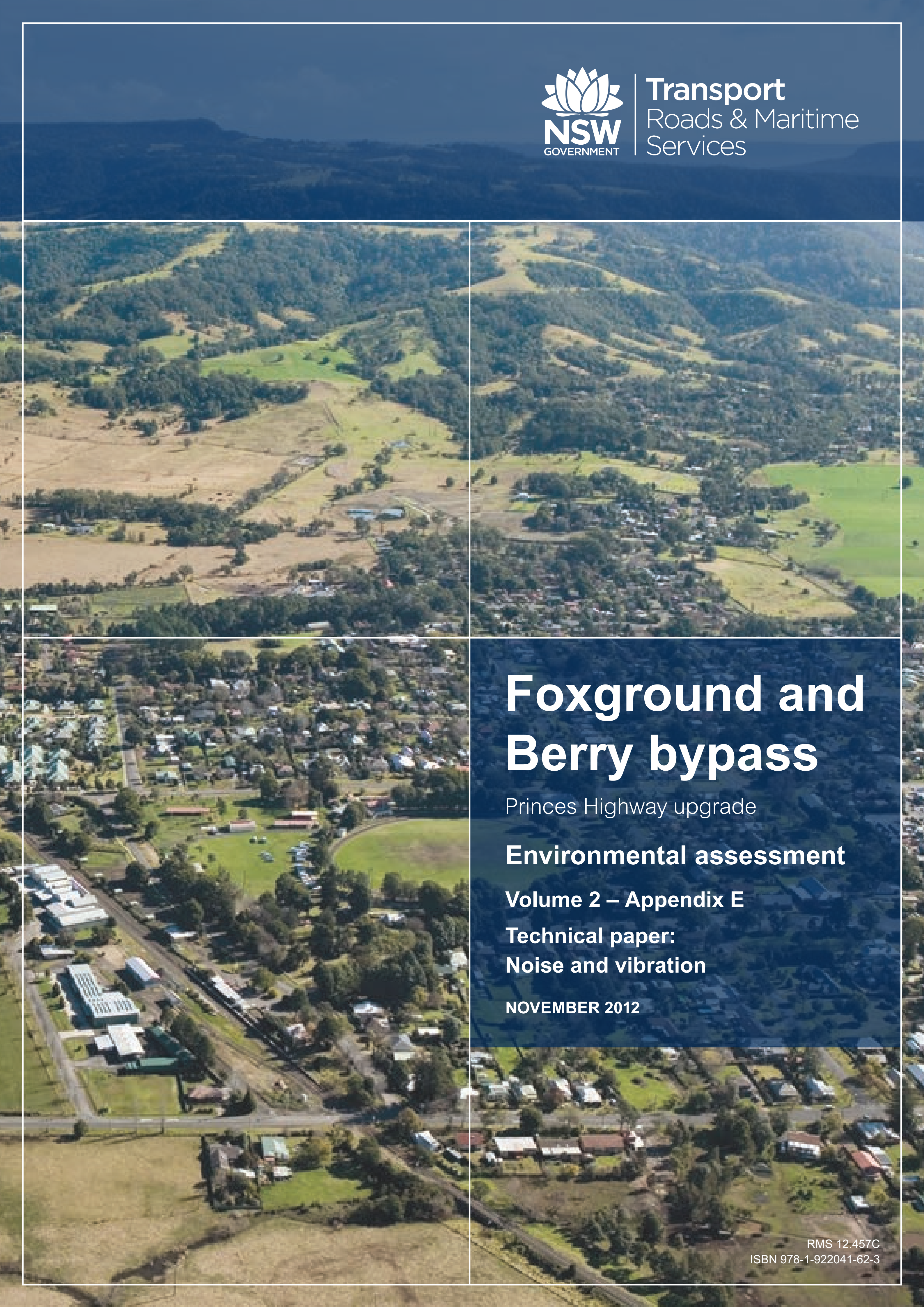

Transport Roads & Maritime Services

NSW GOVERNMENT

# Foxground and Berry bypass

Princes Highway upgrade

## Environmental assessment

**Volume 2 – Appendix E**

**Technical paper: Noise and vibration**

**NOVEMBER 2012**

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# Foxground and Berry bypass

**Prepared for**

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November 2012

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# Executive summary

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

### Existing environment

The different noise environments currently experienced throughout the project area are described and 591 noise sensitive receivers identified.

Attended and unattended ambient noise measurements have been undertaken to define the construction noise management levels (NMLs) and calibrate the SoundPLAN traffic noise model. The attended noise measurements were undertaken to define the dominant noise source(s) at each location and confirm the suitability of the measurement location.

The unattended noise measurements were undertaken at ten locations throughout the project area. Simultaneous traffic counts were undertaken to measure the traffic volumes at the time of the noise measurements. The results of the unattended noise logging provided correlation with the SoundPLAN model within the accuracies of the Calculation of Road Traffic Noise (CoRTN) algorithm.

### Noise criteria

The construction noise management levels were derived from the unattended background noise logging results.

The predicted operational noise from the project has been assessed in accordance with the Road Noise Policy (RNP) (EPA, 2011) and the Environmental Noise Management Manual (ENMM) (RMS, 2001). Appropriate criteria provided in these documents have been used as the basis for the noise impact assessment.

### Noise and vibration impact assessment

Standard construction activities including site establishment, earthworks, piling, bridgeworks and paving activities were assessed in accordance with the Interim Construction Noise Guideline (ICNG, 2009). Both typical and worst case noise levels were predicted for the construction noise assessment. Predicted noise levels were found to exceed the NMLs, but generally remain below the ‘highly affected’ noise level.

Works undertaken within the ancillary facilities were also found to exceed the noise management levels. Extended working hours north of the Berry township have been proposed in this report. As work practices would not differ from those during standard work hours, the predicted noise levels are the same. However, the NMLs are typically 5 dB(A) to 10 dB(A) more stringent during the evening and night-time periods, due to lower background noise levels and a more stringent criteria in the ICNG for out of standard hours works. The potential exceedance of the NMLs would therefore increase accordingly.

Particularly noisy equipment has been identified and respite periods have been recommended where extended periods of work would be scheduled.

Extended hours of work have been recommended in order to increase construction efficiency. Five construction scenarios have been selected and have been recommended for extended hours works based on importance and impacts.

Some out of hours work (separate to the extended hours work) would be required for this project. This work is typically not noise intensive, and it is generally impractical to be undertaken during standard work hours due to safety and inconvenience to Princes Highway traffic. Activities including material deliveries and works that would have a major effect on traffic flows can typically be expected during out of hours work periods.

Blasting would be required along the Toolijooa Ridge to produce a cutting to accommodate the alignment. Appropriate blasting criteria in accordance with the relevant guidelines have been recommended. Higher limits have also been proposed contingent on the approval of the affected residents, and the employment of safe work practices. The aim of the higher blasting limits is to reduce the number of blasts and the overall construction timeframe and consequent impacts on the community.

A community engagement framework has been recommended to ensure noise impacted residents would be consulted satisfactorily. The highest consideration should be given to the closest and most affected noise sensitive receivers.

There are currently no proposed or current works that would be undertaken concurrently with the construction of this project. As such sensitive receivers are unlikely to be impacted by the cumulative impacts of construction noise.

The applicable operational noise criteria would be exceeded at 164 receivers, of which 18 receivers are considered to be acutely affected as a direct result of the new road alignment.

Maximum noise levels currently exceed the recommended limits, and are predicted to continue to do so in the future at most locations. The levels may be lower along the new sections of highway due to a reduction in gradients lessening the tendency for trucks to require engine braking and high engine noise. However, receivers that are exposed to a new road would experience a similar number of noise events exceeding the sleep disturbance guideline similar to that currently experienced on existing sections of the Princes Highway.

### Mitigation

Recommended construction noise mitigation and management measures have been provided in this report to be included in the construction practices wherever practicable. These measures would be further clarified in the construction noise and vibration management plan (CNVMP) to be developed by the contractor and based on detailed design.

Construction safe working distances have been recommended to ensure that receivers would not be not adversely impacted by vibration as a result of the project. Vibration monitoring should be undertaken within the recommended safe working distances to ensure that the appropriate criteria are not exceeded.

Operational noise mitigation measures in the form of a low noise pavement, a four metre noise protection barrier (subject to detailed design in consultation with the community) to the north of North Street, a four metre noise protection barrier (subject to detailed design in consultation with the community) on the on north bound exit ramp alongside Huntingdale Park Road, and 20 architectural property treatments have been recommended.

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# 1 Introduction

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

The Director-General of the NSW Department of Planning and Infrastructure required that the noise and vibration assessment address a number of matters. These are the Director-General's requirements (DGRs) which are outlined in **Table 1-1** and cross referenced to relevant sections in the report in which they are addressed.

**Table 1-1 Director-General's requirements**

| DGR reference | Report section |
|---|---|
| A construction noise and vibration assessment including construction noise, batch plants and blasting impacts. Clearly identify nearest sensitive receivers and assess construction noise/vibration generated by representative construction scenarios focussing on high noise generating works. | Sections 1.2, 2.3,<br>Appendix B, 3.1, 3.2, 3.3, 3.4, 4.1, 4.8, 4.9, 4.10 |
| 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. | Sections 1.2.2, 1.2.3, 4.2.4, 5.1 |
| The assessment must further consider any cumulative impacts during construction, having regard to any other developments (both existing and approved) in the locality | Sections 4.5 |
| 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; | Sections 4.11,4.11.6,4.11.9, 5.2 |
| The assessment(s) must take into account the following guidelines as relevant: Interim Construction Noise Guideline (DECC, 2009), *Road Noise Policy (DECCW, 2011), Environmental Noise Management Manual (RTA, 2001),* Assessing Vibration: A Technical Guidelines (DEC, 2006); and *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).* | Sections 3.1, 3.5 |

## 1.1 Overview of the proposed works

The project would involve widening and realigning a section of the Princes Highway, located within the Kiama and Shoalhaven local government areas (LGAs). The project starts at about the junction of Toolijooa Road and the Princes Highway and finishes at about the junction of Schofield's Lane and the Princes Highway, south of Berry. The total length of the project is 11.6 kilometres.

The project comprises the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.
- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road, referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around190 metres long and 13 metres in height.
  - A bridge at Berry, an 18 span concrete structure around 600 metres long and up to 12 metres in height.
- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.

- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
  - Property access and fauna underpass in the vicinity of Toolijooa Ridge at chainage 8400.
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12770.
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13700.
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100.
- Modifications to local roads, including Toolijooa Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.
- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for direct property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent ancillary facility site for general road maintenance.

Construction activities as part of the project would include the following:

- Site preparation and establishment works.
- Temporary construction facilities, including construction compounds, stockpile sites, creek crossings, sediment control basins and haulage roads.
- Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks.
- Earthworks and bridge construction.
- Pavement construction.
- Drainage construction.
- Street furniture installation.
- Site restoration.

The project and the key features of the project are shown in **Figure 1-1**.

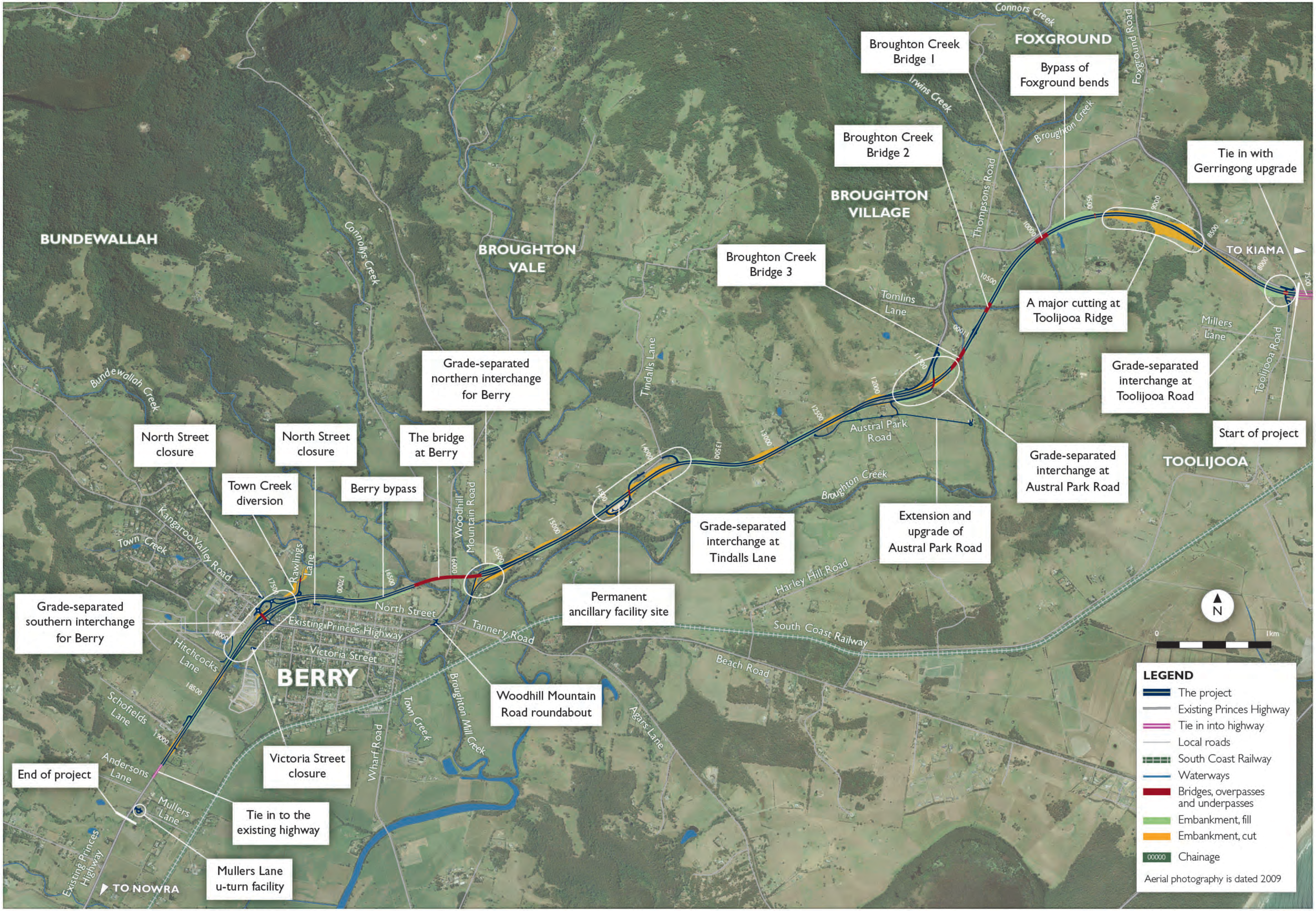



**Figure 1-1: Foxground and Berry bypass project area**

This report has been prepared to supplement the environmental assessment for the proposal and presents the findings of the noise and vibration impact assessment and the results of an investigation into feasible and reasonable construction and operation noise mitigation methods.

The scope of the construction noise and vibration assessment is as follows:

- Utilisation of background noise measurements to establish the construction noise management levels (NMLs) in accordance with the Interim Construction Noise Guideline (ICNG).
- Identification of noise sensitive catchment areas likely to be affected by construction noise and vibration.
- Calculation of noise and vibration levels likely to be associated with the construction works at sensitive receptors and evaluation of the extent of resulting impacts.
- Consideration of the impacts that may result from the proposed construction and mitigation measures to reduce adverse impacts where appropriate.

The scope of the operational road traffic noise assessment on existing residences is as follows:

- Identification of appropriate operational noise criteria in accordance with the *Road Noise Policy* (RNP) and the *Environmental Noise Management* Manual (ENMM).
- Modelling of road traffic noise levels with existing (2011) road traffic volumes (the road traffic volumes and noise levels in 2011 were selected as the existing baseline).
- Calibration of the existing road traffic noise model with site noise measurements.
- Modelling of road traffic noise levels for both the 'build' and 'no build' scenarios for the year of opening and design year.
- The establishment of a 'build' and 'no build' scenario for both programmed year of opening and 10 years after opening.
- Provision of general feasible and reasonable noise control recommendations where the operational noise criteria are exceeded.

The acoustic terminology used in this report is explained in Appendix A.

## 1.2 Construction working hours

### 1.2.1 Standard working hours

The bulk of construction activities would take place within standard working hours, which are from 7am to 6pm, Monday to Friday and 8am to 1pm Saturday, with no work on Sunday or public holidays. However, certain activities would be required to take place during the evening and night time periods due to:

- Technical considerations, such as the need to meet particular quality specifications for placement of concrete pavement.
- Safety and traffic management considerations.

Details of the out of hours work procedure and justification for specific activities are provided in Section 4.2.4.

### 1.2.2 Extended working hours

The RMS is proposing to undertake extended working hours for the duration of the project in order to reduce the construction period, minimise the overall impacts of construction works on sensitive receivers adjacent to the alignment and to provide increased flexibility in recovery from rain or other typical delay events in the construction period. Extended working hours would provide the following benefits:

- Increase the efficiency of the construction work and reduce the construction timeframe wherever possible.
- Provide the contractor with the opportunity to make up any lost time during construction that may be caused by inclement weather or other unforeseen delays.
- Minimise the significant disruption to the transport system and local environment that may occur if construction of the project takes longer than expected to complete.

Extended working hours would consist of an additional hour at the start and end of each working day (6am to 7am and 6pm to 7pm Monday to Friday; plus 1pm to 5pm on Saturday) and would typically comprise of activities with low noise impact including deliveries, site access, refuelling, office works, foot - based activities and possibly work in ancillary facility sites. Additional time 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. These additional hours would be limited to the area between the northern Berry interchange and Toolijooa Road. RMS is not intending to apply extended working hours to the area around Berry. Details of the areas where extended work hours are proposed and the preliminary consultation undertaken with the affected community are provided in Section 4.6.

### 1.2.3 Out of hours works

Some out of hours work would be required due to safety, engineering and timetable feasibility issues. Works that would be undertaken out of hours would typically include:

- Bridge works - lifting and setting of girders over existing roads. Work would typically be undertaken at night when required to reduce the inconvenience to traffic on the Princes Highway, which would need to be closed to allow works to be undertaken safely for both workers and traffic.
- Existing and new road tie-in works - this work would need to be undertaken at night to reduce the inconvenience to road traffic and the highway would need to be closed to allow this work to be undertaken safely for both traffic and workers. Tie-in road works would be required at the beginnings and ends of the new road alignment.
- Utility adjustments - utility adjustments typically need to be undertaken during out of hours work periods to minimise the impact on utility operations, road traffic and to improve the safety of workers involved.
- Refuelling and maintenance operations to plant and machinery.

# 2 Existing environment

## 2.1 Overview

The study area extends from the junction of Toolijooa Road and the Princes Highway, south of Gerringong to the junction of the Princes Highway and Schofields Lane, south of Berry. Defining features include Toolijooa Ridge, the Broughton Creek floodplain and the Foxground bends area. The study area incorporates a mix of land uses including pastureland and agricultural properties, rural residential areas and the town of Berry with its associated urban residential, recreational, commercial and light industrial areas.

## 2.2 Existing noise environments

There are a number of distinct existing noise environments in the study area that would be affected by the project in different ways. Some areas currently experience low levels of noise associated with their rural agricultural setting and others are currently exposed to higher levels of noise due to their proximity to the existing highway. Depending on their location and current land use, these areas may either experience an increase or decrease in existing noise levels, or would be exposed to new noise levels associated with the construction and operation of the project.

### 2.2.1 Rural areas

The area to the north of Berry is dominated by large agricultural properties, pastureland and scattered rural residences. Generally, noise levels experienced by properties in this area would be relatively low, except where they are located in close proximity to existing traffic and are exposed to existing traffic noise.

The existing poor road geometry between Toolijooa Road and Tindalls Lane, and in particular in the Foxground Bends area, affects the travel efficiency of traffic in both directions. Heavy vehicles are particularly affected and noise levels at properties close to the existing highway are high at times due to the braking and acceleration of vehicles on existing steep grades and sharp bends.

### 2.2.2 Berry

The most significant source of noise within Berry is the existing highway as it forms the main street through the town and is named Queen Street. The highway is utilised by heavy and light vehicle through traffic and local traffic and there are different noise environments within town that experience varying noise levels depending on their proximity to the existing highway.

Existing noise levels through the main commercial area are very high at times as both heavy and light vehicles travel through town in both directions along the existing highway. As well as the commercial properties in Berry, there are also a number of residential properties fronting the highway that experience a high level of noise associated with the highway traffic. Noise associated with existing traffic along Queen Street also affects surrounding residences and businesses that do not have a direct frontage to the highway.

### 2.2.3 Berry recreational areas

There are a number of formal and informal recreational areas in Berry that generally experience a low level of background noise associated with the existing highway, with those furthest from the highway experiencing lower noise levels.

