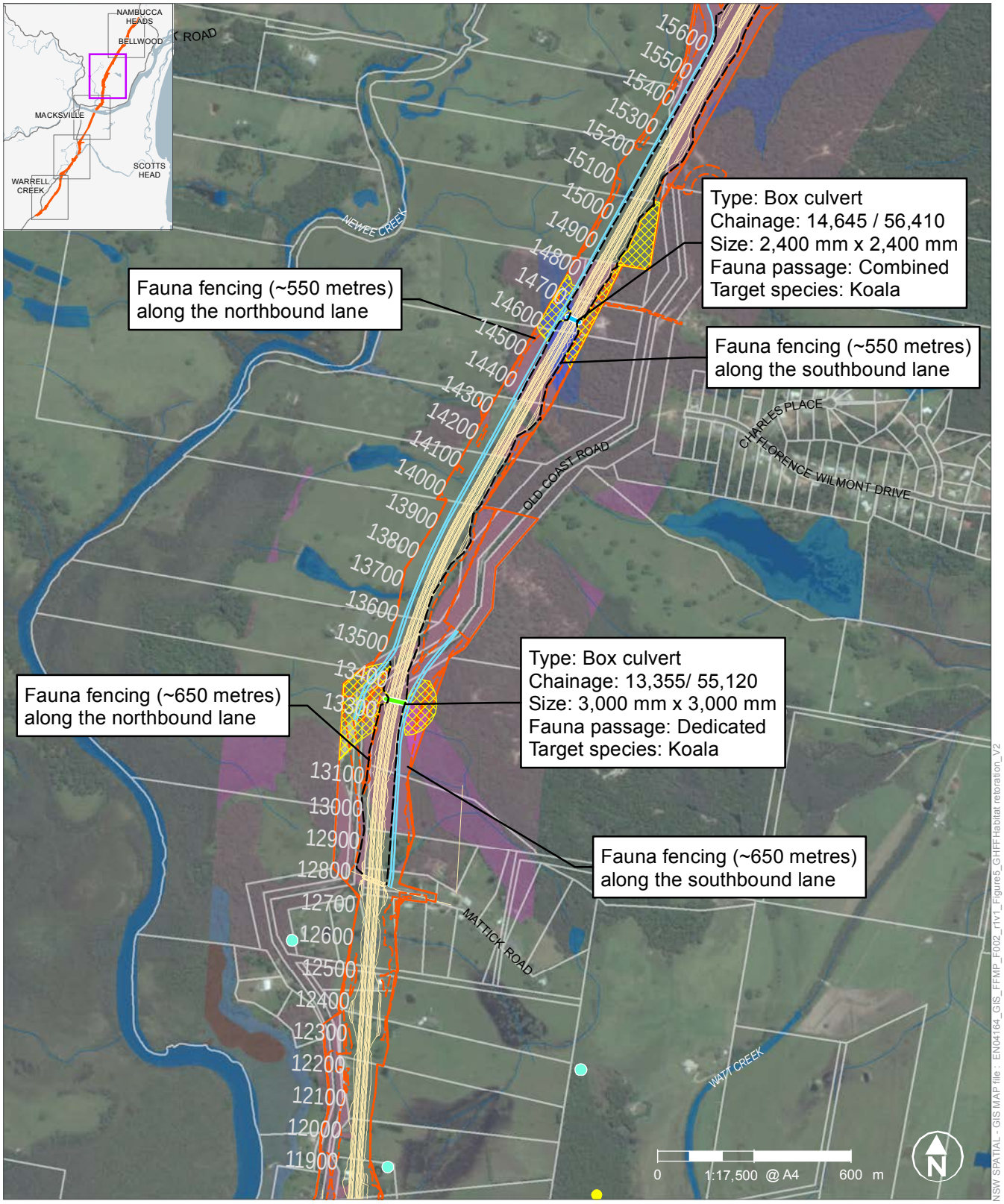
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
This mapping is current as at December 2013 and could be refined with updated survey information



Legend

- Proposed areas of connectivity and habitat restoration
- Road boundary
- Road design
- Service Road - Old Coast Road
- Clearing boundary
- State Forest boundary
- Lot (survey)
- Combined culvert with fauna underpass
- Dedicated fauna underpass
- Fauna fence
- Bridge with fauna passage
- Incidental fauna passage

Vegetation map units (WC2U EA, RTA

- Map Unit 1: Open Forest - Blackbutt
- Map Unit 2: Mixed Floodplain Forest (Subtropical Coastal Floodplain Forest (EEC – TSC Act)
- Map Unit 3: Moist Open Forest - White Mahogany/Grey Gum/Ironbark
- Map Unit 4: Moist Open Forest - Flooded Gum
- Map Unit 5: Lowland Rainforest (EEC – EPBC Act and the TSC Act)
- Map Unit 6: Swamp Forest - Swamp Mahogany/Paperbark (Swamp Sclerophyll Forest (EEC – TSC Act)
- Map Unit 7: Swamp Forest - Swamp Oak (Swamp Oak Floodplain Forest (EEC – TSC Act)
- Map Unit 8: Freshwater Wetlands (TEC – TSC Act)
- Map Unit 9: Mangrove Forest
- Map Unit 10: Coastal Saltmarsh (VEC – EPBC Act and TSC Act)
- Map Unit 11: Open Forest - Scribbly Gum
- Map Unit 12: Hardwood plantation
- Map Unit 13: Softwood plantation

NOTES

- The chainages in this figure reflect the WC2U EA chainages. To convert these to the referral chainages add 41765.
- The locations of the fauna crossings and fauna fences are indicative only.

DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
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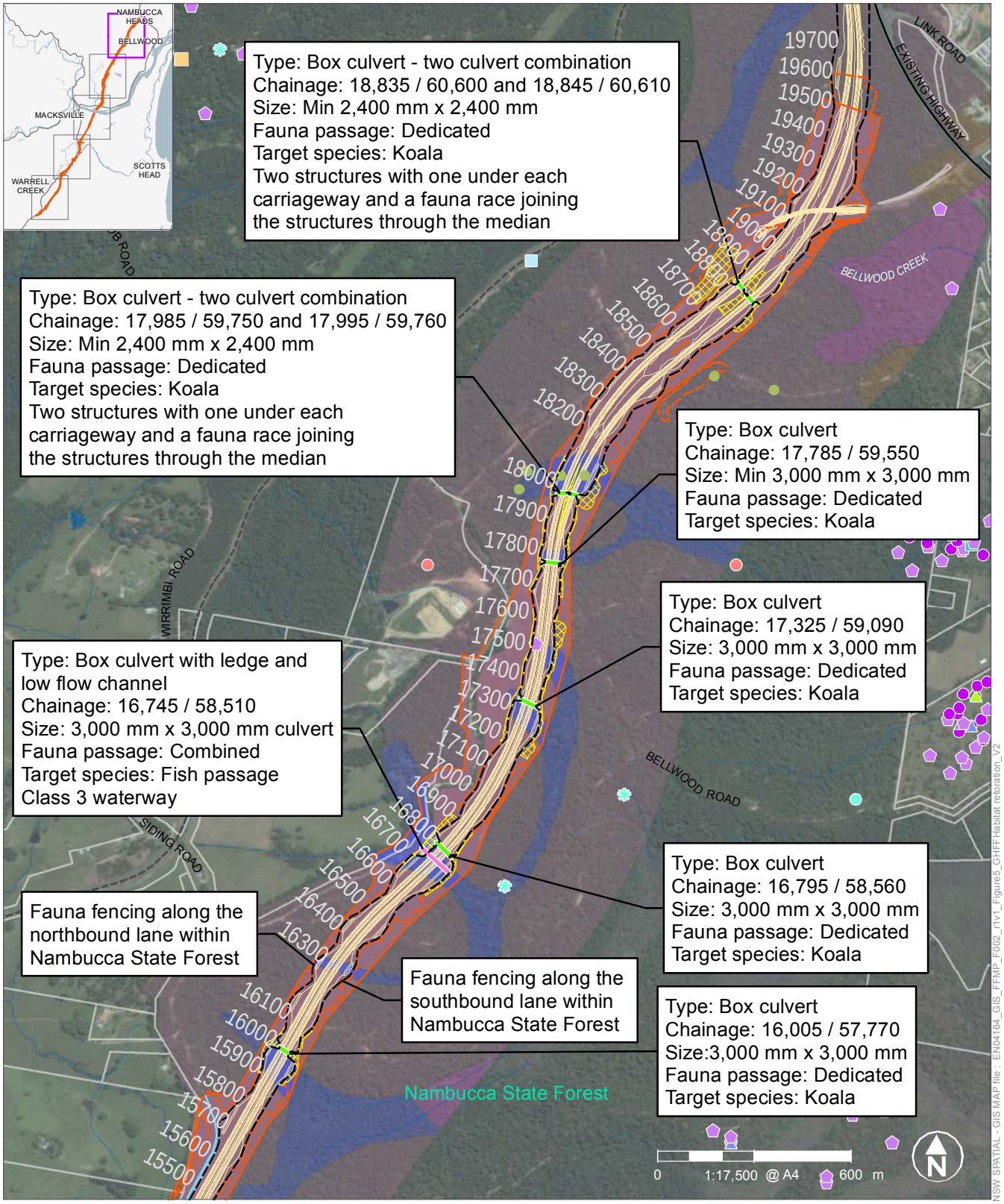

Legend

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NOTES

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- The locations of the fauna crossings and fauna fences are indicative only.

DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
This mapping is current as at December 2013 and could be refined with updated survey information

5.4 Performance thresholds and corrective actions

Table 5-1 presents the main goals of management for construction activities as described in **Section 5.2** and includes a summary of the relevant mitigation measures for flying-foxes that are to be completed during construction. The table also describes how the identified mitigation measures are to be monitored, the timing and frequency of monitoring, who is responsible for implementing the measures, the performance thresholds that each goal is measured against and the corrective actions if deviation from the performance criteria occurs. A full description of the construction management mitigation measures is included in **Section 5.3**.

Table 5-2 Summary of construction management goals, mitigation measures, performance thresholds and corrective actions

Main goals	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
• No injuries or mortality of flying-foxes as a result of vegetation clearance or construction of the Project.	• Pre-clearing and clearing surveys of all vegetation within the clearing footprint conducted as per protocol. • Implement contingency plan for moving flying-fox out of the clearing corridor during vegetation clearing/construction, refer to **Appendix C**. • To minimise the risk of flying-fox vehicle strike during take-off from roosting/foraging, road corridor revegetation and ornamental planting is not to include plants that flower prolifically and produce nectar food sources likely to attract flying-foxes.	• Ecologist on site during all vegetation removal. • Ecologist, experienced with flying-foxes, on site during removal of vegetation in the vicinity of the flying-fox camp. • Daily fauna incident log to be maintained. • Identify if flying-foxes are killed by vehicle strike within the Project boundaries during Roads and Maritime Services routine road inspections.	• D& C contractor • D&C contractor • D&C contractor • Roads and Maritime	• A single flying-fox injured or killed during vegetation clearance. • Zero rate of flying-fox vehicle strikes.	• Stop clearing works within or adjacent to areas of flying-fox habitat immediately. • Delay vegetation clearing until survey by a qualified ecologist has been undertaken to identify where flying-fox are located. • Implement contingency plan for moving flying-fox out of the clearing corridor during vegetation clearing / construction, refer to **Appendix C**. • Review road corridor revegetation adjoining the locations of recorded flying-fox road kills.
• Minimise removal of roosting and foraging habitat outside the boundaries of the Project or within identified exclusion zones.	• Exclusion zones fenced off and/or clearly marked. • Fencing and marking monitored with breaches repaired.	• Audit fencing and marking integrity prior to commencement of and monthly during construction.	• D&C contractor • D&C contractor	• Breach in exclusion zone/fencing by construction vehicle or unauthorised construction activities.	• Stop construction in the area of the breach until exclusion fencing and/or marking has been repaired. Investigate why breach occurred and implement corrective

Main goals	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
					actions as required to prevent reoccurrence. • Supplementary revegetation of disturbed habitat and monitor recovery for period of 12 months.
• Minimise removal to threatened flying-fox habitat outside designated ancillary facility areas.	• Installation of temporary exclusion fencing around ancillary facilities.	• Audit fencing integrity prior to commencement of construction. • Monthly monitoring of exclusion fences and protection zones as part of the FFMP.	• D&C contractor • D&C contractor	• Breach in exclusion zone/fencing by construction vehicle or unauthorised construction activities.	• Stop construction in the area of the breach until exclusion fencing has been repaired. Investigate why breach occurred and implement corrective actions as required to prevent reoccurrence. • Supplementary revegetation of disturbed habitat and monitor recovery for period of 12 months.
• Minimise disturbance to the flying-fox camp from vegetation removal, surface water drawdown, noise, vibration and lighting.	• Pre-clearing and clearing surveys of all vegetation within the clearing footprint conducted as per protocol. • Impacts to the flying-fox camp from construction noise, vibration and light would be managed through maintaining exclusion zone buffers	• Ecologist on site during all vegetation removal. • Ecologist, experienced with flying-foxes, on site during removal of vegetation in the vicinity of the flying-fox camp. • Daily fauna incident log to be maintained. • Regular fortnightly	• D&C contractor • D&C contractor • D&C contractor • D&C contractor	• Breach in exclusion zone/fencing by construction vehicle or unauthorised construction activities. • During flying-fox monitoring (including that undertaken during clearing activities) more than 1 dead Grey-headed Flying-fox/foetus or more	• Stop clearing works within or adjacent to areas of flying-fox habitat immediately. • Immediately stop the low noise or low disturbance construction activities (incl. haulage of materials) and organise a qualified ecologist to evaluate the flying-foxes

