6 Environmental assessment

This section of the REF provides a detailed description of the potential environmental impacts associated with the construction and operation of the proposal. All aspects of the environment potentially impacted upon by the proposal are considered. This includes consideration of the factors specified in the guidelines *Is an EIS required?* (DUAP 1999) and Roads and Related Facilities (DUAP 1996) as required under clause 228(1) (b) of the *Environmental Planning and Assessment Regulation 2000*. The factors specified in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000* are also considered in **Appendix B**. Site-specific safeguards are provided to ameliorate the identified potential impacts.

6.1 Biodiversity

A *Biodiversity Assessment* was prepared by SKM in April 2013 (refer to **Appendix K**) and builds on the existing ecological research and field data completed for the design development phase of the proposal by NGH Environmental (2010). The *Biodiversity Assessment* was prepared in accordance with RMS (2012) *Environmental Impact Assessment Practice Note: Biodiversity Assessment* (EIA-N06). A summary of the assessment has been provided below

6.1.1 Methodology

The methodology was designed to provide specific focus on the further survey requirements recommended in the NGH Environmental (2010), specifically with respect to undertaking a systematic survey for threatened flora and fauna which may be affected by the proposal.

Study area

For the purposes of the *Biodiversity Assessment*, the study area encompasses the construction footprint and any adjoining or adjacent habitat where potential indirect impacts may occur. The construction footprint is defined in **Section 3.3** and shown in **Figure 3-12**. The proposal as defined in **Chapter 3** is fully contained within the construction footprint boundary.

For the purposes of undertaking the threatened species and protected matters database searches a broader study area was assessed and consisted of a 10 kilometre radius around the proposal.

Database search and literature review

A review of existing information and government maintained databases relevant to the study area was undertaken. The following information was reviewed:

- NSW vegetation types database (DECC 2009a). http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm
- NSW threatened species profile database. (DECC 2009b). http://www.environment.nsw.gov.au/biobanking/biobankingtspd.htm
- Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands (Tozer et. al. 2010).
- NGH Environmental (2010) conducted two temporally independent ecological surveys of the northern and southern section of the upgrade along the full

length of the proposal and up to 300 - 400 metre east and west from the highway.

- NSW BioNet (OEH September 2012).
- Atlas of NSW Wildlife maintained by the NSW Office of Environment and Heritage (September 2012).
- The Protected Matters Search Tool provided under the EPBC Act (October 2012).

The review focused on identifying and listing the threatened flora and fauna species, populations and ecological communities previously recorded from a 10 kilometre radius of the proposal. Following collation of database records and species and community profiles a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the study area. This was further refined following field surveys and assessment of habitat present within the area. The list of threatened species recorded from the locality is provided as **Table 6-1** of the *Biodiversity Assessment* (2013).

Previous ecological assessment and gap analysis

The review of the NGH (2010) work was conducted to scope any additional surveys required to complete a biodiversity assessment for the REF. The review concluded that the surveys were of sufficient effort and rigour to adequately identify habitat and species of conservation significance. However the surveys in the southern section only focused on threatened species habitat identification, the presence of key habitat resources and signs of threatened fauna species activity with limited targeted survey. To address this disparity the ecological surveys for the REF included general and targeted surveys over the southern section to the same level of effort as conducted by NGH (2010) for the northern section.

Field investigations

Threatened species recorded from the study area in the original proposal development surveys (NGH 2010), with notes on distribution and survey approach used in the REF to address any spatial gaps are outlined in **Table 6-1**. This includes the recently EPBC listed Koala.

Table 6-1: Review of proposal development survey effort used to scope additional surveys for the REF

Species	REF survey approach
Glossy Black Cockatoo (*Calyptorhynchus lathami*)	As the species had been confirmed in the study area, the survey focused on identifying the extent and condition of food resources (*Allocasuarina* foraging habitat). The data was used to assist in assessing the impacts and devising appropriate mitigation measures during construction. Hollow-bearing trees surveyed in the proposal footprint were identified and included any trees with large hollows considered suitable as nesting nests.
Long-nosed Potoroo (*Potorous tridactylus*)	The species has been tentatively identified and targeted surveys were undertaken to confirm presence. Trapping sites were positioned close to where diggings were reported in NGH (2010) and included the use of wire mesh

Species	REF survey approach
	cage traps and Elliot aluminium box traps set over four consecutive nights in a grid pattern. The trapping program was supplemented with a hair-tube survey at each site and spotlighting surveys in suitable habitat.
Koala (*Phascolarctos cinereus*)	Recent surveys have recorded the species in Kooraban National Park within one kilometre of the study area, and the study area may overlap with an individuals' home range [C.Allen, pers.comm reported in NGH (2010)]. Systematic Koala surveys were conducted on the east and west of the highway to record the distribution of preferred and supplementary habitat up to 300-400 metres from the highway based on dominant *Eucalypt* species and with reference to secondary and supplementary food tree species identified for the south coast region in the *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008b). Regularised scat searches conducted by placing a 500 metre grid over the mapped habitat areas and systematically searching for scats using the spot assessment technique (Phillips and Callaghan 1995, 2011). The initial search trees were selected based on the presence of a scat or given the predicted low abundance of Koalas in the area was based on tree species that are a known important food species.
Square Raspwort (*Halorgris exaltata* subsp. *exaltata*).	Targeted survey conducted to record the distribution and abundance of the species focused on riparian areas and creeks flats surrounding Dignams Creek which constitutes favoured habitat.

The data collected from the targeted surveys was used to inform the design of the upgrade in terms of identifying the most appropriate location for fauna crossing structures to be incorporated into the proposal to ensure habitat connectivity and facilitate movements of fauna, in particular the Koala.

The fauna survey effort was aimed to build on the previous work by NGH (2010) by focusing on further assessment of the known threatened fauna species and identifying critical habitat resources such as feeding and sheltering habitat. The surveys included:

- Small mammal trapping and hair-tube survey targeting Long-nosed Potoroo.
- Koala survey based on identification of activity levels as per Philips and Callaghan (1995, 2011) using a Regularised Grid-based survey in consultation with OEH to provide data consistent with regional Koala surveys.
- Spotlighting and call playback survey targeting Koala and Yellow-bellied Glider.
- Survey of habitat trees and Glossy Black-cockatoo feeding resources in proximity to the alignment.
- Bat call recording and general searches for birds, reptiles and frogs.
- Aquatic surveys for fish, macroinvertebrates and macrophytes.
- USRIVAS modelling and water quality surveys were also undertaken.

Four separate ecological surveys were conducted in the study area during the development of the proposal. These included targeted terrestrial and aquatic surveys

and a survey to assess offsetting options of the proposal. Surveys were completed over three seasons and included the following:

- Terrestrial flora and fauna surveys were completed for the concept design during the autumn (11-15 April 2011) and spring seasons (13-14 September 2011).
- An aquatic survey in Dignams Creek during spring season (7-9 November 2011).
- Flora and fauna surveys during the winter season (4-8 June 2012), which also included assessments of the property RMS has purchased for the offset investigations.

The surveys were designed to use a range of methods including vegetation mapping, habitat assessments, flora plots, transects, general traverses, targeted searches for threatened flora and fauna species.

6.1.2 Existing environment

General flora and fauna

A complete list of flora and fauna including common and threatened species and aquatic species identified from the field surveys is provided in the *Biodiversity Assessment* (SKM 2013) refer to **Appendix K**.

Native floral species diversity was relatively high within the natural vegetated portions of the study area. The grazed open pasture areas of site were relatively low in native species diversity primarily due to the long term effects of the ongoing pastoral land use.

A total of 330 flora species were recorded within the study area, including:

- One cycad species.
- One conifer species.
- 14 species of fern.
- 233 species of dicotyledons.
- 80 species of monocotyledons.

Of the total species recorded, 49 species of introduced flora were identified, representing approximately 15 per cent of the total species.

A total of 82 fauna species were recorded in the study area, including:

- 49 bird species.
- 17 mammal species including two introduced species.
- Two frog species.
- Five reptile species.
- Seven species of fish and aquatic reptiles. .

Vegetation communities and habitat

The vegetation communities in the study area represent a complex of a number of types which intergrade with each other. Distinct boundaries between the communities were difficult to ascertain in the field. This was further confounded by previous disturbances from logging and fire which has altered species composition and vegetation structure. Accordingly topography, aspect and species composition field data were used as an indicator of community boundaries.

The vegetation communities were classified in accordance with Biometric Vegetation Types as defined in DECC (2008a). A total of five separate vegetation community types were identified comprising:

- Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest.
- Map Unit 2: White Stringybark Forest.
- Map Unit 3: Bangalay/Blue Gum Sheltered Forest.
- Map Unit 4: River Peppermint - Rough-barked Apple moist shrubby forest.
- Map Unit 5: Riparian Forest.

A summary of the biometric vegetation type, each community's legal status, a cleared estimate for each community (as defined by DECC [2008a]) and a description of the fauna habitat characteristics within each vegetation community in the study area is provided in **Table 6-2**. The distribution of these communities in the study area is displayed in **Figure 6-1**. Refer to the *Biodiversity Assessment* in **Appendix K,** Section 3.3 Table 3-1 for further details on fauna habitat vegetation community characteristics.

Threatened ecological communities

A total of eight TECs were identified as potentially occurring in the broader area (ten kilometre radius around the mid-point of the proposal). One of these TECs, River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (River-flat Eucalypt Forest on Coastal Floodplains) was confirmed to be present within the construction footprint during the field investigations. This community is listed as endangered under the TSC Act and is located on the banks adjacent to Dignams Creek upstream of the existing bridge crossing and south of Dignams Creek to the east of the Princes Highway. This TEC is also present alongside Blind Creek in the areas adjacent to the proposal to the north-west of Dignams Creek Road. It is dominated by River Oak (*Casuarina cunninghamiana*) along Dignams Creek and River Peppermint (*Eucalyptus elata*) on Blind Creek.

The River-flat Eucalypt Forest on Coastal Floodplains along Dignams Creek and Blind Creek is highly fragmented and disturbed from agricultural activities including clearing, pastoral improvement and grazing, and therefore supports a high abundance of exotic species with diminished structural and species diversity. The distribution of River-flat Eucalypt Forest on Coastal Floodplains in the study area is depicted in **Figure 6-1** as Map Unit 5.

Table 6-2 Vegetation communities in the study area

Map Unit	Biometric Vegetation Type	Status (TSC Act and EPBC Act)	Cleared estimate[#]	Fauna habitat type and characteristics
Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest	E32A:Silvertop Ash - Blue-leaved Stringybark - Woollybutt shrubby open forest on coastal foothills central South East Corner	Not listed	5%	Dry open forest is largely restricted to upper slopes and ridges in the study area and comprises an open canopy with medium to tall trees dominated mainly by Silvertop Ash, and Stringybarks. Midstorey sparse and comprises scattered wattles (Acacia spp) and other small trees. Understorey and ground cover also open and sparsely covered with grasses and gramminoids. Logs and fallen trees are common; however hollow-bearing trees and dead habitat trees are very scarce. The habitat is suited to a range of small to medium-sized forest birds particularly those species represented in drier forest and woodland habitats compared to the moist gully forests. Reptile diversity is also expected to be well developed, with a mix of cover and shelter and abundance of logs.
Map Unit 2: White Stringybark Forest	E34:Coast Grey Box - Mountain Grey Gum - Stringybark moist shrubby open forest in coastal gullies, southern South East Corner	Not listed	15%	Moist gully forest occupying steep gullies and natural drainage areas. Characterised by a complex well developed forest structural diversity and tall overstorey of various eucalypt species. Tall mid-storey (6-7 m) dominated by acacia spp, with abundant nectar and fruit resources. The understorey is also tall and very dense dominated by bracken ferns and in combination with the abundance of fallen trees and logs provides high quality shelter and breeding habitat for a range of small to medium sized ground-dwelling mammals such as bandicoots and rodents. The high structural and floristic diversity is suited to a high diversity of fauna species in particular birds, mammals and reptiles. There are

Map Unit	Biometric Vegetation Type	Status (TSC Act and EPBC Act)	Cleared estimate[#]	Fauna habitat type and characteristics
				limited opportunities for frogs due to lack of permanent water.
Map Unit 3: Bangalay/Blue Gum Sheltered Forest	N183:Mountain Grey Gum - Yellow Stringybark moist shrubby open forest in gullies of the coastal ranges, northern South East Corner	Not listed	5%	As per map unit 2
Map Unit 4: River Peppermint - Rough-barked Apple moist shrubby forest	E19: River Peppermint - Rough-barked Apple moist open forest on sheltered sites, southern South East Corner	Not listed	65%	As per map unit 2
Map Unit 5: Riparian Forest	P30:River Peppermint - Rough-barked Apple - River Oak herb/grass riparian forest of coastal lowlands, southern Sydney Basin and South East Corner	Endangered (River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (River-flat eucalypt forest on coastal floodplains))	50%	Riparian habitat comprised of narrow linear remnants of swamp oak with occasional wattles (*Acacia* spp) and a predominant exotic understorey. Habitat trees are typically absent however some fallen trees and logs are scattered throughout. The habitat has connectivity along creek areas, although is generally fragmented from near-by forest habitats by surrounding cleared and grazed creek flats. The habitat has greatest value for birds, particularly wide-ranging species which would include the migratory listed Cattle Egret and a range of species tolerant of modified habitats. Common reptiles and frogs could be expected, such as the eastern water dragon and common eastern Froglet. Habitat for mammals is limited, in particular arboreal species due to the lack of

Map Unit	Biometric Vegetation Type	Status (TSC Act and EPBC Act)	Cleared estimate[#]	Fauna habitat type and characteristics
				connectivity, feeding and shelter resources. The stream habitat is characterised by a fast flowing clear water moderately deep in parts and containing a series of pools and riffles over a course sandy substrate. Abundant woody debris is present and overhanging vegetation on banks providing habitat for a range of common fish species.

Threatened flora species

A total of 17 threatened flora species (listed under the TSC Act and/or EPBC Act) have been identified as having the potential to occur in the broader study area (refer to **Figure 6-2**). These species have been listed in Table E-1 of the *Biodiversity Assessment* in **Appendix K** and are summarised in **Table 6-3**. One species, the Square Raspwort (*Haloragis exaltata* subsp*. exaltata*) was confirmed as being present in the proposal footprint and surrounds. Of the remaining 16 threatened flora species, 10 have a low potential to occur and six have a moderate potential to occur.

Table 6-3 Summary of threatened flora species having potential to occur

Species	Status			Likelihood of occurrence	Broad Preferred Habitat Type
	EPBC Act	TSC Act	RoTAP		
Acacia georgensis (Bega Wattle)	V	V	2VCi	Low	Dry sclerophyll forest
Aldrovanda vesiculosa Waterwheel Plant	-	E	-	Low	Freshwater wetlands
Budawangia gnidioides (Budawangs Cliff-heath)	V	V	2VC-t	Low	Dry sclerophyll forest and heathland
Caladenia tesselata (Thick-lip Spider Orchid)	V	E	3VCa	Moderate	Grassy woodlands and sclerophyll forest
Correa baeuerlenii (Chef's Cap Correa)	V	V	3VCi	Moderate	Dry sclerophyll forest and heathland
Cryptostylis hunteriana (Leafless Tongue Orchid)	V	V	3VC-	Moderate	Swampy heath and woodland areas
Galium australe (Tangled Bedstraw)	V	V	-	Low	Dry and wet sclerophyll forest and heathland
Genoplesium vernal (East Lynee Midge Orchid)	-	V	3RCi	Low	Dry sclerophyll forest
Halorgris exaltata subsp. exaltata (Square raspwort)	V	V	-	Present	Riparian areas
Lysimachia vulgaris var. davurica (Yellow Loosestrife)	E	-	-	Moderate	Wetlands, riparian areas and cleared pasture.
Monotaxis macrophylla (Large-leaf Monotaxis)	-	E	2VCi	Low	Heath, shrubland and forests
Persicaria elatior (Tall Knotweed)	V	V	3V	Moderate	Wetlands and riparian areas
Pomaderris Bodalla (Bodalla Pomaderris)	V	V		Moderate	Wet Sclerophyll Forest and riparian areas
Pultenaea pedunculata (Matted Bush-pea)	-	V	-	Low	Dry sclerophyll forest
Thesium australe (Austral Toadflax)	V	V	3VCi+	Low	Grassland and grassy woodland

Species	Status			Likelihood of occurrence	Broad Preferred Habitat Type
	EPBC Act	TSC Act	RoTAP		
Wilsonia backhousei (Round-leaf wilsonia)	-	V	-	Low	Saltmarsh
Zieria tuberculata (Warty Zieria)	V	V	-	Low	Dry and wet sclerophyll forest, heathland and rainforest

Sources:

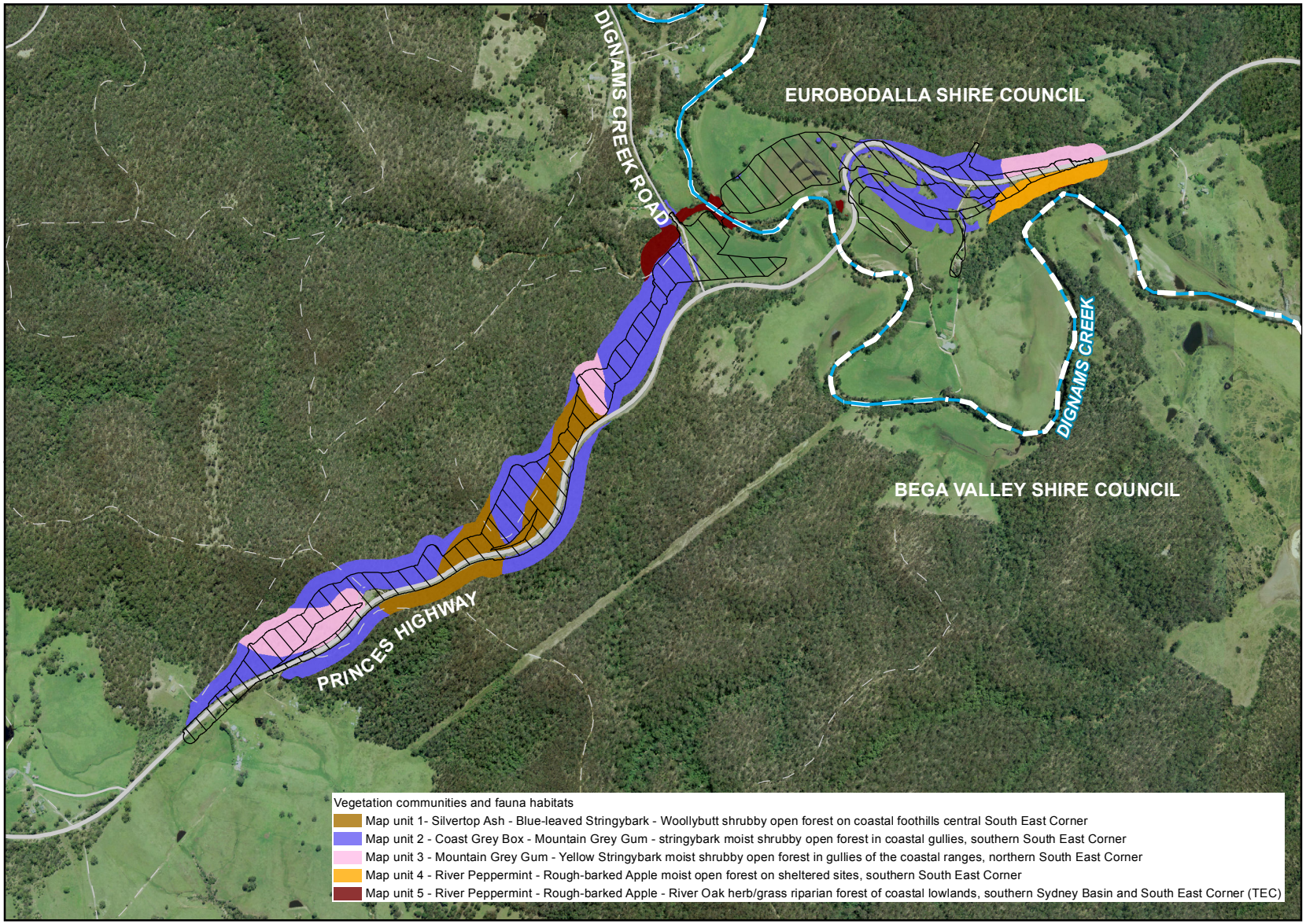
* Distribution and habitat requirement information adapted from the Department of Environment and Climate Change (updated 2005) Threatened Species Website (http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_allspecies.aspx)

+ Rare or Threatened Australian Plants (RoTAP)

Briggs, JD; Leigh, JH [1979] (1996). *Rare or Threatened Australian Plants,* Fourth Edition, CSIRO Publishing

The Square Raspwort (*Haloragis exaltata* subsp*. exaltata*) is listed as vulnerable under the TSC Act and the EPBC Act. This species was identified in relatively high abundance along the edges of Dignams Creek within the study area. Around 50 individuals were recorded in the proposed construction footprint within the thin strip of riparian vegetation along Dignams Creek, including several large clumps on the edges of cleared areas. The local population is conservatively estimated to consist of more than 1,000 plant clumps in the study area. The known distribution of Square Raspwort in the study area is displayed in **Figure 6-3**.