The closest recreational facility in town to the existing highway is Mark Radium Park, located at the south western end of town between Victoria Street and the highway. The area is used by the local community and by visitors as a stopping off point. The park is directly adjacent to the existing highway and is affected by noise from traffic entering and leaving the 50 kilometre per hour speed zone associated with town. The change of speed zone and local grade both increase the existing noise levels at this location as vehicles speed up or slow down according to the change in speed zone. This is particularly noticeable for heavy vehicles that often require the use of exhaust brakes to slow down.

The Berry community sports and recreation ground is located at the eastern end of North Street close to the intersection of Woodhill Mountain Road and the Princes Highway. It provides a variety of facilities including a general sports ground, tennis courts, a skate park and a local pony riding club. There is also a Camp Quality memorial park located in the vicinity between the sports ground and Bundewallah Creek. This location currently experiences low levels of background noise and is largely unaffected by the existing highway. Other recreational facilities in town are located further away from the existing highway and would largely experience low levels of background noise.

### 2.2.4 North of Berry precinct

The area to the north of Berry is characterised by Berry's rural agricultural landscape and is dominated by pastureland and dairy farming properties directly to the north of North Street. Noise generating activities are quite limited and residential properties along North Street currently experience a low noise environment and are largely unaffected by the existing highway traffic.

Traffic volumes along North Street are relatively low. Vehicle movements are dominated by light vehicles accessing local residences and some heavy vehicle and farm machinery movements associated with the two large agricultural properties on the northern side of North Street. The low volumes of traffic encourage pedestrian and recreational access along North Street, which is used both as an informal walking circuit and access to and from the sports ground at the eastern end. There are a number of noise sensitive receivers including churches and other community facilities along the southern side of North Street.

### 2.2.5 Huntingdale Park Estate and Kangaroo Valley Road

Kangaroo Valley Road and the residential development area of Huntingdale Park Estate are located at the south western end of town. This area is considered to be the main development area for the growth of Berry and is dominated by residential properties, with a cemetery located opposite the junction of Kangaroo Valley Road and North Street. The area currently experiences a relatively quiet noise environment primarily limited to light vehicle local access traffic noise.

There is currently a small buffer distance between the houses within the estate that front Huntingdale Park Road and the existing highway, as it passes in a cutting to the south west, adjacent to Mark Radium Park. These houses are currently protected to some degree from noise impacts associated with the existing highway traffic by this buffer area.

## 2.3 Noise sensitive receivers

Aerial photographs and overlays showing the road and the 591 noise sensitive receiver locations are presented in Appendix B. Receivers have generally been labelled from right to left. The noise sensitive receivers near the proposal comprise isolated rural houses and the low density urban area of Berry and surrounds. All six noise catchment areas are identified in Appendix C.

## 2.4 Background noise monitoring

Background noise monitoring was undertaken at 10 locations throughout the project area to determine existing background noise levels (which are used to define the construction noise criteria) and to measure average noise levels from the existing roads (to calibrate the operational noise model).

The locations for the noise logging were chosen through examination of aerial photography and site inspections. Attended noise measurements were also undertaken at each noise logging location. The background noise logging locations are illustrated in Appendix D. The noise logging results are provided graphically in Appendix E.

A noise logger measures the noise level over the sample period and then determines $L_{A1}$, $L_{A10}$, $L_{A90}$, $L_{Amax}$ and $L_{Aeq}$ levels of the noise environment. The $L_{A1}$, $L_{A10}$ and $L_{A90}$ levels are the levels exceeded for one per cent, 10 per cent and 90 per cent of the sample period respectively. The $L_{Amax}$ is indicative of maximum noise levels due to individual noise events. The $L_{A90}$ is taken as the background noise level. The $L_{Aeq}$ is the energy averaged noise level over a defined period.

The results of the noise monitoring have been processed in accordance with the procedures contained in the ICNG, the INP and the RNP.

The assessment background level (ABL) is established by determining the lowest tenth-percentile level of the $L_{A90}$ noise data acquired for each period of interest – daytime, evening and night time – for each 24 hour period. The background noise level or rating background level (RBL) representing the day (7am to 6pm), evening (6pm to 10pm) and night-time (10pm to 7am) assessment periods is the median of individual ABLs determined over the entire monitoring duration. The RBL is representative of the average minimum background sound level (in the absence of the source under consideration), or simply the background level. The $L_{Aeq}$ is essentially the average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

A description of each location and site comments is provided in **Table 2-1**. The RNP requires receivers up to 600 metres from the alignment to be considered. The noise loggers have therefore been located at varying distances from the existing alignment up to 600 metres. This allows the accuracy of the model to be confirmed over the extent of the project.

**Table 2-1: Noise logging locations**

| Logger | Serial number | Address | Comments |
|---|---|---|---|
| BG1 | 194636 | 46 Princes Highway, Broughton Village | 40 m from existing alignment |
| BG2 | 194802 | 10 Austral Park Road, Broughton | 460 m from existing alignment |
| BG3 | 194677 | 200 Princes Highway, Berry | 165 m from existing alignment |
| BG4 | 8199 | 111 Princes Highway, Berry | 270 m from existing alignment |
| BG5 | 194643 | 132 North Street, Berry | 5 m from North Street |
| BG6 | 194525 | 92 North Street, Berry | 5 m from North Street |
| BG7 | 194688 | 2 The Gables, Berry | 5 m from Kangaroo Valley Road |
| BG8 | 194663 | Andersons Lane, Berry | 100 m from existing alignment |
| BG9 | 194687 | Andersons Lane, Berry | 300 m from existing alignment |
| BG10 | 194678 | Andersons Lane, Berry | 600 m from existing alignment |

## 2.5 Background noise monitoring results

The background noise monitoring results are provided in **Table 2-2**. These noise levels are used to define the appropriate construction NMLs for each location, consistent with the ICNG.

**Table 2-2: Background noise levels dB(A)**

| Noise logging location | Rating background level dB(A) | | |
|---|---|---|---|
| | Day (7am to 6pm) $L_{A90}$ | Evening (6pm to 10pm) $L_{A90}$ | Night (10pm to 7am) $L_{A90}$ |
| BG1 | 48 | 40 | 40[1] |
| BG2 | 40 | 41 (40)[2] | 40 |
| BG3 | 41 | 39 | 38 |
| BG4 | 41 | 39 | 37 |
| BG5 | 35 | 37 (35)[2] | 35 |
| BG6 | 36 | 36 | 35 |
| BG7 | 37 | 37 | 37 |
| BG8 | 44 | 41 | 33 |
| BG9 | 41 | 39 | 35 |
| BG10 | 38 | 36 | 33 |

*Note 1: Night time $L_{A90}$ has been adjusted to the lower evening $L_{A90}$.*
*Note 2: The numbers in brackets indicated the RBL with the INP adjustments included*

The noise levels provided in **Table 2-2** are typical of an arterial road or highway operating through a rural area.

Additional attended noise measurements were undertaken at each noise logger location. The attended noise measurements confirmed that at each location the road was the dominant noise source. Noise measurements were typically undertaken during the most sensitive period (night-time) to ensure that the road would always be the dominant noise source.

## 2.6 Operational road noise monitoring results

The average noise levels provided in **Table 2-3** are, in each case, controlled by road noise. These results are used to verify the road noise model.

Logging results for locations close to the Princes Highway show a close correlation with traffic flow figures. Where traffic flows decrease significantly at night, background noise levels drop accordingly, suggesting that traffic noise is the dominant noise source in the area.

Noise levels for locations BG5, BG6 and BG7 drop significantly during night time. This can be attributed to local traffic flows. Local traffic travelling from the north of Berry through to Kangaroo Valley Road often use North Street to avoid the traffic of Queen Street. During night time, local traffic is minimal, hence a larger than usual drop in recorded noise levels is observed in this area.

**Table 2-3: 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 | 60 | 56 |
| BG2 | 50 | 48 |
| BG3 | 53 | 49 |
| BG4 | 53 | 44 |
| BG5 | 58 | 46 |
| BG6 | 56 | 46 |
| BG7 | 63 | 52 |
| BG8 | 56 | 54 |
| BG9 | 52 | 48 |
| BG10 | 49 | 44 |

# 3 Noise and vibration criteria

## 3.1 Construction noise

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.

NML's must be set for the 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.

The ICNG recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the environmental impact assessment process'. A quantitative assessment, based on a likely 'worst case' construction scenario and a 'representative' scenario, has been carried out for the project.

Predicted noise levels at nearby noise sensitive receivers (eg residences, schools, hospitals, places of worship, passive and active recreation areas) are compared to the levels provided in Section 4 of the ICNG. Where an exceedance of the NMLs is predicted, the ICNG advises that the proponent should apply all feasible and reasonable work practices to minimise the noise impact.

NMLs for residential receivers are derived using the information in **Table 3-1** (excerpt from the ICNG).

The ABL is established by determining the lowest tenth-percentile level of the $L_{A90}$ noise data acquired over each period of interest. The background noise level or RBL representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration.

**Table 3-1: Noise at residences using quantitative assessment, extract from the ICNG**

<table>
<tr><th>Time of day</th><th>Noise management level $L_{Aeq}$ (15min)*</th><th>How to apply</th></tr>
<tr><td rowspan="2">Recommended standard hours:<br>Monday to Friday 7am to 6pm<br>Saturday 8am to 1pm<br>No work on Sundays or<br>public holidays</td><td>Noise affected<br>RBL + 10 dB</td><td>The noise affected level represents the point above which there may be some community reaction to noise.<br>Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.</td></tr>
<tr><td>Highly noise affected<br>75 dB(A)</td><td>The highly noise affected level represents the point above which there may be strong community reaction to noise.<br>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:<br>• 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 residences.<br>• If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</td></tr>
<tr><td>Outside recommended standard hours</td><td>Noise affected<br>RBL + 5 dB</td><td>A strong justification would typically be required for works outside the recommended standard hours.<br>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.<br>Where all feasible and reasonable practices have been applied and noise is more than five dB(A) above the noise affected level, the proponent should negotiate with the community.<br>For guidance on negotiating agreements see section 7.2.2 (ICNG).</td></tr>
</table>

** Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 meters above ground level. If 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. Noise levels may be higher at upper floors of the noise affected residence.*

## 3.2 Noise catchment areas

The study area has been divided into six distinct Noise Catchment Areas (NCA's), representing the differing background noise levels measured at each location. A description of the location of each catchment area is provided below in **Table 3-2**. The locations are also provided graphically in Appendix C. The community generally expects greater control of noise during the more sensitive evening and night time periods. Therefore, where measured noise levels are higher during evening and night time periods, the RBL has been reduced to the more stringent level measured in the day.

**Table 3-2: Noise catchment areas**

| NCA | | Chainage | Representative logger | Notes |
|---|---|---|---|---|
| NCA1 | Start | 75000 | BG2 | BG2 is considered to be more representative of this NCA and provides a more conservative assessment. |
| | End | 11100 | | |
| NCA2 | Start | 11100 | BG2 | |
| | End | 13500 | | |
| NCA3 | Start | 13500 | BG3 | |
| | End | 14900 | | |
| NCA4 | Start | 14900 | BG4 | |
| | End | 16400 | | |
| NAC5 | Start | 16400 | BG5 | Representative of receivers on North Street and marginally more conservative than BG6. |
| | End | 18100 | | |
| NAC6 | Start | 18100 | BG10 | Representative of receivers surrounding the proposed stockpiling site. |
| | End | 18300 | | |

The construction NML's for the NCA's are provided below in **Table 3-3**.

**Table 3-3: Noise catchment areas noise assessment levels**

| NCA | Period | Rating background level (RBL)* | Noise management levels (NML)** |
|---|---|---|---|
| NCA1 | Day | 40 | 50 |
| | Evening | 40 | 45 |
| | Night | 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 |

**Details of RBLs are provided in Table 3-1*
*** Details on NMLs are provided in Table 3-3*

The DP&I required that extended construction work hours be 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 is provided in Table 3-4. Noise levels are between 0 dB(A) and 3 dB(A) less stringent than the night-time NMLs.

**Table 3-4: Noise catchment areas 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 |

**Details of RBLs are provided in Table 3-1*
*** Details of NMLs are provided in Table 3-3*

NML's recommended by the ICNG for other sensitive land uses, such as schools, hospitals or places of worship are shown in **Table 3-4**. Sensitive land uses identified for this project include the following:

- 69 Albert Street, Berry – Place of Worship (numerous buildings on this property, all of which have been assessed).
- Camp Quality and Berry Sporting Complex, Woodhill Mountain Road – Active Recreation Area.

**Table 3-4: Construction NMLs– sensitive land uses other than residential, excerpt from ICNG**

| Land use | Management level, $L_{Aeq}$ (15 min) (applies when properties are in use) |
|---|---|
| Classrooms at schools and other educational institutions | Internal noise level 45 dB(A) |
| Hospital wards and operating theatres | Internal noise level 45 dB(A) |
| Places of worship | Internal noise level 45 dB(A) |
| Active recreation 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 65 dB(A) |
| Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation) | External noise level 60 dB(A) |
| Community centres | Depends on the intended use of the centre. Refer to the recommended "maximum" internal levels in AS2107 for specific uses. |

### 3.2.1 Sleep disturbance

The ICNG requires a sleep disturbance analysis to be undertaken where construction works are planned to extend over more than two consecutive nights. The ICNG makes reference to the NSW Environment Criteria for Road Traffic Noise (EPA, 1999) (ECRTN), 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 policy states that for night-time activities, the $L_{A1(60\ Second)}$ noise levels should be calculated and compared with the RBL plus 15 dB(A) as the sleep disturbance screening criterion. In order to determine the likelihood of potential sleep disturbance, the predicted $L_{A1(60\ Second)}$ noise levels and number of expected $L_{A1(60\ Second)}$ noise events should be assessed based on the ambient noise environment during the night-time period. Further analysis is recommended where the screening criterion is exceeded.

The ECRTN contains an assessment of sleep disturbance which represents the EPA's advice on the subject of sleep disturbance due to noise events. Having considered the results of four research papers by Pearson et al (1995), Bullen et al (1996), Griefahn (1992) and Finegold et al (1994), Section B5 of Appendix B concludes with the statement, *'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'*. 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.

### 3.2.2 Construction road traffic noise

The RNP does not provide direct reference to an appropriate criteria to assess the noise arising from traffic generated during the construction period. Typically, the criteria applicable for traffic movements generated during the construction phase of the project is limiting the increase in existing road traffic noise to two dB(A).

## 3.3 Construction vibration

The relevant standards/guidelines used for assessing construction vibration are summarised in **Table 3-5**

**Table 3-5: 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 Department of Environment, Climate Change and Water document "Assessing Vibration: A Technical Guideline" |
| Human comfort (regenerated noise) | NSW Department of Environment, Climate Change and Water document "Interim Construction Noise Guideline" |

*(*) 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 DECCW still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.*

### 3.3.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

The German Standard DIN 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures, provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in **Table 3-6**. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

**Table 3-6: DIN 4150: Structural damage safe limits for building vibration**

| 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 Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order) | 3 | 3 to 8 | 8 to 10 | 8 |

### 3.3.2 Human comfort

In general, human response to vibration is a complex phenomenon. There are wide variations in vibration tolerance of humans. Accordingly, acceptance goals for human comfort are hard to define and quantify. Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (eg 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 perception.

Any construction vibration assessment for work which does not include blasting is to include human comfort for construction in accordance with the guideline, Assessing Vibration: A Technical Guideline (DECC 2006), which refers to BS 6472:1992 ‘Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)’. BS 6472:1992 has been recently superseded by BS 6472:2008, however, the EPA has advised that the 1992 standard should be used rather than the newer 2008 standard.

### 3.3.3 Tactile vibration

The procedure outlined in the OEH document “Assessing Vibration: A Technical Guideline” (DECCW, 2006) has been used in this assessment. The recommended procedures in this guideline are based on British Standard BS 6472:1992 “*Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*”.

The guideline distinguishes between continuous, intermittent and impulsive vibration and provides a set of different vibration goals for each of these activities (**Table 3-7**).

**Table 3-7: Examples of types of vibration**

| Continuous | Impulsive[(*)] | Intermittent |
|---|---|---|
| **Continuous uninterrupted for a defined period (usually throughout daytime and/or night-time** | **A rapid build up to a peak followed by a damped decay. The duration is typically less than 2 seconds.** | **Defined as interrupted periods of continuous vibration or repeated periods of impulsive vibration.** |
| Steady road traffic, continuous construction activity (eg tunnel boring), machinery | Activities that create up to three distinct vibration events in an assessment period (eg occasional dropping of heavy equipment) | Trains, rock breakers, impact pile driving |

*1) [(*)] Blast vibration to be assessed in accordance with ANZECC (1990).*

## 3.3.4 Continuous and impulsive vibration

Preferred and maximum vibration levels for different receivers for continuous and impulsive vibration are provided in **Table 3-8** and **Table 3-9**.

**Table 3-8: Preferred and maximum weighted root mean square (rms) vibration levels for continuous vibration acceleration ($m/s^2$) in the vertical direction**

| Location | Daytime | | Night-time | |
|---|---|---|---|---|
| | Preferred | Maximum | Preferred | Maximum |
| Critical areas[1] | 0.005 | 0.010 | 0.005 | 0.010 |
| 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 |
| Workshops | 0.040 | 0.080 | 0.040 | 0.080 |

*Note 1: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above.*

**Table 3-9: Preferred and maximum weighted root mean square (rms) vibration levels for impulsive vibration acceleration ($m/s^2$) in the vertical direction**

| Location | Daytime | | Night-time | |
|---|---|---|---|---|
| | Preferred | Maximum | Preferred | Maximum |
| Critical areas | 0.005 | 0.010 | 0.005 | 0.010 |
| Residences | 0.30 | 0.60 | 0.100 | 0.200 |
| Offices, schools, educational institutions and places of worship | 0.640 | 1.280 | 0.640 | 1.280 |
| Workshops | 0.640 | 1.280 | 0.640 | 1.280 |

The OEH guideline, 'Assessing vibration: a technical guideline' states:

*"There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration".*

### 3.3.5 Intermittent vibration

The assessment of intermittent vibration outlined in the OEH guideline is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

The VDV (ie eVDV) of an individual event can be estimated by:

> $eVDV=1.4 \times a_{RMS} \times t^{0.25}$, where $a_{RMS}$ is the weighted rms acceleration in m/s$^2$, and t is the cumulative time in seconds. The above formula might not accurately represent the vibration dose if the crest factor exceeds 6 (see the OEH guideline (DECCW, 2006) for detailed assessment procedures).

Where there are repeated vibration events of variable magnitude the total vibration dose for the relevant period may be obtained by summing the N individual vibration doses using following formula:

$$\mathrm{VDV} = \sqrt[4]{\left(\sum_{i=1:N} \mathrm{VDV}_i^4\right)}$$

where $VDV_i$ is the individual vibration dose.

Maximum and preferred VDVs for construction activities are listed in **Table 3-10**.

**Table 3-10: Preferred and maximum vibration dose values for intermittent vibration (m/s$^{1.75}$) during construction activities**

| Location | Daytime | | Night-time | |
|---|---|---|---|---|
| | Preferred | Maximum | Preferred | Maximum |
| Critical areas | 0.1 | 0.2 | 0.1 | 0.2 |
| 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 |
| Workshops | 0.8 | 1.6 | 0.8 | 1.6 |

### 3.3.6 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. This noise is commonly referred to as structure or 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 NMLs as outlined in the ICNG are employed (**Table 3-11**). 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 3-11: Recommended ground-borne noise goals for construction activities**

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

## 3.4 Blasting noise and vibration

The Australian and New Zealand Environment Conservation Council (ANZECC) document 'Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration' (ANZEC, 1990) provides criteria designated to minimise annoyance and discomfort at sensitive receivers as a result of blasting works. The criteria provided in this section are only applicable to annoyance and discomfort from blasting. Building damage criteria is provided in Section 3.3.1. Furthermore the document states that the criteria provided is for guidance only and may be varied to suit local site conditions.

Provided in **Table 3-12** is a summary of the airblast overpressure limits.

**Table 3-12: Airblast overpressure criteria**

| Airblast overpressure (dB(Lin Peak)) | Allowable exceedance |
|---|---|
| 115 | 5% of total number of blasts over a 12 month period |
| 120 | Never |

Provided in **Table 3-13** is a summary of the peak particle velocity vibration limits.

**Table 3-13: Peak particle velocity criteria**

| Peak particle velocity (mm/s) | Allowable exceedance |
|---|---|
| 5 | 5% of total number of blasts over a 12 month period |
| 10 | Never |

Australian Standard AS2107.2 '*Explosives – Storage and use Part 2: Use of explosives*' recommends that if the prescribed limits in **Table 3-12** and **Table 3-13** cannot be achieved, an agreement may be reached with the land owner permitting higher levels. The guideline also recommends that blasting should generally take place no more than once per day.

## 3.5 Operational noise criteria

The RNP was released in July 2011. It provides the appropriate operational noise criteria for both redeveloped existing roads and new roads.