Main goals	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
	and fencing. • Only low noise / low disturbance construction activities to occur within the exclusion zone buffer during mid-September to the following April. • Inclusion of cross drainage and the provision of a permeable, free draining rock platform in the vicinity of the camp. • Implement contingency plan for moving flying-fox out of the clearing corridor and 100 metre buffer during vegetation clearing/ construction, refer to **Appendix C**.	monitoring of the flying-fox camp to start on 1 August and extend until monitoring confirms the camp has been vacated. • Monitoring within, upstream of and downstream of the construction corridor would be carried out to identify any changes to water levels.		than 1 injured Grey-headed Flying-fox is found. • Greater than 10 % change from the baseline in surface water levels in the section of swamp sclerophyll forest where the flying-fox camp is located during construction activities. • Presence of heavily pregnant females or dependent young after 1 August.	condition prior to works restarting. Ecologist to monitor flying-fox behaviour when works restart. • Immediately stop works to the swamp and organise a qualified geotechnical company to evaluate impacts to the surface water levels prior to works restarting. • Clearing of vegetation to halt if there are heavily pregnant GHFF or female GHFF with dependant young present noting that an ecologist, experienced with flying-foxes would be on site during removal of vegetation in the vicinity of the flying-fox camp. • Other construction activities to halt if there are heavily pregnant GHFF or female GHFF with dependant young present after 31 August..
• Impacts to flying-foxes	• Implement exclusion zone	• Audit fencing and marking	• D&C contractor	• Breach in exclusion zone	• Stop construction in area

Main goals	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
during clearing managed in accordance to fauna handling protocol.	and fencing strategy. • Pre-clearing and clearing surveys conducted as per protocol outlined. • Implementation of flying-fox handling procedure.	integrity prior to commencement of construction. • Monthly monitoring of exclusion fence and protection zones. • Monthly fauna incident log to be maintained.	• D&C contractor • D&C contractor	by construction vehicle of personnel. • Flying-fox injured or killed during vegetation clearance.	and review the fencing, pre-clearing and clearing survey and flying-fox handling requirements.
• No contamination or isolation of water supplies.	• Implement water quality procedures from the CEMP.	• Monthly and event based monitoring of water quality controls • Weekly and event based inspection of erosion controls.	• D&C contractor	• A notable change in water quality as per CEMP requirements.	• Review CEMP water management procedures as necessary.
• Construction activities post clearing	• Monitor within the 300 m buffer extents only the cleared project boundary • If presence of flying-foxes identified limit construction activities to low noise activities include haulage only	• Daily pre-dawn inspections for the presence of Flying–foxes • Monthly monitoring and population studies	• D&C Contractor	• No Flying-fox present construction activity continues. • If flying-foxes present initiate haulage and low noise activities only. Commence noise monitoring	• undertake noise monitoring to verify that haulage activities generate noise less than that predicted for operation noise levels measurable noise level being 56.5 dB(A) LAeq. Over 1 hr period • If noise level greater than that predicted for operation stage, haulage activities to cease or be modified to generate noise less than that predicted for operational

Main goals	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
					noise levels.

6. Operational management measures

6.1 Summary of potential impacts during operation

- Noise, vibration and light impacts.
- Mortality due to vehicle strikes during take-off from roosting/foraging sites.
- Impacts to groundwater/ponded surface water levels within flying-fox habitat.

6.1.1 Negative public attitude, conflict with humans and health risks

It is likely that a proportion of flying-foxes that currently use the Macksville camp will relocate to one of the 20 camps present within a 50 kilometre radius of the Macksville camp (refer **Figure 2-1**). It is also possible that one or more new camp sites will establish (Roberts *et. al.,* 2011). The location of a new camp cannot be predicted and there is potential for new sites of conflict to be created. The increase in numbers at some of the camps located near developed areas has the potential to create conflict with humans.

6.2 Main goals for management

- No reduction of the quality of flying-fox habitats adjacent to the Project corridor due to the operation of the Project and to minimise the impact of edge effects.
- No reported mortality and/or injury from vehicle collisions.
- No contamination or isolation of water supplies.

6.3 Mitigation measures

6.3.1 Maintenance of habitat restoration and weeds

Inspection, monitoring and maintenance of revegetated areas of GHFF habitat within the Project would occur periodically during operation of the Project. These activities would be undertaken in all areas disturbed by the Project, including the disturbed section of Swamp Sclerophyll Forest south of Macksville occupied by the flying-fox camp. Details of maintenance activities including weed management would be incorporated into Roads and Maritime's existing environmental management systems in accordance with MCoA D1 under the NSW EP&A Act.

6.3.2 Management of operational noise, vibration and light impacts

Operational impacts associated with noise, vibration and light will include general traffic noise and lighting from vehicles. A low noise pavement will be provided from the bridge over Warrell Creek to the north of Macksville to manage road traffic noise levels for noise sensitive receivers in the township of Macksville and adjacent areas. The Macksville camp is located adjacent to this section of low noise pavement. Consequently, this section of low noise pavement will reduce road traffic noise levels in the vicinity of the camp.

Roadside lighting would be limited to lighting required for the interchange at Bald Hill Road south of the camp.

6.3.3 Management of operational impacts to groundwater/ponded surface water quality

Potential operational impacts to groundwater/ponded surface water are increased runoff containing pollutants and fine sediment and weed invasion. These potential changes may have impacts on the suitability of the habitat as a foraging site for flying-foxes.

Operational erosion and sedimentation control measures such as water quality basins and drainage swales would be utilised on the Project to minimise these impacts and maintain water quality during operation of the Project.

These measures would be important in maintaining the current condition of flying-fox habitat retained within and adjacent to the Project.

6.3.4 Management of operational impacts to groundwater/ponded surface water levels

It is acknowledged that the dynamics of the ground and ponded surface water in the area could indirectly impact on the camp and result in the potential abandonment of the camp. Management of this potential impact would include cross drainage and the provision of a permeable, free draining rock platform to ensure that the proposed activity does not result in long term changes to the natural surface water levels in the vicinity of the camp. It is noted that drought and rainfall may alter water levels and Roads and Maritime would have no influence on changes on these variables, nor any freehold works outside the corridor.

6.3.5 Strategies for minimising flying-fox vehicle strike during take-off from roosting/foraging

To minimise the risk of flying-fox vehicle strike during take-off from roosting/foraging, road corridor revegetation and ornamental planting is not to include plants that flower prolifically and produce nectar food sources likely to attract flying-foxes. Fauna fencing would also be provided along the boundaries of the patch of Swamp Sclerophyll Forest where the Macksville camp is located and includes around 530 metres of fencing along the northbound and southbound carriageways. Fencing would be three metres high in this area to prevent animals striking trucks on the highway when exiting or entering the Macksville camp.

6.3.6 Establishment of new flying-fox camps

There is potential for new flying-fox camps to become established in response to the reduction of roosting habitat at the Macksville camp due to the Project and disturbance of the camp due to the proximity of the new highway alignment. Subject to there being a demonstrable linkage between:

- The Project and the reduction in occupancy of the Macksville camp.
- The reduction in occupancy of the Macksville camp and the establishment of new GHFF camps.

Roads and Maritime would develop and implement a strategy for the management of new GHFF camps that may become established within 5 kilometres of the Macksville camp site. The strategy would be developed in consultation with EPA, DoE, the relevant local council and affected landholders. The strategy would include camps which become established within 12 months of the permanent opening of the full length of the Project to traffic. Roads and Maritime would provide the resources and funding required to implement the agreed reasonable and feasible mitigation measures identified in the strategy.

6.3.7 Strategies for monitoring any flying-fox dispersal (radio-tracking/satellite tracking)

The potential opportunities, benefits and impacts of radio-tracking/satellite tracking of flying-foxes roosting in the Macksville camp have been further investigated by Roads and Maritime Services. Advice from Dr Peggy Eby indicates that radio-tracking/satellite tracking flying-foxes would be of marginal value due to the following:

1) As outlined in **Section 4.4.1**, it is highly likely that all tagged animals would depart the Macksville camp prior to disturbance commencing at the site.

2) The highly variable nature of flying-fox movements would make it difficult to interpret the impact of the disturbance on subsequent migration and feeding patterns.

Based on this advice, opportunities for radio-tracking/satellite tracking of the Macksville camp flying-foxes during operation of the Project will not be pursued.

6.3.8 Management of negative public attitude, conflict with humans and health risks

A procedure for the management of negative public attitudes that may arise from conflict between local residents and flying-foxes would be included in a communications and media strategy. The strategy which would be prepared prior to the commencement of construction would include but not be limited to:

- A mechanism for people to make reports of new GHFF camps or increases in numbers.
- A series of press releases, targeted communication/media for potentially impacted community, particularly for residents/receivers adjacent to existing camp sites.
- A mechanism for dispute resolution.

The strategy will be included in the Community Communication Strategy required under MCoA B28 which would be prepared by Roads and Maritime in consultation with EPA.

6.4 Performance thresholds and corrective actions

Table 6-1 presents the main goals of management for operation activities as described in **Section 6.2** and includes a summary of the relevant mitigation measures for flying-foxes that are to be completed during operation of the Project. The table describes how the identified mitigation measures are to be monitored, the timing and frequency of monitoring, who is responsible for implementing the measures, the performance thresholds that each goal is measured against and the corrective actions if deviation from the performance criteria occurs. A full description of the operation management mitigation measures is included in **Section 6.3**.

Table 6-1 Summary of operation management goals, mitigation measures, performance thresholds and corrective actions

Main goal	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
• No reduction of the quality of flying-fox habitats adjacent to the Project corridor due to the operation of the Project and to minimise the impact of edge effects.	• Continuation of the systematic program of monthly monitoring introduced in winter 2013 (as discussed in **Section 2.2**). • Revegetation and maintenance activities as documented in **Section 5.3.14**.	• Continuation of the systematic program of monthly monitoring introduced in winter 2013 (as discussed in **Section 2.2**) for 12 months after the opening of the Project to traffic. • Quarterly monitoring of the quality of the habitat adjacent to the Project for up to one year after the opening of the Project to traffic unless otherwise agreed with P&I, EPA and DOE.	• Roads and Maritime • Roads and Maritime	• Deterioration in the quality of adjacent habitat vegetation as a result of the Project (as determined by qualified ecologist).	• Implementation of corrective actions agreed with EPA and DoE.
• No contamination or isolation of water supplies.	• Maintenance of operational phase water quality measures.	• Monitoring of water quality as per the Project Surface Water Quality Management Procedure, including in the flying fox swamp area.	• Roads and Maritime	• No notable change in water quality due to the Project taking into account the Surface Water Quality Management Procedure and other factors such as adjacent land use, drought and rainfall.	• Review maintenance arrangements for water quality management measures as necessary.

Main goal	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
• No reported mortality and/or injury from vehicle collisions.	• Maintenance of roadside foraging habitat to discourage roadside foraging. • Construction of fauna fencing along the boundaries of the patch of Swamp Sclerophyll Forest where the Macksville camp is located. Fencing would be three metres high in this area to prevent animals striking trucks on the highway when exiting or entering the Macksville camp.	• Regular maintenance of roadside foraging habitat to discourage roadside foraging. • Regular maintenance of fauna fencing. • Investigation in response to observations and reports of flying-fox kills (refer further to **Chapter 7**).	• Roads and Maritime. • Roads and Maritime. • Roads and Maritime.	• Zero flying-fox mortality within 300 metres of the camp footprint.	• Re-evaluate strategies if flying-foxes continue to collide with vehicles.
• No reported disturbance or mortality from noise generated during operation of the project	• Regular maintenance of road pavements to assure in good condition • Noise dampening technology for trucks to be widely promoted to the industry	• Monthly presence population monitoring to include noise monitoring and description of noise environment in report• • Operational noise monitoring to include trigger limits of 56.5dB(A) LAeq 1hr as measured100 m from the camp from 15September to the end of April the following year	• Roads and Maritime.	• No appreciable impact on flying fox camp from operational noise	• Explore alternative pavement treatments if noise generated during operation has been definitively ascertained to have an adverse impact

Note: Disturbance of the camp is further defined at Sec 3.1.3 of this plan.

7. Monitoring program

A systematic field program for monthly monitoring the Macksville flying-fox camp was initiated in the winter of 2013. The frequency of monitoring was increased to fortnightly monitoring in January 2014 (SKM data; GeoLINK 2013a-g and 2014a-t, refer **Section 6** and **Appendix B**). The objectives are to increase and improve the information available on the biology and ecology of the colony; to provide information pertinent to developing and refining options for mitigating the impacts of construction and operation of the Project; and to provide baseline data for assessing the impact of the Project. The monthly field monitoring program would continue through to 12 months after the opening of the Project to traffic. The fortnightly field monitoring program would continue through construction of the Project during the period when the flying-foxes are anticipated to be in the camp. The fortnightly field monitoring would commence on 1 August (before the flying-foxes are expected to be in camp) and extend until monitoring confirms the camp has been vacated. The monitoring program would be reviewed regularly and refined if considered appropriate.

7.1 Main goals of monitoring program

The main goals of the monitoring program are to assess the impacts of pre-construction, construction and operation activities from the Project on the Macksville flying-fox camp and provide data for any required refinements to mitigation measures.

7.2 Pre-construction monitoring

7.2.1 Aims of pre-construction monitoring

- To collect data on parameters suitable for assessing potential impacts of construction and operation of the Project on the Macksville flying-fox camp, particularly trends in:
  - Patterns of occupation (population size and the location of roosting animals).
  - Demographic composition (sex and age class).
  - Species composition (population size and roosting location).
  - Key behaviours (reproductive and territorial behaviours).
  - Habitat characteristics (tree species and height, depth of ground water).
- To use systematic, repeatable methods suitable for statistical analysis.
- To collect data from a control site to assist with interpreting results from the Macksville camp.
- Where possible, to employ sampling methods consistent with those used to monitor other flying-fox camps in order to create opportunities for comparisons to be drawn with other sites.
- To build a set of baseline data for use in assessing impact and developing and refining mitigation measures.

A system of monthly monitoring would be needed to provide adequate information given the rapid changes in these parameters which occur due to the irregular nature of the primary driver of roost occupation, eucalypt flowering.

7.2.2 Methods of pre-construction monitoring

Patterns of occupation

The boundary of the area occupied by flying-foxes would be mapped using point readings from hand-held GPS taken at regular intervals.

The size of the population would be estimated by ground assessment, where the numbers of individuals in each tree are estimated by direct observation; or by exit count, where observers estimate the numbers of animals exiting the roost at dusk. A categorical estimate of population size would be made at the time of most surveys with a more accurate assessment made at the time of predicted maximum population (January 2014).