Upgrade of the Princes Highway, Dignams Creek



LEGEND
- Construction footprint
- Dignams Creek and LGA boundary
- Major road
- Local road
- Track

DATA SOURCES
LPMA 2010
SKM 2011

0 600
Metres

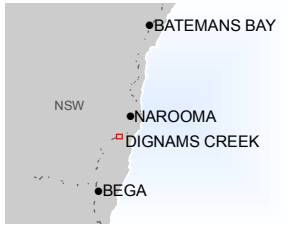
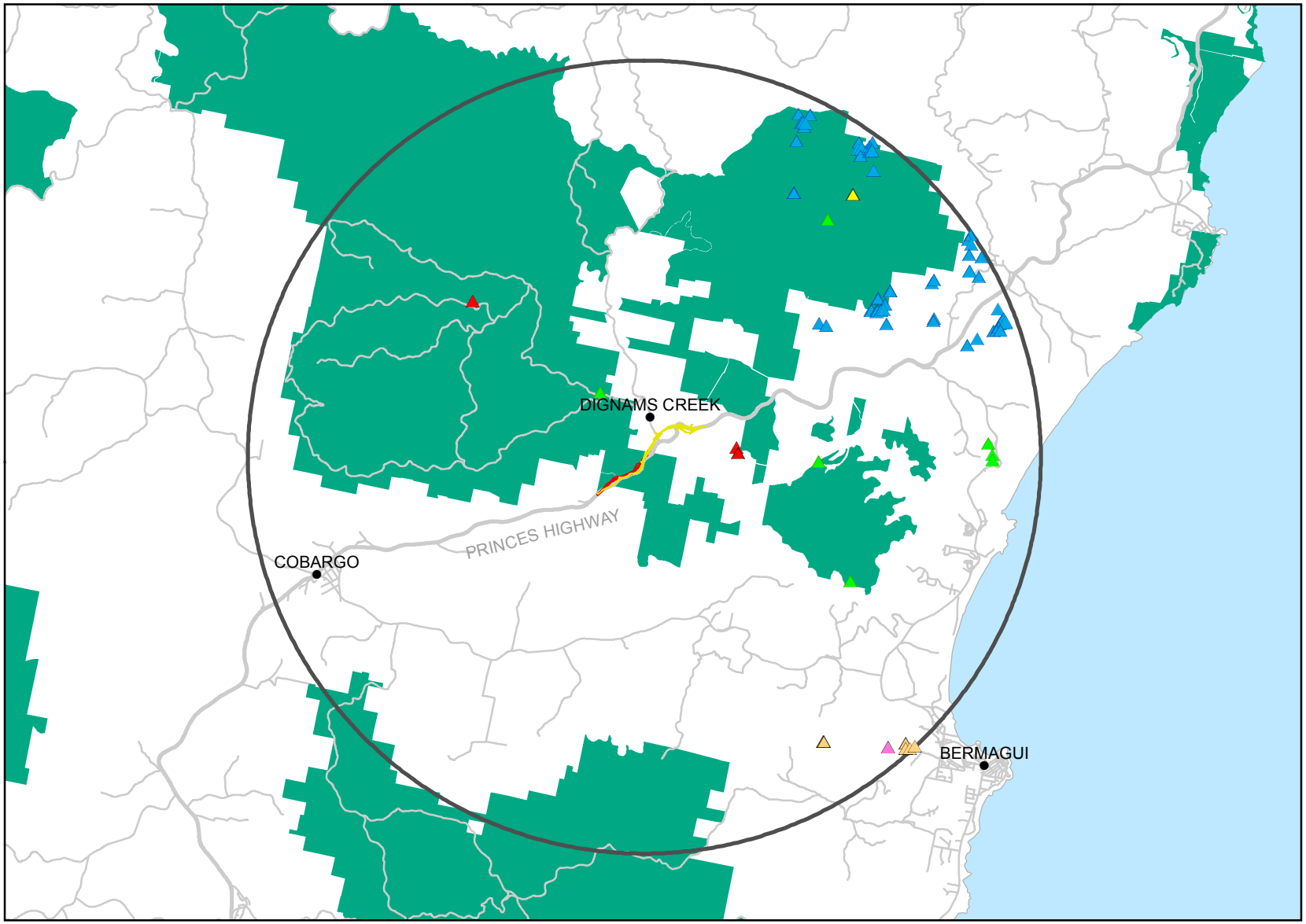


Figure 6-1 | Distribution of vegetation communities and fauna habitats

NSW GOVERNMENT Transport Roads & Traffic Authority
SINCLAIR KNIGHT MERZ SKM

7/06/2013 | I:\ENVR\Projects\EN02937\Technical\GIS\Spatial_Directory\ArcGIS\REF_Ver3\EN02937_GIS_REF2_F011_r2v1_VegComm_Nofauna labels.mxd
Newcastle Spatial Team - Prepared by : AL
Checked by : VC

Upgrade of the Princes Highway, Dignams Creek



LEGEND

- Locality

Concept design

- Stage 1
- Stage 2
- Major road
- Local road
- National park
- 10 km buffer area

NSW Atlas records

Threatened flora

- *Haloragis exalata* subsp. *exalata*
- *Zieria tuberculata*
- *Distichlis distichophylla*
- *Persicaria elatior*
- *Pomaderris bodalla*
- *Wilsonia backhousei*

DATA SOURCES
OEH Atlas of NSW Wildlife 2012
Contextual Data: LPMA 2010 and DoP
Project Data: SKM 2011

0 5
Kilometres

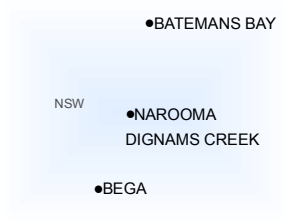


Figure 6-2 | Threatened flora records (OEH Atlas of NSW Wildlife)

Transport Roads & Traffic Authority

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Newcastle Spatial Team - Prepared by : KM
Checked by : RV

Upgrade of the Princes Highway, Dignams Creek

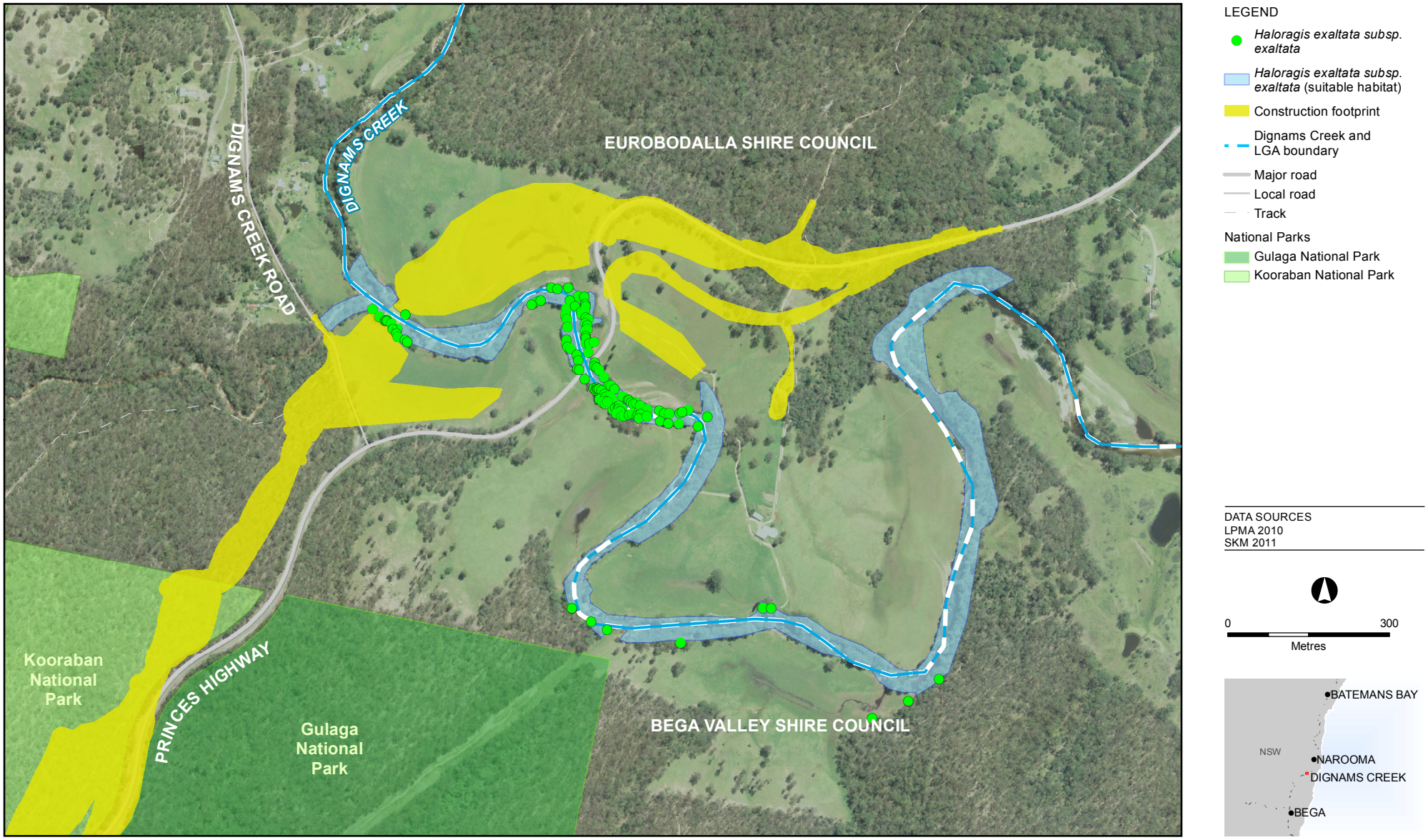


Figure 6-3 | Distribution of Haloragis exaltata subsp. exaltata

8/05/2013 | I:\ENVR\Projects\EN02937\Technical\GIS\Spatial_Directory\ArcGIS\REF_Ver3\EN02937_GIS_REF2_F013_r2v1_Haloragis.mxd
Newcastle Spatial Team - Prepared by : AL
Checked by : JC

Threatened fauna species

On the basis of regional records, reports and the presence of suitable habitat, a total of 49 threatened fauna species have been identified from the broader regional area, which encompasses a range of habitats up to 10 kilometres from the study area. These species are listed in Table E-2 of the *Biodiversity Assessment* refer to **Appendix K**.

Many of these species occur within habitats that are not represented at Dignams Creek, or have a distributional range which does not include the study area, these were considered unlikely to occur or have a low chance. From the review, 14 species were considered to have a moderate chance of occurring and 10 species a high chance of occurring in the study area. The seven species recorded from the site surveys and threatened species as identified under the EPBC Act and/or the TSC Act which are considered to have a moderate to high chance of occurring near the proposal area are described in **Table 6-4**. The distribution of threatened fauna species records in the study area is provided in **Figure 6-4.**

Table 6-4 Threatened fauna species recorded or considered to have a moderate to high likelihood of occurring

Species	EPBC Act Status	TSC Act Status	Potential to occur in the study area
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Moderate
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)		V	Recorded*
Eastern Bent-wing Bat (*Miniopterus schreibersii*)		V	Recorded*
Eastern Freetail Bat (*Mormopterus norfolkensis*)		V	Recorded*
Southern Myotis (*Myotis macropus*)		V	Moderate
Spotted-tailed Quoll (*Dasyurus maculatus*)	E	V	High
Yellow-bellied Glider (*Petaurus australis*)		V	Recorded
Brush-tailed Phascogale (*Phascogale tapoatafa*)		V	Moderate
Koala (*Phascolarctos cinereus*)	V	V	Moderate
Long-nosed Potoroo (*Potoroo tridactylus*)	V	V	Moderate
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	High
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)		V	High
Greater Broad-nosed Bat (*Scoteanax rueppellii*)		V	Recorded*
Square-tailed Kite (*Lophoictinia isura*)		V	Moderate

Species	EPBC Act Status	TSC Act Status	Potential to occur in the study area
Gang-gang Cockatoo (*Callocephalon fimbriatum*)		V	Recorded
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)		V	Recorded
Barking Owl (*Ninox connivens*)		V	Moderate
Powerful Owl (*Ninox strenua*)		V	High
Sooty Owl (*Tyto tenebricosa*)		V	Moderate
Masked Owl (*Tyto novaehollandiae*)		V	Moderate
Pink Robin (*Petroica rodinogaster*)		V	Moderate
Stuttering Frog (*Mixophyes balbus*)	V	E	Moderate
Giant Burrowing Frog (*Heleioporus australicus*)		V	Moderate
White-footed Dunnart (*Sminthopsis leucopus*)		V	Moderate

V- vulnerable; E – endangered; * species recorded in the proposal area by NGH (2010).

Survey Results – species confirmed

The Glossy Black-Cockatoo (*Calyptorhynchus lathami*) was recorded in Kooraban National Park by NGH (2010). Parts of Kooraban and Gulaga National Parks carry dense stands of post-logging or post-fire Allocasuarina regrowth of which is likely to provide feeding resources for the local Glossy Black-cockatoo population. An individual was also recorded several hundred metres to the west of the proposal corridor in Kooraban National Park during the Koala scat searches for the current assessment. Foraging resources for this species are patchy along the proposal alignment and no evidence of a regular feeding tree was recorded in the corridor from the targeted habitat resource survey.

An individual Gang-Gang Cockatoo (*Callocephalon fimbriatum*) was recorded in northern end of the proposal corridor to the west of the highway as part of the current survey. This is a wide-ranging species that could potentially forage in all habitat types identified in the study area.

Yellow-bellied Gliders were recorded at two locations as part of the current survey, firstly to the south of Dignams Creek Road around 200 metres within riparian habitat on private land and secondly within Kooraban National Park at the furthest southern end of the proposal also within riparian forest.

A number of threatened microchiropteran bat species were confirmed in the NGH (2010) survey including the Eastern Freetail-bat (Mormopterus norfolkensis), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) and the Greater Broad-nosed Bat (*Scoteanax rueppellii*). All four species are listed as vulnerable under the TSC Act and were detected via anabat call recording and analysis.

Habitat Trees

The habitat tree survey identified a higher density of hollow-trees on the western side of the highway than the eastern side and a higher density within Kooraban National Park than other parts of the study corridor. This included observation of an important Yellow-bellied Glider sap feeding tree recognised as a Rough-barked Apple (*Angophora floribunda*) and a number of possible den trees in this location at the south-western end of the proposal. Two yellow-bellied gliders were observed on the sap tree and this tree is expected to be an important feature in the home range of at least one family group of gliders. The habitat to the west of the highway in Kooraban National Park is of better quality than on the ridge to the east of the highway in Gulaga National Park which is considered marginal. A total of 51 habitat trees were recorded from a combination of the current survey and the previous investigation (NGH 2010) and this information was used to inform the final design and impact assessment (refer to **Appendix K**, Section 3.6 and Section 4). The locations of habitat trees recorded from the survey are shown in **Figure 6-5**.

Species tentatively identified

The Long-nosed Potoroo (*Potorous tridactylus*) was tentatively identified as part of the NGH survey from conical diggings that were reported in the study area, although it is not possible to distinguish these diggings from those of the common Long-nosed Bandicoot (*Perameles nasuta*) which were observed. The Long-nosed Potoroo was targeted in follow-up surveys for the REF; however this species was not confirmed. As a precautionary measure the Long-nosed Potoroo has been considered a potential subject species.

Results of the targeted Koala survey

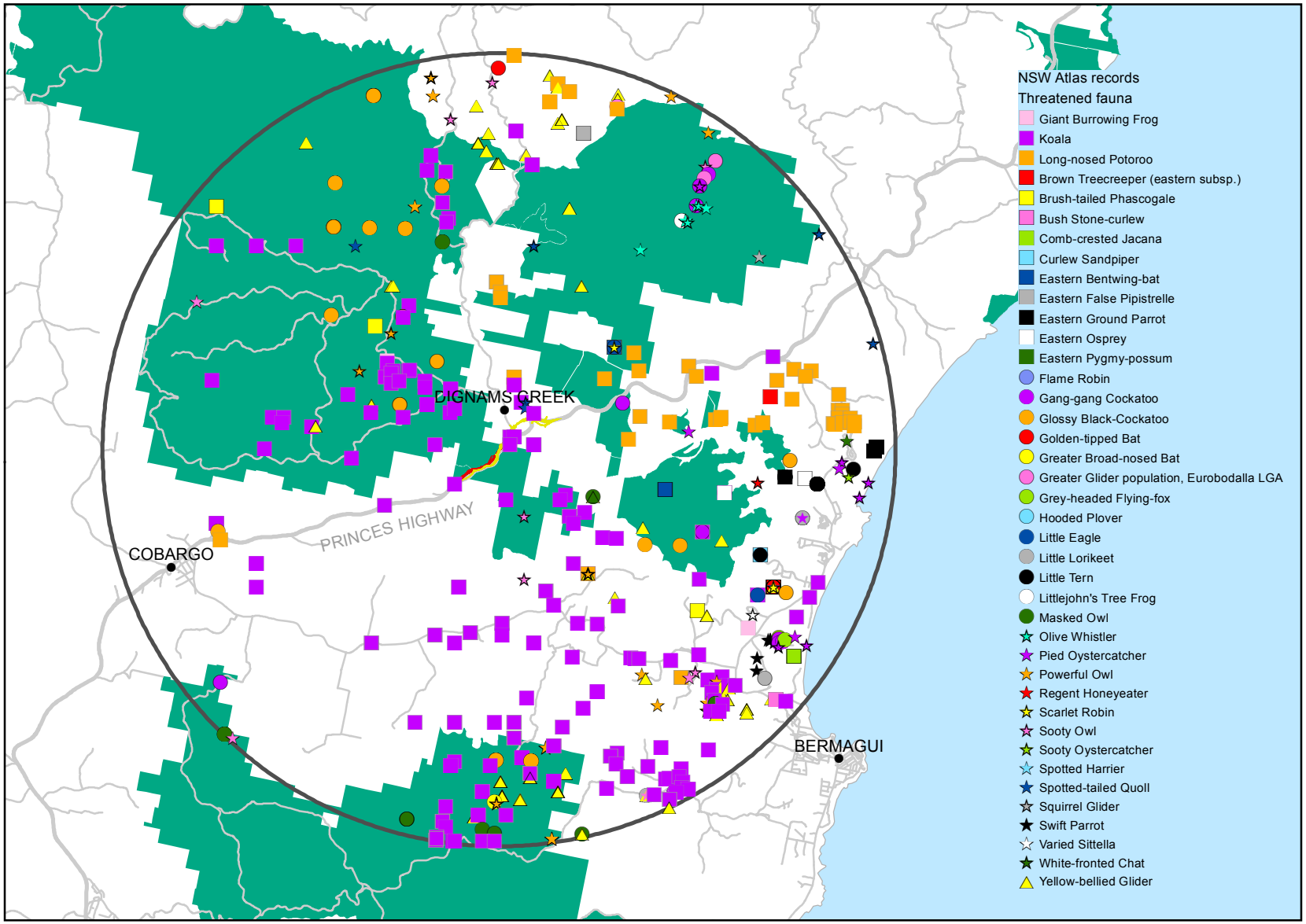
No Koala scats were recorded from the survey of 600 trees on both sides of the highway within the length of the study area (refer to **Appendix K**). Any Koala activity in the study area is considered to be very low and the survey results suggest that the habitats adjoining the proposal corridor may only be used occasionally by dispersing individuals rather than supporting a portion of an important population or the home range of an individual.

Important Koala populations

In a recent Koala surveys conducted by Allen (2011) in Kooraban and Gulaga National Park only 8 per cent of the grid-sites assessed had evidence of Koalas in the Kooraban/Gulaga area. Compared with most areas where this kind of survey is undertaken in the southern forests (Allen *et al* 2010), this success rate is very low. These results suggest probably only 5-15 Koalas are surviving in the approximately 6,000 ha of forests assessed. No Koala activity was report close the current study area.

The two areas in the Kooraban National Park where Koalas (the Sam's Ridge and Jimmy's Creek areas) are persisting are those where Koalas had been identified previously both in anecdotal reports and in previous surveys. The continued persistence in these areas over at least several decades indicates some stability with these two breeding associations (Allen 2011).

Upgrade of the Princes Highway, Dignams Creek



LEGEND

- Locality

Concept design
- Stage 1
- Stage 2

- Major road
- Local road
- National park
- 10 km buffer area

DATA SOURCES
Contextual Data: LPMA 2010 and DoP
Project Data: SKM 2011
OEH Atlas of NSW Wildlife 2012

0 5
Kilometres

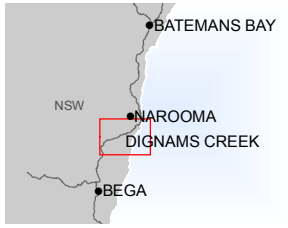


Figure 6-4 | Threatened fauna (OEH Atlas records)

Transport Roads & Traffic Authority

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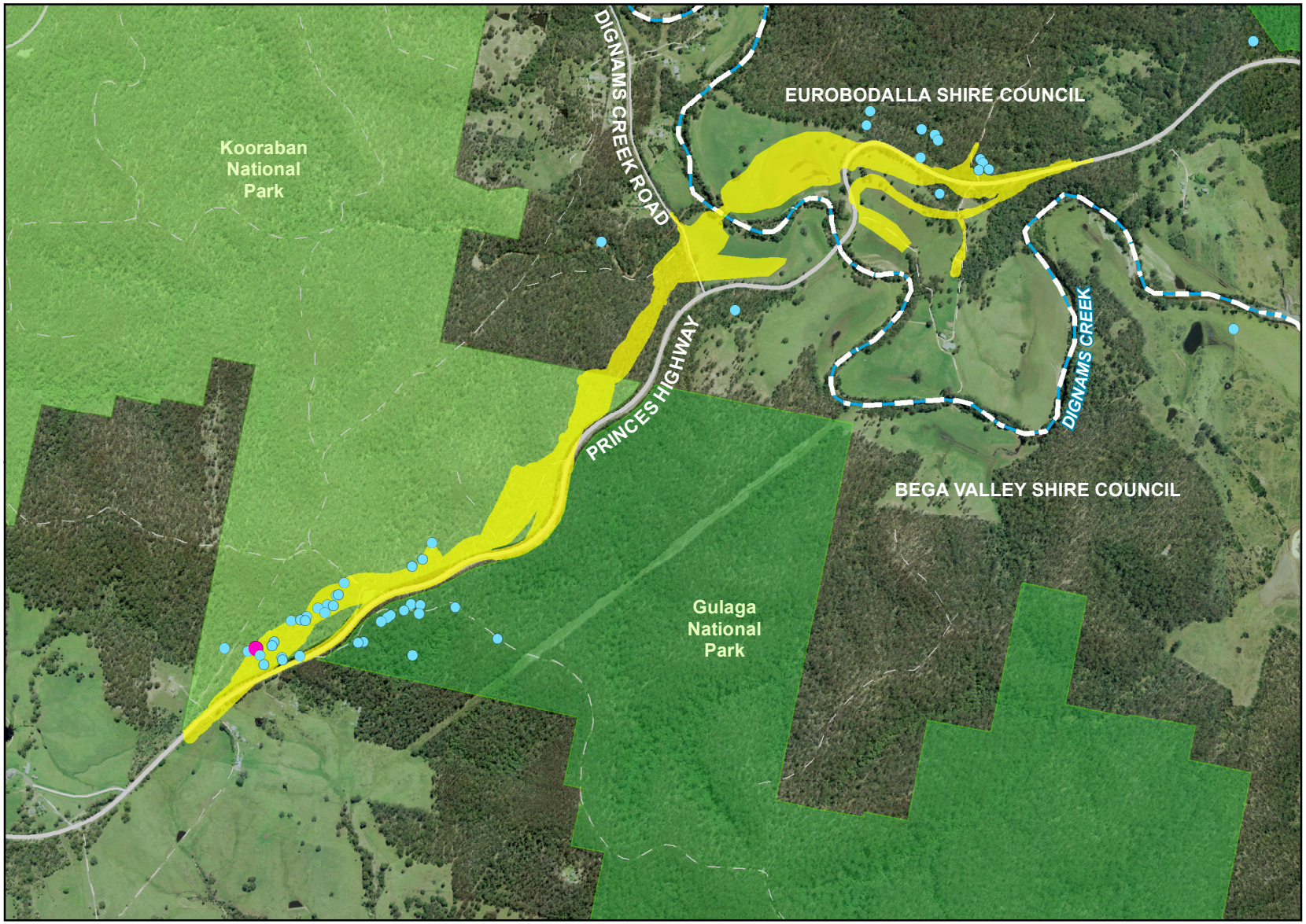
Newcastle Spatial Team - Prepared by : KM
Checked by : RV



LEGEND
- Dignams Creek
- LGA boundary
- Major road
- Local road
- Track

National Parks
- Gulaga National Park
- Kooraban National Park
- Construction footprint

Habitat Survey (SKM, NGH 2012)
- Habitat tree
- Yellow-bellied Glider feed tree

DATA SOURCES
Imagery: LPMA 2010
Contextual Data: LPMA 2010
Project Data: SKM 2011, 2012, NGH 2012

0 600
Metres

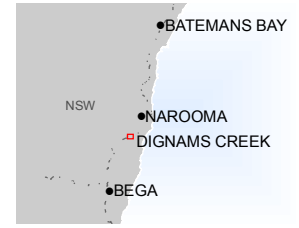


Figure 6-5 | Distribution of habitat trees

NSW GOVERNMENT Transport Roads & Traffic Authority

SINCLAIR KNIGHT MERZ SKM

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Newcastle Spatial Team - Prepared by : KM
Checked by : RV

By the 1960's Koalas were known to be persisting to the east of the Princes Highway and south of Dignams Creek in what was to become the Wallaga Lake National Park, and which was incorporated into Gulaga National Park in 2000. The species was also known from Dignams Hill, immediately to the west of this area which is incised by the Princes Highway. The evidence reported by Allen (2011) and in recent surveys of the regional area indicates that two small populations occur to the west of the proposal study area. These populations would be considered important in the context of the interim referral advice provided by DSEWPaC (2012).

