UPGRADING THE PACIFIC HIGHWAY

Woolgoolga to Ballina Planning Alliance

UPGRADING THE PACIFIC HIGHWAY
Woolgoolga to Ballina Upgrade

Working paper: Noise and vibration

November 2012

Final

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Structure of this report

This noise and vibration assessment working paper comprises Parts A, B and C to provide a logical division of project information.

Part A of this working paper provides methodology and background data and is common to all sections of the project for both operational and construction impacts. It introduces and outlines the broader project context with figures depicting the extents of the proposed works. The methodology applied to the assessment of operational and construction noise and vibration impacts and the project criteria by which the impacts have been assessed are presented in this part. The definition and location of the noise sensitive receivers identified for the study is introduced here, with an overview of the existing noise environment and monitoring procedures.

Part B presents the potential noise and vibration impacts associated with the operation of the project assessed in line with the methodology set out in Part A, and recommends potential mitigation measures identified for each section.

Part C of the report presents the assessment of impacts associated with the construction phase of the project. Within Part C, construction noise and vibration has been assessed in line with the methodology and legislation set out in Part A. As with the operational impacts, Part C outlines potential mitigation and management measures that may be required in order to reduce the impact. An overview of each part is presented below:

Part A

- project introduction
- operational noise and vibration criteria
- construction noise and vibration criteria
- acoustic description and identification of existing environment
- introduction to mitigation measures identification process

Part B

- operational noise impact assessment
- operational vibration impact assessment
- identification of proposed operational noise and vibration mitigation measures

Part C

- construction impact assessment
- construction vibration impact assessment
- identification of proposed construction noise & vibration mitigation measures

Glossary

Acoustic and vibration related terms used in this report:

- **Acoustic Spectrum:** *A representation of a sound sample (usually short term) of the amount of energy or sound level per frequency.*
- **Ambient Noise**: *Ambient noise encompasses all sound present in a given environment, being usually a composite of sounds from many sources near and far.*
- **CONCAWE:** *noise modelling algorithm to predict the geographical propagation of noise from various noise sources*
- **CoRTN:** *Calculation of Road Traffic Noise (CRTN - ISBN 0 11 550847 3, UK Department of Transport 1988)*
- **dB(A):** *A unit of sound measurement which has frequency characteristics weighted so that it approximates the response of the human ear to sound waves*
- **ENMM:** *Environmental Noise Management Manual (RMS, 2001)*
- **eVDV:** *Is the estimated vibration dose for predicting an assessing human comfort exposure, measured as* $ms^{-1.75}$
- **Heavy Vehicle:** *A truck, transport or other vehicle with a gross vehicle weight above a specified level (for example: over 8 tonnes)*
- **L_{A10}:** *Descriptor used to define noise level which is exceeded 10 per cent of the time and is to the average of maximum noise levels*
- **$L_{A10\,(18hr)}$:** *Is the arithmetic average of the* $L_{10(1hr)}$ *levels for the 18-hour period between 0600 and 2400 hours on a normal working day.*
- **L_{A90}:** *Is the noise level that is exceeded 90 per cent of the measurement time. This parameter is commonly referred to as the background noise level*
- **L_{Aeq}:** *Noise level that represents the energy average noise from the source during a specified time period, and is the equivalent continuous sound pressure level for a given period*
- **$L_{Aeq(15hr)}$:** *The* L_{eq} *noise level for the period from 7 am to 10 pm.*
- **$L_{Aeq(9hr)}$:** *The* L_{eq} *noise level for the period from 10 pm to 7 am.*
- **NCA:** *Noise Catchment Area. Grouping dwellings or receivers together in terms of similar noise environment.*
- **Noise barrier**: G*enerally a wall or an earth mound that obstructs or restricts the passage of sounds waves from a noise source*
- **Noise Logger:** *A data logging (data and audio in some cases) which records noise. Usually used for unattended noise monitoring of background or ambient noise.*
- **NML:** *Noise Management Level as detailed in the NSW Interim Construction Noise Guideline. The NML is the noise goal for construction activities.*

- **Octave Bands**: *Sounds that contain energy over a wide range of frequencies are divided into sections called bands. A common standard division is in 10 octave bands identified by their center frequencies 31.5, 63, 250, 500, 1000, 2000, and 4000 Hz*
- **PPV:** *Peak Particle Velocity is is used to measure vibration through a solid surface. When a vibration is measured, the point at which the measurement takes place can be considered to have a particle velocity. This particle vibration will take place in three dimensions (x, y and z) and will usually end up back where it started. The Peak Particle Velocity is the maximum velocity that is recorded during a particular event.*
- **RBL:** *Rating Background Level is the overall single figure background level representing each assessment period over the whole monitoring* period. The RBL is used for determining the appropriate construction noise criteria.
- **RNP:** *Road Noise Policy (OEH, 2011)*
- **Sound Level Meter:** *An instrument consisting of a microphone, amplifier and data analysis package for quantifying and measuring noise.*
- **Sound Power Level (L_w):** *Sound power level or acoustic power level is a logarithmic measure of the sound power in comparison to a specified reference level.*
- **Sound Pressure Level (SPL or L_p):** *The level of noise, usually expressed in dB(A), as measured by a standard sound level meter.*
- **VDV:** *Measured vibration dose value to indicate compliance with human comfort criteria*
- **Vibration:** *Vibration is a force which oscillates about some specified reference point. Vibration is commonly expressed in terms of frequency such as cycles per second (cps), Hertz (Hz), cycles per minute (cpm) or (rpm) and strokes per minute (spm). This is the number of oscillations which occurs in that time period. The amplitude is the magnitude or distance of travel of the force.*

PART A – Introduction, legislation & methodology

1. Introduction

1.1. Project description

The NSW Roads and Maritime Services (RMS) is seeking approval to upgrade a stretch of approximately 155 kilometres of the Pacific Highway between Woolgoolga and Ballina from two-lane, dual carriageway to four lanes of divided highway. The objectives of the upgrade are to:

- Significantly reduce road accidents and injuries
- Reduce travel times
- Reduce freight transport costs
- Develop a route that involves the community and considers its interests
- Provide a route that supports economic development
- Manage the upgrading of the route in accordance with the principles of ecologically sustainable development (ESD)
- Provide the best value for money.

The general location of the project is shown in **Figure 1.1** and an overview of the project is shown in **Figure 1.2**. The project would commence approximately 5 kilometres north of Woolgoolga and finish approximately 6 kilometres south of Ballina. Key features of the project include:

- A class M (motorway standard) highway, comprising a four-lane dual carriageway (two lanes in each direction) that can be upgraded to a six-lane dual carriageway in the future, if required
- Ten grade-separated interchanges to provide access to and from the upgraded highway.
- Bridges for waterway crossings, including major bridges for the crossings of the Clarence River and Richmond River
- Over bridges and underpasses to maintain access along local roads crossed by the upgraded highway
- Viaduct structures in places where the upgraded highway would traverse low-lying or flood-prone areas
- Service roads and access roads to maintain connections to existing local roads and properties
- Rest areas located at 50 kilometre intervals for both northbound and southbound traffic
- Structures to facilitate fauna passage over and under the upgraded highway.

Although the approval sought is for a class M upgrade standard, staging of the project would result in some sections being initially constructed to a class A (arterial) standard. The project does not include the upgrades at Glenugie and Devils Pulpit, which are located between Woolgoolga and Ballina, as these two projects have already been approved.

