Koala Management Plan

Warrell Creek to Nambucca Heads Upgrade of the Pacific Highway

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Warrell Creek to Nambucca Heads Upgrade of the Pacific Highway

Prepared for: Acciona and Ferrovial Joint Venture and Roads and Maritime Services

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Table of Contents

Illustrations

Tables

Appendices

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 Warrell Creek to Urunga (WC2U) Project forms part of the Pacific Highway Upgrade Program and comprises approximately 42 kilometres of dual carriageway road that will bypass the towns of Warrell Creek, Macksville, Nambucca Heads and Urunga on the Mid North Coast of NSW. The Project has been divided into two stages with Stage 1 consisting of the approximate 22.5 kilometre stretch from Nambucca Heads to Urunga (NH2U) and Stage 2 consisting of the remaining approximate 19.5 kilometres of dual carriageway between Warrell Creek and Nambucca Heads (WC2NH). This Koala Management Plan relates to Stage 2 (WC2NH) which is referred to throughout this report as 'the Project' (refer to **Illustration 1.1**).

The NSW Minister for Planning approved the WC2U Pacific Highway Upgrade Project under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 19 July 2011, subject to the Minister's Conditions of Approval (CoA) being met.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).

Koalas (*Phascolarctos cinereus*) were assessed in the WC2U Environmental Assessment (EA) (Sinclair Knight Merz – SKM 2010a, SKM 2010b), in regard to relevant State legislation. At that time, the Koala was listed as a 'Vulnerable' species under the NSW Government *Threatened Species Conservation Act 1995* (TSC Act), however was not listed under Federal legislation. Since completion of the WC2U EA (SKM 2010a, SKM 2010b) and NSW State Government Project approval, Koala populations in Queensland (QLD), NSW and the Australian Capital Territory (ACT) were listed as 'Vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

An assessment of the impacts of the WC2NH Pacific Highway Upgrade on the Koala, in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of Environment and Heritage – DoE 2013a) and *Interim Koala referral advice for proponents* (Department of Sustainability, Environment, Water, Population and Communities – DSEWPaC 2012) was prepared by GeoLINK (2013). This assessment found that the Project has the potential to cause negative (incremental and cumulative) impacts to the Koalas/ breeding aggregation/s whose home range encompass the Nambucca State Forest/ Old Coast Road area, mainly through habitat removal and fragmentation. The majority of Koalas and habitat that supports the subject important Koala population would not be affected by the Project. The Project, with effective implementation of the proposed mitigation measures, was found to be unlikely to result in a significant impact to the subject important local Koala population. Notwithstanding, as the Project adversely affects habitat that satisfies the DSEWPaC (2012) definition of '*habitat critical to the survival of the species*' (including direct removal of approximately 86.5 hectares of vegetation that satisfies this criteria); the Project was considered to constitute a significant impact on the Koala as per the DSEWPaC (2012) and DoE (2013a) guidelines.

In accordance with sections 18 and 18A of the EPBC Act, the Koala is a matter of national environmental significance (MNES) and Roads and Maritime Services (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 the Koala. The DoE have reviewed the referral (number 2013/7101) on 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.

1.2 Purpose and Objectives

This Management Plan identifies the potential impacts of the WC2NH Project on the local population of Koalas. It outlines the proposed management measures to be implemented for the Koala on the Project and a program for monitoring the effectiveness of these measures. The objective of the Management Plan is to provide measures that minimise impacts to Koalas on the Project.

The Plan covers pre-construction, construction and operational phases of the Project and applies to all areas within the WC2NH Project boundary.

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 Koala Management Plan.

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

1.4 Management Structures and Plan Updates

This 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:

- Specific
- Measurable
- Achievable
- Results-based
- Time-based.

The Koala Management Plan has been prepared in consultation with Roads and Maritime, the Environment Protection Authority (EPA) and the Commonwealth Department of the Environment (DoE). General responsibilities for environmental management would be outlined in the Project specific Construction Environment Management Plan (CEMP) and CEMP 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 and the D&C Contractor for this Project (Acciona and Ferrovial Joint Venture [AFJV]) would be responsible for implementing the measures in this Koala Management Plan and this would include the engagement of suitably qualified specialists to undertake and oversee the Koala surveys and monitoring activities reported in the Plan.

1.5 Plan Authors

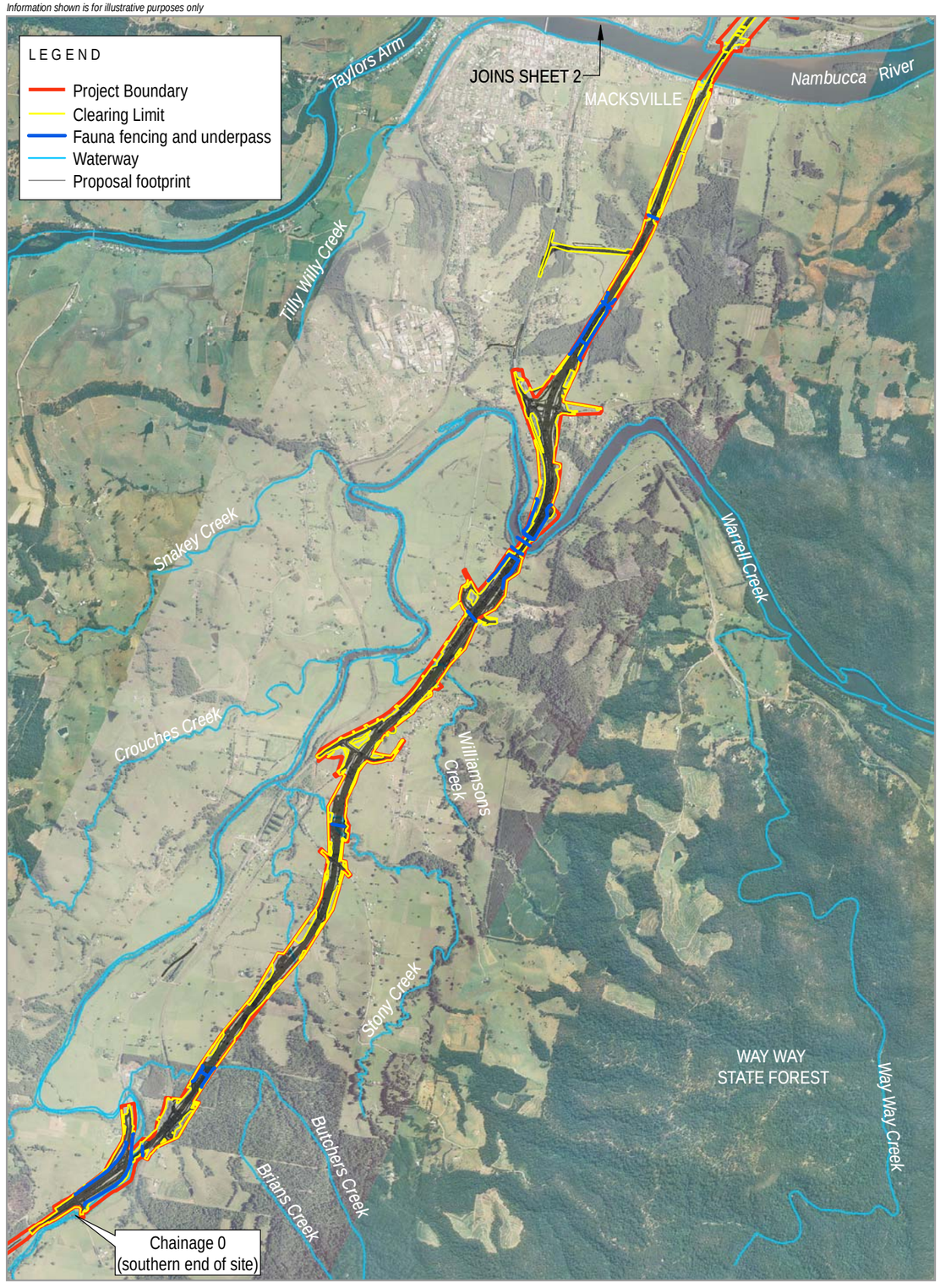
The Koala Management Plan has been prepared by the following personnel from AFJV Project Ecologist (GeoLINK):

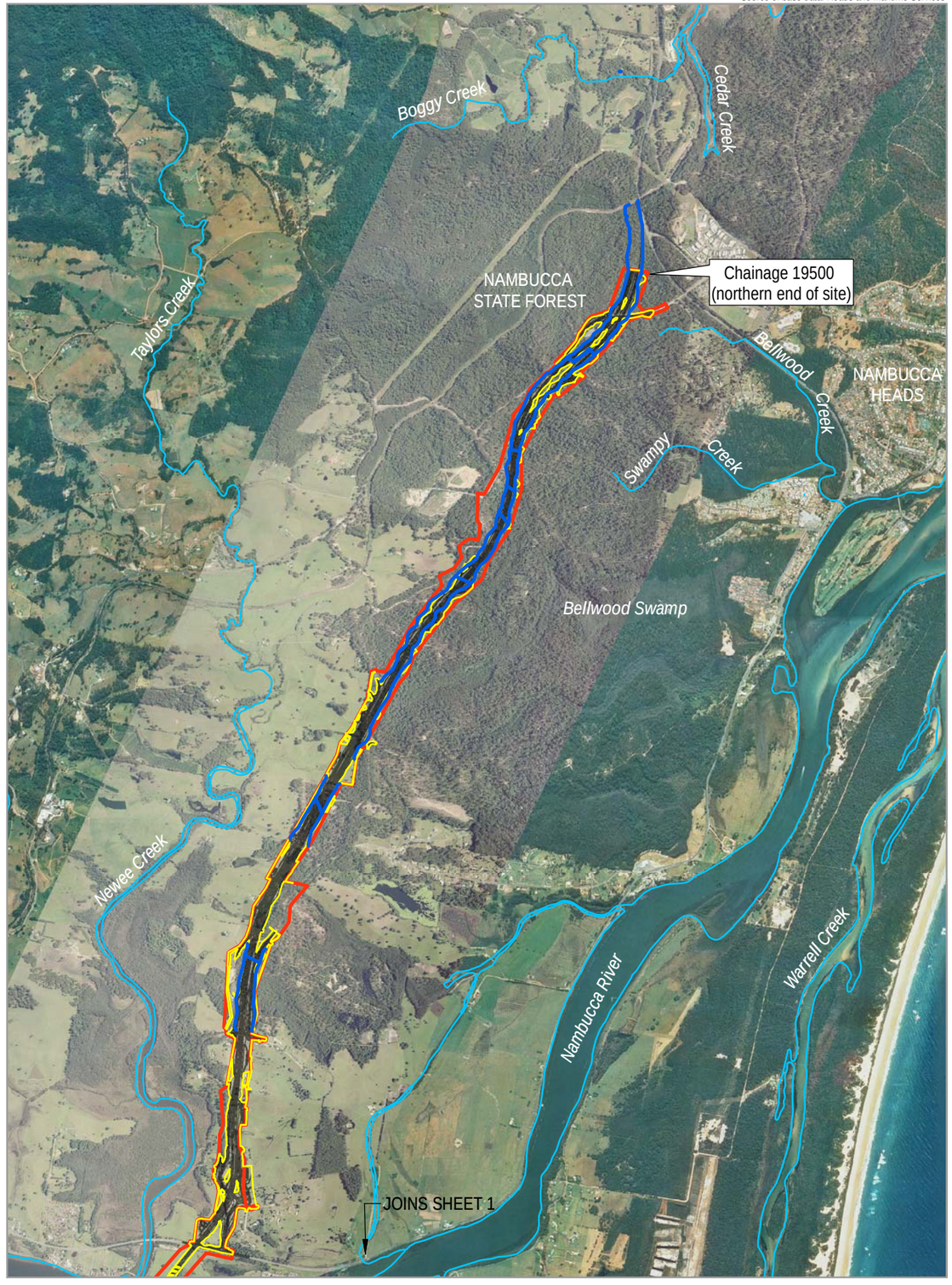
- David Havilah (Senior Ecologist).
- Veronica Silver (Senior Ecologist – Peer Review).

Qualifications and experience of the Plan authors are included in **Appendix A**.

Information shown is for illustrative purposes only

Drawn by: RE Checked by: GJM Reviewed by: JOL Date: 05/09/2016
Source of base data: Roads and Maritime Services





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North

GeoLINK environmental management and design

WC2NH Pacific Highway Upgrade Project - EPBC Act Koala Impact Assessment
2378-1266

The Site

Illustration 1.1

Koala Population

2.1 Species Description

Detailed reviews of Koala biology and ecology based on recent research are provided on the Department of Environment (DoE) *Species Profile and Threats Database* (DoE 2013b) and the NSW *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008). A summary of this information is provided below.

2.1.1 Habitat

Koalas inhabit a range of forest and woodland communities dominated by *Eucalyptus* species. Habitat quality depends on a range of environmental features, including vegetation species composition, soils, climate and disturbance history. The main factor influencing Koala occurrence is the presence of suitable food trees. Shelter trees also provide important habitat features, particularly in harsh climates (DoE 2013b, DECC 2013).

2.1.2 Feeding Requirements

The Koala's diet primarily comprises eucalypt leaves which are low in nutrients and energy, and high in indigestible components (e.g. lignin and cellulose) and toxic compounds (e.g. essential oils and tannins) (Cork *et al.* 1990; Cork and Sanson 1990). In a given area, the diets of individual Koalas/ sub-populations almost exclusively comprise a small number of preferred species to obtain their nutritional needs. Preferred food trees appear to be associated with the presence of formyl phloroglucinol compounds (FPCs) in the leaves (DECC 2008). Koala's also show strong preferences between individual trees of the same species at individual sites, which is believed to be associated with leaf anti-feedant chemicals (DoE 2013b). Foliage from non-preferred food trees are consumed at times to supplement their diet (DoE 2008, DECC 2008). Recognised Koala food tree species for the NSW North Coast region (which encompasses the study area) as identified within the Recovery Plan for the Koala (DECC, 2008) are listed in **Table 2.1** with species relevant to the Project Site noted. In addition to these Forest Oak (*Allocasuraina torrulosa*) and Sydney Blue Gum (*Eucalyptus salignus*) are also considered to be a very important Koala feed tree species within the NSW North Coast region (Smith, 2004 and Miller, 2013). Blackbutt is also locally considered a supplementary Koala food tree species in the region (Professor Rob Close, University of Western Sydney pers. comm. 2013).

Table 2.1 Recognised Koala Food Tree Species for the NSW North Coast Region (DECC, 2008)

Foraging Preference	*Species*	*Species Relevant to the Project Area*
Primary food tree species	Tallowwood (*Eucalyptus microcorys*)	✓
	Cabbage Gum (*E. amplifolia*)	
	Parramatta Red Gum (*E. parramattensis*)	
	Forest Red Gum (*E. tereticornis*)	✓
	Narrow-leaved Red Gum (*E. seeana*)	
	Craven Grey Box (*E. largeana*)	
	Orange Gum (*E. bancroftii*)	
	Swamp Mahogany (*E. robusta*)	✓
Secondary food tree species	Slaty Red Gum (*E. glaucina*)	
	Grey Gum (*E. biturbinata*)	

Foraging Preference	*Species*	*Species Relevant to the Project Area*
	Small-fruited Grey Gum (*E. propinqua*)	✓
	Large-fruited Grey Gum (*E. canaliculata*)	
	Red Mahogany (*E. resinifera*)	✓
	Steel Box (*E. rummeryi*)	
	Mountain Mahogany (*E. notabilis*)	
	Rudder's Box (*E. rudderi*)	
	Grey Box (*E. moluccana*)	
	White-topped box (*E. quadrangulata*)	
	Yellow box (*E. melliodora*)	
Stringybarks/supplementary species	Stringybark (*E. tindaliae*)	
	Blue-leaved Stringybark (*E. agglomerata*)	
	Thin-leaved Stringybark (*E. eugeniodes*)	
	Diehard Stringybark (*E. cameronii*)	
	White Stringybark (*E. globoidea*).	

Primary Koala food tree species are subject to a significantly higher level of usage than other *Eucalyptus* species, independent of tree density. Secondary and/or supplementary food trees are generally subject to lower levels of foraging by Koalas than that of primary food trees, except in areas where primary food trees are absent (DECC 2008).

2.1.3 Social Organisation and Reproduction

Koalas live in breeding aggregations which typically comprise a dominant male, a small number of mature females and juveniles of various ages (Phillips 1997). Home ranges vary in size depending on habitat quality and the number of available food trees, and have been recorded from 0.2 – 500 hectares (DECC 2008). Males generally have larger home ranges than females, with the home range of a dominant male overlapping extensively with the home range of females within its aggregation.

The Koala breeding season peaks between September and February, and comprises a period of heightened activity. Offspring rates typically range between 0.3 – 0.8 per year, with birth occurring during October and May (McLean 2003) following a 35 day gestation period (DECC 2008). Once born the young remain in the pouch for approximately six months, and remain dependent on their mother until about 12 months of age (Mitchell and Martin 1990). Sub-adult Koalas may remain in the mother's home range for a further two to three years, before young Koalas of both sexes disperse to establish their own home range areas (Ramsay 1999). Dispersal distances generally range from 1.0 – 11 kilometres (Mitchell and Martin 1990). Longevity in the wild is >15 years for females and >12 years for males (Martin and Handasyde 1999 cited in DoE 2013b).

2.2 Known Distribution

The Koala's distribution extends from north-eastern Queensland to the south-east corner of South Australia, covering coastal and inland areas (ANZECC 1998 cited in DoE 2013b, DECC 2013).

2.2.1 Database Records

The OEH Atlas of NSW Wildlife (OEH 2013) database shows 100 Koala records within 10 kilometres of the Proposal site. The main clusters of records are located in:

- Valla/ Little Newry State Forest/ Newry State Forest area approximately 3.5 kilometres to the north of Nambucca Heads (41 records).
- Ingalba State Forest area approximately two kilometres to the south-west of Warrell Creek (12 records).
- Way Way State Forest area approximately four kilometres to the south-east of Warrell Creek (10 records).

A small cluster of records (six records) occurs within Nambucca State Forest at the northern end of the Project. The remaining records are scattered at low densities throughout the locality, including around Warrell Creek, Scotts Head to Stuarts Point, Tamban State Forest and the Viewmont State Forest area.

Eight Koala records occur within two kilometres of the site as follows:

- Two Koala records within Nambucca State Forest (1998) between 150 and 350 metres to the east of the Project corridor.
- Four Koala records within Nambucca State Forest (2000, 2005, 2011, 2012) between one and two kilometres to the north-west of the Project corridor.
- One Koala record within Macksville (1974) approximately 800 metres to the west of the Project corridor.
- One Koala record next to Warrell Creek in the Bald Hill Road area (1984), approximately 700 metres to the east of the Project corridor.

No Koala database records occur within the Project boundary.

2.3 Habitat within the Project Footprint

The EPBC Koala Impact Assessment (GeoLINK 2013) included a detailed study of Koala usage of the Project study area and surrounds employing the Koala Spot Assessment Technique (SAT) and assessments of Koala habitat. The interim guidelines Koala referral advice for proponents (DSEWPaC, 2012) was used to assess the impacts of the Project on the local population of Koalas (GeoLINK, 2013). These guidelines have since been superseded by the Draft EPBC Act referral guidelines for the vulnerable Koala (DoE, 2013). The findings of this report are summarised in the Sections below in order to describe Koala habitat associated with the site.

2.3.1 Overview of the Koala Impact Assessment

The Project footprint is defined as:

- Concept design with 15 metre buffer.
- 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 a flying fox camp is located.
- A 10 per cent contingency which includes provision for clearing for construction phase water quality basins, accesses to ancillary facilities, stockpile sites and design refinements.

The Project footprint supports approximately 106.6 hectares of potential Koala habitats (with primary and secondary Koala food tree species). The majority of habitat (81.8 hectares) is located north of the Nambucca River in the Nambucca State Forest/ Old Coast Road area, forming the main stand of intact habitat within the study area. Three (7.9 per cent) of the 38 SATs in this area were subject to medium (normal) Koala usage for a low density Koala population, indicating that part of the range of resident Koala/s or breeding aggregation/s overlaps the study area. Koala records from the field surveys associated with the WC2U Project Environmental Assessment (SKM 2010b) and the Atlas of NSW Wildlife (OEH 2013) support these findings. GeoLINK (2014a) considered that there is insufficient data available to provide an accurate Koala population estimate.

Considering the low levels of Koala usage detected the number of individual Koalas whose home range encompass the study area is likely to be small.

Potential Koala habitat within the remainder of the study area south of the Nambucca River comprises smaller fragmented patches of vegetation within a mostly cleared rural landscape (totalling 24.8 hectares within the Proposal footprint). This vegetation comprises mostly mature regrowth following historic clearing. These factors reduce the potential of this landscape to support a resident Koala population, particularly as a population on erosion/ residual soils would be expected to comprise a low density population as observed north of the Nambucca River, with large home range requirements (Biolink 2009, 2013). No evidence of Koala activity was recorded in this area during this survey and local records are scattered at very low densities. Overall the results of this SAT assessment, the Project EA surveys and the reviewed desktop information suggest that the study area south of the Nambucca River does not currently support a resident Koala population. Due to the Koala's high mobility, it is possible that Koalas may move east-west across this portion of the study area, though such movements are likely to be rare due to:

- The local landscape being predominantly cleared.
- The survey results, Project EA surveys and the reviewed desktop information which suggests an absence of a local Koala population within the study area south of the Nambucca River.
- The low density of Koala records and dominant soils landscapes (erosional/ residual) within the broader locality to the east and west, and potential populations within this area are likely to be low density populations.
- Largely contiguous habitat occurring south of the study area and offering better quality east-west habitat connectivity on a local and regional scale.

2.3.2 Important Population

In DSEWPaC (2012), a Koala population is '*defined by the capacity of individuals to move from one habitat patch to another*'. The resident Koalas/ breeding aggregation/s whose home ranges encompass the study area around Nambucca Heads State Forest/ Old Coast Road, are likely to form part of a local sub-population that is interconnected with sub-populations centred around Newry State Forest to the north and possibly Viewmont State Forest to the west. Key topographic features bounding this sub-population include the Pacific Ocean to the east, Nambucca River to the south and Deep Creek to the north. This sub-population forms part of the broader Nambucca Valley Koala population, which is bound by the Nambucca River to the south, Bellinger and Kalang Rivers to the north and Pacific Ocean to the east.

DoE (2013a) defines an 'important population' as a '*…population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *Key source populations either for breeding or dispersal.*
- *Populations that are necessary for maintaining genetic diversity.*
- *Populations that are near the limit of the species' range.*

The study area is located in north-east NSW which is considered a stronghold for the species in the State (DoE 2013b). While the national Koala recovery plan is yet to be complete, the subject Nambucca Valley Koala population is considered an 'important population' as it provides a local source population for breeding or dispersal, and protection of this population helps maintain genetic diversity in the region.

The subject Nambucca Valley Koala population is situated between the Coffs Harbour and Port Macquarie populations which are regarded as important Koala population centres (DECC 2008). The eastern portions of this population are somewhat separated from the Coffs Harbour population due to the Bellinger River and Kalang River in the north and the Kempsey population by the Nambucca River to the south. The western portion of the subject population is however likely to support north-south Koala movements and contribute to the maintenance of genetic diversity between the abovementioned identified important Koala population centres.

2.3.3 Habitat Critical to the Survival of the Koala

DSEWPaC (2012) identifies habitat critical to the survival of the Koala as areas of '*forest or woodland where:*

- *Primary Koala food tree species comprise at least 30 per cent of the overstorey trees,*
- *Primary Koala food tree species comprise less than 30 per cent of the overstorey trees, but together with secondary food tree species comprise at least 50 per cent of the overstorey trees,*
- *Primary food tree species are absent but secondary food tree species alone comprise at least 50 per cent of the overstorey trees,*
- *The above qualities may be absent in a forest or woodland but other essential habitat features are present and adjacent to areas exhibiting the above qualities (e.g. Koalas in the Pilliga are known to escape the heat of the day by taking refuge in white cypress pines, which are not food trees), or*
- *A relatively high density of Koalas is supported, regardless of the presence of food tree species. Koala population densities vary across their range and regional data should be used to judge relative density.*

Habitat critical to the survival of the Koala is also considered to be any form of landscape corridor which is essential to the dispersal of Koalas between forest or woodland habitats'.

The criteria and how they relate to the study area are discussed below.

2.3.3.1 Proportion of Primary Koala food Trees

Localised areas estimated at 19 per cent of the forest habitats within the study area support proportions of Koala food trees within the overstorey that satisfy the criteria of habitat critical to the survival of the Koala (primary Koala feed trees > 30 per cent). They occur in a mosaic across the landscape and were found within three vegetation communities:

- Map Unit 1: Open Forest – Blackbutt: estimated at 29 per cent of this community.
- Map Unit 3: Moist Forest – White Mahogany/ Grey Gum/ Ironbark: estimated at 10 per cent of this community.
- Map Unit 6: Swamp Forest – Swamp Mahogany/ Paperbark: estimated at 14 per cent of this community.

2.3.3.2 Koala Usage

DECC (2008) states that Koala populations on the NSW North Coast are typically of medium density. As discussed previously, the assessment results indicate study area north of the Nambucca River is likely to support a low density Koala population. Therefore the DSEWPaC (2012) critical Koala habitat criterion of '*a relatively high density of Koalas is supported*' is not satisfied.

2.3.3.3 Habitat Connectivity

In relation to the DSEWPaC (2012) critical Koala habitat criterion '*Habitat critical to the survival of the Koala is also considered to be any form of landscape corridor which is essential to the dispersal of Koalas between forest or woodland habitats*'; the study area north of the Nambucca River meets this criteria. As discussed previously it forms part of a north-south regional corridor (Scotts 2003), bounded by the Nambucca River to the south and east (forming a habitat 'cul-de-sac' or edge). While it does not provide a link between Koala populations, it meets this criterion by being important for:

- The movement of Koalas that occupy this habitat as part of their home range.
- The dispersal of Koalas from this area to other habitats (e.g. to the north and west).
- The dispersal of Koalas from other habitats to this habitat.

Koala records south of the Nambucca River are sparse and connectivity between the main stands of forest in the locality to the west (Ingalba State Forest area) and east (Yarriabini National Park/ Way Way State Forest area) is provided by largely contiguous forest south of the study area. This and the assessment results of the population survey (refer to **Section 2.3.2**) suggest that the study area south of the Nambucca River does not satisfy the SEWPaC (2012) critical Koala habitat criterion in relation to connectivity/ corridor values.

2.3.3.4 Summary

In total approximately 86.5 hectares of habitat within the Proposal footprint comprises habitat critical to the survival of the Koala as per the DSEWPaC (2012) definition. Of this, 81.8 hectares occurs north of the Nambucca River (based on species composition and habitat connectivity values) and 4.7 hectares of which occurs south of the Nambucca River (based on species composition).

Key Threats and Potential Impacts of the Project

3.1 Key Threats to the Species

The main recognised threats to the Koala include habitat loss, fragmentation and degradation; mortality from vehicle strikes; disease; and predation by dogs (DoE 2013b). Other threats include fire, severe weather conditions, swimming pools and over browsing (DECC 2008). These threats are consistent with the assessment of the overall biodiversity impacts of the Proposal (SKM 2010a) which concluded that the main threats relevant to the Proposal include:

- Habitat loss, fragmentation and degradation.
- Mortality from vehicle strike.
- Disease.
- Fire.

Further details on these threats as they relate to the Project are provided in the following Sections.

3.2 Potential Impacts from the Project

3.2.1 Habitat Loss, Fragmentation and Degradation

The Project requires the direct removal of approximately 106.6 hectares of potential Koala habitat. Clearing areas are based on the SKM (2010b) GIS vegetation layer as derived from the vegetation surveys completed for the WC2U EA and are defined in **Section 2.3.1**:

Approximately 86.5 hectares of this vegetation comprises habitat critical to the survival of the Koala as per the DSEWPaC (2012) definition (refer to **Section 2.3.3**). This vegetation clearing represents a negative cumulative impact of habitat removal for the Koala and comprises a listed Key Threatening Process (KTP) responsible for the decline of the Koala.

Approximately 81.8 hectares of the potential Koala habitat requiring removal is located north of the Nambucca River and associated with Nambucca State Forest/ Old Coast Road area. Habitat removal in this area will:

- Result in fragmentation of this large stand of vegetation associated with Nambucca State Forest.
- Create new forest edges and increase edge effects in adjacent habitats (refer to SKM 2010b for details).
- Directly remove and fragment habitat subject to a low level of Koala usage as part of the range of resident individual Koala's/ breeding aggregates of the local low density Koala sub-population.

Approximately 24.8 hectares of the potential Koala habitat requiring removal is located south of the Nambucca River. This will include localised habitat fragmentation of some stands of forest, though the fragmentation will be less substantial than to the north of the Nambucca River due to the existing highly modified state of this landscape.

It is difficult to quantify the impacts of this habitat removal/ fragmentation/ degradation to the local Koala sub-population, especially due to the apparently low density of the local population and low levels of Koala activity detected within the study area. Some individuals whose home range encompasses the site will be affected by direct habitat loss and fragmentation, while other local resident Koalas based in adjacent habitats may be indirectly affected, through changes in Koala usage (e.g. home range configurations), adding increased pressure to the local Koala sub-population.

The number of individual Koalas and proportion of the total local important Koala population potentially affected by the Proposal is likely to be low, given:

- The presence of a low density Koala population and low levels of Koala activity recorded within the study area as part of Koala surveys undertaken for the impact assessment (GeoLINK, 2013) and the results of desktop studies.
- That the broader area surrounding the Project that is occupied by the identified local important Koala population is extensive.

The impacts of habitat fragmentation on wildlife are detailed in SKM (2010b). The main impacts relevant to the Koala include impacts on movement corridors, access to habitat to satisfy biological requirements, genetic exchange, increasing edge effects, and reduced ability for population recovery following stochastic events. While parts of the local landscape have already been fragmented from past clearing and development, the Proposal would contribute to this cumulative fragmentation through habitat clearing and construction of a major highway, approximately 16.5 kilometres of which deviates from the existing highway alignment. To counter these impacts the Proposal design includes a number of fauna underpasses with fauna fencing. The fauna underpass designs proposed have been recorded as being used by Koalas on other projects (SKM 2010b, 2010c). Therefore, while the Proposal without appropriate mitigation could lead to habitat fragmentation and reduced connectivity, opportunities for Koalas to move between habitats on opposing sides of the highway post construction would be available.

During the construction stage of the Proposal, there is a risk of Koala mortality/ injury during clearing works. Mitigation measures associated with the Proposal however aim to reduce the risk of such impacts, including Koala management protocols and procedures for fauna handling and rescue.

3.2.2 Road Kill

Vehicle strikes to the Koala have been well documented (DECC 2008) and pose a particular threat to low density Koala populations due to the large movements undertaken to satisfy their biological requirements (e.g. foraging, reproduction, dispersal, etc) and the low Koala numbers typically associated with such populations (Biolink 2009). Approximately 16.5 kilometres of the 19.5 kilometres WC2NH Pacific Highway upgrade will deviate from the existing Pacific Highway alignment.

The overall risk of vehicle strikes to Koala's locally is unlikely to significantly increase as:

- Extensive fauna fencing is proposed along the highway where it adjoins forest north of Nambucca River and at several locations south of the Nambucca River where the highway intersects vegetation (refer to **Appendix E**). In total approximately 12.1 kilometres of the new highway would support fauna exclusion fencing, approximately 6.7 kilometres of which is located north of the Nambucca River and 5.4 kilometres of which is located south of the Nambucca River.
- Fauna underpasses would be established to allow for safe passage across the highway.
- The study area north of the Nambucca River appears to be subject to a low level of Koala activity.
- South of the Nambucca River:
  - The study area is highly fragmented and does not appear to support a resident Koala population.
  - The potential frequency of east-west Koala movements is likely to be very low and better quality habitat connectivity occurs to the south of the study area.
  - The new highway alignment runs roughly parallel to the existing highway, therefore any Koalas potentially moving through the area are vulnerable to an existing road collision threat.

The use of fauna fencing and associated underpasses has been proven as effective measures to reduce road kill on other highway upgrade projects.

3.2.3 Disease

Disease is a recognised threat to the Koala (DECC 2008; DoE 2013b). The habitat removal/ fragmentation associated with the Proposal has potential to cause environmental pressure and therefore increase the occurrence or severity of disease in the local Koala population. The number of individual Koalas and proportion of the total local Koala population potentially susceptible to environmental stresses as a result of the Proposal is likely to be low.

3.2.4 Fire

The threat of fire to Koalas is documented in DECC (2008). The main area potentially susceptible to changes in fire patterns or where fauna fencing poses a risk of Koala entrapment during fire events is the Nambucca State Forest/ Old Coast Road area. The remainder of habitat in the study area is fragmented and comprises relatively small patches of vegetation. It is hard to quantify the potential changes in fire frequency or intensity as a result of the Proposal. For example, the increased human presences may increase the risk of fires starting (accidental or arson), though the fragmentation imposed by the highway may reduce the risk of stochastic events from wildfire. It is acknowledged however that there is potential for the Proposal to change the dynamics of the fire and Koalas response in the Nambucca State Forest/ Old Coast Road area.

4 Pre-construction Management Measures

4.1 Overview of Activities

Pre-construction activities would involve the following works:

- Survey works.
- Water quality monitoring.
- Translocation of threatened plants.
- Geotechnical investigations.
- Completion of utility relocations.
- Construction of sites accesses.

