7.2 Noise and vibration

This chapter provides an assessment of noise and vibration impacts of the project, which was nominated in the DGRs as a key environmental issue for the project. It represents a summary of the *Noise and Vibration Technical Paper* (AECOM, 2012), which was prepared for the project to address the DGRs. The technical paper is provided at **Appendix E** of this environmental assessment. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Noise and Vibration *- including but not limited to:*	
A construction noise and vibration assessment including construction traffic noise, batch plants and blasting impacts. The EA must clearly identify nearest sensitive receptors and assess construction noise/vibration generated by representative construction scenarios focussing on high noise generating works. Where work hours outside of standard construction hours are proposed, clear justification and detailed assessment of these work hours must be provided including alternatives considered and mitigation measures proposed. The assessment must further consider any cumulative impacts during construction, having regard to any other developments (both existing and approved) in the locality.	Section 7.2.3 Appendix E – Technical paper: Noise and vibration impact assessment.
An operational road traffic noise assessment including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers.	Section 7.2.3 Appendix E – Technical paper: Noise and vibration impact assessment.
The assessment must take into account the following guidelines as relevant: Interim Construction Noise Guideline (DECC 2009), Road Noise Policy (OEH, 2011)*, Environmental Noise Management Manual (RTA 2001), Assessing Vibration: A Technical Guideline (DEC 2006); and Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990).*	Section 7.2.1 Section 7.2.3 Appendix E – Technical paper: Noise and vibration impact assessment.

7.2.1 Methodology

To assess the potential impacts arising from construction and operation of the project, an assessment has been undertaken with consideration to the following:

- *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009) to assess construction noise impacts.
- NSW *Environmental Criteria for Road Traffic Noise* (ECRTN) (Environment Protection Authority (EPA), 1999), which has been superseded by the ICNG but is used for guidance in assessing the potential for sleep disturbance.
- *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation (DEC), 2006) to assess impacts arising from construction vibration, excluding blasting activities.
- *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Conservation Council (ANZECC), 1990) provides criteria designated to minimise annoyance and discomfort at sensitive receivers as a result of blasting works.
- *Road Noise Policy* (RNP) (Office of Environment and Heritage (OEH), 2011), to assess road traffic noise impacts from the project during the operational stages of the project.
- The *NSW Industrial Noise Policy* (INP) (EPA, 2000) in regard to background noise monitoring.

Background noise monitoring was undertaken at ten locations throughout the project area to determine existing background noise levels (to be used to define construction noise criteria) and to measure average noise levels from the existing roads (to calibrate the operational noise model). Background noise monitoring was undertaken in accordance with all relevant guidelines and the procedures contained in the INP, the ICNG and the RNP.

The locations were selected to be representative of potential impacts arising from construction and operational noise impacts, and are located up to 600 metres from the project. The setback distance of 600 metres was selected to satisfy the assessment requirement of the RNP.

Unattended and attended noise measurements were taken at the nominated locations to determine the existing noise levels in order to establish the following:

- L_{A1}, which represents the noise level exceeded for one per cent of the sample period (ie measurement period).
- L_{A10}, which represents the noise level exceeded for ten per cent of the measurement interval. This is commonly referred to as the average-maximum level.
- L_{Amax}, which represents the maximum noise level measured at a given location over the measurement period.
- L_{Aeq} which is essentially the average sound level or the energy averaged noise level over a defined measurement period. For traffic noise, this description is classified as $L_{Aeq15Hr}$ and L_{Aeq9Hr} for the day and night-time noise levels respectively. This is commonly referred to as the ambient noise level.
- L_{A90}, which represents the noise level exceeded for 90 per cent of the measurement interval. This is taken to be the background noise level.
- Rating Background Level (RBL), which represents the average minimum background sound level, which is the tenth percentile of the L_{A90} values.

To assess construction noise impacts, the study area was divided into six distinct Noise Catchment Areas (NCA's), representing the differing background noise levels measured at each of the monitoring locations. These catchment areas are shown in **Figure 7.3**.

To assess the operational impacts of the project, both daytime and night-time noise levels were predicted for 2017, being the year when the project would open, and 2027, representing 10 years after the project opening. Three scenarios were then developed for both years to represent:

- The 'no build' scenario, being noise levels without the project. This would determine the road traffic noise levels that would occur due to natural traffic growth in the absence of the project.
- The 'build' scenario, being noise levels with the project and incorporating all local roads, the main alignment and interchanges. This was used to assess noise levels at sensitive receivers to which the redeveloped road noise criterion applies, being those sensitive receivers that are already exposed to road traffic noise. This criterion is discussed further in **Section 7.2.3**.
- The 'modified build' scenario. This is similar to the 'build' scenario but only includes the main alignment and interchanges. This scenario was used to assess noise levels at sensitive receivers to which the new road criterion applies, being sensitive receivers that would be subject to a new source of road traffic noise. This criterion is discussed further in **Section 7.2.3**.

Comparing predicted noise levels with and without the project at 2017 would identify any potential noise issues at the commencement of the project. Similarly, comparing predicted noise levels with and without the project at 2027, would identify the potential for noise impacts in the longer term once the project is well established and the traffic using the surrounding road network has stabilised.

The 2027 scenario was also modelled with a low noise pavement and a variety of test noise barriers to identify possible approaches to noise mitigation. As noise barriers have the potential to reflect noise to a receiver on the opposite side of the roadway, a +2dB(A) reflection factor was also added to the results for all sensitive receivers that may be impacted in this way. Meteorological conditions were also considered, and are discussed in **Section 7.2.4**.

7.2.2 Existing environment

Residences, businesses and other community facilities (such as churches and open spaces) are located along the project alignment at varying distances from the existing highway and project alignment (refer to **Appendix B** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment). Given the change in land uses and the location of sensitive receivers, there are a number of distinct existing noise environments.

The rural areas to the north of Berry are dominated by pastureland and rural settlement patterns. Generally, the existing noise levels experienced by residences in this area would be relatively low. The exception would be at sensitive receivers which are located in close proximity to the existing highway and would be exposed to traffic noise. In particular, residences located next to the existing highway between Toolijooa Road and Tindalls Lane would be exposed to high traffic noise levels due to the braking and acceleration of vehicles on the steep grades and sharp bends that characterise this section of the existing highway.

Within Berry, the existing highway runs directly through town along Queen Street. Businesses and residences located along Queen Street experience a high level of traffic noise. Noise associated with the existing traffic along Queen Street also affects surrounding residences and businesses that do not have a direct frontage to the highway.

South of Berry, Mark Radium Park and the Bupa Aged Care Facility are located along the Princes Highway.

Residences and churches located along North Street currently experience a low noise environment and are largely unaffected by the existing highway. Traffic volumes are relatively low, although local traffic travelling from the north of Berry through to Kangaroo Valley Road uses North Street to avoid congestion along Queen Street. Occasional heavy vehicle or farm machinery movements also occur on North Street and are associated with the agricultural properties located on the northern side of North Street. The low noise environment at this location makes it an attractive walking and cycling route.

Residences located at Huntingdale Park Estate and other residential areas along Kangaroo Valley Road also experience a relatively quiet noise environment. Traffic noise is largely generated by light vehicular traffic. There is also a small buffer separating residences along Huntingdale Park Road and the existing highway. This shields residences from highway traffic noise to some degree.

The results of the background noise monitoring conducted for the project are provided in **Table 7-24** and **Table 7-25**. Background noise levels for the area reflect the daily traffic volume patterns of the highway with background noise levels dropping when traffic volumes drop significantly. This demonstrates that traffic noise is the dominant noise source in the area. The detailed results of the noise monitoring are provided in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment.