The future delivery of the project would be staged in five sections based on upgrade need and availability of funding. These five stages are identified in **Table 1-1;**

Table 1-1 Indicative staging

Stage	Stage name	Project sections (see Table 1-2)	Construction start	Completion
1	Glenugie upgrade to Tyndale	3	Third quarter 2013	2016
2	Tyndale to Devils Pulpit upgrade	4, 5, 6	Third quarter 2013	
3	Woodburn to Ballina	8, 9, 10, 11	First quarter 2014	
4	Devils Pulpit upgrade to Woodburn	7	First quarter 2015	
5	Arrawarra to Glenugie	1, 2	First quarter 2015	

For the purpose of assessment, the project is described in 11 sections as identified in **Table 1-2** and depicted in **Figure 1-1** to **Figure 1-12**. Each of these sections has a start and end point that tie into the existing highway, assisting the identification of project stages. Project stages may comprise one or more sections identified in **Table 1-2**. In terms of construction and phasing these sections will be completed as per **Table 1-1.**

Table 1-2 Project sections

Section	Location	Approximate station (m)		Length	Initial upgrade standard
		Start	Finish		
1	Woolgoolga to Halfway Creek 1a:Woolgoolga to Range Road 1b:Range Road to Halfway Creek	 0 9650	 9650 17.000	 9.6 7.4	 Class M Class A
2	Halfway Creek to Glenugie upgrade	17.000	28.700	11.7	Class A
3	Glenugie upgrade to Tyndale	33.800	68.800	35.0	Class M
4	Tyndale to Maclean	68.800	82.000	13.2	Class M
5	Maclean to Iluka Road, Mororo 5a: Maclean to Watts Lane 5b: Watts lane to Iluka Road, Mororo	 82.000 87.800	 87.900 96.400	 5.9 8.6	 Class M Class A
6	Iluka Road to Devil's Pulpit upgrade	96.400	105.600	9.2	Class A
7	Devil's Pulpit upgrade to Trustrums Hill	111.100	126.400	15.3	Class A
8	Trustrums Hill to Broadwater National Park	126.400	137.600	11.2	Class M

Section	Location	Approximate station (m)		Length	Initial upgrade standard
		Start	Finish		
9	Broadwater National Park to Richmond River	137.600	145.100	7.5	Class M
10	Richmond River to Coolgardie Road	145.100	158.600	13.5	Class M
11	Coolgardie Road to Ballina bypass	158.600	164.000	5.4	Class M

1.2. Study objectives

The RMS is required to undertake a study of noise and vibration impacts on the community resulting from its construction and operation. The objectives of this study are to quantify and assess the level of traffic noise impact and associated construction noise impact on sensitive receivers, in accordance with the requirements of the Director-General of Planning and Infrastructure. The Director-General's requirements for the assessment of potential noise and vibration impacts are listed in **Table 1-3**.

The outcomes of this study will inform the mitigation requirements for the project and assist in detailed design decisions where noise impacts have the potential to affect the broader community. For the purpose of future residential development or land rezoning in the project area, the output of this study can be used by Department of Planning and Infrastructure or developers to determine potential noise and vibration impacts.

Table 1-3 Director–General's environmental assessment requirements-General Environmental Assessment Requirements

Reference	Requirements	Where addressed in report
Key issues	Construction noise and vibration impacts, including impacts from construction traffic, ancillary facilities, batch plants and blasting. The EIS must identify sensitive receivers and assess construction noise/ vibration generated by representative construction scenarios focusing on high noise generating works. Where work hours outside of standard construction hours are proposed, clear justification and detailed assessment of these work hours must be provided, including alternatives considered, mitigation measures proposed and details of construction practices, work methods, compound design, etc;	Construction report Part C – Sections 6.1 to 6-11

Reference	Requirements	Where addressed in report
	Cumulative impacts during construction, having regard to other developments (both existing and approved) in the locality, the staged construction of the project and the construction of adjoining Pacific Highway Upgrade projects;	Construction report Part C Sections 6.1.2, 6.2.2, 6.3.3, 6.4.2, 6.5.2, 6.6.2, 6.7.2, 6.8.2, 6.9.2, 6.10.2, 6.11.2
	Operational road traffic noise impacts of the project (including service roads and rest areas) on sensitive receivers, including reflective noise impacts from proposed noise mitigation barriers and bridges; and	Operational report Part B Sections 5.1 to 5.11
	Taking into account the following guidelines, as relevant: NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011), Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009), Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006), and Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment and Conservation Council, 1990).	Operational report Part B & Construction report Part C Sections 6.1.2, 6.2.2, 6.3.3, 6.4.2, 6.5.2, 6.6.2, 6.7.2, 6.8.2, 6.9.2, 6.10.2, 6.11.2

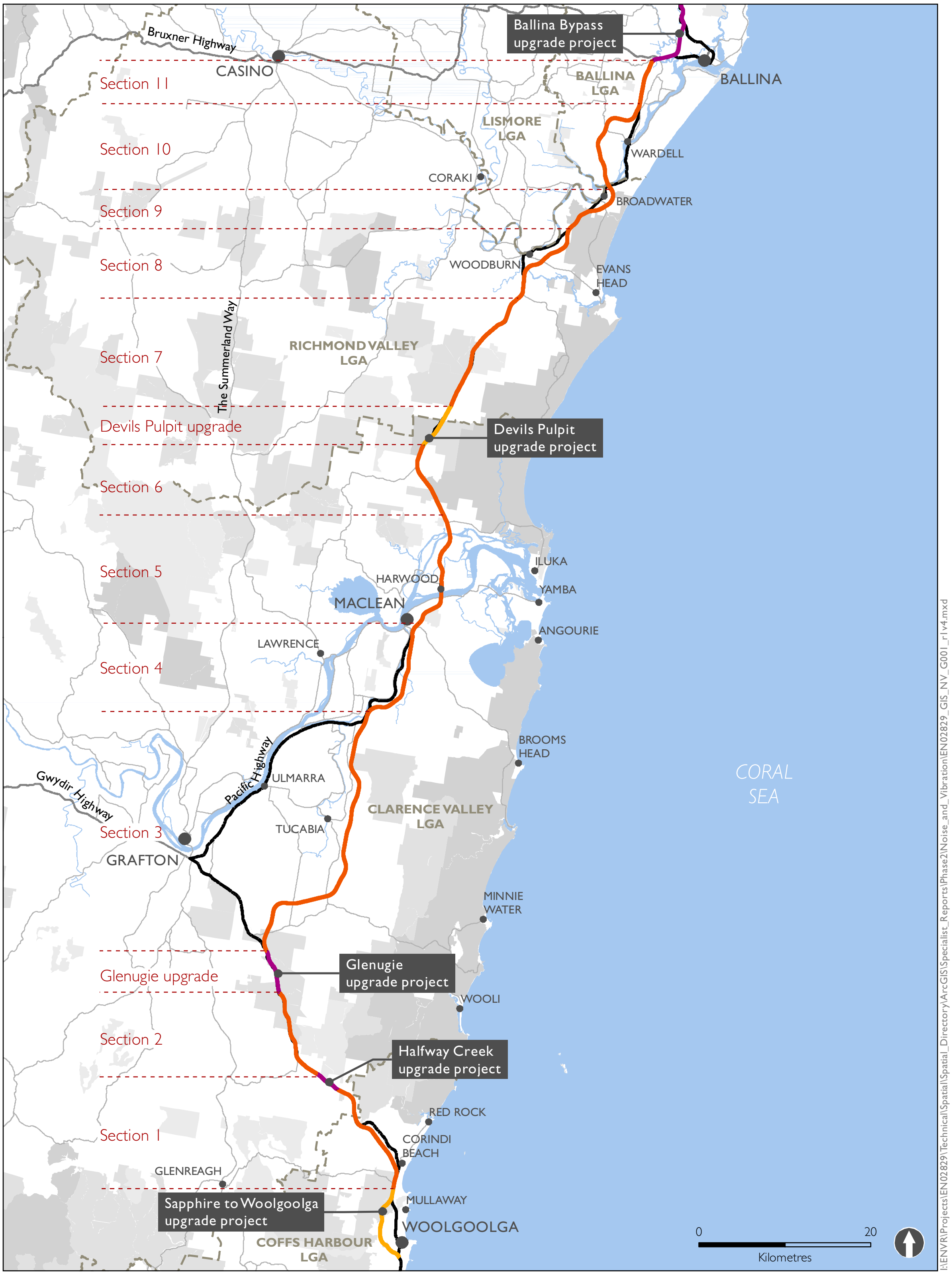
1.3. Study area

The project is nominally between Woolgoolga and Ballina in the NSW north coast region and encompasses a number of other towns and villages located close to the project. These smaller communities include Corindi Beach, Red Rock, South Grafton, Ulmarra, Tyndale, Harwood, Woodburn, Broadwater, and Wardell.