At all but the January 2014 assessment, population size would be recorded in one of the following five categories:

- Nil
- <1,000
- 1,000 – <5,000
- 5,000 - <10,000
- 10,000 - <20,000
- >20,000

In January, population size would be estimated using exit counts conducted on two consecutive nights. Observers would be positioned to observe the exit paths being used at the time.

Species composition

Camps in the study area are primarily occupied by Grey-headed Flying-foxes. Small numbers of Black flying-foxes may also be present. The number of Black flying-foxes present in the Macksville roost would be estimated by ground assessment and their location mapped by GPS reading and the percentage of each species in the population would be estimated. This method would also be used to estimate numbers of Little Red Flying-foxes.

Demographic composition

Randomly located target trees would be identified for assessing population demographics. In each target tree the sex, age class and reproductive status of individuals roosting adjacent to each other would be recorded until at least 10 adult females were sampled.

Key behaviours

Repeat cross-sectional samples of key reproductive (mating, maternal etc) and territorial behaviours taken at target trees, standardised for sampling effort (time).

Habitat characteristics

The height and species of random samples of roost trees and trees located outside the roosting area would be recorded. Changes to the depth of ground water within the roosting area would also be monitored.

Control site

The monthly field survey protocol above would be repeated at a control site to assist with interpreting results collected at the Macksville flying-fox camp. Data collected at a nearby control site would assist in differentiating between environmental conditions that affect flying-fox populations throughout a broad area and site-specific effects. For example, reproductive output in flying-foxes is affected by short-term food shortages which uniformly influence closely-positioned roosts. It is important to be able to interpret levels of reproductive output at the Macksville camp in this broader context. The flying-fox camp at Bellingen Island has been identified as an appropriate control site. The camp site has been monitored on a monthly basis since October 2013.

Reporting

A report of results would be provided to Roads and Maritime on the completion of each field monitoring session.

7.3 Monitoring during construction

7.3.1 Aims of construction monitoring

- To assess the impacts of construction on the Macksville flying-fox camp.
- To refine mitigation measures, particularly the timing of changed activities and the boundary of buffer zone.

7.3.2 Monitoring 16 September to 30 April

Activities within the 300 metre buffer zone around the camp perimeter would be restricted to monitoring, maintenance and incidence response.

Monthly monitoring

The program of monthly field monitoring described in **Section 7.2** would continue through construction of the Project. Methods would be as per **Section 7.2**, and would include ongoing monthly field monitoring of the Bellingen Island control site and observational comments from the regional flying-fox camps at Gordon Park and Bowraville

As flying-foxes would be likely to change their roosting location within the 23.5 hectare remnant during construction, an exit flight would be observed on the evening prior to each monitoring session to confirm the presence of the colony.

Refinements to the monitoring program would include monitoring at any new or substantially increased camps within 5 kilometres of the Macksville camp site to determine impacts of the Project on behavioural patterns and the effectiveness of mitigation measures. The monitoring program would be refined in consultation with EPA and would include monitoring of breeding activities, pregnant females and dependant young.

Fortnightly monitoring

A program of fortnightly monitoring to supplement the monthly assessments would continue during pre-construction. The monitoring program would be reviewed regularly and refined if considered appropriate. A subset of methods employed in the monthly field monitoring would be used for the fortnightly monitoring. The boundary of the area occupied would be mapped, population size would be estimated, species composition would be assessed and general observations would be made of demographic composition and behaviours. Once the flying-foxes have returned to the camp monthly monitoring only will continue.

Additional measures

The monitoring program would be reviewed regularly and refined if considered appropriate.

7.3.3 Monitoring 1 May to 15 September

Survey work undertaken at the flying- fox camp has indicated that the camp would be empty or at its lowest occupancy between May and mid-September. Major construction activities within the 300 metres buffer zone around the camp (eg clearing, earthworks, bridgeworks and pavement construction) would be undertaken at this time. The location of the buffer zones may be modified based on monitoring results of the camp. The existing highway, the temporary construction connection between the existing highway and the alignment (if required) and the Bald Hill Road interchange / cutting would be excluded from the 300 metre construction buffer zone.

Monitoring presence / absence

During vegetation clearing activities in the remnant patch of swamp forest that contains the Macksville flying-fox camp, observation of a dusk exit flight and a dawn entry flight would be used to monitor presence / absence of

flying-foxes. Construction would halt if there are heavily pregnant GHFF or female GHFF with dependant young present after 31 August each year.

Monitoring during vegetation clearing

Pre-clearing and clearing procedures would be outlined in the Flora and Fauna Management Plan (FFMP), and would be undertaken in accordance with *Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* (RTA 2011). In summary, prior to the commencement of clearing operations, the Project ecologist would identify all areas that contain vegetation and habitat to be retained, including exclusion zones. Targeted surveys for flying-foxes would also be undertaken by an ecologist experienced with flying-foxes. An ecologist would be present during clearing activities in the vicinity of the roost. If, between 1 May and 15 September flying-fox are present in the clearing corridor the contingency strategy would be implemented, refer to **Appendix C**.

Vehicle strike monitoring

Incidental observations of flying-fox mortalities would be collected by the construction team during the construction phase. The GPS location of each specimen would be recorded and assessed in relation to its proximity to nearest vegetation.

7.4 Monitoring during operation

7.4.1 Monthly monitoring

A monthly field monitoring program would continue through to 12 months after the opening of the Project to traffic using methods set out in **Section 7.2**.

Flying-foxes would be likely to change their roosting location within the 23.5 hectare remnant. An exit flight would be observed on the evening prior to each monitoring session to confirm the presence of the colony.

7.4.2 Road mortality/vehicle strike monitoring

Road kill / vehicle strike monitoring will occur during operation of the Project. No pre-construction baseline monitoring will be implemented as the existing highway is currently a two lane highway that is located over 500 metres from the Macksville flying-fox camp. Once the Project is constructed it will be a four lane highway that will be running immediately adjacent and through the Macksville roost. As such any baseline data collected will not be comparable to data available during construction and operation of the Project.

Road kill monitoring program, would commence weekly for 12 weeks commencing the week of opening each stage to traffic. Surveys would be targeted 500 metres either side of the Macksville flying-fox camp (chainage 8,000 / 49,765). Excluding the season/s covered by the initial 12 week monitoring period (refer above), subsequent surveys will be conducted weekly during October (spring), January (summer), April (autumn) & July (winter) for up to five consecutive years post opening to traffic, or until mitigation measures have been demonstrated to be effective.

For each road kill observed, the following attributes will be recorded-

- Geographic Coordinates of any road kill.
- Whether fauna fencing was installed at/near the location.
- .
- Species of road kill. Where there is any doubt to the identification of the carcass, photographs shall be forwarded to a qualified ecologist for identification / confirmation of the species.

If the animal is identified as an EPBC Act threatened species, the following information will also be recorded-

- Sex and age class (juvenile or adult) where possible and safety limitations permit.
- Presence of pouch young (for marsupials) where possible and safety limitations permit.
- Presence of flightless young (for flying-foxes or other bats).
- Distance to a fauna connectivity structure.
- Distance to drop down structure.
- If fauna fencing was installed, is there any damage to the fence in the vicinity.
- Weather conditions at the time of the monitoring (from the Bureau of Meteorology) – including temperature, rainfall in the last 24 hours, moon phase.
- If the animal is identified as a flying-fox:
  - Distance to nearest camp,
  - Distance to nearest canopy vegetation,
  - Presence of flowering food trees in neighbouring median or roadside vegetation; plants identified to species and referenced with diet list.
- .

Basic reports of the data collected will be provided after each survey season. This will include graphs of the data and any previously collected data to provide simple visual comparisons of road kill. This will also include overall road kill counts as well as separate graphs for the target species (if deaths have occurred).

The annual report will be provided to DoEEand EPA within one month of completion of the fourth monitoring season. From then on it will be provided within one month of the same monitoring season in subsequent years until monitoring is completed.

Analysis of the data itself will be included in an annual monitoring report. This report will include a statistical analysis of all of the data collected to that time including graphical representations of the road kill that is recorded.

Where any annual report identifies a significant difference between the road kill numbers of the different treatments (transect types), DoEEand EPA shall be notified, and a meeting will be set to discuss such differences with the relevant agencies, Roads and Maritime the reporting ecologist.

Such a meeting would occur within one month of completion of the annual report, which should ensure sufficient time to consider/review the response to any recorded significant differences from the Project. Refer to **Appendix F** for the Warrell Creek to Nambucca Heads Upgrade Road Kill Monitoring Program.

7.4.3 Water quality

Water quality in adjacent drainage areas would be monitored as per the CEMP / water quality management plan.

7.5 Evaluation, Project review and reporting

Monthly reports would be prepared outlining the results of monitoring undertaken pertaining to the Project.

7.5.1 Responsibility

Suitably qualified specialists engaged by Roads and Maritime would be responsible for the evaluation of the monitoring information and reporting to Roads and Maritime.

7.5.2 Timing

A brief report of results would be provided to Roads and Maritime on the completion of each monthly or fortnightly field monitoring session.

An annual report would be prepared during construction and operation for distribution by Roads and Maritime to other relevant government agencies (P&I, EPA and DoE) in regards to monitoring of flying-foxes and outlining actions undertaking under the management plan.

7.6 Performance thresholds and corrective actions

Table 7-1 presents the performance thresholds for the monitoring program and the corrective actions if deviation from the performance criteria occurs. A full description of the mitigation measures to be implemented during the monitoring program is included in **Sections 7.1 to 7.4**.

Table 7-1 Summary of monitoring program performance thresholds and corrective actions

Main goal	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
• To assess the impacts of pre-construction, construction and operation activities from the Project on the Macksville flying-fox camp and provide data for any required refinements to mitigation measures.	• Continuation of the systematic program of monthly flying-fox monitoring introduced in Winter 2013 (as discussed in **Section 2.2**) during the pre-construction and construction stages of the Project. • During the pre-construction stage of the Project continuation of the fortnightly monitoring program introduced in January 2014. • During construction of the Project fortnightly monitoring would start 1 August and extend until clearing is complete. • Initiation of a quarterly monitoring program of the quality of the habitat adjacent to the Project for the first year after the opening of the Project to traffic unless otherwise agreed with P&I, EPA and DOE. • Implementation of a road kill monitoring program upon opening of each stage of the Project to traffic using the methodology outlined in **Section 7.4.2** and **Appendix F**). • Monitoring beyond the two year survey period to be undertaken	• Continuation of the systematic program of monthly monitoring introduced in Winter 2013 (as discussed in Section 2.2) for 12 months after the opening of the Project to traffic. • Continuation of the fortnightly monitoring program introduced in January 2014 during the pre-construction stage of the Project. • During construction of the Project fortnightly monitoring would start 1 August and extend until clearing is complete. • Quarterly monitoring of the quality of the habitat adjacent to the Project for up to one year after the opening of the Project to traffic unless otherwise agreed with P&I, EPA and DOE. • Road kill monitoring would commence upon opening of each stage of the Project to traffic. Excluding the season/s covered by the initial 12 week monitoring period, subsequent surveys will be conducted weekly during October (spring), January (summer), April (autumn) & July (winter) for up to five consecutive	• Roads and Maritime. • Roads and Maritime. • Roads and Maritime. • Roads and Maritime. • Roads and Maritime.	• Significant reduction in reproductive output (measured as mean percentage of females with young in target trees) relative to control site. • Zero flying-fox mortality within 300 metres of the camp footprint. • Should the annual road kill monitoring reports identify a significant difference between the road kill numbers of the different treatments (fenced or unfenced sections).	• Based on a comparison with control sites, investigate possible causes of reduced reproduction, including impacts from the Project and the potential for natural variation in consultation with EPA. • Should investigations indicate that the Project is likely to be a cause of reduced reproduction, review opportunities to undertake onsite corrective actions in consultation with EPA. • Re-evaluate strategies if flying-foxes continue to collide with vehicles. • Where any annual report identifies a significant difference between the road kill numbers of the different treatments (fenced or unfenced sections), DoEEand EPA shall be notified, and a meeting will be set to discuss such differences with the relevant agencies, Roads and Maritime & the reporting ecologist. • Such a meeting would occur within one month of completion

Main goal	Mitigation / control measure	Monitoring/timing frequency	Responsibility	Performance thresholds	Corrective actions if deviation from performance criteria
	as part of the Roads and Maritime Asset Division regular inspection program assessing the operation of the highway.	years post opening to traffic, or until mitigation measures have been demonstrated to be effective.			of the annual report, which should ensure sufficient time to consider/review the response to any recorded significant differences from the Project. Refer further to **Appendix F**.
• To assess the clearing activities from the Project on the Macksville flying-fox camp and assess the implementation of the contingency strategy for moving flying-foxes out of the highway corridor during clearing activities between the period 1 May – 15 September	• During removal of vegetation in the vicinity of the flying-fox camp an ecologist, experienced with flying-foxes would be on site and implement the pre-clearing and clearing procedures outlined in Sections 4 and 5 of this Management Plan and if monitoring identifies flying-fox are present the contingency strategy included as **Appendix C** would be implemented.	• During all times that clearing activities occur within the Swamp Sclerophyll Forest where the Macksville Flying-fox camp is located.	• D&C contractor	• More than 1 dead/foetus or more than 1 injured Grey-headed Flying-fox is found which, in the opinion of the ecologist experienced with flying-foxes, are likely to have been killed or injured by the disturbance activities.	• All physical disturbance activities to the Swamp Sclerophyll Forest will cease immediately. • Disturbance activities will be reviewed by the ecologist experienced with flying-foxes and, where considered appropriate, scaled back. • The flying-foxes would be monitored continuously during the clearing activities to ascertain whether or not the change in the disturbance regime has been successful. If mortality/injury of the animals remains above the performance thresholds then all physical disturbance activities will cease immediately, and further advice sought from OEH and flying-fox experts

8. References

Benwell 2013, *Warrell Creek to Urunga: Threatened Flora Management Plan*. Report prepared for Roads and Maritime Services by Dr Andrew Benwell.

Catterall, C.P., Lynch, R.J. and Jansen, A. 2007. Riparian wildlife and habitats. Pp141-158 in: Lovett, S. and Price, P. (eds.) *Principles for Riparian Lands Management.* Land and Water Australia, Canberra.