Table 7-24 Background noise levels dB(A)

Noise logging location*		Rating background level dB(A)		
		Day (7 am 6pm) L_{A90}	Evening (6pm-10pm) L_{A90}	Night (10pm-7am) L_{A90}
BG1	46 Princes Highway, Broughton Village	48	40	40[1]
BG2	10 Austral Park Road, Broughton	40	41 (40)[2]	40
BG3	200 Princes Highway, Berry	41	39	38
BG4	111 Princes Highway, Berry	41	39	37
BG5	132 North Street, Berry	35	37 (35)[2]	35
BG6	92 North Street, Berry	36	36	35
BG7	2 The Gables, Berry	37	37	37
BG8	Andersons Lane, Berry	44	41	33
BG9	Andersons Lane, Berry	41	39	35
BG10	Andersons Lane, Berry	38	36	33

Noise logger locations are shown in **Figure 7.3*
Note 1: Night time L_{A90} has been adjusted to the lower evening L_{A90}
Note 2: The numbers in brackets indicate the RBL with the INP adjustments included

Table 7-25 Day and night time road traffic noise levels

Noise logging location		Ambient road noise level L_{Aeq} (dB(A))	
		Day ($L_{Aeq\ (15h)}$)	Night ($L_{Aeq\ (9h)}$)
BG1	46 Princes Highway, Broughton Village	60	56
BG2	10 Austral Park Road, Broughton	50	48
BG3	200 Princes Highway, Berry	53	49
BG4	111 Princes Highway, Berry	53	44
BG5	132 North Street, Berry	58	46
BG6	92 North Street, Berry	56	46
BG7	2 The Gables, Berry	63	52
BG8	Andersons Lane, Berry	56	54
BG9	Andersons Lane, Berry	52	48
BG10	Andersons Lane, Berry	49	44

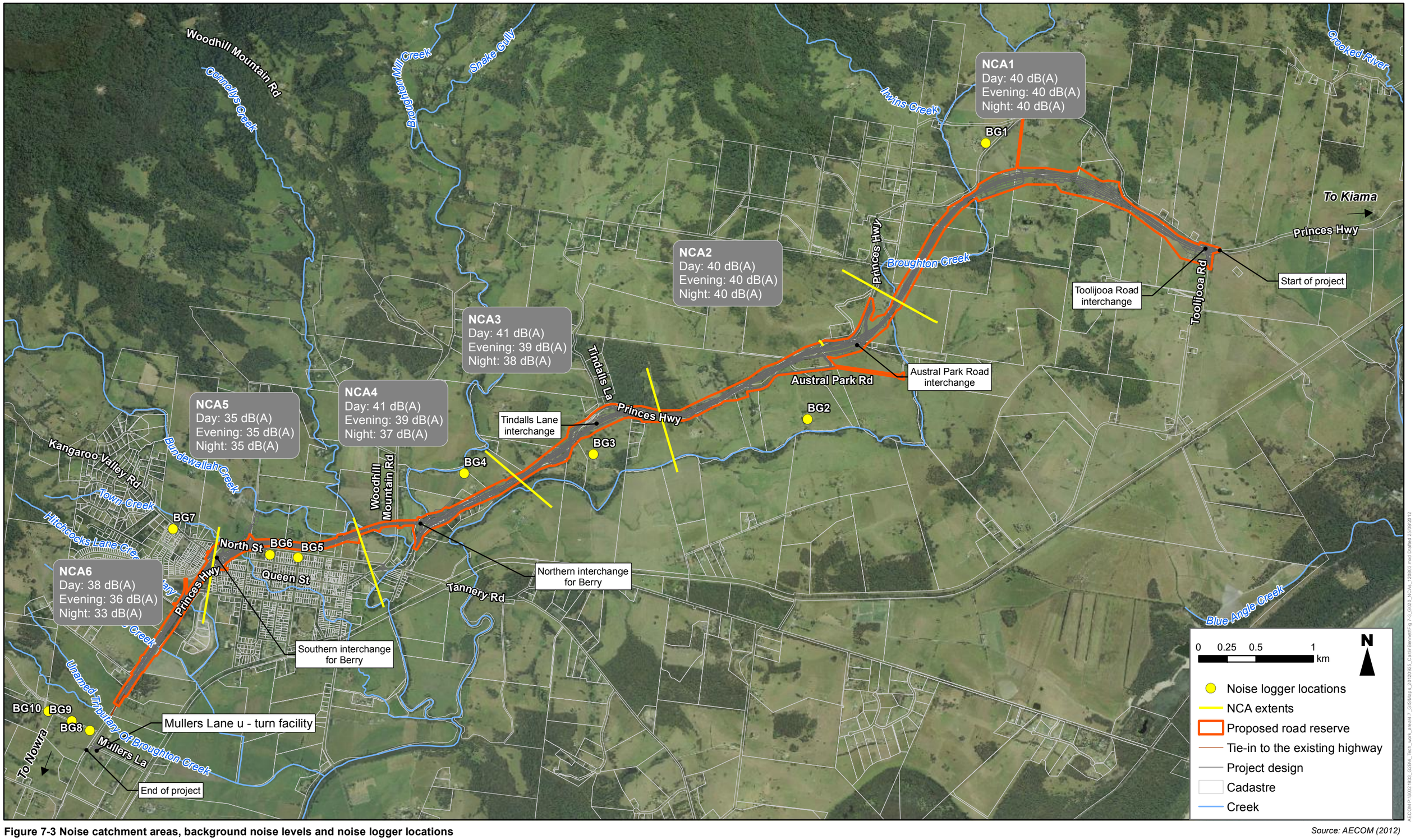

Figure 7-3 Noise catchment areas, background noise levels and noise logger locations

Source: AECOM (2012)

7.2.3 Noise and vibration criteria

Construction noise criteria

The ICNG is used in construction noise assessments. This document supersedes the OEH's previous publication the *Environmental Noise Control Manual* (ENCM) and has been used as the basis for establishing construction noise management levels (NMLs).

NMLs must be set for construction during daytime and out of standard hours periods and must be met where feasible and reasonable. Work that is proposed outside of standard working hours, as defined in the ICNG, generally requires strong justification.

NMLs for residential receivers are derived using the information in **Table 7-26** (excerpt from the ICNG) and are outlined in **Table 7-27** for the noise catchment areas identified for the project.

Table 7-26 Noise management levels for residences for airborne noise

Time of day	Noise management level
	$L_{Aeq(15\ mins)}$
Recommended standard hours Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays	Noise affected RBL + 10dB
	Highly noise affected 75 dB(A)
Outside recommended standard hours	Noise affected RBL + 5dB

Extracted from ICNG (DECCW, 2009)
**Noise affected – The point above which there may be some community reaction to noise*
***Highly noise affected – The point above which there may be strong community reaction to noise*

Table 7-27 Noise management levels for the project

Noise catchment area	Period	Background noise level	Noise management levels
		$L_{Aeq(15\ mins)}$	$L_{Aeq(15\ mins)}$
NCA1	Day[1]	40	50
	Evening	40	45
	Night[2]	40	45
NCA2	Day	40	50
	Evening	40	45
	Night	40	45
NCA3	Day	41	51
	Evening	39	44
	Night	38	43
NCA4	Day	41	51
	Evening	39	44
	Night	37	42
NCA5	Day	35	45
	Evening	35	40
	Night	35	40
NCA6	Day	38	48
	Evening	36	41
	Night	33	38

1. *RBL:+10dB*
2. *RBL: +5dB*

For construction activities proposed outside the standard hours of construction, different noise management levels apply. Extended construction work hours have been assessed in accordance with the INP shoulder periods. The morning shoulder periods are considered to be 6am to 7am Monday to Friday and 8am to 9am Saturdays.

The RBL is considered to be the mid-point between the night-time and daytime RBL. The NML is the RBL + 5dB(A). The assessment period RBL and NML for the morning shoulder period is provided in **Table 7-28**. Noise levels are between 0 dB(A) and 3 dB(A) less stringent than the night-time NMLs.

Table 7-28 Morning shoulder noise assessment levels

NCA	Period	Mid point in Rating Background Levels (RBL)*	Noise management levels (NML)**
NCA1	Morning Shoulder	40	45
NCA2	Morning Shoulder	40	45
NCA3	Morning Shoulder	40	45
NCA4	Morning Shoulder	39	44
NCA5	Morning Shoulder	35	40
NCA6	Morning Shoulder	36	41

Noise management levels for noise sensitive land uses other than residential receivers such as places of worship or recreational areas are based on internal noise levels. These criteria only apply when the building or area is in use. Noise management levels for the two churches located on North Street and the Berry sportsground and Camp Quality memorial park (Woodhill Mountain Road) are provided in **Table 7-29**.

Table 7-29 Noise management levels at sensitive land uses (other than residential) that are applicable to the project

Land use	Noise management level (when in use)
	$L_{Aeq(15\ mins)}$
Places of Worship	Internal noise level 45 dB(A)
Active recreational areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65dB(A)
Passive recreational areas (which are spaces used for contemplative activities that generate little noise and where benefits are compromised by external noise intrusion)	External noise level 60dB(A)

Extracted from ICNG (DECCW, 2009)

Where noise is predicted to be above the noise management levels, all reasonable and feasible measures must be applied to reduce noise emissions. Where noise levels are predicted to be above the 'highly affected' noise management level (being 75 dB(A))(refer to **Table 7-26**), then restrictions to the hours of construction may apply.

Construction road traffic noise criteria

The RNP does not provide a criterion to assess the noise generated by traffic during construction. Typically, the approach applied to construction traffic noise is to limit the increase in existing road noise levels to 2 dB(A). This has been applied to the construction noise impact assessment for this project.

Sleep disturbance criteria

The ICNG requires the potential impacts on sleep disturbance to be considered where construction works are planned to extend over more than two consecutive nights. The ICNG refers to the ECRTN to provide the appropriate assessment approach. The ECRTN has now superseded by the RNP, for assessment of sleep disturbance. However the RNP refers to the ECRTN as being the most appropriate assessment. As such the ECRTN will be referenced for sleep disturbance.