The operational footprint of the project includes ancillary elements such as local access roads and permanent water quality basins, all of which are located within the project design boundary – referred to as the ‘project corridor’. The project corridor is generally 150 metres wide with interchanges and areas of large cuttings and earth embankments typically being wider (200 to 400 metres in some cases).

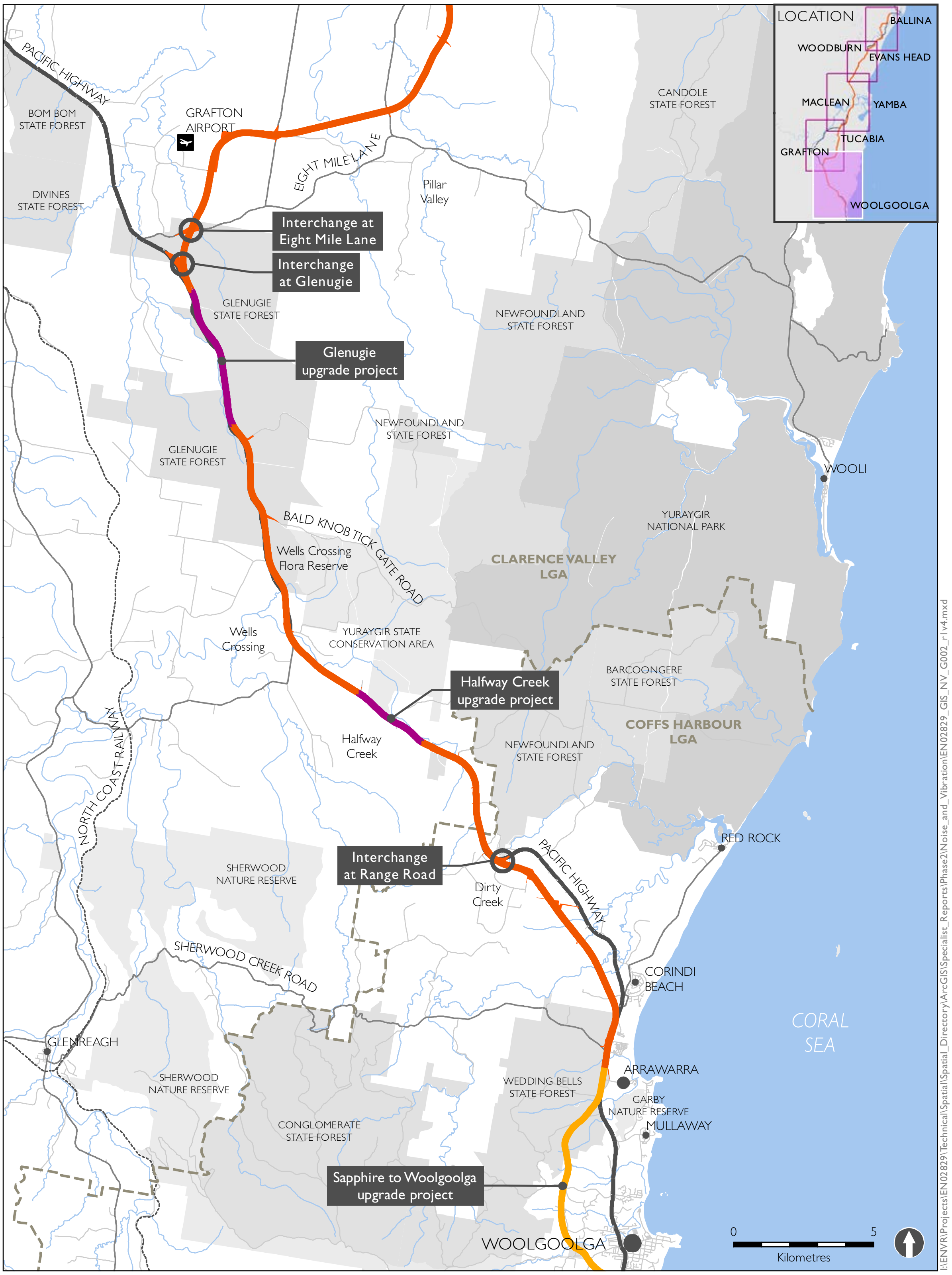
The study area for the noise and vibration assessment extends 600 metres either side of the centre line of the outside lane of the proposed upgrade and may include sections of the existing highway that do not follow the proposed upgrade alignment.