Provided below in **Table 3-14** are the applicable noise criteria for this project.

**Table 3-14: Road traffic noise assessment criteria for residential land use**

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

Noise criteria for other land use are provided in **Table 3-15**.

To determine if each sensitive receiver is subject to the 'new road' or 'redeveloped road' criteria, the ENMM procedure set out in Practice Note i of the ENMM has been followed.

A sensitive receiver has been considered to be subject to noise exposure to a new road where there is no existing road traffic noise exposure or if the receiver is subject to a new source of road traffic noise.

A receiver is subject to existing road traffic noise exposure if the existing noise levels exceed a daytime $L_{Aeq(15hour)}$ of 55 dB(A) or a night-time $L_{Aeq(9hour)}$ of 50 dB(A).

A receiver is considered to be subject to a new source of road traffic noise if the project would develop any of the following:

- 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 producing noise at a receptor from a different direction that increases noise levels at any exposed facade by two dB(A) or more.

The RNP requires the consideration of two scenarios, the 'no build' option and the 'build' option. The 'no build' option represents the scenario if the project was not to proceed. The 'build' option represents the scenario if the project was to proceed. Each of these scenarios must be considered for two time periods, the year of opening and the design year, typically ten years after opening.

The RNP also requires the 'relative increase' to be considered. The relative increase is the difference in noise levels between the 'build' and 'no build' scenarios. The relative increase criteria are provided below in **Table 3-16**. The relative increase criteria are only applicable to residential land uses.

**Table 3-15: Road traffic noise assessment criteria for non-residential land use**

| Existing sensitive land use | Assessment criteria | | Additional considerations |
|---|---|---|---|
| | Day (7am – 10pm) | Night (10pm – 7am) | |
| School classrooms | $L_{Aeq(1hour)}$ 40 (internal) | - | In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000) |
| Hospital wards | $L_{Aeq(1hour)}$ 35 (internal) | $L_{Aeq(1hour)}$ 35 (internal) | |
| Places of worship | $L_{Aeq(1hour)}$ 40 (internal) | $L_{Aeq(1hour)}$ 40 (internal) | The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise.<br>For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, there are areas between the church and the road where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate.<br>As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see point 5) may be applied. |
| Open space (active use) | $L_{Aeq(15hour)}$ 60 | - | Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, |

| Existing sensitive land use | Assessment criteria | | Additional considerations |
|---|---|---|---|
| | Day (7am – 10pm) | Night (10pm – 7am) | |
| Open space (passive use) | $L_{Aeq(15hour)}$ 55 | - | making them less sensitive to external noise intrusion.<br>Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading.<br>In determining whether areas are used for active or passive recreation, the type of activity that occurs in that area and its sensitivity to noise intrusion should be established. For areas where there may be a mix of passive and active recreation, eg school playgrounds, the more stringent criteria apply. Open space may also be used as a buffer zone for more sensitive land uses. |
| Child care facilities | Sleeping rooms $L_{Aeq(1hour)}$ 35 Indoor play areas $L_{Aeq(1hour)}$ 40 (internal) Outdoor play areas $L_{Aeq(1hour)}$ 55 (external) | | Multi-purpose spaces, eg shared indoor play/sleeping rooms should meet the lower of the respective criteria.<br>Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility. |
| Aged care facilities | - | - | Residential land use noise assessment criteria should be applied to these facilities. |

**Table 3-16: Relative increase criteria for residential land uses**

| Road category | Type of project/ development | Total traffic noise level increase dB(A) | |
|---|---|---|---|
| | | Day (7am – 10pm) | Night (10pm – 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 existing road | Existing traffic $L_{Aeq(15hour)}$ + 12 dB (external) | Existing traffic $L_{Aeq(9hour)}$ +12 dB (external) |

A new road must be designed to meet the noise criteria in **Table 3-14, Table 3-15** and **Table 3-16**.

# 4 Impact assessment

## 4.1 Construction noise and vibration

The construction noise and vibration assessment has been separated into two separate components, the construction of the main alignment and noise and vibration impacts associated with the operations of ancillary facilities. The cumulative noise impact has also been considered.

The bulk of construction activities would take place from 7am to 6pm, Monday to Friday and 8am to 1pm Saturday, with no work on Sunday or public holidays. However, certain activities would be required to take place during the evening and night time periods due to:

- Technical considerations (such as the need to meet particular quality specifications for placement of concrete pavement).
- Safety and traffic management considerations.

Details on the out of hours work procedure and justification for specific activities are provided in Section 4.7.

Extended working hours are considered in Section 4.6.

## 4.2 Main alignment construction works

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 (SWL) for these sources, noise level predictions have been undertaken for the individual construction activities. These predictions and working hours are provided in **Table 4-2** to **Table 4-7.**

### 4.2.1 Construction activities and equipment

The construction of the project would consist of five main construction activities. These activities are provided below in **Table 4-1**.

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 4-1.**

**Table 4-1: Construction scenarios and equipment**

| Activity | Typical equipment used | Typical and maximum SWL dB(A) |
|---|---|---|
| Site Establishment /Landscaping | **Typical SWL[1]** | **105 - 110** |
| | Chainsaws | 110 - 118 |
| | Mulching plant and chipper | 113 - 121 |
| | Cranes | 104 - 112 |
| | Generators | 101 - 109 |
| | Bobcat | 104 - 112 |
| | Powered hand tools | 108 - 116 |
| | Air compressor | 109 - 117 |

| Activity | Typical equipment used | Typical and maximum SWL dB(A) |
|---|---|---|
| | Spoil | 95 - 103 |
| | Material | 95 - 103 |
| | Excavators | 99 - 107 |
| Earthworks | **Typical SWL[1]** | **112 - 120** |
| | Compactors | 104 - 112 |
| | Grader | 103 - 111 |
| | Multi-tyred and vibratory rollers | 97 - 105 |
| | Concrete trucks | 105 - 113 |
| | Concrete vibrator | 97 - 105 |
| | Asphalt paving plant | 112 - 120 |
| | Backhoe | 103 - 111 |
| | Sweeper | 104 - 112 |
| | Compressor | 109 - 117 |
| | Generators | 101 - 109 |
| | Rock crushing | 112 - 120 |
| | Road trucks | 95 - 103 |
| Piling | Impact driven piling rig | 124 – 134 |
| | Bored piling rig | 100 – 110 |
| Bridge Works | **Typical SWL[1]** | **112 - 120** |
| | Cranes | 104 - 112 |
| | Piling rigs | 103 - 111 |
| Paving | **Typical SWL[1]** | **113 - 118** |
| | Compactor | 104 - 112 |
| | Jackhammers | 108 - 116 |
| | Multi-tyred vibratory roller | 97 - 105 |
| | Concrete truck | 105 - 113 |
| | Concrete vibrator | 97 - 105 |
| | Asphalt paving plant | 112 - 120 |
| | Backhoe | 108 - 116 |
| | Concrete saw | 111 - 119 |
| | Profiler | 108 - 116 |
| | Sweeper | 104 - 112 |
| | Compressor | 109 - 117 |
| | Generator | 101 - 109 |
| | Road trucks | 95 - 103 |

*Note 1: The Typical SWL is for a 'typical site'. It represents a range of the equipment listed at various distances around the site with varying duty cycles. The levels have been refined from predictions and measurements undertaken at similar sites over many different projects. The typical levels are not a summation of all the equipment listed in this table.*

### 4.2.2 Construction noise modelling

Noise modelling has been undertaken for the scenarios provided in **Table 4-1**. Noise modelling was undertaken using SoundPLAN V7.0. The noise modelling was used to calculate typical and worst case construction noise levels along the entire alignment.

### 4.2.3 Standard hours works

The Standard Hours Work noise modelling results are provided in **Table 4-2** to **Table 4-7** and a summary of the Out of Hours Work modelling results is provided in **Table 4-8** to **Table 4-11**. The tables indicate typical and maximum noise levels at the affected receivers. The results are also provided graphically in Appendix F.

**Table 4-2: Standard hours work predicted noise- establishment/landscaping works**

| 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 |
| 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 |

*Note 1: Highly noise affected is considered to be 75 dB(A)*

The predicted noise levels in **Table 4-2** indicate that 175 receivers would be impacted from typical works and 321 receivers would be impacted as a result of worst case noise levels during site establishment and landscaping works.

**Table 4-3: Standard hours work predicted noise - earthworks**

| 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 1 |
| 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 |

*Note 1: Highly noise affected is considered to be 75 dB(A)*
*NML – Noise management level*

The predicted noise levels in **Table 4-3** indicate that 369 receivers would be impacted from typical works and 549 receivers would be impacted as a result of worst case noise levels during earthworks. An additional 14 receivers would be significantly affected as a result of worst case noise levels.

**Table 4-4: Standard hours work predicted noise - bored piling**

| 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 1 |
| 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 |
| NCA5 | 45 | 60 | 43 | 0 | 70 | 270 | 0 |
| NCA6 | 48 | 52 | 1 | 0 | 62 | 21 | 0 |

*Note 1: Highly noise affected is considered to be 75 dB(A)*

The predicted noise levels in **Table 4-4** indicate that 49 receivers would be impacted from typical works and 321 receivers would be impacted as a result of worst case noise levels during bored piling activities.

**Table 4-5: Standard hours work predicted noise - impact piling**

| 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 1 |
| 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 |

*Note 1: Highly noise affected is considered to be 75 dB(A)*

The predicted noise levels in **Table 4-5** indicate that 555 receivers would be impacted from typical works and 571 receivers would be impacted as a result of worst case noise levels during impact piling activities. An additional 17 receivers would be significantly impacted from typical works and 571 receivers would be significantly impacted as a result of worst case noise.

**Table 4-6: Standard hours work predicted noise – bridge works**

| 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 1 |
| 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 |

*Note 1: Highly noise affected is considered to be 75 dB(A)*

The predicted noise levels in **Table 4-6** indicate that 166 receivers would be impacted from typical works and 484 receivers would be impacted as a result of worst case noise levels during bridge works. An additional three receivers would be significantly impacted as a result of worst case noise levels.

**Table 4-7: Standard hours work predicted noise – paving**

| 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 1 |
| 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 |

*Note 1: Highly noise affected is considered to be 75 dB(A)*

The predicted noise levels in **Table 4-7** indicate that 392 receivers would be impacted from typical works and 532 receivers would be impacted as a result of worst case noise levels during paving works. An additional three receivers would be significantly impacted as a result of worst case noise levels.

It is important to consider that this assessment is representative of the worst case 15 minute period of construction activity and does not necessarily represent the noise impact at noise sensitive receivers for an extended period of time. Particularly noisy activities, such as rock breaking and use of concrete saws, are likely to persist for only a fraction of the overall construction period. Clear communication to potentially affected receivers of when these activities will be taking place is recommended.

The ICNG states that where a construction noise impact level of greater than 75 dB(A) is predicted a receiver must be considered ‘highly noise affected’ and afforded additional consideration. The receivers where noise levels exceed 75 dB(A) can be identified on the noise contours provided in Appendix F. These receivers would receive additional consultation with regards to specific timing and impacts of construction works. Respite periods should also be programmed for these receivers wherever practicable.

### 4.2.4 Morning shoulder works

The morning shoulder works noise modelling results are provided in **Table 4-8** to **Table 4-13**. The tables indicate typical and maximum noise levels at the affected receivers. The results are also provided graphically in Appendix F.

Considering the same works would take place in the morning shoulder period as the standard work hours, the predicted noise levels are identical. The exceedances have increased due to a difference in the noise criteria.

Extended hours work would occur north of Berry township, generally between Toolijooa Road and Tindalls Lane. Therefore works would predominantly be expected to occur in NCA1 to NCA3, as such a shoulder period assessment has been undertaken for these catchment areas. An assessment of NCA4 has also been included as extended hours may also include bridge works and as works occurring in NCA3 may be audible in NCA4.

As described in Section 4.6, activities undertaken during the morning extended hours period would generally be limited to low noise generating activities. Activities such as piling and earthworks have been included in this assessment to present a worst case scenario.

**Table 4-8: Extended hours work predicted noise- establishment/landscaping works**

| NCA | NML dB(A) | Typical works | | Worst case | |
|---|---|---|---|---|---|
| | | Predicted noise level dB(A) | Receivers exceeding NMLs | Predicted noise level dB(A) | Receivers exceeding NMLs |
| NCA1 | 45 | 60 | 4 | 65 | 8 |
| NCA2 | 45 | 58 | 9 | 63 | 13 |
| NCA3 | 45 | 51 | 3 | 56 | 6 |
| NCA4 | 44 | 63 | 15 | 68 | 18 |

The predicted noise levels in **Table 4-8** indicate that 31 receivers would be impacted from typical works and 45 receivers would be impacted as a result of worst case noise levels during site establishment and landscaping works.

**Table 4-9: Extended hours work predicted noise - earthworks**

| NCA | NML dB(A) | Typical works | | Worst case | |
|---|---|---|---|---|---|
| | | Predicted noise level dB(A) | Receivers exceeding NMLs | Predicted noise level dB(A) | Receivers exceeding NMLs |
| NCA1 | 45 | 67 | 11 | 75 | 22 |
| NCA2 | 45 | 65 | 14 | 73 | 16 |
| NCA3 | 45 | 58 | 7 | 66 | 13 |
| NCA4 | 44 | 70 | 29 | 78 | 39 |

The predicted noise levels in **Table 4-9** indicate that 61 receivers would be impacted from typical works and 90 receivers would be impacted as a result of worst case noise levels during earthworks.

**Table 4-10: Extended hours work predicted noise - bored piling**

| NCA | NML dB(A) | Typical works | | Worst case | |
|---|---|---|---|---|---|
| | | Predicted noise level dB(A) | Receivers exceeding NMLs | Predicted noise level dB(A) | Receivers exceeding NMLs |
| NCA1 | 45 | 55 | 3 | 65 | 8 |
| NCA2 | 45 | 53 | 3 | 63 | 13 |
| NCA3 | 45 | 46 | 1 | 56 | 6 |
| NCA4 | 44 | 58 | 12 | 68 | 18 |

The predicted noise levels in **Table 4-10** indicate that 19 receivers would be impacted from typical works and 45 receivers would be impacted as a result of worst case noise levels during bored piling activities.

**Table 4-11: Extended hours work predicted noise - impact piling**

| NCA | NML dB(A) | Typical works | | Worst case | |
|---|---|---|---|---|---|
| | | Predicted noise level dB(A) | Receivers exceeding NMLs | Predicted noise level dB(A) | Receivers exceeding NMLs |
| NCA1 | 45 | 79 | 22 | 89 | 22 |
| NCA2 | 45 | 77 | 16 | 87 | 16 |
| NCA3 | 45 | 70 | 14 | 80 | 14 |
| NCA4 | 44 | 82 | 39 | 92 | 39 |

The predicted noise levels in **Table 4-11** indicate that 91 receivers would be impacted from typical works and 91 receivers would be impacted as a result of worst case noise levels during impact piling activities.

**Table 4-12: Extended hours work predicted noise – bridge works**

| NCA | NML dB(A) | Typical works | | Worst case | |
|---|---|---|---|---|---|
| | | Predicted noise level dB(A) | Receivers exceeding NMLs | Predicted noise level dB(A) | Receivers exceeding NMLs |
| NCA1 | 45 | 64 | 11 | 72 | 22 |
| NCA2 | 45 | 63 | 14 | 71 | 16 |
| NCA3 | 45 | 51 | 7 | 59 | 13 |
| NCA4 | 44 | 72 | 29 | 80 | 39 |

The predicted noise levels in **Table 4-12** indicate that 61 receivers would be impacted from typical works and 90 receivers would be impacted as a result of worst case noise levels during bridge works.

**Table 4-13: Extended hours work predicted noise – paving**

| NCA | NML dB(A) | Typical works | | Worst case | |
|---|---|---|---|---|---|
| | | Predicted noise level dB(A) | Receivers exceeding NMLs | Predicted noise level dB(A) | Receivers exceeding NMLs |
| NCA1 | 45 | 78 | 12 | 83 | 21 |
| NCA2 | 45 | 73 | 14 | 81 | 16 |
| NCA3 | 45 | 66 | 8 | 74 | 13 |
| NCA4 | 44 | 78 | 32 | 86 | 39 |

The predicted noise levels in **Table 4-13** indicate that 66 receivers would be impacted from typical works and 89 receivers would be impacted as a result of worst case noise levels during paving works.

It is important to consider that this assessment is representative of the worst case 15 minute period of construction activity and does not necessarily represent the noise impact at noise sensitive receivers for an extended period of time. Particularly noisy activities, such as rock breaking and use of concrete saws, are likely to persist for only a fraction of the overall construction period. Clear communication to potentially affected receivers of when these activities will be taking place is recommended.

### 4.2.5 Out of hours works

Provided below in **Table 4-14** to **Table 4-17** is a summary of the predicted typical and maximum noise levels during out of hours work (including the proposed extended hours discussed in Section1.2.2. Earthworks are proposed north of Berry township spanning NCA1 to NCA4. Although a fair proportion of bridge works could be undertaken during standard work hours, some would need to be undertaken during out of hours work periods for safety and road traffic considerations. Extended work hours are not proposed south of NCA4, however predicted noise levels and numbers of affected receivers have been provided in the event that out of hours works are required for safety, traffic efficiency or emergency reasons.

**Table 4-14: Evening work predicted noise - earthworks**

| 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[1] |
| NCA1 | 45 | 67 | 11 | 0 | 75 | 22 | 0 |
| NCA2 | 45 | 65 | 14 | 0 | 73 | 16 | 0 |
| NCA3 | 44 | 58 | 8 | 0 | 66 | 13 | 0 |
| NCA4 | 44 | 70 | 29 | 0 | 78 | 39 | 3 |
| NCA5[2] | 40 | 72 | 443 | 0 | 80 | 458 | 11 |
| NCA6[2] | 41 | 64 | 21 | 0 | 72 | 22 | 0 |

*Note1:* *Highly noise affected is considered to be 75 dB(A)*
*Note2:* *Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.*

**Table 4-15: Night-time work predicted noise - earthworks**

| 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[1] |
| NCA1 | 45 | 67 | 11 | 0 | 75 | 22 | 0 |
| NCA2 | 45 | 65 | 14 | 0 | 73 | 16 | 0 |
| NCA3 | 43 | 58 | 9 | 0 | 66 | 13 | 0 |
| NCA4 | 42 | 70 | 34 | 0 | 78 | 39 | 2 |
| NCA5[2] | 40 | 72 | 443 | 0 | 80 | 458 | 5 |
| NCA6[2] | 38 | 64 | 22 | 0 | 72 | 22 | 0 |

*Note1:* *Highly noise affected is considered to be 75 dB(A)*
*Note2:* *Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.*

**Table 4-16: Evening work predicted noise – bridge works**

| 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 [1] |
| NCA1 | 45 | 67 | 6 | 0 | 75 | 19 | 0 |
| NCA2 | 45 | 65 | 7 | 0 | 73 | 9 | 0 |
| NCA3 | 44 | 58 | 2 | 0 | 66 | 7 | 0 |
| NCA4 | 44 | 70 | 25 | 0 | 78 | 36 | 2 |
| NCA5[2] | 40 | 72 | 353 | 0 | 80 | 457 | 1 |
| NCA6[2] | 41 | 64 | 5 | 0 | 72 | 18 | 0 |

*Note1:* *Highly noise affected is considered to be 75 dB(A)*
*Note2:* *Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.*

**Table 4-17: Night-time work predicted noise – bridge works**

| 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 [1] |
| NCA1 | 45 | 67 | 6 | 0 | 75 | 19 | 0 |
| NCA2 | 45 | 65 | 7 | 0 | 73 | 9 | 0 |
| NCA3 | 43 | 58 | 3 | 0 | 66 | 9 | 0 |
| NCA4 | 42 | 70 | 30 | 0 | 78 | 38 | 2 |
| NCA5[2] | 40 | 72 | 353 | 0 | 80 | 457 | 1 |
| NCA6[2] | 38 | 64 | 14 | 0 | 72 | 21 | 0 |

*Note1:* *Highly noise affected is considered to be 75 dB(A)*
*Note2:* *Extended work hours are not proposed south of NCA4. However noise levels are provided here in the event that out of hours works are required for safety or emergency reasons.*

The noise levels provided above do not include mitigation measures and therefore provide a conservative assessment of the potential noise impacts from the proposed construction activities. Recommendations for noise mitigation are provided in Chapter 5.

### 4.2.5 Sleep disturbance

Noise levels related to sleep disturbance ($L_{A1(60\ sec)}$) are typically five dB(A) to eight dB(A) higher than those provided in **Table 4-15** and **Table 4-17.**

Construction works would generally not be undertaken during night-time work periods hence the likelihood for sleep disturbance is low. However, sleep disturbance may occur for any work that is required out of hours. There are currently no specific details available on what works would occur during the night-time period and what equipment would be used. Further information and mitigation would be provided during the detailed design stage to ensure that the potential impacts on affected receivers is minimised.