4.2 Timing

Pre-construction works are to be undertaken up until the commencement of construction stage works which are anticipated to commence in December 2014.

4.3 Summary of Potential Impacts

Pre-construction activities may have the following potential impacts to Koalas:

- Potential mortality to Koalas from pre-construction activities.
- Potential road strike and mortality of Koalas from pre-construction/ local traffic.

4.4 Main Goals for Management

The main goals for management are as follows:

- No habitat loss for the Koala from pre-construction activities.
- No injury/ mortality to Koalas from pre-construction activities.
- Minimise road strike of Koala during pre-construction activities.
- Ensure that appropriate habitat offsets have been identified for Koala conservation.

4.5 Mitigation Measures

4.5.1 Detailed Design Considerations

As detailed design progresses, a number of factors will be addressed to minimise the impacts on the Koala. These include:

- Avoiding and minimising vegetation removal where feasible and reasonable.
- Placement of ancillary facilities outside of Koala habitat.
- Maximising the suitability of fauna crossing structures and fauna exclusion fencing to reduce road kills and enhance habitat connectivity (refer to **Section 6** for further information).

4.5.2 Identifying Habitat Restoration/Connectivity Areas

It is proposed to enhance connectivity in the landscape wherever possible through the provision of strategic tree planting in road reserves and residual land acquired for the Project. A number of areas have been identified by the Project team (Roads and Maritime, Jacobs, AFJV and GeoLINK) and described within preliminary documentation submitted to DoE 9 September 2014 (refer to **Appendix B**). Of the areas identified, 12 of these sites are identified as areas with potential to be used by Koalas. These areas would be rehabilitated during the construction stage of the Project (refer to **Section 5.4.6**).

4.5.3 Controls on Habitat Clearing (Pre-construction)

During the pre-construction stage of the Project (prior to approval of the CEMP) only clearing defined as 'minor' (except where threatened species, populations or endangered ecological communities would be impacted) can be undertaken, unless approval is sought from the Director-General (refer to Approval Instrument Definitions for construction). Prior to any clearing taking place, a suitably qualified Project Ecologist will undertake an inspection of vegetation to be cleared to determine that only 'minor clearing' is to be undertaken. Minor clearing will be defined as the following:

- Vegetation that does not include mature trees >150 mm DBH.
- Vegetation that does not comprise known threatened fauna habitat. In the case of the Koala, this is defined as mature Koala feed trees or areas mapped as Koala habitat during pre-clearance ground-truthing surveys.
- Areas of vegetation that have ecological constraints (e.g. threatened flora habitat/ areas of EEC).

All areas to be cleared are to be delineated with flagging tape to clearly mark the clearing extents.

4.5.4 Pre-clearing Surveys

For any area of vegetation to be cleared during the pre-construction stage of the Project, a suitably qualified ecologist will undertake a search for native fauna (including Koalas) in the vicinity of clearing immediately prior to clearing commencing. In the event that a Koala is identified within 50 metres of a works area, works will be rescheduled to be initiated during the construction stage of the Project (refer to **Table 4.1**). Searches will take place no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the Koala.

4.5.5 Environmental Work Method Statements

Environmental Work Method Statements (EWMS) will be prepared for all pre-construction tasks potentially impacting environmental sensitive areas. The EWMS will provide an opportunity to assess any risks to fauna (including Koalas) for the pre-construction activities and to incorporate mitigation measures into work methodologies where necessary to minimise the potential for impacts. Where an EWMS identifies risks to fauna, the Project Ecologist will be consulted to provide input where necessary.

4.5.6 Inductions

An environmental induction will be prepared and delivered to personnel involved with the pre-construction activities. Relevant points to be delivered in this induction in relation to Koala management are as follows:

- Potential presence on site (identification and potential habitat).
- Requirements for all personnel to report sightings (including road kill) immediately to the Environmental team (including the Project Ecologist).
- Requirements for works to cease within 50 metres of any live Koala detected on/near the site until authorisation has been given for works to commence from the Environmental Manager and other aspects of the Koala Management Protocol (refer to **Table 4.1**).

4.5.7 Koala Management Protocol

For all Koalas detected on/near the site the following protocol as shown in **Table 4.1** is to be implemented with compliance documented. As mentioned, for the pre-construction works, in the event that a Koala is identified within 50 metres of a works area, works will be rescheduled until the construction stage of the Project.

Table 4.1 Management Protocol for Koalas Observed on the Site

Action		*Personnel Responsible*	*Reporting*
1	Report sightings of any Koalas (including road kill) immediately to the Environmental team.	All personnel working on site	The Environmental Manager shall be advised of any Koala records immediately.
2	In the case that Koala road kill is detected, an assessment of future road kill risk for Koalas will be undertaken by a suitably qualified Project Ecologist who will aim to provide actions to mitigate the risk of future Koala road kill in this area. Additional measures to be considered will include (but not be limited to): ▪ Provision of Koala signage. ▪ Temporary fauna fence. ▪ Further escape points.	AFJV/ Roads and Maritime Services/ suitably qualified Project Ecologist	The Environmental Manager shall notify the Roads and Maritime Representative who will inform the EPA Project Officer. Adaptive management recommendations will be provided by a suitably qualified Project Ecologist to the AFJV/ Roads and Maritime for consideration.
3	Where a live Koala is detected on/near the site, no works are to be undertaken within 50 metres of the individual until the animal has relocated from the area and authorisation has been given by a suitably qualified Project Ecologist. Prior to the construction stage where a Koala is detected in the vicinity (within 50 metres) of pre-construction works, such works would be rescheduled to be initiated during the construction stage of the Project.	AFJV/ suitably qualified Project Ecologist	Actions of foreman to be reported to Environmental Manager.
4	A suitably qualified Project Ecologist will inspect the Koala and assess the health of the individual. If the animal is injured/ diseased it will be taken for treatment. Implementation of the FFMP Fauna Handling and Rescue Procedure (refer to FFMP Appendix I).	AFJV/ suitably qualified Project Ecologist	A suitably qualified Project Ecologist to contact Port Macquarie Koala Hospital/ WIRES if animal shows signs of injury/ disease.
5	A suitably qualified Project Ecologist is to assess if self-relocation or capture/ relocation is required based on a risk assessment of the animals welfare. The animal will either be allowed to self-relocate from the site or an ecologist with experience and approval to handle fauna will be engaged to capture/ relocate the animal in accordance with the Koala Capture Relocation Strategy included in **Appendix C**.	AFJV/ suitably qualified Project Ecologist	EPA/ Roads and Maritime to be consulted if capture/ relocation required.

Action		*Personnel Responsible*	*Reporting*
6	No works will proceed within 50 metres of the individual until authorisation has been provided by the AFJV (Environmental Manager) and a suitably qualified Project Ecologist. Prior to the construction stage where a Koala is detected in the vicinity (within 50 metres) of pre-construction works, such works would be rescheduled to be initiated during the construction stage of the Project.	AFJV/ suitably qualified Project Ecologist	A suitably qualified Project Ecologist will follow up with written confirmation that the area was free from Koalas enabling works to proceed.

4.5.8 Identifying Koala Habitat Offsets

As part of the habitat offset strategy currently being prepared for the Project, appropriate habitat offset properties are currently being investigated by Roads and Maritime Services. The investigation of such properties will include targeted Koala surveys including SAT plots, spotlighting and call-playback surveys in accordance with recognised survey approaches to confirm usage of these areas by Koalas.

4.5.9 Pre-construction Monitoring

Pre-construction Koala population monitoring has been undertaken to obtain baseline data on the local Koala population associated with the Project Site. The details of the monitoring program for Koalas are provided in **Section 7**.

4.6 Performance Measures and Corrective Actions

Table 4.2 presents the main goals of Koala management for pre-construction activities and includes the relevant mitigation measures for Koalas that are to be employed 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.

Table 4.2 Pre-construction Management Goals, Mitigation Measures, Performance Thresholds and Corrective Actions

Management Goal	*Mitigation/Control Measure*	*Monitoring/Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
No habitat loss for the Koala from pre-construction activities.	▪ Minimise areas of Koala habitat to be cleared where feasible and reasonable during the detailed design phase.	▪ Constraints maps to include Koala habitat mapping (SAT results).	AFJV (Design team)/ suitably qualified Project Ecologist	▪ No Koala habitat to be cleared during the pre-construction stage.	▪ Consideration of additional offsets for habitat loss.
	▪ All ancillary sites to be located outside of mapped Koala habitat.	▪ Ecological assessments to be prepared for ancillary sites to verify minimal impacts to Koala habitat.	AFJV (Environmental team)/ suitably qualified Project Ecologist	▪ No areas of mapped Koala habitat to be impacted by the ancillary facilities.	▪ Consideration of additional offsets for habitat loss.
	▪ Prior to any clearing taking place, the Project Ecologist will undertake an inspection of vegetation, to be cleared, to determine if work activities do not constitute "Construction" as defined in the planning approval under the NSW EP&A Act and are excluded from the Referral under the Federal EPBC Act.	▪ Pre-clearing permits to be completed by the Project Ecologist prior to the clearing of areas of vegetation.	AFJV/ suitably qualified Project Ecologist	▪ No Koala habitat to be cleared during the pre-construction stage.	
	▪ The limits of clearing are to be clearly marked on all relevant work plans and protective fencing erected to mark these limits (i.e. 'no-go' areas).	▪ Limits of clearing will be marked out prior to clearing commencing in that area. Fencing installed prior to vegetation clearing activities commencing in that area. Fencing and no-go signage inspected weekly, until construction completion.	AFJV	▪ Final Sensitive Area Plans identify sensitive areas and 100% of clearing drawings identify clearing extents. ▪ Completion of pre-clearing survey prior to construction including mark out of clearing extents.	▪ Notification to DoE, EPA if over clearing occurs.

Management Goal	*Mitigation/Control Measure*	*Monitoring/Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
	▪ Areas for Koala habitat restoration/ connectivity are to be identified and included in the detailed design.	▪ Identified areas for Koala habitat restoration/ connectively have been determined (refer to **Appendix B**).	Roads and Maritime/ AFJV (Design team)	▪ All areas outlined as Koala habitat restoration opportunities are to be shown on the detailed design and planted appropriately.	
No injury/ mortality to Koalas from pre-construction activities.	▪ Preparation of an EWMS would be undertaken for all work activities and would include where necessary measures to minimise risk to Koalas. ▪ Induction of all personnel involved with pre-construction activities would be undertaken to advise on Koala management requirements. ▪ For any area of vegetation to be cleared during the pre-construction stage of the Project, a suitably qualified ecologist will undertake a search for native fauna (including Koalas) in the vicinity of clearing immediately prior to clearing commencing. ▪ In the event that a Koala is identified within 50 metres of a works area, works will be rescheduled until the construction stage of the Project. ▪ For all Koalas detected on/near the site the protocol as shown in **Table 4.1** is to be implemented. As mentioned, for the pre-construction works, in the event that a Koala is identified within 50 metres of a works area, works will be rescheduled until the construction stage of the Project.	▪ Pre-clearing permits to be completed by a suitably qualified Project Ecologist prior to the clearing of any vegetation. ▪ Post-clearing inspections to be undertaken of areas cleared to identify any animal (including Koalas) injured or killed during clearing.	AFJV (Environmental & Construction team)/ suitably qualified Project Ecologist	▪ No Koala injuries/ mortalities as a consequence of pre-construction activities.	▪ Notification to DoE, EPA if a Koala mortality is recorded on the Project. ▪ Adaptive management response plan to be provided by Project Ecologist if mortality recorded.

Management Goal	*Mitigation/Control Measure*	*Monitoring/Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
Minimise vehicle strike of Koala during pre-construction activities.	▪ Koala Management Protocol to be implemented requiring all personnel to report Koalas (including road kill). ▪ Assessment of future road kill risk including adaptive management actions to be provided by ecologist where Koala road kill is detected.	▪ Road kill monitoring to be undertaken (refer to **Section 7**).	AFJV/ Roads and Maritime	▪ No road kill of Koalas resulting from the Project.	▪ Where Koala road kill is detected in proximity to the Project the Project Ecologist will provide an assessment of future road kill risk for Koalas and adaptive management requirements where appropriate.
Ensure that appropriate habitat offsets have been identified for Koala conservation.	▪ Appropriate habitat offsets to be identified by including targeted Koala surveys (GeoLINK 2014) using recognised survey approaches to confirm usage of potential offset properties.	▪ Offset properties are currently being investigated by Roads and Maritime.	Roads and Maritime	▪ Suitable offset of Koala habitat in accordance with the EPBC Environmental Offsets Policy (2012).	

5

Construction Management Measures

5.1 Timing

Construction works are anticipated to commence in December 2014 and are expected to be completed in early 2018.

5.2 Summary of Potential Impacts

The construction stage works are anticipated to have the following potential impacts on Koalas:

- Habitat loss for the Koala from clearing works.
- Injury/ mortality to individuals from clearing/ construction works.
- Increased levels of vehicle strike on the existing highway from changed movement patterns in the locality of the site.
- Fragmentation of habitat and impacts to Koala movements.

5.3 Main Goals for Management

The main goals for management are as follows:

- Minimise habitat loss for the Koala from clearing.
- No injury/ mortality to Koalas from construction activities.
- Minimise vehicle strike of Koala during construction activities.
- Undertake habitat rehabilitation works within identified areas associated with the Project Site for to create additional Koala habitat.
- Ensure fauna crossing structures are constructed to maximise usage by fauna.

5.4 Mitigation Measures

5.4.1 Environmental Work Method Statements

Environmental Work Method Statements (EWMS) will be prepared for all construction activities potentially impacting fauna (including Koalas) as detailed in **Section 4.5.5**.

5.4.2 Inductions

An environmental induction will be prepared and delivered to all personnel involved with the construction stage as detailed in **Section 4.5.6**.

5.4.3 Controls on Habitat Clearing

The following controls will be implemented to ensure that no over clearing occurs on the Project:

- Clearing limits are to be marked out accurately with no-go delineation.
- Clearing limits to be checked prior to the commencement of clearing by survey and environmental team.

5.4.4 Pre-clearing Surveys and Staged Habitat Removal

Prior to vegetation clearing, a suitably qualified ecologist/ expert will survey all areas to be cleared and will mark out any areas of significant vegetation (EECs, threatened species, riparian vegetation and mangroves) to be fenced and protected. Pre-clearing surveys will also include spotlighting surveys within suitable habitat on the night prior to clearing operations commencing in a given area.

Immediately prior (within two hours) of clearing commencing an additional ecologist inspection is to be undertaken to confirm that clearing areas remain free of fauna (including Koalas). Where Koalas are identified no works would be undertaken within 50 metres of the animal and the measures within the Fauna Management Protocol for Koalas (refer to **Table 4.1**) would be implemented. This process will affect a two staged approach to clearing of known Koala habitat. Should relocation of Koalas be required, a Koala Relocation Strategy included in **Appendix C** would be implemented.

During the proposed clearing works, an experienced wildlife handler will be present to retrieve any displaced fauna and release the fauna into adjacent habitats safe from construction work.

5.4.5 Jersey Barrier Arrangement

The arrangement of Type F concrete barriers in a continuous line along one side (or centre) of the existing highway has the potential to create additional barriers to Koalas attempting to cross the highway and increase the risk of car strike. Prior to the construction of fauna passage locations and installation of fauna fence, where continuous lines of Type F concrete barriers are to be installed, gaps are to be provided to allow escape of any animals off the highway. The provision of these gaps is to be designed in consultation with the Project Ecologist. It is acknowledged that traffic safety requirements will need to be taken into account. Where continuous lines of Type F concrete barriers are required in Koala habitat, material is to be attached at strategic locations (as advised by the Project Ecologist) to allow Koalas to climb over barriers.

5.4.6 Habitat Rehabilitation Areas

Areas identified for additional Koala habitat/ connectivity (refer to **Appendix B**) would be rehabilitated during the construction stage works. Key rehabilitation measures will 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 of locally occurring species, including plants representative of groundcover, understorey and canopy strata.
- Planting of preferred food trees for native fauna, including appropriate eucalypt species for the Koala.
- Plantings are to be undertaken around fauna crossing structures to optimise utilisation of these structures.
- Monitoring and maintenance of plantings.
- Managing and controlling weeds.

The specific Koala food trees, associated with each of the vegetation map units, to be used in replanting areas are provided in **Table 5.1** below.

Table 5.1 Summary of Primary and Secondary Koala Feed Trees and Corresponding Vegetation Types

Vegetation Community	*Habitat Type*	*Primary Koala Food (DECC 2008)*	*Secondary Food Tree Species (DECC 2008)*
Map Unit 1: Open Forest – Blackbutt	Dry Sclerophyll Forest	Tallowwood	▪ Small-fruited Grey Gum. ▪ Red Mahogany. Note: Blackbutt may also be considered and is identified as a supplementary feed tree (Professor Rob Close, University of Western Sydney. pers. comm. 2013).
Map Unit 2: Mixed Floodplain Forest	Wet Sclerophyll Forest	Tallowwood	▪ Small-fruited Grey Gum. ▪ Red Mahogany.
Map Unit 3: Moist Forest – White Mahogany/ Grey Gum/ Ironbark	Wet Sclerophyll Forest	Tallowwood	▪ Small-fruited Grey Gum. ▪ Red Mahogany.
Map Unit 4: Moist Forest – Flooded Gum	Wet Sclerophyll Forest	Tallowwood	▪ Small-fruited Grey Gum. ▪ Red Mahogany.
Map Unit 6: Swamp Forest – Swamp Mahogany/Paperbark	Swamp Sclerophyll Forest	Swamp Mahogany	▪ Small-fruited Grey Gum. ▪ Red Mahogany.

5.4.7 Construction Stage Monitoring

Construction stage monitoring for Koalas will be undertaken. The details of this monitoring is summarised in **Section 7**.

5.5 Performance Measures and Corrective Actions

Table 5.2 presents the main goals of Koala management for construction activities and includes the relevant mitigation measures for Koalas that are to be completed during the construction phase of the Project. 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.

Table 5.2 Construction Management Goals, Mitigation Measures, Performance Thresholds and Corrective Actions

Management Goal	*Mitigation/Control Measure*	*Monitoring /Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
Minimise habitat loss for the Koala from clearing.	▪ Any design changes required during the construction stage would minimise clearing of Koala habitat where feasible and reasonable.	▪ Ecological Assessments to be prepared for additional areas to be cleared to verify minimal impacts to Koala habitat.	AFJV (Environmental team, Design team)	▪ Koala habitat to be cleared to not exceed areas detailed in **Section 3.2**.	▪ Notification to DoE, EPA if the performance thresholds cannot be met. ▪ Additional habitat rehabilitation works to be undertaken on the Project to offset losses.
	▪ The limits of clearing are to be clearly marked on all relevant work plans and protective fencing erected to mark these limits (i.e. 'no-go' areas).	▪ Clearing limits to be checked (at least five working days) prior to the commencement of clearing by survey and environmental team.	AFJV (Environmental team, Survey team)	▪ Final Sensitive Area Plans identify sensitive areas and 100% of clearing drawings identify clearing extents ▪ Clearing limit not exceeds areas detailed in **Section 3.2**.	
No injury/mortality to Koalas from construction activities.	▪ Preparation of an EWMS would be undertaken for all construction activities to clearly communicate relevant measures within this Plan to work crews. ▪ Ongoing induction of all personnel involved with construction activities would be undertaken to advise of Koala management requirements. ▪ A suitably qualified ecologist will undertake pre-clearing surveys for threatened fauna species (including Koalas) prior to any clearing commencing (within 48 hours). These are to include spotlighting surveys within suitable habitat on the night prior to clearing operations commencing in a given area.	▪ Pre-clearing permits to be completed by the Project Ecologist prior to the clearing of any vegetation. ▪ Post-clearing inspections to be undertaken of areas cleared to identify any animal (including Koalas) injured or killed during clearing.	AFJV (Environmental/ Construction team)/ suitably qualified Project Ecologist	▪ No Koalas injuries/ mortalities as a consequence of construction activities.	▪ Notification to DoE, EPA if a Koala mortality is recorded on the Project.

Management Goal	*Mitigation/Control Measure*	*Monitoring /Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
	▪ During the proposed clearing works, the suitably qualified expert or an experienced wildlife handler under the supervision of the suitably qualified expert will be available to retrieve and provide appropriate care of any displaced matters of NES and release the fauna into adjacent habitats safe from construction work. ▪ Immediately prior to (within two hours) of clearing commencing in a given area, an additional ecologist inspection is to be undertaken to confirm that clearing areas remain free of fauna (including Koalas). ▪ Where Koalas are identified no works would be undertaken within 50 metres of the animal and the measures within the Fauna Management Protocol for Koalas (refer to **Table 4.1**) would be implemented. ▪ Should relocation of Koalas be required, a Koala Relocation Strategy included in **Appendix C** would be implemented.				
Minimise road kill of Koala during construction activities.	▪ Prior to the construction of fauna passage locations and installation of fauna fence, where continuous lines of jersey barriers are to be installed, gaps are to be provided to allow escape of any animals off the highway. Where gaps cannot be provided, a suitable material will be placed over the barrier to allow Koalas to climb over the barrier. ▪ Koala Management Protocol to be implemented requiring all personnel to report Koalas (including road kill). ▪ An assessment of future road kill risks including	▪ Road kill monitoring to be undertaken (refer to **Section 7**).	AFJV (Environmental team/ suitably qualified Project Ecologist	▪ No road kill of Koalas resulting from the Project.	▪ An assessment of future road kill risk will be undertaken by the Project Ecologist for areas where Koala road kill have been detected. This assessment will aim to provide actions to mitigate the risk of future Koala road kill in

Management Goal	*Mitigation/Control Measure*	*Monitoring /Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
	adaptive management actions is to be provided by the Project Ecologist where: - A Koala is detected within/near the site, or - Koala road kill is detected.				such areas.
Undertake habitat rehabilitation works within identified areas associated with the Project Site for to create additional Koala habitat.	▪ Progressive rehabilitation of identified areas (refer to **Appendix B**) during the construction stage using collected topsoil and seed at specific sites and to develop different successional stages of rehabilitation. 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 of locally occurring species, including plants representative of groundcover, understorey and canopy strata. - Planting of preferred food trees for native fauna, including appropriate eucalypt species for the Koala. - Plantings are to be undertaken around fauna crossing structures to optimise utilisation of these structures. - Monitoring and maintenance of plantings. - Managing and controlling weeds.	▪ Monitoring and maintenance of rehabilitation areas to be undertaken regularly as part of the Project landscaping contract. ▪ Weed monitoring would be undertaken on the site.	AFJV (Landscape Design/ Construction team)	▪ Successful establishment of Koala habitat in nominated areas.	▪ Consideration of additional landscaping/ habitat rehabilitation works.
Ensure fauna crossing structures are constructed to maximise usage by fauna.	▪ EPA will be consulted during the detailed design phase on fauna crossing structure specific requirements for fauna furniture and treatments in and around fauna crossing structures. This will include, but not necessarily be limited to	▪ To be undertaken during the detailed design phase.	AFJV/ Project Ecologist	▪ Concurrence from EPA on fauna furniture/ treatments in and around fauna	▪ None required as must be undertaken.

Management Goal	*Mitigation/Control Measure*	*Monitoring /Timing Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
	requirements for refuge poles and/or horizontal rails, pathways and appropriate plantings and/or sizing/ placement of scour rock and treatment of the substrate e.g. soil and/or mulch over the concrete floor and apron. ▪ Advice will be provided by the Project Ecologist on fauna furniture to be installed within fauna crossing structures.			crossing structures	

6 Operational Management Measures

6.1 Summary of Potential Impacts

The operational stage of the Project has the potential to have the following impacts on Koalas:

- Fragmentation of habitat and impacts to Koala movements.
- Increased risk of vehicle strike associated with the upgrade.

6.2 Main Goals for Management

The main goals for management are as follows:

- Maintain connectivity for Koalas potentially utilising habitats on either side of the upgrade.
- Minimise vehicle strike of Koala during operational activities.
- Maintain habitat rehabilitation areas.

6.3 Mitigation Measures

6.3.1 Habitat Offset Strategy

This Strategy would be prepared and implemented to offset the biodiversity impacts of the Project to address the Minister's Conditions of Approval (MCoA B8) for the WC2U Upgrade Project to meet EPBC offset requirements.

6.3.2 Maintenance of Habitat Rehabilitation Areas

Areas identified for additional Koala habitat/ connectivity (refer to **Appendix B**) would be maintained by the AFJV during the landscape maintenance period, which extends into the operational stage of the Project. Maintenance would include weed control works and replacement plantings if necessary. Maintenance would also be undertaken near fauna crossing structures and fencing and in all cases would be undertaken until rehabilitation areas have become self-sustaining.

6.3.3 Fauna Connectivity/Passage

The Proposal design includes fauna underpass and fauna exclusion fencing to allow for safe passage of fauna (including the Koala) crossing the Pacific Highway and reduce the risk of injury/ road kill.

The location and sizes of fauna underpass structures had been identified in the Conditions of the Approval of the Project under the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) issued by the Minister for Planning and Infrastructure on 19 July 2011.

In response to a request from DoE following submission of the Referral under the EPBC Act, these fauna crossing locations were subject to an independent review by the Koala expert[1] Dr Rod Kavanagh and were modified in response to the recommendations of the review. There are a number of differences between the underpass structures identified in the Conditions of Approval under the EP&A Act, those recommended in the independent review and those that would be required to comply with the comments received from DoE following review of the Referral.

[1] Rod Kavanagh is an internationally recognised forest wildlife scientist with more than 35 years' experience in the design, implementation, analysis and reporting of ecological experiments, fauna surveys and biodiversity monitoring programs.

A workshop with NSW Environment Protection Authority (EPA), Rod Kavanagh, ecologists involved with the roject and other stakeholders was held to review the fauna underpass options developed, including additional options developed by the Project team, and to reach agreement on the most appropriate underpass option for each location. Details of the agreed fauna underpasses being constructed as part of the Project are provided in **Appendix D**.

Approximately 12.1 kilometres of the new highway (where it intersects/ adjoins the main areas of forest) would support fauna exclusion fencing. Most of this comprises 'floppy-top' fauna exclusion fencing design which was developed by Koala expert Casper Pieters and has been refined for fauna (including Koalas) to minimise road strike. Details of fauna fencing to be provided as part of the Project are provided in Attachment B of **Appendix E.** Attachment A of Appendix E is provided to give indicative locations of the fauna crossings and fauna fences. The Chainages in Attachment A reflect the WC2U EA chainages. To convert these to the referral chainages add 41765.

The majority of the remaining sections of highway where no fencing is proposed intersects or adjoins mostly cleared pastoral land. Ongoing maintenance and repair of the permanent fauna exclusion fencing would be undertaken to restrict Koala from crossing the Pacific Highway upgrade and facilitate the use of fauna crossings would be undertaken post construction under the operational environmental management system.

Following further consultation with EPA additional fauna fence requirements have been agreed to at the following locations:

- Ch 1600 (16365) to Ch 2500 (17265) (eastern side of carriageway) – additional length 900 metres.
- Floodplain and Bridges at Ch 8500 (23265) to 10300 (25065) (1800 metres both sides of the carriageway in both directions) – additional 3600 metres.

- Ch 13500 (28265) to 14400 (29165) (western side of carriageway) – additional length of 900 metres.

6.3.4 Ecological Monitoring

Operational stage monitoring for Koalas will be undertaken. The full methodology and timing for this monitoring is provided in **Section 7**.

6.4 Performance Measures and Corrective Actions

Table 6.1 presents the main goals of Koala management during operation of the WC2NH Upgrade and includes the relevant mitigation measures for Koalas that are to be completed during the operations phase of the Project. 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.

Table 6.1 Operational 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*
Maintain connectivity for Koalas potentially occurring either side of the upgrade.	▪ Fauna Crossing Structures. ▪ Fauna Fencing.	Monitoring of the use of fauna crossing structures (refer to **Section 7**).	Roads and Maritime Services	▪ No change to densities, distribution, habitat use and movement patterns compared to baseline Koala population data.	Consideration of the following options: ▪ Maintenance of the existing connectivity measures ▪ Additional planting around the entrances of fauna crossing structures ▪ Consider additional offset measures to improve connectivity elsewhere.
Minimise road kill of Koala during operation of the WC2NH Project.	▪ Fauna Fencing. ▪ Fauna Crossing Structures.	▪ Road kill monitoring undertaken (refer to **Section 7**). ▪ The Roads and Maritime Roads Asset Division will undertake monitoring of fauna fencing on a regular basis after contractual obligations.	Roads and Maritime Services	▪ All fauna fencing is installed at the minimum of locations as identified in the EPBC approval prior to the operational phase of the WC2NH Upgrade.	▪ Where road kill monitoring identifies a significant difference between the road kill numbers of the different treatments (transect types), DoE and EPA shall be notified, and a meeting will be set to discuss such differences with the relevant agencies, Roads and Maritime and the reporting ecologist.
Maintain habitat rehabilitation areas.	▪ Maintenance of habitat rehabilitation areas.	▪ Regular maintenance of habitat rehabilitation areas (refer to **Appendix B**) would be undertaken as part of the landscape maintenance works.	Roads and Maritime Services/ AFJV	▪ Self-sufficient areas of rehabilitated habitat for Koalas within all nominated areas.	▪ Further maintenance/ additional planting after the end of the landscape maintenance period.

7 Monitoring Program

Jacobs (2014) and Roads and Maritime have prepared a methodology for Koala Population monitoring on the WC2NH Project which is included as **Appendix F**. This methodology has been peer reviewed by Koala expert, Dr Rod Kavanagh and is summarised in this section of the report. Additionally, monitoring of fauna crossing structures for Koalas is proposed as part of the overarching WC2NH ecological monitoring program (Benchmark, 2014). Road kill monitoring is also proposed as part of this Management Plan.

7.1 Koala Population Monitoring

7.1.1 Objectives

The objective of the baseline Koala population monitoring was to establish baseline data relating to densities, distribution and current usage of habitats by the Koala within proximity to the WC2NH Project.

Ongoing monitoring aims to identify changes in resident Koala activity (abundance, home range and movements) in response to construction of WC2NH and the effectiveness of Koala habitat connectivity mitigation measures (i.e. fauna underpasses and exclusion fencing).

7.1.2 Methodology

The methods described below are to be undertaken over two events for each monitoring session.

Transects are to be established on each side of the Project footprint within the Nambucca State Forest/ Old Coast Road area between chainage 15,600 and 19,500. Twenty-five transects, 500 metres long (or to the limit of vegetation) are spaced approximately 150 metres apart running perpendicular to the proposed Project footprint on each side of the highway upgrade.

Each transect is to be surveyed by personnel experienced in Koala surveys to document Koala presence and occupation. Surveys are to be undertaken over two monitoring events as follows:

- Diurnal survey: One observer with binoculars walking the transect searching for Koalas (110 person hours in total).
- Nocturnal survey: One observer spotlighting the transect on foot searching for Koalas at a rate of 0.5 to 1.0 kilometre/ hour (depending on vegetation density) (120 person hours in total). Koala call playback to be undertaken on each transect during spotlighting to increase the chance of Koala detection.

Additional spotlighting is to be undertaken on tracks and easements across this area with the survey effort of five person spotlighting hours at a rate of two kilometres/ hour targeting each side of the highway (10 person hours in total over four nights). Koala call playback to be undertaken at regular intervals along these tracks and easements during spotlighting to increase the chance of Koala detection.

The following data are to be collected for any Koalas detected:

- Location (using global positioning system [GPS])
- Distance from transect line
- Occupied tree species
- Habitat type
- Tree height
- Diameter at breast height
- Koala's sex where discernible

- Behaviour
- Disease status where discernible
- Reproductive status where discernible.

In interpreting the results of the population monitoring program consideration will be given to abiotic factors (seasonal conditions etc) which will be recorded as part of the project.

7.1.3 Timing/Frequency

Pre-construction (baseline) surveys have been completed for autumn (2014) and spring (2014). The results of these surveys are summarised in **Section 7.1.5** below. Transect surveys would also be undertaken annually (in spring) throughout the construction stage of the project (years 1 and 3) and operational stage years 4, 6 and 8.

7.1.4 Performance Indicators

Performance indicators for Koala population monitoring are as follows:

- Koala abundance and distribution pre-construction are similar to post-construction and maintained in the vicinity of Nambucca State Forest/ Old Coast Road.

7.1.5 Results of Pre-construction (Baseline) Koala Population Monitoring

Pre-construction (baseline) monitoring has recently been completed for autumn (2014) and spring (2014).

- Autumn surveys were undertaken over two events (14/04/2014 – 17/04/2014 and 28/04/2014 – 01/05/2014).
- Spring surveys were undertaken over two events (15/09/2014 – 17/09/2014 and 29/09/2014 – 02/10/2014).

The Koala baseline monitoring reports are included as **Appendix G**.

7.1.5.1 Autumn 2014 Survey Results

Autumn diurnal and nocturnal transect surveys yielded no observations of Koalas. Additionally, no Koala faecal pellets or obvious scratches attributable to Koalas were observed during these surveys. One Koala was recorded during spotlighting surveys being conducted along the Old Coast Road in the vicinity of the Nambucca Heads waste facility, west of the highway alignment. This individual responded to call playback and is likely to be a resident male. Vegetation associated with this area is mapped as being predominantly Open Blackbutt forest with some moister gullies comprising Flooded Gum Moist Open Forest.