Figure 1-1 Project overview



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

Figure 1-2 The project alignment - Arrawarra to Glenugie



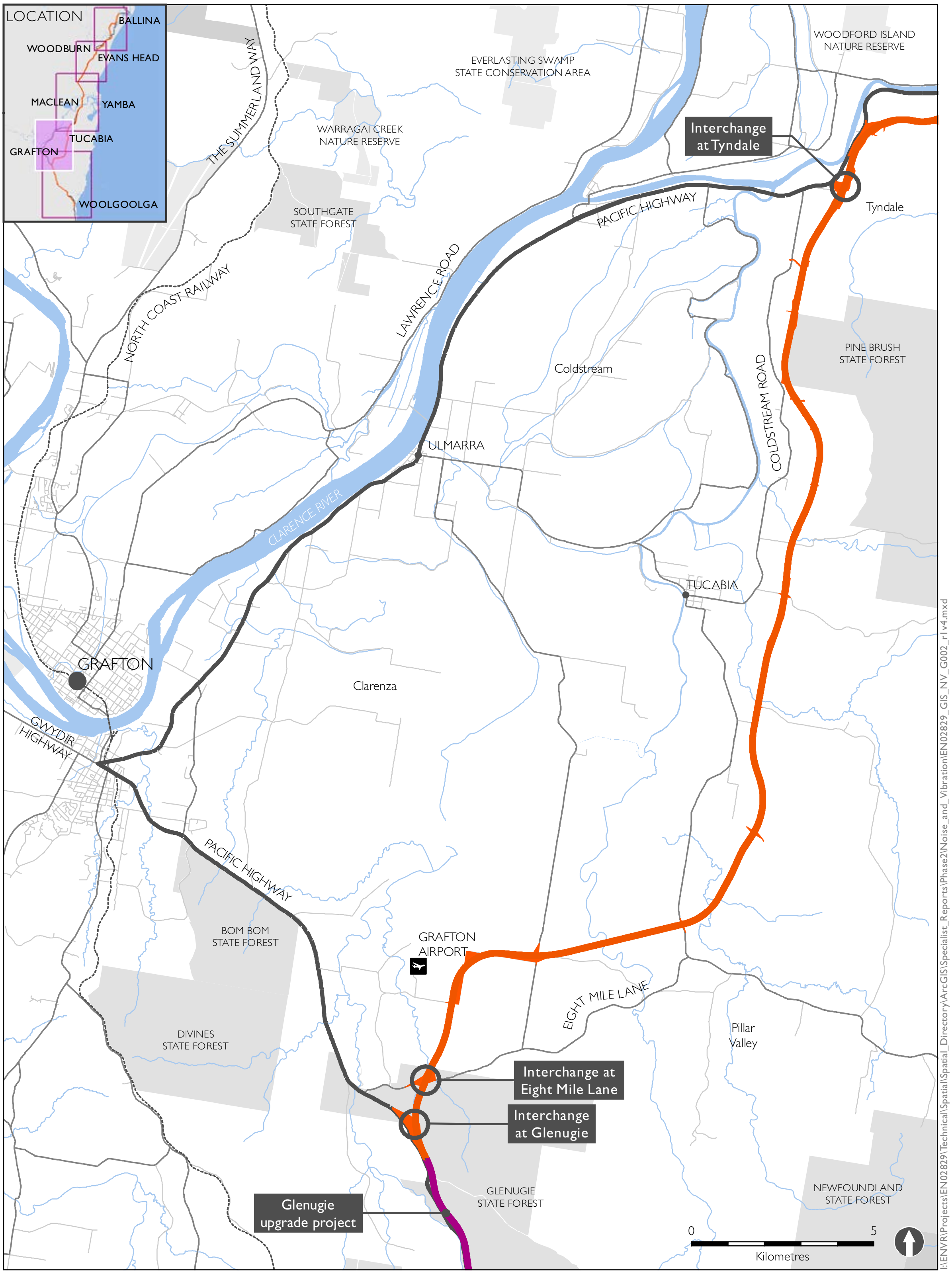
The project

Upgrade completed to dual carriageway

Upgrade under construction

Existing Pacific Highway

Figure 1-3 The project alignment - Glenugie to Tyndale



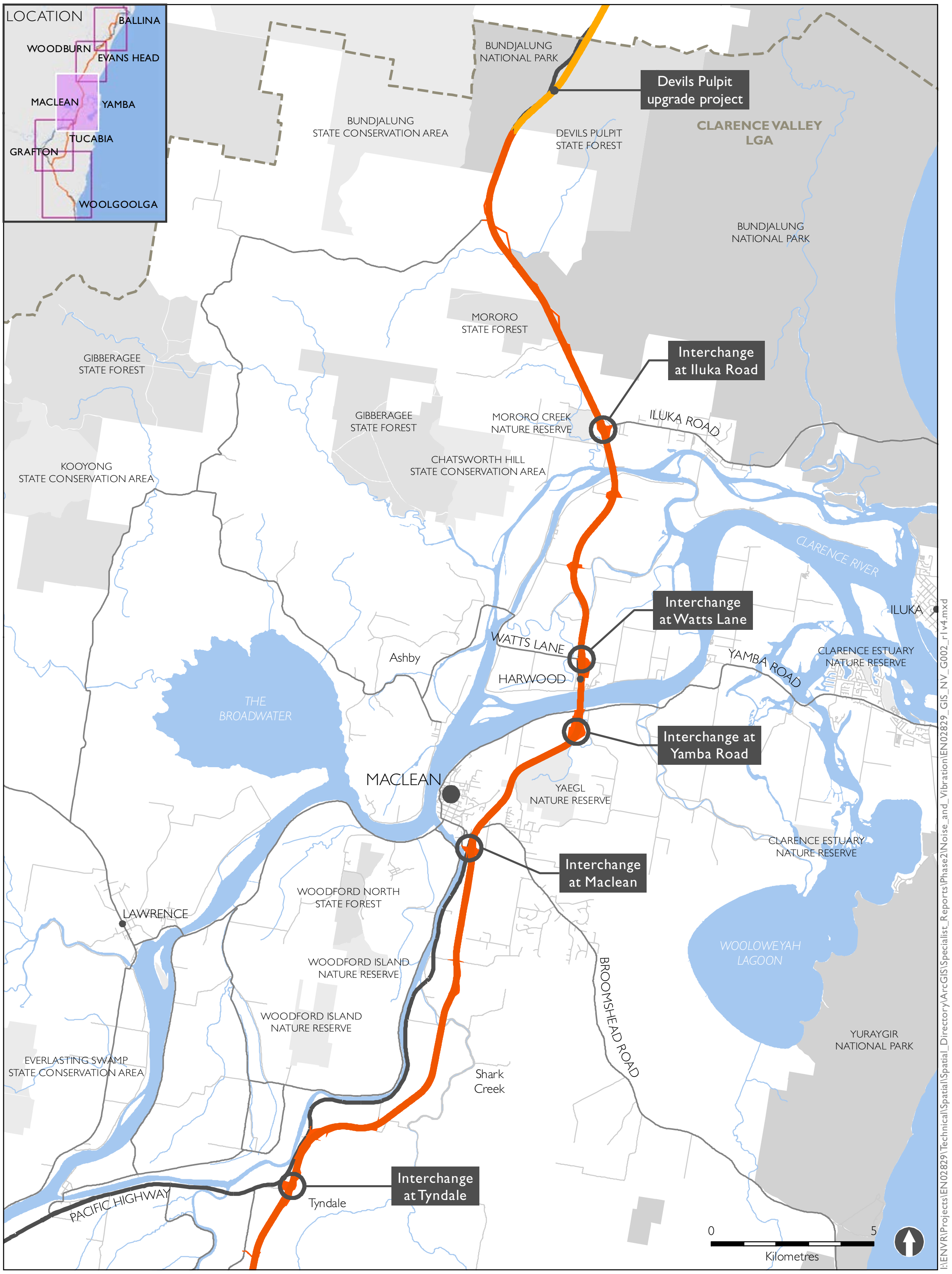
The project

Upgrade completed to dual carriageway

Upgrade under construction

Existing Pacific Highway

Figure 1-4 The project alignment - Tyndale to Devils Pulpit



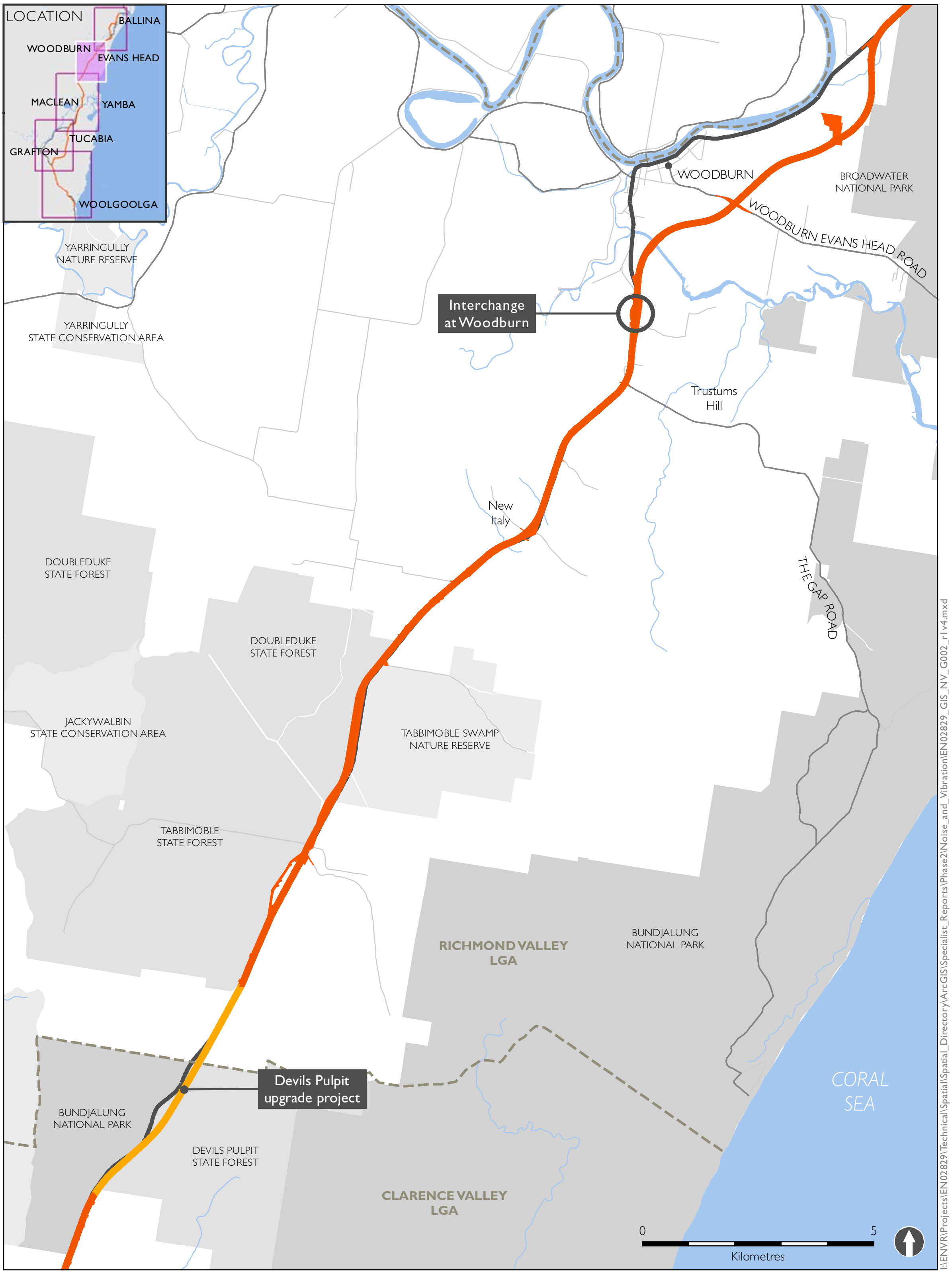
The project

Upgrade completed to dual carriageway

Upgrade under construction

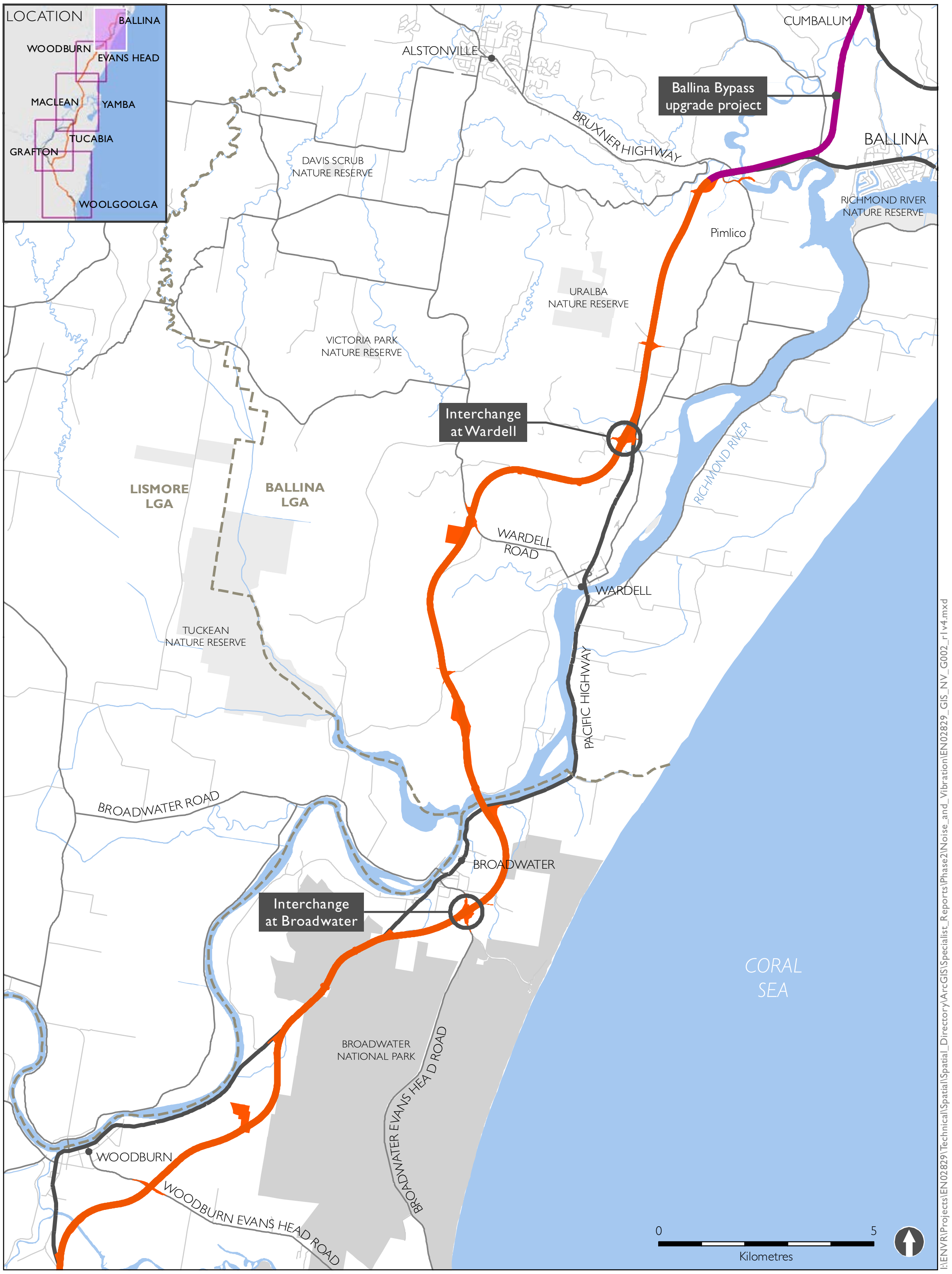
Existing Pacific Highway

Figure 1-5 The project alignment - Devils Pulpit to Woodburn



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

Figure 1-6 The project alignment - Woodburn to Ballina



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

2. Assessment criteria

2.1. Overview

In accordance with the Director-General's environmental assessment requirements for the assessment and management of impacts from the operation and construction of this project, operational road traffic noise, construction noise (including cumulative impacts), construction vibration and blasting impacts have been considered in this report.

This section provides an overview of the relevant legislation and guidelines by which the above project impacts are assessed and an appropriate level of management applied.

2.2. Operational road noise

2.2.1. Road Noise Policy and Environmental Noise Management Manual)

The assessment of road traffic noise impacts has been undertaken using the guidance detailed in the NSW Office of Environment and Heritage (OEH) Road Noise Policy (RNP 2011)) and the RMS Environmental Noise Management Manual (ENMM 2001).). These guidelines detail the criteria and methods used to assess impacts on sensitive receivers for road projects undertaken in NSW.

The operational noise assessment covers a study area of 600 metres either side of the road centreline and applies the noise level targets from the guidelines to residential and non residential sensitive receivers. Where noise goals cannot be reached through design strategies, additional mitigation may be required to address and reduce noise impacts where necessary.