Habitat critical to the survival of Koalas

According to the DSEWPaC *Interim Koala Referral Advice for Proponents* (2012), habitat critical to the survival of the Koala is currently considered to be areas of forest or woodland where:

- Primary Koala food tree species comprise at least 30 per cent of the overstorey trees, or
- 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, or
- Primary food tree species are absent but secondary food tree species alone comprise at least 50 per cent of the overstorey trees, or
- 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, 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.

These criteria have been applied to the field data to identify the proportion of Koala habitat for Koalas situated within the study area. The data used in this assessment includes detailed descriptions gathered for the vegetation community types and floristic composition and the vegetation community mapping for the proposal and other broad-scale mapping of the region as reported in Tozer et al (2010).

In addition to this recent research in the south coast region (DECCW 2010c) has established that eucalypt communities in which Woollybutt (*Eucalyptus longifolia*), White Stringybark (*Eucalyptus. globoidea*), Yellow Stringybark (*Eucalyptus. muelleriana*), Monkey Gum (*Eucalyptus cypellocarpa*), Coast Grey Box (*Eucalyptus. bosi*stoana), Red Ironbark (Eucalyptus tricarpa), Blue Stringybark (*Eucalyptus agglomerata*), Rough-barked Apple (*Angophora floribunda*), Silvertop Ash (*Eucalyptus sieberi*) and Black She-oak (*Allocasuarina littoralis*) occur sustains the known Koala populations in this part of the region.

The Australian Koala Foundation (AKF) (2012) also identifies additional tree species as primary or secondary species. In the Bega Valley and Eurobodalla LGA the AKF (2012) identifies Monkey Gum (*Eucalyptus cypellocarpa*) as a primary feed tree species and the majority of the species listed above have been identified as secondary species (refer to **Table 6-5**). Bangalay (*Eucalyptus botryoides*) and Yertchuk (*Eucalyptus consideniana*) was also identified in the AKF (2012) report as secondary feed trees.

Table 6-5 Summary of primary and secondary food tree species in the overstorey and assessment of habitat critical to the survival of Koalas (EPBC Act) and category of Koala habitat (DECC 2008)

Map Unit	Vegetation types identified in the study area	Food tree species south coast region (DECC 2008) (% cover)			Important food trees south coast region (DECCW 2010c) additional to DECC (2008)	Primary food trees Bega Valley and Eurobodalla LGA (AKF 2012) additional to DECC (2008) and DECCW (2010c)		Habitat critical to Koala survival based on DSEWPaC (2012)	Habitat category, Callaghan unpublished in DECC (2008)
		Primary	Secondary	Supplementary		Primary	Other		
MU 1	Silvertop Ash – Stringybark dry open forest	None	Monkey Gum (*E.cypellocarpa*) (<5%), Yertchuk (*E.consideniana*) (<5%), Coast Grey Box (*E. bosistoana*) (<5%)	Blue-leaved Stringybark (*E.agglomerata*) (>30%), White Stringybark (*E.globoidea*) (10%), Yellow Stringybark (*E.muelleriana*) (5%)	Silvertop Ash (*E.seiberi*) (>30%), Red Ironbark (*E.tricarpa*) (<5%), Rough-barked Apple (*Angophora floribunda*) (20%) Black She-oak (*Allocasuarina littoralis*) (mid-storey 5-20%)	Monkey Gum (*E.cypellocarpa*) (<5%)		No	Secondary habitat (class B)
MU2	White Stringybark dry open forest	None	Monkey Gum (*E.cypellocarpa*) (10%), Coast Grey Box (*E. bosistoana*) (<5%), Woollybutt (*E.longifolia*) (<5%), Blue Box (*E.baueriana*) (<5%)	Yellow Stringybark (*E.muelleriana*) (>30%), White Stringybark (*E.globoidea*) (>30%), Blue-leaved Stringybark (*E.agglomerata*) (5%)	Silvertop Ash (*E.seiberi*), (5%), Rough-barked Apple (*Angophora floribunda*) (20%), Black She-oak (*Allocasuarina littoralis*) (mid-storey 5-20%)	Monkey Gum (*E.cypellocarpa*) (<5%)		No	Secondary habitat (class C)

Map Unit	Vegetation types identified in the study area	Food tree species south coast region (DECC 2008) (% cover)			Important food trees south coast region (DECCW 2010c) additional to DECC (2008)	Primary food trees Bega Valley and Eurobodalla LGA (AKF 2012) additional to DECC (2008) and DECCW (2010c)		Habitat critical to Koala survival based on DSEWPaC (2012)	Habitat category, Callaghan unpublished in DECC (2008)
MU3	Bangalay/ Blue Gum sheltered forest	None	Monkey Gum (*E.cypellocarpa*) (<5%)	Yellow Stringybark (*E.muelleriana*) (>30%), White Stringybark (*E.globoidea*) (10%)	Rough-barked Apple (*Angophora floribunda*) (20%)	Monkey Gum (*E.cypellocarpa*) (<5%)	Bangalay (*E.botryoides*) (>30%) occurs as a hybrid with Sydney Blue Gum (*Eucalyptus saligna*)	No	Secondary habitat (class C)
MU4	River Peppermint – Rough-barked Apple moist shrubby forest	None	None	None	Rough-barked Apple (*Angophora floribunda*) (5%)		Bangalay (*E.botryoides*) (10%) occurs as a hybrid with Sydney Blue Gum (*Eucalyptus saligna*)	No	Tertiary habitat
MU5	Riparian forest	None	None	None	Rough-barked Apple (*Angophora floribunda*) (5%)		Bangalay (*E.botryoides*) (5%) occurs as a hybrid with Sydney Blue Gum (*Eucalyptus saligna*)	No	Tertiary habitat

These feed trees are locally important and associated with frequent Koala activity (DECCW, 2010c), and the majority of these are also recognised in the south coast area as secondary and supplementary Koala food trees in the *Recovery Plan for the Koala* (with the exception of *E. tricarpa* and *E. sieberi*) (DECC, 2008b). There are no recognised primary feed tree species from the south coast region as defined in the *Recovery Plan for Koala* (DECC, 2008b) recorded in the study area and only a low abundance of secondary feed tree species is present. Feed trees present are comprised of Monkey Gum (*Eucalyptus cypelloc*arpa), Yertchuk (*Eucalyptus consideniana*), Woollybutt (*Eucalyptus longifolia*), Coast Grey Box (*Eucalyptus bosistoana*) and Blue Box (*Eucalyptus baueriana*). The feed tree species identified in this biodiversity assessment occur within three vegetation communities identified within the study area (refer to **Figure 6-1**) which are as follows:

- Map unit 1: Silvertop Ash - Stringybark Dry Open Forest.
- Map unit 2: White Stringybark Forest.
- Map unit 3: Bangalay/Blue Gum Sheltered Forest.

Based on the presence and proportion of eucalypt food tree species, none of the vegetation types fit the definition for habitat critical to the survival of Koalas, According to DECC (2008) map unit 1 is secondary habitat (class B), map units 2 and 3 are secondary habitat (class C) and the riparian habitat is classed as tertiary habitat.

In relation to dot point 4 of the DSEWPaC *Interim Koala Referral Advice for Proponents* (2012):

- 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.

The presence of two small Koala populations known from Kooraban National Park and surrounding contiguous areas and the presence of important food tree species reported from DECC (2010) suggests that essential habitat features are present and the study area may occur in an important corridor for dispersal of Koalas to currently unoccupied habitats. Therefore as a precautionary measure the habitat is classed as critical to the survival of Koalas in the Dignams Creek area.

Migratory species

A total of 15 migratory fauna species were identified in the EPBC Act Protected Matters Report as potentially occurring in the broader study area. According to the *Biodiversity Assessment* (refer to **Appendix K**), three have been identified as having high potential to be present in habitats of the study area, eight have a moderate potential, two species are considered to have a low potential and two species are considered unlikely to occur based on the absence of suitable habitat. The 11 species considered to have a high or moderate potential to occur were considered as potential subject species due to the presence of suitable habitat, refer to **Table 6-6**.

Large areas of suitable habitat is present including natural and modified habitats, such as open cleared and agricultural land in the case of Egret species and woodland and forest habitats, particularly moister forest types in the case of the Rufous Fantail and Black-faced Monarch.

Table 6-6 Migratory species listed under the EPBC Act recorded or considered to have a moderate to high likelihood of occurring

Common Name	Species	Preferred habitat	Likelihood of occurrence	EPBC Act status	Important population	Likely significance impact
Black-faced Monarch	*Monarcha melanopsis*	Rainforests, eucalypt forests and coastal scrubs	Moderate	Marine; Migratory (BONN)	No	No
Cattle Egret	*Ardea ibis*	Grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Often seen with cattle.	High	Marine; Migratory (CAMBA, JAMBA)	No	No
Fork-tailed Swift	*Apus pacificus*	The species breeds in Asia and migrate to Australia in the summer from which they spend their entire life-cycle on the wing, hunting, resting and sleeping.	High	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
Great Egret	*Ardea alba*	Prefers shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	High	Marine; Migratory (CAMBA, JAMBA)	No	No
Latham's snipe	*Galliago hardwickii*	Wetlands, wet meadows, flooded grassy paddocks, open grassland and drainage areas	Moderate	Marine; Migratory (CAMBA, JAMBA, ROKAMBA)	No	No
Rufous Fantail	*Rhipidura rufifrons*	Predominantly rainforest and forests	Moderate	Marine; Migratory (BONN)	No	No
Rainbow Bee-eater	*Merops ornatus*	Predominantly woodland and timbered plains	Moderate	Marine; Migratory (JAMBA)	No	No
Satin Flycatcher	*Myiagra cyanoleuca*	Predominantly forests, in particular thick vegetation in gullies	Moderate	Marine; Migratory (BONN)	No	No
Spectacled Monarch	*Monarcha trivirgatus*	Prefers a thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Moderate	Marine; Migratory (BONN)	No	No

Common Name	Species	Preferred habitat	Likelihood of occurrence	EPBC Act status	Important population	Likely significance impact
White-bellied Sea Eagle	*Haliaeetus leucogaster*	Predominantly ocean shores and estuaries, occasionally inland rivers and streams.	Moderate	Marine; Migratory (CAMBA)	No	No
White Throated Needletail	*Hirundapus caudacutus*	An aerial foraging species which occupies a range of habitats from open modified landscapes to woodland and forest.	Moderate	Marine; Migratory(CAMBA, JAMBA, ROKAMBA)	No	No

There is no evidence to suggest that an area of important habitat exists or that the study area is occupied by an ecologically significant proportion of the populations of these migratory species (refer to **Table 6-6**). It is therefore considered unlikely that the proposal would reduce populations of these migratory species or substantially reduce the extent of potential habitat available to these species in the study region.

Noxious weeds, pests and pathogens

Of the total 330 species of flora recorded, 49 introduced flora species were identified, representing approximately 15 per cent of the total species. Two noxious weed species were recorded in the study area. Some of these species are relatively common in roadside habitats and paddock areas and all are known to occupy disturbed areas. These species are listed in **Table 6-7**.

Table 6-7 Noxious weed species identified in the study area

Species	Prevalence on site	Noxious class (under the Noxious Weeds Act)
Patterson's Curse *Echium plantagineum*	Recorded in low abundance on disturbed roadside areas.	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed.
Blackberry *Rubus fruticosus*	Recorded in moderate to high abundance in unmaintained road easements and disturbed areas of remnant vegetation	

There are currently five Key Threatening Processes listed under the TSC Act and three under the EPBC Act that relate to the invasion and establishment of pests. Each of these has potential to be exacerbated by construction and operation of the proposal, which includes:

- Competition and grazing by the feral European Rabbit (EPBC Act and TSC Act).
- Competition from feral honeybees (TSC Act).
- Predation by feral cats (EPBC Act and TSC Act).
- Predation by the European Red Fox (EPBC Act and TSC Act).
- Predation by the Plague Minnow (*Gambusia holbrooki*) (TSC Act).

Pathogens are agents that cause disease in flora and fauna and are usually bacterium, virus or fungus, that can cause disease in flora and fauna. Pathogens known from NSW that have the potential to impact on biodiversity during construction of the proposal include:

- Dieback caused by *Phytopthera* (Root rot, EPBC Act and TSC Act).
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and TSC Act).
- Introduction and establishment of exotic Rust Fungi of the order *Pucciniales* on plants of the family *Myrtaceae* (TSC Act).

Aquatic habitats

The existing Dignams Creek Bridge is located approximately 6.2 kilometres upstream from the Dignams Creek Sanctuary Zone (Batemans Marine Park) which is part of the Batemans Marine Park (refer to **Figure 6-6**). Dignams Creek is identified as key fish habitat (NSW DPI) and contains a diversity of aquatic habitats including freshwater aquatic vegetation and numerous submerged woody snags. According to Fairfull & Witheridge (2003), the aquatic habitat of Dignams Creek is classified as Class 2 – Moderate fish habitat. The results of the aquatic survey data are presented in Appendix D of the *Biodiversity Assessment* (refer to **Appendix K**).

No threatened fish were observed during the field surveys. However the Australian Grayling (*Prototroctes maraena*) which is listed as Vulnerable under the EPBC Act occurs in freshwater, moderate to fast flowing, clear gravelly streams as well as estuarine areas. Habitat is present within the upstream sections of Dignams Creek for the Australian Grayling. However downstream of the proposal a weir is present and the entrance to Wallaga Lake is only intermittently open which present barriers to fish passage. As such, Dignams Creek is considered an unlikely habitat for the Australian Grayling as barriers to fish passage disrupt the diadromous life cycle, preventing both juveniles being swept downstream to marine waters, and juveniles migrating back upstream to adult freshwater habitat (Morris *et al.* 2001).

The Freshwater Catfish (*Tandanus tandanus*) is not listed under NSW legislation but should be considered ecologically significant. The Murray Darling Catchment Basin population of the Freshwater Catfish is listed as endangered under the Fisheries Management Act 1994, whilst the coastal populations (including Dignams Creek) are not listed. Due to these species' reduced numbers, and unclear taxonomy, NSW Fisheries (1999) recommends that the freshwater catfish species and its habitat their habitats be given special consideration in planning decisions throughout their NSW distribution. *Tandanus tandanus* was identified during the aquatic field surveys indicating that suitable habitat is available within the study area.

SEPP 44 Koala Habitat Protection

Consideration of SEPP44 is not required under the provisions of part 5 of the EP&A Act. The Koala is however listed as vulnerable under the EPBC Act and the TSC Act and accordingly, targeted surveys were conducted for this species during the site inspections. The impacts of the proposal on Koala habitat has been considered as part of the *Biodiversity Assessment* (refer to **Appendix K**).

Critical habitat

No areas of declared critical habitat under the TSC Act or the EPBC Act are present in the study area.

Groundwater dependant ecosystems

The majority of vegetation communities in the study area are considered to have a low-level of groundwater dependence considering the dry nature of these communities, their occurrence on relatively steep undulating terrain and slopes, and the lack of any evidence of groundwater expression at the base of slopes and/or in drainage lines. The creek flats around Dignams Creek, Blind Creek and some gully areas potentially have some level of groundwater dependence. Flora species in these areas are adapted to localised flooding and soil water logging which would occur during heavy rain periods.

Upgrade of the Princes Highway, Dignams Creek

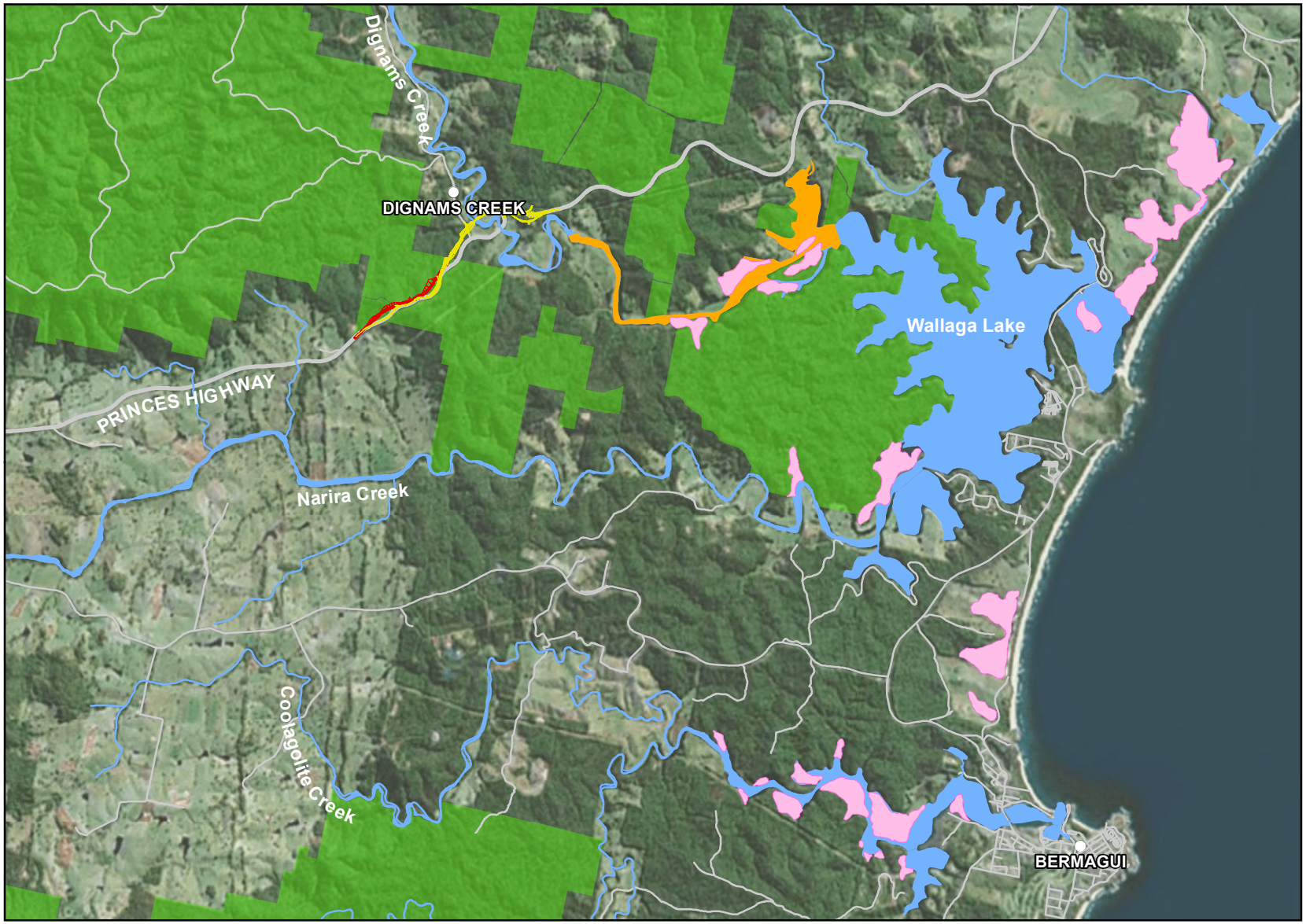

Figure 6-6 | Dignams Creek SEPP 14 wetlands and the Dignams Creek Sanctuary Zone (Batemans Marine Park)

NSW GOVERNMENT Transport Roads & Traffic Authority

SINCLAIR KNIGHT MERZ SKM

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Newcastle Spatial Team - Prepared by : AL
Checked by : JC

Wildlife connectivity corridors

As the existing Princes Highway bisects two large areas of forest and a riparian corridor, the potential for impacts to fauna movements is high, for both terrestrial and arboreal species. The riparian corridor along Dignams Creek is not separated by the existing highway as the vegetation continues underneath the existing bridge. As identified in the *Biodiversity Assessment* (refer to **Appendix K**) a diversity of fauna species has been identified and the current highway would have a barrier effect to the movement of a range of arboreal and terrestrial mammals, including threatened species such as the Koala and Yellow-bellied Glider. The study area forms part of an important Koala movement corridor linking two known Koala populations, associated with Kooraban National Park to the west of the Princes Highway and Gulaga National Park to the east of the highway.

6.1.3 Potential impacts

Potential ecological impacts associated with the construction and operation of the proposal is discussed in the sections below.

Construction

Loss of vegetation and habitat removal

The proposal requires clearance of about 20.6 hectares of remnant vegetation in various condition states, thereby affecting areas of habitat for fauna, including the threatened Koala and Yellow-bellied Glider. The remaining areas to be cleared comprise already cleared and modified lands. These areas have some value for common fauna species such as macropods and birds adapted to agricultural areas but have limited habitat value for threatened species except as foraging habitat for microchiropteran bats.

Impacts on TECs specifically would include the removal of approximately 0.2 hectares of River-flat Eucalypt Forest on Coastal Floodplains listed under the TSC Act (Map Unit 5). The loss of vegetation communities and habitats in the study area is summarised in **Table 6-8.** The assessment of significance concluded that the proposal is unlikely to cause a 'significant' impact on TECs listed under the TSC Act. Impacts would be ameliorated through the implementation of the safeguards and mitigation measures outlined in **Section 6.1.4**.