The ECRTN suggests that for night-time activities, the $L_{A1(60\ second)}$ noise levels should be calculated and compared with the RBL plus 15dB(A) as the sleep disturbance screening criterion. Further assessment is recommended where the screening criterion is exceeded, with consideration given to how often these exceedances occur.

The ECRTN also suggests that:

- The maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dB(A) to 70 dB(A), are not likely to affect health and wellbeing significantly.

Given that a building with an open window provides up to 10 dB(A) noise attenuation from outside to inside, it is reasonable to assume that external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Construction vibration criteria

Vibration targets vary depending on whether the particular activities of interest are continuous in nature, impulsive or intermittent and whether they occur during the day or night. The effects of vibration in buildings can be divided into two main categories:

- Structural damage of buildings, including superficial cracking in cement render or plaster.
- Human comfort, where the occupants or users of the buildings are inconvenienced or possibly disturbed by vibration (tactile vibration) or ground-borne noise.

Criteria relevant to the response of building occupants to vibration are more stringent than those relevant to building damage. The guidelines or standards used in the assessment are provided in **Table 7-30.**

Table 7-30 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures
Human comfort (tactile vibration) (*)	NSW 'Assessing Vibration: A Technical Guideline' (DEC 2006)
Human comfort (regenerated noise)	NSW 'Interim Construction Noise Guideline' (DECCW 2009)

(*) These documents are based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the EPA still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Structural damage

Table 7-31 provides the recommended maximum level of vibration that reduces the likelihood of cosmetic damage caused by vibration. The levels are designed to minimise the risk of cosmetic surface cracks and are set well below the levels that have the potential to cause damage to the main structure. Examples of threshold or cosmetic cracking include minor non-structural effects such as superficial cracking in cement render or plaster.

Table 7-31 Structural damage vibration limits

Group	Type of structure	Vibration velocity in mm/s			
		At foundation At a frequency of		Plane of floor of uppermost storey	
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Groups 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Human comfort (tactile vibration)

Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g. workshop, office, or residence) and the character of vibration (eg continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perceptibility.

Table 7-32, **Table 7-33** and **Table 7-34** provide the preferred and maximum values for continuous, impulsive and intermittent vibration, which have been used for the purposes of this assessment.

Where predicted levels are below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Activities should be designed to meet the preferred values where an area is not already exposed to vibration.

Values up to the maximum level may be used if they can be justified and where all feasible and reasonable measures have been applied. For values beyond the maximum value, consultation with the affected community should be undertaken. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration.

Table 7-32 Preferred and maximum vibration levels for continuous vibration

Location	Daytime		Night time	
	Preferred*	Maximum*	Preferred*	Maximum*
Residences	0.010	0.020	0.007	0.014
Offices, schools, educational institutions and places of worship	0.020	0.040	0.020	0.040

** weighted root mean square (rms) vibration levels for continuous vibration acceleration (m/s^2) in the vertical direction.*

Table 7-33 Preferred and maximum vibration levels for impulsive vibration

Location	Daytime		Night time	
	Preferred*	Maximum*	Preferred*	Maximum*
Residences	0.3	0.6	0.1	0.2
Offices, schools, educational institutions and places of worship	0.640	1.280	0.640	1.280

**weighted root mean square (rms) vibration levels for impulsive vibration acceleration (m/s^2) in the vertical direction*

Table 7-34 Preferred and maximum vibration levels for intermittent vibration

Location	Daytime		Night time	
	Preferred	Maximum	Preferred	Maximum
	$m/s^{1.75}$			
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8

Human comfort (ground-borne noise)

Vibration generated by activities such as compacting or drilling may enter buildings via the ground. This causes the floors, walls and ceilings to vibrate and to radiate noise, which is commonly referred to as ground-borne noise or regenerated noise. Ground-borne noise is typically low frequency and if audible is perceived as a 'rumble'.

In general, ground-borne noise level values are relevant only where they are higher than the airborne noise from the construction activities. Regenerated noise levels would typically be masked by air-borne noise associated with the construction activities.

The ground-borne noise management levels as outlined in the ICNG are provided in **Table 7-35**. The ground-borne noise levels are applicable during the evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

Table 7-35 Recommended ground-borne noise goals for construction activities

Time	Ground-borne noise goals
Evening (6 pm to 10 pm)	40 dB(A) $L_{Aeq,15min}$
Night-time (10 pm to 7 am)	35 dB(A) $L_{Aeq,15min}$

Blasting noise and vibration criteria

Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990) provides criteria designated to minimise annoyance and discomfort at sensitive receivers as a result of blasting works (refer to **Table 7-36**). The criteria provided in this table are only applicable to annoyance and discomfort from blasting. Building damage criteria has previously been provided in **Table 7-31**. The criteria are for guidance only and may be varied to suit local site conditions.

Australian Standard AS2107.2 '*Explosives – Storage and Use Part 2: Use of Explosives'* recommends that if the prescribed limits in **Table 7-36** cannot be achieved, an agreement may be reached with the land owner permitting higher levels. It also recommends that blasting should generally take place no more than once per day.

Table 7-36 Air blast overpressure criteria and peak particle velocity criteria

Airblast overpressure (dB)	Allowable exceedance
115	5% of total number of blasts over a 12 month period
120	Never
Peak particle velocity (PPV) (mm/s)	**Allowable exceedance**
5	5% of total number of blasts over a 12 month period
10	Never

Operational criteria

Operational noise criteria

The RNP establishes noise assessment criteria for new road projects, redeveloped existing roads and new traffic-generating developments in NSW. It was released in July 2011 and replaced the ECRTN.

The RNP identifies different noise assessment criteria depending on the road category, the type of road project being proposed, and the type of noise sensitive receiver that is potentially affected by the project.

The noise assessment criteria for this project are provided in **Table 7-37** (residential noise sensitive receivers) and **Table 7-38** (other noise sensitive land uses). The criteria applied reflect the highway category of the project and the type of project, being the construction of a new road and the redevelopment of an existing road.

In the case of the new road assessment criteria, this is applied to sensitive receivers that would be subject to a new source of road traffic noise. A receiver is considered to fall into this category if the project would develop:

- A new road where a road of the same category did not previously exist.
- A new road within an existing but previously undeveloped road corridor.
- An alignment or realignment of a road that would produce noise at a receiver from a different direction and that increases noise levels at any exposed facade by 2dB(A) or more.

In the case of the redeveloped road noise criteria, this is applied to sensitive receivers that are already subject to existing road traffic noise.

In addition to the noise assessment criteria provided in **Table 7-37** and **Table 7-38**, the RNP also requires the 'relative increase' in noise levels to be considered for residential receivers. The relative increase is defined as the difference in noise levels when comparing road traffic noise without or with the project, with the assessment criterion set at 12 dB over the existing road traffic noise levels (refer to **Table 7-39**). This criterion has been specifically developed to capture excessive changes in amenity due to a road project, particularly in environments where there is a low existing level of traffic noise.

Table 7-37 Noise assessment criteria for residential receivers

Road category	Type of project/land use	Assessment criteria	
		Day (7 am – 10pm)	Night (10 pm – 7am)
Freeway/arterial/sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15\ hour)}$ 55 (external)	$L_{Aeq(9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeways/arterial/sub-arterial roads	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
Local roads	Existing residences affected by noise from new local road corridors Existing residences affected by noise from redevelopment of existing local roads Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Table 7-38 Noise assessment criteria for other sensitive land uses

Existing sensitive land use	Assessment criteria	
	Day (7 am – 10pm)	Night (10 pm – 7am)
Places of Worship	$L_{Aeq(1\ hour)}$ 40 (internal)	$L_{Aeq(1\ hour)}$ 40 (internal)
Open Space (active)	$L_{Aeq\ (15\ hour)}$ 60 (external) when in use	-
Open Space (passive)	$L_{Aeq\ (15\ hour)}$ 55 (external) when in use	

Table 7-39 Relative increase noise assessment criteria for residential receivers

Road category	Type of project/land use	Assessment criteria Total traffic noise level increase dB(A)	
		Day (7 am – 10pm)	Night (10 pm – 7am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on an existing road	Existing traffic $L_{Aeq(15\ hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq(9\ hour)}$ + 12 dB (external)

For sensitive receivers to qualify for the consideration of noise mitigation under the 'new road' criteria, the predicted noise levels must exceed the applicable noise criteria.

Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. The subsequent objective is to protect against excessive decreases in amenity as a result of the project by applying the relative increase criteria. The RNP definitions of reasonable and feasible have been used in this noise assessment. Feasible refers to whether it is feasible for the noise mitigation measure to be engineered or if it is practical to build given project constraints (such as safety and maintenance requirements). Reasonable refers to whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects. This includes considerations to community views and financial costs.

When assessing feasible and reasonable mitigation measures for a redeveloped road, an increase of up to 2 dB(A) represents a minor impact where it is generally not considered feasible and reasonable to provide additional mitigation. An increase of greater than 2 dB(A) would require consideration of all feasible and reasonable mitigation measures.