The criteria for the assessment of road traffic noise outlined in the RNP have been supplemented with "interim approaches" developed by RMS to implement the policy provisions. These interim approaches outline how the provisions in the ENMM apply to the recently released RNP. These documents work together to in developing feasible and reasonable noise mitigation options where the predicted project noise levels exceed the RNP assessment criteria..

2.2.2. Base criteria

Under the RNP, road development is either classified as "new road" or "redevelopment of an existing road". The appropriate noise goals for the daytime and night time aim to achieve the listed noise levels until the design year, which would typically be 10 years after opening. The criteria for each road classification for each assessment period have been listed in **Table 2-1**.

The factors that affect how a receiver is categorised include:

- The influence of existing traffic noise on a receiver.
- Whether the road is in a new or existing road corridor

- Any changes to the direction that new noise emissions would impact a receiver.

Table 2-1: Road traffic noise base criteria

Road category	Type of proposal/land use	Noise criteria	
		Day 7:00am - 10:00pm	Night 10:00pm - 7:00am
Freeway/arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	LAeq (15hour) 55 dB (A)	LAeq (9hour) 50 dB (A)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	LAeq (15hour) 60 dB (A)	LAeq (9hour) 55 dB (A)

The traffic noise influence of the proposed upgrade on the receivers identified for the project are a mixture of new and redeveloped road categories. The ENMM defines an existing road traffic noise exposure in Practice Note (i) as:

"A site is defined as having an "existing road traffic noise exposure" if the prevailing noise level from the existing road alignment(s) under consideration is equal to or greater than 55 dB(A) LAeq (15hr) (day) or 50 dB(A) LAeq (9hr) (night). The noise level contours corresponding to these day and night noise levels define the "noise catchment" for an existing road. In areas outside these contours, road traffic is unlikely to be a significant noise source."

Where the project would upgrade highway along the existing alignment, the nearest sensitive receivers to the alignment are likely to be set an external day time noise criteria of 60 dB(A) and night time level of 55 dB(A) reflecting the noise impact from the existing highway.

Where the project leaves the existing road corridor, noise criteria would reflect the impacts from a new freeway. These receivers would have the 'new road' criteria of 55 dB(A) day and 50 dB(A) night. The operational base criteria for the proposed upgrade are presented for each receiver in each of the project sections, detailed in Part B of this report.