Department of Environment and Climate Change NSW (DECC) (2008) *BioBanking Assessment Methodology.*

Department of Environment and Climate Change (DECC), 2009, *Draft National Recovery Plan for Grey-headed Flying-foxes*. Report prepared by the Department of Environment and Climate Change.

Eby, P. 2012. *An Assessment of the Flying-fox Camp at Macksville*. Unpublished report to NSW Roads and Maritime Services.

Eby, P. 2013. A review of comparative assessment of alternative alignment options. Pacific Highway Upgrade, Warrell Creek to Nambucca Heads. Report to Sinclair Knight Merz.

Eby, P., Martin, J., van der Ree, R., Roberts, B., Divljan, A. and Perry-Jones, K. 2012. Famished – the responses of flying foxes to food shortages in south-east Australia. *The Australasian Bat Society Newsletter* 38: 32.

Fleming, T.H. and Eby, P. 2003. Ecology of bat migration. pp. 156–208 in *Ecology of Bats*. edited by T.H. Kunz and M.B. Fenton. University of Chicago Press, Chicago USA.

Garnett, S. Whybird, O. and Spencer, H. 1998. The conservation status of the Spectacled Flying Fox *Peteropus conspicillatus* in Australia. Australian Zoologist **31**(1) 38-54.

GeoLINK. 2012. *Draft flying-fox Plan of Management Grassy (Lions) Park, Bowraville.* http://www.nambucca.nsw.gov.au/cp_content/resources/DRAFT_Flying-fox_Plan_of_Management_amended_200312.pdf

GeoLINK 2013a, *Monthly Flying-fox Monitoring WC2NH July 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2013b, *Monthly Flying-fox Monitoring WC2NH August 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2013c, *Monthly Flying-fox Monitoring WC2NH September 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2013d, *Monthly Flying-fox Monitoring WC2NH October 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2013e, *Monthly Flying-fox Monitoring WC2NH November 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2013f, *Fortnightly Flying-fox Monitoring WC2NH December 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2013g, *Monthly Flying-fox Monitoring WC2NH December 2013*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014a, *Fortnightly Flying-fox Monitoring WC2NH January 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014b, *Monthly Flying-fox Monitoring WC2NH January 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014c, *Fortnightly Flying-fox Monitoring WC2NH February 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014d, *Monthly Flying-fox Monitoring WC2NH February 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014e, *Fortnightly Flying-fox Monitoring WC2NH March 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014f, *Monthly Flying-fox Monitoring WC2NH March 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014g, *Fortnightly Flying-fox Monitoring WC2NH April 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014h, *Monthly Flying-fox Monitoring WC2NH April 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014i, *Fortnightly Flying-fox Monitoring WC2NH May 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014j, *Monthly Flying-fox Monitoring WC2NH May 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014k, *Fortnightly Flying-fox Monitoring WC2NH June 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014l, *Monthly Flying-fox Monitoring WC2NH June 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014m, *Fortnightly Flying-fox Monitoring WC2NH July 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014n, *Monthly Flying-fox Monitoring WC2NH July 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014o, *Fortnightly Flying-fox Monitoring WC2NH August 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014p, *Monthly Flying-fox Monitoring WC2NH August 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014q, *Fortnightly Flying-fox Monitoring WC2NH September 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014r, *Monthly Flying-fox Monitoring WC2NH September 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014s, *Fortnightly Flying-fox Monitoring WC2NH October 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

GeoLINK 2014t, *Monthly Flying-fox Monitoring WC2NH October 2014*. Report prepared for Roads and Maritime Services by GeoLINK Environmental Management and Design.

Halpin,K., Young, P.L., Field, H. and Mackenzie, J.S. 1999. Newly discovered viruses of flying foxes, *Veterinary Microbiology*, **68**: *83-87*.

Luly JG, Blair D, Parsons JG, Fox SJ and Vanderwal JJ. 2010. *Last Glacial Maximum habitat change and its effects on the grey-headed flying fox (Pteropus poliocephalus Temminck 1825).* In: Altered Ecologies: Fire, Climate and Human Influence on Terrestrial Landscapes. Terra Australis, 32. ANU E Press, Canberra, ACT, Australia, pp. 83-100

NSW Department of Environment and Heritage 2013. Flying-foxes. http://www.environment.nsw.gov.au/animals/flyingfoxes.htmhttp://www.environment.nsw.gov.au/animals/flyingfoxes.htmhttp://www.environment.nsw.gov.au/animals/flyingfoxes.htmhttp://www.environment.nsw.gov.au/animals/flyingfoxes.htm Accessed 2013.

Office of Environment and Heritage NSW (OEH). 2011. *NSW Code of Practice for Injured, Sick and Flying-foxes.*

Office of Environment and Heritage (OEH). 2013. The NSW Wildlife Atlas database records.

Richards, G. 2004. An assessment of flying-fox issues in relation to the Kempsey-Eungai Pacific highway upgrade, NSW. Report to Parsons Brinkerhoff.

Roberts, B. 2005. Habitat characteristics of flying fox camps in south-east Queensland. BSc(Hons) Thesis, Griffith University, Brisbane.

Roberts, B.J. 2006. Management of Urban Flying-fox Camps: Issues of Relevance to Camps in the LowerClarence, NSW. Valley Watch Inc., Maclean.

Roads and Traffic Authority (RTA), 2010, *Warrell Creek to Urunga Upgrading the Pacific Highway. Environmental Assessment* (WC2U EA), Report prepared by Sinclair Knight Merz for the Roads and Traffic Authority January 2010.

Roberts, B. J., Eby, P., Catterall, C. P., Kanowski, J. and Bennett, G. 2011. The outcomes and costs of relocating flying-fox camps: insights from the case of Maclean, Australia. The Biology and Conservation of Australasian Bats (eds B. Law, P. Eby, D. Lunney and L. Lumsden), pp. 277–287. Royal Zoological Society of NSW, Mosman.

Roberts, B.J., Catterall, C. P., Eby, P. and Kanowski, J. 2012. Long-distance and frequent movements of the fruit-bat *Pteropus poliocephalus* and their implications for management. PLoSONE.

Roads and Traffic Authority. 2011. *Biodiversity Guidelines – Protecting and managing biodiversity on RTA Projects,* Roads and Traffic Authority of New South Wales.

SEQ Catchments. 2012. The *Management and Restoration of flying-fox Camps: Guidelines and Recommendations.* Coordinated by SEQ Catchments Ltd and funded by the Australian Government's Caring for Our Country.

Snoyman, S. and Brown, C. 2010. Microclimate preferences of the grey-headed flying fox (*Pteropus poliocephalus*) in the Sydney region. *Australian Journal of Zoology* 58: 376–383.

Tidemann, C.R. 1999. Biology and management of the Grey-headed Flying-fox, *Pteropus poliocephalus*. *Acta Chiropterologica* 1: 151–164.

van der Ree, R. 1999. Barbed Wire Fencing as a Hazard for Wildlife. Research report for The Victorian Naturalist. **116:***210-217.*

Appendix A. Summary table and implementation schedule of the management plan

Table A-1 provides an overall example summary of the actions proposed in the above plan. It also identifies the person responsible for the actions and the estimated timing of the Project.

The program schedule would be updated following a review of the approval and Project timelines.

Table A-8-1 : Summary table and implementation schedule of management plan.

No.	Task	Responsibility	Pre-construction	Construction	Operational				
					Year 1	Year 2	Year 3	Year 4	Year 5
1. Pre-construction management									
1.1	Monthly surveys to establish baseline data about the location and condition of flying-fox habitat and populations.	Ecologist	X						
1.2	Identify exclusion zones and temporary fencing and/or marking to protect habitats in the pre-construction phase.	D&C Contractor	X						
1.3	Location of ancillary facilities outside 500m buffer zone Note: The location of the buffer zones may be modified based on monitoring results of the camp.	D&C Contractor							
2. Construction management									
2.1	Construction work method statements	D&C Contractor		X					
2.2	Construction induction and training	Roads and Maritime / D&C Contractor		X					
2.3	Pre-clearing and clearing surveys	Ecologist		X					
2.4	Fauna handling protocol	D&C Contractor		X					
2.5	Temporary exclusion zones	D&C Contractor		X					
2.6	Habitat revegetation	D&C Contractor		X					
2.7	Water quality and hydrology	D&C Contractor		X					

No.	Task	Responsibility	Pre-construction	Construction	Operational				
					Year 1	Year 2	Year 3	Year 4	Year 5
3. Operational management									
3.1	Maintenance of roadside vegetation	D&C Contractor (years 1, 2 & 3), Roads and Maritime (subsequent years)			X	X	X	X	X
3.2	Water monitoring	Roads and Maritime			X	X	X	X	X
4. Monitoring program									
4.1	Monthly flying-fox monitoring	Ecologist	X	X	X				
4.2	Fortnightly flying-fox monitoring Note: during clearing within the 300 meteres of the perimeter of the camp a program of fortnightly monitoring will be undertaken between 1 August and the end of April the following year. Clearing of vegetation within the buffer zone would halt if there are heavily pregnant GHFF or female GHFF with dependant young present. Construction activities within 300 metres of the perimeter of the camp may be undertaken before 1 May or after 15 September each year if monitoring demonstrates that no GHFF are present..	Ecologist	X	X					
4.3	Quarterly flying-fox monitoring (unless otherwise agreed with P&I, EPA and DOE).	Ecologist				X	X	X	X
4.4	Road mortality monitoring	Roads and Maritime		X	X	X	X	X	X
4.5	Evaluation and reporting	Ecologist	X	X	X	X	X	X	X

Appendix B. Summary of monitoring results - Macksville flying-fox colony

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
Nov - Dec 2011	Neighbours in Eby (2012)	Present, no estimate	No data	Yes	Presence of young determined by vocalisation	No data
Jan 2012	Neighbours in Eby (2012)	>10,000	No data	Yes		No data
Feb-Apr 2012	Neighbours, Nambucca Council in Eby (2012)	Present, no estimate	GHFF March 2012, balance Unknown	Unknown		No data
May	Eby (2012)	0				No data
June	Eby (2012)	2,000 - 5,000	GHFF (>80%); BFF	Not applicable		No data
Oct 2012 – May 2013	Royal Botanic Garden Trust (J. Martin unpublished data)	Present, no estimate	GHFF confirmed, (BFF unknown)	Unknown but presumed	Both male & female satellite-collared GHFF recorded at the site	No data
Apr 2013	SKM	10,000 - >20,000	GHFF; BFF	Yes		No data
Jul 2013	GeoLINK (2013 a)	0				No data
Aug 2013	GeoLINK (2013 b)	0				No data
Sep 2013	GeoLINK (2013 c)	>10,000	GHFF (95%), BFF (5%)	Not applicable	Survey conducted prior to birth period	Not surveyed
Oct 2013	GeoLINK (2013 d)	0 - 40	Unknown	Unknown	Evidence of use as stopover site	Nambucca >10,000 Bowraville 3,000 Bellingen >10,000
Nov 2013	GeoLINK (2013 e)	1,200	GHFF (80%) BFF (20%)	Yes		Nambucca >10,000 Bowraville 4,000 Bellingen >10,000
4 Dec 2013	GeoLINK (2013 f)	0 - 20	Unknown	Unknown	Evidence of use as stopover site	Nambucca >10,000 Bowraville >10,000 Bellingen >10,000
18 Dec 2013	GeoLINK (2013 g)	2,500	GHFF (90%) BFF (10%)	Yes		Not surveyed

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
9 Jan 2014	GeoLINK (2014a)	0 - 25	Unknown	Unknown	Evidence of use as stopover site	Not surveyed
27 January 2014	GeoLINK (2014b)	5,000 – 8,000	GHFF (90%) BFF (10%)	Yes	Due to the dispersed nature flying fox at the site at present, males were generally not in 'bachelor trees' and instead were widely spread and occupied individual mating territories. When females were present they occurred in isolated clumps within areas more broadly occupied by males	Gordon Park: >10,000 Bowraville: >10,000 Bellingen: >20,000
13 February 2014	GeoLINK (2014c)	Around 30,000	Unknown	Yes	The roost footprint at the site was also mapped as being relatively large, occupying 3.60 ha. The relatively large numbers of flying-fox currently occupying the site is likely to be in response to recent heavy flowering of Pink Bloodwood (*Corymbia intermedia*) in the region, and to a lesser degree flowering of Broad-leaved Paperbark (*Melaleuca quinquenervia*), which is just beginning.	Not surveyed
27 February 2014	GeoLINK (2014d)	Around 34,000	GHFF (95%) BFF (5%)	Female GHFF with young (partly dependent; i.e. beginning to show some independent behaviour). However, the majority of females did not have young	The roost footprint was smaller than that recorded in the last survey but more densely occupied. Little Red Flying-fox (LRFF) also present for the first time at Nambucca camp (not at other camps) and mating behaviours were evident. Numbers of flying-fox at Bowraville and Bellingen were reduced as was the roost footprints, and this reduction in numbers was particularly evident at the Bowraville camp. Nambucca camp population was still at same levels as previously recorded.	Gordon Park: >10,000. Bowraville: 5,000-10,000. Bellingen Island: >20,000 (however, a reduction in numbers compared with recent months).
12 March 2014	GeoLINK (2014e)	Between 40,000 to 50,000	GHFF (95%) BFF (5%	Observations indicate that last season's young flying fox are now independent of their mothers.	GHFF mating behaviours were observed. Key GHFF diet species (Eby and Law 2008) which are currently flowering in the region include Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Coastal Blackbutt (*Eucalyptus pilularis*) (foothills and ranges). Pink Bloodwood (*Corymbia intermedia*) has now completed its recent heavy flowering	Not surveyed
25 March 2014	GeoLINK (2014f)	Around 22,000	GHFF (75% - 90%) BFF and LRFF (between 25- 10%)	Female GHFF with young (partially dependent) were observed roosting at the site and other regional camps visited. However, at the site the vast majority of females did not have young.	The proportion of female GHFF at the site is substantially less than that recorded at Bellingen Island. This has been a consistent pattern over the 2013-2014 summer/ autumn period. Little Red Flying-fox were recorded at the site for the first time since the current round of monitoring began in July 2013. It is possible that these Little Red Flying-fox may have been present at the site since the population began to increase in February and remained undetected (due to their aggregating in discrete dense clusters). Mating behaviours were evident.	Gordon Park: >10,000. Bowraville: 5,000-10,000. Bellingen Island: >20,000.
10 April 2014	GeoLINK (2014g)	Around 25,000	GHFF (>90%)	A kinship between	Flying-fox numbers and the roost footprint were similar to that	Not surveyed