Hollow-bearing trees are a critical habitat feature for a number of threatened species (Gibbons and Lindenmayer 2002) and are present in habitats to be cleared by the proposal. The loss of hollow-bearing trees is listed as a key threatening process under the TSC Act. Fifteen listed threatened species (TSC Act or EPBC Act) have either been identified within the study area or are considered likely to occur which would be potentially affected by the loss of hollow bearing trees, these are shown in **Table 6-9**.

Table 6-8 Direct impacts to vegetation communities and fauna habitat

Vegetation Community Type	Fauna Habitat Type	Biometric Vegetation Type	Conservation Status/Percentage Cleared (Tozer 2010)	Condition	Area (ha)
Map Unit 1: Silvertop Ash - Stringybark Dry Open Forest	Dry Open Forest	Silvertop Ash - Blue-leaved Stringybark - Woollybutt shrubby open forest on coastal foothills central South East Corner	5% of original extent estimated to be cleared	High	4.2
Map Unit 2: White Stringybark Forest	Wet Sclerophyll Forest	Coast Grey Box - Mountain Grey Gum - Stringybark moist shrubby open forest in coastal gullies, southern South East Corner	15% of original extent estimated to be cleared	High	10.3
				Moderate	0.6
				Low	1.3
Map Unit 3: Bangalay/Blue Gum Sheltered Forest	Wet Sclerophyll Forest	Mountain Grey Gum - Yellow Stringybark moist shrubby open forest in gullies of the coastal ranges, northern South East Corner	5% of original extent estimated to be cleared	High	3.5
Map Unit 4: River Peppermint - Rough-barked Apple moist shrubby forest	Wet Sclerophyll Forest	River Peppermint - Rough-barked Apple moist open forest on sheltered sites, southern South East Corner	65% of original extent estimated to be cleared	Moderate	0.5
Map Unit 5: Riparian Forest	Riparian habitats	River Peppermint - Rough-barked Apple - River Oak herb/grass riparian forest of coastal lowlands, southern Sydney Basin and South East Corner	Endangered (River-flat Eucalypt Forest on Coastal Floodplains) (TSC Act) 50% of original extent estimated to be cleared	High	0.1
				Moderate	0.1
TOTAL				**20.6 hectares**	

Table 6-9 Threatened species potentially affected by loss of hollow-bearing trees and considered to occur in the study area

Common name	Species	TSC Act	EPBC Act
Eastern bent-wing Bat	*Miniopterus schreibersii oceanensis)*	V	
Glossy Black-cockatoo	*Calyptorhynchus lathami*	V	
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	
Brown Treecreeper (eastern subsp.)	*Climacteris picumnus picumnus*	V	
Powerful Owl	*Ninox strenua*	V	
Masked Owl	*Tyto novaehollandiae*	V	
Barking Owl	*Ninox connivens*	V	
Large-eared Pied Bat	*Chalinolobus dwyeri*		V
Spotted-tailed Quoll	*Dasyurus maculatus*	V	V
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	
Eastern Freetail-bat	*Mormopterus norfolkensis*	V	
Southern Myotis	*Myotis macropus*	V	
Yellow-bellied Glider	*Petaurus australis*	V	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	

A significant Yellow-bellied Glider sap feeding tree was recorded at Easting 766245 Northing 5971353 (MGA zone 55) which is within the construction footprint (refer to **Figure 6-5**). In addition several hollow-bearing trees were identified as potential glider den sites. This information was used to refine the design footprint in order to avoid direct impacts on these features, in particular the sap feeding tree, and thereby avoid an impact on a family group of the Yellow-bellied Glider.

The proposal would also remove potential foraging habitat for 24 threatened fauna species including the Koala (*Phascolarctos cinereus*) and 11 migratory species confirmed to occur in the study area or considered highly likely to occur based on local records and habitat preferences. Potential impacts of the proposal on threatened flora, mammals, birds and amphibians are summarised in **Table 6-10** below, although as outlined above none of these impacts have been assessed as significant.

The assessment of significance concluded that the proposal is unlikely to cause a 'significant' impact on local populations of threatened species or their habitats as listed under the EPBC Act or TSC Act. Impacts would be ameliorated through the implementation of the safeguards and mitigation measures outlined in **Section 6.1.4**. Where there was minimal information on the size and extent of the population in order to make an informed decision regarding the significance of the impact, the likely impact was based on the application of the precautionary principal.

Table 6-10 Summary of impacts to threatened species and ecological communities

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
River-flat Eucalypt Forest	-	E	Impacts include approximately 0.1 hectares of moderate condition vegetation along Dignams Creek comprising a thin strip of riparian vegetation, and approximately 0.1 hectares of high condition vegetation along Blind Creek. There is approximately 76767 hectares of vegetation consistent with River-flat Eucalypt Forest on Coastal Floodplains within 10 kilometres of the construction footprint (Tozer et al. 2010). The potential impacts for the proposed upgrade represent less than 0.002% of the distribution in the locality.	Known
Square Raspwort (*Haloragis exaltata subsp. exaltata*)	V	V	This species was identified in relatively high abundance along the edges of Dignams Creek within the study area. Approximately 50 individuals were recorded in the construction footprint within the thin strip of riparian vegetation along Dignams Creek, including several large clumps on the edges of cleared areas. Impacts to habitat for this species in the construction footprint are likely to be short to medium term in duration. As riparian habitats following construction are likely to support suitable habitat for the species, as it favours disturbance events and was shown to proliferate in the currently disturbed area adjoining the exiting highway and bridge. The local population is conservatively estimated to consist of greater than 1,000 plant clumps in the locality. The proposed upgrade would result in impacts to less than 5% of the local population.	Known
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Removal of approximately 7.40 hectares of potential foraging habitat. There are no roost camps within the locality, however the dry sclerophyll forests provide potential foraging habitat for this species at different times of the year. Flying-foxes are found in a variety of habitats, including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas. Potential foraging habitat is common and widespread.	High
Koala (*Phascolarctos cinereus*)	V	V	There was no evidence of Koala activity recorded in the proposal footprint and adjacent habitat from the targeted surveys. However there are known populations in contiguous	High

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
			forest areas to the south of Bermagui in several State Forests and National Park areas (DECC 2009) and the species was recorded at five sites in Kooraban National Park from surveys conducted by NPWS in 2005 (reported in DECC 2009). Recent Koala surveys conducted by Allen (2011) in Kooraban and Gulaga National Park suggest probably only 5-15 Koalas are surviving in the approximately 6,000 ha of forests assessed across these two reserves. The DECC (2009) report for the Bermagui-Mumbulla area to the south of the study area indicates that the tree species under which Koala faecal pellets were most commonly found *were Eucalyptus longifolia* (Woollybutt*), E. globoidea* (White Stringybark), and *E. muelleriana* (Yellow Stringybark). While E*. cypellocarpa* (Monkey Gum), *E. bosistoana* (Coastal Greybox), *E. tricarpa* (Red Ironbark) and *E. sieberi* (Silvertop Ash) were less frequently encountered, but a relatively high proportion of these species also had Koala pellets underneath them. *E.cypellocarpa* (Monkey Gum) is also listed in the NSW *Recovery Plan for the Koala (Phascolarctos cinereus)* (DECC 2008b) as a secondary food tree species for the south coast region. The Australian Koala Foundation (AKF) (2012) also identifies additional tree species as primary or secondary species. In the Bega Valley and Eurobodalla LGA the AKF (2012) identifies Monkey Gum (*Eucalyptus cypellocarpa*) as a primary feed tree species and the majority of the species listed above have been identified as secondary species (refer to **Table 6-5**). Bangalay (*Eucalyptus botryoides)* and Yertchuk (*Eucalyptus consideniana*), was also identified in the AKF (2012) report as secondary feed trees. The proposal would involve the removal of around 19.9 hectares of potential Koala habitat. Potential impacts to the species associated with the proposal include loss, modification and fragmentation of habitat, and road kill. Currently connectivity for the Koala is restricted by the existing highway and there are no suitable underpasses. The proposal would improve connectivity for larger fauna species including the Koala with suitable underpasses including a large bridge structure aimed at facilitating natural fauna movements across the proposal corridor.	
Spotted-tailed Quoll	E	V	Impacts would be associated with the removal of around 20 hectares of potential habitat	High

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
(*Dasyurus maculatus*)			for this wide-ranging species which may include sheltering and breeding habitat. Also potential barrier impact from the highway, however this threat currently exists and the upgrade would improve connectivity. The Spotted-tailed Quoll is a cryptic species that occurs in a variety of habitats including rainforests, open woodlands, coastal heath and inland riparian forests. The species is known to den in hollow logs, caves and rocky ledges. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. They usually traverse their ranges along densely vegetated creek lines and edges of cleared farmland. The proposal would remove only a very small portion of potential habitat for this species compared to the extent of available habitat in the locality. The quality of the habitat increases with increasing distance from the existing road, including higher quality habitat structure, feeding resources and potential denning habitat. The habitat along the road edge is unlikely to be critical for this species and the provision of a fauna underpass structure would in fact improve the current connectivity.	
Brush-tailed Phascogale (*Phascogale tapoat*afa)	-	V	Impacts would be associated with the removal of habitat associated with map units 1 and 2 and around 16.4 hectares of potential habitat which may include sheltering and breeding habitat. The remaining dense wet sclerophyll forest habitats are considered marginal for the phascogale. Also there is a potential barrier impact from the highway upgrade, however this threat currently exists and the upgrade would improve connectivity. The size and extent of local populations is not known and the species is expected to be widespread in a range of habitats.	Moderate
Long-nosed Potoroo (*Potoroo tridactylus*)	V	V	The species was not confirmed in the study area although is considered to have potential to occur. Conical diggings were noted in several locations however these are not distinguishable from the Long-nosed Bandicoot which are likely to occur. The northern end of the proposal corridor, north of Dignams Creek provides suitable habitat for the species given that the soil type and dense understorey compared to the remainder of the study area. Based on known habitat preferences, habitats in the national park areas of the southern section would be considered marginal for this species.	Moderate

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Yellow-bellied Glider (*Petaurus australis*)	-	V	Yellow-bellied Gliders were recorded at two locations, firstly to the south of Dignams Creek Road approximately 200 m within riparian habitat on private land and secondly within Kooraban National Park at the furthest southern end of the proposal also within riparian forest. The hollow tree survey identified a higher density of hollow-trees on the western side of the highway than the eastern side and a higher density within Kooraban National Park than other parts of the study area. This included observation of a significant Yellow-bellied Glider sap feeding tree (refer to **Figure 6-5**) and a number of possible den trees in this location. Two yellow-bellied gliders were observed on the sap tree and this tree is expected to be an important feature in the home range of at least one family group of gliders. The habitat to the west of the highway in Kooraban NP is of better quality than on the ridge to the east of the highway in Gulaga NP which is considered marginal. . The location of the sap feeding tree was considered in the design of the upgrade such that it would be protected from direct impacts. There may be indirect impacts from traffic noise and lights. The location of actual den sites is not known, and a several habitat trees would be removed. The proposal is likely to impact on the extent of food and shelter resources available for the species in this location and movements across the highway. The Yellow-bellied Glider feeds primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein.	Known
White-footed Dunnart (*Sminthopsis leucopus*)		V	Of the habitat within the proposal study area, the dry sclerophyll forest along the upper slopes and ridges of Gulaga and Kooraban National Park (Map Unit 1 Silvertop Ash open forest) would be considered suitable although marginal. The proposal would directly impact on around 4.6 hectares of this habitat type mainly in edge affected habitats along the existing highway. The remaining wet sclerophyll vegetation types and particularly gullies and slower slopes with dense understorey are not optimum habitat and their dominance in the study area may suggest that there are minimal opportunities for populations of the dunnart. There are very few records in the locality, with the majority occurring in more coastal areas dominated by dry forests and heath.	Moderate

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Giant burrowing Frog (*Heleioporus australicus*)		V	The Giant Burrowing Frog was not recorded during the field surveys. Potential habitat was noted along Blinds Creek which is a tributary of Dignams Creek and also the upper reaches of Dignams Creek outside of the study area are also suitable. The lower portions of Dignams Creek impacted by the proposal appear to be too deep and rapid flowing to be suited as breeding sites for this species and are considered only very marginal. Breeding habitat of this species is generally soaks or pools within first or second order streams. They are also commonly recorded from 'hanging swamp' seepage lines and where small pools form from the collected water. As such the areas of potential breeding habitat noted are outside of the proposal construction footprint and upstream of the activity outside of the zone of influence. Some areas of non-breeding habitat near Blinds Creek may be impacted particularly on the south-side of Dignams Creek Road in loamy and sandy soils. The impact area would equate to less than 2-3 hectares.	Moderate
Stuttering Frog (*Mixophyes balbus*)	E	E	The species is found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Suitable habitat is widespread in the region particularly to the west of the study area in the more contiguous wet forests along the range and only considered marginal in the study area. If present in the locality the preferred areas of habitat would occur in the upper reaches of Dignams Creek and Blind Creek upstream of the proposal corridor and outside of the zone of influence. The proposal is unlikely to impact on the habitat or life-cycle of the species. The clearing for the proposal would not isolate areas of breeding or non-breeding habitat which would be retained outside of the construction zone. Important breeding areas of habitat may occur within the region in the upper reaches of the Dignams and Blind Creek ecosystems, however not within the study area.	Moderate
Cave-roosting Microbats				

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	-	V	These bats inhabit a range of habitats from tropical mixed woodland and wet sclerophyll forest, and Melaleuca swamps to drier forests, and woodlands. All roost in domes in the roofs of caves as well as in rock cracks and crevices, and in mines. Some also roost in culverts and under bridges and occasionally tree hollows. Clearing of foraging habitats and loss of roosting areas is a threat. The likely impact of the proposal would include disturbance to foraging habitat only as there are no caves or potential roosting locations within the actual proposal footprint. The disturbance would be temporary only, and long-term impacts on prey availability of movements are not expected. An inspection of the Dignams Creek bridge did not detect any roosting bats or potential bat roosting habitats.	Moderate
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V		Moderate
Southern Myotis (*Myotis macropus*)	-	V		Moderate
Tree-roosting Microbats				
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	-	V	These bats occupy a wide range of habitats from rainforest, floodplains, tall open forest, savannah woodlands and grasslands. Some exhibit preferences for riparian zones, others are known to frequent coastal scrub and sand dunes. However, all rely on the presence of mature trees with hollows, or other fissures, cracks and crevices in living or dead vegetation for roosting. Clearing of roosting and foraging habitats is a threat. Likely impacts from the proposal include permanent loss of a small area of habitat containing potential roost trees and temporary disturbance to foraging habitat and habitat for insect prey species in the study area, potentially leading to a short- term reduction in habitat and feeding resources across the study area for these species.	Recorded
Eastern Freetail-bat (*Mormopterus norfolkensis*)	-	V		Recorded
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	-	V		High
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V		Recorded

Threatened Species / community	Status		Potential Impacts	Potential to occur in the study area
	EPBC Act	TSC Act		
Birds				
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	-	V	While this widespread species could potentially utilise much of the forest habitat in the study area for roosting, the distribution and extent of food resources (Allocasuarina spp) is restricted and no evidence of foraging, as shown by chewed cones, was noted. Tree hollows potentially suitable as nesting habitat are present as identified in the habitat tree survey and there is potential for the feeding and nesting life-cycle activities of the species to be impacted.	Recorded
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	-	V	A wide-ranging and locally nomadic species. All forested areas in the corridor could contain food resources for this species which favours a variety of seeds and fruits and apparently favours old growth forests for roosting and nesting. This would include Map units 1, 2, 3 and 5. The proposal would remove potential foraging habitat including trees with hollows potentially suitable as nesting habitat. Tree hollows potentially suitable as nesting habitat are present as identified in the habitat tree survey and there is potential for the feeding and nesting life-cycle activities of the species to be impacted.	Recorded
Square-tailed Kite (*Lophoictinia isura*)	-	V	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses and appears to occupy large hunting ranges of more than 100 km2. No nest site for the species was located in the proposal area at the time of the survey. This was determined from a traverse of the entire proposal footprint for the habitat resource survey. If present, the proposal would involve the removal of potential prey habitat as the species is a specialist hunter of birds, especially honeyeaters and insects in the tree canopy. Potential habitat is common and widespread.	Moderate
Pink Robin (*Petroica rodingaster*)		V	The Pink Robin inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies. Suitable habitat is marginal is some of the wetter gullies, particularly to the north of Dignams Creek on the western side of the highway and at the far southern end of the proposal on the eastern side of the highway there is a small area of potential habitat just outside the proposal footprint. The impacts to potential habitat would equate to less than 4 hectares of habitat for prey	Moderate

Threatened Species / community	Status EPBC Act	Status TSC Act	Potential Impacts	Potential to occur in the study area
			species and would contribute to fragmentation of habitat in the study area for very small bird species. However the longer distance migratory behaviour of this species suggests that it is adapted to moving across fragmented landscapes. There would be no impact on breeding habitat and the study area would not be considered important for the species.	
Large Forest Owls				
Powerful Owl (*Ninox strenua*)	-	V	Habitat for Powerful Owl occurs across the entire proposal corridor, and is particularly associated with the moist gullies and adjacent slopes (MU 1-3) rather than the open and cleared modified lands around Dignams Creek. This is similar for the Sooty Owl which prefers moist gullies and tall mature forest, while the Masked Owl would favour open forest on the ridge tops and adjoining edges of cleared farmland. The proposal would remove potential hunting habitat and may remove potential roost and or nesting habitat associated with map units 1-3. These species require very large tree hollows for nesting and these feature were found to be very scarce given the previous logging history of the study area.	High
Masked Owl (*Tyto novaehollandiae*)	-	V		Moderate
Sooty Owl (*Tyto tenebricosa*)	-	V		Moderate
Barking Owl (*Ninox connivens*)		V		Moderate

Wildlife connectivity and habitat fragmentation

The proposal would potentially impact on wildlife connectivity through the loss of vegetation along the edges of the existing highway, which increases the exposed travel distance for any wildlife crossing the road. There would also be several large cuttings and retaining walls which would create a barrier to movement by terrestrial and arboreal fauna. The main fauna species potentially impacted from the increased width of the road and the retaining walls/cuttings would be terrestrial species such as Spotted-tailed Quoll and Long-nosed Potoroo, reptiles and macropods, as well as arboreal species such as Koala and the Yellow-bellied Glider.

The study area lies between the Kooraban and Gulaga National Parks, which combine with other regional reserves to form an important east-west link of conserved lands connecting the coast to the tablelands, as well as a north-south link along the escarpments forests from the Illawarra to East Gippsland in Victoria (NPWS 2006). Although the proposal would result in impacts to connectivity, impacts would not be associated with extensive fragmentation of habitat as the proposal lies adjacent to the existing road corridor. The existing habitat fragmentation in this area has been created through clearing of the creek flats and adjacent slopes surrounding Dignams Creek for grazing land.

There is an existing edge effect evident along both sides of the existing highway associated with increased weed abundance, rubbish disposal and areas of soil disturbance and erosion. The proposal would involve widening the road in some parts and creating a new corridor in others thereby increasing the extent of the edge effect within the national park areas and particularly in map units 1-3 refer to **Figure 6-1** and **Table 6-2**. Edge effects are expected to be less pronounced in the already cleared and modified habitats between Dignams Creek Road and the northern end of the proposal.

Injury and mortality

There is potential for injury or mortality to fauna species during construction, particularly during vegetation clearing activities. Moreover, construction activities may intersect existing movement corridor. Some diurnal and mobile species, such as birds and large reptiles, may be able to move away from the path of clearing. However, other species that are less mobile or those that are nocturnal, or have smaller home ranges and/or strong site fidelity, may be less inclined to move rapidly or disperse large distances away from the activity. This includes species such roosting microchiropteran bats, arboreal mammals, small reptiles and frogs. RMS has developed policies and guidelines for procedures to avoid and minimise mortality of these species and other threatened and common fauna during construction. These are outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). Further details on the procedures to be adopted to minimise the potential impacts of the proposal on fauna species are outlined in **Section 6.1.4.**

Introduction of weeds, pests and pathogens

During construction, there is potential to disperse weed seeds and plant material into areas of remnant vegetation, including the national parks, where weeds do not currently occur. Activities that can disperse weeds include:

- Clearing vegetation.
- Stockpiling contaminated mulch and topsoil during earthworks.

- Movement of soil, seeds and propagules attached to construction vehicles and machinery.

Impacts related to the invasion and establishment of pests may also be exacerbated during construction of the proposal. The proposal may contribute to increased levels of predation on native fauna from foxes and cats. This could occur, through the habitat fragmentation, which can lead to displacement of resident fauna. Fragmentation can also result in juveniles being more susceptible to predation during dispersal. Vegetation clearing and habitat fragmentation may increase the value of habitat for rabbits (*Oryctolagus cuniculus)* in the study area over the long term, as rabbits tend to colonise more disturbed and modified habitats.

The removal of hollow-bearing trees may increase competition for tree hollows since the occupation of these trees by feral honeybees reduces the number of hollows available for native animals to breed and shelter. This is of particular concern for species which are threatened and include tree-roosting microbats, and several bird species (refer to **Table 6-10**).

No pests and diseases are known from the proposal footprint, but could potentially be present. No pathogens were identified during the field investigations, although there have been reports of Myrtle Rust spreading from the coast to more western districts. The potential for pathogens to infect the area during construction should, therefore be treated as a risk. The risk is especially high in construction areas affecting waterways (refer to **Table 6-11**). There is also some potential for the proposal to exacerbate tree dieback associated with over-abundant psyllids and Bell Minor (*Manorina melanophrys*) birds along gullies and creek lines as a result of indirect impacts to these areas.

Table 6-11 Pathogens that may affect flora and fauna during construction

Pathogen	Description	Potential disease transmission
Phytophthora (*Phytophthora cinnamomi*).	A soil-borne fungus that causes tree death (dieback). Attacks the roots of a wide range of native plant species.	Spores can be dispersed over relatively large distances by surface and sub-surface water flows. Infected soil/root material may be dispersed by vehicles (eg earth moving equipment)
Myrtle rust (*Uredo rangelli*).	An introduced fungus that attacks the young leaves, short tips and stems of Myrtaceous plants eventually killing the plant.	Myrtle rust is an air-borne fungus that may be spread by moving infected plant material, contaminated clothing, equipment and vehicles.
Chytrid fungus (*Batrachocytrium dendrobatidis*).	A soil and water-borne fungus which attacks keratin in frog skin and organs, causing death.	Chytrid is a water-borne fungus that may be spread as a result of handling frogs or through cross contamination of water bodies by vehicles and workers.

Mitigation measures to limit vegetation clearance and the management of weed, pest and pathogen occurrence are listed in **Section 6.1.4**.