7.1.5.2 Spring 2014 Survey Results

Spring diurnal and nocturnal transect surveys again did not yield any observations of Koalas nor were any Koala faecal pellets or obvious scratches detected opportunistically. One male Koala was detected calling in response to call playback surveys whilst spotlighting along tracks. This individual was recorded in the southern portion of Nambucca State Forest to the east of the new alignment.

An additional record of a Koala was detected in proximity to this record during other monitoring activities, (Spotted-tail Quoll baseline) being undertaken on the WC2NH project prior to the spring surveys.

7.1.5.3 Conclusions

The results of the baseline Koala surveys confirm earlier studies undertaken as part of the Koala Impact Assessment (GeoLINK, 2013) that the Nambucca State Forest/ Old Coast Road area is subject to low level usage by Koalas. Insufficient data is available from both the previous SAT surveys and these targeted surveys to provide an accurate population estimate of Koalas in the area. However, given the low levels of Koala usage evidenced by the results of the baseline surveys and previous surveys and that the home range of Koalas in low density populations may exceed 100 hectares (Ellis *et al.* 2002 – cited in Biolink 2009), the number of individual Koalas whose home range encompass the study area is likely to be small.

Results to date indicate that Koalas are primarily using the moist gullies that primarily occur in the southern portion of Nambucca State Forest.

The results of the baseline transect surveys do not trigger the need for the provision of GPS/VHF fitted collaring and pit tagging Koalas or the establishment of additional transect survey control sites.

7.2 Monitoring of Fauna Underpasses/Fauna Fences

7.2.1 Objective of Monitoring Program

The objective of the monitoring program is to determine whether mitigation measures (fauna underpasses and fauna fence) are effective in maintaining connectivity for fauna (including Koalas) in the vicinity of the project.

7.2.2 Methodology

7.2.2.1 Fauna Underpasses

Monitoring of fauna underpasses would be undertaken in spring to coincide with the Koala breeding season and likely juvenile dispersal period and involve the use of remote camera surveys at fauna underpasses that include the Koala as a target species as agreed between Roads and Maritime and EPA (refer to **Table 7.1**). Monitoring of underpasses will be undertaken using the following techniques:

- A motion-detecting camera would be installed, at both ends of each crossing structure to be monitored. Cameras are to operate continuously for a period of 60 days during spring/ early summer.
- Sand-plots would be established at each end of each crossing structure to be monitored for a period of eight nights per monitoring event. Sand plots, at least one metre wide, will be established across the entire width of the underpass and will be inspected each following morning period for tracks each morning and then raked clean.
- Scat searches within crossing structures (approximately one to two metres from the end to minimise wind and rain disturbance) and in adjoining habitat would be undertaken. Searches to be undertaken when installing and checking sand plots (i.e. twice per monitoring period).

Table 7.1 Fauna Crossing Structures to be Monitored

Chainage	*Fauna Crossing Structure Type*	*Structure Form*	*Dimensions*
42500	Combined	Bridge over Warrell Ck	
55120	Dedicated	Box Culvert	3000x3000
56410	Combined	Box Culvert	2400x2400
57770	Dedicated	Box Culvert	3000x3000
58510	Combined	Box Culvert	3000x3000
58560	Dedicated	Box Culvert	3000x3000
59090	Dedicated	Box Culvert	3000x3000
59550	Dedicated	Box Culvert	3000x3000
59750 North Bound lanes	Dedicated	Box Culvert	24000x2400
59760 South Bound Lanes	Dedicated	Box Culvert	2400x2400
60600 North Bound Lanes	Dedicated	Box Culvert	2400x2400
60610 South Bound Lanes	Dedicated	Box Culvert	2400x2400

7.2.2.2 Adjacent Forested Areas

Forested habitats adjacent to fauna underpass entrances will be surveyed to assess the range of fauna species occurring in proximity to each underpass structure. These results will then be compared with underpass monitoring results to identify which species present in the immediate area are not utilising the underpass structure. A one hectare area adjacent to fauna underpass entrances (in forested areas) will be

surveyed at the time of fauna underpass surveys and will include spotlighting, arboreal and ground-based trapping, hairtube sampling, timed diurnal and nocturnal searches and scat and track searches.

7.2.2.3 Fauna Fences

Fauna fence monitoring would be undertaken annually post construction as part of standard ongoing road maintenance to ensure that fences are not damaged. The contractor has a contractual period of 36 months to maintain fences. At the completion of this time period, Roads and Maritime Services Asset Division will continue to monitor and maintain fauna fencing in perpetuity.

7.2.3 Timing/Frequency

Fauna underpass monitoring (including surveys of adjacent forested areas) will commence upon completion of construction of the Project (year 4) and will be undertaken in spring/ early summer each year for a minimum of 60 days. Monitoring will continue in years 5 to 8 of the operational phase and additional monitoring may be required if fauna underpasses are determined to be ineffective.

7.2.4 Performance Indicators

Indicators of success for fauna underpasses/fauna fences are as follows:

- Demonstrated use of fauna crossing structures by Koalas with consideration of population estimates as derived from the Koala population monitoring surveys.

7.3 Road Kill Monitoring

7.3.1 Objective of Monitoring Program

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 fauna fencing to prevent fauna being killed by vehicles while attempting to cross the WC2NH Upgrade.

A detailed methodology for road kill monitoring is included in **Appendix H**. The methodology and timing of this monitoring are summarised below.

7.3.2 Methodology

7.3.2.1 Monitoring Procedure

A two person team vehicle being driven along the entire length of the existing highway in the Project area and identifying dead wildlife (road kill) seen on the roads and within three metres of the road edge. Both driver and passenger will search the left-hand side of the road and its verge for road kill with the driver searching the road and shoulder and the passenger searching the verge. When a road kill is observed from the vehicle, a close visual inspection of the carcass will be undertaken where access is possible and where safely limitations permit. 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. 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.

7.3.2.2 Detailed Methodology

Specific details of the monitoring methodology are:

- The highway will be monitored using 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 12 weeks commencing the week of opening each stage to traffic and for four weeks in spring, summer, autumn and winter (refer to Section 7.3.3).
- When 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 and road kill unidentifiable.
- If possible, each survey will be carried out on the same day 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 the location.
  c. Species of road kill, however, 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 carcass will be photographed and the following information will also be recorded where possible and where 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:
     i. Distance to nearest camp,
     ii. Distance to nearest canopy vegetation,
     iii. Presence of flowering food trees in neighbouring median or roadside vegetation; plants identified to species and referenced with diet list.

7.3.2.3 Data Analysis

The data to be collected will be analysed using a suitable non-parametric 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. Such information will indicate if the mitigation measures in the area are area working as expected to keep road kills to acceptable levels and that none of the target species are killed.

7.3.3 Timing/Frequency

The timing and frequency of road kill monitoring is summarised in **Table 7.2**

Table 7.2 Road Kill Monitoring Timing

Project Phase	*Timing of Surveys*	*Location*	*Responsibility*
During clearing operations.	Daily	Portion of existing Pacific Highway adjacent to clearing operations.	AFJV
One month following clearing operations	Daily	Portion of existing Pacific Highway adjacent to clearing operations.	AFJV
Duration of construction.	Weekly	Entire length of existing Highway in Project area.	AFJV/ Roads and Maritime Services
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	Roads and Maritime Services

Project Phase	*Timing of Surveys*	*Location*	*Responsibility*
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	Roads and Maritime Services

7.3.4 Performance Indicators

Indicators of success for fauna underpasses/ fauna fences are as follows:

- 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.

7.4 Summary of Monitoring Program

A summary of the monitoring program is provided in **Table 7.3**.

Table 7.3 Summary of Monitoring Program

Monitoring Component	*Main Goal*	*Timing/Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
Koala population monitoring	To establish the numbers and distribution of individual Koalas, in relation to proposed mitigation structures, so that an informed assessment can be made of the impacts of the WC2NH Project on Koalas in the Nambucca State Forest/ Old Coast Road area.	▪ Pre-construction baseline surveys completed (autumn and spring). ▪ Ongoing established transect surveys annually (spring) at years 1 and 3 during construction, and years 4, 6 and 8 during operational.	Roads and Maritime Services/ AFJV	▪ Koala abundance and distribution pre-construction are similar to post-construction and maintained in the vicinity of Nambucca State Forest/ Old Coast Road. ▪ Demonstrated use of fauna crossing structures by Koalas with consideration of population estimates as derived from the Koala population monitoring surveys. ▪ No breaches in fauna exclusion fencing.	▪ Modify, if appropriate, design of existing measures where feasible and reasonable. ▪ Consider additional offset measures to provide additional compensation for animals and habitat lost due to the development.
Monitoring of fauna underpasses, fauna fences and adjacent forested habitat	To determine if possible whether mitigation measures (fauna underpasses and fauna fence) are effective in maintaining connectivity for fauna (including Koalas) in the vicinity of the project.	▪ Operational stage (spring/early summer - year 4 to 8).	Roads and Maritime Services		
Road Kill Monitoring	To effectively demonstrate that road kill rates are mitigated by the presence of fauna fencing by preventing fauna of concern from attempting to cross the WC2NH Upgrade.	▪ During clearing operations (up until one month after clearing is completed) – daily. ▪ Duration of construction (weekly). ▪ 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. . ▪ Operational stage - excluding the season/s covered by the initial 12 week monitoring period (refer	AFJV/ Roads and Maritime Services	▪ 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.	▪ Where results identify a significant difference between the road kill numbers of the different treatments (transect types), DoE and EPA shall be notified, and a meeting will be set to discuss such differences with the relevant agencies, Roads and Maritime and the reporting ecologist.

Monitoring Component	*Main Goal*	*Timing/Frequency*	*Responsibility*	*Performance Threshold*	*Corrective Actions if Deviation from performance Criteria*
		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.		▪ All fauna fencing is installed at the minimum of locations as identified in the EPBC approval prior to the operational phase of the WC2NH Upgrade.	

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Definitions and Acronyms

ACT	Australian Capital Territory
AKF	Australia Koala Foundation
CEMP	Construction Environmental Management Plan
DoE	Australian Government Department of Environment
DoPI	NSW Department of Planning and Infrastructure
DSEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
FFMP	Flora and Fauna Management Plan
NH2U	Nambucca Heads to Urunga Pacific Highway Upgrade Project
NSW	New South Wales
OEH	Office of Environment and Heritage
Project Ecologist	A suitably qualified ecologist engaged to advise on/undertake ecological management throughout the Project.
Project footprint	All areas to be cleared as part of the Project inclusive of permanent and temporary works.
QLD	Queensland
RCBC	Reinforced Concrete Box Culvert
SKM	Sinclair Knight Merz
TSC Act	NSW *Threatened Species Conservation Act 1995*
UDLP	Urban Design and Landscape Plan
WC2NH	Warrell Creek to Nambucca Heads Pacific Highway Upgrade Project
WC2U	Warrell Creek to Urunga Pacific Highway Upgrade Project (referred to throughout the document as 'the Project'.

Copyright and Usage

Appendix A

Plan Authors CVs

David HAVILAH

BSc (Biol)

Ecologist

Qualifications

Bachelor of Science (Biology), Sydney University, 2003

Professional Affiliations

Member, Ecological Consultants Association of NSW
Member, NSW Wildlife Information, Rescue and Education Services Inc (WIRES-Northern Rivers)

Experience

David is an experienced ecological consultant who has developed a broad range of skills from working on a variety of small and large-scale projects. He specialises in undertaking terrestrial flora and fauna surveys and providing high quality ecological reports within Queensland and New South Wales. This work has included designing and implementing threatened species management plans and ecological monitoring programs. David has a detailed working knowledge of environmental legislation relevant to ecological impact assessment and an ability to balance practical applications of environmental requirements with good environmental outcomes.

Key Experience and Skills

A large focus of David's work has been providing ecological services on large infrastructure projects. He has been engaged as the Project Ecologist for construction contractors on a number of sections of the NSW Pacific Highway upgrade project. This work has included providing technical advice, ecological surveys and assessments and managing threatened species on these projects.

David's skills and key areas of expertise include:

- Design, implementation and management of ecological monitoring programs.
- Determining and documenting best practice and innovative management plans for threatened species occurring on infrastructure projects.
- Undertaking detailed systematic terrestrial flora / fauna surveys and vegetation / weed mapping.
- Preparing high quality ecological / environmental assessments for a broad range of projects in accordance with NSW, QLD and Federal environmental legislation.
- Preparing vegetation management plans and environmental management plans.
- Providing peer reviews of ecological assessments.
- Providing technical advice, ecological surveys and reporting in the role of project ecologist for large-scale infrastructure projects.
- Supervising and delivering pre-clearing surveys and spotter / catcher (fauna capture / relocation services) as part of large infrastructure projects.
- Delivering environmental awareness presentations.

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Senior Associate / Ecologist / Planner

Qualifications

Bachelor of Environmental Science (Environmental Management),
The University of Newcastle, [2000]
Graduate Diploma of Urban and Regional Planning, The University of New England, [2007]

Professional Affiliations

Member, Planning Institute Australia
Member, Environment Institute of Australia and New Zealand
Member, Ecological Consultants Association of NSW Inc.
Member, Australian Network for Plant Conservation Inc.

Professional Short Courses

- Planning for Bushfire Prone Areas
- Certificate IV Bushland Regeneration
- Certificate IV Workplace Training and Assessment
- Certificate II Australian Land Conservation and Restoration
- Project Management, Chifley Business School
- Effective Communication, Negotiation and Mediation, Chifley Business School
- Urban Design, Chifley Business School
- Acid Sulfate Soils: Identification, Assessment and Management
- Woodland Birds Identification and Ecology
- Signed English, TAFE Newcastle

Licences

- Scientific Licence (SL100152) issued by the Office of Environment and Heritage.
- Animal Research Authority issued by the Animal Care and Ethics Committee of the Director-General of NSW Department of Primary Industries to undertake fauna surveys throughout NSW and SE Queensland.

Experience

Veronica has been a key member of GeoLINK's ecology team since 2004. She specialises in flora / fauna field surveys; ecological monitoring; bushfire assessment; environmental impact assessment and bushland regeneration.

Veronica has further diversified her skills and knowledge in the built environment, having completed a Graduate Diploma of Urban and Regional Planning through The University of New England in 2007.

Veronica possesses high level project management skills, developed through working with a broad range of public and private sector clients on challenging environmental projects. Having project managed a variety of ecological and planning projects; she has significant skills in liaison and the management of multidisciplinary teams.

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Appendix B

Connectivity Habitat Restoration Areas

DoE Information Request 3, Task 5 and 6 – Connectivity and fragmentation of habitat

Document: Item 2-1 Independent review Koala, Table 4-1.

DoE comment 5:

Given the likely residual impact from connectivity loss and increased fragmentation of the koala habitat/population, please demonstrate how connectivity will be increased in the landscape (e.g. through tree plantings) to compensate for this loss. Please include this information in the proposed Urban Design and Landscape Plan (UDLP) (see comment 6a below).

DoE comment 6:

Table 1.2:

(a) Habitat restoration and management –

(i) It is unclear what areas of the proposed action will require a targeted UDLP. Please show on a map the locations along the length of the highway where habitat restoration and management will occur and how this will result in connectivity for relevant threatened species (e.g. see comment 5 regarding the koala above). Additionally, to provide context, please overlay all fauna mitigation measures proposed on the same map.

(ii) Please advise the likely timing for completion of the UDLP, noting that RMS must provide the plans to the Department for approval prior to commencement (Note: The submission of the plans can be staged to align with construction staging).

Response Task 5:

Identification of potential opportunities to enhance connectivity

Roads and Maritime Services propose to enhance connectivity in the landscape wherever reasonable and feasible through the provision of strategic tree planting in road reserves and residual land acquired for the project. In a brief memorandum provided by GeoLINK environmental consultants (dated 24th July 2014), the ecologists involved in the baseline Koala surveys identified opportunities to enhance habitat / vegetation connectivity post-construction for fauna in general including the Koala, refer to Table 1 of **Attachment A**.

Further to this Roads and Maritime Services identified several small parcels of residual property acquired for the project and outside the road corridor that are also well suited to enhancing connectivity in the landscape. This includes

- Additional planting within the Roads and Maritime residual property on the eastern side of the project between chainages 1,600 / 43,365 and 1,900 / 43,665 with vegetation indicative of the Moist Open Forest Flooded Gum community to expand areas of habitat in this area.

- Additional planting within the Roads and Maritime residual property on the eastern side of the project between chainages 14,900 / 56,665 and 15,100 / 56,865 with vegetation indicative of the Blackbutt community to expand areas of habitat in this area.

Review of potential opportunities to enhance connectivity

Subsequent to the identification of connectivity sites along the project by GeoLINK reviews of the proposed areas of revegetation and planting from a flooding and visual impact perspective were undertaken. This included an assessment by Spackman Mossop Michaels of visual amenity impacts and an assessment by Arup to assess any potential flood afflux impacts and changes in roughness values as a result of increasing the planting density along creeks and rivers.

The results of the visual impact assessment of the proposed connectivity sites are summarised below:

- 735 / 42,500 - Upper Warrell Creek eastern bank: This area would benefit visually from as much re-vegetation and planting as can be provided to assist with visual mitigation of the interchange from multiple viewpoints (including road users).
- 3,140 / 44,905 – Rosewood Creek: This location south of the over bridge appears to be in fill, so road user views would be largely unaffected. Houses are approximately 500 metres away so visual mitigation can be addressed fairly easily. Re-vegetation and planting would form part of the visual mitigation approach in this area anyway.
- 9,220 / 50,985 - Floodplain Bridge No.2: This location is in a combination of open/ wooded landscape and is located in fill, so road user views would be largely unaffected. Houses are well away and few in number so visual mitigation can be addressed fairly easily.
- 10,600 / 52,365 - Nambucca River Bridge north bank: The north bank is currently reasonably well vegetated, additional planting here would have a positive visual impact.

In addition, Roads and Maritime Services made the following comments:

- 3,140 / 44,905 – Rosewood Creek – Roads and Maritime Services have no concerns with this location subject to any connectivity planting in this area being limited to replacement of vegetation removed for the project to minimise potential impacts on flooding.
- 5,235 / 47,000 Williamsons Creek - Roads and Maritime Services don't see the need / benefit of connectivity planting in this area noting that it is identified for fish passage only and that there is no native vegetation downstream of the old highway crossing.
- Ch.14800 - 15500 west of the alignment - Roads and Maritime Services don't see the need / benefit of connectivity planting in this area noting that there are no fauna underpasses between Ch.14645 (56,410) and Ch.16005 (57,770).
- Ch.13300 fauna underpass - Roads and Maritime Services don't have any concerns with the proposed connectivity planting in this area due to the extent of existing vegetation and noting that the natural surface slopes from west to east at this location.

The results of the flood afflux assessment of the proposed connectivity sites as completed by Arup is provided below. It should be noted that the assessment is very high level and has tried to identify if an increase in roughness would result in an increase in flood levels and afflux. In addition, no modelling has however been completed to date. Arup notes that assuming that the afflux of the project is calculated as the difference between the existing levels (with existing vegetation) and the design levels (with the improved vegetation) then it is possible that changing the roughness values (as a result of increasing the planting density) will impact on flood afflux.

The results of the high level assessment indicates that it is most likely that the areas around the culverts are not of major concern, however the areas around the major water way crossings may be more problematic. **Table 1** provides a summary of the structures / locations which may be sensitive.

Table 1 Summary of the connectivity areas identified by GeoLINK that may potentially be flood sensitive

Location	Existing roughness	Revised vegetation roughness	Possible impact
735 / 42,500 - Upper Warrell Creek	0.04	0.08	Probable impact as afflux here is sensitive to channel works and vegetation.
5,235 / 47,000 Williamsons Creek	0.04	0.08	Probable impact as afflux here is sensitive to channel works and vegetation.
6,510 / 48,275 Warrell Creek	0.08	0.08	Limited as out of bank and already high roughness
8,450 / 50,215 Floodplain Bridge 1	0.08	0.08	Limited as already high roughness
9,220 / 50,985 Floodplain Bridge 2	0.06	0.08	Possible impact as within the Nambucca floodplain and only 15mm allowable afflux
10,600 / 52,365 Nambucca Bridge north bank	0.04	0.08	Possible impact as within the Nambucca floodplain and only 15mm allowable afflux

Roads and Maritime Services concurred with Arup regarding the potential flooding impacts identified in **Table 1** with the possible exception of:

- 735 / 42,500 - Upper Warrell Creek eastern bank: subject to any connectivity planting in this area being limited to replacement of vegetation removed for the project and planting of vegetation suitable for Giant Barred Frog.
- 735 / 42,500 - Upper Warrell Creek western bank: subject to any connectivity planting in this area being limited to planting of vegetation suitable for Giant Barred Frog.
- 9,220 / 50,985 - Floodplain Bridge No.2: due to the very low velocities in this area (noting the 15mm afflux limit) and 10,600 / 52,365 - Nambucca River Bridge north bank: subject to any connectivity planting in this area would be limited to replacement of vegetation removed for the project.

Based on the analysis completed above, the connectivity sites identified by GeoLINK in Table 1 of **Appendix A** would be modified as follows:

- Connectivity plantings would not be included at:
  - 5,235 / 47,000 Williamsons Creek due to visual impacts and lack of vegetation connectivity.
  - Ch.14800 - 15500 west of the alignment due to visual impacts and lack of vegetation connectivity.

- Connectivity planting would be limited to replacement of vegetation removed for the project in the following areas:
  - 735 / 42,500 - Upper Warrell Creek eastern bank due to flooding impacts.
  - 3,140 / 44,905 - Rosewood Creek (visual impacts)
  - 9,220 / 50,985 -Floodplain Bridge No.2 due to flooding and visual impacts.
  - 10,600 / 52,365 -Nambucca River Bridge north bank due to flooding and visual impacts.

Selected locations for planting to enhance connectivity

The updated locations for connectivity planting are provided in the map series included as **Attachment B**. In summary, 14 separate locations across the 19 kilometre upgrade have been identified where there is opportunity to conduct strategic planting to enhance connectivity. The areas identified are generally associated with riparian zones as they are viewed to present the best opportunity to enhance connectivity. The locations selected within these zones include future road reserve.

Of the areas identified, twelve of these sites are identified as areas with potential to be used by Koalas. In these locations it is recommended that the use of primary Koala feed trees be targeted in the planting mixes. The specific Koala food trees associated with each of the vegetation map unit impacted are summarised in **Table 2**.

Table 2. Summary of primary and secondary Koala feed trees and corresponding vegetation type

Vegetation Community	Habitat Type	Primary Koala Food (DECC 2008)	Secondary Food Tree Species (DECC 2008)
Map Unit 1: Open Forest – Blackbutt	Dry Sclerophyll Forest	Tallowwood (*Eucalyptus microcorys*)	• Small-fruited Grey Gum (*E. propinqua*). • Red Mahogany (*E. resinifera*). Note Blackbutt (*E. pilularis*) may also be considered and is identified as a supplementary feed tree (Professor Rob Close, University of Western Sydney. pers. comm. 2013).
Map Unit 2: Mixed Floodplain Forest	Wet Sclerophyll Forest	Tallowwood (*E. microcorys*)	• Small-fruited Grey Gum (*E. propinqua*). • Red Mahogany (*E. resinifera*).
Map Unit 3: Moist Forest – White Mahogany/ Grey Gum/ Ironbark	Wet Sclerophyll Forest	Tallowwood (*E. microcorys*)	• Small-fruited Grey Gum (*E. propinqua*). • Red Mahogany (*E. resinifera*).

Vegetation Community	Habitat Type	Primary Koala Food (DECC 2008)	Secondary Food Tree Species (DECC 2008)
Map Unit 4: Moist Forest – Flooded Gum	Wet Sclerophyll Forest	Tallowwood (*E. microcorys*)	• Small-fruited Grey Gum (*E. propinqua*). • Red Mahogany (*E. resinifera*).
Map Unit 6: Swamp Forest – Swamp Mahogany/ Paperbark	Swamp Sclerophyll Forest	Swamp Mahogany (*E. robusta*)	• Small-fruited Grey Gum • (*E. propinqua*). • Red Mahogany (*E. resinífera).*

It is noted that five of the connectivity sites are located within Nambucca State Forest which is associated with the known Koala population in this location. A review of Koala records for the study area from the Atlas of NSW Wildlife identifies a low number of records between Warrell Creek and Macksville, both to the east and west of the project. Given the high degree of fragmentation between chainage 0 / 41,765 to 7,500 / 49,265 the corridor south of Macksville represents the best opportunities for enhancement of connectivity.

Of the combined number of proposed habitat planting locations, three of these sites are located between chainage 5,200 / 46,965 and 6,600 / 48,365 and are associated with where the road alignment occurs immediately adjacent to the existing Pacific Highway. This includes the riparian corridors along Warrell Creek. There are very limited opportunities for Koalas to cross the existing highway in this location due to the lack of connectivity structures on the existing highway and extensive habitat fragmentation. The proposed strategic plantings in this location are therefore considered to present a substantial improvement or enhancement over the current situation.

Response Task 6:

In regards to the Department of the Environment (DoE) comment to include this information in the proposed Urban Design and Landscape Plan (UDLP) the following is noted. During a discussion between Colette Boraso from the DoE and Chris Clark from Roads and Maritime Services on the 10 July 2014, it was agreed that the UDLP was not the appropriate document to identify measures to improve connectivity in the landscape, including the locations of habitat restoration and management measures. It was agreed that these measures were best identified in the five individual species management plans that are being prepared to address the requirements of Attachment A2 of the DoE letter provided to Roads and Maritime Services on the 27 June 2014. As such this information will be included in these management plans which will be available for review by DoE in the near future.

The map series included as **Attachment B** shows all proposed fauna mitigation measures on the same map.

ATTACHMENT A GeoLINK Memorandum Koala Connectivity (24th July 2014)

GeoLINK
environmental management and design

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24 July 2014
Ref No: 2378-1004

Acciona and Ferrovial Joint Venture (AFJV)
Level 10, 207 Kent St
Sydney, NSW 2000

Attention: Alex Dwyer

WC2NH: Assessment of Opportunities to Enhance Vegetation/ Habitat Connectivity as part of the Project

GeoLINK has been requested to undertake an assessment to identify opportunities to enhance habitat/ vegetation connectivity as part of the landscaping and urban design plan to be adopted for the WC2NH project. This assessment involved a desktop review of the following information:

- Aerial imagery of vegetation surrounding the project site;
- Vegetation mapping for the project site and surrounds;
- Current locations and designs of fauna crossing structures; and
- WC2U Urban Landscape Design Plan.

Areas identified as opportunities to enhance habitat/ vegetation connectivity are shown on a series of mark ups contained within Appendix A. These areas are summarised in Table 1.1.

Identified areas are generally associated with bridges/ culverts, as riparian zones throughout the broader landscape provide the best opportunity to provide fauna habitat connectivity. Additionally, a small number of areas were identified where planting of endemic vegetation communities have the potential to create additional linkages between fragmented patches of vegetation occurring within the local landscape.

A number of recommendations were made for identified areas which are included in Table 1.1.

Feel free to contact me if you require any additional information.

Yours sincerely
GeoLINK

David Havilah
Ecologist/ Associate

Table 1.1 Proposed Habitat Connectivity Focus Areas

Area	*Chainages*	*Connectivity Opportunity*	*Recommendation*
Upper Warrell Creek (bridge site and fauna crossing location)	200 - 900	▪ A section of primarily cleared grazing land adjacent to Warrell Creek (between CH 200-700). Revegetation of this area would improve habitat/ vegetation connectivity along a relatively large portion of Warrell Creek. Additional benefits to improving aquatic fauna habitat. ▪ Areas associated with the fauna passage (CH 800) inlet/ outlet could be enhanced with additional planting of native vegetation in these areas to encourage fauna usage	▪ Riparian restoration planting along the western side of Warrell Creek (CH 200-700) with endemic species recommended. ▪ Habitat enhancement planting using appropriate endemic species proposed in areas either side of the fauna crossing culvert (CH 800) to maximise the potential use of this structure. ▪ As this area has potential to be used by Koalas the use of primary Koala feed trees in planting mixes (e.g. Tallowwood, Forest Red Gum, Grey Gum) is recommended.
Butchers Creek (combined culvert with fauna underpass)	1,450 – 1,600	▪ Areas associated with the fauna passage (CH 1,550) inlet/ outlet could be enhanced with additional planting of native vegetation in these areas to encourage fauna usage	▪ Habitat enhancement planting using appropriate endemic species proposed in areas either side of the fauna crossing culvert (CH 800) to maximise the potential use of this structure. ▪ As this area has potential to be used by Koalas the use of primary Koala feed trees in planting mixes (e.g. Tallowwood, Forest Red Gum, Grey Gum) is recommended.
Rosewood Creek (combined culvert with fauna underpass)	3,100	▪ A combined culvert with fauna underpass is to be provided at this location. The creek line is currently vegetated with Camphor Laurel forest. Connectivity could be enhanced by bush restoration works being undertaken along sections of Rosewood Creek occurring within the project site with the aim of maximising use of the culvert by fauna.	▪ Riparian plantings using endemic flora species recommended along Rosewood Creek (within the project site) as well as control of Camphor Laurel.
Unnamed tributary (incidental fauna passage)	3,800	▪ Tributary largely cleared with little vegetation/ habitat connectivity currently.	▪ No major gains to be made by restoration plantings in this area as little connectivity is currently present.

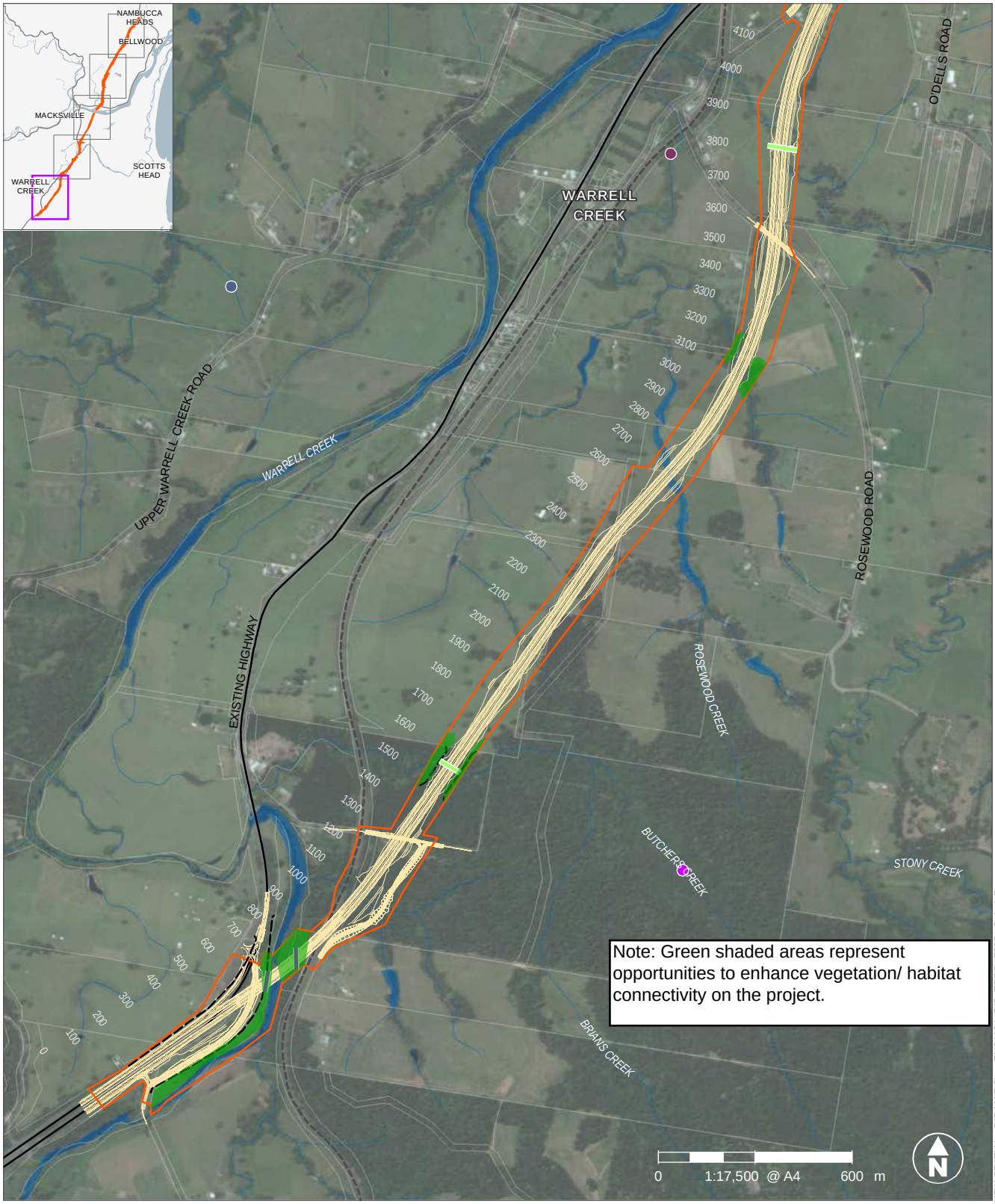
Williamsons Creek (bridge site and eastern side of the alignment)	5,200 - 5,700	▪ Habitat/ vegetation connectivity could be enhanced along Williamsons Creek by providing additional planting of appropriate riparian vegetation which would improve the likelihood of fauna movements along Williamsons Creek. ▪ Planting of a corridor of native vegetation on the eastern side of the alignment between Williamsons Creek and the unnamed tributary to the north (Ch 5,750) would improve connectivity between fragmented patches of forest in the locality.	▪ Habitat enhancement and additional riparian plantings are recommended along Williamsons Creek to improve connectivity. ▪ Planting of a corridor of native plantings including primary Koala feed trees (Tallowwood, Forest Red Gum, Grey Gum) are recommended along the eastern edge of the site between CH 5,200 and 5,700 to link fragmented patches of vegetation.
Lower Warrell Creek (areas associated with southern and northern abutment of new bridge.	6,400 - 6,800	▪ Only minor opportunities exist on the southern bank of Warrell Creek either side of the bridge footprint to enhance connectivity by a small amount of native plantings along the riparian zone. ▪ Restoration plantings within an area to the east of the new bridge site (northern bank) where vegetation is sparse and fragmented would improve connectivity by enhancing habitat values within the riparian zone	▪ Minor additional riparian plantings recommended along the southern bank either side of the bridge site where possible. ▪ Restoration/ regeneration of vegetation recommended in an area on the northern side of Warrell Creek (to the east of the new bridge site). This area is currently highly disturbed with scattered mature trees and dense weeds in the understorey.
Floodplain Plank Bridges and incidental fauna passage locations	8,000 - 9,400	▪ Minor opportunities to enhance and extend areas of EEC/ fauna habitat either side of the alignment primarily associated with fauna crossing structures and plank bridges.	▪ Recommend planting of Broad-leaved Paperbark/ Swamp Oak to enhance/ extend areas of habitat where possible and improve the likelihood of fauna movement at fauna crossing locations.
Nambucca River Bridge (northern bank)	10,600	▪ Additional planting/ restoration along the riparian corridor would enhance connectivity under the bridge which forms a linkage with large areas of vegetation associated with Newee Creek.	▪ Recommend planting of Swamp Oak, Forest Red Gums and other appropriate riparian plantings either side of the new bridge (within the riparian zone).