2.2.3. Additional criteria

In addition to the base criteria, the ENMM identifies a category of highly affected noise sensitive receivers that have been termed "acute". Where receivers experience noise levels that would be greater than or equal to $L_{Aeq\ (15hour)}$ 65dB(A) and $L_{Aeq\ (9hour)}$ 60 dB(A), as a result of existing or future road traffic noise, they would be classed as 'acute'. In these instances a detailed assessment of noise mitigation in accordance with ENMM practice note (iv) would be necessary.

In areas of new or existing impact, where the increase in noise would be due to a road proposal or a traffic generating development, the RNP recommends that a relative increase greater than 12 dB(A) in total traffic noise levels should be considered for mitigation. This relative increase criterion does not apply for open spaces or where the main road to be assessed is a local road. Table 2-2 presents a summary of the relative increase criterion to be adopted for the proposal.

Table 2-2: Relative increase criteria for residential land use

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

Assessment criteria for other non residential land uses are presented in **Table 2-3** and are taken from Section 2.3.2 of the RNP.

These criteria do not require an assessment against a 'build' and 'no build' scenario as they are based on the level of impact that, below which, normal operations or use can continue with minimal interruption or disturbance. For example, where the internal ambient noise environment of a school classroom is below 40dB(A) $L_{Aeq,1hour}$ (see **Table 2-3**), the internal acoustic environment is considered to be suitable for teaching. Where ambient internal noise levels are above 40 dB(A) $L_{Aeq,1hour}$, the area is likely to be poor as a teaching environment.

The locations of non residential receivers have been determined for each of the 11 project sections and are presented in Part B of this report. A discussion and reference to the existing environment at receivers within the project is presented in **Section** 4**.**

Table 2-3: Noise criteria for non-residential land use

Existing sensitive land use	Assessment criteria dB(A)		Additional Considerations
	Day (7 a.m.– 10 p.m.)	Night (10 p.m.– 7 a.m.)	
1. School classrooms	L_{Aeq}, (1 hour) 40 (internal) when in use		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).
2. Hospital wards	L_{Aeq}, (1 hour) 35 (internal)	L_{Aeq}, (1 hour) 35 (internal)	
3. Places of Worship	L_{Aeq}, (1 hour) 40 (internal)	L_{Aeq}, (1 hour) 40 (internal)	
4. Open space (active use)	L_{Aeq}, (15 hour) 60 (external) when in use	–	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading. 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.
5. Open space (passive use)	L_{Aeq}, (15 hour) 55 (external) when in use	–	

Existing sensitive land use	Assessment criteria dB(A)		Additional Considerations
	Day (7 a.m.– 10 p.m.)	Night (10 p.m.– 7 a.m.)	
6. Isolated residences in commercial or industrial zones	–	–	For isolated residences in industrial or commercial zones, the external ambient noise levels can be higher than those in residential areas. Internal noise levels in such residences are likely to be more appropriate in assessing any road traffic noise impacts, and the proponent should determine suitable internal noise level targets, taking guidance from Australian Standard 2107:2000 (Standards Australia 2000).
7. Mixed use development	–	–	Each component of use in a mixed use development should be considered separately. For example, in a mixed use development containing residences and a childcare facility, the residential component should be assessed against the appropriate criteria for residences in Table 3, and the childcare component should be assessed against point 8 below.
8. Childcare facilities	L_{Aeq}, (1 hour) 35 (internal) - **Play areas** Indoor 40 (internal) Outdoor 55 (external)	–	Multi-purpose spaces, eg shared indoor play/sleeping rooms should meet the lower of the respective criteria. 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.
9. Aged care facilities	–	–	Residential land use noise assessment criteria should be applied to these facilities (see Table 3).

2.2.4. Maximum noise level assessment – sleep disturbance

Noise events that substantially exceed a relatively continuous ambient noise level are more likely to give rise to awakenings and generate annoyance within a community. For assessment purposes, at locations where traffic noise is continuous rather than intermittent, the ENMM employs a methodology to assess these impacts based on the emergence of the L_{Amax} over the $L_{Aeq\ (1hr)}$ noise level.

A maximum noise pass-by event is defined as the emergence of the L_{Amax} level above the $L_{Aeq\ (1hr)}$ noise level by 15 dB(A) or more, ie:

$$L_{Amax} \geq L_{Aeq\ (1hr)} + 15 \text{ dB(A)}$$

One of the major causes of maximum noise level events is the use of engine brakes on heavy vehicles. The engine brake, also called a “Jake brake” uses the compression developed in diesel engines to slow the engine and therefore the vehicle by retarding the release of exhaust gases. This process causes a pulsing of the gas which is then exhausted through the truck’s muffler system. While engine brakes generate these noise emissions, the impact is transmitted to the environment by the use of old or poor quality mufflers which have low back pressures that provide cost savings to operators but have a higher transmission of noise.

The use of engine brakes is generally noticed on downhill gradients and sections of road where trucks cannot overtake slower vehicles. These effects are not always able to be predicted as the use of engine brakes even in these situations has a degree of uncertainty involved. The noise model developed for the project does not account for engine brake noise in the calculation of impacts; however the design of the proposed upgrade is expected to limit the occurrence of these emissions.

The correlation of maximum noise level events from the existing highway to the proposed upgrade is not directly proportional. In providing an optimised dual lane carriage way, heavy vehicles can maintain a constant speed with more even gradients and can overtake where necessary to avoid slower vehicles. In minimising the cause of these high noise level events, the road design is providing the most effective form of mitigation of impacts.

While the exceedance of sleep disturbance criteria for a project does not necessarily constitute a need for mitigation;, as part of the development of the concept design, the assessment of maximum noise levels is recommended for each project phase.

2.2.5. Rest areas and vehicle inspection stations (including weigh bridges)

Rest areas and vehicle inspection stations do not generate the same type of continuous noise that is present near a major road. The types of noise at rest areas are likely to be a mixture of heavy vehicle movements and refrigerated unit operations, passenger vehicle movements and short term loud noises such as car doors and truck air brakes. The types of noise at vehicle inspection stations will consist of heavy vehicle movements at slow speeds only. The *NSW Industrial Noise Policy* (EPA, 2000) (INP) provides guidance in the assessment of noise emissions from premises that are scheduled under the *Protection of the Environment and Operations Act 1997*.

While the INP is not strictly used for the assessment of non industry based noise emissions, the application of the criteria may be implemented where guidance on appropriate noise levels is required. The INP requires that the noise assessment complies with the lower of the amenity or intrusive noise criteria. The intrusive criterion requires that the noise from the activity under assessment is no greater than 5 dB(A) above the RBL, while the amenity criterion is based on the zoning and general land use near the residences likely to be affected by noise emissions.

In general, the amenity levels are more suited to planning of noise levels rather than the assessment of project specific impacts. The intrusive noise criteria are designed to account for shorter duration noise impacts and are often the most appropriate tool for assessing the effects of noise at a residential location. According to the INP a noise source is considered to be non-intrusive if:

- The $L_{Aeq,\ 15\ minute}$ level does not exceed the RBL by more than 5 dB(A) for each of the day, evening and night-time periods.
- The subject noise does not contain tonal, impulsive, or other modifying factors as detailed in Chapter 4 of the INP.

2.3. Construction noise

The risk of adverse impact of construction noise on a community is determined by the extent of its emergence above the existing background noise level, the duration of the event and the characteristics of the noise. Impacts can then be exacerbated by the proximity of construction to residences or other sensitive land uses and the scheduled times of construction activities.

To address potential construction noise impacts the EPA refers to the *Interim Construction Noise Guideline* ICNG (DECC, 2009). This guideline has been developed to assist with the management of noise impacts, and rather than presenting absolute noise criteria for construction activities, it recognises the variability of existing noise environments experienced throughout the day and assigns a noise goal accordingly.

The ICNG describes two methods of assessing noise impacts from construction activities: the quantitative method, which is suited to major and complex construction projects; and the qualitative method, suited to short-term (less than three weeks) works undertaken during standard construction hours.

Detailed construction methods for each of the five project stages, and subsequent 11 sections have been provided by RMS. At this stage these methods are indicative and have the potential to change during detailed design.