Groundwater dependent ecosystems

The vegetation communities in the study area are considered to have a low-level of groundwater dependence considering the dry nature of these communities, their occurrence on steep undulating terrain and slopes, and the lack of any evidence of

groundwater expression at the base of slopes and/or in drainage lines. The creek flats around Dignams Creek support some remnant eucalypt species and riparian vegetation with only low-level groundwater dependence. These species are adapted to localised flooding and soil water logging which would occur during heavy rain periods, a process which would not be impacted by the proposal.

Hydrological regimes including groundwater levels and flooding regimes are unlikely to be substantially altered from the proposal. Intersection of the water table in cut areas on elevated lands is considered unlikely and potential groundwater dependence of vegetation communities surrounding cut areas is considered low. Construction works in floodplain areas will be largely limited to fill batters with minor excavations required for the bridge piers. It is considered unlikely that there will be any groundwater drawdown as a result of the proposal. Considering groundwater levels are unlikely to be altered as a result of the proposal, potential groundwater-dependant ecosystems on floodplains and riparian areas are considered unlikely to be impacted.

Aquatic impacts

Construction within and adjacent to Dignams Creek, and other aquatic habitats within the study area, has the potential to cause impacts on aquatic ecosystems due to habitat loss, instream barriers and changes in water quality. Woody debris is an important component of aquatic habitat throughout Dignams Creek. Construction of the proposal may reduce the presence and availability of woody debris and snags if not managed appropriately. The removal of large woody debris or snags is listed under Schedule 6 of the FM Act as a key threatening process. Woody debris plays an important role in freshwater and marine ecosystems by providing essential habitat for aquatic organisms, providing a refuge from predation and a resting place away from the main flow of the waterway and providing important refuge and breeding habitat for fish including threatened species. Woody debris also provides habitat for a number of fauna such as frogs and turtles, plants, algae, microorganisms and invertebrates. Tree trunks and fallen branches are also structurally important for stabilising stream beds and banks.

Although bridge works would be undertaken from the banks where feasible, a temporary bridge crossing possibly comprised of a suitably sized pipe culvert with geotextile encased clean rock fill may also be required. Construction of this temporary crossing would be undertaken in accordance with the requirements of NSW DPI (Fisheries) and a permit to block fish passage would be required (refer to **Section 4.3.4**). Any temporary bridge crossing, if required, would be designed as a fish friendly passage. It is unlikely the proposal would result in extensive changes to the hydrology of the Dignams Creek that would alter flow velocities, water way depth or the natural flow regimes of the waterway. The new bridge would span the creek channel and avoid the placement of piles within the waterways and as such would avoid interruption to fish passage.

Construction of the new bridge over Dignams Creek and excavation works associated with piling of the bridge piers is considered to be reclamation/dredging works under the FM Act. As such formal notification with the Minister of the Department of Primary Industries is required under section 199 of the FM Act.

There is the potential for increased sedimentation and erosion during construction of the new bridge. Potentially polluting activities associated with construction of the proposal include earthworks, placement of road surface, disposal of wastewater, equipment and chemical storage areas and erosion from exposed ground and

stockpiles. Increased suspended solids can impact fish and macroinvertebrate abundance through clogging gill structures and benthic smothering. Increased particulates in the water column can also reduce water infiltration which may limit plant growth and influence predator foraging behaviour. Increased turbidity can result in a reduction of light penetration and in turn reduce the number of aquatic macrophytes or algae, altering the existing aquatic habitat.

There is also potential for indirect impacts to SEPP 14 coastal wetlands and the Dignams Creek Sanctuary Zone (Batemans Marine Park) present downstream of the proposal. These impacts would largely be associated with polluted construction water entering Dignams Creek, Blind Creek and Narira Creek. These creeks flow downstream to SEPP 14 wetlands, and pollution of these systems could reduce the extent and quality of the wetlands. Dignams Creek and Blind Creek also flow downstream into the Dignams Creek Sanctuary Zone (Batemans Marine Park), potentially reducing the water quality of this marine park with associated impacts on the aquatic ecology. Implementation of the safeguards outlined in **Section 6.3.4**, such as the construction of temporary sedimentation basins would reduce the likelihood and limit the severity and duration of these impacts. Further assessment of potential impacts on water quality is provided in **Section 6.6.**

Noise, vibration and light

There is potential for impacts to local fauna from noise and vibration during construction, which may result in fauna temporarily avoiding habitats adjacent to the proposal. Measures to manage potential noise and vibration impacts are discussed in **Section 6.2**. Measures to manage potential light impacts are discussed in **Section 6.3.4**.

Operation

Wildlife connectivity and habitat fragmentation

The wider corridor and several large cuttings and retaining walls would create a barrier to terrestrial fauna movements and gliders. As there is currently no fauna underpasses along the Dignams Creek section of the Princes Highway, the proposal would improve this situation by placing targeted wildlife crossing structures that would maintain and improve connectivity, refer further to **Table 3-6** in **Section 3.2.3**. In stage 1 of the proposal this includes provision of one dedicated fauna underpass that includes fauna furniture and one combined drainage culvert/fauna underpass. In stage 2 of the proposal this includes provision of one dedicated fauna underpass with fauna furniture, one combined drainage culvert/fauna underpass and one rope canopy bridge. Fauna fencing is also proposed in all areas of bushland in the southern part of the proposal along the alignments for stage 1 and stage 2 and would funnel fauna towards wildlife crossing structures and stop fauna accessing the highway. Fauna fencing is not required at the tops of cut batters. As such the proposal would provide connectivity strategies for fauna species including the threatened species that are aimed at facilitating the natural movements of fauna across the proposal corridor.

Injury or mortality

Fauna injury or death can also occur during operation of the proposal, as a result of collision with vehicles and habitat fragmentation, degradation and loss. Threatened fauna that could potentially be affected by vehicle strike in this location are species

that are regularly reported as road kill and include Koala (Canfield 1991) and Spotted-tailed Quoll (Beckers 2008).

It is anticipated that the risk of collisions with vehicles would not increase as a result of the proposal. However, consideration has been given to opportunities to address fauna movement, and hence the risk of injury/mortality, by maintaining or enhancing connectivity between habitat fragments in the concept design. This has included provision for two dedicated fauna underpasses, one rope canopy bridge and two combined fauna underpasses/drainage culverts in the design.

Water Quality

The main operational activity that would potentially impact on the aquatic environment adjacent to the proposal is traffic use, which may lead to increased pollutant load in the road run-off. Road run-off can contain a variety of pollutants, which may impact negatively on the aquatic environment. Pollutants can include cigarette butts, nutrients, heavy metals, pesticides, herbicides and petroleum hydrocarbons. The volume of traffic is not expected to increase from the current situation following the proposal. The following water quality controls would be constructed for use during operation of the proposal:

- Five biofiltration basins.
- A water quality basin.
- Two constructed wetlands.
- Biofiltration/vegetated swales.

For further details of these impacts to water quality refer to **Section 6.6**.

Noise, vibration and light

It is unlikely that there would be a substantial increase to existing levels of operational noise, vibration and light from the proposal, which would result in any significant impacts to native fauna species.

The light levels beneath the proposed bridge structure would be relatively low and may limit the growth of any plantings associated with landscaping activities. The low light levels from the Princes Highway are not envisaged to significantly deter fauna movements or foraging activities in this area. Low speed vehicle movements along the private access road underneath Dignams Creek Bridge are expected to occur infrequently and as such there is low potential for vehicle strike to fauna. Noise and light associated with these movements are anticipated to be minor. Refuge for native animals would be available in the vegetated riparian zone located along the banks of Dignams Creek and any clearing for the proposal would be revegetated.

Groundwater dependant ecosystems

No impacts to groundwater-dependant ecosystems on floodplains and riparian areas are considered to be impacted by operation of the proposal.

Biodiversity Offset

Although the various management and mitigation measures would be incorporated in the proposal, there are some residual impacts that cannot be adequately mitigated such as:

- A loss of native vegetation (20.6 hectares).
- A loss of habitat for native flora and fauna including threatened species and habitat.
- Direct loss of about 50 Square Raspwort individuals.

The residual impacts on biodiversity would be improved through the development of a biodiversity offset strategy that aims to maintain or improve biodiversity values in the proposal area in the long-term. The offset package is in response to these residual impacts, including the 18.28 hectares of land previously identified as Kooraban National Park which has undergone revocation by the *National Parks and Wildlife Amendment (Adjustment of Areas) Bill 2012* (refer to **Section 4.3.1**). The proposal would include a land and biodiversity offset package negotiated between RMS and OEH.

Based on an analysis of the proposal utilising the Biobanking assessment (OEH, 2009) methodology (refer to **Appendix K**), it is expected that RMS would need to secure improved biodiversity outcomes in the order of 125 hectares of intact (good to moderate condition) vegetation comprised of similar vegetation communities to those that are being impacted (refer to **Table 6-2**). Alternatively a mix of intact forest and cleared land that would be rehabilitated would provide an improved biodiversity outcome, for example approximately 100 hectares of good to moderate vegetation and rehabilitation of around 25 hectares of cleared land back to forest. Management measures on land would also improve biodiversity (e.g. fencing and vermin control). RMS currently own a property adjacent to the proposal that can satisfy the requirements of the two possible offset strategies proposed above. RMS and OEH are currently finalising an agreement for an appropriate offset package.

6.1.4 Safeguards and management measures

Safeguards and mitigation measures to manage potential impacts to biodiversity have been outlined in **Table 6-12.**

Table 6-12 Summary of mitigation measures for biodiversity

Impact	Environmental safeguards	Responsibility	Timing
Design updates	Any updates to the design of the proposal should include the following: • Four fauna underpasses, with at least two including fauna furniture. • A vegetated fauna crossing underneath the new bridge to encourage fauna passage • One canopy rope bridge at the southern end of the proposal.	RMS project manager	Detailed design
Impact on flora and fauna	Measures involving minimising the construction footprint in areas of important habitat and subsequent removal of vegetation would be considered in the detailed design. Specific measures include: • Avoiding habitat currently occupied by the Yellow-Bellied Glider,	RMS project manager	Detailed design

Impact	Environmental safeguards	Responsibility	Timing
	including a significant sap feeding tree and several hollow–bearing habitat trees located in the southern part of the proposal adjacent to stage 2 works. This may include reducing the size of the proposed batter during detailed design. • Where possible, minimise impacts to areas of high quality habitat for the Koala and other threatened fauna. This includes vegetation associated with vegetation map units 1, 2 and 3 and areas of the TEC recognised as River-flat Eucalypt Forest on Coastal Floodplains (map unit 5). • Minimise the removal of vegetation/ habitat to minimise impacts to threatened fauna species would be considered in the detailed design • Minimise impacts to the TEC (River-flat Eucalypt Forest on Coastal Floodplains) that is located along the banks of Dignams Creek and Blind Creek during construction of the new bridge and any temporary bridge crossing.		
Impact on flora and fauna -	A flora and fauna management plan would be prepared as part of the construction environmental management plan (CEMP). It would be prepared in accordance with the RMS *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) (Biodiversity Guidelines). The plan would include a clearing procedure, which in turn would specify the requirements for: • Undertaking pre-clearing surveys in accordance with Guide 1 of the Biodiversity Guidelines. This includes provision for a suitably qualified and licensed fauna ecologist to confirm the appropriate management. • Identifying the locations and extent of impacted habitats to be salvaged for reuse/relocation such	Construction contractor	Pre-construction and during construction

Impact	Environmental safeguards	Responsibility	Timing
	as bush rock, hollow trees and woody debris. • Identifying, defining and managing exclusion zones for construction sites, including temporary fencing requirements, to avoid damage to vegetation, fauna habitat (both potential Koala feed trees and Yellow-bellied Glider sap feed trees and hollow-bearing trees). Maps of exclusion zones would be provided and developed in accordance with Guide 2 of the Biodiversity Guidelines. • Identifying nearby habitats for suitable release of fauna that may be encountered during pre-clearing process of habitat removal • Checking for the presence of threaten flora and fauna species immediately before clearings begins. • Handling fauna in accordance with Guide 9 of the Biodiversity Guidelines, including the requirement to contact a local vet and wildlife handler prior to vegetation clearance, to ensure that any fauna injuries that may occur during clearing and other construction activities can be treated. • Undertaking staged habitat removal in accordance of Guide 4 of the Biodiversity Guidelines.		
Impacts to retained vegetation	Vehicles, equipment and stockpiles would not be located in the drip line of trees.	Construction Contractor	Construction
Controlling the spread of noxious weeds	A weed management plan would be developed as part of the CEMP in accordance with the *Biodiversity Guidelines(2011)* and *Introduction Weed Management Manual (Natural Heritage trust 2004*), and would include descriptions and mapping of major weed infestation during the pre-clearing survey and appropriate management actions to be undertaken.	Construction contractor	Construction
Controlling the spread of	Measures to confirm the presence of pathogens/disease causing agents	Construction	Construction

Impact	Environmental safeguards	Responsibility	Timing
pathogens/disease causing agents such as bacteria and fungi	such as bacteria and fungi would be undertaken prior to construction. This would include the following: • A background search of government-maintained websites for the most up-to-date hygiene protocols for each pathogen and for the most recent known locations of contamination. • If risks are identified in the vicinity of the proposal, testing from a National Association of Testing Authorities (NATA) approved laboratory may be required to confirm the presence of pathogens in the soil and/or water. If pathogens/disease causing agents are found to present, measures to prevent the introduction and/or spread of these pathogens/disease causing agents would be incorporated into the Pest and Disease Management Plan developed as part of the CEMP for the proposal. The pest and disease management plan would be developed in accordance Guide 7 of the *Biodiversity Guidelines* (RTA 2011). If pathogens are identified exclusion zones with fencing and signage to restrict access into contaminated areas would be required.	contractor	
Habitat re-establishment	The landscape plan would detail the re-establishment of native vegetation on batters, cut faces, areas surrounding sediment basins and other areas disturbed during construction. Re-establishment of habitat would take into account Guide 3 of the Biodiversity Guidelines (RTA 2011) and would include local species derived from vegetation communities identified within the proposal, refer to **Figure 6-1** and **Table 6-2**. A nest box management strategy would be developed as part of the CEMP in accordance with Guide 8 of the RMS Biodiversity Guidelines.	RMS project manager	Pre-construction and post-construction

Impact	Environmental safeguards	Responsibility	Timing
Maintaining wildlife connectivity	Incorporate design principles for the proposed wildlife crossing structures and fauna fencing as outlined in the Biodiversity Report (refer to **Appendix K**). If a temporary creek crossing is required and impacts to fish passage are unavoidable, a permit would be sought from DPI (Fisheries and aquaculture). In-stream structures would be designed and constructed to minimise potential impacts to fish passage according to Fairfull & Witheridge (2003).	RMS project manager	Pre-construction and during construction
Impacts to riparian and aquatic habitat	Prior to any disturbance on the banks a thorough inspection for aquatic fauna would be conducted. Instream and riparian disturbance, and the removal of sediment, woody snags or debris from streams or stream channels would be minimised. Trimming or 'lopping' of branches and logs would be considered as a first option before moving. The risk of instream and riparian weeds would be minimised through the implementation of a vegetation clearing and revegetation management strategy that would form part of the Flora and Fauna Management Plan. Working platform sites would avoid direct impacts to Dignams Creek and would avoid clearing of riparian vegetation located adjacent to the creek where possible. If a temporary creek crossing over Dignams Creek is required, vegetation clearance of riparian vegetation would be minimised where possible. Exclusion zone fencing would be erected around any surrounding vegetation to avoid indirect impacts.	Construction contractor	Pre-construction and during construction

Impact	Environmental safeguards	Responsibility	Timing
Instream woody debris management	Any large woody debris (ie logs and branches) located instream would be retained to the greatest extent possible. If any instream woody debris is removed during construction for the proposal, it would be stockpiled and replaced at the completion of the works within the same waterways from which it was removed.	Construction contractor	Pre-construction and during construction
Biodiversity offset	An offset plan would be developed for the loss of native vegetation (20.6 hectares), threatened species and habitat for native flora and fauna. This plan would be developed in consultation with OEH. This strategy would be developed in accordance with the *RMS Guideline for Biodiversity Offsets*, November 2011 and would also identify when offsets would be implemented.	RMS project manager	Pre-construction
Impact to Yellow-Bellied Glider sap feeder tree	The design would avoid direct impacts to the identified Yellow-Bellied Glider sap feeder tree identified at Easting 766245 Northing 5971353.	RMS project manager	Detailed design
Impacts to Square Raspwort	Prior to clearing, clumps of Square Raspwort within the construction footprint surrounding Dignams Creek would be protected (ie flagged and identified to construction staff) where possible.	Construction contractor	Pre-construction and during construction
Impacts to TECs	The location of TECs would be mapped and identified in the CEMP. Exclusion zones would be erected to identify TECs.	Construction contractor	Construction
Clearance of existing vegetation	• A landscape management plan would be developed as part of the (CEMP) which provides specific details for the re-establishment of native vegetation areas disturbed during construction. This would include revegetation and habitat restoration activities. Landscaping for the proposed action would follow the RTA (2011) Biodiversity Guidelines document and would include the following: • Landscaping of areas impacted by	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	the proposed action including batter slopes, any ancillary sites, sediment basins and other areas disturbed/cleared during construction. • Removal of existing road followed by revegetation with local flora species and habitat re-establishment. • Habitat re-establishment including provision of bushrock and woody debris (Guide 5 of the Biodiversity Guidelines). • Revegetation activities along Dignams Creek and habitat re-establishment to improve wildlife connectivity and provide safe fauna passage across the proposed action beneath the proposed bridge structure (Guide 3 of the Biodiversity Guidelines).		

6.2 Noise and vibration

A *Noise and Vibration Assessment* was prepared by SKM. A summary of the assessment is provided below and the full report is included in **Appendix G**.

The noise and vibration assessment considered impacts from both the construction and operational aspects of the proposal. The study area for the noise assessment includes a corridor extending 600 metres either side from the proposal road centreline.

6.2.1 Existing environment

The study area is characterised by rural residential land uses to the north of the proposal and national park lands to the south and the existing Princes Highway. The small local community of farms and rural residences is primarily located along the cleared Dignams Creek Valley along Dignams Creek Road west of the Princes Highway.

The location of receivers was determined from recent aerial photography and confirmed during site inspections. Ten residences (dwellings) were identified within the study area and their locations are show in **Figure 6-7**. No commercial or industrial noise sensitive receivers were identified for the proposal.

Five representative locations were selected from the identified receiver locations for the noise monitoring survey (refer to **Figure 6-7**). The monitoring locations were used for calibration of the noise model (locations L4 and L5) and establishing the background noise level for construction noise management (locations L1-L4). **Table 6-13** lists the receiver locations used for the noise monitoring survey.

Upgrade of the Princes Highway, Dignams Creek

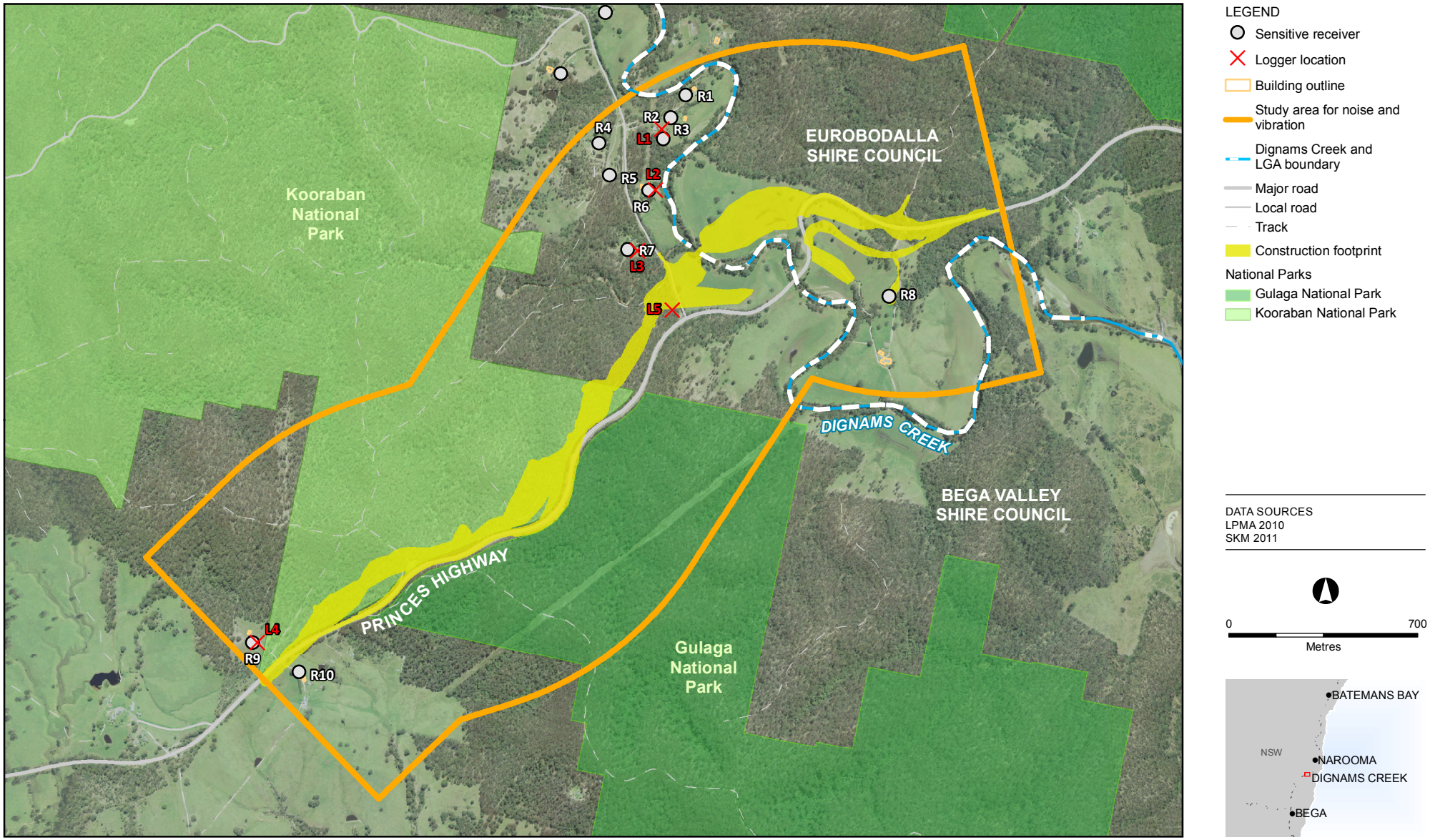

Figure 6-7 | Noise sensitive receivers

18/06/2013 | I:\ENVR\Projects\EN02937\Technical\GIS\Spatial_Directory\ArcGIS\REF_Ver3\EN02937_GIS_REF2_F016_r2v1_NoiseReceivers.mxd
Newcastle Spatial Team - Prepared by : AL
Checked by : JC

Table 6-13 Monitoring locations – unattended noise survey

Description	ID	Monitoring location	Distance from existing road centreline
Location 1	L1	66 Dignams Creek Road, Dignams Creek	560 metres
Location 2	L2	42 Dignams Creek Road, Dignams Creek	480 metres
Location 3	L3	21 Dignams Creek Road, Dignams Creek	320 metres
Location 4	L4	9860 Princes Highway, Cobargo	120 metres
Location 5	L5	Corner of Dignams Creek Road and Princes Highway	25 metres

To characterise the existing noise environment, unattended noise monitoring was undertaken between the 15 and 25 October 2012, for L1 – L4 and between 1 and 14 April 2011 for L5 using automatic (type 1) noise monitoring equipment. Monitoring locations were selected to be representative of locations most likely to be affected by the proposal, as well as at locations where noise levels would primarily relate to road traffic noise, rather than unrelated sources (refer to **Figure 6-7**). Measurements from noise monitoring were then used to derive construction noise goals and to provide a validation of the traffic data used in the noise modelling scenario for the proposal.