Area on the western side of the alignment, north of Mattick road (combined fauna passage)	13,100 – 13,450	▪ Areas associated with the fauna passage (CH 13,350) inlet/ outlet could be enhanced with additional planting of native vegetation in these areas to encourage fauna usage. ▪ Additional planting associated with Old Coast Road as it occurs within the project site would extend and enhance habitat values and linkages to large areas of vegetation to the west (Newee Creek).	▪ Habitat enhancement planting using appropriate endemic species proposed in areas either side of the fauna crossing culvert (CH 800) to maximise the potential use of this structure. ▪ Additional planting of endemic vegetation to the west of the alignment to improve connectivity. ▪ As this area has potential to be used by Koalas the use of primary Koala feed trees in planting mixes (e.g. Tallowwood, Forest Red Gum, Grey Gum) is recommended.
Nambucca State Forest (south) – fauna passage combined.	14,600 - 14,700	▪ Areas associated with the fauna passage inlet/ outlet could be enhanced with additional planting of native vegetation in these areas to encourage fauna usage.	▪ Habitat enhancement planting using appropriate endemic species proposed in areas either side of the fauna crossing culvert to maximise the potential use of this structure. ▪ As this area has potential to be used by Koalas the use of primary Koala feed trees in planting mixes (e.g. Tallowwood, Forest Red Gum, Grey Gum) is recommended.
Nambucca State Forest – six fauna crossing locations between CH 16,600 and 18,800.	16,600 – 18,800	▪ Minimal opportunities exist within this part of the project site to enhance vegetation/ habitat connectivity given the already heavily forested nature of this part of the site. ▪ Areas associated with the fauna passage inlets/ outlets could be enhanced with additional planting of native vegetation in these areas to encourage fauna usage, including the use of Koala feed trees where possible.	▪ Habitat enhancement planting using appropriate endemic species proposed in areas either side of the fauna crossing culvert to maximise the potential use of this structure. ▪ As this area has potential to be used by Koalas the use of primary Koala feed trees in planting mixes (e.g. Tallowwood, Forest Red Gum, Grey Gum) is recommended.

Appendix A

Proposed Habitat Connectivity Focus Areas

Attachment A Figure 5-1 Threatened fauna, exclusion fencing and underpasses



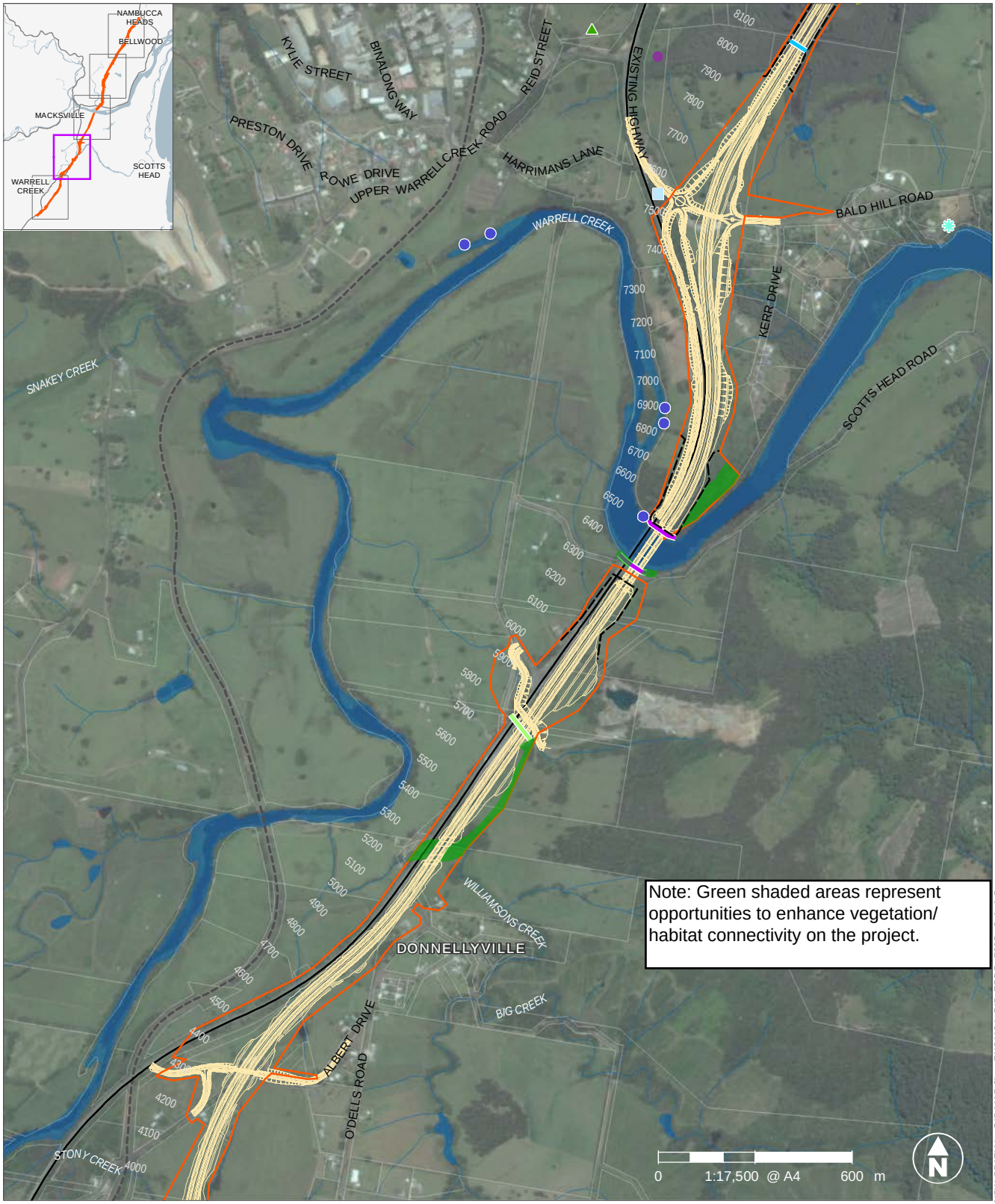
Road boundary
Road design
Temporary construction road boundary
Temporary construction road
November 2013 Flying-fox camp footprint
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna passage
Fauna fence

Threatened fauna

- Black Bittern
- Black Grass-dart Butterfly
- Black-necked Stork
- Brolga
- Brush-tailed Phascogale
- Cattle Egret
- Common Greenshank
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Eastern Osprey
- Glossy Black-Cockatoo
- Glossy Ibis
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Koala
- Latham's Snipe
- Little Bentwing-bat
- Masked Owl
- Oriental Pratincole
- Osprey (nest site)
- Pacific Golden Plover
- Powerful Owl
- Rainbow Bee-eater
- Regent Honeyeater
- Sooty Owl
- Southern Myotis
- Spotted-tailed Quoll
- Square-tailed Kite
- Squirrel Glider
- White-bellied Sea-Eagle
- Yellow-bellied Glider

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

Attachment A Figure 5-2 Threatened fauna, exclusion fencing and underpasses



Road boundary
Road design
Temporary construction road boundary
Temporary construction road
November 2013 Flying-fox camp footprint
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna passage
Fauna fence

Threatened fauna

- Black Bittern
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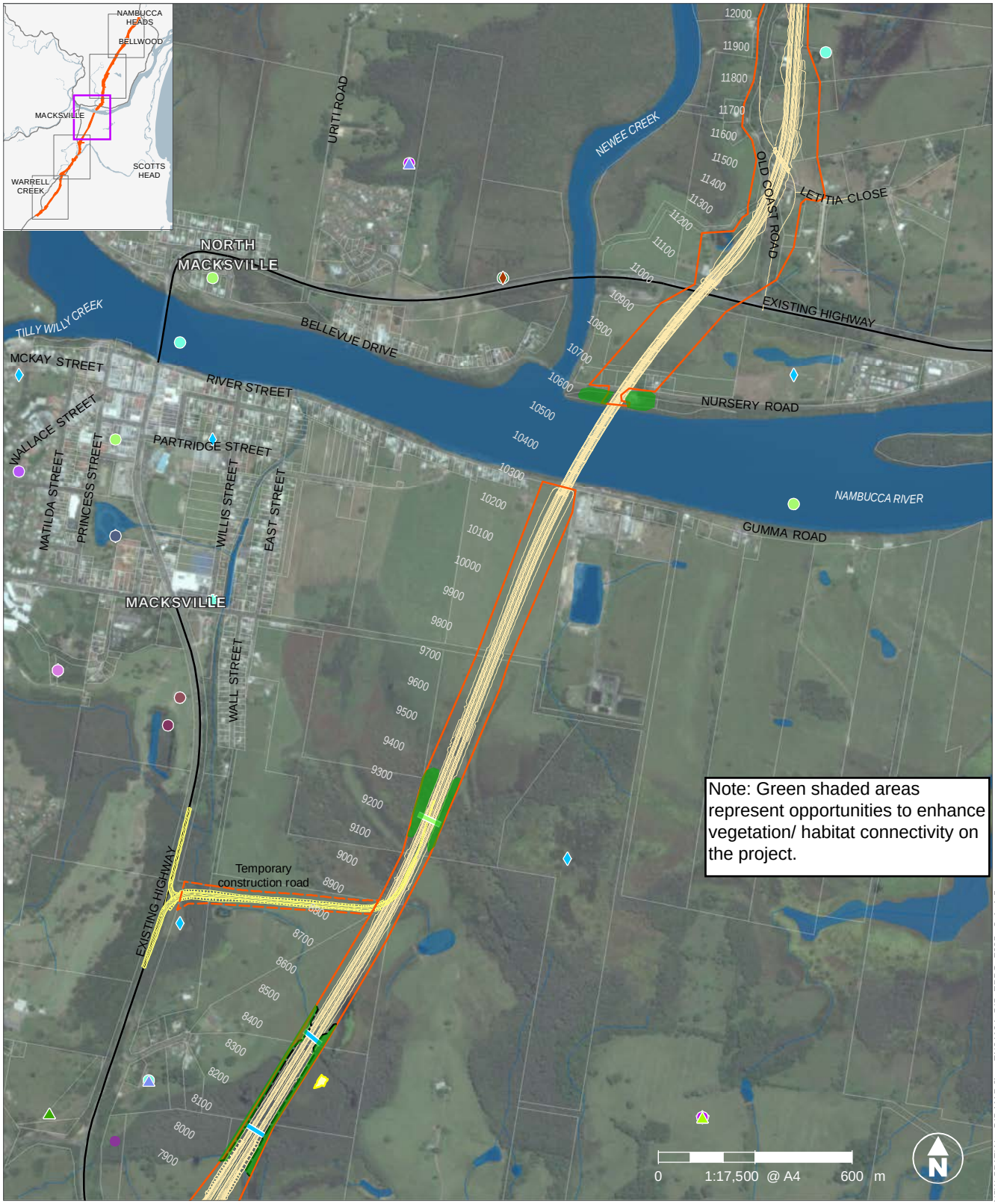
- Square-tailed Kite
- Squirrel Glider
- White-bellied Sea-Eagle
- Yellow-bellied Glider

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

Attachment A Figure 5-3 Threatened fauna, exclusion fencing and underpasses



Road boundary
Road design
Temporary construction road boundary
Temporary construction road
November 2013 Flying-fox camp footprint
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna passage
Fauna fence

Threatened fauna

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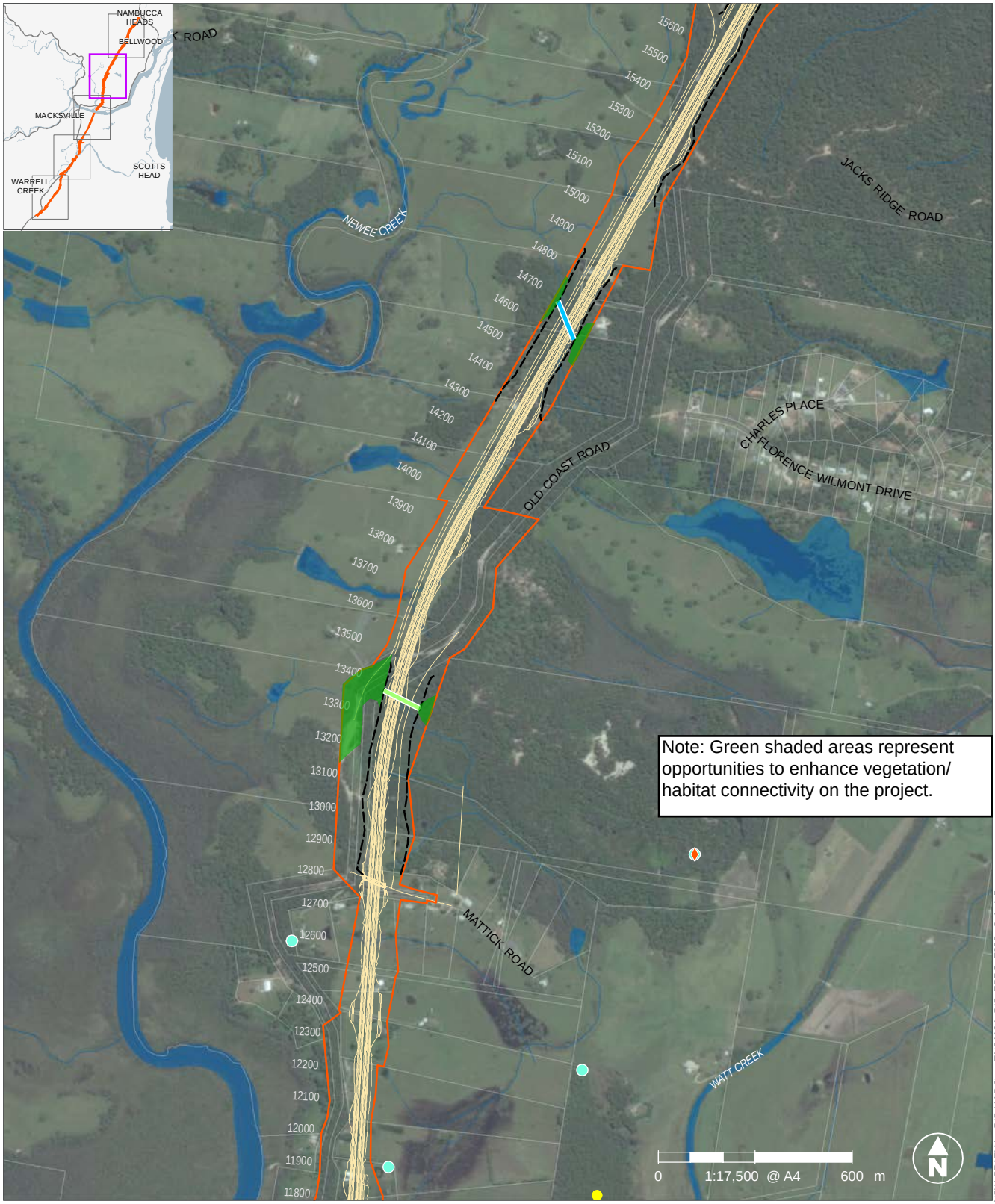
DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
This mapping is current as at December 2013 and could be refined with updated survey information



Road boundary
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November 2013 Flying-fox camp footprint
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna passage
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Threatened fauna

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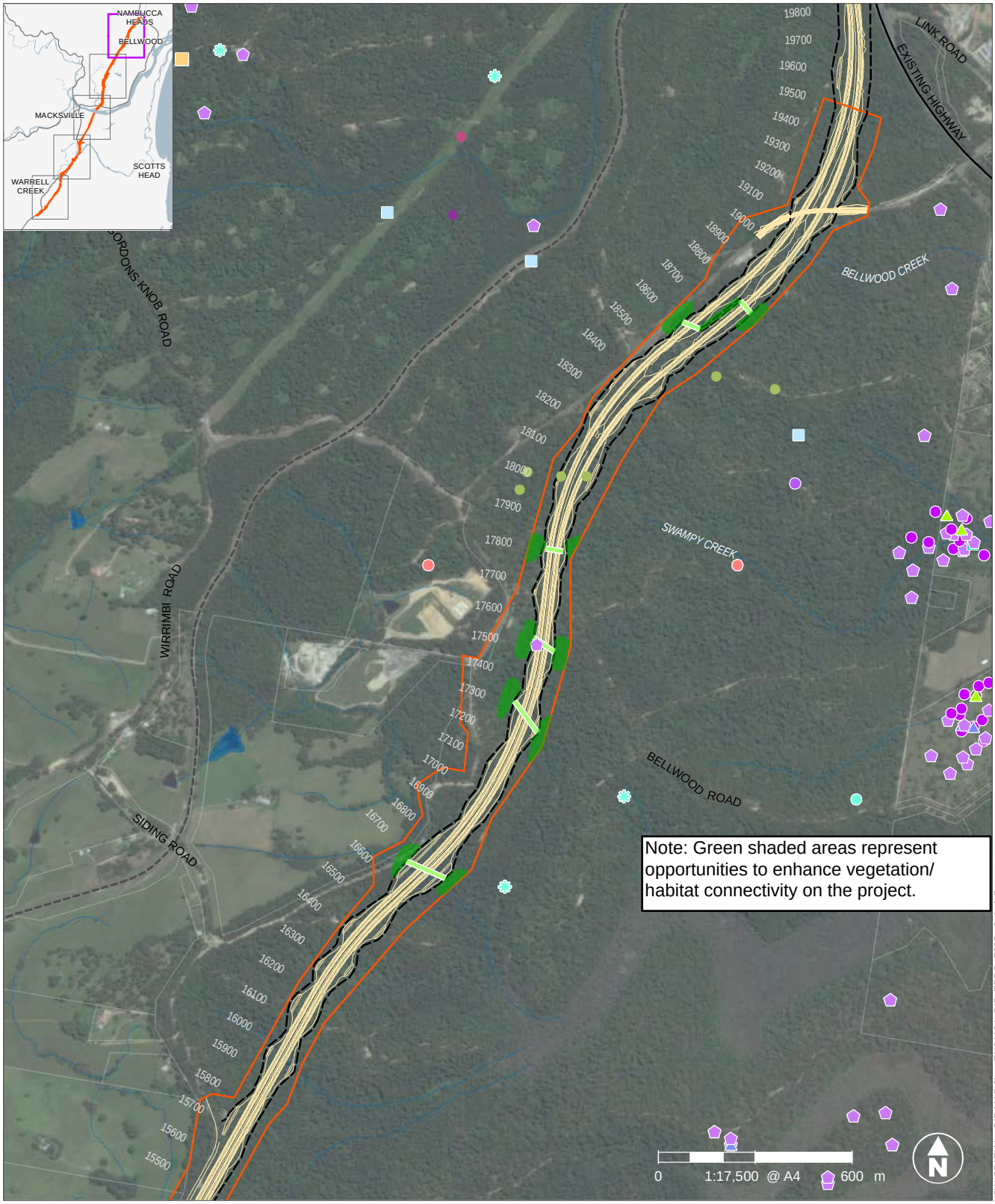
DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
This mapping is current as at December 2013 and could be refined with updated survey information

Attachment A Figure 5-5 Threatened fauna, exclusion fencing and underpasses



Road boundary
Road design
Temporary construction road boundary
Temporary construction road
November 2013 Flying-fox camp footprint
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna passage
Fauna fence

Threatened fauna

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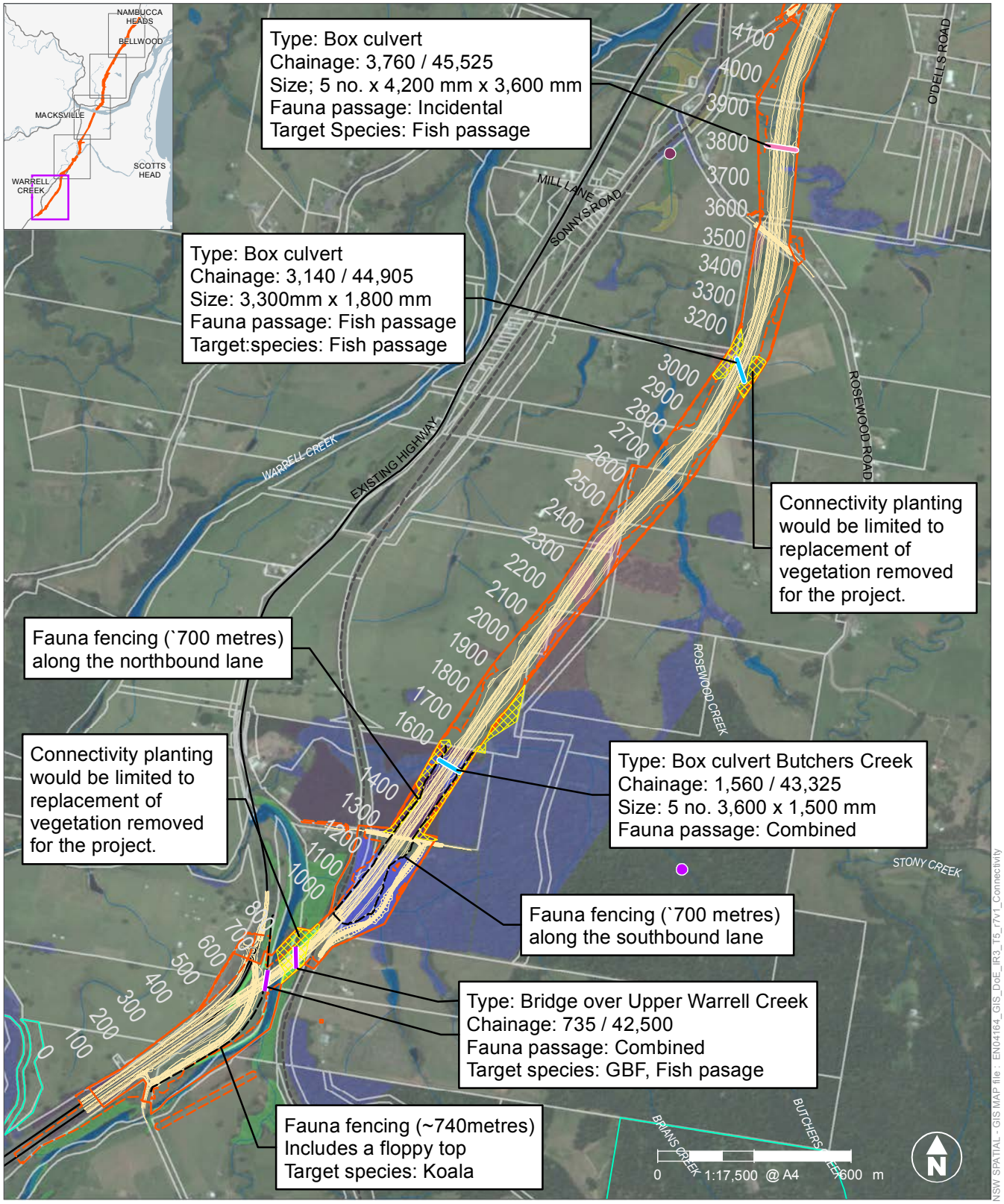
DATA SOURCES
ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013
This mapping is current as at December 2013 and could be refined with updated survey information

ATTACHMENT B Map Series of Connectivity / Habitat Restoration Areas



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 2010)

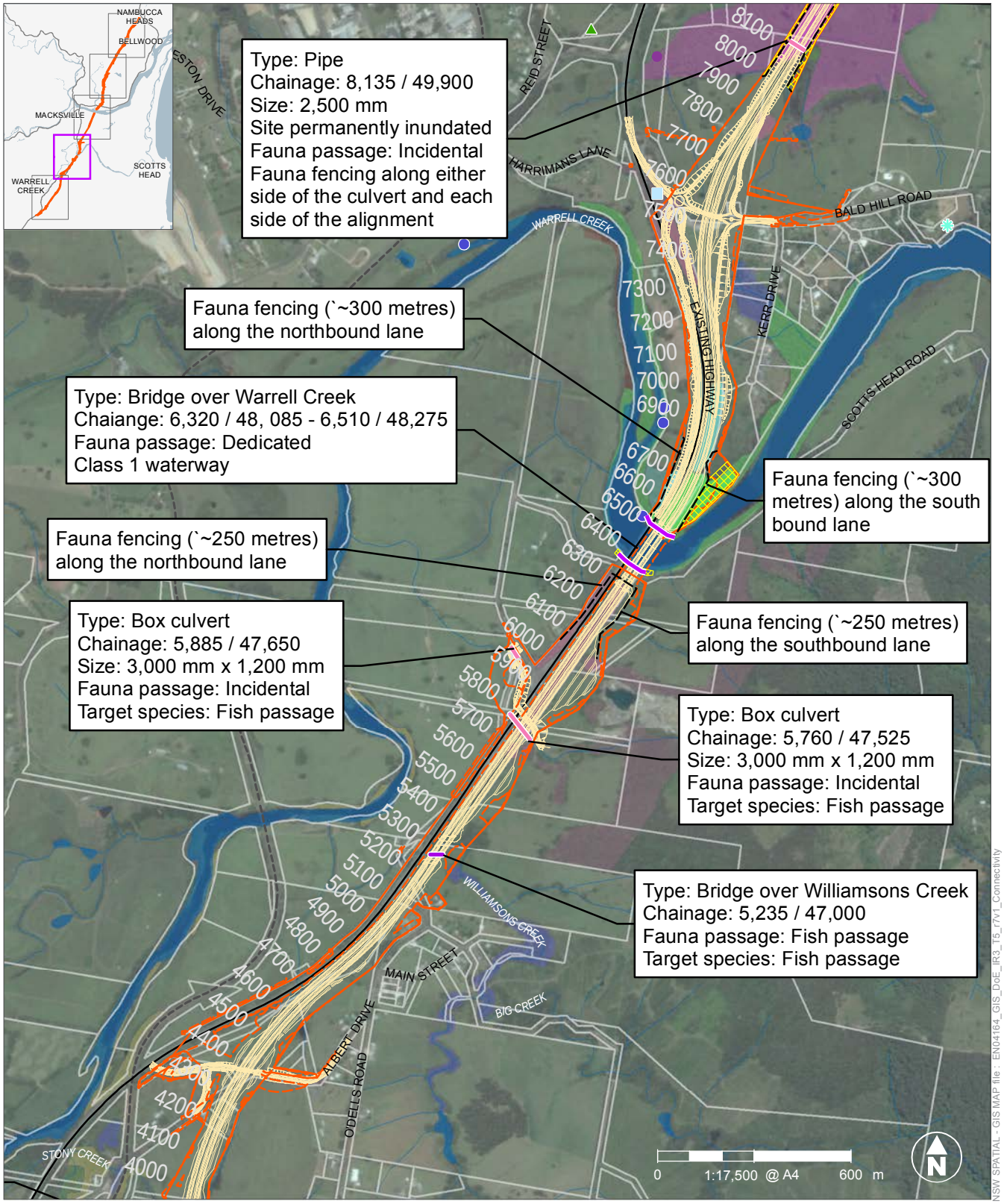
- Map Unit 1: Open Forest - Blackbutt
- Map Unit 2: Mixed Floodplain Forest (Subtropical Coastal Floodplain Forest (EEC – TSC Act)
- Map Unit 3: Moist Open Forest - White Mahogany/Grey Gum/Ironbark
- Map Unit 4: Moist Open Forest - Flooded Gum
- Map Unit 5: Lowland Rainforest (EEC – EPBC Act and the 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

NSW GOVERNMENT Transport Roads & Maritime Services JACOBS



NSW SPATIAL - GIS MAP file : EN04164_GIS_DoE_IR3_T5_r7v1_Connectivity

Legend

- Proposed areas of connectivity and habitat restoration
- Road boundary
- Road design
- Service Road - Old Coast Road
- Clearing boundary
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- Lot (survey)
- Combined culvert with fauna underpass
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- 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

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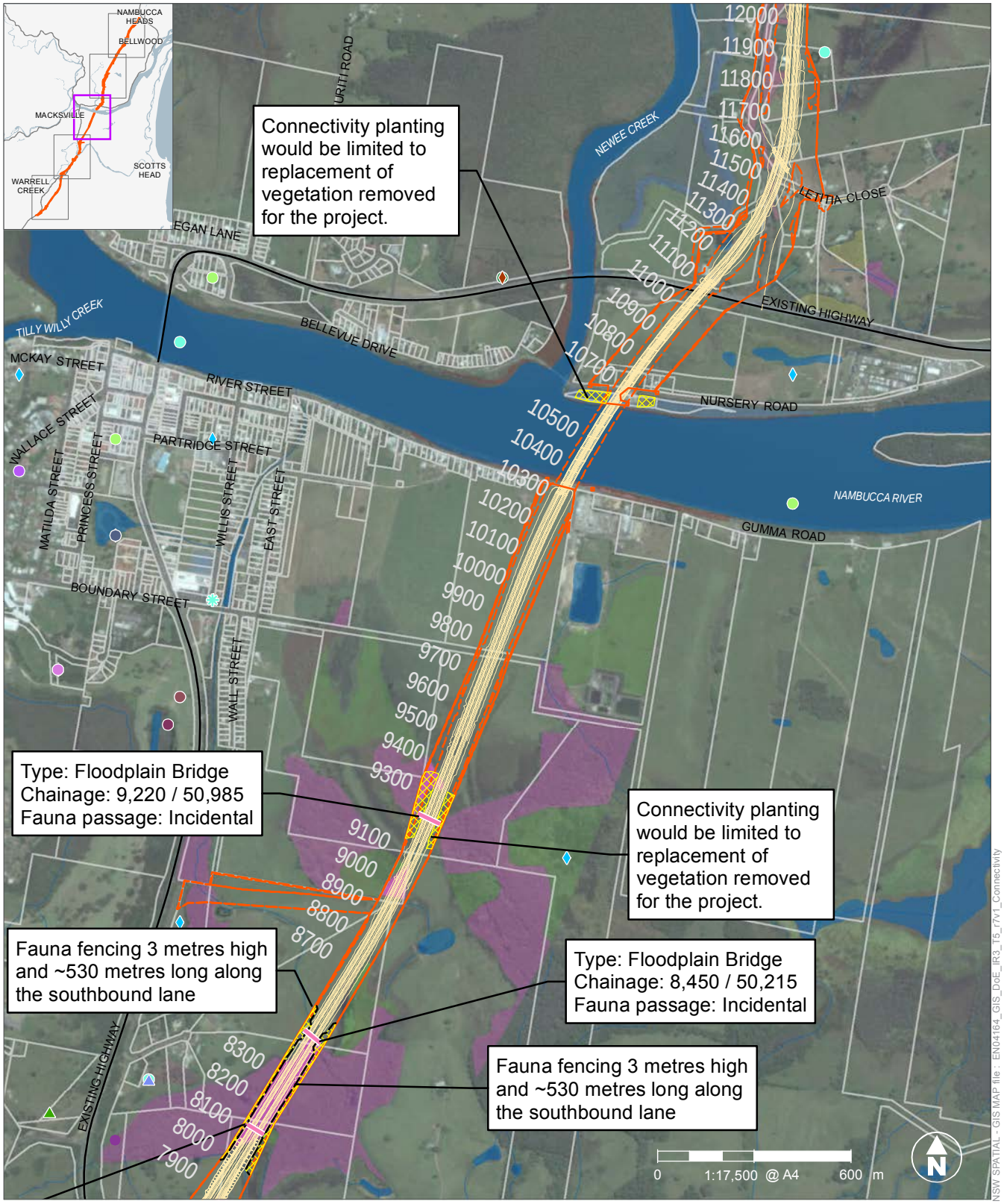

NSW SPATIAL - GIS MAP file : EN04164_GIS_DoE_IR3_T5_r7v1_Connectivity

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 2010)