## 4.3 Specific works

The preceding section provided general information for typical and worst-case noise levels at sensitive receivers. Provided in this section is detailed information for specific construction scenarios, including estimated duration of works and with a focus on high noise generating works as required by the DGRs. The final duration of specific activities will depend on the plant and methodology utilised in the construction phase.

Typical and maximum noise levels for each scenario have been found to be very similar. Noise levels were initially calculated for each works type and found to be within ±2 dB(A). On the basis that a difference of two dB(A) is typically considered indiscernible and the actual noise levels may vary depending on the specific plant used by the contractor, there was deemed to be no benefit to model each work activity within each location.

The work activities and estimated durations are provided below in **Table 4-18**. Noise contours are provided in Appendix G. Typical noise levels have been modelled at 112 dB(A) and represent a small number of machinery operating simultaneously (such as a dump truck, an excavator and a couple of haul trucks idling). Maximum (or worst-case) noise levels have been modelled at 120 dB(A), representing larger numbers of equipment undertaking noise intensive work for long durations. Work activities that are considered to be noise intensive are presented in bold.

**Table 4-18: Work activities and duration**

| Work activities | Duration |
|---|---|
| **Toolijooa tie-in, Ch7600<br>Toolijooa Road** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 1 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 1 month |
| **Earthworks** | **2 months** |
| Pavement construction | 2 weeks |
| Drainage construction | 2 weeks |
| Street furniture installation | 2 weeks |
| Site restoration | 2 weeks |

| Work activities | Duration |
|---|---|
| **Toolijooa interchange, Ch 7700**<br>**Toolijooa Road** | |
| **Site preparation and establishment** | **3 months** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 month |
| **Earthworks and bridge construction** | **8 months** |
| Pavement construction | 1 month |
| Drainage construction | 2 weeks |
| Street furniture installation | 2 weeks |
| Site restoration | 1 month |
| **Toolijooa cutting Ch8450 - Ch9400**<br>**West of Toolijooa Road, east of Foxground Road** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 1 month |
| **Pre-drilling, blasting, crushing, earthworks** | **12 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 1 month |
| Site restoration | 2 months |
| **Toolijooa fill embankment, Ch 9450 – Ch 9850**<br>**West of Toolijooa Ridge, east of Broughton Creek** | |
| **Site preparation and establishment** | **2 weeks** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 weeks |
| **Earthworks** | **9 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 1 month |
| Site restoration | 2 months |

| Work activities | Duration |
|---|---|
| **Broughton Creek bridge #1, #2, #3 Ch 10000, Ch 10750, Ch 11200 Broughton Creek** | |
| **Site preparation and establishment** | **2 weeks** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 1 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 1 month |
| **Earthworks and bridge construction** | **7 months** |
| Pavement construction | 1 month |
| Drainage construction | 2 weeks |
| Street furniture installation | 2 weeks |
| Site restoration | 1 month |
| **Broughton Creek fill embankment Ch 10050 – 10650, Ch 10800 – 11100** | |
| **Site preparation and establishment** | **2 weeks** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 weeks |
| **Earthworks** | **9 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 1 month |
| Site restoration | 2 months |
| **Broughton Creek fill embankment, Ch 10050 – 10650, Ch 10800 – 11100 Broughton Creek floodplain** | |
| **Site preparation and establishment** | **2 weeks** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 weeks |
| **Earthworks** | **9 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 1 month |
| Site restoration | 2 months |

| Work activities | Duration |
|---|---|
| **Austral Park interchange Ch 11700**<br>**Austral Park Road** | |
| **Site preparation and establishment** | **3 months** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 month |
| **Earthworks and bridge construction** | **8 months** |
| Pavement construction | 1 month |
| Drainage construction | 2 weeks |
| Street furniture installation | 2 weeks |
| Site restoration | 1 month |
| **Austral Park southbound heavy vehicle rest area Ch 12500**<br>**Intersection of Austral Park Road and Princes Highway** | |
| **Site preparation and establishment** | **2 weeks** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 weeks |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 weeks |
| **Earthworks** | **2 months** |
| Pavement construction | 1 month |
| Drainage construction | 2 weeks |
| Street furniture installation | 2 weeks |
| Site restoration | 1 month |
| **General realignment Ch 12750 – 13750**<br>**West of Austral Park Road, east of Tindalls Lane** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 3 months |
| **Earthworks** | **9 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 2 months |
| Site restoration | 2 months |

| Work activities | Duration |
|---|---|
| **Tindalls Lane interchange Ch 13800 – 14600**<br>**Intersection of Tindalls Lane and Princes Highway to 700m west of Tindalls Lane** | |
| **Site preparation and establishment** | **3 months** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 month |
| **Earthworks and bridge construction** | **8 months** |
| Pavement construction | 1 month |
| Drainage construction | 2 weeks |
| Street furniture installation | 2 weeks |
| Site restoration | 1 month |
| **North Berry interchange, Ch 15450 – 15800**<br>**Near David Berry Memorial Park** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 3 months |
| **Earthworks and bridge construction** | **12 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 2 months |
| Site restoration | 2 months |
| **Bridge at Berry, Ch 15800 – 16400**<br>**Launches off ridge at David Berry Memorial Park and lands west of the sports grounds** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 2 months |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 3 months |
| **Earthworks and bridge construction** | **12 months** |
| Pavement construction | 2 months |
| Drainage construction | 2 months |
| Street furniture installation | 2 months |
| Site restoration | 2 months |

| **Work activities** | **Duration** |
|---|---|
| **Berry roundabout, Ch 16000**<br>**Intersection of Princes Highway and Tannery Road** | |
| **Site preparation and establishment** | **1 week** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 1 week |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 1 week |
| **Earthworks** | **2 weeks** |
| Pavement construction | 1 week |
| Drainage construction | 1 week |
| Street furniture installation | 1 week |
| Site restoration | 1 week |
| **Berry embankment works, Ch 16400 – 17200**<br>**North of North Street** | |
| **Site preparation and establish** | **2 months** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 1 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 1 month |
| **Earthworks** | **3 months** |
| Pavement construction | 1 month |
| Drainage construction | 1 month |
| Street furniture installation | 1 month |
| Site restoration | 1 month |
| **Kangaroo Valley Road interchange, Ch 17200 – 18250**<br>**Kangaroo Valley Road Cul-de-sac of North Street** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 1 month |
| **Earthworks and bridge construction** | **8 months** |
| Pavement construction | 1 month |
| Drainage construction | 1 month |
| Street furniture installation | 1 month |
| Site restoration | 6 weeks |

| Work activities | Duration |
|---|---|
| **General alignment works to Mullers Lane Ch 18250 – 19600**<br>**South of Victoria Street to Mullers Lane** | |
| **Site preparation and establishment** | **1 month** |
| Temporary construction facilities, including construction compounds, stockpiles sites, creek crossings, sediment control basins and haulage roads | 1 month |
| Temporary works, including relocation/protection of services, tie-ins, traffic facilities and side tracks | 2 months |
| **Earthworks** | **6 months** |
| Pavement construction | 1 month |
| Drainage construction | 1 month |
| Street furniture installation | 1 month |
| Site restoration | 1 month |

## 4.4 Ancillary facilities

Typical works undertaken within ancillary facilities would include site establishment and landscaping, stockpiling, earthworks, pavement construction, drainage construction, casting yard, street furniture installation and site restoration. There are no batch plants planned within the ancillary facilities or within the project extents. The equipment used would be similar to the scenarios listed in **Table 4-1**, specifically site establishment and landscaping, earthworks, paving and bridgeworks. Based on this information the typical sound power level from ancillary facilities would be 112 dB(A) while the maximum sound power level would be 120 dB(A).

The noise criteria for the ancillary facilities are dependent on which NCAs the nearest receivers are located in. Provided below in **Table 4-19** is a summary of the potentially most affected receivers surrounding each compound and predicted typical and worst case noise levels for each. Noise contours for the operations of the ancillary facilities are provided in Appendix F.

**Table 4-19: Compound noise management levels**

| Receiver number | Distance (m) | NCA | Predicted noise levels dB(A) | | Standard hours NML dB(A) | Out of hours NML dB(A) | |
|---|---|---|---|---|---|---|---|
| | | | Typical | Worst case | | Evening | Night-time |
| **Compound 1** | | | | | | | |
| 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 |
| **Compound 2** | | | | | | | |
| 9 | 210 | NCA1 | 51 | 59 | 50 | 46 | 45 |
| 10 | 185 | NCA1 | 52 | 60 | 50 | 46 | 45 |
| 11 | 185 | NCA1 | 51 | 59 | 50 | 46 | 45 |
| **Compound 3** | | | | | | | |
| 12 | 123 | NCA1 | 40 | 48 | 50 | 46 | 45 |
| 14 | 109 | NCA1 | 58 | 66 | 50 | 46 | 45 |
| 16 | 394 | NCA1 | 43 | 51 | 50 | 46 | 45 |
| **Compound 4** | | | | | | | |
| 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 |
| **Compound 5** | | | | | | | |
| 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 |
| **Compound 6** | | | | | | | |
| 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) | NCA | Predicted noise levels dB(A) | | Standard hours NML dB(A) | Out of hours NML dB(A) | |
|---|---|---|---|---|---|---|---|
| | | | Typical | Worst case | | Evening | Night-time |
| **Compound 7** | | | | | | | |
| 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 |
| **Compound 8** | | | | | | | |
| 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 |
| **Compound 9** | | | | | | | |
| 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 predicted noise levels indicate that activities within the site compounds are likely to exceed the appropriate NMLs. All reasonable and feasible noise mitigation and management measures should be considered and detailed by the contractor in the Construction Noise and Vibration Management Plan (CNVMP).

## 4.5 Cumulative impact

Simultaneous noise from a site compound and works on the main alignment has the potential to increase noise levels at sensitive receivers. Noise levels as a result of the cumulative impact could increase by as much as three dB(A) higher than the maximum noise level of the site compound works and alignment works. Although three dB(A) is generally not considered significant, as far as possible the cumulative impact of noise should be managed by the contractor to ensure that the potential for adverse comment at sensitive receivers is minimised.

Construction of the project, if approved by the Minister for Planning, is forecast to commence in 2015 with the project opening to traffic in 2017.

In addition to this project, the Princes Highway upgrade program in the immediate region also includes the Gerringong upgrade and the proposed Berry to Bomaderry upgrade, which are located at the northern and southern ends of the project respectively.

The detailed design and construction of the Gerringong upgrade is currently underway following approval of the project under Part 5 of the EP&A Act, with the upgraded highway opening to traffic in 2014.

The Berry to Bomaderry proposal is only in its planning stage. In the event that the proposal moves forward to the assessment and approval stage, construction may be underway in 2017, with this section of the upgraded highway open to traffic by 2019.

A review of the major projects register, administered by the NSW Department of Planning and Infrastructure (DP&I), indicates that, at the time of writing, no other major projects in the Shoalhaven and Kiama LGAs have been recently approved and/or are likely to be under construction at the same time as the project.

The North Nowra Link Road (NNLR) is a major project in the region that is currently being assessed by the DP&I as a concept plan under Part 3A of the EP&A Act. The link road is proposed to relieve traffic congestion at the Illaroo Road and the Princes Highway intersection by providing an alternative access to the Princes Highway, as well as to provide network capacity for future growth in North Nowra and Bomaderry.

The concept plan provides a comparative assessment of three route options through and/or adjacent to the Bomaderry Creek Regional Park, and seeks approval of the preferred route. The environmental assessment for the concept plan was publicly exhibited by the then NSW Department of Planning between 16 February 2011 and 18 March 2011. At the time of writing, Shoalhaven City Council (the proponent) was reviewing submissions received during the public exhibition period. Construction of the project may coincide with this project, should the Minister for Planning (or his delegate) determine to approve the concept plan.

### 4.5.1 Assessment of potential impacts

The Princes Highway upgrade works would largely be undertaken sequentially, however as at this early stage of the project it is not possible to eliminate the potential for some overlap of construction, a worst case scenario has been assumed for the Gerringong upgrade to the north and this project. Notwithstanding, 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 proposed Berry to Bomaderry upgrade, any associated cumulative impacts from this proposal are not able to be accurately predicted. As such, for the Berry to Bomaderry upgrade, the onus will be on the environmental assessment for that proposal to assess and rectify any potential cumulative impacts with the project.

## 4.6 Extended work hours

Due to the scale of the project and the potential benefits of reducing the period of construction and improving the capacity to recover from wet weather or other delays, extended working hours are proposed. Minimising the construction period would also minimise the overall impacts of construction works on sensitive receivers adjacent to the alignment. Extended working hours would be highly beneficial for works surrounding the Toolijooa cut and a number of major bridge structures, away from the township of Berry.

The ICNG permits five types of work that may be undertaken outside normal construction hours. These are:

- Deliveries of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads.
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours.
- Public infrastructure works that shorten the length of the project and are supported by the affected community.
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

For this project, approval is sought for extended working hours to shorten the length of the project construction and improve the capacity to recover lost construction capability due to wet weather or other delays. Extended work hours would be limited to:

- 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).

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

- Shorten the overall construction period by approximately 3 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.

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 work in ancillary activities.

The potential noise impact for extended work hours has been considered in Section 4.2.4. Extended work hours would be programmed and managed in accordance with the processes recommended in this report to minimise the noise and vibration impact on individual receivers. Consultation with potentially affected residents has already commenced.

**Extended working hours construction noise consultation**

The ICNG states that *"a strong justification would typically be required for works outside the recommended standard hours"*. However in some situations, and with community negotiation, the ICNG also considers that approval for out of hours work can be granted.

Targeted community consultation has been undertaken with property owners potentially affected by these extended hours from Toolijooa Road to the northern Berry interchange 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 and existing tenants were contacted by the leasing agent with one tenant contacting the project team for further feedback. For the remaining 49 privately owned properties, telephone calls were made to 44 properties. The remaining five properties did not have a telephone number listed. Letters were sent to all 49 private property owners.

A total of 34 of the property owners contacted requested an interview with the project team to discuss potential impacts or seek clarification regarding the proposed extended working hours. A summary of the comments and feedback recorded during these interviews is included in Chapter 6 and Appendix C of the environmental assessment. Discussions included a general summary of the standard working hours and what the extended hours would mean for each property. Information on the likely work activities that may be undertaken during extended hours was based on current information and the potential construction scenarios. Property owners were also informed about the likely complaints management procedures, EPL conditions and project conditions of consent that would likely be put in place during construction and the team noted that consultation 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.

Although feedback was generally supportive of extended construction hours, a number of property owners raised concerns relating to potential disruptions to cattle movements, distribution or grazing patterns within the property that may be required 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 events such as weddings or birthdays on the property, would be discussed in more detail prior to and during construction through the ongoing project consultation. Of the 33 consultation interviews undertaken, three property owners expressed some concern over extended working hours in the morning and evening and one was concerned about work being undertaken on Saturday afternoons.

## 4.7 Out of hours work activities

Some out of hours work would be required due to safety, engineering and timetable feasibility issues. The work packages required for out of hours are summarised below. All feasible and reasonable mitigation measures would be implemented by the contractor to ensure that the potential for adverse impact on the local community is minimised. Detailed information on the mitigation measures that would be implemented would be provided by the construction team in the form of a CNVMP.

### 4.7.1 Bridge works - lifting and setting of girders over existing roads or demolition

The only bridge that would require out of work hours is located near Tindalls Lane. The Princes Highway would need to be closed to allow this work to be undertaken safely for both traffic and workers. There are no other bridges to be constructed on the existing alignment.

### 4.7.2 Existing and new road tie-in works

Tie-in roadworks would be required at the beginning and end of new road alignments, where the new road alignment joins an existing road. This work would need to be undertaken at night to reduce the inconvenience to road traffic. The Princes Highway or local roads where appropriate, would need to be closed to allow this work to be undertaken safely for both traffic and workers.

### 4.7.3 Utility adjustments

Utility adjustments typically need to be undertaken during out of hours work periods to minimise the impact on utility operations and road traffic and to improve the safety of workers involved. The details of utility adjustments are not certain at this stage and would be clarified in the CNVMP.

### 4.7.4 Refuelling operations and maintenance

To maximise the plant and machinery operations during the recommended standard hours, and thus reduce the overall duration of the project, refuelling operations of plant and machinery are proposed between 5am and 7am in the morning Monday to Saturday or between 6pm to 9pm Monday to Friday or 1pm to 9pm Saturday.

This work would be undertaken in accordance with the Out of Hours Work Procedure that would be provided in the CNVMP, and away from sensitive receptors receivers and such that the noise emissions are shielded or directed away from sensitive receivers where possible.

Reversing has been identified as the single loudest activity during refuelling and the vehicles undertaking this work would be fitted with less annoying ‘smart’ reversing alarms, subject to approval by the site Safety Manager.

### 4.7.5 Inaudible out of hours works

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

- The works do not exceed the noise management levels.
- For delivery of materials required outside these 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.

## 4.8 Construction road traffic noise

Most spoil would be moved on internal haul routes, reducing the number of heavy vehicle movements on local roads. However the construction works would increase both light and heavy vehicle movements on the Princes Highway. Given that 3 per cent of traffic is predicted to shift to the ‘Sandbank’ route during the construction period, the additional traffic would be partially offset by a small reduction in local traffic. Provided below in **Table 4-20** is a summary of the increase in traffic movements during the daytime (exclusive of the 3 per cent traffic shift for a conservative assessment). An increase in construction traffic during the night-time period is not predicted for this project.

**Table 4-20: Construction road traffic**

| Route \| Direction | Daily total | 15 Hour (7am - 10pm) | | |
|---|---|---|---|---|
| | | Light | Heavy | % Heavy |
| **Existing traffic** | | | | |
| Princes Highway northbound | 4,664 | 3,700 | 514 | 12 |
| Princes Highway southbound | 4,630 | 3,689 | 502 | 12 |
| **Existing traffic with construction movements** | | | | |
| Princes Highway northbound | 4,782 | 3,765 | 567 | 13 |
| Princes Highway southbound | 4,748 | 3,754 | 555 | 13 |

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 two dB(A), the impact from the additional traffic associated with the construction works is not considered to be significant.

## 4.9 Construction vibration

Vibration intensive works may occur during each phase of the project. The safe working distances that relate to cosmetic/structural damage and human discomfort for the proposed works are presented in **Table 4-21**.

Depending on the construction equipment that is used, the safe working distances provided in **Table 4-21** may be exceeded. The construction equipment used in the works should be planned to ensure that the safe working distances are not breached wherever possible. If these distances are breached, alternative equipment and vibration monitoring should be implemented. This is discussed in more detail below.

The primary form of mitigation of vibration should be ensuring vibration intensive works do not occur within the safe working distance outlined in **Table 4-21**. If vibration intensive works are planned within the safe working distances identified, alternative equipment should be identified to ensure these distances are not exceeded.

**Table 4-21: Recommended safe working distances for vibration intensive plant**

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

Further mitigation of vibration would not be required provided that the safe working distances in **Table 4-21** are adhered to.

In some circumstances, construction activity within the safe working distance cannot be avoided due to the work required and the prevalent geological site conditions. These conditions may not be fully understood until work has commenced, resulting in a potential change in operating equipment. If vibration intensive plant is to be used within the safe working distance for cosmetic damage, works should not proceed until attended vibration measurements are undertaken. A permanent vibration monitoring system should be installed, to warn operators (via flashing light, audible alarm, short message service (SMS) etc) when vibration levels are approaching the cosmetic damage objective. It may also be advisable to carry out dilapidation surveys of the affected properties.

## 4.10 Blasting assessment

A list of the nearest sensitive receivers to the proposed blasting is provided below in **Table 4-22**. The nearest receiver must comply with the appropriate noise and vibration criteria. By ensuring that the nearest receivers have been considered adequately, all other receivers would comply with the appropriate criteria.

**Table 4-22: Sensitive receivers**

| Receiver | Offset distance (m) |
|---|---|
| 14 | 450 |
| 12 | 450 |
| 11 | 300 |
| 9 | 260 |

To predict overpressure and PPV levels, the equations are highly dependent on local site conditions and the nature of the blast. The maximum offset distances calculated under 'typical' conditions are provided below for confined blasts. It is recommended that smaller test blasts are undertaken initially to determine the correct constants that should be employed for this project. This should allow for a higher certainty in the prediction of overpressure and PPV levels.

The offset distances provided below in **Table 4-23** have been calculated to ensure compliance with the criteria in **Table 3-12** and **Table 3-13**.