However if the receiver is found to be acutely affected then appropriate mitigation options must be considered. A receiver is considered acutely affected if the predicted noise levels are equal to or greater than a daytime $L_{Aeq(15hour)}$ of 65 dB(A) or a night-time $L_{Aeq(9hour)}$ of 60 dB(A).

Sleep disturbance

The RNP includes a review of international sleep arousal research and concludes that at our current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance.

The application notes for the RNP recommend that sleep disturbance is assessed based on the emergence of the $L_{A1\ (1\ minute)}$ noise level over the corresponding $L_{A90\ (15\ minute)}$ noise level (ie the noise level exceeded for 1 per cent of the measurement period, or the 'typical maximum' noise level, against the background noise). The emergence is the amount the maximum noise levels rise above the typical noise levels. If the maximum noise levels (typically from engine braking) are significantly higher than the typical noise, the noise has a high level of emergence. As the emergence increases, the likelihood for sleep disturbance also increases. The emergence level is used as the basis for the sleep disturbance assessment.

The following screening criterion for sleep disturbance is recommended for the assessment of sleep disturbance: $L_{A1\ (1\ minute)} < L_{A90\ (15\ minute)} + 15$ dB(A).

7.2.4 Assessment of potential impacts

Construction noise and vibration

The proposed construction activities have the potential to generate a range of impacts on sensitive receivers along the project alignment. These have been considered separately and are as follows:

- Impacts from construction noise sources and activities.
- Impacts from construction activities during standard construction hours.
- Impacts from extended or out-of-hours construction activities including sleep disturbance.
- Impacts from temporary construction ancillary facilities, such as stockpiling sites and site compounds.
- Impacts from increased traffic noise due to construction traffic.
- Impacts from construction vibration on buildings and/or human comfort from general construction activities.
- Impacts on buildings and/or human comfort due to blasting activities at Toolijooa Ridge.
- Cumulative noise impacts.

Impacts from construction noise sources and activities

For the purposes of this assessment, six main construction activities have been identified. The equipment expected to be used and the expected working hours for each construction activity are provided below in **Table 7-40**. This does not include batching plant activities, as this activity is not proposed as part of the project. Sources of construction noise and vibration would comprise a range of heavy vehicles, plant and equipment and hand tools. Based on the typical sound power levels for these sources, noise level predictions have been undertaken (refer **Appendix E**).

Table 7-40 Construction equipment for general construction work

Activity	Typical equipment used	Typical and maximum SWL* dB(A)	Expected working hours
Site Establishment /Landscaping	Excavators, chainsaws, mulching plant and chipper, cranes, generators, bobcat, powered hand tools, air compressor.	105 – 110	Standard
Earthworks	Road trucks, compactor, grader, multi-tyred and vibratory rollers, concrete trucks, concrete vibrator, asphalt paving plant, backhoe, sweeper, compressor, generators, rock crusher.	112 – 120	Standard
Bored piling	Bored piling rig.	100 – 110	Standard
Impact piling	Impact (driven) piling rig.	124 – 134	Standard
Bridge works	Piling rigs, cranes.	112 – 120	Standard
Paving	Road trucks, compactor, jackhammers, multi-tyred vibratory rollers, concrete trucks, concrete vibrator, asphalt paving plant, backhoe, concrete saw, profiler, sweeper, compressor, generator.	113 – 118	Standard, Evening, Night-time

**SWL – Sound power level*

A noise source may exhibit a range of particular characteristics that increase annoyance, such as tones, impulses, low frequency noise and intermittent noise. Where this is the case, an adjustment is applied to the source noise level received at the assessment point to account for the additional annoyance caused by the particular characteristics. The adjustments have been applied to the activities in **Table 7-40**.

Impacts from construction activities during standard construction hours

The majority of construction activities would take place from 7am-6pm, Monday to Friday and 8am-1pm Saturday, with no work on Sunday or public holidays.

For each of the six construction activities described in **Table 7-41**, a worst case and representative scenario was assessed to predict impacts on nearby sensitive receivers during standard hours of construction. This does not factor in reductions on noise levels that can be achieved through reasonable and feasible mitigation measures.

The representative scenario reflects a most likely scenario, in which not all the equipment would be in use at the same time (resulting in 112 dB(A)). The worst case scenario represents a larger number of the equipment being in operation at the same time (resulting in 120dB(A)). The results for each scenario and the number of sensitive receivers that would be impacted are provided in **Table 7-41**. The table also provides a total number of highly noise affected sensitive receivers (being those above 75dB(A)).

NCA 5, which represents Berry, contains the majority of the impacted sensitive receivers. This is because of the higher density of sensitive receivers within that noise catchment and the proximity of construction work to sensitive receivers. Activities that are likely to have the most impact on sensitive receivers include paving, bridge works and piling.

For other sensitive land uses:

- Construction activities are not expected to correspond with Sunday services at churches along North Street. As such, impacts are considered to be unlikely.
- Activities at the sportsground at Berry would typically only occur concurrently with construction works during Saturdays mornings, from 9am to 1pm. Impacts could occur, and these would need to be considered during construction scheduling.

The worst case scenario for each activity significantly increases the number of sensitive receivers that would be impacted. However, it is important to note that these scenarios do not necessarily represent the noise impact at sensitive receivers for an extended period of time. Highly noisy activities, such as rock breaking and use of concrete saws, are only likely to occur for a small fraction of the total construction period. The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **Section 7.2.5**.

Highly noise affected sensitive receivers would require noise mitigation, as detailed in **Section 7.2.5**.

Additional scenarios were assessed for specific works during standard construction hours, such as the Toolijooa cutting and the construction of the southern interchange for Berry. These scenarios were based on predicted activities and duration of the activities as discussed in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment.

Table 7-41 Predicted levels of construction noise during standard construction hours (daytime)

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected
Establishment and landscape works							
NCA1	50	60	3	0	65	4	0
NCA2	50	58	3	0	63	9	0
NCA3	51	51	0	0	56	2	0
NCA4	51	63	12	0	68	15	0
NCA5	45	65	150	0	70	270	0
NCA6	48	57	7	0	62	21	0
		Total	**175**	**0**	**Total**	**321**	**0**
Earthworks							
NCA1	50	67	4	0	75	12	0
NCA2	50	65	10	0	73	18	0
NCA3	51	58	4	0	66	9	0
NCA4	51	70	15	0	78	32	3
NCA5	45	72	315	0	80	456	11
NCA6	48	64	21	0	72	22	0
		Total	**369**	**0**	**Total**	**549**	**14**
Bored Piling							
NCA1	50	55	1	0	65	4	0
NCA2	50	53	0	0	63	9	0
NCA3	51	46	0	0	56	2	0
NCA4	51	58	4	0	68	15	0

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected
NCA5	45	60	43	0	70	270	0
NCA6	48	52	1	0	62	21	0
		Total	**49**	**0**	**Total**	**321**	**0**
Impact Piling							
NCA1	50	79	16	1	89	22	3
NCA2	50	77	16	0	87	16	4
NCA3	51	70	10	0	80	14	2
NCA4	51	82	34	4	92	39	13
NCA5	45	84	457	12	94	458	95
NCA6	48	76	22	0	86	22	6
		Total	**555**	**17**	**Total**	**571**	**123**
Bridge Works							
NCA1	50	64	2	0	72	10	0
NCA2	50	63	6	0	71	8	0
NCA3	51	51	0	0	59	3	0
NCA4	51	72	6	0	80	28	2
NCA5	45	71	152	0	79	427	1
NCA6	48	43	0	0	51	8	0
		Total	**166**	**0**	**Total**	**484**	**3**
Paving							
NCA1	50	78	4	0	83	10	0
NCA2	50	73	10	0	81	16	0
NCA3	51	66	4	0	74	7	0
NCA4	51	78	15	0	86	23	0
NCA5	45	80	338	0	88	455	0
NCA6	48	72	21	0	80	21	0
		Total	**392**	**0**	**Total**	**532**	0

NCA – Noise Catchment Area
NML-Noise Management Limit
*Refer to **Table 7-27** for NMLs specific to NCAs*

Impacts from extended or out-of-hours construction activities, including sleep disturbance

It is proposed that construction activities would be undertaken outside standard construction hours. These activities fall into three categories as discussed below:

- Inaudible construction activities, which do not require approval to be carried out.
- Activities to be undertaken during extended construction hours of 6am to 7am and 6pm to 7pm Monday to Friday; plus 1pm to 5pm on Saturdays. Certain additional activities would be undertaken during the extended construction hours for the duration of construction. Approval is sought for these activities as part of the project.
- Out-of-hours activities, which would be undertaken with agreement with the affected receiver or agreed to by the EPA on a case-by-case basis.