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
			BFF (5%) and LRFF (5%)	some female GHFF and young was still apparent.	recorded during the last monitoring event in late March. Mating behaviours were observed at the site and the regional camps. Numbers of flying-fox and the roost footprint at the site, Nambucca and Bellingen was similar to that recorded during the last monitoring event.	
28-29 April 2014	GeoLINK (2014h)	0	No flying-fox of any species were recorded at the site. Therefore, no detailed species composition data was collected for the site.	Not applicable for the Macksville site.	A small number (<300) of flying-foxes were observed flying-over the site, but are likely to have originated in other regional camps (e.g. Gordon Park) and are passing by the site and/ or foraging in flowering Swamp Mahogany present at the site. No flying-fox were recorded in the site traverse. Numbers of flying-fox and regional camps appear to be decreasing since a summer population peak (except for at Gordon Park). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox making up a relatively small proportion. Little Red Flying-fox have left the Gordon Park site. A small proportion (10-30%) of females had (semi) dependent young at the Bellingen Island comparison camp which has decreased from the proportion recorded in the previous monitoring event (no data collected at the site as no flying-fox were present). Mating behaviours were observed at occupied regional camps.	Gordon Park: 10,000 – 20,000. Bowraville: 0. Bellingen Island: 10,000.
14 May 2014	GeoLINK (2014i)	0	No flying-fox of any species were recorded at the site. Therefore, no detailed species composition data was collected for the site.	Not applicable for the Macksville site.	A small number (<100) of flying-foxes were observed flying-over the site, but are likely to have originated in other regional camps (e.g. Gordon Park) and are passing by the site and/ or foraging in flowering Swamp Mahogany present at the site. No flying-fox were recorded in the site traverse. Flying-fox numbers at regional camps have decreased since a summer population peak (except for at Gordon Park). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox making up a relatively small proportion (<10% at the Gordon Park camp). The key GHFF nectar source trees Swamp Mahogany and Broad-leaved Paperbark are flowering locally.	Gordon Park: 10,000 – 20,000. Bowraville: 0. Bellingen Island: <1,000.
28-29 May	GeoLINK (2014j)	0	No flying-fox of any species were recorded at the site. Therefore, no detailed species composition data was	Not applicable for the Macksville site.	No flying-foxes were counted exiting the site during this month's exit count. Also no flying-fox were recorded to be roosting at the site in the site traverse. A small numbers (<10) of flying-foxes were observed flying-over the site, but are likely to have originated in other regional camps (e.g. Gordon Park) and are passing by the site and/ or foraging in	Gordon Park: 10,000 – 20,000. Bowraville: 0 Bellingen Island: 0 (note: GHFF continue to roost at an alternative site in Bellingen near the showground behind Wheatley

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
			collected for the site.		flowering Swamp Mahogany present at the site. Flying-fox numbers at regional camps have decreased since a summer population peak (except for at Gordon Park). GHFF were observed to be roosting at an alternative site in Bellingen near the showground behind Wheatley Street and currently number in the thousands. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up a 10% of all individuals at the Gordon Park camp. Both male and female GHFF present. No dependent young were observed. The key GHFF nectar source trees Swamp Mahogany and Broad-leaved Paperbark are flowering locally, and along with flowering Coast Banksia are likely to be influencing which camps are currently occupied, and in what numbers, within the locality.	Street and currently number in the thousands).
10 – 11 June 2014	GeoLINK (2014k)	0	No flying-fox of any species were recorded at the site. Therefore, no detailed species composition data was collected for the site.	Not applicable for the Macksville site.	A small number (<100) of flying-foxes were observed flying-over the site, but are likely to have originated in other regional camps (e.g. Gordon Park) and are passing by the site and/ or foraging in flowering Swamp Mahogany present at the site. No flying-fox were recorded in the site traverse. Flying-fox numbers at regional camps have generally decreased since a summer population peak (except for at Gordon Park). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up a 10% of all individuals at the Gordon Park camp. The key GHFF nectar source trees Swamp Mahogany and Broad-leaved Paperbark are flowering locally, and along with flowering Coast Banksia are likely to be influencing which camps are currently occupied, and in what numbers, within the locality.	Gordon Park: 10,000 – 20,000. Bowraville: 0 Bellingen Island: 0 (note: GHFF continue to roost at an alternative site in Bellingen near the showground behind Wheatley Street and currently number in the thousands).
30 June 2014	GeoLINK (2014l)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse. Therefore, no detailed species composition data was collected for the site	Not applicable for the Macksville site.	Flying-fox numbers at the site and regional camps have generally decreased since a summer population peak, including an absence of flying-foxes at Bowraville and Bellingen Island (however, as has been recorded in previous monitoring events, GHFF continue to roost at a nearby alternative site in Bellingen behind Wheatley Street and currently number in the thousands). The exception to the general decrease in flying-fox numbers at the visited regional camps is Gordon Park (Nambucca Heads) where flying-fox numbers are still relatively high – estimated to be 10,000 – 20,000 individuals.	Gordon Park: 10,000 – 20,000. Bowraville: 0 Bellingen Island: 0 (note: GHFF continue to roost at an alternative site in Bellingen near the showground behind Wheatley Street and currently number in the thousands).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up a 10% of all individuals at the Gordon Park camp and 5% of all individuals at the Wheatley Street camp (Bellingen). Heavy flowering of Swamp Mahogany (a key GHFF nectar source tree) within the broader locality has now finished. Flowering in a number of other key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum and Broad-leaved Paperbark) also typically occurs at this time of the year (although no substantial flowering in the region of any of these species was observed in the current monitoring event).	
12-17 July 2014	GeoLINK (2014m)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	Flying-fox remain absent at Bowraville and Bellingen Island (however, as has been recorded in previous monitoring events, GHFF continue to roost at a nearby alternative site in Bellingen behind Wheatley Street and currently number in the thousands. However, numbers appear to have decreased recently). At Gordon Park (Nambucca Heads) flying-fox numbers are still relatively high – estimated to be 10,000 – 20,000 individuals. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up a 10% of all individuals at the Gordon Park camp and none of the individuals at the Wheatley Street camp (Bellingen). Heavy flowering of Swamp Mahogany (a key GHFF nectar source tree) within the broader locality has now finished. Flowering in a number of key GHFF nectar source species (Swamp Mahogany, Coastal Blackbutt, Forest Red Gum and Broad-leaved Paperbark) typically occurs at this time of the year (although no substantial flowering in the region of any of these species was observed in the current monitoring event). Flying-fox were observed to be regularly foraging in Coast Banksia (non key GHFF nectar source) at Nambucca Heads during the monitoring event.	Gordon Park: 10,000 – 20,000. Bowraville: 0 Bellingen Island: 0 (note: GHFF continue to roost at an alternative site in Bellingen near the showground behind Wheatley Street and currently number in the thousands).
30-31 July 2014	GeoLINK (2014n)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	As has been recorded since May, the number of flying-foxes at regional camps remains generally low, including an absence of flying-foxes at Bowraville and Bellingen Island (however, as has been recorded in previous monitoring events, GHFF continue to roost at a nearby alternative site in Bellingen behind Wheatley Street and currently number approximately 1,000). The exception to the general low number of flying-foxes recorded at the visited regional camps is Gordon Park (Nambucca Heads) where flying-fox numbers are still relatively	Gordon Park: 10,000 – 20,000. Bowraville: 0 Bellingen Island: 0 (note: GHFF continue to roost at an alternative site in Bellingen near the showground behind Wheatley Street and currently number approximately 1,000).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					high – estimated to be 10,000 – 20,000 individuals. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up approximately 10% of all individuals at the Gordon Park camp and 5% of all individuals at the Wheatley Street camp. Both female and male GHFF are present at the Wheatley Street camp and females outnumber males. No mating behaviour was recorded and no young flying-foxes are present. Flowering in a number of other key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum and Broad-leaved Paperbark) also typically occurs at this time of the year although no substantial flowering of any of these species was observed in the region during the current monitoring event.	
15-16 August 2014	GeoLINK (2014o)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	As has been recorded since May, the number of flying-foxes at regional camps remains generally low, including an absence of flying-foxes at Bowraville and <1,000 at Bellingen Island (re-occupied after intermittent absence over the last couple of months). Flying-foxes were absent from the nearby Wheatley Street camp in Bellingen. The exception to the general low number of flying-foxes recorded at the visited regional camps is Gordon Park (Nambucca Heads) where flying-fox numbers are still relatively high – estimated to be >10,000 individuals. GHFF dominated flying-fox numbers at occupied camps. Black Flying-fox constituted approximately 10% of all individuals at the Gordon Park camp. Flowering in a number of other key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum and Grey Ironbark) typically occurs at this time of the year although no substantial flowering of any of these species was observed in the region during the current monitoring event.	Gordon Park: >10,000. Bowraville: 0 Bellingen Island: < 1,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).
2-3 September 2014	GeoLINK (2014p)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	As has been recorded since May, the number of flying-foxes at regional camps remains generally low, including an absence of flying-foxes at Bowraville. Bellingen Island was occupied with a relatively low number of flying-foxes (estimated to be 3,000-5,000 individuals) and the Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high but less than has been recorded over recent months (estimated to be around 10,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with	Gordon Park (around 10,000) Bowraville: 0 Bellingen Island: (around 3,000 – 5,000)

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Black Flying-fox only making up approximately 10% of all individuals at the Gordon Park and Bellingen Island camps. Both female and male GHFF are present at the Bellingen Island camp and females outnumber males. No young flying-foxes are present. Flowering in a number of key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum and Grey Ironbark) typically occurs at this time of the year in the region, although only minor flowering of Forest Red Gum was observed in the region during the current monitoring event.	
15-17 September 2014	GeoLINK (2014q)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	As has been recorded since May, the number of flying-foxes at regional camps remains generally low, including an absence of flying-foxes at Bowraville. Bellingen Island was occupied with a relatively low number of flying-foxes (estimated to be 3,000-5,000) and the Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000 to 15,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up approximately 10% of all individuals at the Gordon Park and Bellingen Island camps. Flowering in a number of key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum and Grey Ironbark) typically occurs at this time of the year in the region, although only minor flowering of Forest Red Gum and light flowering of Grey Ironbark was observed in the region during the current monitoring event.	Gordon Park (between 10,000 to 15,000) Bowraville: 0 Bellingen Island: (around 3,000 – 5,000)
30 September – 1 October 2014	GeoLINK (2014r)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	As has been recorded since May, the number of flying-foxes at regional camps remains generally low, including an absence of flying-foxes at Bowraville. Bellingen Island was occupied with a relatively low number of flying-foxes (estimated to be 5,000) and the Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000 individuals) but have decreased since the last monitoring event. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up approximately 10% of all individuals at the Gordon Park and Bellingen Island camps. Flowering in a number of key GHFF nectar source species (Forest Red Gum and Grey Ironbark) typically occurs at this	Gordon Park (around 10,000) Bowraville: 0 Bellingen Island: (around 5,000)

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					time of the year in the region, although only minor flowering of Forest Red Gum and light flowering of Grey Ironbark was observed in the region during the current monitoring event. No young observed yet. Female GHFF outnumbered males at most demographic point count sites.	
14 October 2014	GeoLINK (2014s)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	Flying-fox were absent from Bowraville. Bellingen Island was occupied with a relatively low number of flying-foxes (estimated to be approximately 5,000) and the Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up <10% of all individuals at the Gordon Park and Bellingen Island camps. Dependent young GHFF were observed at Gordon Park and Bellingen Island for the first time this breeding season. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark and Silky Oak) typically occurs at this time of the year in the region. Observations locally included minor flowering of Forest Red Gum, moderate flowering of Grey Ironbark, and heavy flowering of Silky Oak (likely planted: outside of natural distribution).	Gordon Park (around 10,000) Bowraville: 0 Bellingen Island: (around 5,000)
29 - 30 October 2014	GeoLINK (2014t)	0	No flying-fox of any species were recorded at the site in the exit count or the site traverse.	Not applicable for the Macksville site.	Flying-fox have returned to the Bowraville camp in low numbers (between 1,000-5,000 individuals). The number of flying-foxes at Bellingen Island has increased slightly (estimated to be approximately 7,500-10,000 individuals) and the Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000-15,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up around 5-10% of all individuals at the Gordon Park and Bellingen Island camps. Dependent young GHFF were recorded with between 40% and 90% of female GHFF at Bellingen Island (an average of 75% of females had dependent young). Dependent young were also observed at Gordon Park. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark and Silky Oak) typically occurs at this time of the year in the region. Observations locally	Gordon Park (around 10,000 – 15,000) Bowraville: (around 1,000 to 1,500) Bellingen Island: (around 7,500 – 10,000)