**Table 4-23: Overpressure and blast limits**

| Criteria | Charge offset distance | | |
|---|---|---|---|
| | 1 kg | 5 kg | 10 kg |
| Overpressure[1] | 550 m | 900 m | 1150 m |
| PPV[2] | 30 m | 67 m | 95 m |

*Note1: $K_a$=100, a= -1.45*
*Note2: $K_a$=1140, a= -1.6*

Based on the offset distances provided in **Table 4-23**, the results indicate that although vibration limits would be complied with, overpressure is likely to exceed the appropriate limits. It is likely that as the project proceeds, the noise levels would be attenuated by the deepening cut. As such noise levels will gradually decrease. On this basis, the blast size is likely to be able to be increased as the works progress. Blasts should be monitored closely to determine the insertion loss the cut is providing.

Blast shields or similar should be used to reduce noise levels and minimise the likelihood of exceedance. If the noise criteria cannot be met at sensitive receivers, the residents may need to be relocated during the blast operations.

To improve productivity of the construction, and hence reduce both the number of blasts and the duration of construction, it is considered reasonable to exceed overpressure and blast limits should the written consent of local residents be attained. With the consent of local residents, recent major road upgrade projects have used the criteria provided in **Table 4-24**.

**Table 4-24: Secondary overpressure and peak particle velocity criteria**

| Criteria | Maximum allowable level |
|---|---|
| Overpressure | 125 dB(Lin) |
| PPV | 15mm/s |

The limits recommended above in **Table 4-24** comply with the structural damage criteria in DIN4150. On the basis that these limits have been implemented successfully in the past without incident, it is recommended that these conditions also be considered for this project.

Provided in **Table 4-25** are the maximum offset distances incorporating the criteria identified in **Table 4-24**.

**Table 4-25: Overpressure and blast limits**

| Criteria | Charge offset distance (metres) | | |
|---|---|---|---|
| | 1 kg | 5 kg | 10 kg |
| Overpressure[1] | 240 | 410 | 520 |
| PPV[2] | 15 | 34 | 48 |

*Note1: $K_a$=100, a= -1.45*
*Note2: $K_a$=1140, a= -1.6*

# 4.11 Operational noise assessment

## 4.11.1 Modelling methodology

Noise emission levels from the road were calculated using SoundPLAN software, which implements the Calculation of Road Traffic Noise (CoRTN) algorithm. The UK Department of Transport devised the CoRTN algorithm and with suitable corrections, this method has been shown to give accurate predictions of traffic noise levels under Australian conditions.

The noise model for this project incorporated the following features:

- Traffic volume and/or percentage of cars on the roadway.
- Traffic volume and/or percentage of medium / heavy trucks on the roadway.
- Correction for pavement surface.
- Corrections for roadway gradient.
- Road chainage and three dimensional coordinates of traffic lanes and topographic features imported from electronic data (DXF format).
- Three dimensional receiver coordinates, calculated at the most affected storey.
- Intervening ground absorption.
- Roadside or topographic barriers.
- Contributed noise from other traffic sources to determine the cumulative noise impact.
- 2.5 dB(A) correction for facade effects.
- A sensitivity factor of one dB(A) has been applied to the design year noise model.
- Verification factor of -1.7 dB(A) for day-time noise levels and +0.5 dB(A) for night-time noise levels.
- Noise sensitive receivers were identified from aerial photographs and are presented in Appendix B. The height and number of floors of the identified receivers was identified from Google Street View where possible.

To determine the most affected facade, noise levels were calculated at each facade of every identified sensitive receiver. All facades were assessed against the criteria, however only the most affected facade has been reported.

The calibration noise model incorporated measured traffic volumes on the Princes Highway and all major roads around town.

Both daytime and night-time noise levels were predicted for the year of opening (2017), the design year (10 years after opening - 2027). The design year was also modelled with a low noise pavement (stone-mastic asphalt) and a variety of test barriers.

Three models were developed for both the year of opening scenario and the design year scenario. The first two models were the ‘no build’ scenario and the ‘build’ scenario which incorporated all local roads, the main alignment and interchanges. The models were used to assess the increase in noise. The ‘build’ scenario was also used to assess noise levels for the redeveloped road noise criteria. The last model incorporated the main alignment and interchanges only and was used to assess the noise as a result of the project for receivers subject to the criteria for a new road.

### 4.11.2 Traffic volumes

The existing traffic volumes were obtained from traffic count data recorded at various positions along the Princes Highway, Berry. Appendix H contains a summary of the traffic data used to calibrate the noise model. Predicted traffic volumes (2017 and 2027) for both the proposal and for the existing road were sourced from traffic modelling undertaken by AECOM and are summarised in Appendix H.

### 4.11.3 Ground absorption

The ground absorption was set at 0.5 for the modelled area. This provided the best correlation with measured data and, based on AECOM’s previous experience, is typical for rural locations in NSW.

### 4.11.4 Traffic source strings

A three source height model was utilised throughout the modelling with individual source strings for each lane of traffic. The source height was set at 0.5 metres for light vehicles and 1.5 metres and 3.6 metres for heavy vehicle engines and exhausts respectively (including the default 0.5 metres height assumed by the implementation of CoRTN within SoundPLAN). Source corrections of 0.6 dB(A) and -8.6 dB(A)) were applied to the heavy vehicle engine and exhaust strings respectively to take in to account the relative source contributions of the engine and exhaust in the three source height model.

### 4.11.5 Road surfaces

The existing road surface was modelled as dense grade asphalt in the CoRTN model for both the existing future and design year models. No correction factor has been used for dense grade asphalt road surface.

Stone mastic asphalt was also considered as a low noise pavement option. The correction factors used was -2.2 dB(A) for light vehicles and -4.3 dB(A) for heavy vehicles.

### 4.11.6 Reflections of barriers

Barriers have the potential to reflect noise to a receiver on the opposite side of the carriageway. The maximum increase in noise would typically be in the range of one dB(A) to two dB(A), dependent on the arrangement of the source, barrier and receivers. Reflections are typically included in the SoundPLAN noise modelling; however for the avoidance of doubt and to provide a conservative assessment, a correction factor of +2 dB(A) has been included for receivers that may be exposed to an increase in noise as a result of reflection.

The receivers that may be potentially impacted are located to the north of North Street. The impact of reflections from the proposed Huntingdale Park Road noise barrier were considered by analysing the future impact on receivers currently located on Queen Street, opposite Huntingdale Park Road.

The noise levels would be controlled by noise from the main alignment. Reflections from the Huntingdale Park Road noise barrier due to traffic on that road were found not to increase noise levels. Additionally due to the distance of the reflection path between the main alignment, the proposed Huntingdale Park Road noise barrier and the receivers on Queen Street, reflections from the main alignment were also found not to impact overall noise levels. On this basis the impact of reflections from the Huntingdale Park Road noise barrier were considered to be negligible and would not impact sensitive receivers. A correction factor was not included for receivers located on Queen Street.

### 4.11.7 Noise model calibration

Standard corrections are typically applied when using the CoRTN in Australia to account for Australian conditions. These correction factors of -1.7 dB(A) [1] and +0.5 dB(A) [2] have been applied to the daytime and night-time predicted noise results respectively.

Noise logging was undertaken over a period of two weeks at ten locations to verify the noise model. Traffic flow monitoring was undertaken simultaneously to determine the traffic flows at each location over the same time periods.

The noise logging results and noise model predictions have been provided in **Table 4-26**. The noise logger locations are provided in Appendix D.

[1] *An evaluation of the U.K. DoE traffic noise prediction method: final report of the NAASRA Working Group on Traffic Noise Prediction Evaluation / by R.E. Saunders...[et al.] Vermont South, Vic. : Australian Road Research Board, 1983.*

[2] *Based on AECOM experience*

**Table 4-26: Noise model calibration**

| Noise logger | Daytime noise level dB(A) | | | Night-time noise level dB(A) | | |
|---|---|---|---|---|---|---|
| | Measured | Predicted with standard correction | Difference | Measured | Predicted with standard correction | Difference |
| BG1 | 62 | 64.1 | 2.1 | 58.4 | 59.2 | 0.8 |
| BG2 | 52.2 | 51.5 | -0.7 | 49.3 | 46.6 | -2.7 |
| BG3 | 55.9 | 54.7 | -1.2 | 51.2 | 49.8 | -1.4 |
| BG4 | 55.9 | 53.8 | -2.1 | 46.7 | 48.6 | 1.9 |
| BG5 | 58.4 | 58.0 | -0.4 | 48.9 | 48.7 | -0.2 |
| BG6 | 58.1 | 57.6 | -0.5 | 48.1 | 48.2 | 0.1 |
| BG7 | 65.6 | 61.8 | -3.8 | 54.8 | 50.8 | -4 |
| BG8 | 58.9 | 61.3 | 2.4 | 56.5 | 56.1 | -0.4 |
| BG9 | 54.3 | 55.6 | 1.3 | 50.7 | 50.2 | -0.5 |
| BG10 | 51.4 | 51.4 | 0 | 46 | 46 | 0 |

The results in **Table 4-26** indicate that disregarding BG7, measured noise levels during the daytime period vary between -1.6 dB(A) to +2.4 dB(A). Rounding results to the nearest decibel results in an accuracy of ±2 dB(A). This calibration is within CoRTNs documented accuracy of ±3 dB(A) at a distance of 600 metres.

The predicted night-time levels (disregarding BG7) are within -2.7 dB(A) and +1.9 dB(A). Rounding results to the nearest decibel results in an accuracy of ±2 dB(A). This calibration is within CoRTNs documented accuracy of ±3 dB(A) at a distance of 600 metres.

BG7 was located near a corner that appears to have a high number of cars accelerating past it. This has resulted in much higher measured noise levels during the daytime and night-time period so has not calibrated sufficiently.

The predicted noise levels indicate that the impact of the daytime and night-time periods are quite close. As such, both time periods would be assessed in detail to ensure that no receivers are missed as a result of focusing on only one period.

### 4.11.8 Operational noise assessment

The results of the operational noise modelling are presented in Appendix I and Appendix J.

A total of 108 receivers exceed the appropriate noise criteria during the daytime period of which 7 are considered to be 'acute' ($L_{Aeq(15hour)}$ is 65 dB(A) or greater) as a result of the project. During the night-time period 131 receivers exceed the appropriate noise criteria of which 16 are considered to be 'acute' ($L_{Aeq(9hour)}$ is 60 dB(A) or greater) as a result of the project.

The numbers above indicate that the night-time period is generally more stringent than the daytime results. However both time periods have been considered in the assessment of the results.

Overall, 164 receivers exceed the appropriate noise criteria, of which 18 are considered to be 'acute' as a result of the project.

Results for receivers that would be impacted by the project are provided graphically in the following pages. A small 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 receivers experiencing an increase of greater than two dB(A) .

The designation of the ‘redeveloped’ and ‘new road’ noise criteria to sensitive receivers along the project is consistent with Practice Note i of the ENMM as discussed in Section 3.4. Typically the ‘redeveloped’ criteria apply where the road will not deviate significantly from the existing alignment.

Sensitive receivers that have been assigned the ‘new road’ noise assessment criterion are those that would be exposed to a new source of road traffic noise or where the sensitive receiver is not currently exposed to road traffic noise. Examples for this project include sensitive receivers that are typically located along the off line sections of the project near Toolijooa Ridge and near the Berry bypass.

Receivers predicted to exceed criteria are shown in **Figure 4-1**, **Figure 4-2** and **Figure 4-3**.


**Figure 4-1: Receivers predicted to exceed criteria in areas from Toolijooa Road interchange to just east of the Austral Park Road interchange**


**Figure 4-2: Receivers predicted to exceed criteria in areas between Austral Park Road interchange and Tindalls Lane interchange**

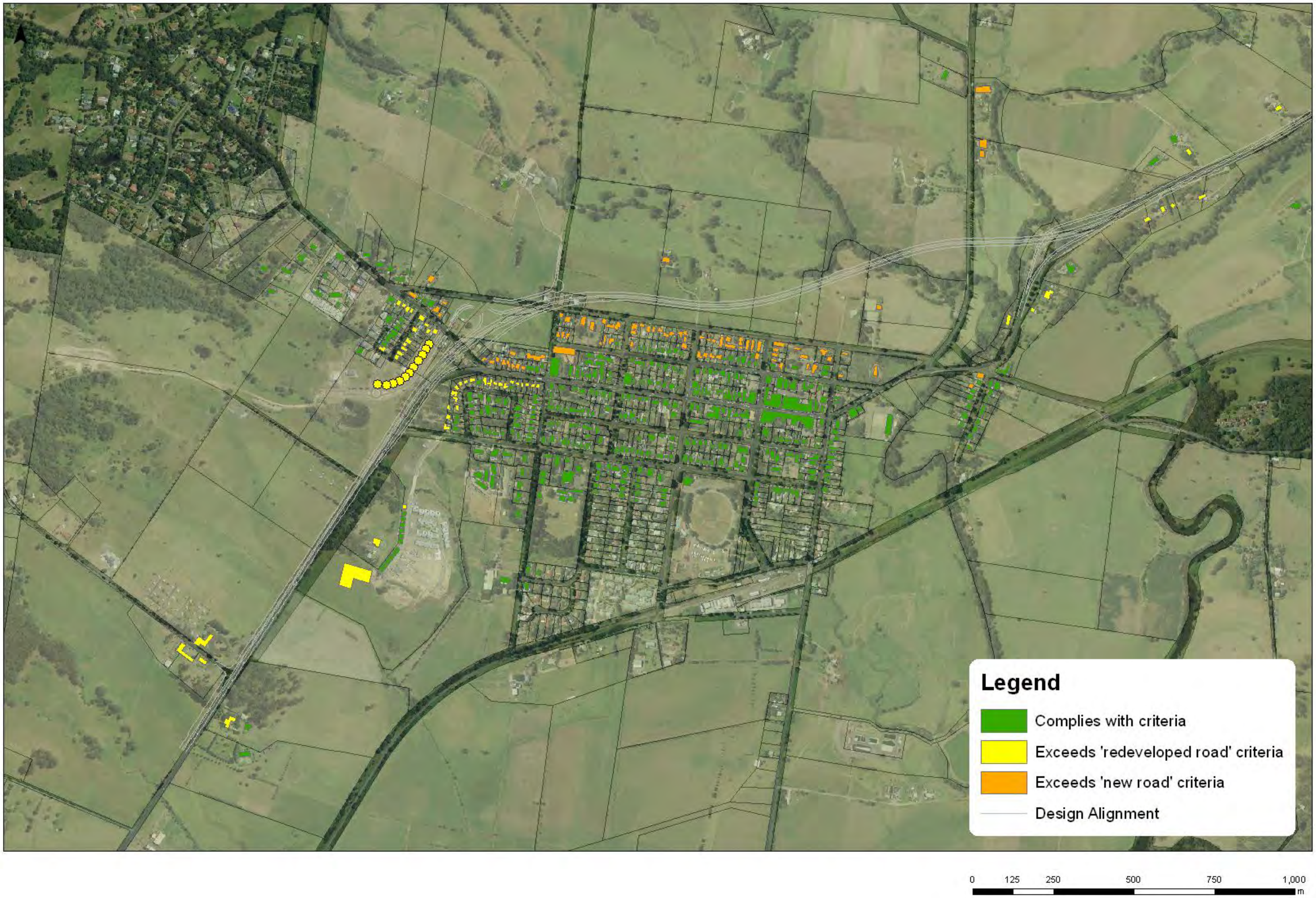



**Figure 4-3: Receivers predicted to exceed criteria in areas between Tindalls Lane interchange and Berry bypass**

### 4.11.9 Queen Street and Closure of Victoria Street

A considerable number of receivers along Queen Street are currently acutely affected by noise associated with traffic on the existing highway (Queen Street). Noise levels emitted from the new alignment (located to the north of Berry) comply with the appropriate noise criteria. 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. As discussed previously noise generated by new alignment comply with the appropriate noise criteria. As receivers would not be impacted directly by the project, and noise levels would appreciably reduce as a result of this project, RMS considers that the receivers on Queen Street are not considered to be eligible for noise mitigation.

The closure of Victoria Street would result in a redistribution of some local road traffic and an increase in traffic along north-south running local roads including Prince Alfred Street, Alexandra Street, Albany Street, Edward Street and George Street. The increase in traffic would be predominantly local traffic accessing the new bypass and would generally be restricted to the sections of these local roads between Victoria Street and Queen Street.

An assessment of these local roads has been conducted in accordance with the RNP. The results of the assessment show that receivers located along the north-south running local roads are currently dominated by noise from Queen Street during the peak hour traffic flows and this would continue should the project proceed. Given that the traffic along Queen Street is predicted to decrease to 33 per cent of the existing traffic flows following the opening of the project, most receivers would experience a reduction in overall noise levels. A small number of receivers located further from and therefore less affected by traffic noise on Queen Street, would experience an increase in noise levels associated with the closure of Victoria Street during peak hour flows. The level of increase is expected to be less than 2 dB(A) which is typically considered indiscernible.

It is important to note that some receivers are currently experiencing noise levels well above the relevant criteria, and would continue to do so in the future. The noise at these receivers emanates from traffic movements on Queen Street, rather than the local road on which the receiver is located. With the proposed changes to Victoria Street, noise levels would continue to be controlled by movements on Queen Street.

Predicted noise levels results for some of the impacted receivers are presented below in **Table 4-27**. To be eligible for the consideration of noise mitigation the noise levels at the receivers must exceed an $L_{Aeq(1hour)}$ of 55 dB(A) and increase by more than 2.0 dB(A).

**Table 4-27: Berry local road indicative results**

| Receiver | Most affected facade | Noise criteria dB(A) | 2027 LAeq(1hour) Predicted Noise Levels – dB(A) | | |
|---|---|---|---|---|---|
| | | | ‘No Build’ | ‘Build’ | Increase |
| 132 | N | 55 | 66 | 65 | -0.9 |
| 174 | E | 55 | 60 | 59 | -0.9 |
| 244 | N | 55 | 62 | 62 | 0 |
| 332 | W | 55 | 60 | 60 | -0.7 |
| 336 | E | 55 | 62 | 60 | -1.4 |
| 402 | E | 55 | 60 | 58 | -2.5 |
| 420 | E | 55 | 62 | 61 | -1.4 |

Although the receivers in **Table 4-27** exceed the 55 dB(A) criteria, they do not increase by more than 2 dB(A) as a result of the project and hence are not eligible for mitigation.

As with those receivers on Queen Street discussed above, the project would redistribute a significant number of traffic movements away from sensitive receivers on local roads, that are currently affected by traffic noise on Queen Street, to the new alignment (located to the north of Berry). This would result in a reduction in noise levels for these sensitive receivers. There remain exceedances of the appropriate noise criteria; however these exceedances are owing to existing background levels which would be alleviated somewhat by the project. Considering the project would not directly impact local roads and noise levels associated with the bypass would comply with the local road noise criteria, receivers are not considered eligible for noise mitigation.

### 4.11.10 Other land uses

The Berry Sportsground, Berry Riding Club and Camp Quality Memorial Park are all located to the north of Berry and would be located directly adjacent to the proposed alignment. These locations can be considered 'Open Space (active use)' for the Sports Ground and Berry Riding Club and 'Open Space (passive use)' for Camp Quality Memorial Park as described by the RNP. The noise criteria are only applicable when the space is in use. For playing fields this would typically be outside standard working hours, usually during evenings and weekends. However considering the playing field, riding club and Camp Quality Memorial Park can be used anytime, the receivers have been assessed as operating during the day with typical traffic that has been used throughout the remainder of the project.

The $L_{Aeq(15hour)}$ noise level at the tennis courts is predicted to be 59 dB(A). Hence the predicted noise levels comply with the criteria of $L_{Aeq(15hour)}$ 60 dB(A) for 'Open Space (active use)' and exceed the criteria of $L_{Aeq(15hour)}$ 55 dB(A) for 'Open Space (passive use)'. Noise mitigation should be considered for Camp Quality Memorial Park, where reasonable and feasible.

Mark Radium Park (receiver 588) is located to the west side of the Berry township, to the east of the existing and proposed alignment. This location is considered 'Open space (passive use)' as described by the RNP. The noise criteria is only applicable when in use. The $L_{Aeq(15hour)}$ noise level at the centre of the park is predicted to be 62 dB(A). The predicted noise levels will exceed the 55 dB(A) criteria by 7 dB(A) when in use.

Berry Uniting Church is represented as receivers 116, 117 and 119 in this assessment, Saint Patrick's Catholic Church is represented as receiver 367. A place of worship has a noise criteria with an internal $L_{Aeq(1hour)}$ parameter of 40 dB(A), to be assessed when in use. Hourly traffic predictions while the church is operational have not been undertaken, however a screening assessment has been undertaken to determine the potential impact on the church.

$L_{Aeq(15hour)}$ noise level at the most affected church building is predicted to be 60 dB(A) for Berry Uniting Church and 61 dB(A) for Saint Patrick's Catholic Church at the facade of the building. Assuming that each hour results in an equal contribution means that the $L_{Aeq(1hour)}$ is equal to the $L_{Aeq(15hour)}$. The facade reflection that has been included in the prediction is equivalent to 2.5 dB(A). For typical buildings the external to internal noise reduction is generally assumed to be 10 dB(A) with windows open and 20 dB(A) with windows closed. The building has not been inspected so the conservatively 10 dB(A) noise reduction has been assumed. These corrections result in an estimation of 47 dB(A) for Berry Uniting Church and 48 dB(A) for Saint Patrick's Catholic Church. This exceeds the noise criteria by 7 dB(A) and 8 dB(A) for the two Churches, hence noise mitigation would be considered for these receivers.