- 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
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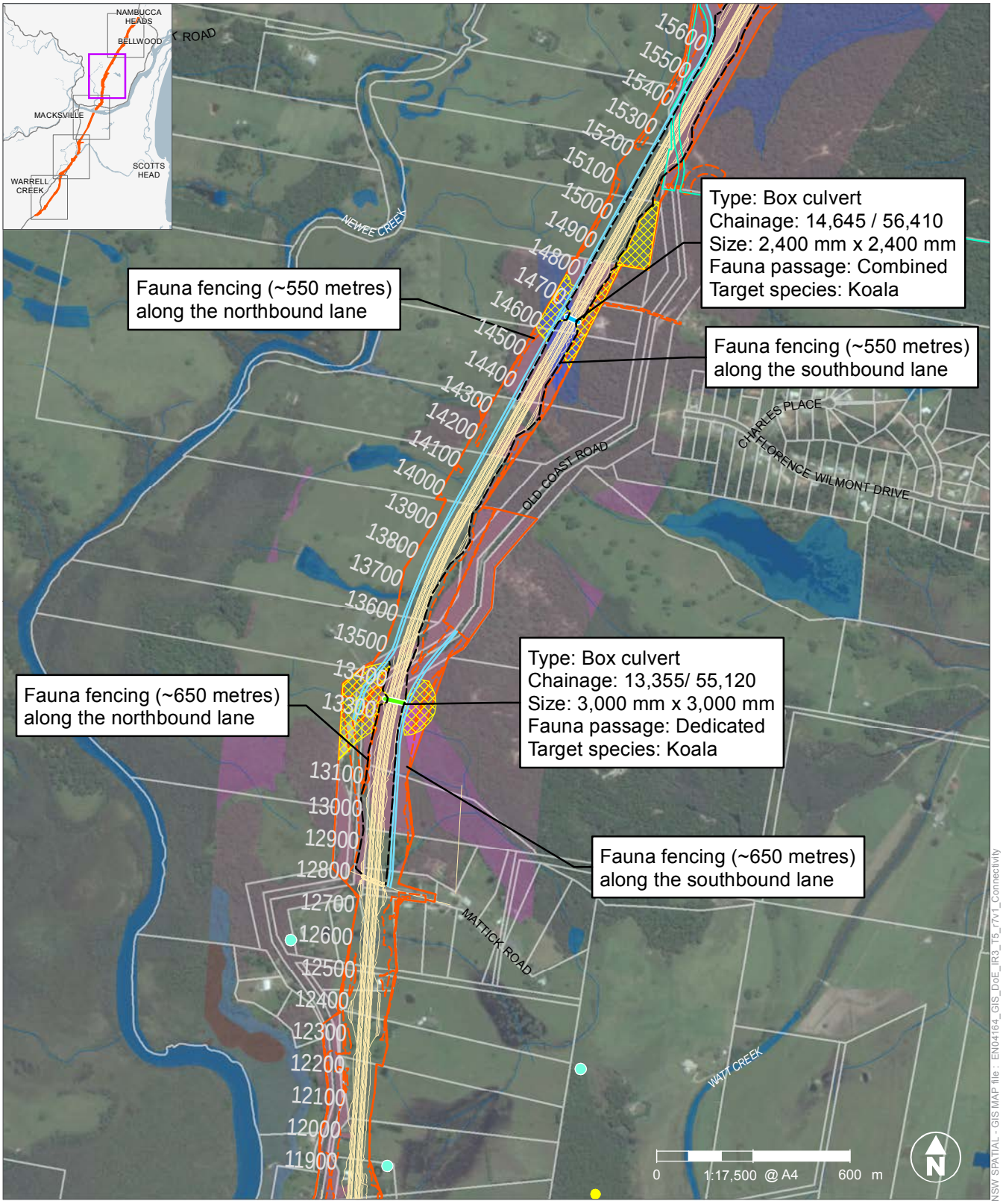

Legend

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- Road boundary
- Road design
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- Map Unit 13: Softwood plantation

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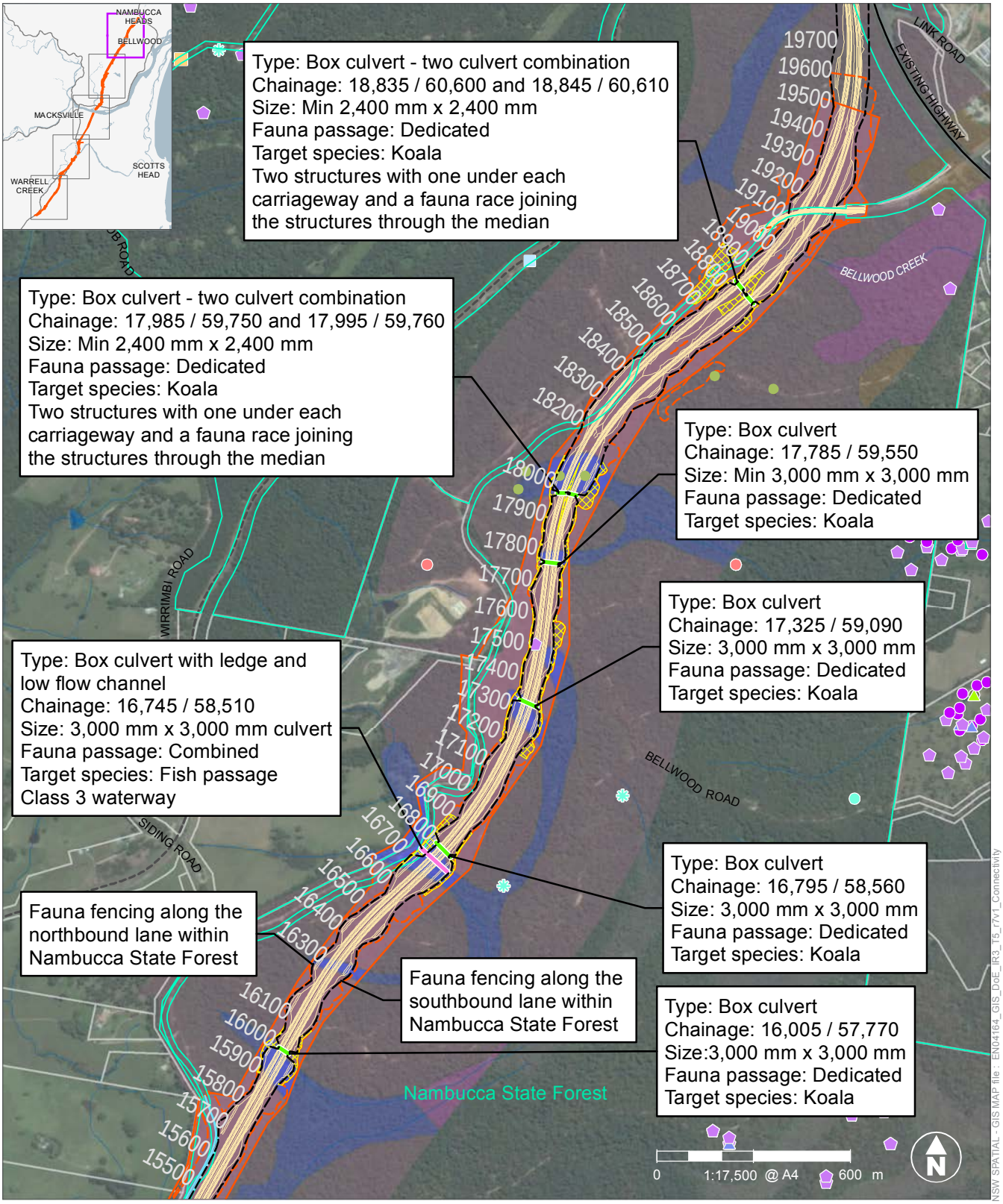

Legend

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Appendix C

Koala Capture Relocation Strategy

Warrell Creek to Nambucca Heads (WC2NH) Pacific Hwy Upgrade Koala Capture and Relocation Strategy

The Koala *(Phascolarctos cinereus*) is listed as threatened (vulnerable) under NSW (*Threatened Species Conservation Act* 1995) and Commonwealth (*Environment Protection and Biodiversity Conservation Act* 1999) legislation. The following strategy has been prepared to minimise impacts on Koalas during the construction phase of the Warrell Creek to Nambucca Heads Pacific Highway Upgrade and satisfy standard pre-clearing protocols. The strategy establishes a procedure to be followed during the clearing phase and guidelines for the capture and relocation of Koalas that are encountered during clearing and grubbing operations.

Background information on the distribution of Koalas within and adjoining the WC2NH upgrade alignment will be obtained from the baseline surveys conducted to satisfy EPBC Act conditions of approval. This data will identify areas of Koala habitat and will compliment targeted surveys during the clearing phase.

1. Surveys for Koalas during clearing operations:
    a. In areas containing potential Koala habitat, foot-based, observational surveys for Koalas ('Koala Surveys') will be conducted the night before (using spotlights) and in the morning immediately prior to clearing in all areas of habitat. Potential Koala habitat is defined as areas where scats have been collected, where Koalas have been sighted, or where primary and secondary feed trees meet the appropriate thresholds of 30 per cent and 50 per cent.
    b. Koala Surveys will cover the area scheduled for clearing that day ('Day Clearing Zone') and immediately adjacent habitat.
    c. Koala Surveys may extend beyond the Day Clearing Zone to establish the presence or otherwise of Koalas ahead of the clearing front.
    d. Clearing contractors and site staff will be asked to provide any sightings of Koalas to the Environment Team.

NB: Pre-clearing surveys will concentrate on habitat within the Limit of Clearing (LoC) and Koalas outside that area will be recorded incidentally.

2. Koala identified in tree within Day Clearing Zone and within LoC in area of contiguous habitat:
    a. Immediately enforce a 50 metre-radius Exclusion Zone (refer Point 6) around occupied tree.
    b. Install Koala pen trap, unless sighting occurs on a Friday when individuals would be left to move unassisted.
    c. Capture Koala and assess health status.
    d. Sick and/or injured Koalas transported to Port Macquarie Koala hospital.
    e. Healthy and un-injured Koalas relocated as per Point 5 below.
    f. Koalas would only be removed from site if they require treatment or hospitalisation.

NB: In some instances it may take several days to capture a Koala, and capture time may be influenced by stress. Pen traps would be installed for 72 hours before alternate methods are applied. Standard alternate procedure would involve the use of flags to force Koalas to descend the tree where they are hand captured. A tree climber may be required in some instances.

3. Koala identified in tree within Day Clearing Zone and within LoC in isolated remnant (no suitable release habitat within 200 metres of site):
    a. Clearing of remnant would cease and Koala allowed to move unassisted – no trapping would occur.
    b. Periodic daytime observation and spotlighting would occur to track Koala movement within remnant.

4. Koala identified in tree up to 50 metres outside the LoC and adjacent Day Clearing Zone:
    a. Immediately enforce a 50 metre-radius Exclusion Zone (refer Point 6) around occupied tree.
    b. Assess the site and ecologist to determine an appropriate course of action. Options include:
        i. Retain Exclusion Zone and avoid clearing the buffer until Koala has relocated.
        ii. Implement trapping protocol (Point 2).
        iii. Continue clearing whilst spotter observes Koala.

5. Retention and relocation:
    a. Captured individuals shall be relocated within their predicted home range, and:
        i. Behind the clearing front.
        ii. Outside LoC.
        iii. Away from source of mortality.
        iv. Within suitable habitat as identified by the ecologist.
    b. Captured individuals will be released at dusk or cessation of days clearing operations (whichever is later) on the day of capture. Until release, Koalas will be moved from the pen trap into a large nest box (owl size) where they will be kept in a cool, dark location. If Koalas are captured in the early hours of the morning they shall be released immediately.
    c. Where possible a captured Koala would be released within the Project boundary. However, the suitability of the release site must be carefully assessed and it may be necessary to release the animal in adjoining habitat. If the capture site adjoins private land contact the Communications Manager to organize access.
    d. Key points to consider in identifying a suitable release site include: sex (female Koalas have smaller home ranges than males); predicted home range in the locality (has there been any home range studies nearby?); location and proximity of busy roads or other potential sources of mortality/ disturbance; extent of forest and degree of fragmentation; area to be cleared and direction of clearing; presence of suitable feed trees.

6. Exclusion (Buffer) Zone restrictions:
    a. No clearing or grubbing operations within Exclusion Zone with the exceptions outlined below.
    b. Hand felling of small shrubs around occupied tree (i.e. shrubs with interlocking canopy or within two metres of trunk) is permissible to improve effectiveness of pen trap.
    c. Plant and equipment may be 'walked' through Exclusion Zone under supervision of Project Ecologist. Machinery must be walked as far from the occupied tree as possible and clearing would be limited to vegetation <150 mm diameter.
    d. Clearing outside the buffer must be done in such a manner to ensure that felled timber does not enter the buffer zone.

7. Incidental Observations of Koalas:
    a. All site personnel to be instructed (weekly tool box, staff notifications) to report Koala sightings to the Project Ecologist or Environmental Manager and to immediately enforce a 50 metre Exclusion Zone around sighted individual(s).
    b. Environmental staff and plant and machinery operators conducting clearing operations shall be tool boxed on key aspects of the Koala Capture and Relocation Strategy, particularly Exclusion Zone restrictions and areas of known or predicted high Koala activity.
    c. All contractors and staff must be aware of Koala presence when moving around the site at dawn or dusk (periods of increased Koala activity) particularly during the winter months when site work overlaps these periods.

8. Data management and review:
    a. Project Ecologist to maintain record of Koala sightings, captures, relocations and transfers to Koala hospital.
    b. Koala Capture and Relocation Strategy to be reviewed by ecologist prior to 2014 Koala breeding season (Jul – Dec).

Appendix D

Fauna Crossing Structures

Appendix A Summary of the fauna crossing locations for the upgrade of the Pacific Highway, WC2NH.

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
42km500	735	Combined	Bridge over Upper Warrell Creek	(-)	Class 1 waterway[3]	Minimum 3 metre wide fauna passage required at each abutment. Giant Barred Frog and fish included as target species.
43km325	1,560	Combined	Box culvert Butchers Creek	Minimum 5 no. x 3600mm x 1500mm high	Class 2 waterway[3] Set one culvert cell 200mm (minimum) below existing bed level. Continue low flow channel through scour protection	Two outside cells must provide dry passage during a 1 in 1 year ARI, 3 day (72 hour) storm event and must not have wet sections that retain water for longer than three days.. No refuge poles required. Approximate culvert length is 47 m.
44km905	3,140	Fish passage	Box culvert	Minimum 3300 mm wide x 1800 mm high	Class 3 waterway [3]. Include low flow channel 200 mm (minimum) below existing bed level and 450 mm wide. Continue low flow channel	Waterway realignment must ensure bed stability; and maintain existing flow velocity. Fish passage.
45km525	3,760	Incidental	Box culvert	Minimum 5 no. x 4200 mm wide x 3600 mm high	Class 3 waterway [3]. Set one culvert cell 200 mm (minimum) below existing bed level. Continue low flow channel through scour protection	Waterway realignment must ensure bed stability; minimise increasing or decreasing existing waterway length; and maintain existing flow velocity. Fish passage.

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
47km000	5,235	Fish passage	Bridge over Williamsons Creek	(-)	Class 3 waterway[3]	
47km525	5,760	Incidental	Box culvert	Minimum 3000 mm wide x 1200 mm high	Class 3 waterway [3]. Include low flow channel 200 mm (minimum) below existing bed level and 450 mm wide. Continue low flow channel through scour protection	Must extend under existing Pacific Highway. Fish passage.
47km650	5,885	Incidental	Box culvert	Minimum 3000 mm wide x 1200 mm high	Fish passage.	
48km085	6,320	Dedicated	Bridge	(-)		Fauna corridor listed is under southern end span of bridge. Minimum 3 metre wide fauna passage required.
48km215	6,450	Dedicated	Bridge	(-)	Class 1 waterway[3]	
48km275	6,510	Dedicated	Bridge	(-)		Fauna corridor listed is under northern end span. Minimum 3 metre wide fauna passage required
49km900	8,135	Incidental	Pipe	2,500 mm diameter	No	Must provide water connectivity across Main carriageways. Site permanently inundated.

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
50km215	8,450	Incidental	Bridge	Minimum width between the intersection of the scour protection and the finished ground level under the bridge to be 50.4m (see Note 1). Minimum vertical clearance to be 2.0 m (subject to detailed design).	No	
50km985	9,220	Incidental	Bridge	Minimum width between the intersection of the scour protection and the finished ground level under the bridge to be 50.4m (see Note 1). Minimum vertical clearance to be 2.0 m (subject to detailed design).	No	

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
55km120	13,355	Dedicated	Box culvert	3000 mm x 3000 mm	No	Approximate length of culvert under main carriageway is 50 m. No culvert is to be provided under the service road but detailed design to investigate lowering the service road to provide better visibility across the service road from the culvert. Fauna fencing to be provided along the bottom of the batter slope between the highway and the service road to prevent fauna accessing the main highway. Koala included as target species
56km410	14,645	Combined	Box culvert	Minimum 2400 mm x 2400 mm	No	Approximate culvert length under main carriageway is 45 m. No fauna underpass is required under the service road. Koala included as target species. Provide ledge for dry passage during a 1 in 1 year ARI, 3 day (72 hour) storm event and must not have wet sections that retain water for longer than three days.
57km770	16,005	Dedicated	Box culvert	3000 mm x 3000 mm	No	Maximum culvert length is 50 m. Koala included as target species

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
58km510	16,745	Combined	Box culvert	3000 mm x 3000 mm	Class 3 waterway3 Include low flow channel 1200mm wide x 200mm deep below existing bed level. Continue low flow channel through scour protection. Fish passage.	Approximate culvert length is 84m. Provide ledge for dry passage during a 1 in 1 year ARI, 3 day (72 hour) storm event and must not have wet sections that retain water for longer than three days. Adjacent box or pipe culvert to also be provided for drainage.
58km560	16,795	Dedicated	Box culvert	3000 mm x 3000 mm	No	Maximum culvert length is 50 m. Koala included as target species
59km090	17,325	Dedicated	Box culvert	3000 mm x 3000mm	No	Culvert length is 58 m. Length slightly in excess of 50 metres however was agreed to be acceptable if needed to achieve desired location. Koala included as target species
59km550	17,785	Dedicated	Box culvert	Minimum 3000 mm x 3000 mm	No	Approximate culvert length is 50 m. Koala included as target species
59km750 (northbound carriageway)	17,985	Dedicated	Box culvert	2400 mm x 2400 mm	No	Approximate culvert length is 38 m. Culvert to be moved up the bank to achieve the 1 in 100 year ARI flood immunity. Koala included as target species

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
59km760 (southbound carriageway)	17,995	Dedicated	Box culvert	Minimum 2400 mm x 2400 mm	No	Approximate culvert length is 25 m. Combined length of the northbound and southbound underpasses is around 63 m. Carriageway separation is approximately 10 m with a fauna fenced race in between underpasses. Koala included as target species
60km615 (northbound carriageway)	18,850	Dedicated	Box culvert	2400 mm x 2400 mm	No	Approximate culvert length is 29 m. Structure to be shifted to the north around 15 metres to align with southbound carriageway. Koala included as target species.
60km600 (southbound carriageway)	18,835	Dedicated	Box culvert	Minimum 2400 mm x 2400 mm	No	Approximate culvert length is 30 m. Combined length of the northbound and southbound underpasses is around 59 m. Carriageway separation is approximately 19 m with a fauna fenced race in between underpasses. Koala included as target species.

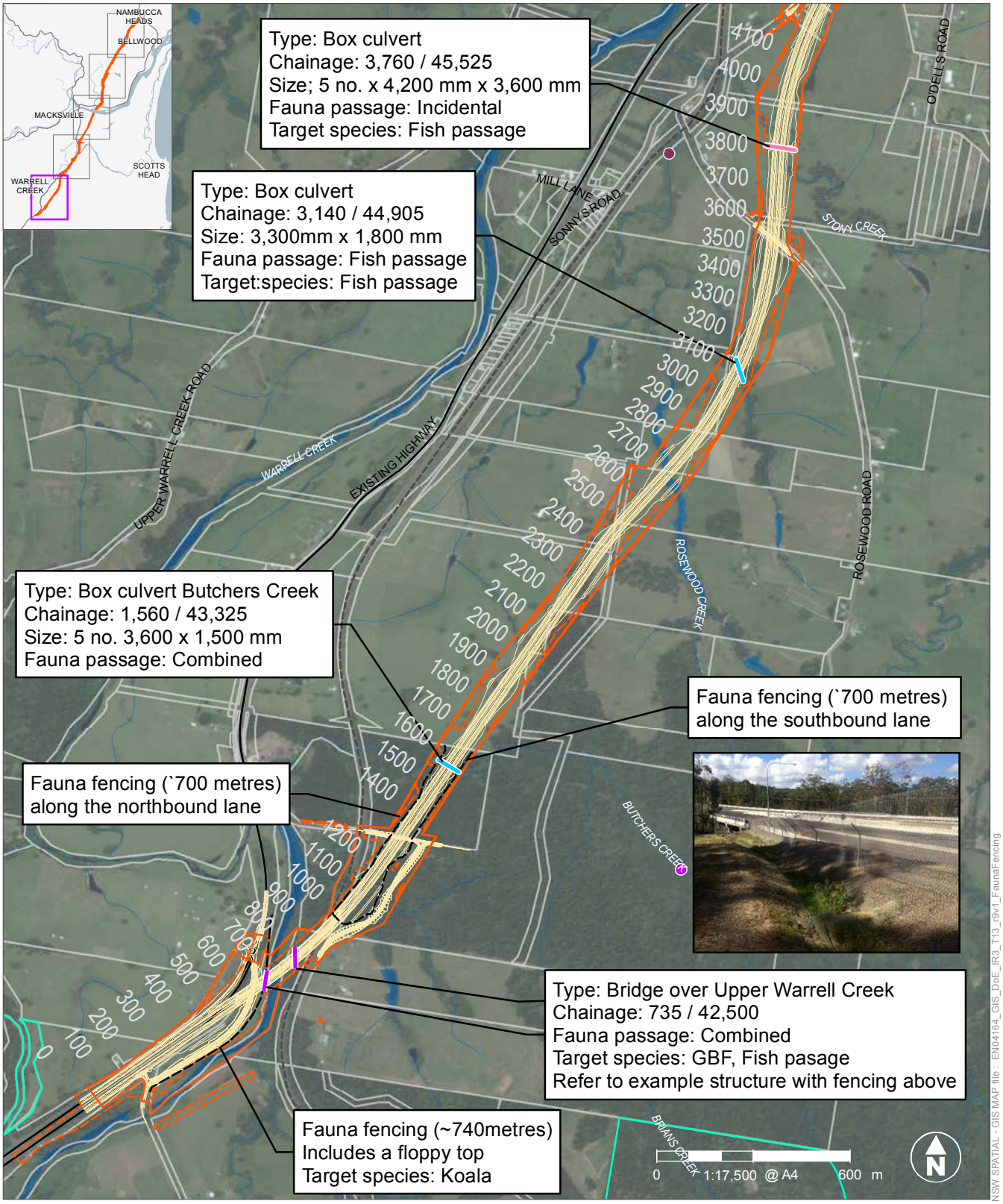
1 A bridge may be provided in lieu of a box culvert provided that the total width between the intersection of the scour protection and the finished ground level under the bridge is at least equivalent to the total clear width of the cells of the replaced box culvert.

2 Separate fauna crossing structures must be provided for the Main Carriageways and Service Road to provide daylight between the Main Carriageways and Service Road structures.

3 Classification identified in consultation with DPI (Fisheries Conservation and Aquaculture)

Appendix E

Fauna Exclusion Fencing



Legend

Road design
Service Road - Old Coast Road
Road boundary
Clearing boundary
Lot (survey)
State Forest boundary
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna fence
Bridge with fauna passage
Incidental fauna passage

Threatened fauna

- Black Bittern
- Black Grass-dart Butterfly
- Black-necked Stork
- Brolga
- Brush-tailed Phascogale
- Cattle Egret
- Common Greenshank
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Eastern Osprey
- Glossy Black-Cockatoo
- Glossy Ibis
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Koala
- Latham's Snipe
- Little Bentwing-bat
- Masked Owl
- Oriental Pratincole
- Osprey (nest site)
- Pacific Golden Plover
- Powerful Owl
- Rainbow Bee-eater
- Regent Honeyeater
- Sooty Owl
- Southern Myotis
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- Square-tailed Kite
- Squirrel Glider
- White-bellied Sea-Eagle
- Yellow-bellied Glider

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NSW SPATIAL - GIS MAP file : EN04164_GIS_DoE_IR3_T13_r9v1_FaunaFencing

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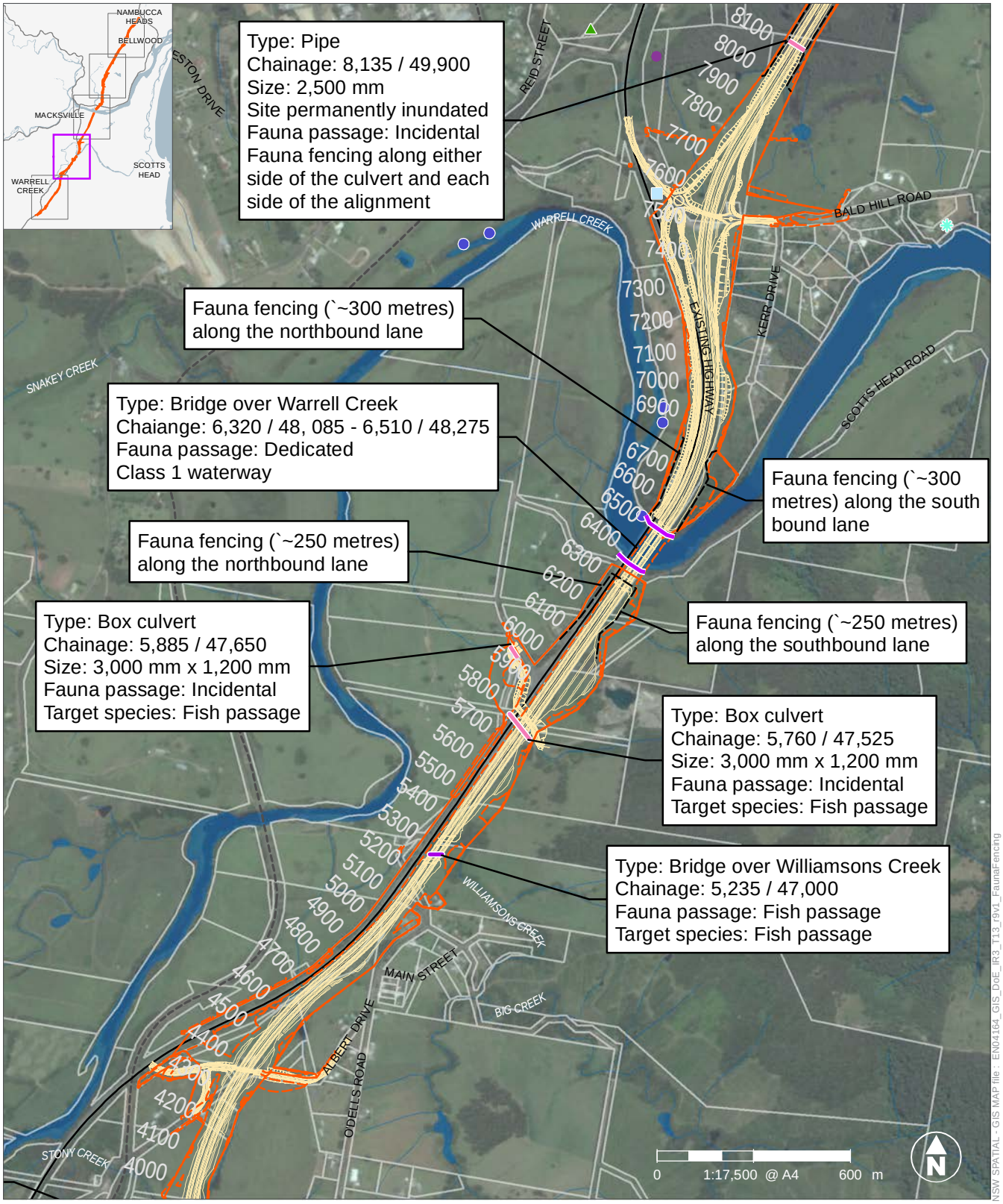

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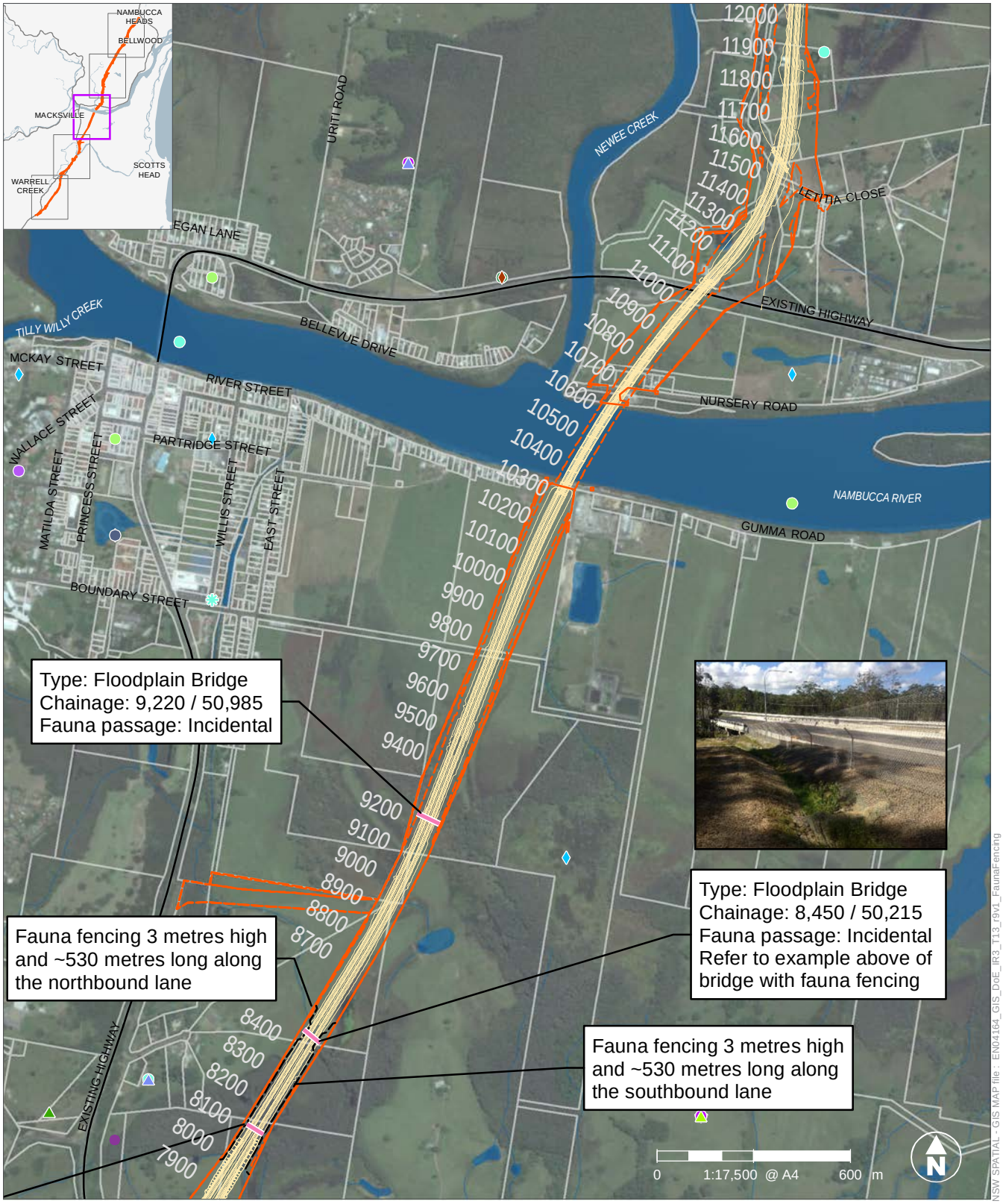