Some construction activities would be undertaken outside of the standard and extended construction hours without approval in the following circumstances:

- The works do not exceed the NMLs.
- For delivery of materials required outside standard and extended working hours by the Police or other relevant authorities for safety reasons.
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

Extended construction hours

RMS is proposing to undertake extended working hours for the duration of the project in order to reduce the construction period. Extended working hours would consist of an additional time at the start and end of each working weekday (6am to 7am and 6pm to 7pm Monday to Friday; plus 7am to 8am and 1pm to 4pm on Saturday).

Noise modelling has been undertaken to determine the impact of extended hours during the morning shoulder period. The result of this noise modelling is provided in **Table 4-2** to **Table 4-7** of the *Noise and Vibration Technical Paper* provided at **Appendix E**.

The morning shoulder noise modelling showed that there would be a maximum of 91 receivers impacted during this period. However, this scenario represents a worst case scenario and would occur for activities such as impact piling which would be unlikely to occur during the morning shoulder period.

Activities during the morning extended period hours would typically comprise of low noise impacts including deliveries, site access, refuelling, office works, foot-based activities and possibly work in ancillary activities.

When required, certain other activities would also be undertaken during extended construction hours. These activities include compound and site maintenance, bridge works (excluding the bridge at Berry), concrete works, and preparation works associated with blasting activities (such as drilling, haulage and rock crushing). These activities would be limited to the following times and locations:

- Between 6am and 7pm Monday to Friday for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Between 8am and 5pm on Saturdays for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Outside of known likely major traffic peaks (such as the Friday evening prior to a public holiday long weekend).

No construction activity would be undertaken near Berry during the proposed extended hours, given the number of sensitive receivers located close to the construction activities.

The ICNG permits certain types of work that may be undertaken outside normal construction hours. This includes public infrastructure works in which extended construction hours would shorten the length of the project and are supported by the affected community. It also identifies that out of hours work can be granted where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.

Extended construction hours at the start and finish of each working day are considered to be in the public interest as they would:

- Shorten the overall construction period by approximately three months or 10 per cent. This would minimise the disruption to the Princes Highway and improve access to the NSW south coast. It would also minimise impacts to local businesses that may be experienced during the construction period.
- Reduce the publics' exposure to a substandard and inefficient road, reducing the potential for crashes.
- Potentially reduce the overall cost of construction.

The impact of the extended hours would not differ from the predicted noise level for daytime works in **Table 7-41**. However, as the works would take place during the night-time and evening periods, the NMLs would be exceeded by as much as 10 dB(A).

To determine if the extended hours would be supported by the affected community, targeted community consultation with property owners was completed in September 2011 and January 2012. A total of 58 properties from Toolijooa Road to the northern Berry interchange were identified as being potentially impacted by construction noise and therefore may be subject to potential impacts associated with works during extended hours. Of these properties nine are owned by RMS. Contact was made with all 58 properties, via phone calls and/or letters, offering information on the intended activities and offering to meet to discuss the potential impacts further.

A total of 34 of the property owners requested an interview with the project team to discuss potential impacts or to seek clarification regarding the proposed extended working hours. A summary of the comments and feedback recorded during these interviews is included in **Chapter 6**. Discussions included information on:

- The standard working hours and what the extended hours would mean for each property.
- The likely work activities that may be undertaken during extended hours based on current information and the potential construction scenarios.
- The likely complaints management procedures that would be put in place during construction.
- The approvals and control regime that would be put in place for construction activities (such as conditions of consent or the conditions of an Environment Protection Licence).
- Consultation that would be ongoing as the project progresses through detailed design and construction.

Feedback received during the consultation demonstrated that with the appropriate construction programming in place and the consideration of periods of respite during the day, there is general support overall for the application of extended working hours, as it provides a way to potentially shorten the construction period and enables the contractor to make up potential lost time due to inclement weather or other unexpected delays. An additional hour at the start and finish of each working day is generally considered to be an appropriate 'trade-off' to minimise construction delays and complete the project as quickly as possible.

Although feedback was generally supportive of extended construction hours, a number of property owners raised concerns relating to potential disruptions to cattle movements, the requirement to separate livestock from loud noise associated with construction or loud noise events (including blasts) that may disturb livestock (including horses). It was noted that these issues, and other concerns relating to possible personal special events on the property, could be discussed in more detail prior to and during construction through the ongoing project communications channels. Of the 34 consultation interviews undertaken, three property owners expressed some concern over extended working hours in the morning and evening, and one was concerned about Saturday afternoons.

Mitigation and management strategies for extended hours are discussed in **Section 7.2.5**.

Out of hours works

Some construction activities would also be undertaken outside of the standard and extended construction hours in the following circumstances:

- As agreed through negotiations between RMS and potentially affected sensitive receivers. Any such agreement would be recorded in writing and a copy kept on-site for the duration of the works.
- As agreed by the EPA for a specific activity for out-of-hours work, determined on a case-by-case basis.

Activities that would fall into this category are described in **Section 4.7** of **Appendix E**, and include paving, bridge works, refueling activities, utlitity adjustments and road tie-in works. These would need to be undertaken outside of normal and extended construction hours to ensure road safety, minimise disruption to regional and local traffic flows and/or for technical and timetabling reasons.

To consider the impacts of the noisiest out-of-hours construction activities, representative and worst case scenarios were assessed for earthworks, bridge works and paving. Concrete cutting associated with the paving works has the greatest potential for advserse impacts during out of hours work periods. Mitigation measures are available that could minimise this impact, as discussed in **Section 7.2.5.** The detailed results of this assessment can be found in **Appendix E**.

Out of hours activities may cause sleep disturbance. The extent of this impact would be dependent on the specific details of the works, such as equipment and what type of works would be undertaken. Potential impacts on sleep disturbance would need to be included in any future planning for out of hours work.

Impacts from temporary construction ancillary facilities, such as stockpiling sites and site compounds

The noise criteria for the ancillary facilities apply to the NCA within which the facility occurs (refer to **Figure 7.3**). **Table 7-42** is a summary of the potentially most affected sensitive receivers surrounding each ancillary facility site (refer to **Appendix B** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment) and predicted typical and worst case noise levels for each. In cases where two proposed ancillary facilities are in close proximity to one another, the noise assessment has considered this as one site. Evening and night time periods were also considered, as these sites may be required to support extended or out of hours construction activities. Noise contours for the operations of the ancillary facilities are provided in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment.

The predicted noise levels indicate that activities within the site compounds are likely to exceed the appropriate NMLs. There would also be the potential for cumulative impacts to arise when road works and activities at ancillary construction sites occur at the same time. This could increase noise levels by as much as three dB(A) above the maximum noise level. This is not generally considered to be a significant increase.

However, given noise has been predicted to be above the NMLs, all reasonable and feasible noise mitigation and management measures would be considered and detailed by the contractor in the Construction Noise and Vibration Management Plan (CNVMP).

Table 7-42 Construction ancillary facilities*

Receiver number	Distance (m)	Noise catchment area	Predicted noise levels dB(A)		Standard hours NML dB(A)	Out of hours NML dB(A)	
			Representative	Worst case		Evening	Night-time
Construction ancillary site A							
1	89	NCA1	58	66	50	46	45
3	45	NCA1	61	69	50	46	45
4	457	NCA1	43	51	50	46	45
5	190	NCA1	51	59	50	46	45
Construction ancillary sites B and C							
9	210	NCA1	51	59	50	46	45
10	185	NCA1	52	60	50	46	45
11	185	NCA1	51	59	50	46	45
Construction ancillary site D							
12	123	NCA1	40	48	50	46	45
14	109	NCA1	58	66	50	46	45
16	394	NCA1	43	51	50	46	45
Construction ancillary sites E and F							
19	328	NCA1	45	53	50	46	45
20	340	NCA1	46	54	50	46	45
23	285	NCA1	46	54	50	46	45
25	575	NCA2	40	48	50	46	45
Construction ancillary sites G and H							
30	380	NCA2	45	53	50	46	45
31	240	NCA2	50	58	50	46	45
32	220	NCA2	51	59	50	46	45
33	50	NCA2	63	71	50	46	45
34	165	NCA2	54	62	50	46	45
35	350	NCA2	46	54	50	46	45
36	0	NCA2	78	86	50	46	45
38	335	NCA2	46	54	50	46	45
Construction ancillary site I							
41	180	NCA2	51	59	50	46	45
46	200	NCA2	51	59	50	46	45
48	40	NCA2	65	73	50	46	45
51	70	NCA3	61	69	51	44	43
52	200	NCA3	51	59	51	44	43
53	77	NCA3	58	66	51	44	43
56	147	NCA4	53	61	51	44	42
57	267	NCA4	50	58	51	44	42

Receiver number	Distance (m)	Noise catchment area	Predicted noise levels dB(A)		Standard hours NML dB(A)	Out of hours NML dB(A)	
			Representative	Worst case		Evening	Night-time
Construction ancillary site J							
66	235	NCA4	49	57	51	44	42
69	142	NCA4	52	60	51	44	42
71	38	NCA4	62	70	51	44	42
73	38	NCA4	63	71	51	44	42
92	170	NCA4	53	61	51	44	42
93	270	NCA4	48	56	51	44	42
Construction ancillary site K							
435	35	NCA5	72	80	45	42	40
452	30	NCA5	66	74	45	42	40
462	26	NCA5	75	83	45	42	40
466	26	NCA5	77	85	45	42	40
467	28	NCA5	76	84	45	42	40
476	31	NCA5	64	72	45	42	40
Construction ancillary site L							
561	57	NCA6	58	66	48	41	38
562	57	NCA6	55	63	48	41	38
564	60	NCA6	56	64	48	41	38

** The construction ancillary sites correspond to the sites illustrated in **Figure 4-19**.*

Impacts from increased traffic noise due to construction traffic

While spoil would be transported as much as practicable along internal haulage routes, construction of the project would increase both light and heavy vehicle movements on the Princes Highway. An increase in construction traffic during the night-time period is not predicted for this project as the extent of haulage activities is not currently known. This would be considered in any request for out-of-hours work.