Descriptors used in the assessment of noise impacts are generally defined as follows:

- LA10: the noise level exceeded for 10 per cent of the measurement interval, commonly referred to as the average-maximum level.
- LA90: the noise level exceeded for 90 per cent of the measurement interval, commonly referred to as the background noise level.
- LAeq: the noise level having the same energy as the time varying noise level over the 15 minute interval. For traffic noise this descriptor is classified as LAeq 15 hr and LAeq 9 hr for the day and night time noise levels respectively. This is commonly referred to as the ambient noise level.
- LAmax: the maximum noise level measured at a given location over the measurement interval.
- RBL: the Rating Background Level (RBL) is the overall single figure background level, which is the 10th percentile of the LA90 values for each of the day, evening and night time periods over the whole monitoring period.

The daily noise measurement profile of environmental statistics for the five monitoring locations identified in **Figure 6-7** are summarised in **Table 6-14** below.

Table 6-14 Summary of monitoring results - environmental noise descriptors

Location ID	Day			Evening			Night		
	L_{Amax}	L_{Aeq}	RBL	L_{Amax}	L_{Aeq}	RBL	L_{Amax}	L_{Aeq}	RBL
L1	76.7	50.3	29.7	71.3	43.3	28.5	64.4	41.2	28.5
L2	74.6	52.1	35.1	64.8	50.8	32.9	64.6	48.3	28.3
L3	76.2	54.3	37.5	71.0	49.0	33.7	62.3	43.6	26.0
L4	79.8	54.6	32.3	75.0	50.1	27.2	68.9	47.2	22.8
L5	86.7	59.5	28.3	86.9	56.6	30.3	83.6	52.2	23.0

At monitoring locations L1, L2 and L3, daytime noise levels are influenced by the natural environment, which includes bird song, crickets and wind in trees with infrequent passby vehicle noise. These monitoring locations are between 300 to 600 metres from the road, with traffic noise being experienced infrequently and then only marginally audible above background levels. On occasion a noisy vehicle passby was observed. During the night, traffic noise at these locations is very infrequent with frogs and insects dominating the noise environment.

At monitoring location L4, the noise environment is largely influenced by vehicle movements on the Princes Highway. Bird calls and other insect noise are audible during the intervals between vehicles, and truck noise at this location is prominent. Location L5, within 25 metres of the highway, was mostly influenced by traffic noise from vehicle passbys.

The LAeq 15 hour and LAeq 9 hour data were used to correlate traffic noise levels against the initial noise modelling predictions. The results of the traffic noise monitoring at these locations are provided in **Table 6-15**.

Table 6-15 Summary of monitoring results -traffic noise descriptors

Location ID	L_{A10} 18 hour	$L_{Aeq\ 15\ hour}$ Day	L_{Aeq} 9 hour Night	$L_{Amax\ 15\ hour}$ Day	L_{Amax} 9 hour Night
L1	41.9	50.5	41.2	76.3	67.0
L2	51.2	52.1	48.3	75.7	70.0
L3	52.5	53.7	43.6	76.2	71.9
L4	51.7	53.8	47.2	82.8	72.8
L5	55.7	59.1	52.2	83.8	82.2

In general, the measure noise levels are very low for both the daytime and night time periods. At monitoring locations L1 to L3, the measured noise levels reflect the natural environment and do not represent traffic noise influences in the area. Location L4 is around 120 metres from the existing road and the measured noise levels correspond well with traffic movements. Location L5 is about 25 metres from the highway at the intersection of Dignams Creek Road. This location is therefore representative of traffic noise in the northern section of the proposal.

6.2.2 Criteria

Construction noise criteria

Construction noise is assessed during the early stages of the proposal to provide an indication of the type of impacts to be expected during construction and to plan for preliminary mitigation measures where these impacts may exceed recommended levels. The *Interim Construction Noise Guideline* (ICNG) (DECC 2009) is developed to assist with the management of noise impacts and provides recommendations for proposal noise goals for construction activities.

The rating background level (RBL) is used when determining the noise management level and is assessed for the main locations during the noise measurement survey. **Table 6-16** outlines the method for deriving management levels for construction noise at sensitive receivers and how they would be applied according to the ICNG.

Table 6-16 also presents the ICNG standard construction hours. For the purpose of this assessment, it is assumed that with a few exceptions, the majority of the works would be undertaken within these standard hours. An extension outside of standard hours may be required from time to time to accommodate possession of the road or other facilities during non-peak traffic times. Works conducted outside of the standard construction hours, a strong justification is typically required and additional noise mitigation and management obligations would be applied.

Table 6-16 General construction noise management levels (NMLs)

Hours	NML	Description
Recommended standard hours Monday to Friday 7:00am to 6:00pm Saturday 8:00am to 1:00pm No work on Sundays or public holidays	Noise affected RBL + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to meet the noise affected level. The proponent would also inform all potentially impacted residents of the nature of works to be carried out, expected noise levels and the duration of activities. Contact details for a construction representative would also be provided.
	Highly noise affected above 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near

Hours	NML	Description
		residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent would apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent would then undertake negotiations with the community. For guidance on negotiating agreements refer to Section 7.2.2 of the guideline*.

Source: Table 2 Interim Construction Noise Guideline, DECC, 2009

Table 6-17 outlines the construction noise management levels (CNMLs) for noise at sensitive receivers and how they would be applied. The noise management levels apply at any property boundary that is exposed to construction noise at a height of 1.5 metres above ground level. In cases where the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence.

Table 6-17 Calculated noise management levels for construction work

Distance from works	Day		Evening		Night	
	RBL	NML	RBL	NML	RBL	NML
Within 200 metres	32	42	27	35[1]	23	35[1]
Over 200 metres	38	48	34	39	26	35[1]

Note: [1] Based on the minimum RBL of 30 dB(A)

The proposal specific noise management levels (NML) were based on LA90 statistics for the day, evening and night time periods derived from the monitoring data in **Table 6-14** and presented in **Table 6-17**. The monitoring locations are representative of receivers close to the highway (L4 and L5) and those further back (L1-L3). Receivers within 200 metres of the proposed alignment have been assessed against noise level values as recorded at L4 while receivers located greater than 200 metres from the alignment have been assessed against L3.

Vibration assessment (human comfort) criteria

Assessing Vibration - a technical guideline (DECC 2006) provides guidance on disturbance to human occupants of buildings as a result of vibration. This document

provides criteria which are based on the British Standard BS 6472-1992, *Evaluation of human exposure to vibration in buildings (1-80Hz)*. For the purpose of this assessment, vibration can be defined as follows:

- Continuous – where vibration occurs uninterrupted for a defined period. This can include sources such as machinery and steady road traffic.
- Impulsive – where vibration occurs as a rapid build-up of the vibration energy to a peak followed by a decay. It can also consist of a sudden application of several cycles at about the same amplitude, provided that the duration is short, typically less than two seconds. This may include activities such as occasional dropping of heavy equipment or loading/unloading activities.
- Intermitted – where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and passing heavy vehicles or trains.

Preferred and maximum values for continuous and impulsive vibration are defined in **Table 6-18.**

Table 6-18 Preferred and maximum weighted root mean square values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz

Location	Assessment period	Preferred values		Maximum values	
		z axis	x and y axis	z axis	x and y axis
Continuous vibration					
Critical areas[2]	[1]Day or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92

Location	Assessment period	Preferred values		Maximum values	
		z axis	x and y axis	z axis	x and y axis
Workshops	Day or night-time	0.64	0.46	1.28	0.92
Note: [1] Daytime is 7.00am to 10.00pm and night-time is 10.00pm to 7.00am [2] Such as hospital operating theatres or precision laboratories					

Intermittent vibration is assessed using vibration dose values (VDV). Preferred and maximum VDVs are defined in Table 2.4 of the DECC (2006) guideline and are reproduced in **Table 6-19.**

Table 6-19 Acceptable VDV for intermittent vibration (m/s$^{1.75}$)

Location	Daytime (7:00am 10:00pm)		Night time (10:00pm 7:00am)	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Vibration assessment (structural damage) criteria

The Australian Standard *AS2187.2-2006 Explosives – Storage, Transport and Use* provides guidance for the assessment of structural damage to buildings caused by vibration. This section of the standard is based on the British Standard *7385: Part 2 Evaluation and measurement of vibration in buildings* and is used as a guide to assess the likelihood of building damage from ground vibration inducing activities including piling, compaction, construction equipment or other construction equipment (refer to **Table 6-20**).

The levels set by this standard are considered ‘safe limits’ up to which no damage due to vibration effects are observed for particular types of buildings. These values relate to intermittent vibration. Continuous vibration can give rise to magnifications due to resonances and may need to be reduced by up to 50 per cent.

Table 6-20 Structural damage criteria

Group	Type of structure	Peak Component Particle Velocity1, mms 1		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures, industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures, residential or light commercial type buildings	15 to 20	20 to 50	50

The German DIN Standard identifies more stringent vibration levels for building damage and includes a category specifically for heritage buildings. *The Structural Vibration, Part 3: Effects of Vibration on Structures* (DIN 4150-3) recommends frequency dependent values for Peak Particle Velocity (PPV) for different building categories, which are reproduced in **Table 6-21.** DIN 4150-3 is to be used to assess potential vibration impacts at heritage buildings locations, or other sensitive heritage structures identified for the proposal.

Table 6-21 DIN 4150-3 Vibration guidelines for heritage buildings

Type of structure	Guideline values for velocity (mm/sec)			
	Vibration at the foundation at a frequency of			Vibration at the horizontal plane of the highest floor at all frequencies
	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	
Heritage buildings	3	3 - 8	8 - 10	8

Operational noise criteria

The criteria for the assessment of road traffic noise is guided by the OEH *New South Wales Road Noise Policy* (RNP) (DECCW 2011). The RMS provides additional information in the *Environmental Noise Management Manual* (ENMM) (RTA 2001) to assist in application of the criteria and development of the noise mitigation where required.

Under the RNP, road development is either classified as “new road” or “redevelopment of an existing road”. The criteria for each road classification for each assessment period are listed in **Table 6-22**. The appropriate noise goals for the daytime and night time would be applicable for the acoustic design year, which would typically be 10 years after proposal opening.

Table 6-22 Road traffic noise base criteria

Road category	Type of proposal/land use	Daytime noise criteria	Night time noise criteria
Freeway/arterial/sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	LAeq (15hour) 55 dB (A)	LAeq (9hour) 50 dB (A)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	LAeq (15hour) 60 dB (A)	LAeq (9hour) 55 dB (A)

The initial designation of development type (ie 'new or 'redevelopment') for the receivers identified in the study area are based on a visual assessment of existing traffic noise influence, the direction that new noise emissions would impact a receiver and the location of the proposal in relation to the identified receivers. Receivers L1 to L8 have been identified as 'new', while receivers L9 and L10 are considered to be redevelopment road receivers.

In areas of new or existing impact, the RNP recommends that a relative increase in total traffic noise levels of more than 12 dB(A) would warrant consideration of such areas for mitigation. This relative increase criterion does not apply for open spaces or where the main road to be assessed is a local road. **Table 6-23** presents a summary of the relative increase criterion to be adopted for the proposal.

Table 6-23 Relative increase criteria for residential land use

Road category	Type of proposal/land use	Total traffic noise level increase dB(A)	
		Daytime noise criteria	Night time noise criteria
Freeway/arterial/ sub-arterial roads	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic LAeq (15hour) + 12 dB (external)	Existing traffic LAeq (9hour) + 12 dB (external)

In addition to the base criteria and the relative increase criteria from the RNP, the ENMM identifies a category of highly affected noise sensitive receivers referred to as "acute". These receivers experience noise levels that would be greater than or equal to a daytime level of 65 dB(A) and/or a night time level of 60 dB(A). In these instances a detailed assessment of noise mitigation in accordance with the ENMM practice note (iv) would be necessary.

Where base criteria are exceeded a comparison of the 'build and 'no build' levels is undertaken to determine the change in the noise environment. Where the noise level exceeds 60 dB(A), mitigation is assessed in accordance with the ENMM Practice Note (iv).

An exceedance of the relative increase or acute level criteria would also trigger a review of mitigation options for affected receivers. While other criteria for non-residential sensitive receivers are provided in the RNP, only residential receivers were identified in this study.

6.2.3 Potential impacts

Construction

The majority of construction activities are expected to be undertaken during standard working hours (refer to **Table 6-16**). As the proposal would largely be constructed offline (outside the existing road corridor) much of the construction activity would occur without significant interruption of the existing road traffic, reducing the need for out of hours' activities. Accordingly, the assessment of impacts was principally based on work being conducted during standard construction hours, although an out of hours assessment was also undertaken and the results of these are contained.

For the assessment of construction noise impacts, the likely equipment to be used during each activity across the different stages of the proposal and the typical sound power levels associated with the equipment used, were considered (refer to **Table 6-24** and **Table 6-25**).

Table 6-24 Construction activities and timing

Construction phase	Typical activities	Typical plant and equipment
Early works and Service relocations Site preparation Finalising site works and site reinstatement	Establishment of site office and compounds Service relocations (electricity, Telstra) Clearing and grubbing of vegetation Mulching Fencing Stripping and stockpiling of topsoil Establishment of access tracks Establishment of temporary and permanent crossovers Traffic barrier erection Temporary pavement widening Dismantling site offices Removal of temporary barriers and fences	Graders, rollers and water carts Excavators and backhoes Generators Trucks and cranes Elevated platform vehicle Excavators and backhoes Trenchers Under boring machines Bulldozers hand tools hand compactors Mulching plant and chipper Chainsaw Crane + Hiab

Construction phase	Typical activities	Typical plant and equipment
	Site clearing and rubbish removal	
Earthworks	Excavation of cuttings Fill embankments Rock crushing (if required) Placement of select materials Batter treatments Retaining Walls	Rock breaker Rock crusher Excavators Bulldozers Trucks Scrapers Graders Water carts Compactors Vibratory rollers Cutting and drilling equipment for hard rock cuttings
Bridges and drainage	Bridges Culverts Catch drains Drainage blankets Permanent water quality control basins	Piling rigs (bored) Concrete pumps Cranes Overhead gantry crane Excavators Trucks
Pavement	Pavements Road base layers Asphalt paving	Trucks Concrete paver Profiler Concrete curing equipment Concrete saws Asphalt paver Concrete pumps Concrete trucks Stabiliser Water carts Vibratory rollers Rubber-tyred rollers

Table 6-25 Summary of construction equipment

Activity	Plant noise source	L_{Aeq} sound power level dB(A)
Formation, clearing and mulch	1 x Excavator – 30t 1 x Dozer – 20t	103 103

Activity	Plant noise source	L_{Aeq} sound power level dB(A)
	5 x Product Truck – 4 axle, 25t	108
	1 x Vibratory Compactor – 12t	112
	1 x Grader – 25t	114
	1 x Smooth Barrel Roller – 18t	107
Total sound power of all equipment		118
Earthworks	2 x Excavator – 30t	103
	1 x Dozer – 20t	103
	5 x Product Truck - 4 axle, 25t	108
	1 x Vibratory Compactor – 12t	112
	1 x Padfoot Compactor	107
	1 x Grader – 25t	114
	1 x Smooth Barrel Roller – 18t	107
	1 x Backhoe	110
	1 x Front End Loader	114
	1 x Scraper	108
Total sound power of all equipment		120
Paving and asphalting	2 x Generator	111
	2 x Backhoe	110
	1 x Asphalt Paver	111
	1 x Concrete Paver	111
	1 x Concrete Truck	111
	1 x Concrete Vibrator	110
	2 x Concrete Saw	105
	2 x Bob Cat	104
Total sound power of all equipment		119
Bridge works	1 x Bored Piling Rig	114
	1 x Pneumatic Hammer	113
	1 x Excavator	112
	3 x Haul Trucks	112
	2 x Generator	111
	2 x Mobile Crane (45T)	105
	1 x Concrete Truck	110
	1 x Concrete Pump	107
	2 x Air Compressor	105
	1 x Air Ratchet Gun	101
Total sound power of all equipment		121

*In the absence of site specific data, all ancillary sites were assumed to be batch plants.

Noise emissions from the activities outlined in **Table 6-25** were predicted for all receiver locations to determine the potential for exceedances of the noise goals at

these locations. During construction, the actual noise levels at receiver locations would vary throughout the day as the different construction plant and equipment moves through the proposal site. The assessment of construction noises impacts are therefore based on typical construction activities, plant noise and working methods.

The predicted levels in **Table 6-25** indicate the highest expected noise levels at each of the noise sensitive receivers in the study area, based on earth works during the initial clearing phase. At this stage the construction equipment would be at the existing ground level and receivers would not receive any benefit from shielding. This is potentially the worst case for construction, and has been used to determine the potential for noise impacts in accordance with the estimated NML. A summary of the noise levels predicted is shown in **Table 6-26**, along with the adopted day, evening and night time NML for each receiver location.

Table 6-26 Predicted noise level from construction activities

Receiver IDF	Distance from works (m)	Daytime NML dB(A)	Evening NML dB(A)	Night NML dB(A)	Predicted levels L_{Aeq*} dB(A)
1	560	48	39	35	50
2	520	48	39	35	53
3	460	48	39	35	56
4	540	48	39	35	50
5	420	48	39	35	56
6	480	48	39	35	60
7	320	48	39	35	64
8	240	48	39	35	57
9	120	42	35	35	68
10	90	42	35	35	73

The modelling predictions for construction noise indicate that NML are expected to be exceeded at all receiver locations. Under this worst case assessment it is predicted that the receiver at Location 10 may experience noise levels that are close to the highly affected noise level criteria outlined in **Table 6-16**. As construction progresses, the benefit of local shielding from cuttings would reduce the emissions and minimise impacts.

Where receivers were predicted to be exposed to levels exceeding the adopted NML, management of noise impacts would be required. Construction noise mitigation measures are provided in **Section 6.2.4**.

Out of hours construction work

As detailed in **Section 3.3.3**, work would be conducted during standard construction hours wherever possible (refer to **Table 6-16**). However, to minimise traffic impacts, some work would be required to be undertaken outside of the standard working hours, including:

- Bridge works, including deliveries of oversized components.
- Road tie-in works of the new alignment with existing road network.
- Delivery of oversized elements of plant and construction equipment.
- Emergency work.

An assessment of the construction noise implication of out of hours work (refer to **Appendix G**, **Section 6.2** and **Table 6-26**) indicates that, where no management measures are employed, all locations would exceed the NMLs. The ICNG states that where all feasible and reasonable practices have been applied and noise is more than five dB(A) above the NML, the proponent should then undertake negotiations with the community.

The procedures contained in the *Environmental Noise Management Manual* (RTA 2001), "*Practice Note vii – Roadworks Outside of Normal Working Hours*": The Interim Construction Noise Guidelines (DECCW 2010) and the safeguards contained in this REF would be followed for work outside of the standard working hours. This would include notifying the local community of any works planned to be undertaken outside standard construction hours and respite periods. Consultation would occur as part of the public display of this REF with potentially affected members of the community, as detailed in **Chapter 5**. Furthermore, during periods were out of hours works are required more detailed assessment of potential impacts, identifying specific equipment types, works locations and durations, would be undertaken to identify feasible and reasonable management and mitigation measures.

Mitigation measures to manage potential impacts associated with these works would be detailed in the CEMP. However in general these would be managed through consultation with the community, RMS, OEH/EPA in accordance with the procedures discussed in **Section 6.2.4**.

Sleep disturbance is typically caused by short term maximum noise levels and may occur during periods of out of hours work. These events are typically random in nature and caused by events such as horns, voices and infrequent, accidental bangs. Given the preliminary stage of construction planning, a detailed assessment of these impacts is not possible, however, they would be further considers as part of the CEMP.

Based on the summary data in **Table 6-25,** typical L_{Aeq} noise levels from night time construction activities that may cause sleep disturbance, such as paving and asphalting, would generate noise levels at receiver locations similar to those predicted in **Table 6-26.** An estimate of potential sleep disturbance impacts has been undertaken for the proposal for paving and asphalting activities for out of hours' works, refer to **Appendix G**, Section 5.2.1. The predicted sleep disturbance noise levels indicate that this is a high probability for out of hours construction activities to impact on all receiver locations. These impacts are expected to be exacerbated by the low night time background noise levels. Once the detailed actives and methods for out hours work are confirmed, an individual assessment would be completed prior to undertaking any work during these times.

Vibration

The predicted levels in **Table 6-27** below provide an indication of the expected vibration impacts from the works based on typical vibration generation activities.

Table 6-27 Estimated vibration impacts – vertical impacts

Activity	Distance for activity (m)					
	5	10	20	30	40	50
Structural damage (PPV) (mm/s)						
High impact vibratory roller	10	6	2.5	1	0.5	0.2
Heavy rock hammer (1.5 t)	4.5	3	1.5	0.4	0.35	0.3
Medium rock hammer (0.6t)	0.2	0.06	0.02	0.01	-	-
Human Comfort[1] m/s						
High impact vibratory roller	8.2	4.9	2.05	0.82	0.4	0.16
Heavy rock hammer (1.5 t)	2.9	1.9	1.0	0.3	0.2	0.2
Medium rock hammer (0.6t)	0.1	-	-	-	-	-

Vibration impacts for both structural damaged and human comfort for the proposal were assessed against the typical activities identified in **Table 6-25** at varying distances from the works. The shaded orange figures indicate exceedance of the maximum project criteria for daytime impacts related to heritage structures (refer to **Table 6-21**) and human comfort (refer to **Table 6-18** and **Table 6-19**).

As is evident from **Table 6-27** while each receiver may experience differences due to local conditions, there would be a possibility that potential adverse vibration impacts associated with earthworks activity may occur within 30 metres of construction works.

The predicted levels indicate that human comfort vibration criteria would be the first to be exceeded, and it was estimated that exceedances of the project criteria would extend for up to 30 metres from the vibration generating activity. Exceedance of the structural criteria was estimated to extend for up to 10 metres from the activity. However, since the closest receiver (building) is 25 metres away, structural damage as a result of any works is considered to be unlikely. Where vibration generating works are to be undertaken near residence, an additional assessment would be required.