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					included minor flowering of Grey Ironbark and heavy flowering of Silky Oak (likely planted: outside of natural distribution).	
12 November 2014	GeoLINK (2014u)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse. Flying-fox have returned to Bowraville, approximately 5,000 individuals. Bellingen Island was occupied with a relatively small number of 3,000-5,000 flying-foxes. This represents a decrease wince the last monthly monitoring event when it was estimated that approximately 7,500-10,000 flying-foxes were present. The Wheatley Street 'over-flow' camp nearby remains unoccupied.Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000-15,000 individuals).GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up <10% of all individuals at the Gordon Park and Bellingen Island camps. No Black flying foxes were observed at Bowraville. Dependent young GHFF were observed at Gordon Park, Bellingen Island and Bowraville. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark and Silky Oak) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps indicated that light flowering of Grey Ironbark (E. siderophloia) is currently occurring in the region.	Gordon Park: approx. 10,000. Bowraville: 5,000. Bellingen Island: approx. 5,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).
20 November 2014	GeoLINK (2014v)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse. The number of flying-foxes at Bowraville have increased substantially recently, with the camp now estimated to be supporting >15,000 individuals. Bellingen Island was occupied with a relatively low number of flying-foxes (estimated to be approximately 3,000-5,000 individuals) and the Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000-15000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox only making up 5-10% of all individuals at the Gordon Park and Bellingen Island camps. No Black flying foxes were observed at Bowraville. Dependent young GHFF were observed at Gordon Park,	Gordon Park: approx. 10,000-15,000. Bowraville: approx. >15,000. Bellingen Island: approx. 3,000-5,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Bellingen Island and Bowraville. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark and Silky Oak) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps indicated that flowering of Grey Ironbark (*E. siderophloia*) is continuing locally.	
	GeoLINK (2014w)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse. The number of flying-foxes at Bowraville was estimated to be approximately 5,000-7,500 individuals. Numbers at Bowraville have been between 5,000 and 15,000 over the last couple of months. The number of flying-foxes at Bellingen Island appears to have increased since the last monthly monitoring event, and was estimated at approximately 7,500-10,000 individuals. The Wheatley Street 'over-flow' camp nearby was unoccupied. Flying-fox numbers at Gordon Park (Nambucca Heads) were still comparatively high (around 10,000-15000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing <10% of individuals at all regional camps. Dependent young GHFF were observed at all occupied camps. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark, Coastal Blackbutt, and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood typically occurs at this time of the year in the region). Observations when travelling between regional flying-fox camps indicated that light flowering of Grey Ironbark (*E. siderophloia*) is continuing locally.	Gordon Park: approx. 10,000-15,000. Bowraville: approx. 5,000-7,500. Bellingen Island: approx. 7,500-10,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).
22 and 23 December 2014	GeoLINK (2014x)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse. No flying-foxes have been recorded roosting at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early. March. Previous monitoring of the site at the same time in December 2013 indicated that a relatively small number of flying-foxes were roosting at the site at that time, with	Gordon Park: approx. 10,000-15,000. Bowraville: approx. 5,000-7,500. Bellingen Island: approx. 5,000-7,500 (note: flying-foxes were absent from the nearby Wheatley Street camp).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					approximately 2,500 individuals recorded during the exit count. Previous monitoring at all of the visited regional flying-fox camps at the same time in December 2013 indicated occupation levels of >10,000 individuals at each camp. The only regional camp to have consistently recorded flying-fox numbers in excess of 10,000 individuals in 2014 has been Gordon Park in Nambucca Heads. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing <10% of individuals at all regional camps. Dependent young GHFF were observed at all occupied camps. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark, Coastal Blackbutt, and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood typically occurs at this time of the year in the region). Observations when travelling between regional flying-fox camps for the current monitoring indicated that no significant flowering of any of these species is currently occurring in the region.	
16 January 2015	GeoLINK (2015a)	3,000-5,000	GHFF (90%) BFF (10%).	Yes	3,000-5,000 flying-foxes were recorded in the exit count undertaken at the site. There is the first time that flying-foxes have been recorded roosting at the site since early-mid April 2014. Flying-fox numbers appear to have remained steady at Bellingen Island since the last monthly monitoring event in December 2014, and have undergone minor decreases at both Gordon Park and Bowraville. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing between 5-10% of individuals at all regional camps. Dependent young GHFF were observed at all occupied camps. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark, Coastal Blackbutt, and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood typically occurs at this time of the year in the region). Observations when travelling between regional flying-fox camps for the current monitoring indicated that light flowering of Pink Bloodwood is currently occurring in the region.	Gordon Park: approx. 10,000. Bowraville: approx. 3,000-5,000. Bellingen Island: approx. 5,000-7,500 (note: flying-foxes were absent from the nearby Wheatley Street camp).
28 and 29 January	GeoLINK (2015b)	0	No flying-fox of any species were	Not applicable for the	No flying-foxes were recorded in the exit count undertaken at	Gordon Park: approx. 10,000.

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
2015			recorded at the site.	Macksville site.	the site. No flying-fox were recorded in the site traverse. This continues a long period of absence at the site since early-mid April 2014, with the exception of the last monitoring event in mid-January 2015 when 3,000-5,000 flying-foxes were recorded. The absence of flying-fox at the site since April 2014 (excepting the mid-January monitoring result) may be related to the re-occupation of the nearby Bowraville camp by flying-foxes. Flying-fox numbers appear to have remained relatively steady at Gordon Park and Bowraville since the last monthly monitoring event; while at Bellingen Island numbers appear to have undergone a moderate increase over the same period. Current numbers of flying-foxes at regional camps are generally moderate in relation to the higher numbers recorded in the 2013-2014 summer-autumn season, with the exception of the Gordon Park camp which has retained a generally steady population of flying-foxes over the past 12 months. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing between 5-10% of individuals at all regional camps. Dependent young GHFF were observed at all occupied camps. Flowering in a number of key GHFF nectar source species (Forest Red Gum, Grey Ironbark, Coastal Blackbutt, and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood typically occurs at this time of the year in the region). Observations when travelling between regional flying-fox camps for the current monitoring indicated that light to moderate flowering of Pink Bloodwood is currently occurring in the region.	Bowraville: approx. 3,000-5,000. Bellingen Island: approx. 10,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).
18 and 19 February 2015	GeoLINK (2015c)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse. This continues a long period of absence at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. As was observed in the previous monitoring event, flying-fox numbers appear to have remained relatively steady at Gordon Park and Bowraville while at Bellingen Island numbers appear to have undergone a moderate increase. GHFF dominated flying-fox numbers at occupied camps, with	Gordon Park: approx. 10,000. Bowraville: approx. 3,000-5,000. Bellingen Island: approx. 15,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Black Flying-fox representing between 5-10% of individuals at all regional camps. Dependent young GHFF were observed at all occupied camps. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt (foothills and ranges), and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that light flowering of Broad-leaved Paperbark and Pink Bloodwood is currently occurring in the region.	
2 and 3 March 2015 (delayed February monthly monitoring event)	GeoLINK (2015d)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse. This continues a long period of absence at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. As was observed in the previous monitoring event, flying-fox numbers appear to have remained relatively steady at Gordon Park and Bowraville while at Bellingen Island numbers continue to increase to moderate levels (now numbering estimated 15,000 to 20,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing between 5-10% of individuals at all regional camps. Dependent young GHFF were observed at all occupied camps. The proportion of female GHFF with young at Bellingen Island was relatively high (averaging 78%). Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt (foothills and ranges), and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that light to moderate flowering of Broad-leaved Paperbark and light flowering of Pink Bloodwood is currently occurring in the region.	Gordon Park: approx. 10,000. Bowraville: approx. 5,000. Bellingen Island: approx. 15,000-20,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).
18 and 19 March 2015	GeoLINK (2015e)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. No flying-fox were recorded in the site traverse.	Gordon Park: approx. 10,000. Bowraville: approx. 3,000 - 5,000.

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					However, note that a new flying-fox camp has established on the edge of Macksville in Melaleuca swamp forest between the Golf Course and the Cemetery. This camp will be monitoring in future monitoring events. This lack of roosting flying-foxes at the site continues a long period of absence since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. As was observed in the previous monitoring event, flying-fox numbers appear to have remained relatively steady at Gordon Park and Bowraville and may also have now plateaued at Bellingen Island (now numbering an estimated 15,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing between 5-10% of individuals at all regional camps. Young GHFF showing dependent behaviours were observed at all occupied camps. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt (foothills and ranges), and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark and light flowering of Pink Bloodwood is currently occurring in the region.	Bellingen Island: approx. 15,000 (note: flying-foxes were absent from the nearby Wheatley Street camp).
1 and 2 April 2015 (March monthly monitoring delayed)	GeoLINK (2015f)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox were recorded in the site traverse. This lack of roosting flying-foxes at the site continues a long period of absence since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 7,500 flying-foxes were recorded in an exit count of the recently established Macksville cemetery flying-fox camp within 2 km of the site. Since the previous monitoring event, flying-fox numbers appear to have remained relatively steady at Gordon Park and declined at Bowraville and Bellingen Island. GHFF dominated flying-fox numbers at occupied camps, with	Gordon Park: approx. 10,000-15,000. Bowraville: approx. 1,000 - 2,500. Bellingen Island: approx. 10,000 (note: several thousand flying-foxes were also recorded roosting in Camphor Laurel regrowth at Wheatley Street, Bellingen).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Black Flying-fox representing between 0 -10% of individuals at all regional camps. A relatively low proportion (average 7%-17%) of young GHFF were observed displaying (semi) dependent behaviours at the Macksville cemetery and Bellingen Island camps. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt (foothills and ranges), and a number of *Corymbia* species including Spotted Gum, Red Bloodwood and Pink Bloodwood) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark is currently occurring in the region.	
15 and 16 April 2015	GeoLINK (2015g)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This lack of roosting flying-foxes at the site continues a long period of absence since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 7,500 flying-foxes were estimated to be currently roosting at the recently established Macksville cemetery flying-fox camp within 2 km of the site. Flying-foxes are now absent from both Bowraville and Bellingen Island (however, flying-foxes numbering several thousand are roosting nearby at Wheatley Street). In contrast, numbers at Gordon Park appear to have remained relatively steady. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox estimated to make up only 0 -5% of individuals present. No dependent young GHFF were observed at either the Macksville cemetery or Gordon Park camps. Mating behaviours at these camps were evident. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt [lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark continues in the region.	Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: 0 (note: however, several thousand flying-foxes were recorded roosting in Camphor Laurel and Slash Pine vegetation behind Wheatley Street).
28 and 29 April 2015	GeoLINK (2015h)	0	No flying-fox of any species were	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse.	Gordon Park: approx. 10,000-15,000

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
			recorded at the site.		There has been a long period of absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 6,000 flying-foxes were recorded in an exit count of the recently established Macksville cemetery flying-fox camp within 2 km of the site. As has been recorded for the past month, flying-foxes are absent from both Bowraville and Bellingen Island (however, flying-foxes numbering several thousand are roosting nearby at Wheatley Street). In contrast, numbers at Gordon Park have remained relatively steady. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-fox representing between 0 -10% of individuals at all regional camps. No dependent GHFF were recorded at any of the occupied camps. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt [coastal lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark continues in the region.	Bowraville: 0 Bellingen Island: 0 (note: however, several thousand flying-foxes were recorded roosting in Camphor Laurel and Slash Pine vegetation behind Wheatley Street).
15 May 2015	GeoLINK (2015i)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 5,000 flying-foxes were estimated to be currently roosting at the Macksville cemetery flying-fox camp within 2 km of the site. Flying-foxes remain absent from both Bowraville and Bellingen Island (however, flying-foxes estimated to number between 2,500 and 5,000 were observed to be roosting nearby at Wheatley Street). In contrast, numbers at Gordon Park appear to have remained relatively steady (approximately 10,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up only 0 -5% of	Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: 0 (note: however, 2,500-5,000 flying-foxes were recorded roosting in Camphor Laurel and Slash Pine vegetation behind Wheatley Street).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					individuals present. No dependent GHFF were recorded at any of the occupied camps. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt [coastal lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark continues in the region along with light flowering of Swamp Mahogany.	
28 and 29 May 2015	GeoLINK (2015j)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 15,000 flying-foxes were estimated to be currently roosting at the Macksville cemetery camp within 2 km of the site, a substantial increase on numbers recently observed (5,000 to 7,500). Flying-foxes remain absent from both Bowraville and Bellingen Island (however, flying-foxes number between 2,500 and 5,000 were observed to be roosting nearby at Wheatley Street). In contrast, numbers at Gordon Park appear to have remained relatively steady (approximately 10,000-15,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up only 0 -10% of individuals present. Results indicated that the proportion of female GHFF present at Macksville cemetery and Bellingen (Wheatley Street) ranged from 53-83% and no dependent young GHFF were observed. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt [coastal lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark continues in the region as well as light flowering of Swamp Mahogany.	Gordon Park: approx. 10,000-15,000 Bowraville: 0 Bellingen Island: 0 (note: however, 2,500-5,000 flying-foxes were recorded roosting in Camphor Laurel and Slash Pine vegetation behind Wheatley Street).
10 and 11 June 2015	GeoLINK (2015k)	0	No flying-fox of any species were	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site or in direct observations at the site.	Macksville Cemetery: 15,000 Gordon Park: approx. 10,000-

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
			recorded at the site.		Approximately 15,000 flying-foxes were estimated to be currently roosting at the Macksville cemetery camp within 2 km of the site, the same population level as was recorded in the previous monitoring event. Flying-foxes remain absent from both Bowraville and Bellingen Island (however, flying-foxes number of approximately 2,500 were observed to be roosting nearby at Wheatley Street, representing a small decrease in numbers compared with the previous monitoring event). In contrast, numbers at Gordon Park appear to have remained relatively steady (approximately 10,000-15,000 individuals). GHFF dominated flying-fox numbers at occupied camps. However, a substantial population (20-30% of all individuals) of Black Flying-foxes were recorded at the Macksville cemetery camp. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Swamp Mahogany, and Coastal Blackbutt and Forest Red Gum (both coastal lowlands) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that flowering of Broad-leaved Paperbark has now finished. Flowering of other non-key diet species is occurring, particularly heavy flowering of Coast Banksia.	15,000 Bowraville: 0 Bellingen Island: 0 (note: however, approx. 2,500 flying-foxes were recorded roosting in Camphor Laurel and Slash Pine vegetation behind Wheatley Street).
28 and 29 June 2015	GeoLINK (2015l)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 7,750 flying-foxes were estimated to be currently roosting at the Macksville cemetery camp within 2 km of the site, a substantial decrease in numbers compared with 15,000 that were present in the previous monthly monitoring event in May. Flying-foxes remain absent from both Bowraville and Bellingen Island (however, a relatively small number of flying-foxes were observed to remain roosting nearby at Wheatley Street, Bellingen). In contrast, numbers at Gordon Park appear to have remained relatively steady (approximately 10,000individuals). However, the roost footprint at Gordon Park appears to have decreased	Macksville Cemetery: 7,750 Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: 0 (note: however, approx. 1,000 flying-foxes were recorded roosting in Camphor Laurel and Slash Pine vegetation behind Wheatley Street).