NSW SPATIAL - GIS MAP file : EN04164_GIS_DoE_IR3_T13_r9v1_FaunaFencing

Legend

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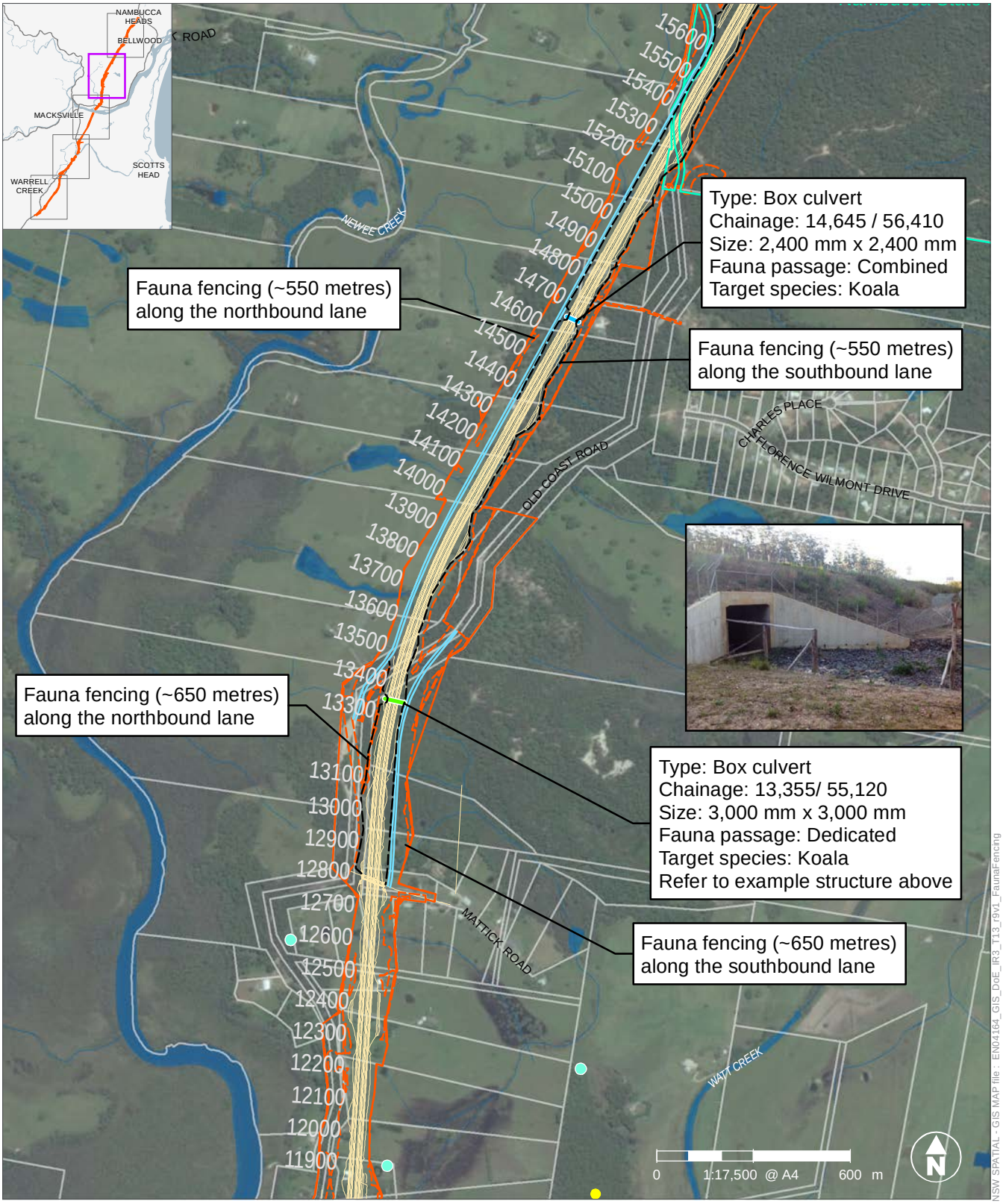

NSW SPATIAL - GIS MAP file: EN04164_GIS_DoE_IR3_T13_r9v1_FaunaFencing

Legend

Road design
Service Road - Old Coast Road
Road boundary
Clearing boundary
Lot (survey)
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ESRI basemaps 2013, Roads and Maritime Services 2010, 2013, LPMA 2010, SKM 2010, OEH 2013

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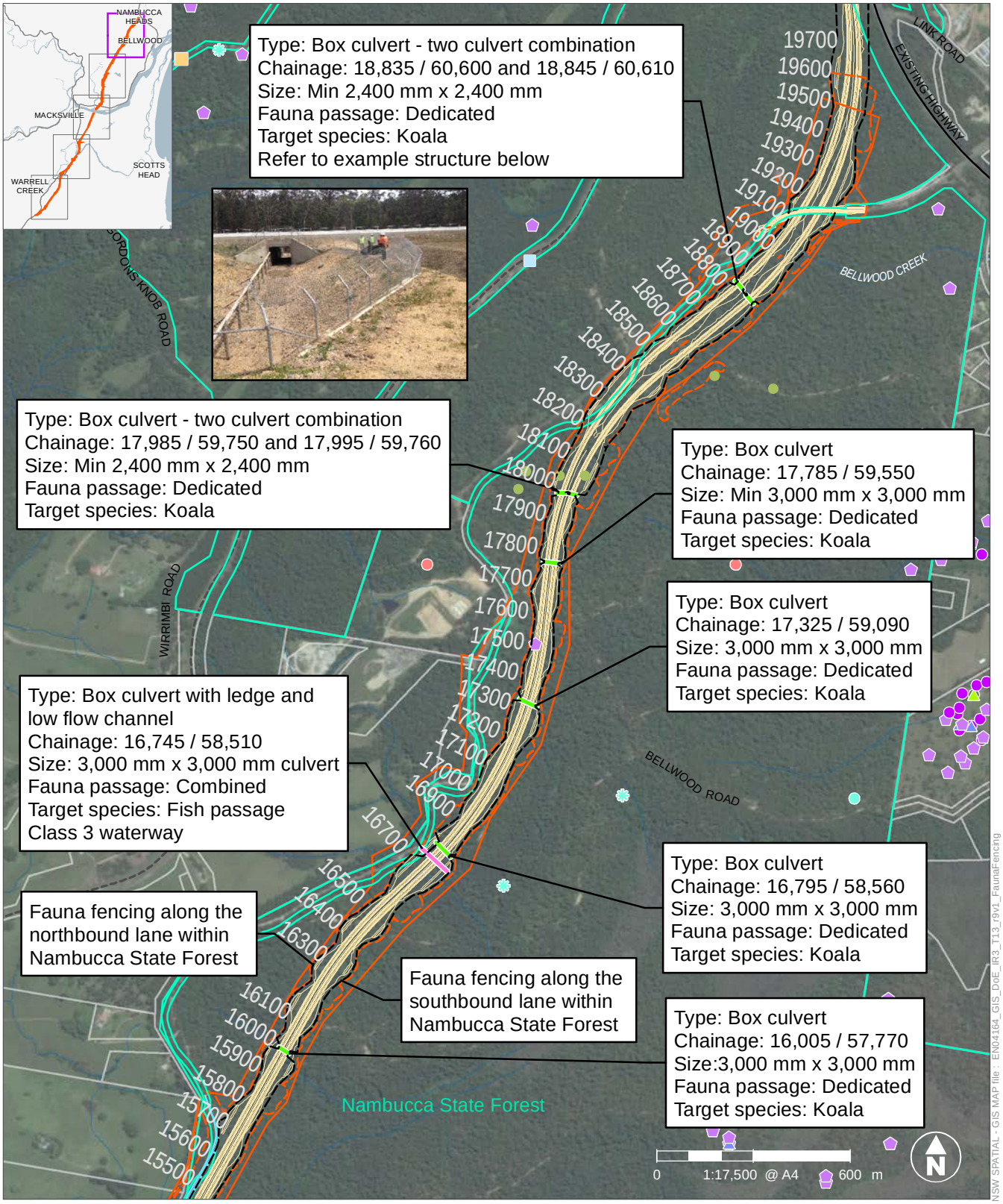


Legend

Road design
Service Road - Old Coast Road
Road boundary
Clearing boundary
Lot (survey)
State Forest boundary
Combined culvert with fauna underpass
Dedicated fauna underpass
Fauna fence
Bridge with fauna passage
Incidental fauna passage

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.

Threatened fauna

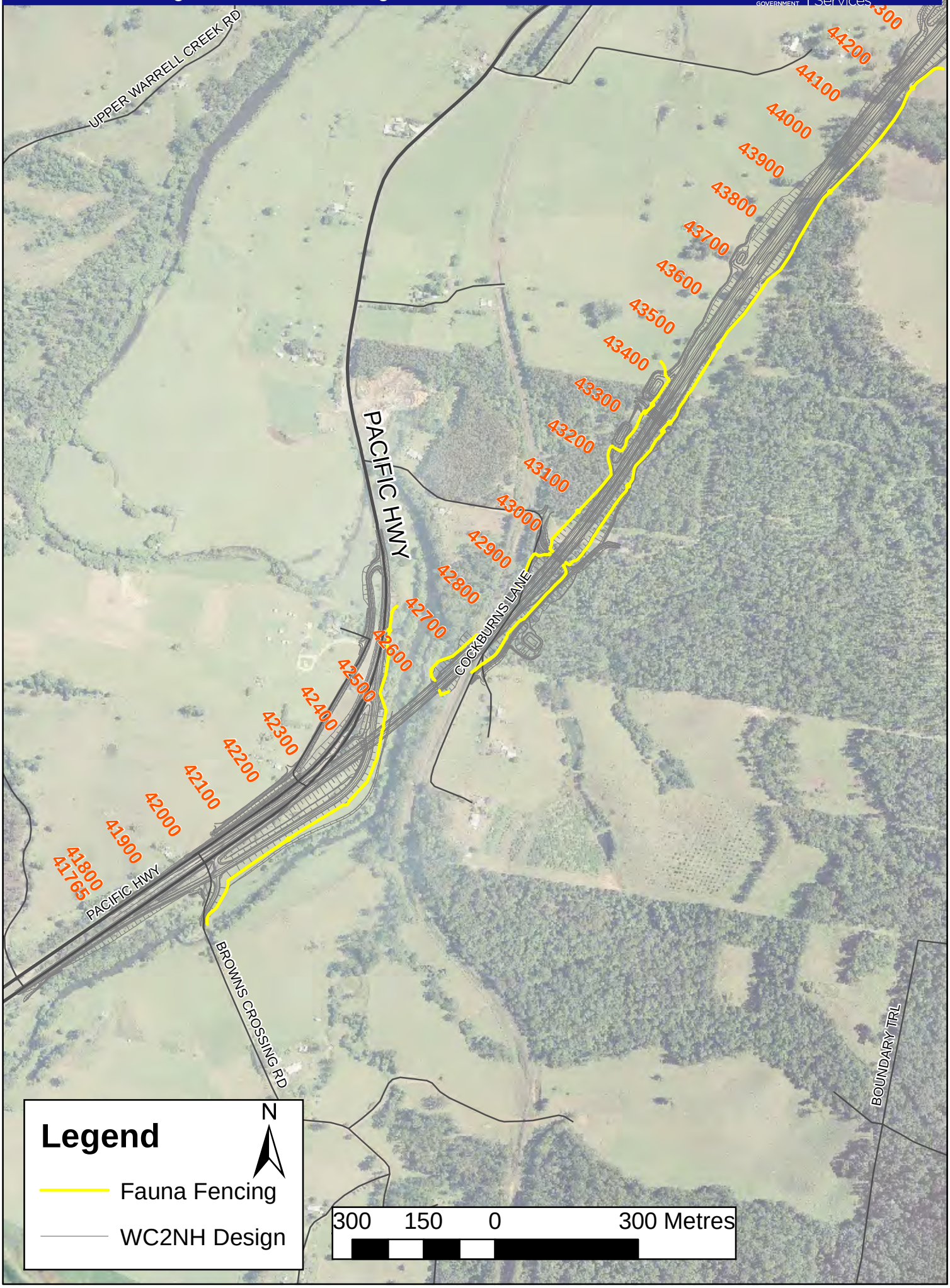
- Black Bittern
- Black Grass-dart Butterfly
- Black-necked Stork
- Brolga
- Brush-tailed Phascogale
- Cattle Egret
- Common Greenshank
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Eastern Osprey
- Glossy Black-Cockatoo
- Glossy Ibis
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Koala
- Latham's Snipe
- Little Bentwing-bat
- Masked Owl
- Oriental Pratincole
- Osprey (nest site)
- Pacific Golden Plover
- Powerful Owl
- Rainbow Bee-eater
- Regent Honeyeater
- Sooty Owl
- Southern Myotis
- Spotted-tailed Quoll
- Square-tailed Kite
- Squirrel Glider
- White-bellied Sea-Eagle
- Yellow-bellied Glider

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

PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 1 Fauna Fencing locations

Transport Roads & Maritime Services



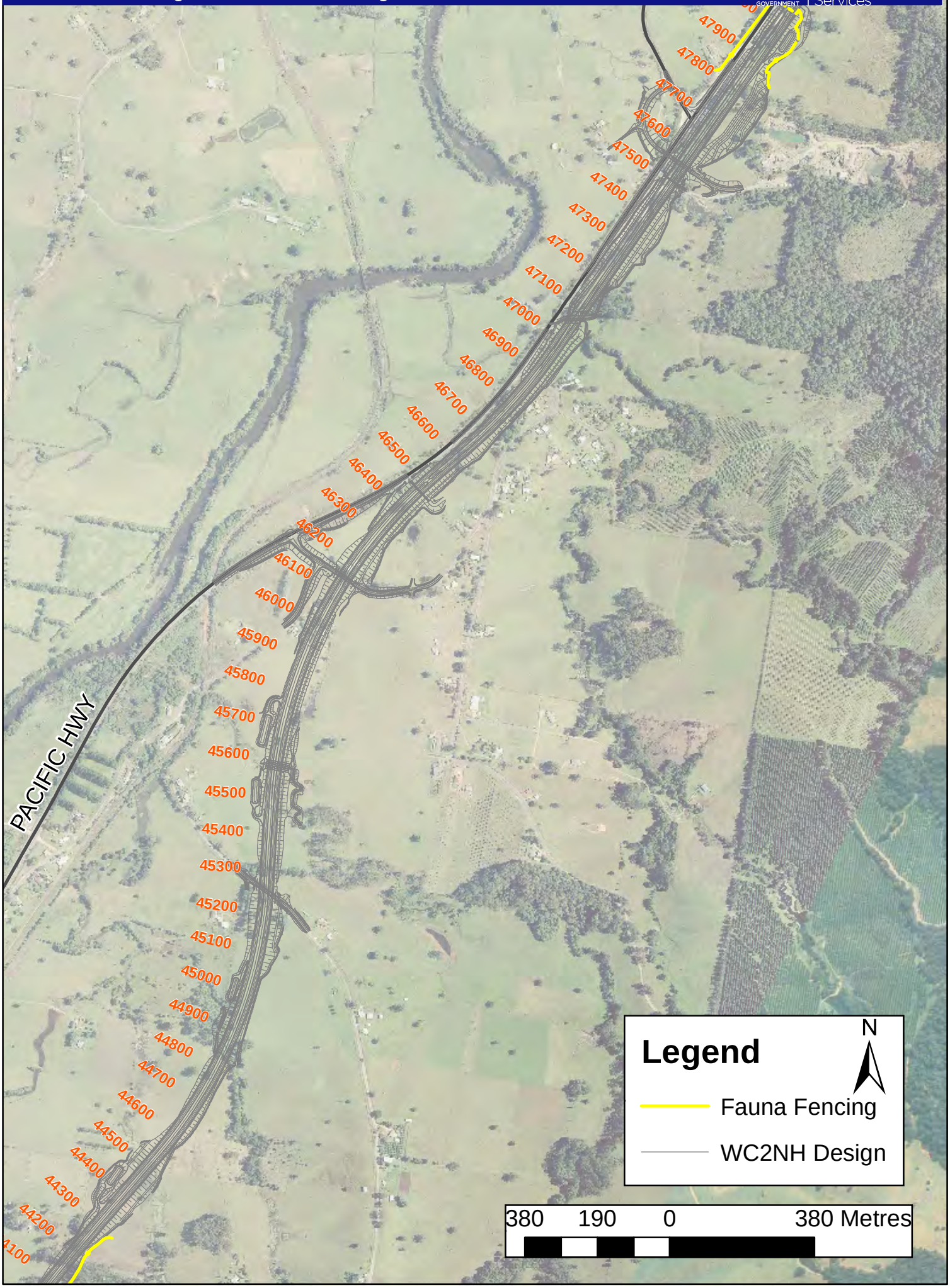
PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 2 Fauna Fencing locations

PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 3 Fauna Fencing locations

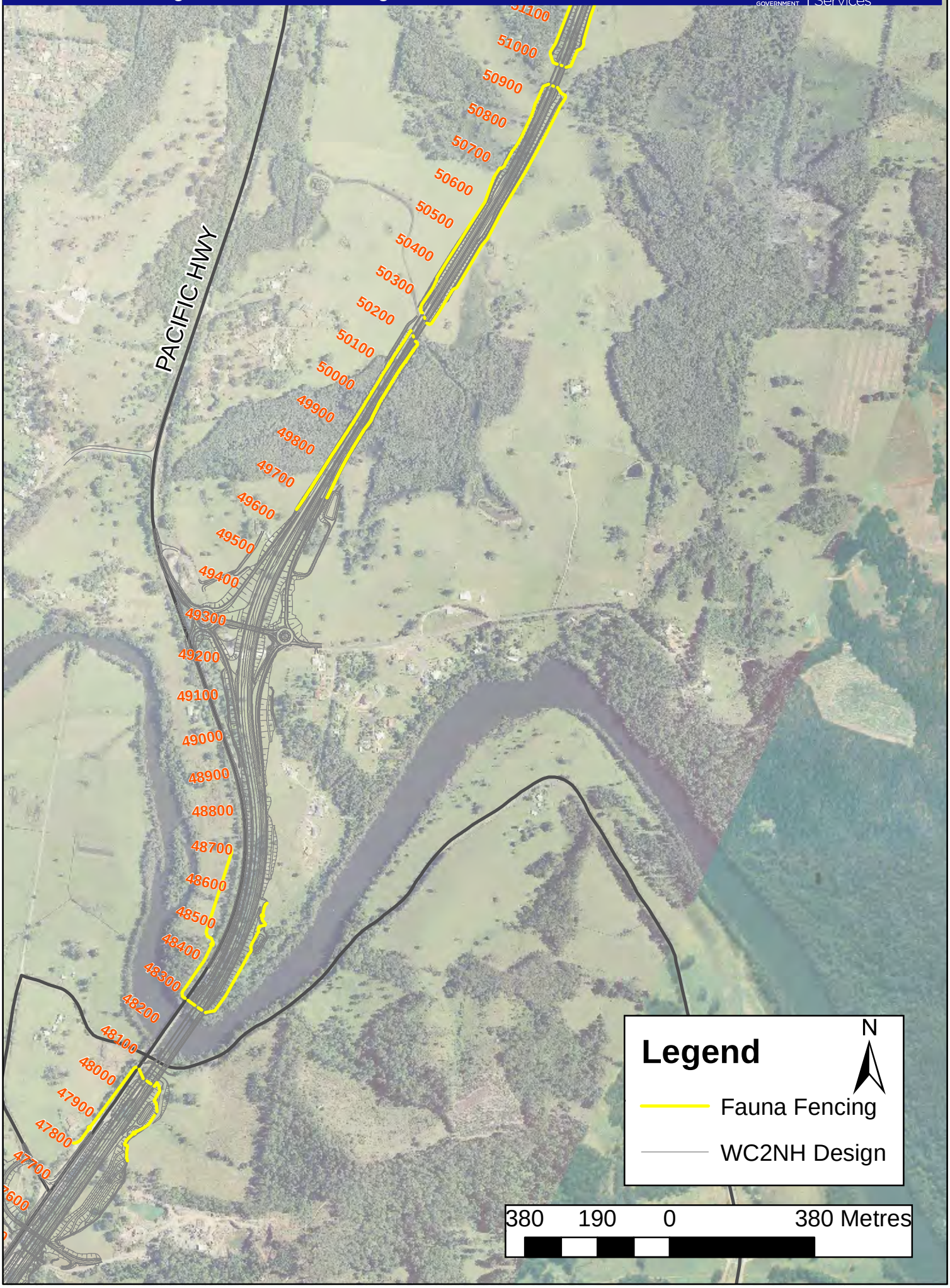
Transport Roads & Maritime Services



PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 4 Fauna Fencing locations

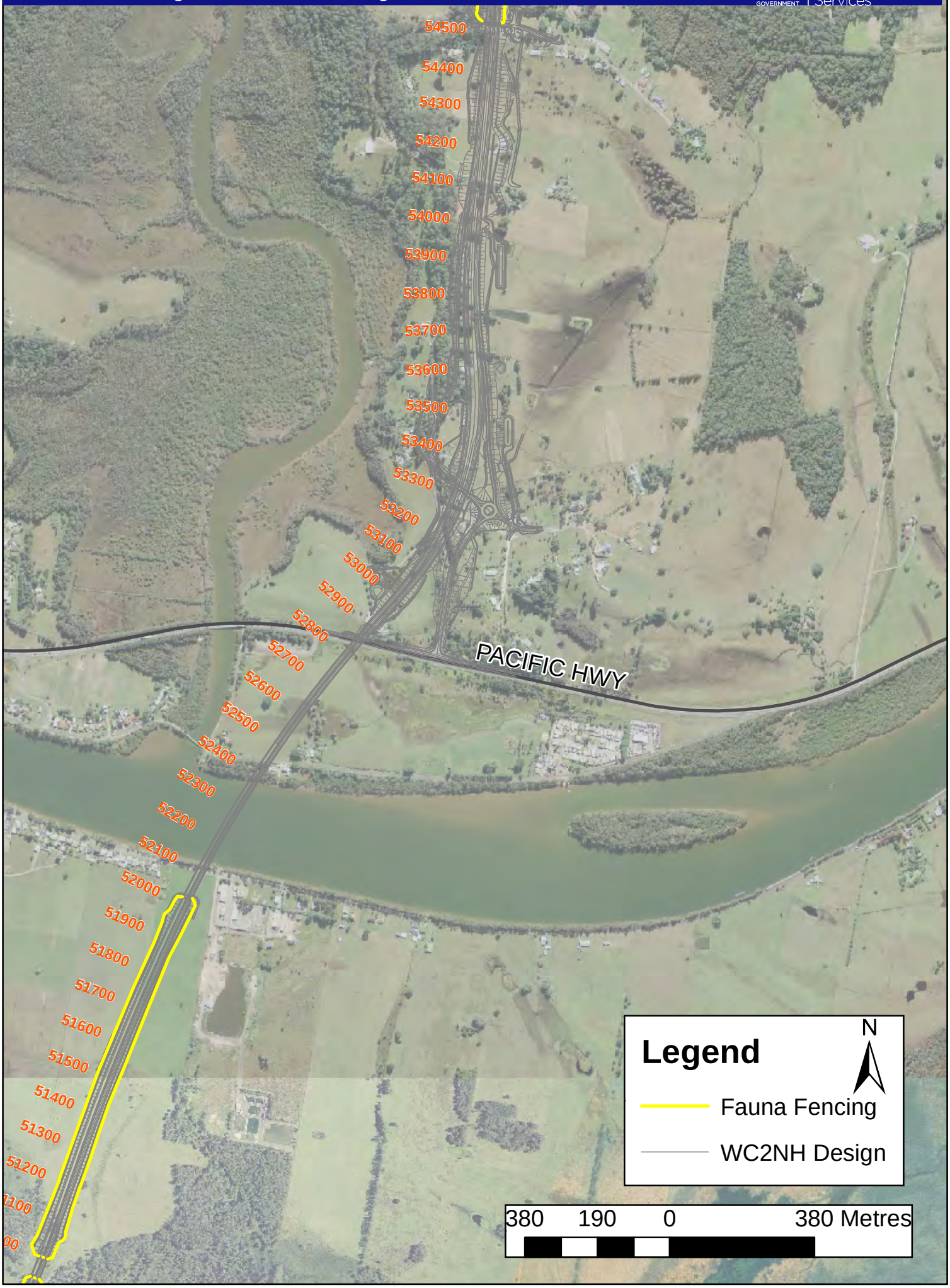
Transport Roads & Maritime Services



PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 5 Fauna Fencing locations

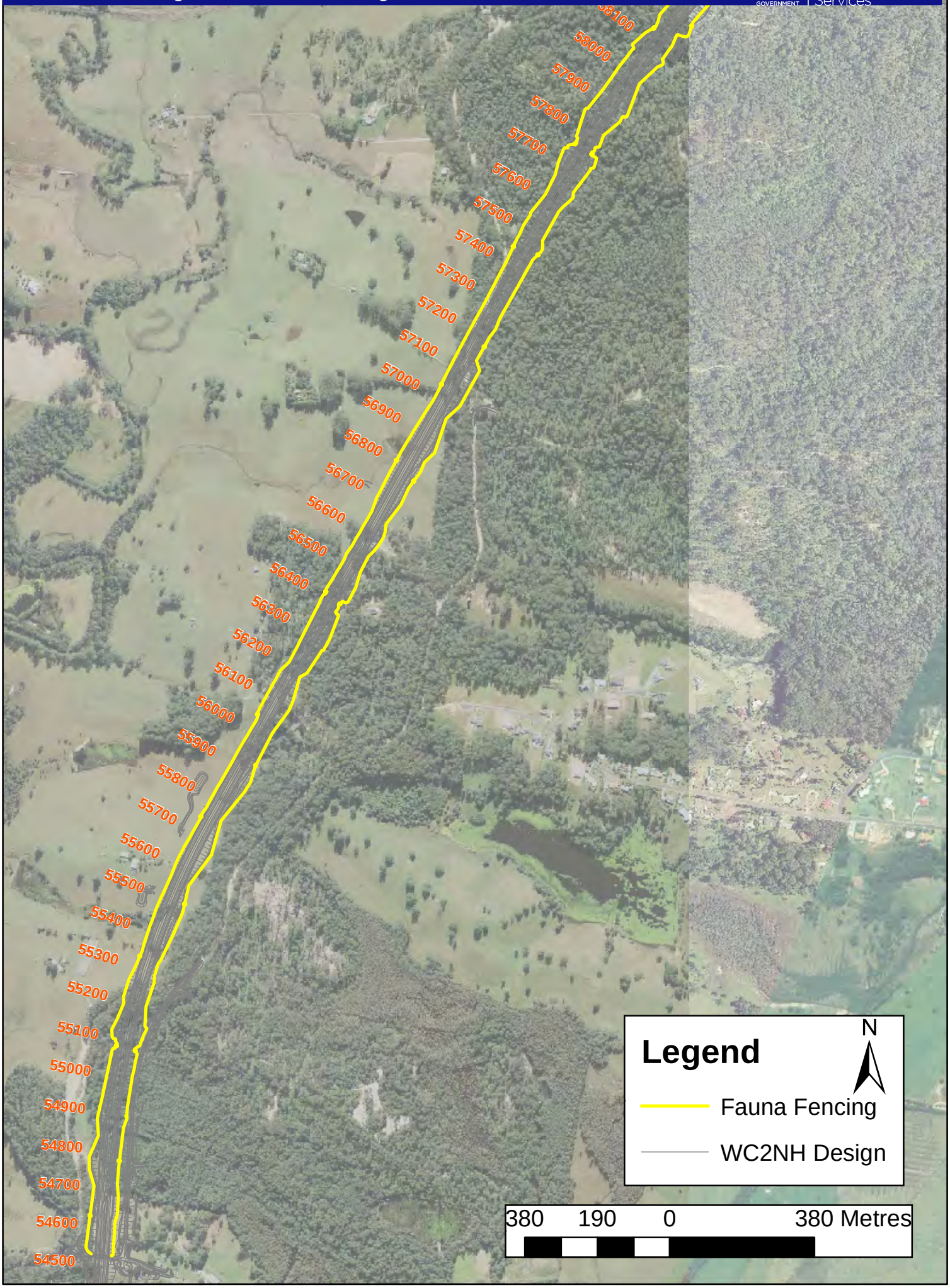
Transport Roads & Maritime Services



PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 6 Fauna Fencing locations

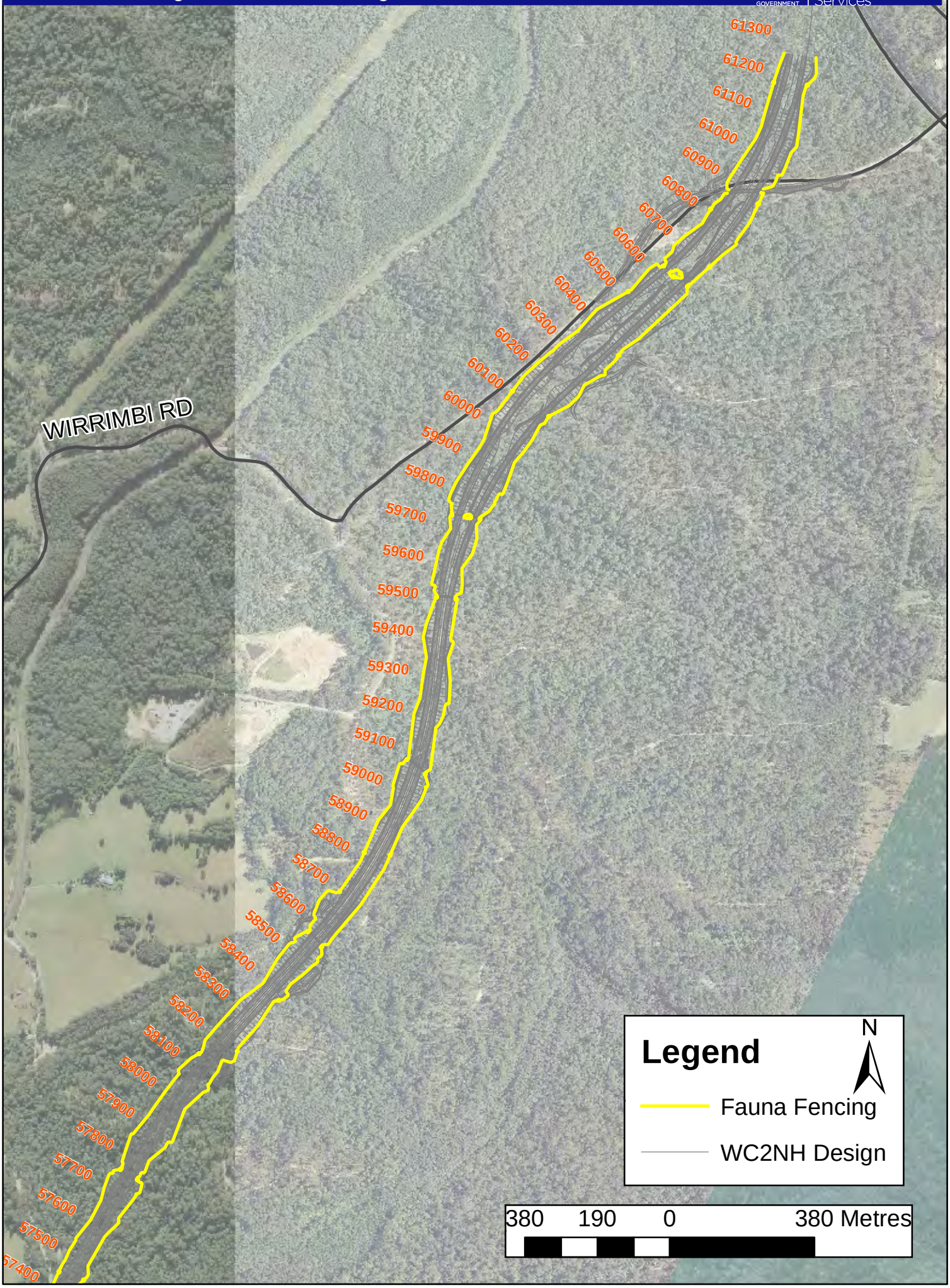
Transport Roads & Maritime Services



PACIFIC HIGHWAY UPGRADE - Warrell Creek to Nambucca Heads

Attachment B Figure 7 Fauna Fencing locations

Transport Roads & Maritime Services



Appendix F

Koala Monitoring Methodology

Draft Pre-clearance Baseline Koala Monitoring Methodology

Objectives

The objective of the pre-clearance baseline Koala monitoring is to establish the numbers and distribution of individual Koalas, in relation to proposed mitigation structures, so that an informed assessment can be made of the impacts of the upgrade of the Pacific Highway Warrell Creek to Nambucca Heads (WC2NH) on Koalas in the Nambucca State Forest/ Old Coast Road area. Monitoring would be undertaken to provide reliable information such that sound conclusions can be drawn in relation to management of Koalas at WC2NH and help inform other future road infrastructure projects. Specifically, the monitoring aims to identify changes in resident Koala activity (abundance, home range and movements) in response to construction of WC2NH and the effectiveness of Koala habitat connectivity mitigation measures (i.e. fauna underpasses and exclusion fencing).

Scope

The following Koala monitoring would be undertaken targeting the Nambucca State Forest/ Old Coast Road area:

- Standard monitoring items:
  - Transect surveys (diurnal and nocturnal surveys).
  - Fauna underpass monitoring (remote cameras).
  - Fauna exclusion fence monitoring.
  - Road kill monitoring.
- Provisional monitoring items:
  - Koala Global Positioning System (GPS) receiver/Very High Frequency (VHF) transmitter attachment and pit-tagging.

Timing

Monitoring would be undertaken pre-construction (baseline data), during and post-construction until such time as the management measures have proven to be effective or up to a maximum of 5 years post-construction. A summary of the proposed timing is provided in **Table 1.**

Baseline Koala surveys would be completed during the pre-construction phase to determine the presence and approximate abundance of Koalas in the Nambucca State Forest/Old Coast Road section of WC2NH. These surveys would commence as soon as possible to maximise the duration and effectiveness of the pre-construction monitoring. The outcomes of the initial transect surveys would determine the future direction of the monitoring program and need for provisional monitoring items. Specifically, should three or more Koalas be recorded, the provisional monitoring items of GPS/VHF fitted collaring and pit-tagging of recorded Koalas would be triggered.

Standard Koala monitoring items (fauna underpass and fence monitoring) would be undertaken at all structures designed specifically for the Koala (i.e. not just those in the Nambucca State Forest/Old Coast Road area) irrespective of the results of the baseline Koala surveys. This would comprise:

- Underpass monitoring: Would be undertaken post-construction and coincide with the breeding season and likely juvenile dispersal period of the Koala (September to February and July to August) and involve

remote camera surveys at fauna underpasses that include the Koala as a target species. Koala movements would be expected to be more frequent and extensive during the breeding season and dispersal periods due to expansion of home ranges and movement of juveniles away from natal areas. Therefore, these periods would be likely to represent peaks in fauna movement, resulting in higher rates of usage of connectivity structures and thus higher detection rates.