The increase in noise from additional traffic associated with the construction of this project is likely to be less than 0.5 dB(A). Considering the predicted increase in noise is well below 2 dB(A), the impact from the additional traffic associated with the construction works would not be significant.

However operations, such as idling trucks for long periods alongside sensitive receivers, still has the potential to adversely impact sensitive receivers. Mitigation measures in **Section 7.2.4** would be needed to minimise this potential impact.

Impacts from construction vibration on buildings and/or human comfort from general construction activities

Vibration intensive works may occur during each phase of the project. Vibration generated during construction has the potential to cause structural/cosmetic damage or cause human discomfort by continuous, intermittent and impulsive vibration generated by general construction activity. Ground-borne noise impacts may also be generated by vibration-generating activities, such as compacting or drilling.

The extent of the potential impact is dependent on the type of equipment, the activity being undertaken and the separation distance. Earthworks and bridge works are expected to be the major vibration causing activities, given the use of vibratory rollers, hydraulic hammers and pile drivers. There is a higher likelihood that these activities would cause human annoyance from seven metres to 100 metres away from the construction area (Refer to **Table 7-43**).

Beyond 100 metres, general construction activity from the project is unlikely to cause human response to vibration. For structural impacts, cosmetic damage to buildings would not be likely where the building is distanced from the project by five metres to 25 metres. Safe working distances for vibration intensive plant equipment have been established, and are provided in **Table 7-43**. These were developed using the criteria provided in **Section 7.2.3**.

There are likely to be instances where vibration intensive activities within these setbacks must occur and cannot be avoided. This could be due to the work required, the underlying geological site conditions or the proximity of the building/receiver to the construction site. In these instances, mitigation and management measures would need to be implemented.

Table 7-43 Recommended safe working distances for vibration intensive plant

Plant	Rating/description	Safe working distance	
		Cosmetic damage	Human response
Vibratory roller	< 50 kN (Typically 1-2t)	5 m	15-20 m
	< 100 kN (Typically 2-4t)	6 m	20 m
	< 200 kN (Typically 4-6t)	12 m	40 m
	< 300 kN (Typically 7-13t)	15 m	100 m
	> 300 kN (Typically 13-18t)	20 m	100 m
	> 300 kN (> 18 t)	25 m	100 m
Small hydraulic hammer	(300 kg – 5-12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg – 12-18t excavator)	7 m	23 m
Large hydraulic hammer	(1,600 kg – 18-34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2–20 m	20 m
Pile boring	≤ 800 mm	2 m	N/A
Jackhammer	Handheld	1 m nominal	Avoid contact with structure

Impacts on buildings and/or human comfort due to blasting activities at Toolijooa Ridge

Construction of the cutting at Toolijooa Ridge may require the use of explosives, with typically one blast occurring per day. This has the potential to generate vibration and overpressure impacts that may impact on the structural integrity of nearby buildings and cause human discomfort. Four sensitive receivers that have the potential to be affected by blasting activities at Toolijooa Ridge have been identified. These range in distance from around 260 metres to 450 metres away from the cutting.

Overpressure and vibration levels are highly dependent on local site conditions and the charge of the blast. As these conditions are not known at this stage of the project, minimum offset distances have been calculated in **Table 7-44** under 'typical' conditions to meet the overpressure and vibration goals provided in **Section 7.2.3** of this environmental assessment. Smaller test blasts would need to be undertaken before project-specific distances can be confirmed.

Table 7-44 Minimum offset distances for overpressure and blast limits

Charge	Minimum offset distances (metres)	
	Overpressure	Vibration (PPV)
1kg	550	30
5 kg	900	67
10 kg	1150	95

Based on the calculated minimum offset distances (refer to **Table 7-44**), the results indicate that although vibration limits would be complied with, overpressure is likely to exceed the appropriate limits at all four sensitive receivers. However, as the project proceeds, it is likely that the noise levels would be mitigated by the cut, and noise levels would gradually decrease. On this basis, the blast size could be increased as the works progress, subject to monitoring confirming that the required levels of mitigation can be achieved.

Blast mitigation strategies would need to be implemented to reduce noise levels and to minimise the likelihood of an exceedance. These are discussed further in **Section 7.2.5** of this environmental assessment.

To improve productivity of the construction, it is also proposed that simultaneous blasts may be undertaken. As blasting would only need to occur for a discrete construction period, simultaneous blasts would deliver the benefits of reducing both the number of blasts and the duration of construction at Toolijooa Ridge. This would require an increase to the maximum allowable levels for overpressure and blast limits given the cumulative impact of the blasts.

In these cases, alternative or secondary criteria and minimum setback distances have been determined, and are provided in **Table 7-45** and **Table 7-46**. As this represents a lowering of recommended criteria, simultaneous blasts would only occur where agreement of the affected receiver is obtained.

Table 7-45 Standard and secondary overpressure and peak particle velocity (PPV) criteria

Criteria	Standard maximum allowable levels	Secondary maximum allowable level
Overpressure	115 dB(Lin)	125 dB(Lin)
PPV	10mm/s	15mm/s

Table 7-46 Secondary minimum setback distances for overpressure and blast limits

Charge	Minimum offset distances (metres)	
	Overpressure	Vibration (PPV)
1kg	240	15
5 kg	410	34
10 kg	520	48

Cumulative noise impacts

The construction of the project is expected to commence in 2014, with the project opening to traffic in 2017. Other major construction work in the area would be associated with:

- The Gerringong upgrade, which is located to the north of the project. Construction work commenced in 2012, with the upgrade expected to open to traffic in 2014.
- The Berry to Bomaderry upgrade proposal, located to the south of the project. This is still in the planning stage. In the event that this project moves forward to assessment and approval stage, it is expected that construction work would commence in 2017.

It is not possible to eliminate the possibility of some overlap of the construction activities of the project with those associated with the Gerringong upgrade. This could increase noise levels by as much as three dB(A) above the maximum noise level. This is not generally considered to be a significant increase, but would be considered in any mitigation strategies (should this eventuate).

Given the current status of the Berry to Bomaderry upgrade proposal which is still in the planning phase, any associated cumulative impacts with specific regard to noise and vibration are not able to be accurately predicted. A cumulative impact assessment can only be made when the Berry to Bomaderry upgrade is at a much more advanced stage where construction stages and scheduling have commenced. If the Berry to Bomaderry upgrade proposal proceeds to the environmental assessment stage, that assessment would assess and consider any cumulative impact from the Foxground and Berry Bypass.

There are no other major projects in the immediate area that would be under construction at the same time as the project.

Operational noise

The project has the potential to generate a range of impacts on sensitive receivers along the project alignment during operation.

Based on the results of noise assessment modelling, noise at a total of 108 sensitive receivers would be above the appropriate noise criteria during the daytime period as a result of the project (refer to **Appendix I** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment. Of the 108 sensitive receivers, 7 are considered to be acutely affected (being $L_{Aeq(15\ hour)}$ of 65dB(A) or greater). During the night-time period, noise at 131 sensitive receivers would exceed the appropriate noise criteria as a result of the project, of which 16 are considered to be acutely affected (being $L_{Aeq(9\ hour)}$ of 60dB(A) or greater).

Overall, noise at a total of 164 receivers was found to exceed the applicable operational noise criteria (with some receivers experiencing exceedances during both the daytime and night-time periods) of which 18 receivers are considered to be acutely affected.

The results of the operational noise model can be found in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment, and are shown on **Figure 7-4** to **Figure 7-6.**

Queen Street

A considerable number of receivers along Queen Street have been found to be acutely affected by noise associated with traffic on the existing highway (Queen Street). The project would redirect a significant amount of existing and future traffic from Queen Street to the new alignment, which would result in appreciable decreases in noise levels at receivers on Queen Street. However, noise levels at these receivers would still exceed relevant noise criteria.