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					slightly since the last monitoring event. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make <20% of individuals present. A substantial population of Black Flying-foxes (approx. 20% of all individuals) were recorded at the Macksville cemetery camp. Results indicated that the proportion of female GHFF present at Macksville cemetery and Bellingen (Wheatley Street) ranged from 56-71% and no dependent young GHFF were observed. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt and Forest Red Gum [coastal lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated only very light flowering of Coastal Blackbutt is occurring. However, strong flowering of the non-key diet species Coast Banksia continues.	
29 and 30 July 2015	GeoLINK (2015m)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. No flying-foxes were present at the Macksville Cemetery camp within 2 km of the site, which has supported flying-foxes since early 2015. Flying-foxes remain absent from the Bowraville camp, however have returned to the Bellingen Island (approximately 5000 individuals). No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with a slight increase in numbers (approximately 15,000individuals). The roost footprint is the same however the density of flying-foxes appears to have increased slightly. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up <5% of flying-foxes at Bellingen Island and <10% of flying-foxes at Gordon Park. Results indicated that the proportion of female GHFF present at Bellingen Island ranged from 77-100% and no dependent young GHFF were observed. Flowering in a number of key GHFF nectar source species	Macksville Cemetery: 0 Gordon Park: approx. 15,000 Bowraville: 0 Bellingen Island: 5000. Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					(Swamp Mahogany, Coastal Blackbutt and Forest Red Gum [coastal lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. No strong flowering of these species was observed when travelling between regional flying-fox camps. Flowering of the Coast Banksia continues, though appears to be tapering.	
26 August 2015	GeoLINK (2015n)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. No flying-foxes were present at the Macksville Cemetery camp within 2 km of the site, which supported flying-foxes between early 2015 and early July 2015. Flying-foxes remain absent from the Bowraville camp. Approximately 10,000 flying-foxes were present at Bellingen Island and no flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with similar numbers (approximately 15,000 individuals) and a similar roost footprint as last month. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up <5% of flying-foxes at Bellingen Island and <10% of flying-foxes at Gordon Park. Results indicated that the proportion of female GHFF present at Bellingen Island ranged from 71-100% and no dependent young GHFF were observed. Flowering in a number of key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum [coastal lowlands] and Grey Ironbark) typically occurs at this time of the year in the region. Moderate flowering of Forest Red Gum and Grey Ironbark was observed when travelling between regional flying-fox camps. Flowering of the Coast Banksia continues, though appears to be tapering.	Macksville Cemetery: 0 Gordon Park: approx. 15,000 Bowraville: 0 Bellingen Island: 10,000. Wheatley Street, Bellingen: 0
29 September 2015	GeoLINK (2015o)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded.	Macksville Cemetery: 0 Gordon Park: approx. 10,000-15,000 Bowraville: 0 Bellingen Island: 7,000-10,000.

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					No flying-foxes were present at the Macksville Cemetery camp within 2 km of the site, which supported flying-foxes between early 2015 and early July 2015. Flying-foxes remain absent from the Bowraville camp. Approximately 7,500 to 10,000 flying-foxes were present at Bellingen Island and no flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with similar numbers (approximately 10,000 to 15,000 individuals) and a minor contraction of the roost footprint since last month. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up <5% of flying-foxes at Bellingen Island and <10% of flying-foxes at Gordon Park. Results indicated that the proportion of female GHFF present at Bellingen Island ranged from 63-91%. Approximately 10-20% of the female Grey-headed Flying-foxes had dependent young, with the survey coinciding with the start of the birthing period. Flowering in a number of key GHFF nectar source species (Coastal Blackbutt, Forest Red Gum [coastal lowlands] and Grey Ironbark) typically occurs at this time of the year in the region. Light flowering of Forest Red Gum and Grey Ironbark was observed when travelling between regional flying-fox camps.	Wheatley Street, Bellingen: 0
22 and 23 October 2015	GeoLINK (2015p)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 4,500 flying-foxes were present at the Macksville Cemetery camp within 2 km of the site, having recently returned following an absence between July 2015 and September 2015. Flying-foxes remain absent from the Bowraville camp. Approximately 5,000 flying-foxes were present at Bellingen Island and no flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with similar numbers (approximately 10,000 individuals) and a contraction of the roost footprint since last month. GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up 5% of flying-foxes at	Macksville Cemetery: 4,500 Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: 5,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Bellingen Island and 20-30% of flying-foxes at Gordon Park. This is higher proportion than that recorded in September 2015 monitoring and may indicate an influx of Black Flying-fox has recently occurred to coastal camps. The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event was 45% (range 30-70%) and 33% at the Macksville Cemetery site (range 0-50%). This proportion is substantially lower than the average proportion of 62% (range 40-90%) recorded at the same time of year in 2014 but may relate to unfavourable observing conditions. Flowering in a number of key GHFF nectar source species (Grey Ironbark, Forest Red Gum, Large-leaved Spotted Gum) typically occurs at this time of the year in the region. Light flowering of Grey Ironbark was observed when travelling between regional flying-fox camps.	
25 and 26 November 2015	GeoLINK (2015q)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 19,000 flying-foxes were present at the Macksville Cemetery camp within 2 km of the site, having recently returned following an absence between July 2015 and September 2015. This is a substantial increase in numbers from the previous month. Flying-foxes remain absent from the Bowraville camp. Approximately 5,000 flying-foxes were present at Bellingen Island and no flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with similar numbers to that recorded last month (approximately 10,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up only 5-20% of all individuals present. The highest proportion was recorded at Gordon Park. The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event ranged between 20% and 60%. At Macksville Cemetery the proportion was similar ranging between 30% and 60%.	Macksville Cemetery: 19,000 Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: 5,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Flowering in a number of key GHFF nectar source species typically occurs at this time of the year in the region. Light flowering of Grey Ironbark and light to moderate flowering of Coastal Blackbutt was observed when travelling between regional flying-fox camps.	
21 December 2015	GeoLINK (2015r)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Over 30,000 flying-foxes were present at the Macksville cemetery camp within 2 km of the site, having recently returned following an absence between July 2015 and September 2015. This is a substantial increase in numbers from October with increased numbers recorded in both November and December. Flying-foxes remain absent from the Bowraville camp. Over 20,000 flying-foxes were recorded at Bellingen Island, representing a substantial increase since last month (5,000) and the largest number since a brief departure in Winter. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with similar numbers to that recorded last month (approximately 10,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up only <5-20% of all individuals present. The highest proportion was recorded at Gordon Park. The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event ranged between 70% and 100% (average 86%). At Macksville Cemetery the proportion was slightly lower ranging between 30% and 100% (average 65%). Flowering in a number of key GHFF nectar source species typically occurs at this time of the year in the region. No flowering foraging resources were detected.	Macksville Cemetery: >30,000 Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: >20,000 Wheatley Street, Bellingen: 0
27 January 2016	GeoLINK (2016a)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded.	Macksville Cemetery: >40,000 Gordon Park: approx. 15,000 Bowraville: 0 Bellingen Island: >20,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Over 40,000 flying-foxes were present at the Macksville cemetery camp within 2 km of the site, having recently returned following an absence between July 2015 and September 2015. This is a substantial increase in numbers from October with increased numbers recorded over the last three months. Flying-foxes remain absent from the Bowraville camp. Over 20,000 flying-foxes were recorded at Bellingen Island, representing similar numbers to last month and a substantial increase since November (5,000) and the largest number since a brief departure in Winter. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with a slight increase in numbers to that recorded last month (approximately 15,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up only <5-10% of all individuals present. The highest proportion was recorded at Gordon Park. The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event ranged between 90% and 100% (average 94%). At Macksville Cemetery the proportion was slightly lower ranging between 80% and 100% (average 92%). Flowering in a number of key GHFF nectar source species typically occurs at this time of the year in the region. Red Bloodwood (*Corymbia gummifera*) and Pink Bloodwood (*Corymbia intermedia*) were observed exhibiting heavy flowering over the period surveyed.	
25 February 2016	GeoLINK (2016b)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Over 50,000 flying-foxes were present at the Macksville Cemetery camp within 2 km of the site. This is a substantial increase in numbers from October 2015 with increased numbers recorded over the last four months. Flying-foxes remain absent from the Bowraville camp. Over 20,000 flying-foxes were recorded at Bellingen Island,	Macksville Cemetery: >50,000 Gordon Park: approx. 10,000 Bowraville: 0 Bellingen Island: >20,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					representing similar numbers to last month and a substantial increase since November 2015 (5,000) and the largest number since a brief departure in winter. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with a slight decrease in numbers to that recorded last month (approximately 10,000 individuals). GHFF dominated flying-fox numbers at occupied camps, with Black Flying-foxes estimated to make up only <5-10% of all individuals present. The highest proportion was recorded at Gordon Park. The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event ranged between 0% and 60% (average 23%). At Macksville Cemetery the proportion was higher ranging between 30% and 100% (average 74%). Flowering in a number of key GHFF nectar source species typically occurs at this time of the year in the region. Pink Bloodwood (*Corymbia intermedia*) and Broad-leaved Paperbark were observed flowering during the monitoring event.	
23 March 2016	GeoLINK (2016c)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded in the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 32,000 flying-foxes were present at the Macksville Cemetery camp within 2 km of the site. This is a decrease numbers from February 2016. Flying-foxes remain absent from the Bowraville camp. Approximately 15,000 flying-foxes were recorded at Bellingen Island, representing a slight decrease to last month. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with a slight decrease in numbers to that recorded last month (approximately 7,000 individuals) and the lowest numbers recorded over the last 12 months. GHFF dominated flying-fox numbers at occupied camps, with	Macksville Cemetery:32,000 Gordon Park: approx. 7,000 Bowraville: 0 Bellingen Island: 15,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Black Flying-foxes estimated to make up only <5-10% of all individuals present. The highest proportion was recorded at Gordon Park. The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event ranged between 63% and 740% (average 74%). At Macksville Cemetery the proportion was higher ranging between 71% and 91% (average 80%). Flowering in a number of key GHFF nectar source species typically occurs at this time of the year in the region. Broad-leaved Paperbark was the main key nectar resource observed flowering during the monitoring event.	
26 and 27 April 2016	GeoLINK (2016d)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 12,000 flying-foxes were present at the Macksville Cemetery camp within 2 km of the site. This is a decrease numbers from March 2016. Flying-foxes remain absent from the Bowraville camp. Approximately 3,000 flying-foxes were recorded at Bellingen Island, representing a large decrease to last month. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with a large increase in numbers to that recorded last month (approximately 15,000 individuals). Little Red Flying-fox have moved into the centre of the camp and pushed the other species to the fringes. GHFF dominated the species composition comprising between 90-95% of all individuals present at all camps, with Gordon Park being an exception. At Gordon Park Little Red Flying-foxes comprised >60% of all individuals present. Black Flying-foxes at all camps accounted for a relatively small proportion of all individuals present (5-10%). Four dependent young GHFF were observed (three at Bellingen Island camp and one at Macksville Cemetery camp). All other camps did not support dependent young. This coincides with dependent young transitioning to independence and the	Macksville Cemetery:12,000 Gordon Park: approx. 15,000 Bowraville: 0 Bellingen Island: 3,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					completion of weaning. Flowering in a number of key GHFF nectar source species typically occurs at this time of the year in the region. Broad-leaved Paperbark and Swamp Mahogany were the main key nectar resources flowering during the monitoring event.	
19 and 20 May 2016	GeoLINK (2016e)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Approximately 1,000 flying-foxes were present at the Macksville Cemetery camp within 2 km of the site. This is a decrease numbers from April 2016. Flying-foxes remain absent from the Bowraville camp. Approximately 7,000 flying-foxes were recorded at Bellingen Island, representing an increase from last month. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park remains occupied, with a large increase in numbers for the second consecutive month with (approximately 30,000 individuals). Little Red Flying-fox numbers have increased significantly and are pushing other species to the fringes. GHFF dominated the species composition comprising between 90-95% of all individuals present at all camps, with Gordon Park being an exception. At Gordon Park Little Red Flying-foxes comprised approximately 60% with GHFF making up 35% of all individuals present. Black Flying-foxes at all camps accounted for a relatively small proportion of all individuals present (<5%). No dependant young were recorded at any of the sites surveyed. This coincides with dependent young transitioning to independence and the completion of weaning. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Coastal Blackbutt [coastal lowlands], and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated that moderate flowering of Broad-leaved Paperbark continues in the region along with light flowering of Swamp Mahogany.	Macksville Cemetery:1,000 Gordon Park: approx. 30,000 Bowraville: 0 Bellingen Island: 7,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
30 June 2016	GeoLINK (2016f)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded in the exit count undertaken at the site. Nor were any flying-fox recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Flying-foxes were absent at the Macksville Cemetery camp within 2 km of the site. This is has resulted from downward trending numbers since April 2016. Flying-foxes remain absent from the Bowraville camp. Approximately 10,000 flying-foxes were recorded at Bellingen Island, representing an increase from last month. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park is occupied by approximately 10,000 individuals, with a large decrease in numbers from last month coinciding with the departure of Little Red Flying-fox. GHFF dominated the species composition comprising > 95% of all individuals present at occupied camps. Black Flying-foxes accounted for a relatively small proportion of all individuals present (<5%). No dependant young were recorded at any of the sites surveyed. Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Forest Red Gum and Swamp Mahogany) typically occurs at this time of the year in the region. Observations when travelling between regional flying-fox camps for the current monitoring indicated Broad-leaved Paperbark, Swamp Mahogany and Coastal Banksia are in flower.	Macksville Cemetery: 0 Gordon Park: 10,000 Bowraville: 0 Bellingen Island: 10,000 Wheatley Street, Bellingen: 0
28 July 2016	GeoLINK (2016g)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded during the exit count undertaken at the site. Nor were any flying-foxes recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early-mid April 2014, with the exception of the mid-January 2015 monitoring event where 3,000-5,000 flying-foxes were recorded. Flying-foxes were absent at the Macksville Cemetery camp within 2 km of the site. Numbers of flying-foxes at the Macksville Cemetery camp had been decreasing since April	Macksville Cemetery: 0 Gordon Park: 15,000 Bowraville: 0 Bellingen Island: 4,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					2016. Flying-foxes remain absent from the Bowraville camp. Approximately 4,000 flying-foxes were recorded at Bellingen Island, a decrease of 6,000 individuals from June 2016. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park is occupied by approximately 15,000 individuals, an increase of 5,000 individuals since June 2016. GHFF dominated the species composition comprising 85%->95% of all individuals present at occupied camps. Black Flying-foxes (BFF) accounted for a relatively small proportion of all individuals present (<5%-15%). Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Forest Red Gum and Swamp Mahogany) typically occurs at this time of the year in the region. Observations made when travelling between regional flying-fox camps for the current monitoring indicated Broad-leaved Paperbark, Swamp Mahogany, Forest Red Gum and Coastal Banksia are in flower.	
15 August 2016	GeoLINK (2016h)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded during the exit count undertaken at the site. Nor were any flying-foxes recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early to mid-April 2014, with the exception of the mid-January 2015 monitoring event where 3,000 to 5,000 flying-foxes were recorded. Flying-foxes were absent at the Macksville Cemetery camp within 2 km of the site. Numbers of flying-foxes at the Macksville Cemetery camp had been decreasing since April 2016. Flying-foxes remain absent from the Bowraville camp. Approximately 5,000 flying-foxes were recorded at Bellingen Island, an increase of 1,000 individuals from July 2016. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park is occupied by approximately 10,000 individuals, a decrease of 5,000 individuals since July 2016. GHFF dominated the species composition comprising 95% at Bellingen Island and 90% at Gordon Park. Black Flying-foxes accounted for a relatively small proportion of all individuals present (5% at Gordon Park and 10% at Bellingen Island).	Macksville Cemetery: 0 Gordon Park: 10,000 Bowraville: 0 Bellingen Island: 5,000 Wheatley Street, Bellingen: 0