- Fauna fence monitoring: Would be undertaken annually post construction as part of standard ongoing road maintenance. The contractor has a contractual period of 36 months to maintain fences. At the completion of this time period, Roads and Maritime Services Asset Division will continue to maintain fauna fencing.
- Road kill monitoring: Monitoring of all road kills forms part of the Roads and Maritime Services Asset Division regular inspection program.

Should the provisions for GPS/VHF and pit-tag Koala monitoring be triggered, initial collaring and pit-tagging would occur as soon as possible, with the animals re-captured every 6 months so that the GPS data can be downloaded. During re-captures, the animals would be inspected (and treated) to ensure their welfare is maintained, and GPS and VHF batteries replaced. This would continue during construction and until 3 years post-construction. Three transect surveys would be undertaken post-construction.

Table 1 Summary of Monitoring Timing

Monitoring Type	Objective	Pre-construction (Baseline)	During Construction		Post-construction				
			Year 1	Years 2 and 3 (if required)	Year 1	Year 2	Year 3	Year 4	Year 5
Transect Surveys	Record resident population presence and occupation/ density	Yes	-	-	Yes	-	Yes	-	Yes
Fauna underpass Monitoring – Camera Monitoring	Record Koala use of fauna underpasses as identified in **Appendix A**	-	-	-	-	Yes	Yes	-	Yes
Road Kill Monitoring	Record any Koala mortalities	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fauna Exclusion Fence Monitoring	Ensure exclusion fences are functional	-	-	-	Yes	Yes	Yes	Yes	Yes
GPS/VHF fitted transmitters and pit-tagging	Observe individual Koala impacts and monitor interactions with connectivity structures and fences	Provisional	Provisional	Provisional	Provisional	Provisional	Provisional	-	-
Update Reporting	Update RMS on monitoring progress	-	-	Provisional	-	Provisional	Yes	-	-
Formal Reporting	Analysis and document monitoring findings	Yes	-	Provisional	Yes	-	Provisional	-	Yes

Pre-construction monitoring

Initial transect surveys would be undertaken to document Koala presence and occupation. Should adequate data be obtained, population estimates would also be made based on the 'Strip (fixed-width) transect' or 'Line-transect' method described in Dique *et al*., (2003). Specifically, transects would be established on each side of the Proposal footprint within the Nambucca State Forest/ Old Coast Road area between chainage 15,600 and 19,500 where Koalas or Koala activity has previously been recorded (GeoLINK, 2013). Twenty-five transects 500 metre long (or to the limit of vegetation if <500 metres) would be spaced approximately 150 metres apart running perpendicular to the proposed project footprint on each side of the highway upgrade. Each transect would be surveyed as follows:

- Diurnal survey: One observer with binoculars walking the transect searching for Koalas.
- Nocturnal survey: One observer spotlight the transect on foot searching for Koalas at a rate of 0.5 to 1.0 kilometres/hour (depending on vegetation density). Koala call playback would also be undertaken on each transect during spotlighting to increase the chance of Koala detection.

If a Koala is identified, the following information would be recorded: location (GPS), distance from transect line, occupied tree species, habitat type, tree height, diameter at breast height (DBH), and if possible the Koala's sex, behaviour, disease status and reproductive status. The transect surveys must be undertaken by personnel experienced in Koala surveys.

Additional spotlighting would follow tracks and easements across this area (exact locations to be determined on site); with the survey effort of five person spotlighting hours at a rate of one kilometres/hour targeting each side of the highway (10 person hours in total over four nights). Koala call playback would be undertaken at regular intervals along these tracks and easements during spotlighting to increase the chance of Koala detection.

Transect surveys would be repeated twice per event with a minimum one week separation between monitoring events pre-construction and one month separation between monitoring events post-construction.

Should three or more Koalas be recorded during the transect surveys, the provisions for GPS/VHF fitted collaring and pit-tagging recorded Koalas and establishing transect surveys control sites would be triggered. This would encompass the following additional pre-construction monitoring activities:

- GPS/VHF collar-fitted receiver and transmitter and pit-tagging: Locating, capturing and fitting Koalas with GPS receiver/VHF transmitters; capturing the collared animals after six months or prior to the start of construction (whichever occurs first) to download GPS data, inspect the animals welfare (take any necessary action) and replace collar batteries. The GPS would be set to record the maximum number of location fixes for six months. The VHF transmitter will allow for easier Koala re-location during subsequent capture events. VHF transmitter batteries would be replaced every time the animal is recaptured.
- Transect surveys: Establish 'control' transect survey sites greater than 500 metres from the Pacific Highway upgrade alignment to complement 'impact' transect survey sites.

Construction monitoring

Koala monitoring during construction would relate to management of GPS/VHF fitted receiver/transmitters and pit-tagged Koalas and only be required if provisional monitoring items are triggered. This includes:

- Six monthly capturing of the collared animals to download GPS data, inspect the animals welfare (take any necessary action) and replace transmitter batteries.
- Pit-tagging Koalas during the capture event before fauna underpasses are operational.
- Installing pit-tag scanners at both ends of each Koala fauna underpass structure.

Post construction monitoring

Standard post-construction Koala monitoring relates to fauna underpass and exclusion fence monitoring, and would include:

- Detection with automated (remote) cameras (minimum 40 sampling nights per camera per monitoring event) for three or five years post-construction. Cameras would be installed at both ends of each target underpass (refer to **Appendix** A) with cameras set to ensure each underpass cell is monitored (i.e. multiple cameras may be required in some locations based on final underpass designs).
- Transect surveys (diurnal and nocturnal) during the first, third and fifth years. Monitoring of fauna exclusion fencing.
- Road kill monitoring. Should any Koala mortalities occur, the location and likely cause would be investigated and documented.

Provisional post-construction Koala monitoring activities would include:

- Six monthly capturing of the collared animals to download GPS data, inspect the animals welfare (take any necessary action) and replace collar batteries for three years.
- Downloading pit-tag scanner data should this provisional item be triggered.

Reporting

The results of the monitoring would be documented and provided to RMS in two key forms: Update Reporting and Formal Reporting. Update Reporting would be in a short report format and include monitoring undertaken to date, monitoring results and a brief discussion of results. Formal Reporting would be in a comprehensive report format and include details of monitoring progress updates, methodologies, results and discussion including a pre/post-construction and impact/control site analysis and a discussion of the results in relation to the monitoring objectives to date where appropriate. The need for revision to the monitoring methodology or corrective actions would also be identified.

Performance measures

The objectives of the fauna underpass structures and exclusion fencing are to provide a safe passage for the movement of wildlife, including Koalas, across the highway and to minimise wildlife morality due to vehicle strike. Specifically, Koalas should maintain their existing population size and distribution in the local area and the opportunity for genetic exchange between animals living either side of the highway should be demonstrated. Performance of the underpass structures and associated fauna fencing would be measured by achievement of the following possible outcomes:

- Koala abundance and distribution are maintained in the vicinity of Nambucca State Forest/Old Coast Road.
- Evidence of usage of the designated underpasses by the Koala is confirmed at a frequency which maintains population viability.
- Zero or minimal Koala vehicle strikes in the Nambucca State Forest/Old Coast Road area.
- No breaches in fauna exclusion fencing or encroachment of shrub or canopy vegetation within three metres of fauna exclusion fencing.

Corrective actions

There is the potential for natural variation in Koala populations for a range of reasons. Further monitoring/assessment would be undertaken if a decline of Koala population numbers is identified as being attributable to the construction and operation of the project. The monitoring / assessment to determine the cause of the decline and/or remedial actions would be commenced as necessary, taking into account potential causes such as dry seasons, population fluctuations and other natural variation, hence the requirement for use of unmitigated control sites. The monitoring / assessment would be dependent upon the monitoring already conducted prior to the decline being noted. Any contingency measures to be implemented would be agreed to by the relevant regulatory authorities prior to commencement.

If during the operational phase Koalas are found to be unable or unwilling to use designated crossing structures, provisional options would be developed that could be implemented if research and/or monitoring identify that additional or alternative measures are required. Depending on the outcome of the monitoring of crossing structures the following options would be considered:

- Maintenance of the existing connectivity measures.
- Modify design of existing measures where feasible and reasonable.
- Consider additional offset measures to improve connectivity elsewhere.

References

Dique, D. S., de Villiers, D. L., & Preece, H. J. (2003) Evaluation of line-transect sampling for estimating koala abundance in the Pine Rivers Shire, south-east Queensland, *Wildlife Research*, 30: 127-133.

GeoLINK (2013). *Warrell Creek to Nambucca Heads Pacific Highway Upgrade: EPBC Act Koala Impact Assessment*. Unpublished report to NSW Roads and Maritime Services. GeoLINK Consulting, Coffs Harbour.

Appendix A Summary of the fauna crossing locations for the upgrade of the Pacific Highway, WC2NH.

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
42km500	735	Combined	Bridge over Upper Warrell Creek	(-)	Class 1 waterway[3]	Minimum 3 metre wide fauna passage required at each abutment. Giant Barred Frog and fish included as target species.
43km325	1,560	Combined	Box culvert Butchers Creek	Minimum 5 no. x 3600mm x 1500mm high	Class 2 waterway[3] Set one culvert cell 200mm (minimum) below existing bed level. Continue low flow channel through scour protection	Two outside cells must provide dry passage during a 1 in 1 year ARI, 3 day (72 hour) storm event and must not have wet sections that retain water for longer than three days.. No refuge poles required. Approximate culvert length is 47 m.
44km905	3,140	Fish passage	Box culvert	Minimum 3300 mm wide x 1800 mm high	Class 3 waterway [3]. Include low flow channel 200 mm (minimum) below existing bed level and 450 mm wide. Continue low flow channel	Waterway realignment must ensure bed stability; and maintain existing flow velocity. Fish passage.
45km525	3,760	Incidental	Box culvert	Minimum 5 no. x 4200 mm wide x 3600 mm high	Class 3 waterway [3]. Set one culvert cell 200 mm (minimum) below existing bed level. Continue low flow channel through scour protection	Waterway realignment must ensure bed stability; minimise increasing or decreasing existing waterway length; and maintain existing flow velocity. Fish passage.

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
47km000	5,235	Fish passage	Bridge over Williamsons Creek	(-)	Class 3 waterway[3]	
47km525	5,760	Incidental	Box culvert	Minimum 3000 mm wide x 1200 mm high	Class 3 waterway [3]. Include low flow channel 200 mm (minimum) below existing bed level and 450 mm wide. Continue low flow channel through scour protection	Must extend under existing Pacific Highway. Fish passage.
47km650	5,885	Incidental	Box culvert	Minimum 3000 mm wide x 1200 mm high	Fish passage.	
48km085	6,320	Dedicated	Bridge	(-)		Fauna corridor listed is under southern end span of bridge. Minimum 3 metre wide fauna passage required.
48km215	6,450	Dedicated	Bridge	(-)	Class 1 waterway[3]	
48km275	6,510	Dedicated	Bridge	(-)		Fauna corridor listed is under northern end span. Minimum 3 metre wide fauna passage required
49km900	8,135	Incidental	Pipe	2,500 mm diameter	No	Must provide water connectivity across Main carriageways. Site permanently inundated.

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
50km215	8,450	Incidental	Bridge	Minimum width between the intersection of the scour protection and the finished ground level under the bridge to be 50.4m (see Note 1). Minimum vertical clearance to be 2.0 m (subject to detailed design).	No	
50km985	9,220	Incidental	Bridge	Minimum width between the intersection of the scour protection and the finished ground level under the bridge to be 50.4m (see Note 1). Minimum vertical clearance to be 2.0 m (subject to detailed design).	No	

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
55km120	13,355	Dedicated	Box culvert	3000 mm x 3000 mm	No	Approximate length of culvert under main carriageway is 50 m. No culvert is to be provided under the service road but detailed design to investigate lowering the service road to provide better visibility across the service road from the culvert. Fauna fencing to be provided along the bottom of the batter slope between the highway and the service road to prevent fauna accessing the main highway. Koala included as target species
56km410	14,645	Combined	Box culvert	Minimum 2400 mm x 2400 mm	No	Approximate culvert length under main carriageway is 45 m. No fauna underpass is required under the service road. Koala included as target species. Provide ledge for dry passage during a 1 in 1 year ARI, 3 day (72 hour) storm event and must not have wet sections that retain water for longer than three days.
57km770	16,005	Dedicated	Box culvert	3000 mm x 3000 mm	No	Maximum culvert length is 50 m. Koala included as target species

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
58km510	16,745	Combined	Box culvert	3000 mm x 3000 mm	Class 3 waterway3 Include low flow channel 1200mm wide x 200mm deep below existing bed level. Continue low flow channel through scour protection. Fish passage.	Approximate culvert length is 84m. Provide ledge for dry passage during a 1 in 1 year ARI, 3 day (72 hour) storm event and must not have wet sections that retain water for longer than three days. Adjacent box or pipe culvert to also be provided for drainage.
58km560	16,795	Dedicated	Box culvert	3000 mm x 3000 mm	No	Maximum culvert length is 50 m. Koala included as target species
59km090	17,325	Dedicated	Box culvert	3000 mm x 3000mm	No	Culvert length is 58 m. Length slightly in excess of 50 metres however was agreed to be acceptable if needed to achieve desired location. Koala included as target species
59km550	17,785	Dedicated	Box culvert	Minimum 3000 mm x 3000 mm	No	Approximate culvert length is 50 m. Koala included as target species
59km750 (northbound carriageway)	17,985	Dedicated	Box culvert	2400 mm x 2400 mm	No	Approximate culvert length is 38 m. Culvert to be moved up the bank to achieve the 1 in 100 year ARI flood immunity. Koala included as target species

Chainage Referral	Chainage WC2U EA	Fauna Crossing Structure Type	Structure Form	Number and Dimensions	Fish Passage Requirements	Additional Requirements
59km760 (southbound carriageway)	17,995	Dedicated	Box culvert	Minimum 2400 mm x 2400 mm	No	Approximate culvert length is 25 m. Combined length of the northbound and southbound underpasses is around 63 m. Carriageway separation is approximately 10 m with a fauna fenced race in between underpasses. Koala included as target species
60km615 (northbound carriageway)	18,850	Dedicated	Box culvert	2400 mm x 2400 mm	No	Approximate culvert length is 29 m. Structure to be shifted to the north around 15 metres to align with southbound carriageway. Koala included as target species.
60km600 (southbound carriageway)	18,835	Dedicated	Box culvert	Minimum 2400 mm x 2400 mm	No	Approximate culvert length is 30 m. Combined length of the northbound and southbound underpasses is around 59 m. Carriageway separation is approximately 19 m with a fauna fenced race in between underpasses. Koala included as target species.

1 A bridge may be provided in lieu of a box culvert provided that the total width between the intersection of the scour protection and the finished ground level under the bridge is at least equivalent to the total clear width of the cells of the replaced box culvert.

2 Separate fauna crossing structures must be provided for the Main Carriageways and Service Road to provide daylight between the Main Carriageways and Service Road structures.

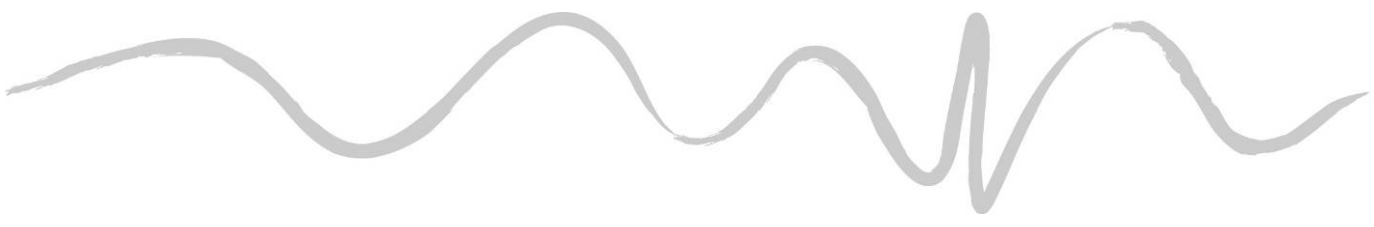
3 Classification identified in consultation with DPI (Fisheries Conservation and Aquaculture)

Appendix G

Koala Baseline Monitoring Reports

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

Baseline Koala Surveys



quality solutions sustainable future

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Warrell Creek to Nambucca Heads Pacific Highway Upgrade

Baseline Koala Surveys

Prepared for: NSW Roads and Maritime Services

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UPR	*Description*	*Date Issued*	*Issued By*
2364-1007	First issue	19/05/2014	David Havilah
2364-1008	Second issue	02/06/2014	David Havilah
2364-1009	Third issue	17/06/2014	David Havilah

Table of Contents

Illustrations

Tables

Appendices

A Experience of Survey Team Relevant to Koalas

1 Introduction

1.1 Introduction

The Pacific Highway Upgrade Program is a joint commitment by the Australian and New South Wales governments to improve the standard and safety of the Pacific Highway between Hexham and the Queensland border.

The NSW Minister for Planning approved the Warrell Creek to Urunga (WC2U) Pacific Highway Upgrade Project (the Project) under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 19 July 2011, subject to the Minister's Conditions of Approval (CoA) being met.

The WC2U Project comprises approximately 42 km 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 Project has been divided into two stages with Stage 1 consisting of approximately 22.5 km from Nambucca Heads to Urunga (NH2U) and Stage 2 consisting of the remaining 19.5 km of dual carriageway between Warrell Creek and Nambucca Heads (WC2NH). This report relates to Stage 2 (WC2NH) as 'the Proposal' which is shown in Illustration 1.1.

Koalas were assessed in the Project Environmental Assessment (Sinclair Knight Merz [SKM] 2010a, SKM 2010b), in regard to relevant State and Federal legislation. At that time, the Koala was listed as a 'Vulnerable' species under the NSW Government *Threatened Species Conservation Act 1995* (TSC Act), however was not listed under Federal legislation. Since completion of the Project Environmental Assessment (SKM 2010a, SKM 2010b) and NSW State Government Project approval, Koala (*Phascolarctos cinereus*) populations in Queensland, NSW and the Australian Capital Territory have been listed as 'Vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

An assessment of the impacts of the WC2NH Pacific Highway Upgrade Proposal on the Koala, in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of Environment and Heritage – DoE 2013a) and *Interim Koala referral advice for proponents* (Department of Sustainability, Environment, Water, Population and Communities – DSEWPaC 2012) was prepared by GeoLINK (2014). This assessment found that the Proposal will have some substantial negative (incremental and cumulative) impacts to the Koalas/ breeding aggregation/s whose home range encompass the Nambucca State Forest/ Old Coast Road area, mainly through habitat removal and fragmentation. The majority of Koalas and habitat that supports the subject important Koala population would not be affected by the Proposal. The Project, with effective implementation of the proposed mitigation measures, was found to be unlikely to result in a significant impact to the subject important local Koala population. Notwithstanding, as the Project adversely affects habitat that satisfy the SEWPaC (2012) definition of '*habitat critical to the survival of the species*' (including direct removal of approximately 86.5 ha of vegetation that satisfies this criteria); the Project was considered to constitute a significant impact on the Koala as per the DSEWPaC (2012) and DoE (2013a) guidelines.

1.2 The Monitoring Program

The WC2NH Project includes a number of mitigation measures to minimise impacts on biodiversity. These include:

- Ecological monitoring to be implemented to monitor the effectiveness of the ecological mitigation measures undertaken as part of the Project.
- Fauna crossing and fauna exclusion fencing to allow for safe passage of fauna (including the Koala) crossing the Pacific Highway.

- Large areas of 'floppy-top' fauna exclusion fencing design which was developed by Koala expert Casper Pieters and has been refined for fauna (including Koalas) to minimise road strike.

A Draft Pre-clearance Baseline Koala Monitoring Methodology has been prepared by SKM (2014) in consultation with GeoLINK for the WC2NH Project. The objective of the baseline monitoring is to supplement previous surveys and provide a more robust estimate of the numbers and distribution of individual Koalas, in relation to proposed mitigation structures, so that a more informed assessment can be made of the impacts of the project on Koalas in the Nambucca State Forest/ Old Coast Road area.

The additional monitoring would be undertaken to provide more reliable information such that more robust conclusions can be drawn in relation to management of Koalas at WC2NH and help inform other future road infrastructure projects. Specifically, the monitoring aims to identify changes in resident Koala activity (abundance, home range and movements) in response to construction of WC2NH Project and the effectiveness of Koala habitat connectivity mitigation measures (ie fauna underpasses and exclusion fencing).

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: DGH Date: May 2014
Source of base data: Roads and Maritime Services

LEGEND

- Project boundary
- Proposal footprint (the site)
- Waterway

JOINS SHEET 2

MACKSVILLE

Nambucca River

Taylors Arm

Tilly Willy Creek

Snakey Creek

Warrell Creek

Crouches Creek

Williamsons Creek

Stony Creek

Butchers Creek

Brians Creek

Way Way Creek

WAY WAY STATE FOREST

Chainage 0
(southern end of site)

Boggy Creek

Cedar Creek

NAMBUCCA STATE FOREST

Chainage 19500
(northern end of site)

Taylors Creek

Bellwood Creek

NAMBUCCA HEADS

Swampy Creek

Bellwood Swamp

Newee Creek

Nambucca River

Warrell Creek

JOINS SHEET 1

0 800

North

GeoLINK environmental management and design

WC2NH Pacific Highway Upgrade Project - Koala Baseline Surveys
2364-1004

The Site

Illustration 1.1

2 Koala Biology and Ecology

2.1 Introduction

Detailed reviews of Koala biology and ecology based on recent research are provided on the Department of Environment (DoE) *Species Profile and Threats Database* (DoE 2013b) and the NSW *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008). A summary of this information is provided below.

2.2 Distribution and Habitat

The Koala's distribution extends from north-eastern Queensland to the south-east corner of South Australia, covering coastal and inland areas (ANZECC 1998 cited in DoE 2013b, DECC 2013). They inhabit a range of forest and woodland communities dominated by *Eucalyptus* species. Habitat quality depends on a range of environmental features, including vegetation species composition, soils, climate and disturbance history. The main factor influencing Koala occurrence is the presence of suitable food trees. Shelter trees also provide important habitat features, particularly in harsh climates (DoE 2013b, DECC 2013).

2.3 Feeding Requirements

The Koala's diet primarily comprises eucalypt leaves which are low in nutrients and energy, and high in indigestible components (eg lignin and cellulose) and toxic compounds (eg essential oils and tannins) (Cork *et al*. 1990; Cork and Sanson 1990 cited in DECC 2008). In a given area, the diets of individual Koalas/ subpopulations almost exclusively comprise a small number of preferred species to obtain their nutritional needs. Preferred food trees appear to be associated with the presence of formyl phloroglucinol compounds in the leaves (DECC 2008). Koala's also show strong preferences between individual trees of the same species at individual sites, which is believed to be associated with leaf anti-feedant chemicals (DoE 2013b). Foliage from non-preferred food trees are consumed at times to supplement their diet (DoE 2008, DECC 2008). Recognised Koala food tree species for the NSW North Coast region (which encompasses the study area) are listed in Table 2.1. Blackbutt is also locally considered a supplementary Koala food tree species in the region (Professor Rob Close, University of Western Sydney. pers. comm. 2013).

Table 2.1 Potential Koala Habitats for the NSW North Coast Region

Foraging Preference	*Species*
Primary food tree species	▪ Tallowwood (*Eucalyptus microcorys*). ▪ Parramatta Red Gum (*E. parramattensis*). ▪ Forest Red Gum (*E. tereticornis*). ▪ Orange Gum (*E. bancroftii*). ▪ Swamp Mahogany (*E. robusta*). ▪ Cabbage Gum (*E. amplifolia*).

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(Source: DECC 2008)

Primary Koala food tree species are subject to a significantly higher level of usage than other Eucalyptus species, independent of tree density. Secondary and/ or supplementary food trees are generally subject to lower levels of foraging by Koalas than that of primary food trees, except where primary food trees are absent (DECC 2008).

2.4 Social Organisation and Reproduction

Koalas live in breeding aggregations which typically comprise a dominant male, a small number of mature females and juveniles of various ages (Phillips 1997, cited in DECC 2008). Home ranges vary in size depending on habitat quality and the number of available food trees, and have been recorded from 0.2 – 500 ha (DECC 2008). Males generally have larger home ranges than females, with the home range of a dominant male overlapping extensively with the home range of females within its aggregation.

The Koala breeding season peaks between September and February, and comprises a period of heightened activity. Offspring rates typically range between 0.3 – 0.8 per year, with birth occurring during October and May (McLean 2003 cited in DoE 2013b) following a 35 day gestation period (DECC 2008). Once born the young remain in the pouch for approximately six months, and remain dependent on their mother until about 12 months of age (Mitchell and Martin 1990 cited in DECC 2008). Sub-adult Koalas may remain in the mother's home range for a further two to three years, before young Koalas of both sexes disperse to establish their own home range areas (Ramsay 1999 cited in DECC 2008). Dispersal distances generally range from 1.0 – 11 km (Mitchell and Martin 1990 cited in DECC 2008). Longevity in the wild is >15 years for females and >12 years for males (Martin and Handasyde 1999 cited in DoE 2013b).

3 Methodology

3.1 Transect Surveys

Transects were established on each side of the Project footprint within the Nambucca State Forest/ Old Coast Road area between chainage 15,600 and 19,500. Twenty-five transects, 500 m long (or to the limit of vegetation) were spaced approximately 150 m apart running perpendicular to the proposed project footprint on each side of the highway upgrade. The location of transects is shown on Illustration 3.1.

Each transect was surveyed by personnel experienced in Koala surveys (David Havilah, David Andrighetto, Tony Coyle and Craig Faulkner) to document Koala presence and occupation. Relevant experience of survey personnel is summarised in Appendix A. Surveys were undertaken over two monitoring events (14/04/2014-17/04/2014 and 28/04/2014-01/05/2014) as follows:

- Diurnal survey: One observer with binoculars walking the transect searching for Koalas (110 person hours in total).
- Nocturnal survey: One observer spotlighting the transect on foot searching for Koalas at a rate of 0.5 to 1.0 km/hour (depending on vegetation density132) (120 person hours in total). Koala call playback was also undertaken on each transect during spotlighting to increase the chance of Koala detection.

Additional spotlighting was undertaken on tracks and easements across this area with the survey effort of five person spotlighting hours at a rate of 2 km/hour targeting each side of the highway (10 person hours in total over four nights). Koala call playback was undertaken at regular intervals along these tracks and easements during spotlighting to increase the chance of Koala detection.

The following data was to be collected for any Koalas detected:

- Location (using global positioning system [GPS]).
- Distance from transect line.
- Occupied tree species.
- Habitat type.
- Tree height.
- Diameter at breast height.
- Koala's sex.
- Behaviour.
- Disease status.
- Reproductive status.

3.2 Survey Limitations

A number of small areas associated with the transects were unable to be accessed at the time of survey due to property access restrictions. These include:

- Council owned land around the Nambucca Heads waste facility where access was not provided.
- Part of three transects west of the highway, in the State Forest north-west of the Bowraville turn off from Old Coast Road where a very wary individual was camping in the forest.

Dense lower storey vegetation associated with the site created some obstacles to viewing the tree canopy within parts of some transects, particularly during nocturnal surveys. Notwithstanding this, the combination of diurnal/ nocturnal target searches, call playback and track surveys were considered appropriate to identify resident Koalas if present.

3.3 Monitoring Triggers

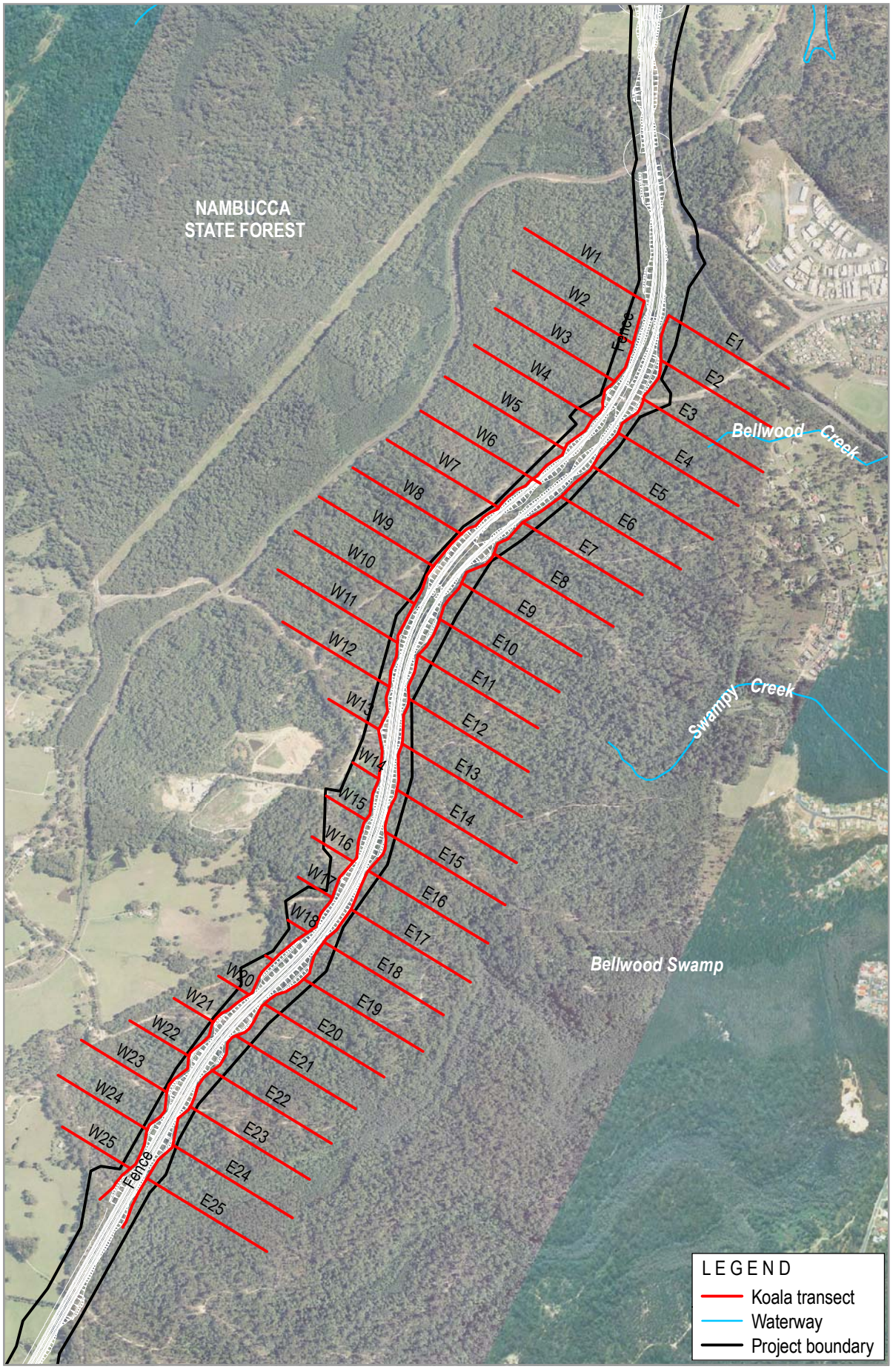
Should adequate data be obtained, population estimates are to be made based on the 'strip (fixed width) transect' or 'line transect' method described in Dique *et al.* (2003).

In the event that three or more Koalas are recorded during the transect surveys, the provision for GPS/ VHF fitted collars and pit tagging of recorded Koalas and establishment of transect survey control sites would be triggered. This would encompass the following additional pre-construction monitoring activities:

- GPS/ VHF collar-fitted receiver and transmitter and pit-tagging: Locating, capturing and fitting Koalas with GPS receiver/VHF transmitters; capturing the collared animals after six months or prior to the start of construction (whichever occurs first) to download GPS data, inspect the animals welfare (take any necessary action) and replace collar batteries. The GPS would be set to record the maximum number of location fixes for six months. The VHF transmitter will allow for easier Koala re-location during subsequent capture events. VHF transmitter batteries would be replaced every time the animal is recaptured.
- Transect surveys: Establish 'control' transect survey sites greater than 500 m from the Pacific Highway upgrade alignment to complement 'impact' transect survey sites.

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: DGH Date: May 2014
Source of base data: Roads and Maritime Services



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North

Transect Locations

GeoLINK environmental management and design

WC2NH Pacific Highway Upgrade Project - Koala Baseline Surveys
2364-1005

Illustration 3.1

4 Results and Discussion

4.1 Field Survey Results

4.1.1 Transect Surveys

Diurnal and nocturnal transect surveys conducted over both monitoring events yielded no observations of Koalas. Additionally, no Koala faecal pellets or obvious scratches attributable to Koalas were observed during these surveys

Survey conditions for both monitoring events were generally fine with some scattered showers falling mostly late at night. Weather conditions at all times were considered to be appropriate for observing Koalas.

4.1.2 Spotlighting Surveys on Tracks/ Easements

One Koala was recorded during spotlighting surveys being conducted along the Old Coast Road in the vicinity of the Nambucca Heads waste facility, west of the highway alignment (refer to Illustration 4.1). This individual responded to call playback and is likely to be a resident male. Vegetation associated with this area is mapped as being predominantly Open Blackbutt forest with some moister gullies comprising Flooded Gum Moist Open Forest.