The Bupa Care Services – Aged Care Facility has been assessed in accordance with the RNP, against the residential criteria. 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. Therefore the Bupa Care Services – Aged Care Facility is not eligible for mitigation.

### 4.11.11 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. As such the effectiveness of noise mitigation with weather effects has not been considered here.

Weather data has been sourced from the Bureau of Meteorology, incorporating the closest weather station at Gerroa, NSW. The weather data comprises the period of January 2000 to January 2001.

The occurrence of temperature inversions was considered to determine if they represented a significant feature of the area. Between 6pm and 7am during the winter months of June, July and August temperature inversions were found to occur for about 47 per cent of the total time. On this basis and consistent with the INP, temperature inversions are considered to be a feature of the area.

The noise propagation algorithm CONCAWE provides guidance to the potential impact of temperature inversion. This high level assessment has considered the dominant frequency of road traffic noise only at about one kHz. A temperature inversion typically falls under the Pasquill Stability Category F, with a wind speed of three metres per second results in a Meteorological Category 6.

Provided below in **Table 4-28** is the likely increase in noise as a result of temperature inversions.

**Table 4-28: Temperature inversion influence on noise levels**

| Distance to receiver (m) | Increased noise levels as a result of temperature inversions dB(A) |
|---|---|
| 100 | 0.4 |
| 200 | 3.6 |
| 300 | 4.5 |
| 400 | 4.9 |
| 500 | 5 |
| 1000 | 5 |

The INP considers wind effects to be assessed when source-to-receiver wind speeds of three metres per second or below occur for at least 30 per cent of the assessment period in any season. The occurrences of wind speeds of up to three metres per second for each season are provided in Appendix K.

The INP requires wind effects to be modelled at the highest measured wind speed. For all locations receivers that are wind affected were modelled at three metres per second, this represents a conservative approach. A summary of the modelling requirements is provided graphically in **Figure 4-4**.

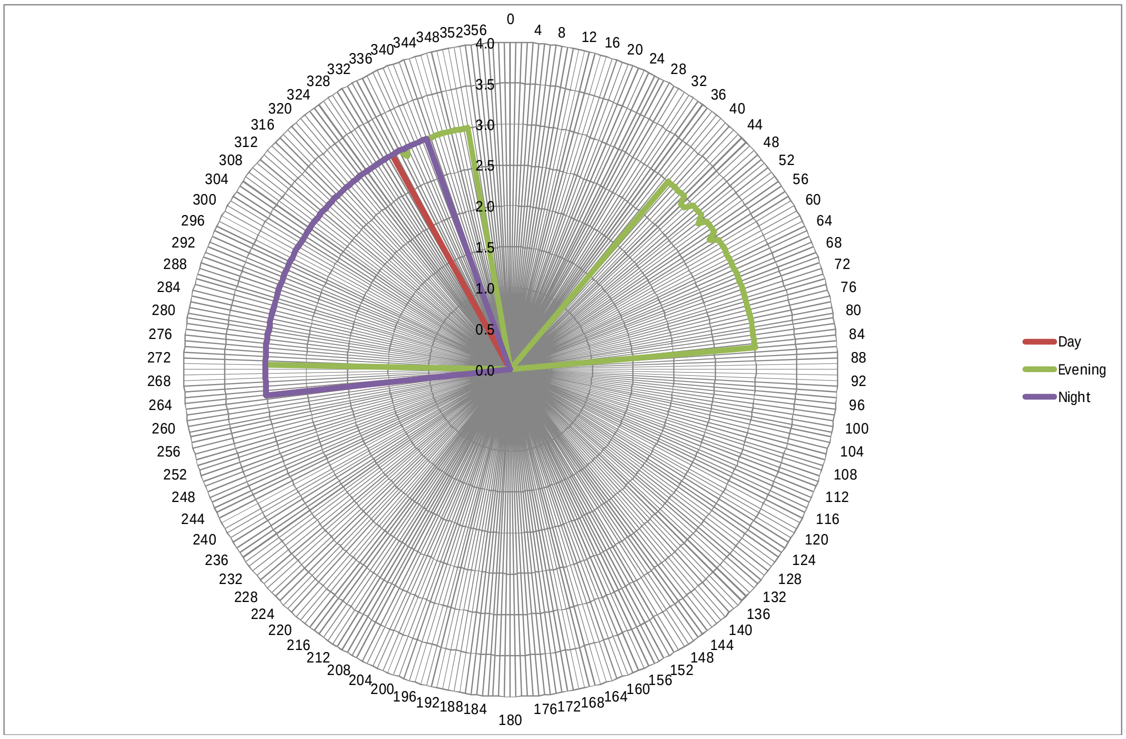



**Figure 4-4: Wind speed and direction modelling**

Considering the alignment generally runs east to west (rather than north to south), the figure above indicates that receivers located towards the south of the alignment would be adversely impacted as a result of wind affects.

The noise propagation algorithm CONCAWE provides guidance to the potential impact of wind effects. This high level assessment has considered the dominant frequency of road traffic noise only at about one kHz. The CONCAWE algorithm provides noise attenuation curves for vector wind speeds greater than one metre per second.

**Table 4-29** shows the likely increase in noise as a result of wind. Note that the noise levels provided below are not intended to be used in addition to those provided in **Table 4-28**.

**Table 4-29: Wind effects influence on noise levels**

| Distance to receiver (m) | Increased noise levels as a result of vector winds > 1m/s dB(A) |
|---|---|
| 25 | 2.2 |
| 50 | 2.8 |
| 100 | 3.4 |
| 200 | 4 |
| 300 | 4.4 |
| 400 | 4.6 |
| 500 | 4.8 |
| 1000 | 5.4 |

The results in **Table 4-28** and **Table 4-29** indicate that noise levels at sensitive receivers could increase by as much as five dB(A) as a result of temperature inversions and wind effects.

### 4.11.12 Maximum noise levels

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 emergence of noise levels has been considered at two locations, BG9 and BG6. These locations are considered to be typical of existing receivers north and south of Berry located on the existing alignment. Provided below are illustrations of the hourly median and maximum emergence levels.

The above noise logger indicates that typical noise levels meet the emergence criteria, with hourly maximum emergence levels exceeding the emergence criteria (of 15 dB(A) ) by more than five dB(A) (refer to **Figure 4-5**). As such the sleep disturbance noise goals would be exceeded more than two to three times in one night and are considered to be regular events.

BG6 noise logger indicates that typical noise levels exceed the emergence criteria by as much as five dB(A) (refer to **Figure 4-6**). Hourly maximum emergence levels regularly exceed the emergence criteria (of 15 dB(A) ) by at least five dB(A) . On the basis of these results, the sleep disturbance noise goals can be considered to be exceeded more than two to three times in one night and are considered to be regular events.

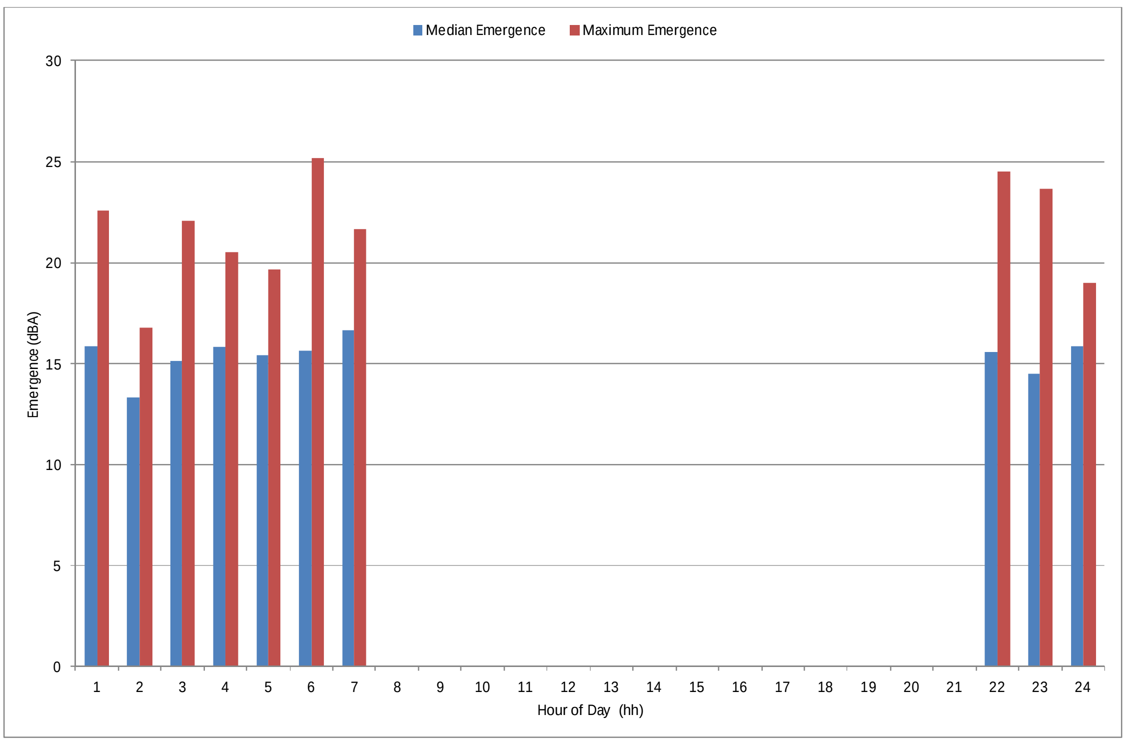



**Figure 4-5: Logger BG9 – 10 Austral Park Road, Broughton**

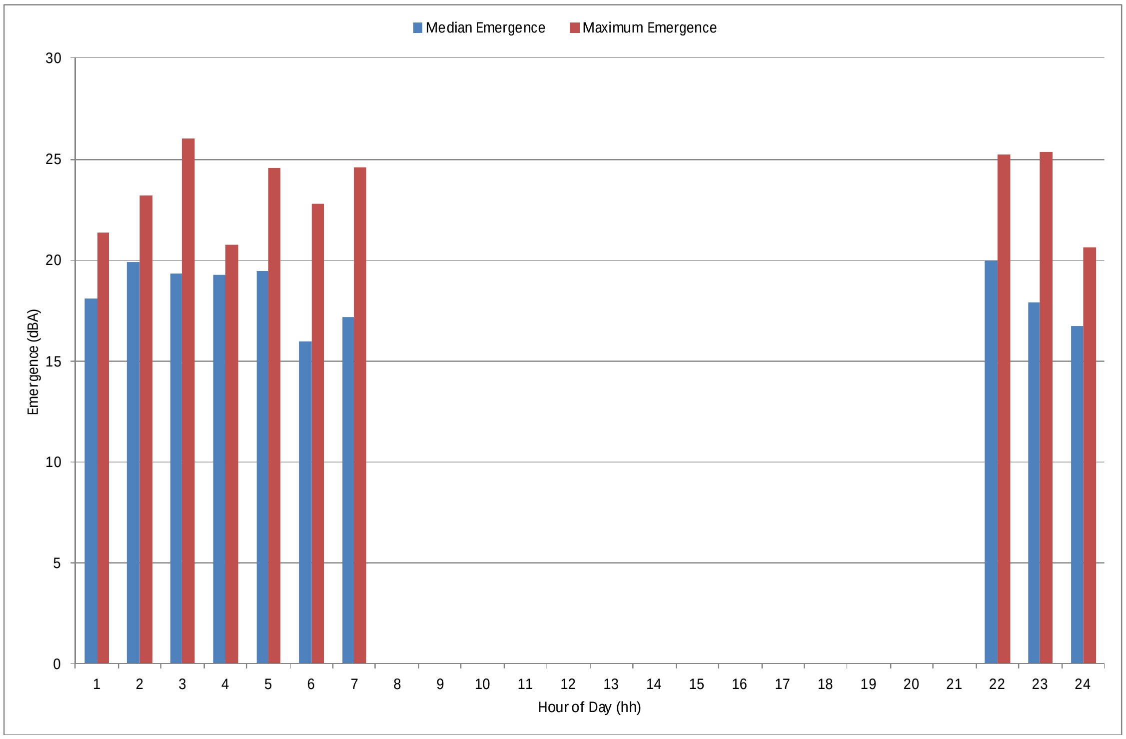



**Figure 4-6: Logger BG6 – Andersons Lane, Berry**

These results indicate that sleep disturbance is likely to be an existing issue for the local area.

For receivers where the proposed road would not move closer to them, 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 moving closer 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.

The RNP does not provide any requirements to meet maximum noise levels criteria. A cost-benefit analysis was undertaken for the noise proposed barrier, however the ENMM does not require maximum noise levels to be considered in this assessment.

# 5 Mitigation

## 5.1 Construction noise mitigation

Under the existing EPA policy a CNVMP is typically required to be prepared by the Contractor prior to construction commencing.

The CNVMP should detail the ‘best practice’ construction methods to be used, presenting a feasible and reasonable approach. The CNVMP should identify the extent of the noise sensitive receivers affected and assess the impact on the community. The CNVMP should detail any community relation programs that are planned eg prior notification for particularly noisy activities, letter box drops regarding out of hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The ICNG defines what is considered to be feasible and reasonable as follows:

**Feasible**

A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

**Reasonable**

Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Guidance on noise control measures is provided in AS2436-2010: Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites. Provided in this standard are practical noise reduction opportunities for various equipment. **Table 5-1** shows mitigation and management measures to limit the noise impact from various construction equipment used on projects similar to this.

**Table 5-1: Noise sources and possible mitigation and management solutions, AS2436-2010 Table C1**

<table>
<tr><th>Machine</th><th>Source of noise</th><th colspan="2">Possible remedies</th><th>Possible alternatives</th></tr>
<tr><td rowspan="4">Pneumatic concrete breaker and tools</td><td>Tool</td><td>Fit a muffler that will reduce the noise without impairing efficiency</td><td rowspan="2">Use the breaker inside a portable acoustic enclosure</td><td rowspan="2">Use rotary drill and burster. Hydraulic and electric tool are also available. A thermic lance can be used to burn holes in concrete and to cut through large sections of concrete, any reinforcement helps the burning process for breaking large areas of concrete, equipment which breaks concrete by bending could be used.</td></tr>
<tr><td>Bit</td><td>Use dampened bit to eliminate ‘ringing’. Little noise once surface is broken.</td></tr>
<tr><td>Air line</td><td colspan="2">Leaks in air lines should be sealed</td><td></td></tr>
<tr><td>Motor</td><td colspan="2">Fit muffler to pneumatic saws.</td><td></td></tr>
</table>

<table>
<tr><th>Machine</th><th>Source of noise</th><th colspan="2">Possible remedies</th><th>Possible alternatives</th></tr>
<tr><td>Power saws</td><td>Vibration of blade or material being cut</td><td colspan="2">Keep saw sharp. Use a damped blade. Clamp material while cutting with packing if necessary</td><td></td></tr>
<tr><td>Rotary drills diamond drilling and boring</td><td>Drive motor and bit</td><td colspan="2">Use machine inside an acoustic enclosure</td><td>Thermic lance<br>Thermal oxy-torch</td></tr>
<tr><td>Riveters</td><td>Impact on rivet</td><td colspan="2">Enclosure working area in acoustic screen</td><td>Design for high tensile steel bolts instead of rivets</td></tr>
<tr><td>Explosive powered tools</td><td>Explosion of cartridge</td><td colspan="2">Use a sound reduced gun</td><td>Drilled fixings</td></tr>
<tr><td>Pumps</td><td>Engine pulsing</td><td colspan="2">Enclosure in acoustic screen (allowing for engine cooling and exhaust)</td><td></td></tr>
<tr><td>Batching plant</td><td>Engine</td><td>Fit more efficient silencer on diesel or petrol engine. Enclose engine</td><td rowspan="3">Locate static mixing plant as far as possible from those likely to be inconvenienced by the noise</td><td rowspan="3">Use electric motor in preference to diesel or petrol engine</td></tr>
<tr><td rowspan="2">Concrete mixer</td><td>Filling</td><td>Do not let aggregates fall from an excessive height</td></tr>
<tr><td>Cleaning</td><td>Do not hammer the drum</td></tr>
<tr><td>Hammer</td><td>Impact on nail</td><td colspan="2"></td><td>Screws</td></tr>
<tr><td>Electric impact chisel</td><td>Impact</td><td colspan="2"></td><td>Rotary hand milling machine</td></tr>
<tr><td>Materials handling</td><td>Impact of material</td><td colspan="2">Do not drop materials from a height. Screen dropping zones especially on conveyor system.</td><td>Cover surface with resilient material or unload elsewhere</td></tr>
<tr><td>Steam cleaning</td><td>Escaping of jet stream</td><td colspan="2">Pass escaping steam through silencer or screen the outlet zone</td><td></td></tr>
</table>

**Table 5-2** lists mitigation and management measures to achieve potential noise reductions for various items of construction equipment used on similar projects.

**Table 5-2: Typical examples of noise reduction, AS2436-2010 Table C2**

| Type of machine | Typical treatment | Typical reduction in total A-weighted sound pressure level $L_{pA}$ after treatment dB |
|---|---|---|
| Diesel concrete mixer | Acoustic silencer | 5 |
| | Enclosure of the engine | 7 |
| Tracked loading shovel | Better silencer | 10 |
| Pneumatic concrete breaker | Muffler and screen | 20 |
| | Hydraulic System | 25 |
| Pneumatic breaker | Fabric muffler | 6 |
| | Rubber silencer | 6 |
| Diesel compressor | Silencer and enclosure | 20 |
| Crawler mounted rock drill | Silencer and enclosure | 20 |
| 0.5 t pneumatic hoist | Diffuser | 20 |
| Piling, Sheet | Screen drop hammer driver | 20 |
| Piling impact | Resilient pad (dolly) between pile and hammerhead | 10 |

The likely attenuation that can be provided from various noise control measures are set out in **Table 5-3** below.

**Table 5-3: Relative effectiveness of various forms of noise control, AS2436-2010 Table C3**

| Control by | Nominal noise reduction possible, in total A-weighted sound pressure level $L_{pA}$ dB |
|---|---|
| Distance | Approximately 6 for each doubling of distance |
| Screening | Normally 5 to 10, maximum 15 |
| Enclosure | Normally 15 to 25, maximum 50 |
| Silencing | Normally 5 to 10, maximum 20 |

Receivers potentially affected by construction noise would be consulted regarding specific timing and impacts of construction works. Respite periods should also be programmed for these receivers where practicable.

### 5.1.1 Ancillary facilities

Without knowing the exact location, orientation and source height of the equipment to be used in each ancillary facility, it is difficult to determine the appropriate height of noise barriers and mounds to attenuate noise levels. Noise barriers and mounds should be considered by the contractor once details on the specific location and nature of ancillary facilities are finalised. Additional mitigation measures that would be included in the CNVMP and operation of the ancillary facilities are provided in Section 5.1.3.

### 5.1.2 Community engagement framework

All residents where noise from the proposed works are expected to exceed the NMLs should be consulted about the project, with the highest consideration given to those that are predicted to be most affected as a result of the works.

The information provided to the residents should include:

- Programmed times and locations of construction work.
- The hours that the proponent proposes.
- Construction noise, vibration and air quality impact predictions.
- Construction noise, vibration and air quality mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration would be detailed in the Community Involvement Plan for the construction phase of the project and would include a 24 hour hotline and complaints management process.

Specific details of all out of hours work required will be provided to the EPA as part of the CNVMP.

### 5.1.3 Specific noise mitigation

Additional noise amelioration practices are provided below that should be included in the CNVMP.

- Noise intensive construction works should be carried out during standard construction hours wherever practicable.
- Schedule noisy activities that cannot be undertaken during standard construction hours to as early as possible during the evening and/or night-time periods.
- Appropriate plant should be selected for each task, to minimise the noise impact.
- Deliveries should be carried out during standard construction hours where practical and safe to do so.
- Non-tonal reversing alarms should be fitted on all construction equipment where possible.
- If it is safe, plan for and conduct night-time activities in such a manner as to eliminate or minimise the need for audible warning alarms.
- Maximise the offset distance between noisy plant items and nearby residential receivers.
- Orientate noisy equipment away from residential receivers.
- Position site access points and roads as far as practicable away from residential receivers.
- Use structures or enclosures to shield residential receivers from noise sources where practicable.
- Trucks should travel via internal haul routes and major roads and routes where practicable and not be allowed to queue near residential dwellings.
- Consider respite periods 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 should 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 it is proposed that multiple simultaneous blasts be undertaken for this project. 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 should be used in place of impact piling wherever possible. Additionally, impact piling should only be undertaken during standard work hours.