The 11 Sections have been looked at individually in terms of the construction assessment, with the data collated to look at the impacts with each of the five construction stages. These are presented in **Part C**. With the construction works for the project anticipated to last for longer than three weeks for any given section of the alignment, combined with the relevant construction methodologies from RMS, a comprehensive quantitative assessment of impacts has been undertaken for the project in accordance with the guideline.

The ICNG identifies a Noise Management Level (NML), which is the project specific noise criteria used to assess the level of impact at a receiver location. The NML is derived from the RBL noise monitoring information at a given receiver location. Due to the scale of the works, monitoring at each receiver location cannot be undertaken for the project and so a representative noise level is applied using either actual monitoring data or is assigned using a nearby or similarly situated receiver location.

The NML level applies at the property boundary that is most exposed to the construction noise, at a height of 1.5 metres above ground level. In cases where the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence, otherwise at 1 metre from the facade.

2.3.1. Residential criteria

Table 2-4 is taken from the ICNG and outlines the procedures for determining a NML for sensitive receivers and how this should be applied throughout a given 24 hour period. The table also identifies a category of ‘highly noise affected’ receivers to which restrictions of construction hours may apply where the proposed activities generate noise levels above 75dB (A) at sensitive receivers. The table also details recommended hours of operation for the project construction activities.

Table 2-4 Construction noise management levels (NMLs)

Construction work hours	Noise affected level	Assessment outcomes
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected (RBL + 10 dB)	▪ The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all reasonable and feasible work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, expected noise levels and the duration of activities. Contact details for a construction representative should also be provided.
	Highly noise affected (75 dB(A))	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected (RBL + 5 dB)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all reasonable and feasible work practices to meet the noise affected level. Where all reasonable and feasible practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should then undertake negotiations with the community. For guidance on negotiating agreements refer to Section 7.2.2 of the ICNG (DECC, 2009).

2.3.2. Non-residential criteria

For other relevant land uses within the area of the project, the following noise criteria would apply:

- Industrial premises: external $L_{Aeq(15min)}$ 75 dB(A).
- Offices, retail outlets: external $L_{Aeq(15min)}$ 70 dB(A).
- Classrooms: internal $L_{Aeq(15min)}$ 45 dB(A).
- Places of worship: internal $L_{Aeq(15min)}$ 45 dB(A).
- Passive recreational areas: external $L_{Aeq(15min)}$ 60 dB(A).

Receivers have been separated into residential and non-residential and therefore the criteria outlined **Table 2-4** will be used alongside the 70dB(A) criteria for offices/retail outlets for receivers within the project boundary. The location of schools and churches has been identified along the project corridor, and are shown in **Table 2-5.**

Table 2-5: Location of schools and churches

Receiver	Designation	Section	NCA*	Distance from alignment centreline
Corindi Beach Public School	School	1	n/a	850 m
Chatsworth Public School	School	5	n/a	1 km
Woodburn Primary School	School	8	n/a	1.25 km
Maclean High School	School	4	n/a	640 m
Harwood Island Primary School	School	5	5-e	170 m
Broadwater Public School	School	9	n/a	630 m
Roman Catholic Church	Church	TBC	TBC	TBC
Jehovah's Witness Church	Church	TBC	TBC	TBC
For definition and description of NCAs see **Section 4.3*				

Where a non-residential receivers lies within the 600 metre noise study area, an assessment of predicted internal noise levels has been undertaken using estimates of the different noise reduction characteristics for each building type at the above receivers. These estimations are presented in **Table 2-6.** The internal noise levels are calculated based on the predicted external levels minus the noise reduction offered by the building facade.

Table 2-6: Estimated non-residential sound reduction index

Building Type	Estimated weighted sound reduction index Rw / dB(A)
Weatherboard	20
Demountable	23
Masonry	30

The actual internal predictions for the above receivers will be assessed within **Parts B** and **C** for operational and construction noise.

2.4. Construction vibration

2.4.1. Human comfort

Vibration from construction activities with regard to human comfort within a building must comply with the Environmental Protection Authority (EPA) Assessing Vibration: A Technical Guideline and AS2670.2 (DEC 2006). It is not always possible to undertake major infrastructure projects in very close proximity to residential dwellings and comply with this criterion. However, the criteria within this guideline should always be used as the objective, and represents the basis of the human comfort assessment. When assessing vibration, the NSW EPA classifies vibration as one of three types:

- Continuous – Where vibration occurs uninterrupted and can include sources such as machinery and constant road traffic;
- Impulsive – Where vibration occurs over a short duration (typically less than 2 seconds) and occurs less than three times during the assessment period, which is not defined. This may include activities such as occasional dropping of heavy equipment or loading / unloading activities; and
- Intermittent – Occurs where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and heavy vehicle or train passbys.

Due to the nature of the human comfort criteria, it is necessary to undertake vibration measurements in terms of acceleration at the location of human occupancy, whether residential or commercial. Actual exposure criteria is determined by exposure time (16 hour day, 8 hour night averaging periods), acceleration magnitude and vibration direction and can either be measured using integrating equipment or derived from particle velocity: eVDV.

The criteria are applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis, as required in the guideline. Preferred and maximum values for continuous and impulsive vibration are defined in **Table 2-7.**

The EPA ‘Assessing Vibration’ guideline does make an allowance for higher limit levels, above those identified in **Table 2-7**. This applies in circumstances “where work is short term, and all feasible and reasonable mitigation measures have been applied, and the project has demonstrated high levels of social worth and broad community benefits”. For the purpose of the EPA ‘Assessing Vibration’ guidelines, short term work is defined as construction works that occur for a duration of approximately 1 week.

Table 2-7 Preferred and maximum weighted root means squared values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz.

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

Note:
1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am
2. Such as hospital operating theatres or precision laboratories

Intermittent vibration is assessed using vibration dose values (VDVs). The VDV method is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline (DECC, 2006). Preferred and maximum VDVs are defined in Table 2.4 of DECC (2006) and are reproduced in

Location	Daytime (7:00 am – 10:00 pm)		Night-time (10:00 pm – 7:00 am)	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas1	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 2-8 Preferred and maximum weighted root means squared values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz.

Location	Daytime (7:00 am – 10:00 pm)		Night-time (10:00 pm – 7:00 am)	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[1]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note: 1 Includes operating theatres, precision laboratories and other areas where vibration sensitive activities may occur.

2.4.2. Structural damage

The Australian Standard AS2187.2-2006 *Explosives – Storage, Transport and Use* provides guidance for the assessment of structural damage to buildings caused by vibration. This section of the standard is based on the British Standard 7385: Part 2 *Evaluation and measurement of vibration in buildings* and is used as a guide to assess the likelihood of building damage from ground vibration including piling, compaction, construction equipment and road and rail traffic. BS 7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

British Standard 7385: Part 2 *Evaluation and measurement of vibration in buildings* recommends that the peak particle velocity (PPV) is used to quantify vibration and specifies damage criteria for frequencies within the 4 Hz to 250 Hz range usually encountered in buildings. At frequencies below 4 Hz, a maximum displacement value is recommended. The levels from the standard are outlined in Table 2-9**.**

Table 2-9 BS 7385 Structural damage criteria

Group	Type of structure	Peak particle velocity (PPV), mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

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

In addition, further guidance on ground vibration assessment is contained in German Standard 4150-3 *Structural Vibration, Part 3: Effects of Vibration on Structures* (DIN 4150-3). This standard also recommends assessment be considered through the measurement of PPV and contains the guideline values for short term vibration impacts on heritage structures as outlined in **Table 2-10** DIN4150-3 is used in this report to assess potential vibration impacts on heritage buildings and other sensitive structures.

Table 2-10 DIN 4150-3 Vibration guidelines for heritage buildings

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

It is noted that where work is short term (less than one week), where feasible and reasonable impact mitigation measures have been applied, and the project has a high level of social worth and broad community benefits, then higher vibration values may apply (DECC, 2006).