4.2 Koala Population – Discussion and Summary

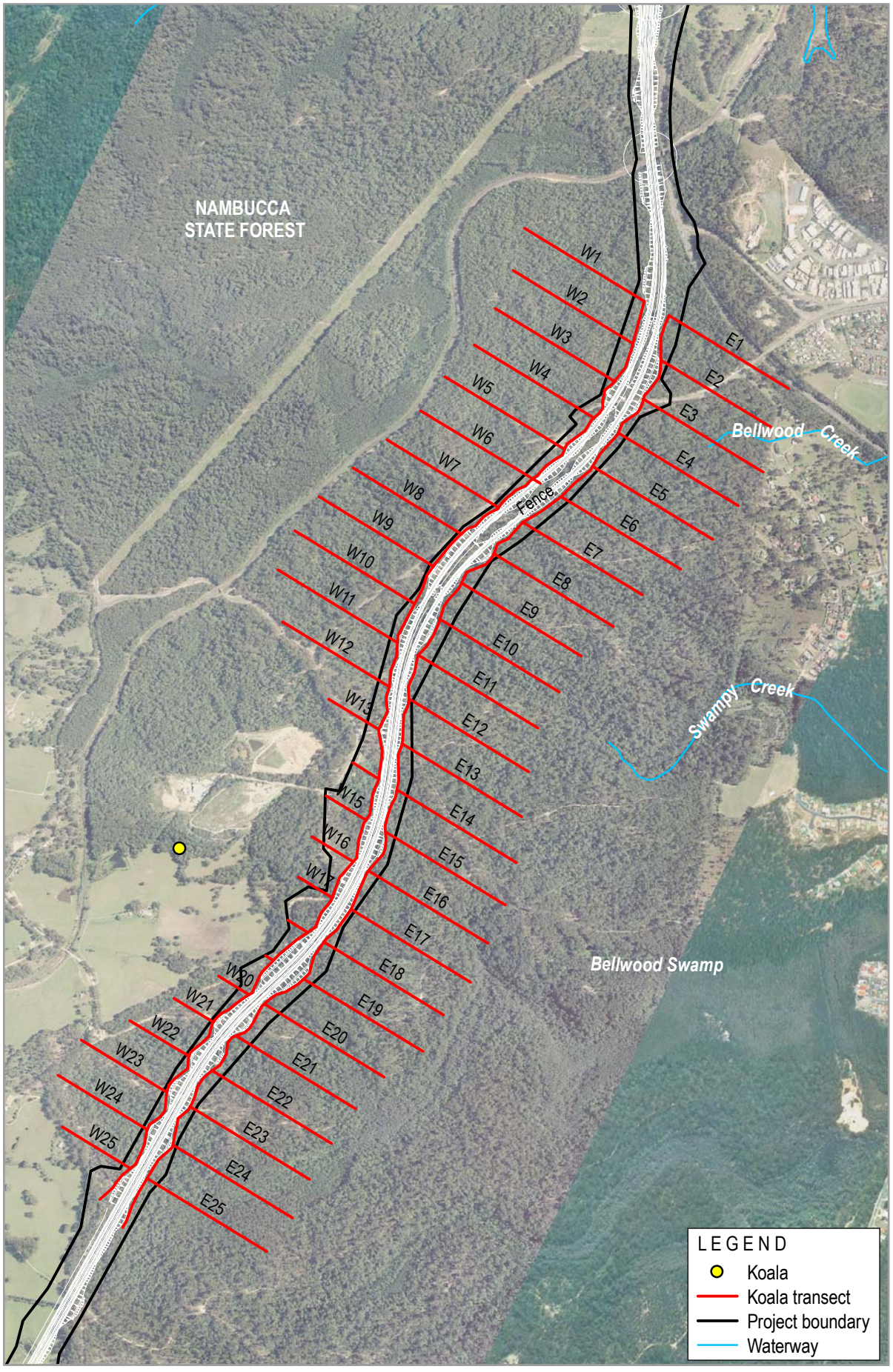
Previous Koala surveys undertaken by GeoLINK (2013) as part of the Koala impact assessment for the WC2NH Project surveyed 38 Koala Spot Analysis Technique (SAT) plots within the Nambucca State Forest/ Old Coast Road area. Three (7.9 %) of the 38 SAT plots surveyed in this area were subject to medium (normal) Koala usage for a low density Koala population, indicating that part of the range of resident Koala/s or breeding aggregation/s overlaps the study area (GeoLINK 2013). Koala records from field surveys associated with the WC2U Project Environmental Assessment (SKM 2010b) and the Atlas of NSW Wildlife (OEH 2013) supported these findings.

The results of the baseline Koala surveys confirm that the Nambucca State Forest/ Old Coast Road area is subject to low level usage by Koalas. Insufficient data is available from both the previous SAT surveys and these targeted surveys to provide an accurate population estimate of Koalas in the area. However, given the low levels of Koala usage evidenced by the results of the baseline surveys and previous surveys and that the home range of Koalas in low density populations may exceed 100 ha (Ellis *et al.* 2002 – cited in Biolink 2009), the number of individual Koalas whose home range encompass the study area is likely to be small.

The results of the transect surveys do not trigger the need for the provision of GPS/VHF fitted collaring and pit tagging Koalas or establishing transect survey control sites.

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: DGH Date: June 2014
Source of base data: Roads and Maritime Services



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North

Koala Records

5

Conclusions

The baseline Koala monitoring surveys located only one Koala during spotlighting surveys being conducted along the Old Coast Road in the vicinity of the Nambucca Heads waste facility, west of the highway alignment. This individual responded to call playback and is likely to be a resident male. These results confirm the previous findings of Koala SAT surveys undertaken as part of the Koala impact assessment (GeoLINK 2013) which found three SAT plots subject to medium (normal) Koala usage for a low density Koala population. Insufficient data from this survey and previous SAT surveys preclude an accurate estimate of the size of the population although all available data suggests that this population is low.

The results of the baseline monitoring do not trigger the need for the provision of GPS/VHF fitted collaring and pit tagging Koalas or establishing transect survey control sites.

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Appendix A

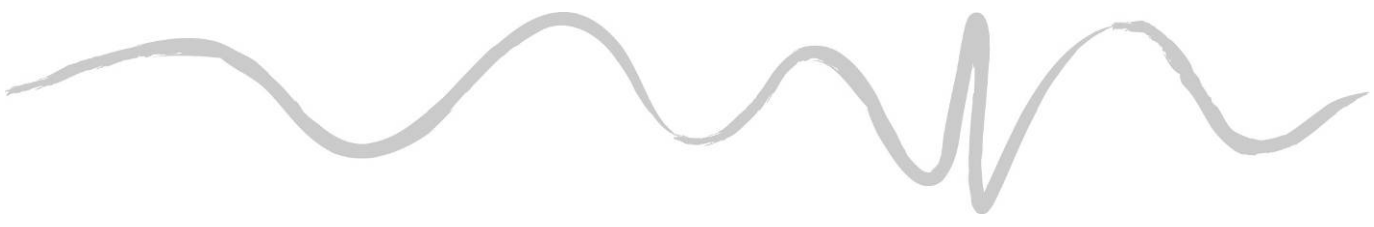
Experience of Survey Team Relevant to Koalas

Table A.1 Experience of Survey Personnel

Survey Personnel	*Years of Experience as an Ecologist*	*Projects involving Koala surveys (spotlighting, call playbacks, and/or SAT plots):*
David Andrighetto	8	▪ Comprehensive Koala surveys and impact assessment for the Koala on the WC2NH Project. ▪ Surveys and advice relating to Koalas for the Devils Pulpit Pacific Highway Upgrade project. ▪ RMS projects including habitat assessments at Camerons Corner, Waterfall Way and Martells Road intersection, Pacific Highway; ▪ Full flora and fauna assessment including SAT plots at Karangi Quarry, Karangi, NSW. ▪ Surveys and Assessments for the Koala as part of the Old Glenn Innes Road subdivision Koala Plan of Management. ▪ Lanham Halfway Creek Subdivision (SEPP 44) Koala Habitat Assessment. ▪ Sawtell Rail Corridor Koala Habitat Assessment.
David Havilah	7	▪ Comprehensive Koala surveys and impact assessment for the Koala on the WC2NH Project. ▪ Koala surveys and assessments for a number of residential development sites within various Local Government Areas. ▪ RMS projects including habitat assessments at Camerons Corner, Waterfall Way and Martells Road intersection, Pacific Highway. ▪ Extensive Koala habitat mapping and monitoring associated with the development of the Coffs Harbour water supply project, Grafton, NSW.
Tony Coyle	14	▪ Subdivision of a 60 ha site including remnant open forest near Lismore, NSW. ▪ Upgrade of the Pacific Highway (Devil Pulpit section). ▪ RMS projects including habitat assessments at Camerons Corner, Waterfall Way and Martells Road intersection, Pacific Highway. ▪ Full flora and fauna assessment including SAT plots at Karangi Quarry, Karangi, NSW. ▪ SAT plot assessments with Biolink (Steve Phillips) associated with mapping of Koala habitat, Tweed Shire, NSW. ▪ Extensive Koala habitat mapping and monitoring associated with the development of the Coffs Harbour water supply project, Grafton, NSW.
Craig Faulkner	10	▪ Field surveys for the development of the Gunnedah Koala Plan of Management (on behalf of Greenloaning Biostudies). ▪ Field surveys for comprehensive ongoing koala monitoring for the Shannon Creek water storage facility south of Grafton (on behalf of Greenloaning Biostudies). ▪ Extensive koala surveys for the proposed Kings Forest development near Kingscliff (on behalf of Aspect North Pty Ltd [now Landapartners]). ▪ Field survey and drafting of Koala Plan of Management for a caravan park/retirement village near Evans Head (on behalf of Aspect North Pty Ltd [now Landpartners]). ▪ Koala surveys and drafting of Koala Plan of Management for proposed development at Myocum (on behalf of Stephen Fletcher and Associates town planners). ▪ Targeted Koala surveys for the proposed extension to Batson's Quarry at Suffolk Park (on behalf of Greenloaning Biostudies Pty Ltd).

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

Baseline (Spring) Koala Surveys



quality solutions sustainable future

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

Baseline (Spring) Koala Surveys

Prepared for: NSW Roads and Maritime Services

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UPR	*Description*	*Date Issued*	*Issued By*
2364-1013	First issue	31/10/2014	David Havilah

Table of Contents

Illustrations

Tables

Appendices

1 Introduction

1.1 Introduction

The Pacific Highway Upgrade Program is a joint commitment by the Australian and New South Wales governments to improve the standard and safety of the Pacific Highway between Hexham and the Queensland border.

The NSW Minister for Planning approved the Warrell Creek to Urunga (WC2U) Pacific Highway Upgrade Project (the Project) under Part 3A (now repealed) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 19 July 2011, subject to the Minister's Conditions of Approval (CoA) being met.

The WC2U Project comprises approximately 42 km 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 Project has been divided into two stages with Stage 1 consisting of approximately 22.5 km from Nambucca Heads to Urunga (NH2U) and Stage 2 consisting of the remaining 19.5 km of dual carriageway between Warrell Creek and Nambucca Heads (WC2NH). This report relates to Stage 2 (WC2NH) as 'the Proposal' which is shown in Illustration 1.1.

Koalas were assessed in the Project Environmental Assessment (Sinclair Knight Merz [SKM] 2010a, SKM 2010b), in regard to relevant State and Federal legislation. At that time, the Koala was listed as a 'Vulnerable' species under the NSW Government *Threatened Species Conservation Act 1995* (TSC Act), however was not listed under Federal legislation. Since completion of the Project Environmental Assessment (SKM 2010a, SKM 2010b) and NSW State Government Project approval, Koala (*Phascolarctos cinereus*) populations in Queensland, NSW and the Australian Capital Territory have been listed as 'Vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

An assessment of the impacts of the WC2NH Pacific Highway Upgrade Proposal on the Koala, in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of Environment and Heritage – DoE 2013a) and *Interim Koala referral advice for proponents* (Department of Sustainability, Environment, Water, Population and Communities – DSEWPaC 2012) was prepared by GeoLINK (2013). This assessment found that the Proposal will have some substantial negative (incremental and cumulative) impacts to the Koalas/ breeding aggregation/s whose home range encompass the Nambucca State Forest/ Old Coast Road area, mainly through habitat removal and fragmentation. The majority of Koalas and habitat that supports the subject important Koala population would not be affected by the Proposal. The Project, with effective implementation of the proposed mitigation measures, was found to be unlikely to result in a significant impact to the subject important local Koala population. Notwithstanding, as the Project adversely affects habitat that satisfy the SEWPaC (2012) definition of '*habitat critical to the survival of the species*' (including direct removal of approximately 86.5 ha of vegetation that satisfies this criteria); the Project was considered to constitute a significant impact on the Koala as per the DSEWPaC (2012) and DoE (2013a) guidelines.

1.2 The Monitoring Program

The WC2NH Project includes a number of mitigation measures to minimise impacts on biodiversity. These include:

- Ecological monitoring to be implemented to monitor the effectiveness of the ecological mitigation measures undertaken as part of the Project.
- Fauna crossing and fauna exclusion fencing to allow for safe passage of fauna (including the Koala) crossing the Pacific Highway.
- Large areas of 'floppy-top' fauna exclusion fencing design which was developed by Koala expert Casper Pieters and has been refined for fauna (including Koalas) to minimise road strike.

A Draft Pre-clearance Baseline Koala Monitoring Methodology has been prepared by SKM (2014) in consultation with GeoLINK for the WC2NH Project. The objective of the baseline monitoring is to supplement previous surveys and provide a more robust estimate of the numbers and distribution of individual Koalas, in relation to proposed mitigation structures, so that a more informed assessment can be made of the impacts of the project on Koalas in the Nambucca State Forest/ Old Coast Road area.

The additional monitoring would be undertaken to provide more reliable information such that more robust conclusions can be drawn in relation to management of Koalas at WC2NH and help inform other future road infrastructure projects. Specifically, the monitoring aims to identify changes in resident Koala activity (abundance, home range and movements) in response to construction of WC2NH Project and the effectiveness of Koala habitat connectivity mitigation measures (ie fauna underpasses and exclusion fencing).

The baseline monitoring program comprised of surveys in Autumn and Spring. Autumn surveys have been completed previously and the results of these surveys are summarised in this report. This report also documents the results of the Spring surveys and discusses findings of the baseline Koala surveys in general.

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: DGH Date: May 2014
Source of base data: Roads and Maritime Services

LEGEND

- Project boundary
- Proposal footprint (the site)
- Waterway

JOINS SHEET 2

MACKSVILLE

Nambucca River

Taylors Arm

Tilly Willy Creek

Snakey Creek

Warrell Creek

Crouches Creek

Williamsons Creek

Stony Creek

Butchers Creek

Brians Creek

Way Way Creek

WAY WAY STATE FOREST

Chainage 0
(southern end of site)

Boggy Creek

Cedar Creek

Chainage 19500
(northern end of site)

NAMBUCCA STATE FOREST

Taylors Creek

Bellwood Creek

NAMBUCCA HEADS

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Bellwood Swamp

Newee Creek

Nambucca River

Warrell Creek

JOINS SHEET 1

North

0 800

GeoLINK environmental management and design

WC2NH Pacific Highway Upgrade Project - Koala Baseline (Spring) Surveys
2364-1004

The Site

Illustration 1.1

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(Source: DECC 2008)

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3.1 Transect Surveys

Transects were established on each side of the Project footprint within the Nambucca State Forest/ Old Coast Road area between chainage 15,600 and 19,500. Twenty-five transects, 500 m long (or to the limit of vegetation) were spaced approximately 150 m apart running perpendicular to the proposed project footprint on each side of the highway upgrade. The location of transects is shown on Illustration 3.1.

Each transect was surveyed by personnel experienced in Koala surveys (David Havilah, Tony Coyle and Craig Faulkner) to document Koala presence and occupation. Relevant experience of survey personnel is summarised in Appendix A. Surveys were undertaken over two monitoring events (15/09/2014-17/09/2014 and 29/09/2014-02/10/2014) as follows:

- Diurnal survey: One observer with binoculars walking the transect searching for Koalas (110 person hours in total).
- Nocturnal survey: One observer spotlighting the transect on foot searching for Koalas at a rate of 0.5 to 1.0 km/hour (depending on vegetation density) (120 person hours in total). Koala call playback was also undertaken on each transect during spotlighting to increase the chance of Koala detection.

Additional spotlighting was undertaken on tracks and easements across this area with the survey effort of five person spotlighting hours at a rate of 2 km/hour targeting each side of the highway (10 person hours in total over four nights). Koala call playback was undertaken at regular intervals along these tracks and easements during spotlighting to increase the chance of Koala detection.

The following data was to be collected for any Koalas detected:

- Location (using global positioning system [GPS]).
- Distance from transect line.
- Occupied tree species.
- Habitat type.
- Tree height.
- Diameter at breast height.
- Koala's sex.
- Behaviour.
- Disease status.
- Reproductive status.

3.2 Survey Limitations

A number of small areas associated with the transects were unable to be accessed at the time of survey due to property access restrictions. These include:

- Council owned land around the Nambucca Heads waste facility where access was not provided.
- Part of three transects west of the highway, in the State Forest north-west of the Bowraville turn off from Old Coast Road where a very wary individual was camping in the forest.

Dense lower storey vegetation associated with the site created some obstacles to viewing the tree canopy within parts of some transects, particularly during nocturnal surveys. Notwithstanding this, the combination of diurnal/ nocturnal target searches, call playback and track surveys were considered appropriate to identify resident Koalas if present.

3.3 Monitoring Triggers

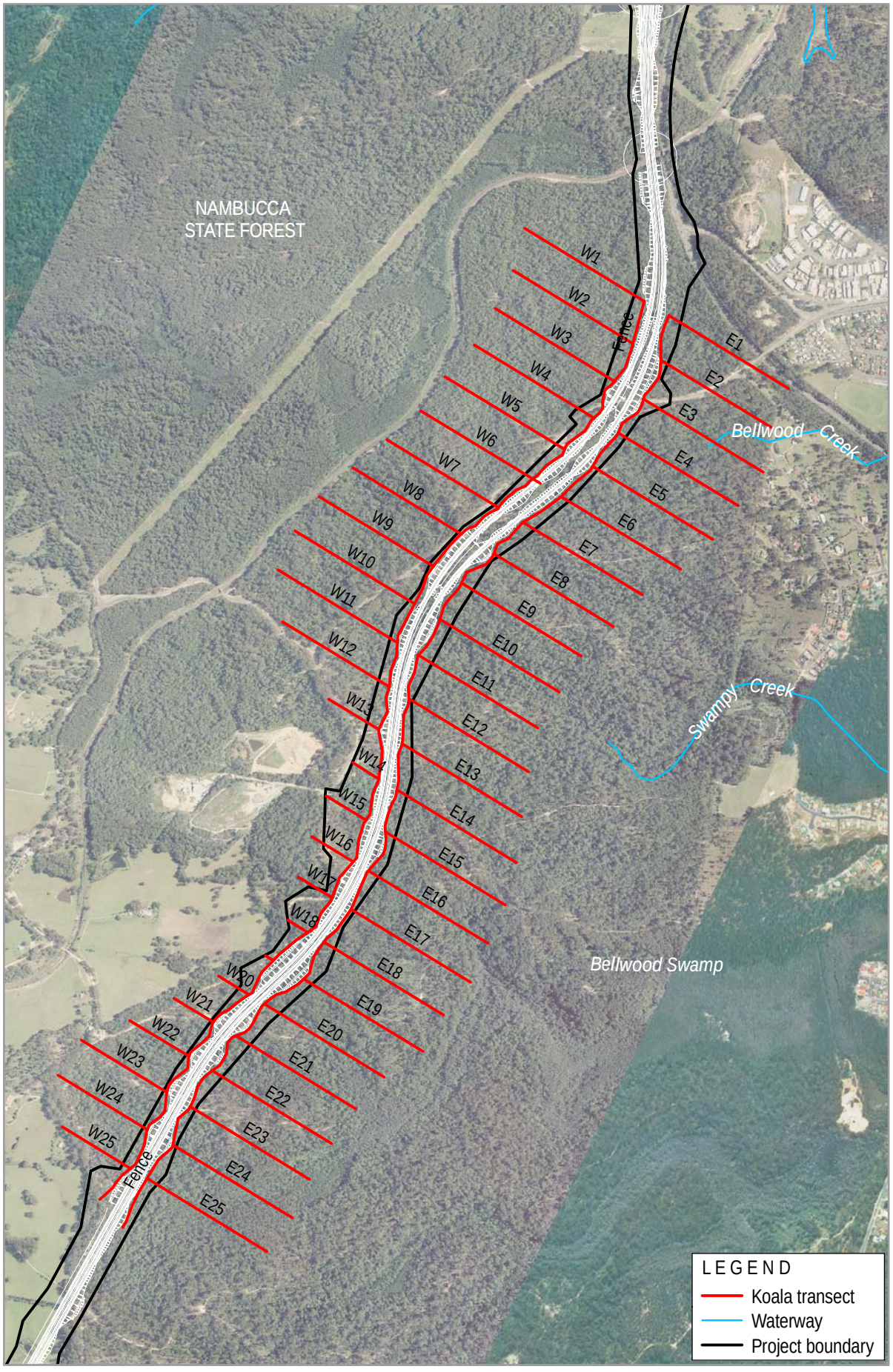
Should adequate data be obtained, population estimates are to be made based on the 'strip (fixed width) transect' or 'line transect' method described in Dique *et al.* (2003).

In the event that three or more Koalas are recorded during the transect surveys, the provision for GPS/ VHF fitted collars and pit tagging of recorded Koalas and establishment of transect survey control sites would be triggered. This would encompass the following additional pre-construction monitoring activities:

- GPS/ VHF collar-fitted receiver and transmitter and pit-tagging: Locating, capturing and fitting Koalas with GPS receiver/VHF transmitters; capturing the collared animals after six months or prior to the start of construction (whichever occurs first) to download GPS data, inspect the animals welfare (take any necessary action) and replace collar batteries. The GPS would be set to record the maximum number of location fixes for six months. The VHF transmitter will allow for easier Koala re-location during subsequent capture events. VHF transmitter batteries would be replaced every time the animal is recaptured.
- Transect surveys: Establish 'control' transect survey sites greater than 500 m from the Pacific Highway upgrade alignment to complement 'impact' transect survey sites.

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: DGH Date: May 2014
Source of base data: Roads and Maritime Services



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North

Transect Locations

GeoLINK environmental management and design

WC2NH Pacific Highway Upgrade Project - Koala Baseline (Spring) Surveys
2364-1005

Illustration 3.1

4

Results and Discussion

4.1 Field Survey Results

4.1.1 Spring 2014 Surveys

4.1.1.1 Transect Surveys

Surveys of transects undertaken diurnally and nocturnally did not locate any Koalas during both Spring monitoring events. No Koala faecal pellets or other obvious sign of usage were detected during the Spring surveys. Survey conditions were fine for both events.

4.1.1.2 Spotlighting Surveys on Tracks/ Easements

No Koalas were observed during spotlighting surveys on tracks/ easements. One Koala was heard calling in response to call playback in the vicinity of transect E21 (refer to Illustration 4.1) in the southern portion of Nambucca State Forest, to the east of the new alignment. A search was undertaken for the animal however the Koala could not be located. Vegetation associated with this area comprises Flooded Gum Moist Open Forest.

4.1.2 Autumn 2014 Surveys

4.1.2.1 Transect Surveys

Diurnal and nocturnal transect surveys conducted over both monitoring events yielded no observations of Koalas. Additionally, no Koala faecal pellets or obvious scratches attributable to Koalas were observed during these surveys Survey conditions for both monitoring events were generally fine with some scattered showers falling mostly late at night. Weather conditions at all times were considered to be appropriate for observing Koalas.

4.1.2.2 Spotlighting Surveys on Tracks/ Easements

One Koala was recorded during spotlighting surveys being conducted along the Old Coast Road in the vicinity of the Nambucca Heads waste facility, west of the highway alignment (refer to Illustration 4.1). This individual responded to call playback and is likely to be a resident male. Vegetation associated with this area is mapped as being predominantly Open Blackbutt forest with some moister gullies comprising Flooded Gum Moist Open Forest.

4.2 Koala Population – Discussion and Summary

The results of baseline Koala surveys confirm that the Nambucca State Forest/ Old Coast Road area is subject to low level usage by Koalas. The results to date indicate that Koalas are occasionally using the moist gullies that occur predominantly in the southern portion of the study site. An additional Koala record was detected in Winter 2014 during ecological monitoring surveys being undertaken for the WC2NH project, in the vicinity of the recent spring monitoring record, supporting the primary use of the southern portions of Nambucca State Forest. Whilst areas of similar habitat do occur in the northern part of the study site, the moist gullies in this area are not as extensive as those in the southern portion. There is potential that the dry upper slopes and ridges associated with the northern portion of Nambucca State Forest are utilised by Koalas, however currently there is no evidence to suggest this is the case.

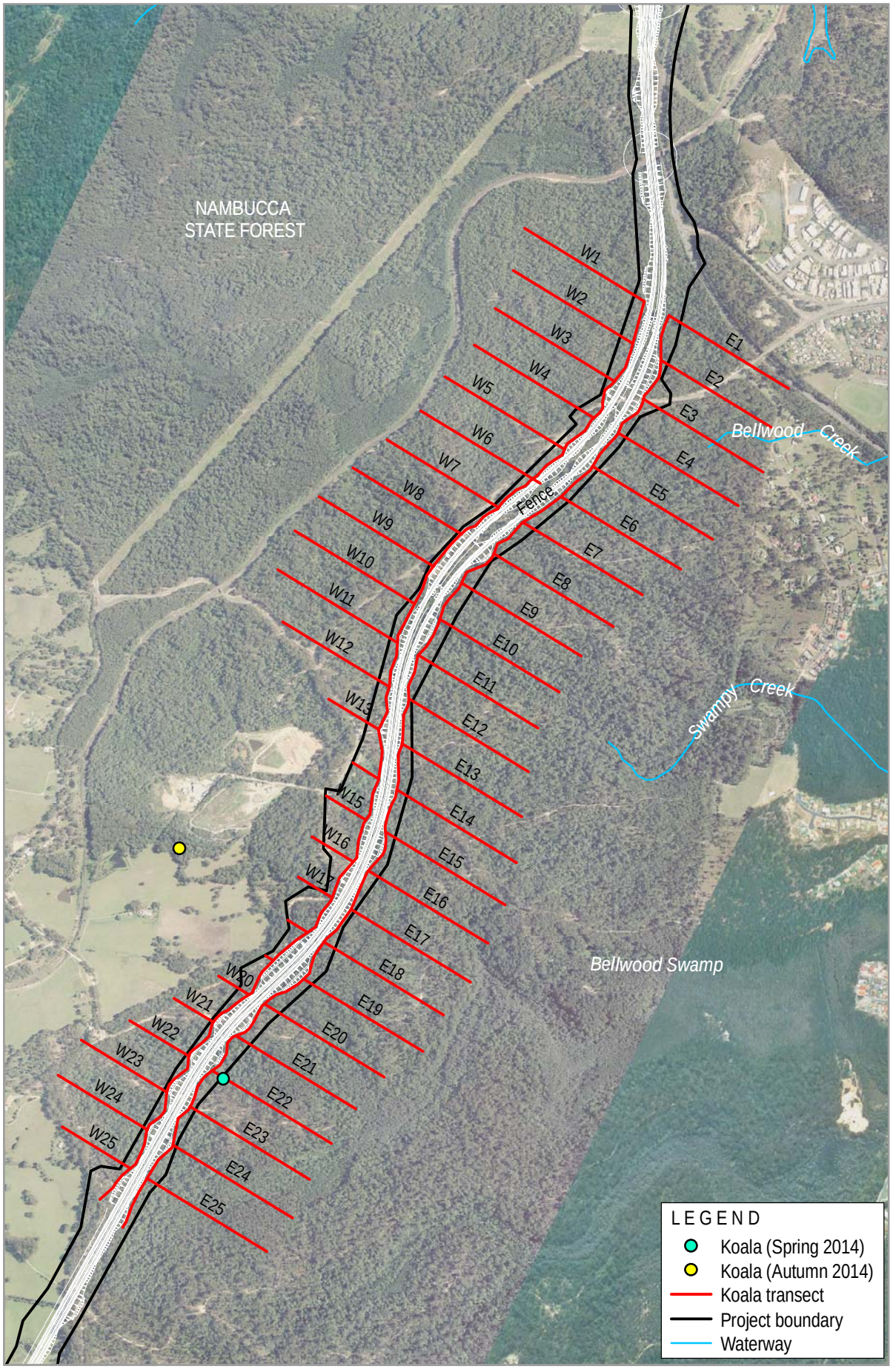
Previous Koala surveys undertaken by GeoLINK (2013) as part of the Koala impact assessment for the WC2NH Project surveyed 38 Koala Spot Analysis Technique (SAT) plots within the Nambucca State Forest/ Old Coast Road area. Three (7.9 %) of the 38 SAT plots surveyed in this area were subject to medium (normal) Koala usage for a low density Koala population, indicating that part of the range of resident Koala/s or breeding aggregation/s overlaps the study area (GeoLINK 2013). Koala records from field surveys associated with the WC2U Project Environmental Assessment (SKM 2010b) and the Atlas of NSW Wildlife (OEH 2013) support these findings.

Insufficient data is available from both the previous SAT surveys and baseline monitoring to provide an accurate population estimate of Koalas in the area. However, given the low levels of Koala usage evidenced by the results of the baseline surveys and previous surveys and that the home range of Koalas in low density populations may exceed 100 ha (Ellis *et al.* 2002 – cited in Biolink 2009), the number of individual Koalas whose home range encompass the study area is likely to be small (estimated at 1-2 animals).

The results of the transect surveys to date do not trigger the need for the provision of GPS/VHF fitted collaring and pit tagging Koalas or establishing transect survey control sites.

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: DGH Date: June 2014
Source of base data: Roads and Maritime Services



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North

Koala Records

5

Conclusions

The spring baseline Koala monitoring surveys located only one Koala during spotlighting surveys in the southern portion of Nambucca State Forest. This individual responded to call playback and is likely to be a resident male. This result is similar to the survey results from the autumn baseline surveys which detected one Koala in the vicinity of the Nambucca Heads waste facility, west of the highway alignment.

The results of spring and autumn monitoring events support the results of previous Koala surveys, undertaken as part of the WC2NH Koala Impact assessment and confirm that the southern parts of the Nambucca State forest are subject to low level usage by a small number of Koalas (estimated at 1-2 animals).

The results of the baseline monitoring do not trigger the need for the provision of GPS/VHF fitted collaring and pit tagging Koalas or establishing transect survey control sites.

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Appendix A

Experience of Survey Team Relevant to Koalas

Table A.1 Experience of Survey Personnel

Survey Personnel	*Years of Experience as an Ecologist*	*Projects involving Koala surveys (spotlighting, call playbacks, and/or SAT plots):*
David Andrighetto	8	▪ Comprehensive Koala surveys and impact assessment for the Koala on the WC2NH Project. ▪ Surveys and advice relating to Koalas for the Devils Pulpit Pacific Highway Upgrade project. ▪ RMS projects including habitat assessments at Camerons Corner, Waterfall Way and Martells Road intersection, Pacific Highway; ▪ Full flora and fauna assessment including SAT plots at Karangi Quarry, Karangi, NSW. ▪ Surveys and Assessments for the Koala as part of the Old Glenn Innes Road subdivision Koala Plan of Management. ▪ Lanham Halfway Creek Subdivision (SEPP 44) Koala Habitat Assessment. ▪ Sawtell Rail Corridor Koala Habitat Assessment.
David Havilah	7	▪ Comprehensive Koala surveys and impact assessment for the Koala on the WC2NH Project. ▪ Koala surveys and assessments for a number of residential development sites within various Local Government Areas. ▪ RMS projects including habitat assessments at Camerons Corner, Waterfall Way and Martells Road intersection, Pacific Highway. ▪ Extensive Koala habitat mapping and monitoring associated with the development of the Coffs Harbour water supply project, Grafton, NSW.
Tony Coyle	14	▪ Subdivision of a 60 ha site including remnant open forest near Lismore, NSW. ▪ Upgrade of the Pacific Highway (Devil Pulpit section). ▪ RMS projects including habitat assessments at Camerons Corner, Waterfall Way and Martells Road intersection, Pacific Highway. ▪ Full flora and fauna assessment including SAT plots at Karangi Quarry, Karangi, NSW. ▪ SAT plot assessments with Biolink (Steve Phillips) associated with mapping of Koala habitat, Tweed Shire, NSW. ▪ Extensive Koala habitat mapping and monitoring associated with the development of the Coffs Harbour water supply project, Grafton, NSW.
Craig Faulkner	10	▪ Field surveys for the development of the Gunnedah Koala Plan of Management (on behalf of Greenloaning Biostudies). ▪ Field surveys for comprehensive ongoing koala monitoring for the Shannon Creek water storage facility south of Grafton (on behalf of Greenloaning Biostudies). ▪ Extensive koala surveys for the proposed Kings Forest development near Kingscliff (on behalf of Aspect North Pty Ltd [now Landapartners]). ▪ Field survey and drafting of Koala Plan of Management for a caravan park/retirement village near Evans Head (on behalf of Aspect North Pty Ltd [now Landpartners]). ▪ Koala surveys and drafting of Koala Plan of Management for proposed development at Myocum (on behalf of Stephen Fletcher and Associates town planners). ▪ Targeted Koala surveys for the proposed extension to Batson's Quarry at Suffolk Park (on behalf of Greenloaning Biostudies Pty Ltd).

Appendix H

Road Kill Monitoring Methodology

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 non-parametric 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.