### 5.1.4 Road traffic noise mitigation measures

Operations such as idling trucks for long periods alongside sensitive receivers have the potential to adversely impact sensitive receivers. As such the following mitigation measures should be employed to minimise the potential impact on sensitive receivers:

- Deliver materials and remove spoil during standard construction hours wherever practicable.
- Avoid idling trucks alongside sensitive receivers.
- Plan deliveries and spoil removal to ensure a consistent and minimal number of trucks arrive at site at any one time.
- Where practical consider traffic management practices to minimise reversing as far as practicable and arrange for construction vehicles and mobile plant to reverse predominantly away from noise-sensitive properties.
- Where practical, stage traffic movements that occur from any one location if there is potential for traffic movements to pass by noise sensitive receiver properties.

## 5.2 Operational noise mitigation

Where feasible and reasonable, noise levels from redeveloped and new roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land-use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

The hierarchy of noise mitigation is firstly to consider at-source noise mitigation measures such as road design and traffic management, then the use of quieter pavements. If these measures cannot be designed to meet the noise criteria the use of ‘in corridor’ mitigation measures should be considered, which are generally noise barriers and mounds. Finally, if the applicable noise criteria cannot be met by using a combination of all these methods, at-receiver mitigation measures can be considered such as architectural treatments and property boundary walls.

To be eligible for the consideration of additional noise mitigation from a ‘redeveloped road’ the predicted noise levels at the receiver must either:

- Exceed the applicable noise criteria and be significantly affected by the project.
- Be considered to be ‘acute’.

For a receiver to be eligible for the consideration of mitigation under the ‘new road’ criteria, the predicted noise levels must exceed the applicable noise criteria.

The ENMM provides guidance on the significance of impact:

*‘A “significant contribution to road traffic noise exposure” from a road development or upgrading proposal is defined as an increase in road traffic noise at any exposed façade of more than 2 dB(A) compared to the road traffic noise level from the existing road.’*

When assessing feasible and reasonable mitigation measures for a redeveloped road, an increase of up to two dB(A) represents a minor impact where it is generally not considered feasible and reasonable to provide additional mitigation. An increase of greater than two dB(A) (considered to be 2.1 dB(A) or greater), would require consideration of all feasible and reasonable mitigation measures.

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).

On this basis a total of 85 receivers during the daytime period and 113 receivers during the night-time period are eligible for the consideration of noise mitigation. Some of these receivers are eligible for consideration of mitigation under both the daytime and night-time criteria. A total of 114 receivers are eligible for the consideration of noise mitigation. These receivers have been summarised in Appendix I.

When designing noise mitigation, the target noise level is the lowest applicable noise criteria or controlling criterion, however it may not be feasible and reasonable to achieve these levels.

For this project, all road design and traffic management options have been exhausted. As such the next form of noise mitigation to be considered is a low noise surface.

Additional noise modelling has been undertaken assuming a low-noise pavement for the entire alignment. A low-noise surface in the form of stone mastic asphalt was modelled. The road surface corrections implemented for stone mastic asphalt were -2.2 for cars and -4.3 for trucks tyres. The results for the low-noise pavement are provided in Appendix I.

When the proposed noise mitigation reduces noise levels to within 2 dB(A) or less of the noise criteria at any individual receiver, it is not considered reasonable to provide additional noise mitigation at that residence.

The results indicate that with a low-noise pavement, a total of 67 receivers are significantly affected as a result of this project. A total of fifteen of these receivers would be isolated, located in groups of three or less. The ENMM stipulates that where reasonable and feasible, architectural treatment should be offered to isolated receivers that exceed the noise criteria and are located in groups of three or less. Receivers that are located in larger groups may be considered for a noise barrier.

A noise barrier (the next form of noise mitigation in the hierarchy) was considered for receivers located within the Berry township to reduce noise levels to the applicable noise criteria.

Modelling combining low-noise pavement and a noise barrier to the north of the Berry township and a noise barrier on the northbound off-ramp (adjacent to Huntingdale Park Road) resulted in 20 receivers remaining significantly affected. The noise barrier assessments are provided below. fifteen of these receivers are isolated as single residences.

### 5.2.1 North Street noise barrier assessment

Provided below is an assessment of a noise barrier, consistent with the requirements of Practice Note iv of the ENMM. The location of the noise barrier is presented in Appendix L.

#### Define the road traffic noise catchment area

The noise catchment area has been separated into a single group located along North Street.

#### Calculate existing and future noise levels, including changes in noise levels

The predicted noise levels are provided in Appendix I and Appendix J.

#### Identify all the options

All alternative feasible and reasonable traffic management and other road design opportunities for reducing traffic noise have been exhausted. A low-noise pavement is already included in the design at this location. A realignment of the road and more stringent limits on traffic flow speeds would have minimal effectiveness and cannot be considered either feasible or reasonable for this catchment area.

#### Analyse the barrier height and other road treatment options

There are more than three affected residences grouped together, so noise barrier options need to be considered.

#### Design a range of barrier options

A comparison of noise reductions for a range of barrier heights has been carried out for the most affected residences located on North Street. The graph provided in **Figure 5-1** shows the relation between barrier height and resulting noise levels for the design year (2027).

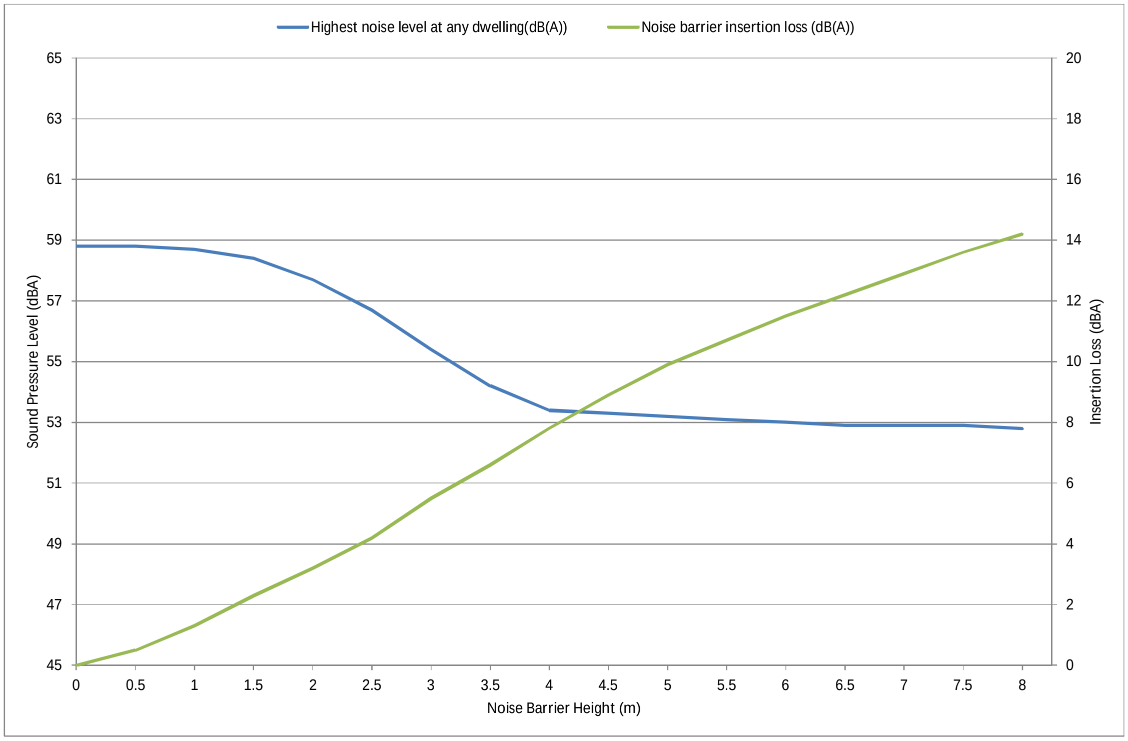



**Figure 5-1: Maximum insertion loss**

The graph provided in **Figure 5-1** shows the maximum insertion loss (reduction in noise by inserting a barrier between the source and receiver) at any receiver and the maximum sound pressure level at any receiver. Specific receivers may not be the same for the different barrier heights, hence the decrease in insertion loss is not necessarily consistent with the maximum noise level.

The graph provided in **Figure 5-1** indicates that the minimum insertion loss of at least five dB(A) is achieved at a three metre barrier height and at least 10 dB(A) is achieved at a five metre barrier height. Hence the noise barriers could be considered viable in this instance.

The 'target barrier' is the barrier that achieves compliance with the appropriate noise criteria at all sensitive receivers. The noise criteria for these receivers is 50 dB(A). The graph provided in **Figure 5-1** indicates that the 'target barrier' (the minimum barrier required to achieve the applicable noise criteria at all receiver locations) is greater than 8 m. However, allowing an exceedance at the four most affected receivers, the 'target barrier' would be four metres in height.

The Total Noise Benefit (TNB), the Marginal Benefit Value (MBV) and the Total Noise Benefit per Unit Area (TNBA) are illustrated in **Figure 5-2**. The TNB is the sum of the noise reduction provided by the barrier. The MBV is the increase in TNB, divided by the increase in barrier height. The TNBA is the TNB divided by the total area of the barrier.

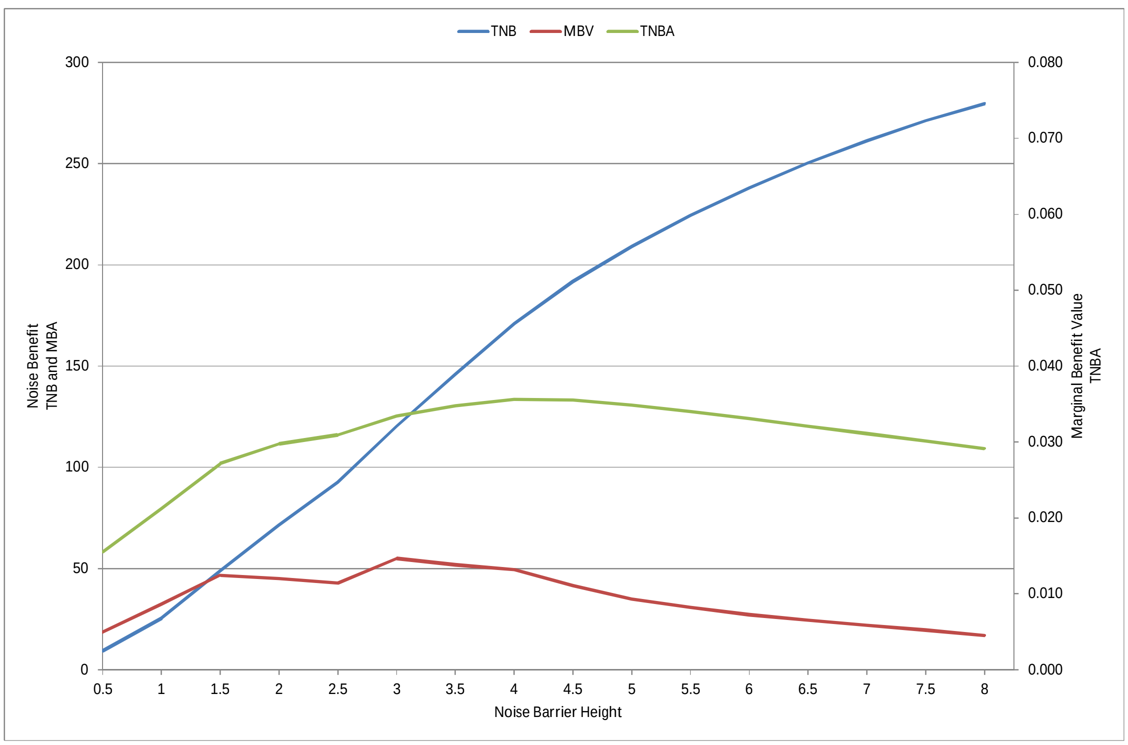



**Figure 5-2: Noise benefit**

The 'assessed barrier' (three metre barrier height) is the barrier option selected after considering the TNB, MBV and TNBA. In this instance the MBV peaks at three metres and the TNBA peaks at four metres. As such the 'assessed barrier' is considered to be three metres for this scenario.

For this project, the community has expressed a desire to have lower noise barriers to maintain the existing views from the town towards the north. As such the cost effectiveness of lower noise barriers will be considered.

If the ‘assessed barrier’ (three metre barrier height) option was chosen, twenty nine receivers would exceed the RNP noise targets. Twenty of these exceedances would exceed the RNP noise targets by up to 2 dB(A), with thirteen receivers exceeding by more than 2 dB(A).

The ENMM considers that where noise mitigation has been already provided (in this case a low-noise pavement and a noise barrier), it is not considered feasible and reasonable to provide additional noise mitigation such as architectural treatments for receivers that are not subject to a significant impact (an exceedance of the RNP criteria by more than 2 dB(A)).

As such, if the ‘assessed barrier’ was chosen, only thirteen receivers impacted by the proposed North Street barrier would be eligible for additional noise mitigation (in this case architectural treatments).

To assess the additional costs, architectural treatments in the form of mechanical ventilation has conservatively been assumed to be $20,000. Based on similar projects the additional cost of noise barriers has been calculated at $500 per square meter. On this basis the cost of the architectural treatments would be $260,000 and the cost of the additional one metre for the length of the wall (1200 metres) is approximately $600,000.

The cost of the ‘assessed barrier’ is approximately $693 per dB(A) reduction per residence. The cost of the ‘target barrier’ is $363 per dB(A) reduction per residence. The ENMM states that:

*“If the cost per dB(A) reduction per residence of the “assessed barrier” option is within 25 per cent of the cost per dB(A) reduction per residence for the “target barrier” option, but the increased benefit would be only 2 dB(A) or less, the “assessed barrier” option would normally be preferred (again, this is before any consideration of aesthetics and community views). In these circumstances the provision of additional architectural treatments would normally not be cost-effective.”*

For this situation the ENMM puts emphasis on the ‘community views. As such, the community should be consulted to determine if they would prefer a four metre noise barrier that would provide adequate noise mitigation to meet the noise criteria, or if they are willing to accept an indiscernible increase in noise and prefer a noise barrier one metre shorter.

In absence of community input the four metre noise barrier has been included as the preferred option. This may change once the community has been adequately consulted or following detailed design, in which case this report will be updated.

### 5.2.1 Kangaroo Valley Road northbound off-ramp

A noise barrier was assessed for the Kangaroo Valley northbound off - ramp consistent with the requirements of Practice Note iv of the ENMM. The location of the noise barrier is presented in Appendix L.

**Define the road traffic noise catchment area**

The noise catchment area has been separated into a single group located along Huntingdale Park Road.

**Calculate existing and future noise levels, including changes in noise levels**

The predicted noise levels are provided in Appendix I and Appendix J.

### Identify all the options

All alternative feasible and reasonable traffic management and other road design opportunities for reducing traffic noise have been exhausted. A low-noise pavement is already included in the design at this location. A realignment of the road and more stringent limits on traffic speeds would have minimal effectiveness and cannot be considered either feasible or reasonable for this catchment area.

### Analyse the barrier height and other road treatment options

There are more than three affected residences grouped together, so noise barrier options need to be considered.

### Design a range of barrier options

A comparison of noise reductions for a range of barrier heights has been carried out for the most affected residences located on Huntingdale Park Road. **Figure 5-3** shows the relation between barrier height and resulting noise levels for the design year (2027).

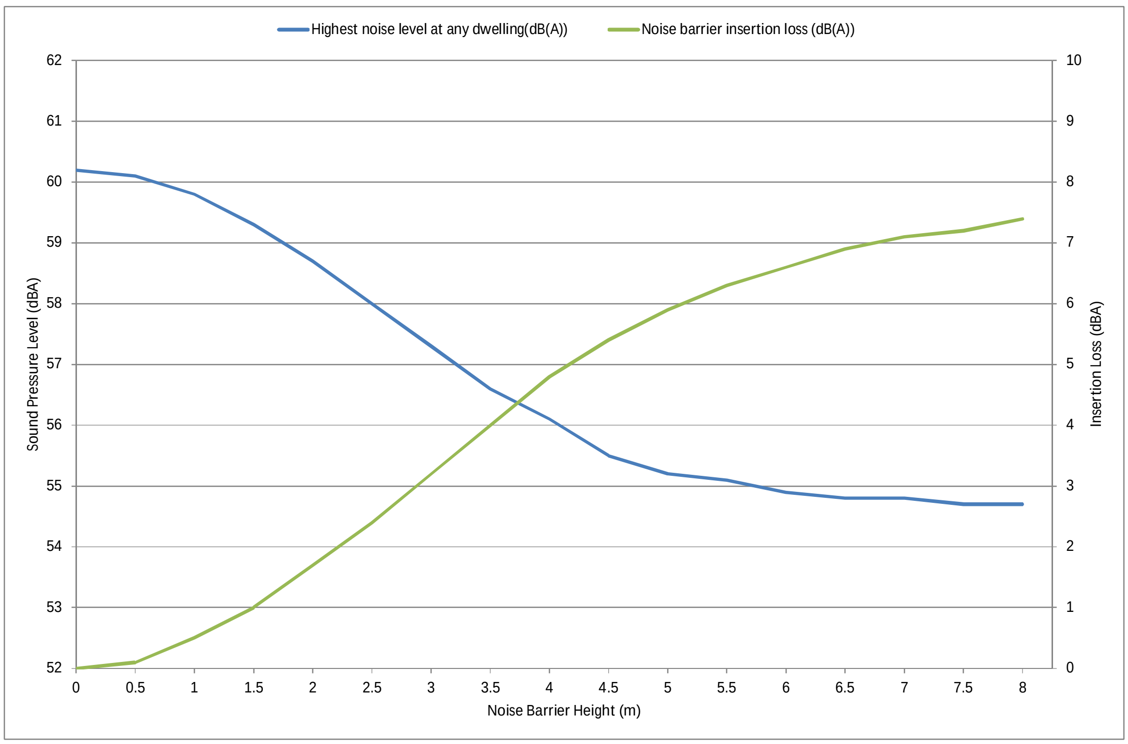



**Figure 5-3: Maximum insertion loss**

**Figure 5-3** shows the maximum insertion loss at any receiver and the maximum sound pressure level at any receiver. Over the varying barrier heights the specific receiver may not be the same, hence the decrease in insertion loss is not necessarily consistent with the maximum noise level.

The graph shows a minimum insertion loss of at least five dB(A) is achieved at a barrier height of four metres and metres. A 10 dB(A) insertion loss is not achieved. Hence a four metre and 4.5 metre noise barrier can be considered viable for this location.

The 'target barrier' is the barrier that achieves compliance with the appropriate noise criteria at all sensitive receivers. The noise criteria for these receivers is 55 dB(A). The graph provided in **Figure 5-3** indicates that the 'target barrier' (the minimum barrier required to achieve the applicable noise criteria at all receiver locations) is four metres.

**Figure 5-4** illustrates the TNB, the MBV and the TNBA.

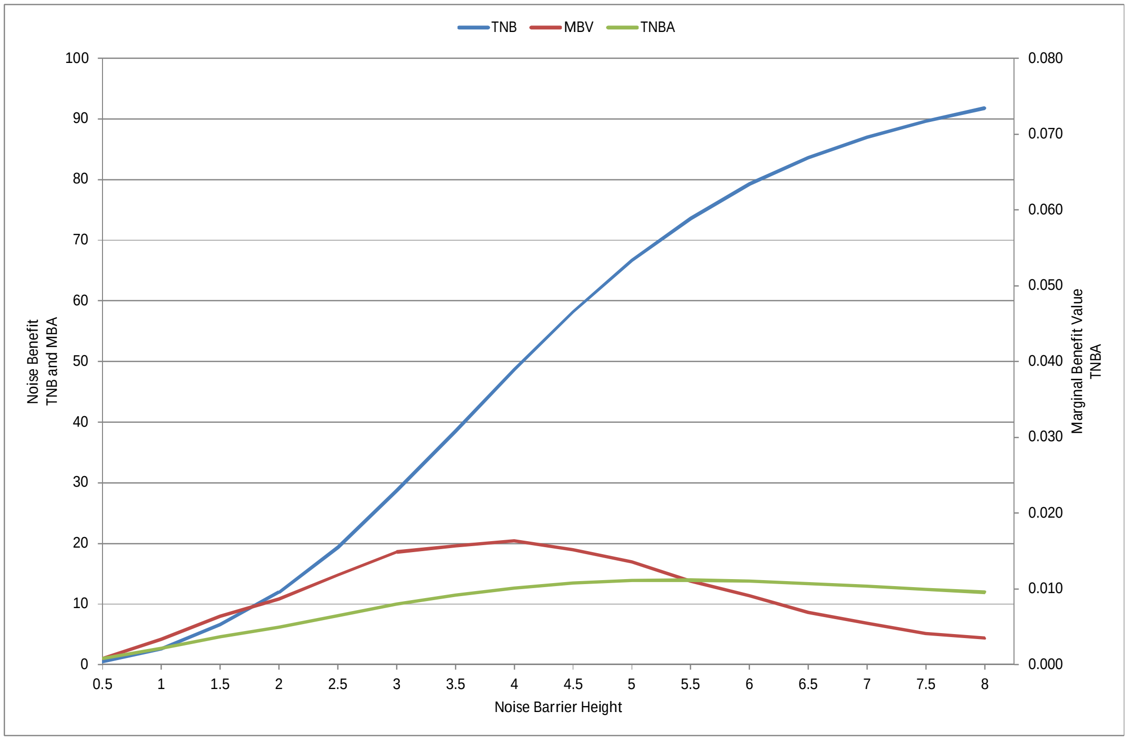



**Figure 5-4: Noise benefit**

As discussed previously, the 'assessed barrier' is the barrier option selected after considering the TNB, MBV and TNBA. In this instance the MBV peaks at four metres and the TNBA continues increasing until six metres. Given that the 'assessed barrier' does not achieve the minimum insertion loss requirement, the shortest barrier to achieve this is selected. In this scenario, a four metre barrier has been selected.