Date	Source of data	Population estimate	Species composition	Dependent young	Comment	Population estimate control sites
					Flowering in a number of key GHFF nectar source species include Coastal Blackbutt (Eucalyptus pilularis) (coastal lowlands), Forest Red Gum (Eucalyptus tereticornis) (coastal lowlands and inland low altitude) and Grey Ironbark (Eucalyptus siderophloia) (coastal lowlands). Observations when travelling between regional flying-fox camps indicated minor flowering of Swamp Mahogany, Broad-leaved Paperbark, Forest Red Gum and Coast Banksia (Banksia integrifolia).	
30 August 2016	GeoLINK (2016i)	0	No flying-fox of any species were recorded at the site.	Not applicable for the Macksville site.	No flying-foxes were recorded during the exit count undertaken at the site. Nor were any flying-foxes recorded during the site traverse. This continues an absence of flying-foxes roosting at the site since early to mid-April 2014, with the exception of the mid-January 2015 monitoring event where 3,000 to 5,000 flying-foxes were recorded. Flying-foxes were absent at the Macksville Cemetery camp within 2 km of the site. Numbers of flying-foxes at the Macksville Cemetery camp had been decreasing since April 2016. Flying-foxes remain absent from the Bowraville camp. Approximately 1,000 flying-foxes were recorded at Bellingen Island, a decrease of 4,000 individuals from mid-August 2016. No flying-foxes were present at the Wheatley Street, Bellingen site. Gordon Park is occupied by approximately 10,000 individuals; the same number of flying-fox was recorded in mid-August 2016. GHFF dominated the species composition comprising 85% at Bellingen Island and 95% at Gordon Park. Black Flying-foxes accounted for a relatively small proportion of all individuals present (5% at Gordon Park and 15% at Bellingen Island). Flowering in a number of key GHFF nectar source species (Broad-leaved Paperbark, Forest Red Gum and Swamp Mahogany) typically occurs at this time of the year in the region. Observations made when travelling between regional flying-fox camps for the current monitoring indicated Swamp Mahogany and Coastal Banksia are in flower.	Macksville Cemetery: 0 Gordon Park: 10,000 Bowraville: 0 Bellingen Island: 1,000 Wheatley Street, Bellingen: 0

Appendix C. Contingency strategy for moving flying-foxes out of the highway corridor during clearing operations between the period 1 May – 15 September.

Appendix D. Grey-headed Flying-fox food plant list (blossom diet and fruit diet)

GHFF primary food tree species (blossom diet)			
Banksia integrifolia	Coastal Banksia	*Eucalyptus robusta*	Swamp Mahogany
Corymbia gummifera	Red Bloodwood	*Eucalyptus saligna*	Sydney Blue Gum
Corymbia intermedia	Pink Bloodwood	*Eucalyptus siderophloia*	Northern Grey Ironbark
Corymbia maculata	Spotted Gum	*Eucalyptus tereticornis*	Forest Red Gum
Corymbia variegata	Spotted Gum	*Grevillea robusta*	Silky Oak
Castanospermum australe	Black Bean	*Melaleuca quinquenervia*	Broad-leaved Paperbark
Eucalyptus pilularis	Blackbutt	*Syncarpia glomulifera*	Turpentine
GHFF secondary food tree species (blossom diet)			
Angophora costata	Smooth-barked Apple	*Eucalyptus grandis*	Flooded Gum
Angophora floribunda	Rough-barked Apple	*Eucalyptus propinqua*	Grey Gum
Eucalyptus acmenoides	White Mahogany	*Eucalyptus resinifera*	Red Mahogany
GHFF food tree species (fruit diet)			
Acmena smithii	Lilly Pilly	*Hedycarya angustifolia*	Native Mulberry
Alphitonia excelsa	Red Ash	*Livistona australis*	Cabbage Palm
Archontophoenix cunninghamiana	Bangalow Palm	*Maclura cochinchinensis*	Cockspur Thorn
Avicennia marina	Grey Mangrove	*Melia azedarach*	White Cedar
Cissus hypogaluca	Five-leaf Water Vine	*Melodinus australis*	Southern Melodinus
Dendrocnide excelsa	Giant Stinging Tree	*Morinda jasminoides*	Morinda
Dendrocnide photinophylla	Shining-lved Stinging Tree	*Pennantia cunninghamii*	Brown Beech
Diospyros pentamera	Myrtle Ebony	*Pittosporum undulatum*	Sweet Pittosporum
Diploglottis australis	Native Tamarind	*Planchonella australis*	Black Apple
Eucalyptus reticulatus	Blueberry Ash	*Podocarpus elatus*	Plum Pine
Ehretia acuminata	Koda	*Polyosma cunninghamii*	Featherwood
Elaeocarpus obovatus	Hard Quandong	*Rauwenhoffia leichardtii*	Zig Zag Vine
Ficus coronata	Creek Sandpaper Fig	*Rhodamnia argentea*	Malletwood
Ficus fraseri	Sandpaper Fig	*Syzygium australe*	Brush Cherry
Ficus macrophylla	Moreton Bay Fig	*Syzygium corynanthum*	Sour Cherry
Ficus obliqua	Small-leaved Fig	*Syzygium crebrinerve*	Purple Cherry
Ficus rubiginosa	Rusty Fig	*Syzygium luehmanii*	Riberry
Ficus superba	Deciduous Fig	*Syzygium. oleosum*	Blue Lilly Pilly
Ficus watkinsiana	Strangler Fig	*Schizomeria ovata*	Crabapple

Appendix E. Roads and Maritime Services response to DoEEand EPA comments on the draft Flying-fox Management Plan.

Appendix F. Warrell Creek to Nambucca Heads Upgrade Road Kill Monitoring Program.

WC2NH Road Kill Monitoring Program

1.1 Timing of Monitoring

Timing of road kill surveys for the WC2NH Project is described in Table 1.

Table 1 – Timings and locations of road kill surveys

Project Phase	Timing of Survey	Location
During clearing operations	Daily	Portion of existing Pacific Highway adjacent to clearing operations
One month following clearing operations	Daily	Portion of existing Pacific Highway adjacent to clearing operations
Duration of construction	Weekly	Entire length of existing Highway in Project area
Upon opening of each stage of the Project to traffic (operational phase)	Weekly for 12 weeks commencing the week of opening each stage to traffic.	Entire length of opened stage.
Upon completion of the Project (operation phase)	Excluding the season/s covered by the initial 12 week monitoring period (refer above), weekly during October (spring), January (summer), April (autumn) and July (Winter) for up to five consecutive years post construction, or until mitigation measures have been demonstrated to be effective.	Entire length of completed Project

1.2 Monitoring Program Objectives

The aim of the monitoring program is to;

- report on any animal road kill on the project following the opening to traffic; and
- assess the effectiveness of the presence of fauna fencing to prevent fauna being killed by vehicles while attempting to cross the WC2NH Upgrade.

1.3 Monitoring Procedure

A two-person team vehicle being driven along the entire length of the highway in the Project area and identifying dead wildlife (road kill) seen on the road and within three metres of the road edge. The passenger will search the road and its verge for road kill. When a road kill is observed from the vehicle, a closer visual inspection of the carcass will be undertaken where safe access is available. If safe access is not possible, due to local traffic conditions, binoculars will be used to try to identify and provide as detailed information as is possible on the carcass.

Road kill fauna will be identified to species level where possible, with reference to field guides. Where there is any doubt to the identification of the carcass, photographs will be taken and forwarded to a qualified ecologist for identification /confirmation of species. Those too seriously damaged to be accurately identified will be recorded as “unknown”.

To assist with the correct identification of road kills, the following will be undertaken –

a. The provision of a qualified ecologist (shall be a recognised expert in mammal identification in coastal northern NSW) to undertake the initial phase of operational monitoring (first season) with relevant Roads and Maritime team members providing appropriate detailed training and a baseline of expert monitoring of road kills;

b. The provision of specialist training (to be provided by an expert as above in point a) in fauna identification for Contractors and Roads and Maritime staff involved in the construction phase monitoring of road kill; and

c. Where there is any doubt to the identification of the carcass, the provision of photographs of road kill to be sent to a qualified ecologist (an expert as above in point a) to confirm the identity of road kill and to maintain a permanent record of road kill for further comparisons, if needed.

1.4 Monitoring Methodology

- The highway will be monitored using the method previously indicated (section 1.3) consisting of a two-person team traversing the upgrade in a vehicle to locate and identify road kills;

- The speed of travel will be the same in all cases to avoid confounding the data collection, and should be as slow as is safely possible;
- The highway will be surveyed weekly for four weeks in spring, summer, autumn and winter (see Table 1);
- Where possible, each survey shall be completed within two hours of sunrise in order to maximise the potential to record road kills before either carrion eating animals or traffic render any road kill unidentifiable;
- if possible, each survey will be carried out on the same day of the week to remove the influence of varying environmental conditions and to ensure consistent temporal spacing;
- For each road kill observed, the following attributes will be recorded

    a. Geographic Coordinates of any road kill.

    b. Whether fauna fencing was installed at/near the location.

    c. Species of road kill where possible, however, where there is any doubt as to the identification of the carcass, photographs shall be forwarded to a qualified ecologist for identification /confirmation of the species.

If the animal is identified as an EPBC Act threatened species, the carcass will be photographed and the following information will also be recorded where possible and safety considerations permit

a. Sex and age class (juvenile or adult).

b. Presence of pouch young (for marsupials).

c. Presence of flightless young (for flying-foxes or other bats).

d. Distance to a fauna connectivity structure.

e. Distance to drop down structure.

f. If fauna fencing was installed, is there any damage to the fence in the vicinity.

g. Weather conditions at the time of the monitoring (from the Bureau of Meteorology) – including temperature, rainfall in the last 24 hours, moon phase.

h. If the animal is identified as a flying-fox:
    - Distance to nearest camp,
    - Distance to nearest canopy vegetation,

- Presence of flowering food trees in neighbouring median or roadside vegetation; plants identified to species and referenced with diet list.

1.5 Analysis of data

The data to be collected will be analysed using a suitable nonparametric test such as a Kruskal-Wallis test. The aim will be to test both whether the fenced and unfenced locations have different mean numbers of road kills and if the amount of road kill varies through time in either or both of the two types of areas. Associations with other measured variables will be described as data allow, including sex, age class, presence of dependent young and, in the case of flying-foxes, proximity to roost sites or flowering food trees. Such information will indicate if the mitigation measures in the area are working as expected to keep road kills to acceptable levels and that none of the target species are killed.

1.6 Reporting

1.6.1 Quarterly reports

A report will be prepared by the ecologist following the initial 12 week monitoring period (after opening for each stage) to identify any roadkill hotspots and review the mitigation measures. The initial report and ongoing seasonal reports of the data collected will be provided to Roads and Maritime. This will include graphs of the data and any previously collected data to provide simple visual comparisons of road kill. This will also include overall road kill counts as well as separate graphs for each of the target species (if deaths have occurred).

Anecdotal road kill information collected on days that are not monitored as part of this program may be added as a note for discussion.

1.6.2 Annual Reports

The annual report will be prepared in consultation with a qualified ecologist and provided to DoEE and EPA within one month of completion of the fourth monitoring season. From then on it will be provided within one month of the same monitoring season in subsequent years until monitoring is completed (Table 1).

Analysis of the data itself shall be included in an annual monitoring report. This report will include a statistical analysis of all of the data collected to that time including graphical representations of the road kill that is recorded.

Annual reports will record any potential or obvious failures in road kill mitigation identified in the monitoring program and provide a date by which meetings will take place to discuss any such adverse findings. This will include at least:

- where statistically larger number numbers of road killed animals are detected on fenced sections compared to unfenced sections;
- where any of the target threatened fauna are recorded as killed;
- where there is a clear pattern of unexpected road kill at any point on the Upgrade.

1.7 Performance Measures

- Lower rates of road kill in proximity to fauna fencing (i.e. areas of the main carriageways within areas adjacent to installed fauna fencing) than in sections of the upgrade not near fauna fencing during monitoring events up to five years post construction phase, or until such time as mitigation measures have been demonstrated to be effective.

1.8 Adaptive Management

Where any annual report identifies a significant difference between the road kill numbers of the fenced and unfenced areas, DoEE and EPA shall be notified, and a meeting will be set to discuss such differences with the relevant agencies and Roads and Maritime.

Such a meeting would occur within one month of completion of the annual report, which should ensure sufficient time to consider/review the response to any recorded significant differences.