Operation

Operational traffic noise impacts were predicted for identified receivers for 2016 and 2026 using SoundPLAN noise modelling software. The receiver locations identified within 600 metres of the road alignment were included in the assessment. The traffic data used for the prediction of noise impacts for the proposal has been adapted from the traffic study undertaken by RMS in October 2011 and is representative of the Average Daily Traffic (ADT) flows.

In accordance with the RNP, each scenario for the year of opening (2016) and the design year (2026) was assessed for the “build” and “no build” options for the proposal. These scenarios include a traffic linear growth rate of 0.8 per cent per

annum. To account for large proportion of heavy vehicles in the night time traffic stream the assessment has been modified to incorporate three different source heights for emissions from truck engines, truck exhaust and cars (1.5 metres, 3.6 metres and 0.5 metres respectively). **Table 6-28** present the ADT traffic volumes for the year of opening and includes composition details for noise modelling scenario in terms of total traffic number for the day and night time and the per cent of heavy vehicles included in the traffic mix. **Table 6-28** is applicable to both the "no build" and "build" options.

Table 6-28 ADT data input to noise model for the year (2016)

Location	Predicted Traffic Flows							
	Daytime (15 hour)				Night time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Princes Highway (North bound)	658	98	757	13%	34	17	51	34%
Princes Highway (South bound)	672	119	791	15%	33	21	54	39%

Similarly the design year traffic data in **Table 6-29** is also applicable to both "no build" and "build" options. **Table 6-29** present the ADT traffic volumes for the design year (opening plus 10) and included composition of heavy and light vehicles in the traffic stream.

Table 6-29 ADT data input to noise model for the year (2026)

Location	Predicted Traffic Flows							
	Daytime (15 hour)				Night time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Princes Highway (North bound)	703	105	809	13%	36	19	55	34%
Princes Highway (South bound)	718	127	845	15%	35	22	57	39%

Due to the low traffic numbers and the distances from the road, traffic noise was only found to have an influence over the natural environment at two of the five monitoring locations. These locations (L4 and L5) were used to calibrate the model's predictions with the measured traffic noise levels outlined in **Table 6-15** to determine any variation between the two.

The calibration levels incorporate modelling corrections of -3 dB(A) for the conversion from an L_{A10} to L_{Aeq} parameter. When measured and modelled values are compared, the difference is considered to be within an acceptable level of accuracy for the noise model, and therefore the model is suitable for use in predicting the future assessment scenarios.

The results of the noise modelling are shown in **Table 6-30**. Appendix A of the *Noise and Vibration Assessment* (refer to **Appendix G**) presents the noise contours overlaid on aerial photography.

The increase in noise levels at some receivers is due to the realignment of the carriageway to the west of the existing Princes Highway, bringing the highway up to 300 metres closer to receiver locations in the Dignams Creek Road area. At the southern end of the proposal, there would be no changes as part of the stage 1 works. However the stage 2 component of works would re-join the existing Princes Highway alignment slightly to the west of the current alignment, bringing the proposal a couple of metres closer to receiver R9 (refer to **Figure 6-7**).

The assessment of the scenarios indicated that traffic noise levels at the existing receiver locations would generally rise by between 2 dB(A) and 5 dB(A) when compared to the existing alignment. The modelling indicates that no receivers are expected to have an acute noise level impact and there are no receivers that exceed the relative increase criteria. All but one receiver (R7) are below the project noise criteria for both day and night time noise impacts; this is due to the low traffic volumes and the distance to the carriageway. Sensitive receiver R7 is predicted to exceed the base noise criteria. Moreover, the modelling suggests that R7 would likely exhibit an overall increase in noise levels between the 'build' and 'no build' scenarios of 6-7 dB(A) (refer to **Table 6-30**). As a result, this receiver has been identified for consideration of mitigation in the form of architectural treatments as noise walls along the proposal would not represent best solution for mitigation or value for money.

In accordance with Practice Note III of the ENMM a maximum noise level assessment was undertaken for the proposal (refer to Section 4.4 of **Appendix G**). The maximum noise level assessment found that receivers R1 to R7, all located in the northern part of the proposal, do not currently experience maximum noise events (ie events above the 65 dB(A) threshold). However there were a total of 19 maximum noise level events recorded at R9 (L4) in the southern part of the proposal during the 9 hour night time period. The majority of these events occur in the early hours of the morning and are expected to be related to heavy vehicle movements on the highway. The majority of events tend to fall within the 65-70 dB(A) range, external to the dwelling. As these events are spread throughout the night time period, and may be up to 10 dB(A) lower inside the building, this indicates a very low risk of an awakening as the result of a current maximum traffic noise event.

At the receiver location R9, in the southern part of the alignment, the occurrence and level of maximum noise events are not expected to change as the result of the proposal. At receivers R1 to R7, however, there are currently no reportable maximum noise events due to road traffic noise. At these locations, in the northern section of the proposal, the new alignment would be about 300 metres closer to the dwellings and, therefore, the occurrence and level of maximum noise events are expected to increase for these receivers.

Table 6-30 Predicted noise levels (D = day and N = night)

ID	Assessed facade	Year opening 'no build' scenario dB(A)		Year opening 'build' scenario dB(A)		Design year 'no build' scenario dB(A)		Design year 'build' scenario dB(A)		RNP criteria, dB(A)		Are the RNP Criteria exceeded?		Change in noise level dB(A)				Acute level of noise		Mitigation required
														Opening year		Design year				
		D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	
1	South	44	37	46	41	44	38	46	41	55	50	NO	NO	2.1	3.4	2.1	3.4	NO	NO	NO
2	East	46	39	47	42	46	40	48	43	55	50	NO	NO	1.7	3.1	1.7	3.1	NO	NO	NO
2	South	46	40	47	42	46	40	47	43	55	50	NO	NO	1.1	2.5	1.0	2.5	NO	NO	NO
3	East	45	39	47	43	45	39	48	43	55	50	NO	NO	2.3	3.6	2.3	3.6	NO	NO	NO
3	South	46	40	48	44	47	40	49	44	55	50	NO	NO	2.2	3.4	2.2	3.5	NO	NO	NO
4	East	42	36	44	39	43	36	45	40	55	50	NO	NO	2.1	3.3	2.0	3.3	NO	NO	NO
4	South	43	36	44	39	43	37	45	40	55	50	NO	NO	1.8	3.1	1.8	3.1	NO	NO	NO
5	East	46	40	49	44	46	40	49	44	55	50	NO	NO	2.8	4.2	2.8	4.2	NO	NO	NO
5	South	46	40	49	44	46	40	49	44	55	50	NO	NO	3.0	4.4	3.0	4.4	NO	NO	NO
6	East	47	41	51	46	47	41	51	46	55	50	NO	NO	4.2	5.5	4.2	5.5	NO	NO	NO
6	South	46	40	50	45	47	40	50	45	55	50	NO	NO	3.5	4.9	3.5	4.9	NO	NO	NO
7	East	49	43	55	50	50	44	56	51	55	50	**YES**	**YES**	6.0	7.0	6.0	7.0	NO	NO	**YES**
7	South	47	41	52	47	47	41	52	47	55	50	NO	NO	4.6	5.9	4.6	5.9	NO	NO	NO
8	North	50	44	47	42	50	44	47	42	55	50	NO	NO	-3.4	-2.0	-3.4	-2.0	NO	NO	NO
8	West	51	45	47	42	51	45	47	42	55	50	NO	NO	-4.3	-3.0	-4.4	-2.9	NO	NO	NO
9	South-east	57	50	56	51	57	50	56	51	60	55	NO	NO	-0.8	0.7	-0.8	0.7	NO	NO	NO
10	North-west	59	52	57	52	59	53	57	52	60	55	NO	NO	-1.8	-0.3	-1.9	-0.3	NO	NO	NO

The increase in maximum noise levels at R1-R7 would primarily be due to the new highway alignment moving closer to these receiver locations. However maximum noise levels at these locations would also be affected by the road gradient which drops from around 70 metres in height down to about 13 metres in the north bound lane and around 30 metres down to 13 metres in the south bound lane near these residences.

These changes in gradient are likely to be conducive to the use of exhaust brakes in heavy vehicles that would trigger a maximum noise event in the northern section of the proposal. Due to the low volume of traffic using the alignment, the occurrence of these events would be similar to that currently identified at L4 which is about 19 events per night.

Only one receiver location (R7) has been identified for noise mitigation measures in the form of architectural treatment. The daily levels for maximum noise events resulting from the proposal have been estimated to be between 65 and 72 dB(A) external to the dwelling for the closest receiver R7 based on the distance of the proposed alignment. Based on the above analysis of maximum noise level events, there are no recommendations for the prioritisation of these noise mitigation measures at this receiver location.

6.2.4 Safeguards and management measures

Safeguards and mitigation measures to manage potential noise and vibration are outlined in **Table 6-31**.

Table 6-31 Noise and vibration safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration management plans	When developing and implementing management strategies, make all practical efforts to comply with the requirements of the POEO Act and, where applicable; the EPA publications *Interim Construction Noise Guideline*, *Industrial Noise Policy* and *Environmental Criteria for Road Traffic Noise*; and the RMS publication *Environmental Noise Management Manual*.	Construction contractor	Pre-construction
Impacts to sensitive receivers from construction noise	Prepare and implement a Noise Management Plan (NMP) in accordance with RMS *QA Specification G36* as part of the CEMP to minimise the impact of noise from your operations on adjacent properties. The Noise Management Plan must cover all significant noise generating activities. The NMP would include measures to reduce noise impacts to adjacent sensitive receivers. The plan include but not be limited to the following: • Substitution by an alternative low noise process.	Construction contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	• Restricting times when noisy work is carried out. • Placement of work compounds, parking areas, equipment and material stockpile sites away from noise-sensitive locations; • Screening or enclosures; • Consultation with affected residents. All construction plant and equipment used would be, in addition to other requirements: • Fitted with properly maintained noise suppression devices in accordance with the manufacturer's specifications. • Maintained in an efficient condition. • Operated in a proper and efficient manner.		
Vibration impacts to sensitive receivers from construction activities	Prepare and implement a Vibration and Airblast Management Plan (VAMP) as part of the CEMP to minimise the impact of noise from your operations on adjacent properties. The Noise Management Plan would be developed in accordance with RMS QA Specification G36 and must cover all significant noise generating activities. The NMP would include measures to reduce noise impacts to adjacent sensitive receivers. Feasible and reasonable vibration mitigation measures to be adopted during construction would include: • Substitution by an alternative process. • Restricting times when work is carried out. • Screening or enclosures. • Consultations with affected residents.	Construction contractor	Construction
Operational noise impacts	During the detailed design stage of the proposal, investigations of all feasible and reasonable mitigation treatments would be considered for the affected receiver (L7). All feasible and reasonable measures would be considered in accordance with the NSW Road Noise Policy (DECCW, March 2011) and Practice Note iv of the RMS Environmental Noise Management Manual (ENMM).	RMS	Detailed design
Out of hours noise and vibration	Works would be carried out during standard working hours (that is 7am-6pm Monday to Friday, 8am-1pm Saturdays).	Communications manager and	Construction

Impact	Environmental safeguards	Responsibility	Timing
impacts	Any work that is performed outside normal work hours or on a Sunday or public holiday would need to minimise noise impacts in accordance with the *Environmental Noise Management Manual, "Practice Note vii – Roadworks Outside of Normal Working Hours* and the *Interim Construction Noise Guidelines* (OEH 2010). This would include notifying the local community of any works planned to be undertaken outside standard construction hours prior to the works occurring using the following methods: • Contact the local community potentially affected by the proposed works (outside of recommended construction hours) and inform them by letter of the proposed work, location, type of work days and dates of work and hours involved. The contact would be made 5 days prior to commencement of works. • Place a suitable advertisement in local papers including a reference to night-time noise impacts. Provide a community liaison phone number and permanent site contact so that complaints can be received and addressed in a timely manner.	contractor	

6.3 Landscape character impact, visual impact and urban design

An *Urban Design, Landscape Character and Visual Impact Assessment* has been prepared for the proposal (SMM, 2013), and is summarised below (refer to **Appendix C** for the full report). The assessment has been prepared in accordance with the RMS (2009) *Guidelines for Landscape Character and Visual Impact Assessment* and the RMS (2009) *Beyond the Pavement* guidelines.

For the purposes of this assessment the study area was broadly defined as the length of the proposal and the surrounding views. However, for the urban design and landscape character assessments the study area is specifically defined as the area within and immediately adjacent to the proposal. For the purposes of visual impact assessment, the study area covered a much larger region and extended up to three kilometres from the edges of the proposal.

6.3.1 Existing environment

Landform and topography

The proposal is located in south eastern New South Wales, within a coastal lowlands system consisting of rolling to undulating terrain. Elevations in the region range between 10 to 200 metres above sea level.

To the north of the proposal around Tilba Tilba the Princes Highway winds through areas of forests before descending into a cleared east-west orientated valley containing Dignams Creek. The valley is comprised of cleared pastoral and agricultural lands which are located on the floodplains adjacent to Dignams Creek. The Princes Highway then ascends a steep winding ridge that passes Dignams Hill to the west. At the top of the climb the Princes Highway cuts through an east-west ridge line, before descending once again into a broad open coastal valley to the south and the town of Cobargo. To the east of the proposal lies Wallaga Lake, a tidal estuary of the Pacific Ocean. To the west lie forested slopes of the Great Dividing Range which separate the proposal from the plains of the Monaro grazing districts.

Vegetation

A large part of the area surrounding the proposal includes areas of remnant forest. Some of the areas are private lands, some are State forests and a large section to the south of the proposal is contained within Kooraban National Park and Gulaga National Park (refer to **Figure 1-2**). As a result, significant stands of forest surround the proposal, particularly on the steeper and higher slopes, creating significant vegetative corridors across and adjacent to the site.

The area of Kooraban National Park adjacent to the existing highway was previously a State forest and had been extensively logged. Steeper upper slopes tend to be forested with native species, while valleys and pockets of ridgelines are often defined by gentler slopes that are often cleared for agriculture and settlements. Areas outside of national parks that are covered in forest within both the Eurobodalla and Bega Valley LGAs also comprise plantations of timber for harvesting purposes or remnant forest. The remainder of the vegetation within the study area consists of occasional exotic tree planting and introduced weeds and grasses located mainly in the cleared valleys. The vegetation surrounding the proposal has been described in detail in **Section 6.1**.

Land use

Land use surrounding the proposal includes:

- Rural residential properties.
- Agricultural lands, used predominantly for cattle grazing and occasionally for cropping.
- Conservation areas including two national parks.
- Forestry.

In the Dignams Creek area, the main agricultural practices consist of grazing, which represents more than 140 years of history in the area. Dairy farming, whilst being a historically important land use is presently a relatively small local industry. Forestry practices have been a large industry for the area and the private property immediately to the south has an active logging permit in use. Tourism, particularly in the Bega Valley Shire to the south is an important growth industry.

Transport network

Formerly known as the Main South Road (pre-1930's), the Princes Highway formed an important link to Sydney which had previously relied upon boat transport to ship goods and materials to and from the area. In the present day, the Princes Highway provides access to several coastal townships, and is part of an important link between Sydney and Melbourne. Further details of the existing road network are contained within **Chapter 2** and **Section 6.10**.

6.3.2 Methodology

Methodology for the landscape character assessment

For the landscape character assessment, an analysis of the road corridor was undertaken to identify a series of landscape character zones (refer to **Section 6.3.3**). This assessment is based on the sensitivity of the landscape character zones and the magnitude (physical size and scale) of the proposal in that zone. The combination of sensitivity and magnitude is used to derive an impact rating for the proposal on the various landscape character zones (refer to **Table 6-32**).

Table 6-32 Landscape character impact assessment grading matrix

		MAGNITUDE					
		High	High to Moderate	Moderate	Moderate to Low	Low	Negligible
SENSITIVITY	High	High	High	Moderate / High	Moderate / High	Moderate	Negligible
	High to Moderate	High	Moderate / High	Moderate / High	Moderate	Moderate	Negligible
	Moderate	Moderate / High	Moderate / High	Moderate	Moderate	Moderate / Low	Negligible
	Moderate to Low	Moderate / High	Moderate	Moderate	Moderate / Low	Moderate / Low	Negligible
	Low	Moderate	Moderate	Moderate / Low	Moderate / Low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Landscape character zones

The study area has been divided into four landscape character zones (refer **to Figure 6-8**). The zones correspond to landscape character types in the area and allow for a more detailed discussion of the character of each precinct, of the proposed works within it and of the likely impact on the landscape character resulting from the proposal.

The four landscape character zones are:

- Landscape character zone 1 - Northern Forested Ridges (towards Tilba Tilba within Eurobodalla Shire). The landscape character of zone 1 is typified as a highway enclosed by dense forest with cleared valleys beyond. There are frequent short steep cut batters and shallow fills due to the rolling natural of the topography.
- Landscape character zone 2 - Dignams Creek Valley. The landscape character of the valley is a secluded pastoral setting with cleared native vegetation, rolling hills with landmark exotic trees.

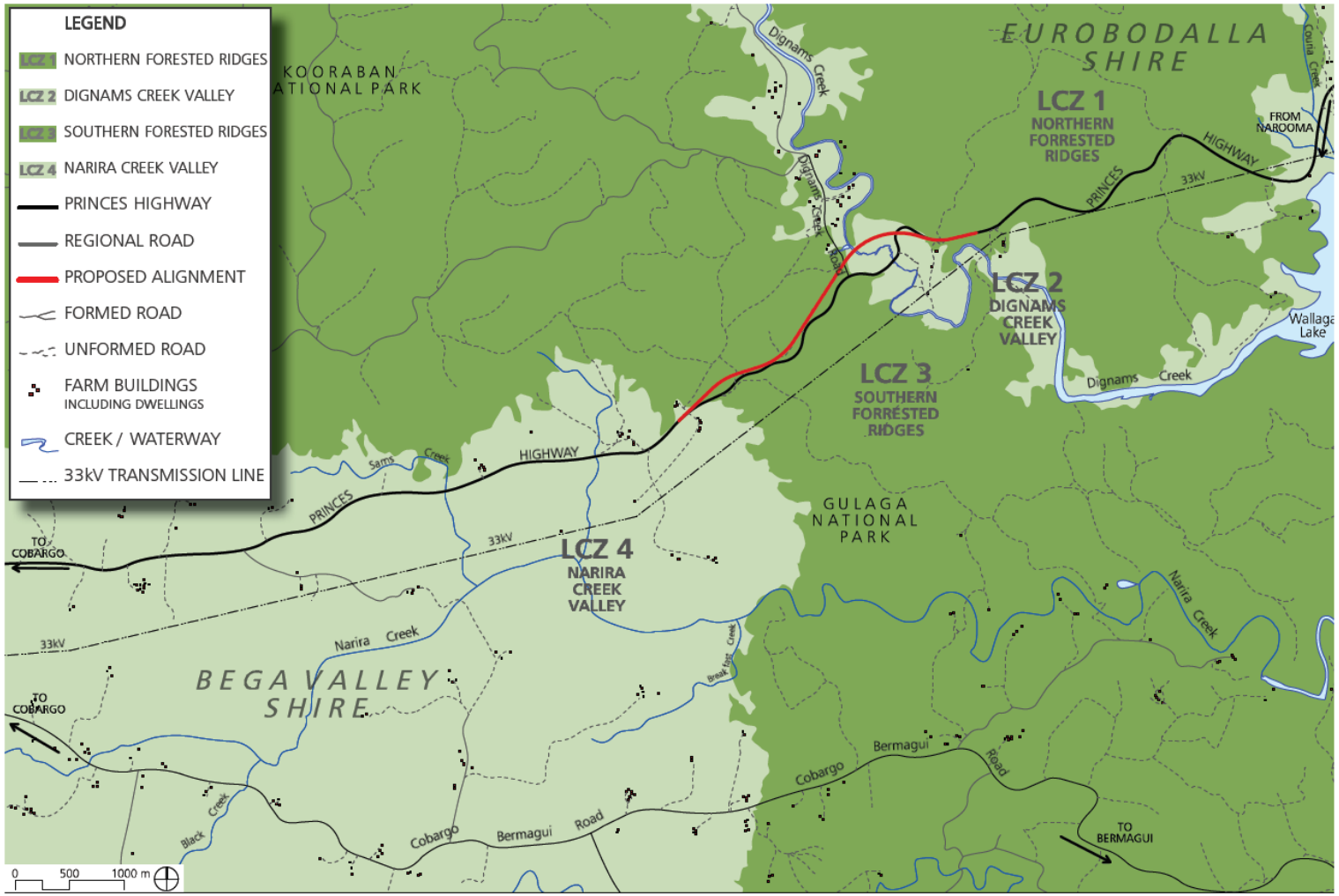

Figure 6-8 Landscape character zones

- Landscape character zone 3 - Southern Forested Ridges (Gulaga and Kooraban National Parks). The landscape character of zone 3 was characterised by the dense vegetation of the national parks on both sides of the route with broader landscapes views at several locations. Steep rock cuttings are visual along this section of the road.
- Landscape character zone 4 - Narira Creek Valley (towards Cobargo within Bega Valley Shire The landscape character of zone 4 was of a broad and undulating valley with paddock trees and forested margins similar in characteristic to Dignams Creek Valley (landscape character zone 2).

Generally, the existing landscape character of the Princes Highway, Dignams Creeks is dense roadside vegetation with occasion broad views along the higher elevations opening up to undulating pastoral valleys at low evaluation.

Methodology for the visual impact assessment

For the purposes of the visual impact assessment, the estimated extent of visibility of the proposal has been defined in terms of three visual catchment based on geographic proximity to the proposal. There are shown in **Figure 6-9** and include:

- Primary visual catchment zones between 0 to 0.5 kilometres from the proposal.
- Secondary visual catchment zones between 0.5 to 1.5 kilometres from the proposal.
- Tertiary visual catchment zones between 1.5 to three kilometres from the proposal.

Within these visual catchment zones, a number of viewpoints have been identified as representative locations for the visual impact assessment and include views from homesteads, lookouts and entry points to property access roads, refer to **Figure 6-10**. Views of the proposal within these zones are influenced by major landforms, minor landforms, distance, and direction. Vegetation, whilst often blocking potential views, is not considered as a permanent obstruction as it can be removed by a significant event such as a bush fire.

The viewpoints chosen for the visual impact assessment have enabled the assessment of the impact of the proposal against two primary conditions:

- The impact upon private properties or other selected locations likely to be accessed by viewers where they fall within the visual catchment.
- The impact upon users of the road itself or other connecting roads.