Considering the 'assessed barrier' and 'target barrier' are the same height, and given they do not achieve the minimum insertion loss, a four metre noise barrier is recommended for the Kangaroo Valley Road northbound off-ramp.

### 5.2.2 Other land uses

The Camp Quality Memorial Park required further mitigation above the proposed dense graded asphalt (DGA). With the low-noise pavement and the noise proposed barrier the $L_{Aeq(15hour)}$ noise levels are predicted to be 55 dB(A). Hence the predicted noise levels comply with the criteria of $L_{Aeq(15hour)}$ 55 dB(A).

With the additional low noise pavement, noise levels are reduced at Mark Radium Park. The $L_{Aeq(15hour)}$ noise level at the centre of the park is predicted to be 60 dB(A), a reduction of two dB(A). Given the park is used for passive recreation, the park will experience exceedances of the 55 dB(A) criteria by five dB(A) when in use.

However, for the provision of noise mitigation, the ENMM requires the proposed mitigation to be considered both reasonable and feasible. Although it would be considered feasible to build noise mitigation to reduce noise levels within the park, the ENMM recommends buffer zones as the primary mitigation measure for recreation areas, which is not considered reasonable or feasible for this project. As such, additional noise mitigation is not recommended for Mark Radium Park.

With the additional low noise pavement and proposed noise barriers, noise levels are significantly reduced at both Berry Uniting Church and Saint Patricks Catholic Church. The $L_{Aeq(15hour)}$ noise level at the most affected church building is predicted to be 53 dB(A) and 52 dB(A) at the facade of the building, a reduction of 7 dB(A) and 9 dB(A) respectively. Including the corrections for facade reflections and external to internal losses, the $L_{Aeq(1hour)}$ noise levels are predicted to be 40 dB(A) and 39 dB(A). The noise levels are equal and below the criteria, hence compliance is achieved.

Although compliance would only just be achieved, additional mitigation is not warranted at this stage. However assumptions have been made about the noise levels from the road during the operation of the church, and external to internal noise losses. It is recommended that further analysis is undertaken at the opening of the project to ensure that the internal noise levels within the church are compliant with the criteria and services are not adversely affected as a result of the new road. If for some reason the church does not achieve the internal noise criteria, mitigation in the form of upgraded doors, glazing and seals would be sufficient to meet the required noise levels.

The maximum $L_{Aeq(9hour)}$ noise level predicted on the site of the Bupa Care Services – Aged care Facility with low-noise pavement is 56 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. Therefore the Bupa Care Services – Aged Care Facility is not eligible for further mitigation.

### 5.2.3 Recommended noise mitigation

Road traffic noise contours of the design year incorporating the recommended noise mitigation are presented in Appendix J.

Mitigation in the form of a low-noise pavement, two noise barriers, and a small number of architectural treatments are recommended to achieve compliance with the applicable noise goals. A summary of the receivers that would continue to have residual noise levels above the controlling criterion after in corridor measures are considered, are listed in **Table 5-4**.

#### Additional architectural treatment

For the 20 properties with exceedances up to 10 dB(A), fresh air ventilation, sealing of wall vents and upgraded window and door seals is generally considered appropriate (Architectural treatment type 1). Where exceedances are over 10 dB(A) *additional* upgrade of windows and doors may be considered (Architectural treatment type 2).

**Table 5-4: Architectural treatment**

| Receiver | Treatment type |
|---|---|
| 14a | Treatment Type 1 |
| 17a | Treatment Type 1 |
| 22a | Treatment Type 1 |
| 23 | Treatment Type 1 |
| 25 | Treatment Type 2 |
| 28 | Treatment Type 1 |
| 29 | Treatment Type 1 |
| 30 | Treatment Type 1 |
| 33a | Treatment Type 1 |
| 73 | Treatment Type 1 |
| 110 | Treatment Type 1 |
| 299 | Treatment Type 1 |
| 355 | Treatment Type 1 |
| 374 | Treatment Type 1 |
| 384 | Treatment Type 1 |
| 386 | Treatment Type 1 |
| 438 | Treatment Type 1 |
| 439 | Treatment Type 1 |
| 445 | Treatment Type 1 |
| 451 | Treatment Type 1 |

# 6 Conclusions

Attended and unattended ambient noise measurements have been undertaken to define the construction NMLs and calibrate the SoundPLAN noise model used for operational noise assessment. The attended noise measurements were undertaken to define the dominant noise source(s) at each location and confirm the suitability of the measurement location.

### Existing acoustic environment

The unattended noise measurements were undertaken in six noise catchment areas throughout the project area. Simultaneous traffic counts were undertaken to measure the traffic volumes at the time of the noise measurements. The results of the unattended noise logging provided good correlation with the SoundPLAN model during the daytime and night-time periods with almost all results falling within the accuracy of CoRTN. A small number of results fell outside the accuracy of CoRTN, however these calibrations were not considered to influence the outcome of the report.

### Noise criteria

The appropriate construction NMLs were derived from the unattended background noise logging results.

The predicted operational noise from the project has been assessed in accordance with the RNP and the ENMM. Appropriate criteria provided in these documents have been used as the basis for the noise impact assessment.

### Impact assessment

Standard construction activities including site establishment, earthworks, piling, bridgeworks and paving activities were assessed in accordance with the ICNG. Both typical and worst case noise levels were predicted for the construction noise assessment. Predicted noise levels were found to exceed the noise management levels, but generally remain below the 'highly affected' noise level.

Works undertaken within the ancillary facilities were also found to exceed the noise management levels.

Extended working hours north of the Berry township have been proposed in this report. Considering the work practices would not differ from those during standard work hours, the predicted noise levels are the same. However the NMLs are typically 5 dB(A) to 10 d(A) more stringent during the evening and night-time periods, hence the potential exceedance of the NMLs would increase accordingly.

Some out of hours work (separate to the extended hours work) would be required for this project. This work is either typically not noise intensive or generally impractical to be undertaken during standard work hours due to safety and the need to maintain the operational integrity of the Princes Highway traffic.

Cumulative noise impacts from construction activities associated with other projects have also been considered. There are currently no proposed or current works that would be undertaken concurrently with the construction of this project. As such sensitive receivers are unlikely to be impacted from the cumulative impacts of construction noise.

Blasting criteria has been recommended to comply with the relevant guidelines. Higher limits have also been proposed with approval of the affected residents and the employment of safe work practices, to ensure that residents are not adversely affected as a result of blasting activities. A detailed Blast Management Plan would be prepared as part of the detailed design process.

The predicted noise from the project has been assessed in accordance with the RNP and the ENMM.

Reflection of noise from the proposed noise barrier has been considered in this assessment by adding a correction factor to residents located to the north of the proposed wall. The predicted noise levels indicate that the receivers would not be significantly impacted as a result of the additional wall. Appropriate mitigation has been recommended for these receivers (where appropriate) on the basis of the noise barrier correction factor.

Both temperature inversions and wind have been found to be a feature of the area. These weather effects have the potential to increase noise levels at affected receivers up to five dB(A).

A total of 164 receivers were found to exceed the applicable operational noise criteria of which 18 receivers are considered to be acutely affected as a result of the project.

Maximum noise levels currently exceed the recommended limits, and at most locations are predicted to in the future. The levels may reduce somewhat with the new road due to a reduction in gradients lessening the tendency for trucks to require engine braking and high engine revs. Receivers that would be exposed to a new road would be exposed to events similar to those currently experienced on existing sections of the Princes Highway.

### Mitigation

Recommendations have been made to mitigate and manage the potential noise and vibration impacts from the construction works, wherever feasible and reasonable. The construction contractor would provide a detailed CNVMP to clarify the mitigation and management practices that will be utilised on this project.

Construction safe working distances have been recommended to ensure that receivers would not be adversely impacted by vibration as a result of the project. Vibration monitoring has been recommended within the prescribed safe working distances to ensure that the appropriate criteria are not exceeded. If a significant amount of vibration intensive activities are required within the safe working distances, the development of site laws for the decay of vibration are recommended to determine the project specific safe working distances, which are likely to be less stringent than those provided in this document.

Operational noise mitigation measures in the form of a low-noise pavement, a noise protection barrier of total height four metres to the north of North Street, a four metre noise barrier located on the Kangaroo Valley Road northbound off-ramp and consideration of 20 architectural property treatments have been recommended. These mitigation measures will ensure that the levels of road traffic noise experienced by residents would be reduced as low as reasonable and feasible once the bypass is operational. These requirements would be confirmed when assessed against the detailed design.

# Appendix A

## Glossary

## Glossary of terms and definitions

The following is a brief description of acoustic terminology used in this report.

| Term | Definition |
|---|---|
| Sound power level | The total sound emitted by a source |
| Sound pressure level | The amount of sound at a specified point |
| Decibel [dB] | The measurement unit of sound |
| A Weighted decibels [dB(A]) | The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A). |
| Decibel scale | The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume.<br>Examples of decibel levels of common sounds are as follows:<br>0dB(A) Threshold of human hearing<br>30dB(A) A quiet country park<br>40dB(A) Whisper in a library<br>50dB(A) Open office space<br>70dB(A) Inside a car on a freeway<br>80dB(A) Outboard motor<br>90dB(A) Heavy truck pass-by<br>100dB(A) Jackhammer/Subway train<br>110 dB(A) Rock Concert<br>115dB(A) Limit of sound permitted in industry<br>120dB(A) 747 take off at 250 metres |
| Frequency [f] | The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound. |
| Equivalent continuous sound level [$L_{eq}$] | The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy. |
| Insertion loss | Reduction in noise by inserting a barrier between the source and receiver |
| $L_{max}$ | The maximum sound pressure level measured over the measurement period |
| $L_{min}$ | The minimum sound pressure level measured over the measurement period |
| $L_{10}$ | The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the $L_{10}$. |

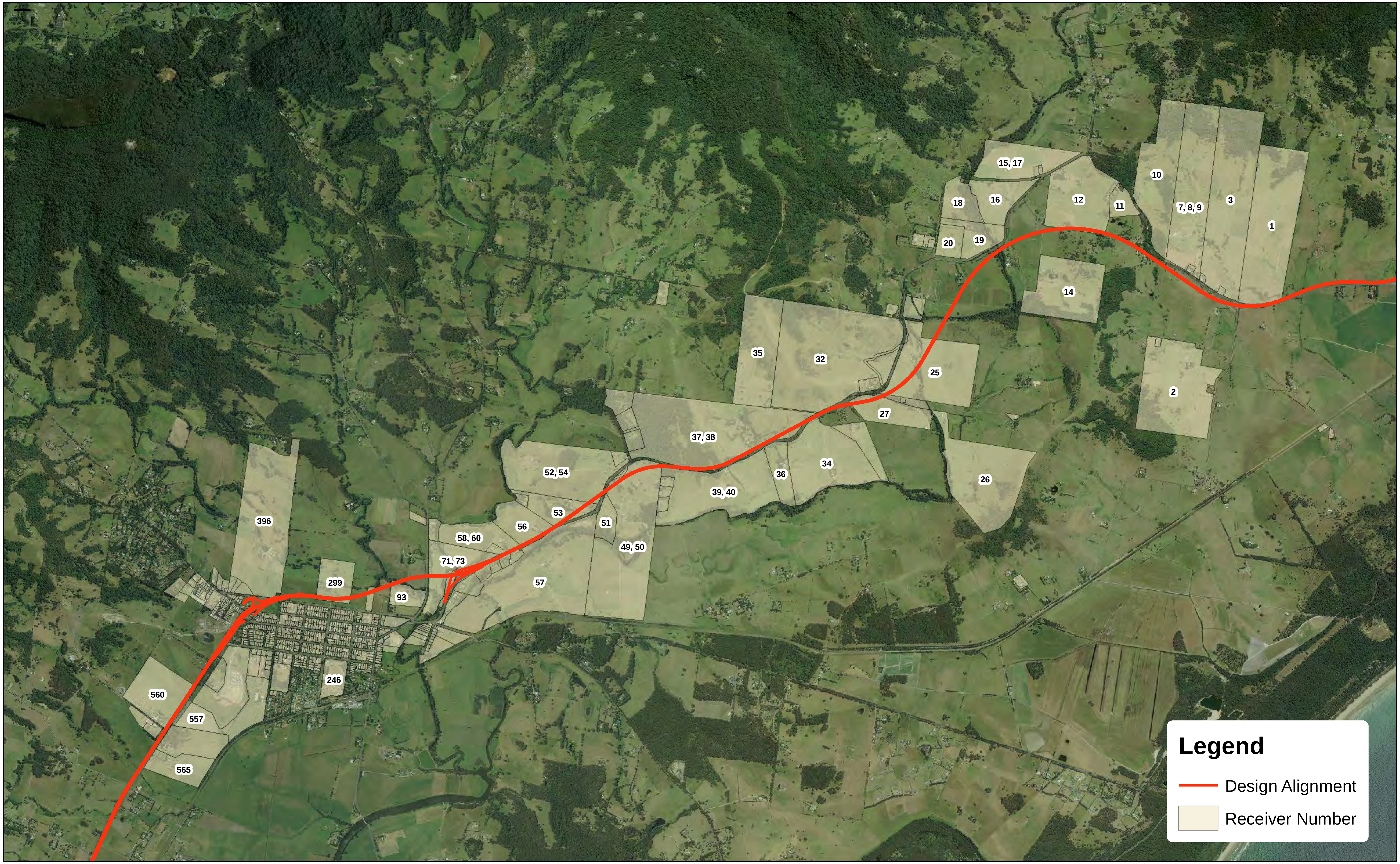
| Term | Definition |
|---|---|
| $L_{90}$ | The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the $L_{90}$. |
| Ambient noise | The all-encompassing noise at a point composed of sound from all sources near and far. |
| Background noise | The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L90 sound pressure level is used to quantify background noise. |
| Traffic noise | The total noise resulting from road traffic. The $L_{eq}$ sound pressure level is used to quantify traffic noise. |
| Day | The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays. |
| Evening | The period from 1800 to 2200 h Monday to Sunday and Public Holidays. |
| Night | The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays. |
| Assessment background level [ABL] | The overall background level for each day, evening and night period for each day of the noise monitoring. |
| Rating background level [RBL] | The overall background level for each day, evening and night period for the entire length of noise monitoring. |

**Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 “Acoustics – Glossary of terms and related symbols”, the OEH’s INP and the OEH’s Road Noise Policy.*

# Appendix B

## Sensitive receiver locations

AECOM




Foxground and Berry Bypass
**Reciever Numbers**
*Source:*

0 500 1,000 2,000 3,000 4,000 m

**JUL 2012**
60021933

Fig. **1**


Foxground and Berry Bypass
**Reciever Numbers**
*Source:*

0 125 250 500 750 1,000 m

**JUL 2012**
60021933
Fig. **2**


Foxground and Berry Bypass

**Reciever Numbers**

*Source:*

0 125 250 500 750 1,000 m

**JUL 2012**

60021933

Fig. **3**


Foxground and Berry Bypass
**Reciever Numbers**
*Source:*

**JUL 2012**
60021933

0 50 100 200 300 400 m

Fig. **4**


Foxground and Berry Bypass

**Reciever Numbers**

Source:

**JUL 2012**

60021933

Fig. **5**

AECOM


Foxground and Berry Bypass

**Reciever Numbers**

*Source:*

0 50 100 200 300 400 m

**JUL 2012**

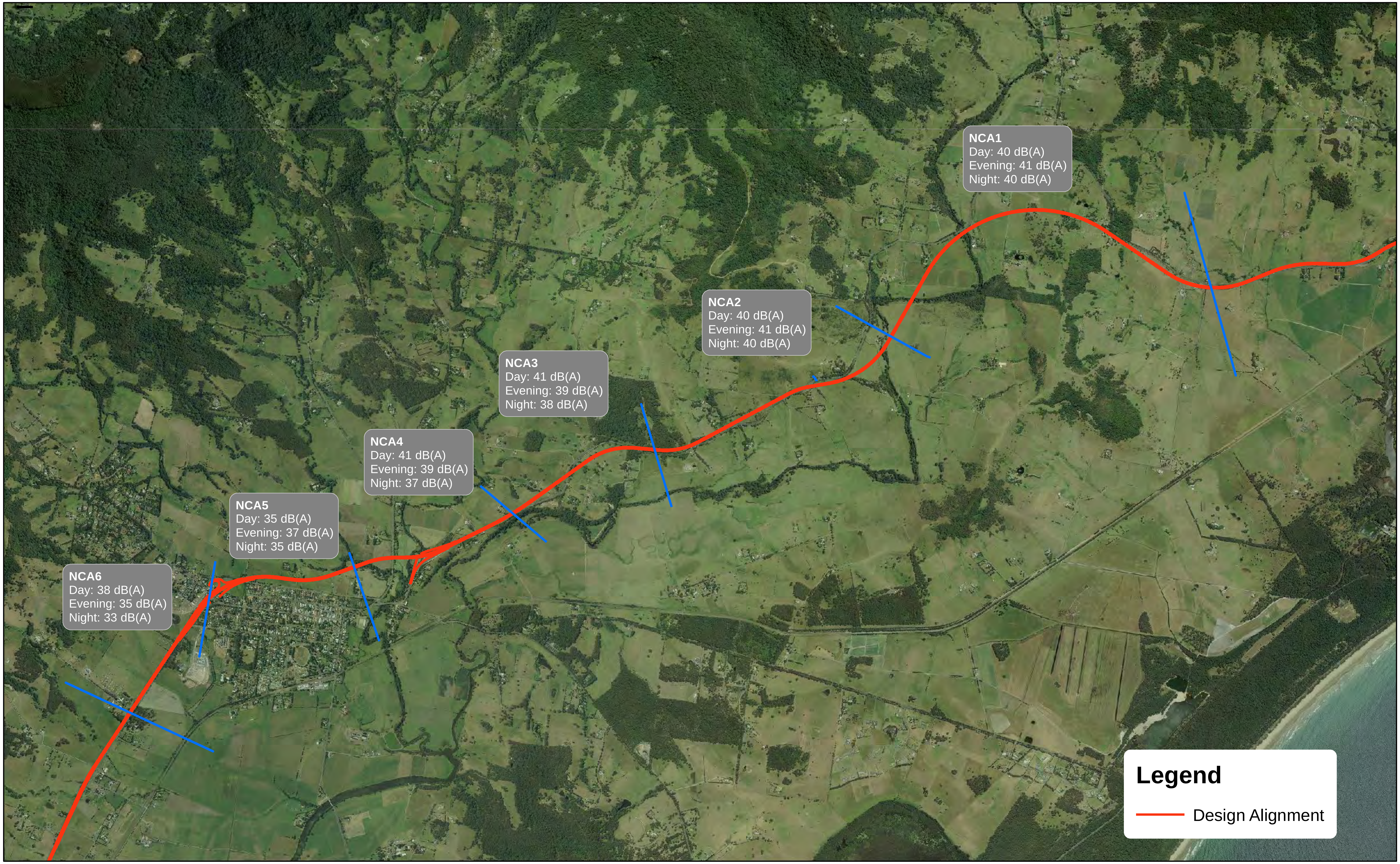
60021933

Fig. **6**

# Appendix C

## Noise catchment areas

AECOM




Foxground and Berry Bypass

**Noise Catchment Areas**

*Source:*

0 500 1,000 2,000 3,000 4,000 m

**JAN 2012**

60021933

Fig. **1**

# Appendix D

## Logger locations and site compounds

AECOM


Foxground and Berry Bypass
**Noise Logger Locations**
*Source:*

0 100 200 400 600 800 m

AUG 2012
60021933

Fig. **1**

AECOM


Foxground and Berry Bypass

**Noise Logger Locations**

*Source:*

**AUG 2012**

60021933

0 100 200 400 600 800 m

Fig. **2**