Noise levels emitted from the new alignment (located to the north of Berry) would comply with the appropriate noise criteria at the Queen Street receivers. Considering noise levels emitted from the new alignment would comply with the appropriate noise criteria, these receivers would not be impacted directly by the project. Noise levels at Queen Street receivers would still exceed relevant noise criteria, however this would not be as a result of the project and therefore these receivers would not be considered to be eligible for noise mitigation.

Local roads in Berry

The closure of Victoria Street, Berry would result in changed traffic patterns on local roads within the town. Traffic that currently accesses or exits the highway from Victoria Street would be required to access and exit the project at the southern interchange for Berry utilising Queen Street. As discussed in **Section 7.1,** this would increase traffic volumes on the north-south running local roads in Berry between Queen Street and Victoria Street. These local roads include Prince Alfred Street, Alexandra Street, Albany Street, Edward Street and George Street.

Existing noise levels at receivers along the north-south local roads are currently dominated by noise generated from Queen Street during peak hour traffic flows. As discussed above, traffic flows on Queen Street would decrease as a result of the project and therefore most receivers on the north-south local roads would experience a reduction in noise levels following construction. A small number of receivers located further form Queen Street would experience an increase in noise levels during peak hour flows that is typically considered inaudible (less than two dB(A)).

As with receivers on Queen Street, a number of receivers on the north-south local roads currently experience noise levels above the relevant criteria. The noise at these receivers is currently controlled by traffic movements on Queen Street, rather than the local road on which the receiver is located. With the proposed closure of Victoria Street, noise levels on the north-south local roads would continue to be controlled by movements on Queen Street. As such, the project would not adversely impact noise levels at receivers on north-south local roads within Berry and receivers would not be considered eligible for noise mitigation.

North Street

A large number of receivers along North Street, between the Berry Sportsgrounds and Kangaroo Valley Road would be impacted by the project during operation (refer **Figure 7-6**). It is proposed that a noise barrier would be located along the North Street corridor to reduce the traffic noise impacts on these receivers. The noise barrier would start at the western end of the bridge at Berry and extend along the length of the North Street corridor to the southbound off-ramp of the southern interchange to finish near the intersection of Queen Street and Kangaroo Valley Road (refer to **Figure 7-7**).

A noise barrier over eight metres in height at this location would achieve compliance with the noise criteria at all sensitive receivers at this location. However, an eight metre barrier is not considered appropriate, given the significant visual impacts a barrier at this height would have along North Street. It would also be inconsistent with the community's expressed desire to maintain the existing district views from the town to the north.

Instead, a noise barrier four metres in height has been recommended as part of the project. Following construction of a four metre high noise barrier, 29 receivers would remain above the noise criteria. Six receivers on North Street would be eligible for additional noise mitigation. The remaining receivers would be above the criteria by one to two dB(A) and as a result would not be eligible for additional noise mitigation.

Additional work has been undertaken to assess and minimise visual impacts of the noise barrier along North Street. This would include the incorporation of an embankment or Ha-ha barrier to provide a vanishing slope affect to the noise barrier along North Street. The visual assessment of the noise barrier is discussed in more detail in **Section 7-6** and **Appendix I**.

Northbound off-ramp at the southern interchange for Berry

A noise barrier height of four metres is proposed along the northbound off-ramp for the southern interchange for Berry. It would be located between Huntingdale Park Road and the off-ramp and would finish near the intersection with Kangaroo Valley Road (refer to **Figure 7-7**). In addition to the proposed noise barrier, four properties on Kangaroo Valley Road and North Street would be eligible for additional noise mitigation.

Noise barrier reflection

The proposed noise barriers would be unlikely to impact sensitive receivers located on the opposite side of the project due to the reflection of noise. Any reflection impacts have been included in the noise predictions. As such, any qualification for mitigation at these receivers would have factored in this potential impact.

Other sensitive noise receivers

A small number of receivers located further from Queen Street would experience an increase in noise of typically between one dB(A) and two dB(A) is predicted between the year of opening and 10 years after opening, with a small number of sensitive receivers experiencing an increase of greater than two dB(A).

The proposed low noise pavement for the entire alignment and four metre noise barrier would reduce noise levels at the Berry Uniting Church and at Saint Patrick's Catholic Church, with:

- A noise reduction of seven dB(A) at the facade of the most effected building at the Berry Uniting Church. After taking into account external to internal losses and facade reflections, internal noise levels are predicted to be 40 dB(A) and would be equal to the internal noise criterion of 40 dB(A) ($L_{Aeq(1\ hour)}$).
- A noise reduction of nine dB(A) at the facade of the most effected building at Saint Patrick's Catholic Church. After taking into account external to internal losses and facade reflections, internal noise levels at predicted to be 39 dB(A) and would be below the internal noise criterion of 40 dB(A) ($L_{Aeq(1\ hour)}$).

The predicted noise levels at these locations would be equal to or below the criterion. However, as the noise levels predicted for the churches have been based on a number of assumptions, further analysis would be undertaken at the opening of the project to ensure the noise levels comply with the criterion.

The aged care facility (Bupa Care Services) accessed from Victoria Street, Berry has been assessed in accordance with the RNP against the residential criteria (refer to **Appendix I** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment). The maximum $L_{Aeq(9hour)}$ noise level predicted on the site of the Bupa Care Services is 58 dB(A). The predicted noise level exceeds the 'redeveloped road' criteria of 55 dB(A). However, there is no significant increase in noise levels as a result of the project.

A total of 20 isolated properties have been identified that would experience noise levels above the controlling criterion such that they would qualify for the consideration for architectural treatments. These properties are identified generally in **Figure 7-4** to **Figure 7-6.** These properties are identified as Noise Receiver 14a, 17a, 22a, 23, 25, 28, 29, 30, 33a, 73, 110, 299, 355, 374, 384, 386, 438, 439, 445 and 451 in **Appendix B** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment. The type of treatment applicable would depend on the level of the noise exceedances, namely:

- Fresh air ventilation, sealing of wall vents and upgraded window and door seals would be generally considered appropriate for properties that experience exceedances up to 10 dB(A) (Architectural treatment type 1).
- Additional upgrade of windows and doors would be considered in addition to the above for properties that experience exceedances over 10 dB(A) (Architectural treatment type 2).

Based on the predicted noise exceedances, all isolated properties, except for Noise Receiver 25, would experience exceedances up to 10 dB(A). Noise Receiver 25 may be eligible for architectural treatment type 2.

Noise levels at the active open space areas, being the Berry Sportsground and the Berry Riding Club, did not exceed the criteria. Noise at the Camp Quality Memorial Park would be above the criteria for passive open space land uses. However, noise reductions are expected at all three locations due to the inclusion of a low-noise pavement and the proposed four metre high noise barrier along North Street. As a result of these mitigation measures, a noise level reduction to 55 dB(A) is predicted. This complies with both noise criteria for active and passive recreational areas.

At Mark Radium Park, the proposed low noise pavement would reduce noise levels by two dB(A) at this location. This remains five dB(A) above the passive recreation criterion of $L_{Aeq(15hour)}$ 55 dB(A). Given the location of Mark Radium Park next to the existing highway and that the park is already receiving treatment in the form of a low noise pavement, the only other form of mitigation suitable is a noise protection barrier. A noise protection barrier in the order of 4 metres would be required to achieve compliance with the criteria. A noise barrier would be a significant structure and impede the use and the serenity of the park, a barrier is considered unfeasible. A small exceedence of the noise criteria at this location would be less significant than a noise barrier, for this reason, the impacts on the park are considered acceptable and not significant.

Figure 7-4 Receivers predicted to exceed criteria in areas from Toolijooa Road interchange to just east of the Austral Park Road interchange

Source: AECOM (2012)

Figure 7-5 Receivers predicted to exceed criteria in areas between Austral Park Road interchange and Tindalls Lane interchange

Source: AECOM (2012)