In measuring the impact, the following conditions were taken into account:

- The distance between the viewer and the road.
- The elevation change between the viewer and the road. A negative zenith indicates the viewer overlooks the target, a positive zenith indicates the viewer looks up to the target.
- The elements of the proposal that would be visible.

Twenty-one static viewpoints and one dynamic viewpoint from the perspective of the road user were identified for the visual impact assessment and these are summarised in **Table 6-33**.

Table 6-33 Summary of viewpoints (existing environment)

Viewpoint	Location	Category of viewer
01A primary	Looking east-north-east toward fill embankment which forms approach to the bridge	Private residence
01B primary	Looking east-north-east towards elevated cutting in vegetated hillside at the northern tie-in.	Private residence
01C primary	Looking east towards the proposed bridge at Dignams Creek from private residence and to the elevated cutting in the vegetated hillside beyond	Private residence
02A Primary	Looking east towards the bridge and adjacent fill embankment.	Private residence
02B primary	Looking east towards elevated cutting in vegetated hillside at northern tie-in.	Private residence
02C primary	Looking south-east towards bridge and adjacent fill embankment.	Private residence
03A primary	Looking east towards fill embankment which approach to the bridge.	Private residence
03B primary	Looking south towards cutting on southern side of Dignams Creek valley.	Private residence
04A secondary	Looking east-south-east towards fill embankment which forms approach to bridge.	Private residence
04B secondary	Looking south towards cutting on southern side of Dignams Creek valley.	Private residence
05A secondary	Looking south towards bridge and adjacent fill embankment.	Private residence
05B secondary	Looking south towards cutting on southern side of Dignams Creek valley.	Private residence
06A secondary	Looking south toward cutting on southern side of Dignams Creek Valley.	Private residence
06B secondary	Looking south towards cutting approaching southern tie in.	Private residence
07A secondary	Looking south towards bridge and adjacent fill embankment.	Private residence
07B secondary	Looking south towards cutting on southern side of Dignams Creek valley	Private residence
08A secondary	Looking south towards bridge and adjacent fill embankment.	Private residence
08B secondary	Looking south towards cutting on southern	Private residence

Viewpoint	Location	Category of viewer
	side of Dignams Creek Valley	
09A secondary	Looking south towards cutting on southern side of Dignams Creek valley.	Private residence
09B secondary	Looking south towards cutting approaching southern tie in.	Private residence
10A primary	Looking north-west towards fill embankment which forms approach to bridge.	Private residence
10B primary	Looking west towards the bridge crossing at Dignams	Private residence
10C primary	Looking south-west towards cutting on southern side of Dignams Creek valley.	Private residence
11 primary	Looking north towards the southern tie-in fill embankment.	Private residence
12 primary	Looking east-north towards the southern tie-in embankment	Private residence
13 secondary	Looking north-east towards the southern tie-in fill embankment	Private residence
14 secondary	Looking north-east towards the southern tie-in fill embankment.	Private residence
15 secondary	Looking north-east towards the southern tie-in fill embankment.	Private residence
16 secondary	Looking north towards the southern tie-in fill embankment.	Private residence
17 secondary	Looking north towards the southern tie-in fill embankment.	Private residence
18 tertiary	Looking south towards the proposal from Mount Dromaderry.	Public view point
19 tertiary	Looking south towards proposal from private residence oat the foot hills of Mount Dromaderry.	Private residence
20 tertiary	Looking north towards the proposal from the Cobargo-Bermagui road.	Private residence
21 tertiary	Looking north towards the proposal from the Cobargo-Bermagui.	Private residence
Viewpoint along highway as a motorist	Road Tie-Ins	Motorist

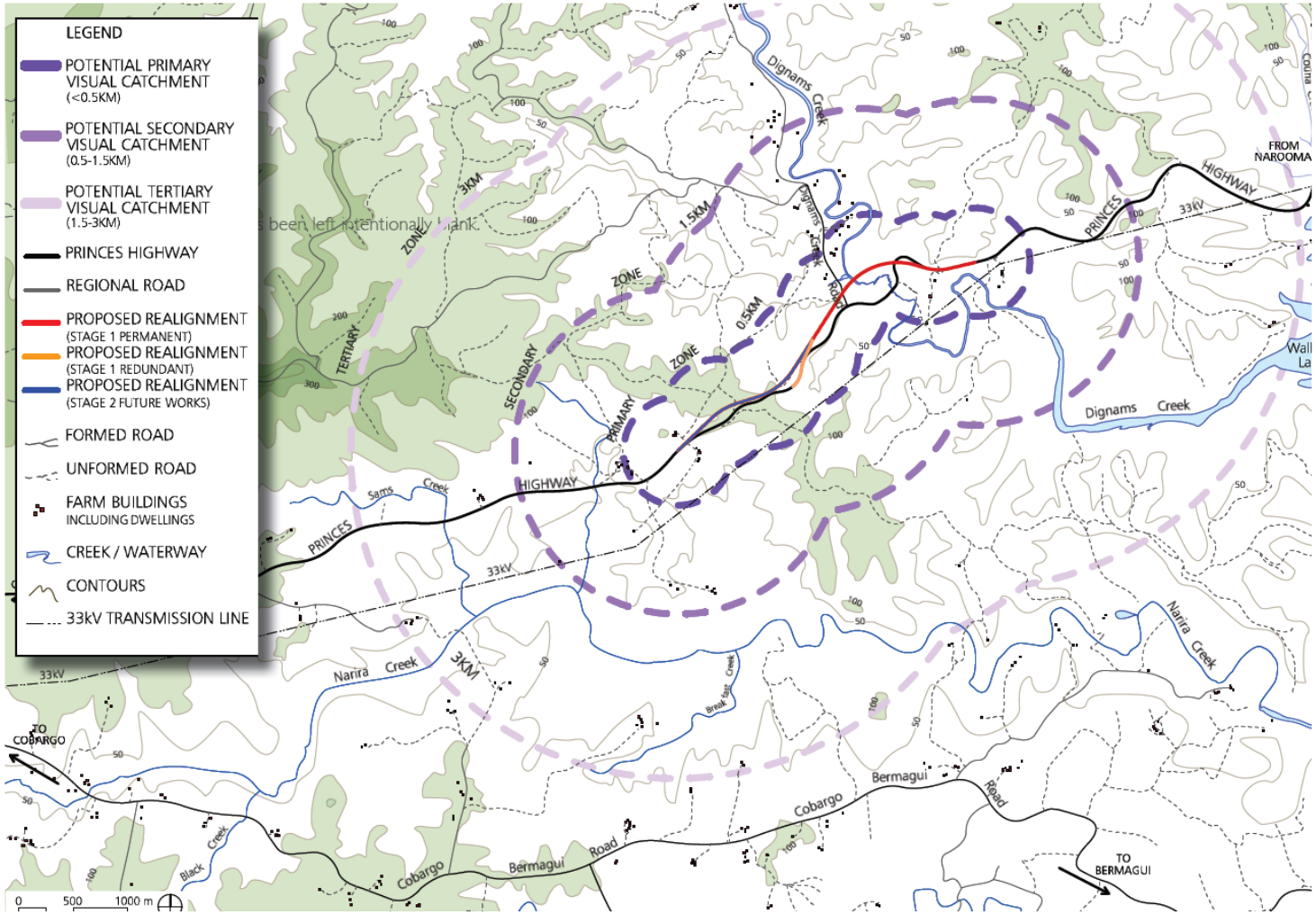

Figure 6-9 Visual catchment zones

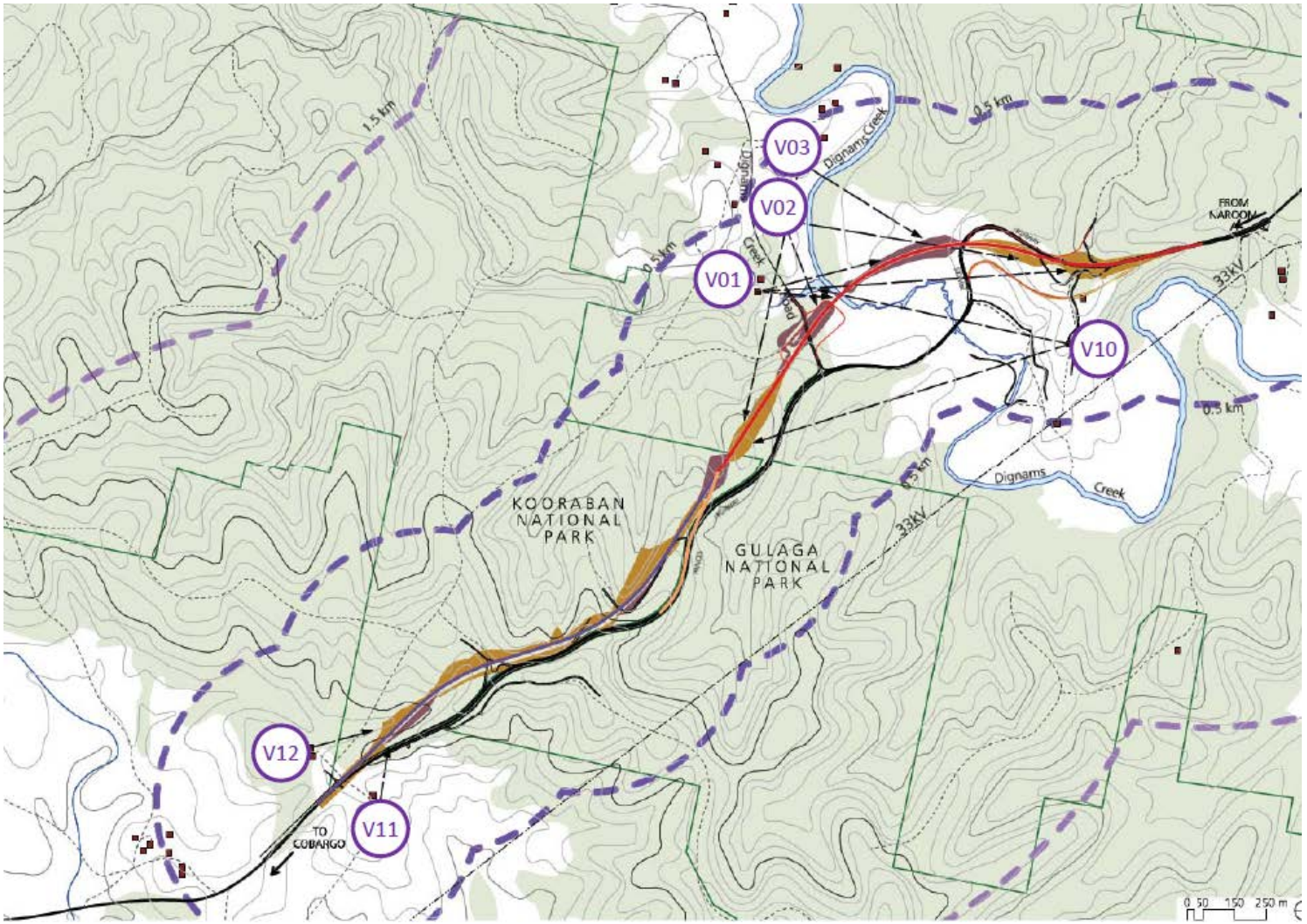

Figure 6-10 Primary visual catchment zone viewpoints (north)

The assessment of the visual impact of the proposal on the identified viewpoints has considered the sensitivity of the view (ie quality of the view and how it would be affected by the proposal) and the magnitude of the proposal within that view (ie the physical size and scale of the change and its proximity to the viewer). The combination of sensitivity and magnitude is used to derive the visual impact rating (refer to **Table 6-32**).

Methodology for the Urban Design Assessment

The urban design assessment considered the impact of the proposal against the seven urban design principles defined previously in **Section 2.3,** namely:

- To retain the existing character of the natural and cultural landscapes through which the highway passes.
- To maintain the integrity of existing ecological systems.
- To minimise the construction and operational impacts of the highway on the local community.
- To maintain and improve the amenity and economic viability of the local area.
- To retain and enhance the essential qualities of the existing highway travel experience.
- To ensure that the highway upgrade makes a positive contemporary contribution to the local and regional landscape.
- To undertake an iterative process whereby landscape character impacts and visual impacts are avoided as part of the design process.

The urban design assessment also considered the proposal within the context of local and regional planning and developed a landscape strategy for the proposal, refer to **Appendix C.**

6.3.3 Potential Impacts

Construction

Construction impacts to visual and urban amenity would include changes in the visual landscape from the clearing of vegetation, generation of wastes and construction activities associated with the proposal. These impacts would be ongoing throughout the construction period. These impacts would generally be temporary in nature and mitigation measures for ameliorating the visual impacts are summarised in **Section 6.3.4.** Additional measures for managing waste generation are outlined in **Section 6.12**.

Operation

Landscape character

Impacts on landscape character associated with the proposal have been summarised in **Table 6-33** below.

Table 6-34 Landscape character impact assessment grading matrix

Landscape character zone	Sensitivity	Magnitude	Landscape character impact
Landscape character zone 1 - Northern forested ridges	**High to Moderate:** due to tightly enclosed forest and infrequent openings.	**Moderate:** due to relatively short length and minimal cuttings. The proposed works in this zone would not substantially increase the pavement width.	**High to Moderate:** due to the High to Moderate sensitivity of the zone and the Moderate magnitude of the works.
Landscape character zone 2 - Dignams Creek valley	**High:** due to attractive rural setting, with an open valley. The valley is defined by the contrast between the enclosed forested hillsides and the openness of the cleared valley floor.	**High:** due to the bulk and scale of the proposed work in this zone the proposal would substantially alter the form of the valley due to the bridge structure and associated raising of the road levels.	**High:** due to the change of the zone and high magnitude of works**.**
Landscape character zone 3 - Southern forested ridges	**High to Moderate:** due the attractive and visually uniform forested landscape.	**High:** due to the increased pavement width which would require clearing and encroach into the national parks though cutting and filling works required to establish the road levels.	**High:** due to the change in the zone and high magnitude of the works**.**
Landscape character zone 4 - Narira Creek valley	**High to Moderate:** due to the contrast between the enclosed forested hillsides and the openness of the cleared valley floor.	**Low:** due to the proposed works in this zone not increasing pavement width substantially, nor does it require substantial cut and fill operations or loss of vegetation.	**Moderate:** due to High to Moderate sensitivity of the zone and the Low magnitude of the works.

While the works, for the most part, are to take place adjacent to an established road corridor, they would impact on all landscape character zones to some degree, with the greatest impact being in landscape character zone 2: Dignams Creek Valley.

From the perspective of the road viewer such as local property owners, tourists, cyclists and pedestrians, the character of the landscape would be greatly impacted.

There would also be substantial changes in landscape character zone 2: Dignams Creek Valley, due to the large intervention into the landscape.

The impression of landscape character from the road user's perspective would be altered in that the road would be less responsive to the physical features of the landscape, and speed limits increased which reduces viewing time of cultural and biophysical features.

The predicted landscape character impacts for each zone reflect the corresponding local conditions. They further reflect the scale of the road infrastructure within each zone's setting. However, the qualitative landscape character zone assessment does not reflect the cumulative effect of the landscape character impact on the study area as a whole.

Visual impact

Visual impacts were rated for 21 static viewpoints, and one dynamic viewpoint from the perspective of the road user. The results of the visual impact assessment ranged from low to high potential impacts, and the results for each visual catchment zone is summarised in **Table 6-35.**

Table 6-35 Visual impact assessment: overall summary

Visual Catchment Zone	Sensitivity	Magnitude	Visual impact
Primary Zone 0 - 0.5 km	High to medium	High	High to medium
Secondary Zone 0.5 - 1.5	Medium	Medium to low	Medium
Tertiary Zone 1.5 – 3 km	Medium low	Low	Medium low
Road user	High to medium	High to medium	High to medium

Overall, the proposal would impact on views in and around the study area. While the works, for the most part, are to take place in an established road corridor, they would impact on all of the visual catchment zones to some degree, with the greatest impact being on local residents within the primary zone (within 500 metres) and the road user.

From the perspective of the road viewer such as local property owners, tourists, cyclists and pedestrians, the character of the landscape would be greatly impacted on, however this is not necessarily in a negative sense. The new cuttings would provide an opportunity to view underlying geology and revegetation would be undertaken in currently bare areas. The new bridge would allow views of Dignams Creek Valley and when driving north, a background view of Mount Dromaderry.

For the full visual impact assessment results refer to **Appendix C**.

Urban Design

The urban design assessment found that operation of the proposal would have the following impacts:

- The new bridge over Dignams Creek would be a large structure and highly visible from local viewpoints.
- The proposal would involve extensive earthworks including cuttings, fill embankments and retaining walls to achieve the necessary horizontal and vertical alignments. This would include changes to the existing landform.
- The proposal would involve the removal of substantial areas of vegetation within a road corridor currently characterised by enclosed forest views.
- The proposal would involve substantial changes in Dignams Creek valley (landscape character zone 2) due to the construction of the new Dignams Creek Bridge and associated fill embankments.
- Fencing, barriers, fauna crossing structures and signage would be required as part of the upgrade and have the potential to clutter the visible landscape.
- Local connectivity, local community functions/activities and sense of place would be modified by the proposal.
- Installation of new drainage features.

6.3.4 Safeguards and management measures

Urban design objectives and principles

Principles for development of the proposal have been based on the urban design objectives defined for the proposal and which have been outlined in **Section 2.3** and **Section 6.3.2**. The specific urban design principles are summarised in **Table 6-36** and reflect the urban design principles contained in the RMS (2009) *Beyond the Pavement* (2009) as well as responding to the ongoing transformation of the area as a result of this proposal and the expected surrounding development

Table 6-36 Urban design objectives and principles

Objective	Principle
A. To improve the safety and operation efficiency of the highway	• Reduce the number of local road intersection and direct property connections along the upgraded highway. • Provide continuous, off–highway, local access routes wherever possible. • Improve facilities for all road users – including motorists, pedestrians and cyclist.
B. To retain the existing character of the natural and cultural landscapes through which the proposal passes	• Minimise the physical footprint of the proposal, including during the construction stages. • Design the highway to be physically and visually integrated with the surrounding landscape. • Minimise the physical and visual intrusion of road-related elements (such as batters and water quality control measures) on the local landscape. • Preserve the integrity of cultural heritage sites and areas of cultural importance, regardless of whether or not they contain heritage items. • Minimise the impact of the proposal on native vegetation and existing cultural plantings.

Objective	Principle
C. To maintain the integrity of existing ecological systems	• Minimise the physical footprint of the proposal, including during the construction stages. • Minimise the impact of the highway upgrade on native vegetation. • Avoid the introduction of environmental weeds.
D. To minimise the construction and operational impacts of the proposal on the local community	• Minimise the physical footprint of the proposal, including during the construction stages. • Design the highway to be physically and visually integrated with the surrounding landscape. • Provide continuous, off-highway, local access options wherever possible. • Provide generous and direct local vehicular connections across the highway of appropriate scale and character to the significance of the crossing. • Minimise the potential noise impacts of the proposal. • Consider opportunities for public transport throughout the proposal. • Provide safe and effective highway crossings for livestock where necessary.
E. To maintain and improve the amenity and economic viability of the local area	• Provide continuous, off-highway, local access routes wherever possible. • Provide straightforward connections between the highway and the local road network.
F. To retain and enhance the essential qualities of the existing highway travel experience	• Make the character of the local topography a tangible experience for the motorist by providing, as much as possible, a constantly varying horizontal (curving) and vertical (undulating) road alignment. • Minimise the visual scale of the highway from the motorist's perspective. • Maximise the motorist's experience of, and visual connection to, the surrounding natural and cultural landscapes. • Retain, and where possible improve, regional views and views to important landmarks.
G. To ensure that the proposal makes a positive contemporary contribution to the local and regional landscape	• Avoid the use of token "gateway" statements. Instead, utilise unique features of the local area and functional elements of the highway as visual markers and experiences that provide a sense of arrival or sense of place along the highway journey. • Recognise that large-scale road elements (such as walls, cuttings and bridges) have iconic potential and provide important visual and landscape markers. Design these elements accordingly. • Design the visual expression of the road elements to be true to their infrastructural function, using robust materials and streamlined, uncomplicated forms.

Environmental safeguards have been developed in response to the potential impacts identified in **Section 6.3.3**. These are presented in **Table 6-37**, and specifically respond to the urban design objectives outlined previously.

Table 6-37 Landscape character and visual impact safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Change of landscape character and visual impact	Detailed design would be undertaken according to the urban design vision, objectives and principles (refer to **Table 6-36**) which underpin the concept design.	RMS	Detailed design
Views of the new Dignams Creek Bridge	The design would be undertaken to reflect the advice given in the *RMS Bridge Aesthetics* guidelines. The bridge structure is to be integrated into the adjacent landform.	RMS	Detailed design
Impact from large earthworks and change in landform	The potential visual impact of earthworks would be minimised by careful design that allows them to integrate with adjoining landforms.	RMS	Detailed design
Visual amenity impacts from construction of new retaining walls/cut batters	Retaining walls and batters would be steepened to grades suitable for the proposed surface treatment in order to minimise the overall footprint of the proposal, whilst still enabling appropriate landscaping. Where possible, retaining walls/batters would be constructed of materials that would visually integrate with the surrounding geology and landscape. Screen planting would be provided below walls and use materials that integrate visually with the surrounding environment.	RMS	Detailed design
Impact from new drainage features	Visible roadside channels and median channels would be vegetated or rock lined. Concrete lined channels would be avoided as much as possible. Where they are to be used, the concrete would be coloured and/or heavily roughened.	RMS	Detailed design
Changes to the landscape character and visual	Existing cultural/landmark trees in the surrounding paddocks would be retained where feasible. This would be undertaken by identifying 'no go areas' to restrict access	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
amenity of the existing environment	around trees not affected by the proposal and making minor adjustments to the horizontal and vertical carriageways to move them clear of root zones. Natural rock cutting faces would be maintained were feasible, to allow the geological character of the landscape to be viewed.		
Changes to the landscape character and visual amenity of the existing environment	Following construction, landscaping of areas impacted by the proposal would be undertaken in accordance with the Landscape Plan and would consider: • Revegetation of cleared areas using species occurring from vegetation map units identified within the proposal footprint (refer to **Table 6-2**). • Including screening trees and shrubs to block views of the proposal and intercept potential headlight glare. • Ensuring trees and revegetation areas are in conformance with the landscape drawings. • Restoring and enhancing areas impacted along Dignams Creek with endemic, riparian vegetation, from the TEC recognised as River-flat Eucalypt Forest on Coastal Floodplains. • Ensuring clear zones are kept to the minimum in order to allow regeneration to occur, particularly in parts of the proposal where regeneration would assist with screening and headlight glare control such as on the west facing fill embankments visible from Dignams Creek Road. • Re-using removed vegetation in the form of mulch added to planting and bushland reconstruction areas; and coarse woody debris in fauna crossings and creeklines (downstream of structures).	Construction contractor	Construction