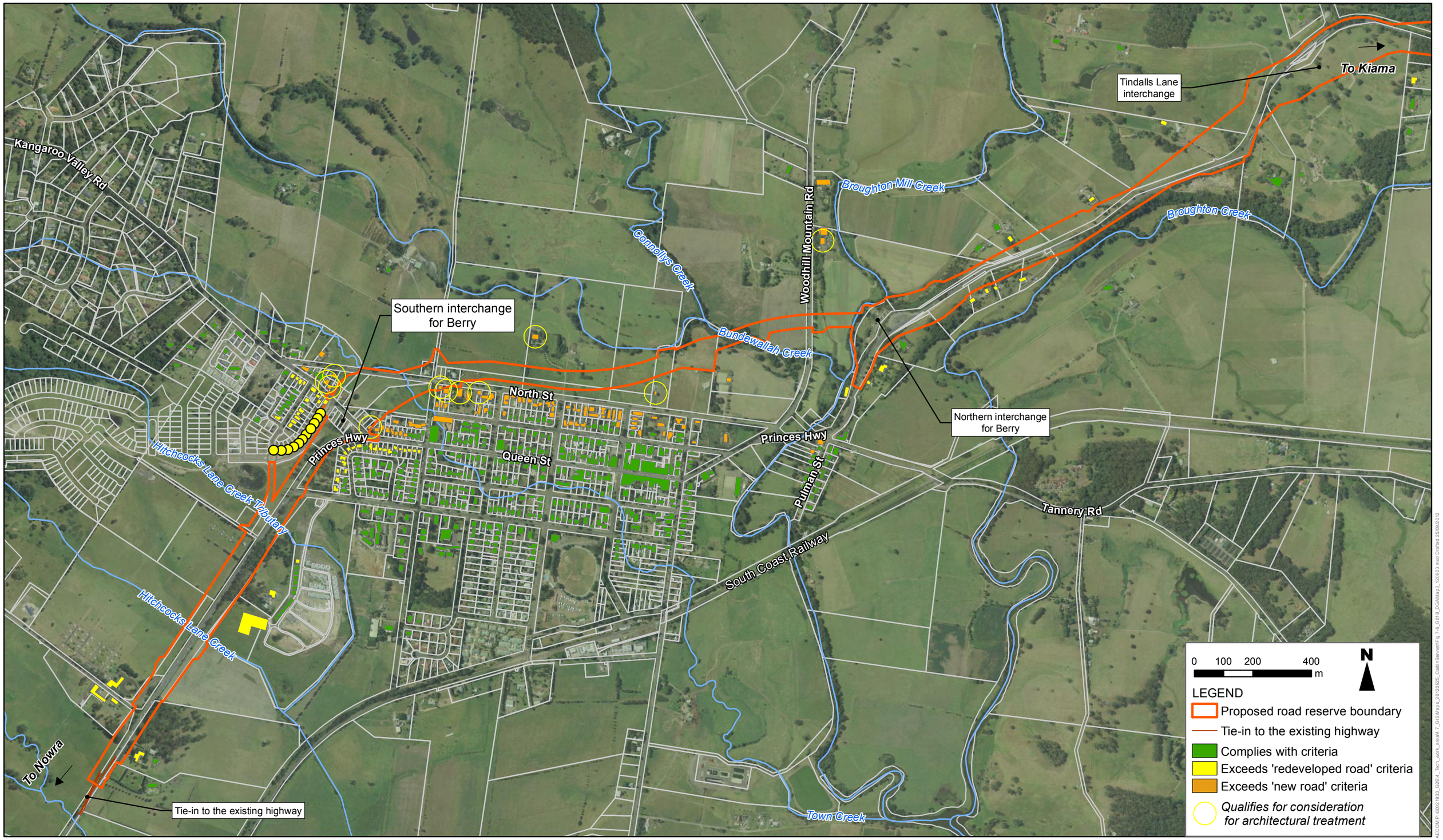

Figure 7-6 Receivers predicted to exceed criteria in areas between Tindalls Lane interchange and Schofields Lane junction

Source: AECOM (2012)

Figure 7-7 Noise barrier locations at Berry

Source: AECOM (2012), LPMA (2011)

Meteorological effects

Meteorological effects have been assessed in accordance with the INP, as required by the DGRs. There is no requirement to meet the noise criteria under adverse weather conditions and the effectiveness of noise mitigation measures with weather effects has not been considered in this section.

Weather data between January 2000 and January 2001 for the closest weather station at Gerroa, NSW, was sourced from the Bureau of Meteorology. Based on this data, it was noted that:

- Temperature inversions are considered to be a feature of the area, with temperature inversions occurring 47 per cent of the total time between 6pm and 7am during the winter months. Temperature inversions could increase the noise levels at sensitive receivers by up to 5dB(A).
- Sensitive receivers located towards the south of the project would be adversely impacted as a result of wind effects (being residences exposed to wind speeds of up to three metres per second). At these sensitive receivers, noise levels could increase by up to around 5dB(A).

Sleep disturbance

The emergence level (or sleep disturbance guideline) has been considered at two monitoring locations BG9 and BG6 (refer **Figure 7-3**). These locations are considered to be typical of existing receivers north and south of Berry located on the existing alignment.

Monitoring at these two locations indicates that sleep disturbance is likely to be an existing issue for the local area.

For receivers where the project would not move the road closer to them, compared to the existing situation, the emergence is likely to decrease in the future. As traffic volumes increase, the $L_{Aeq(1hr)}$ noise levels would also increase, however as the road is not located closer to receivers, the maximum noise levels would not increase. As the difference between these levels decrease (resulting in a decrease in emergence), the potential for sleep disturbance is likely to become less prominent.

The proposed alignment would also decrease the gradient in some areas, and reduce the undulating nature of the existing alignment. This should reduce the use of truck engine braking and high engine revs, reducing maximum noise levels.

However receivers exposed to a new road would still be likely to receive emergence levels greater than 15 dB(A). Maximum noise levels decay from the source at twice the rate than average noise levels. On this basis, receivers located further from the alignment are theoretically likely to have lower emergence levels and therefore sleep disturbance is likely to be less of an issue.

7.2.5 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage noise and vibration impacts. These mitigation and management measures are identified in **Table 7-47** and have been incorporated in the draft statement of commitments in **Chapter 10**.

Table 7.47 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Construction noise	Prepare and implement a CNVMP that identifies reasonable and feasible approaches to reduce noise impacts during construction including for ancillary facilities. Inform the community at least 48 hours before any out of hours work is to be undertaken and provide the following information: • Programmed times and locations of construction work. • Construction noise and vibration impact predictions. • Construction noise and vibration mitigation measures being implemented on site. Provide specific details of all out of hours work to the EPA. Implement a notification and consultation procedure to identify when noise impacts during extended hours and out of hours work are above relevant criteria and enable appropriate management measures to be developed. Implement a hot line and complaints handling procedure for noise and other construction related complaints. Include specific noise mitigation measures in the CNVMP including: • Noise intensive construction works would be carried out during standard construction hours wherever practicable. • Noisy activities that cannot be undertaken during standard construction hours would be scheduled as early as possible during the evening and/or night-time periods. • Appropriate plant would be selected for each task, to minimise the noise impact. • Deliveries would be carried out during standard construction hours where practical and safe to do so. • Non-tonal reversing alarms would be fitted on all construction equipment where possible. • If it is safe, night-time activities would be planned and conducted in such a manner as to eliminate or minimise the need for audible warning alarms. • The offset distance between noisy plant items and nearby residential receivers would be maximised. • Noisy equipment would be oriented away from residential receivers.

Potential impacts	Mitigation and management measures
	• Site access points and roads would be positioned as far as practicable away from residential receivers. • Structures or enclosures would be used to shield residential receivers from noise sources where practicable. • Trucks would travel via internal haul routes and major roads and routes where practicable and would not be allowed to queue near residential dwellings. • Respite periods would be considered during times of noise intensive works where sensitive receivers would be adversely impacted for extended periods. These could include late start and/or early finishes. • Wherever practicable, noise intensive works would be planned in the following order of priority to minimise the potential impacts on sensitive receivers. – Standard working hours. – Extended working hours. – Evening working hours. – Night time working hours. • To reduce the total number of blasts, multiple simultaneous blasts would be undertaken. Simultaneous blasts would not increase the perceived number of blasts in one day, hence would be unlikely to increase the annoyance of potentially impacted receivers. • Bored piling would be used in place of impact piling wherever possible. Additionally, impact piling would only be undertaken during standard work hours.
Construction vibration	Prepare and implement a CNVMP that identifies reasonable and feasible approaches to reduce vibration impacts during construction including for ancillary facilities. Include specific vibration mitigation measures in the CNVMP including: • Vibration intensive works would not occur outside the safe working distances outlined in **Table 7-43** unless necessary. • If vibration intensive works would be required outside the safe working distances outlined in **Table 7-43**, alternative equipment would be used to ensure these distances are not exceeded. • If vibration intensive plant is to be used within the safe working distance for cosmetic damage, works would not proceed until attended vibration measurements are undertaken. • A permanent vibration monitoring system would be installed to warn operators (via flashing light, audible alarm, short message service (SMS) etc) when vibration levels are approaching the cosmetic damage objective to ensure applicable criteria are not exceeded. • Dilapidation surveys of the affected properties would be considered, and if required, undertaken prior to the commencement of construction. • Test blasts would be undertaken initially to determine the correct constants (blast size and offset distance) that would be employed for this project to ensure compliance with appropriate overpressure and vibration criteria for both structural damage and human comfort.

Potential impacts	Mitigation and management measures
Operation	
Noise levels from road traffic exceed criteria at sensitive receivers	Develop and implement all reasonable and feasible mitigation measures required to meet the applicable noise criteria in consultation with the sensitive receivers. Specific noise mitigation recommended for this project includes, where reasonable and feasible: • Low noise road surface. • Noise protection barriers. • Building architectural treatments. Monitor operational traffic noise at sensitive receivers between six months and one year after opening. If the traffic noise levels are above the predicted levels, consult with receivers on the development of further feasible and reasonable mitigation measures to meet the applicable criteria.