As such it is proposed that where vibration inducing activities are proposed for a period of less than one week, the building damage criteria of 10 mm/sec is used as the limiting construction vibration criteria, unless private agreement has been reached with the landholder. Where the likelihood exists for this limit to be exceeded, a negotiated agreement would be obtained from the landowner to permit higher vibration levels. In this case vibration would not be permitted to exceed 25 mm/sec.

2.4.3. Blasting

Ground borne vibration and airblast overpressure have the potential to impact human amenity and/or buildings and infrastructure at sites in close proximity to the blast. Assessment criteria recommended for overpressure and ground vibration from blasting in Australia are taken from the Australian and New Zealand Environment Council (ANZEC) guidelines, and are based on data contained in the AS2187.3-2006 *Australian Standard: Explosives – Storage and Use*.

The ANZEC criteria for the recommended maximum level for air blast at residential locations is 115 dB(L), which may be exceeded on up to 5% of the total number of blasts over a 12 month period; however the level should not exceed 120 dB(L) at any time.

The recommended maximum level for ground vibration at a residential location is a Peak Particle Velocity (PPV) of 5 mm/s. The PPV level of 5 mm/s may be exceeded up to 5 percent of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time without agreement of the property owner.

2.4.4. Summary of project specific vibration criteria

The guidelines outlined above indicate the complexities involved with determining vibration impacts on receivers. The following minimum vibration limits have been summarised in **Table 2-11** from the above tables for human comfort and building damage. These limits indicate the lowest threshold levels that are to be used in identifying impacts on residential dwellings and their inhabitants.

Table 2-11 Vibration criteria summary

Area	Vibration limit
Human comfort 1-80 Hz (continuous)	0.01 m/sec^2 Daytime
	0.007 m/sec^2 Night time
Human comfort 1-80 Hz (impulsive)	0.3 m/sec^2 Daytime
	0.1 m/sec^2 Night time
Human comfort 1-80 Hz (intermittent – vibration dose value)	0.2 m/sec$^{1.75}$ Daytime
	0.13 m/sec$^{1.75}$ Night time
Residential building damage – BS7385	15 mm/sec
Heritage building damage – DIN4150-3	3 mm/sec
Airblast overpressure	▪ must be not more than 115 dB (Lin) peak for 95% of blasts over 12 months ▪ must not exceed 120 dB (Lin) peak for any blast.
Blast-induced ground-borne vibration	▪ must not exceed a peak particle velocity of 5 mm per second for nine out of any ten consecutive blasts initiated, regardless of the interval between blasts; and ▪ must not exceed a peak particle velocity of 10 mm per second for any blast.

3. Methodology

This chapter of the report provides an outline of the methodologies used in the assessment of noise and vibration impacts from operation and construction of the project. Each of the 11 project sections was assessed according to these methodologies for operational noise and construction noise, vibration and blasting.

3.1. Operational noise

3.1.1. Receiver identification and noise monitoring

Noise sensitive receivers for the project were identified from cadastral information and aerial photography taken in July 2010. This review provided the preliminary classification for residential and non residential sensitive receivers within the study area.

The location of receivers identified from the aerials and cadastre were used to direct noise monitoring studies used in establishing the ambient noise along the existing and proposed project corridor. The noise levels at these locations have been quantified using noise monitoring equipment that collect long term data and was undertaken in conjunction with vehicle counts during the survey periods. These data provide baseline noise levels and are used to establish the predictive noise model, which is calibrated against these measurements. Monitoring was undertaken in line with AS 2702 'Methods for the measurement of road traffic noise' and AS1055:1997 'Description and measurement of environmental noise'.

At about 100 metres from the road, the traffic noise would generally decrease by about 10 dB(A) and at 400 metres, a 30 dB(A) general reduction means that ambient environmental noise sources are likely to become the dominant factor in the overall measured levels. Traffic noise is still expected to be audible at greater distances but actual measurement of the traffic contribution is more difficult due to local noise sources and unfavourable meteorological conditions. Noise measurements for all applicable locations are included in this assessment; however calibration against noise measurements further than about 300 metres is generally not practical.

Construction noise monitoring is used to measure all noise sources audible at a receiver location to determine the background noise levels for the day, evening and night time periods. The background noise levels whether influenced by existing traffic noise or the natural environment provide the base levels used to set the construction noise goals. In making the project noise goals specific to the environment that influences the noise level, target construction noise goals can be set to minimise the disturbance to noise sensitive receivers affected by the works.

The monitoring is undertaken using two methods of capturing noise level data. The first is with automatic unattended monitoring equipment that gathers statistical data continually over the survey period. The second is by operator attended measurements over short durations where noise for 15 minute periods is recorded and the observations of the noise sources during the survey are noted.

For most road projects it is not practical to undertake background noise monitoring at all receiver locations to individually characterise the noise environment. Therefore, the approach recommended in the RNP and ICNG is to undertake monitoring at representative locations to obtain typical information for the broader project. The representative locations were identified and property access was obtained for 50 unattended monitoring locations and 12 attended monitoring locations, which were used to assess the existing noise environment over the 11 sections of the study area.

Baseline noise monitoring was undertaken between February and March 2012 in accordance with the ENMM and RNP, with a mix of ARL Ngara and EL-21x noise loggers deployed at each monitoring location. Where possible, loggers were placed one metre from the most potentially affected facade of the dwelling or, if necessary, in the free field (away from acoustically reflective surfaces). Microphone heights were 1.2metres from the ground and each logger was calibrated against a standard tone (1000 Hz) prior to and following completion of monitoring to establish that any drift was within acceptable limits (±0.5 dB (A))

The weather during the monitoring period was highly variable with frequent rain A summary of the results of baseline noise monitoring is presented for each of the 11 sections in **Part B** and **Part C**. Details of monitoring locations for each section are presented in **Section 4.3.**

Baseline monitoring establishes background noise levels to aid in assessing construction impacts and is also used to establish the existing traffic noise levels for the day and night time periods. For the purpose of road traffic noise assessment, these periods are defined as:

- $L_{Aeq, (15\ hour)}$ representing the LAeq noise level for the day period 7 am – 10 pm
- $L_{Aeq, (9\ hour)}$ representing the LAeq noise level for the night period 10 pm – 7 am

3.1.2. Modelling of existing and proposed upgrade

While monitoring can be used to identify specific details of the noise environment at individual locations, the objective of noise modelling is to establish the noise impacts across the broader study area. To do this, a noise model must be created using data for the existing terrain, current and projected traffic volumes and mixes, and the existing and proposed highway design.

The noise model is calibrated using the monitoring data collected during the field surveys and becomes the basis for predicting noise levels at all receiver locations for each of the assessment scenarios.

The modelling has been undertaken based on the concept design and the modelling scenarios are in accordance with the requirements outlined in the RNP which includes consideration of the 'do nothing' option. The assessment scenarios for road projects include the evaluation of noise impacts for two timeframes:

- Within one year of changed traffic conditions
- For a design year (typically ten years) after changed traffic conditions.

For each of these timeframes, a comparison is made between:

- The road traffic noise levels if the project proceeds, referred to as the 'build option', and

- The corresponding road traffic noise levels, due to general traffic growth, that would have occurred if the project had not proceeded, referred to as the 'no build option'.

The outcome of these modelling scenarios is compared to the requirements in the guidelines. Where locations are predicted to exceed the noise level criteria, mitigation measures are to be considered.

Modelling of traffic noise levels is undertaken using the Calculation of Road Traffic Noise (CoRTN) method through the SoundPLAN noise modelling program. The CoRTN method predicts the $L_{A10,\ 18\ hour}$ and the $L_{A10,\ 1\ hour}$ noise levels at a receiver location based on the specific project design parameters. The model incorporates the elements summarised in **Table 3-1**.

Table 3-1 Summary of parameters including in predictive modelling

Parameter	Description
Traffic volumes and mix	The number of vehicles using the road (both for existing and upgrade) as well as the proportion of heavy to light vehicles.. A higher ratio of heavy vehicles increases the noise levels proportionally. The CoRTN model sets the height of the traffic stream at 0.5 metres above pavement height, irrespective of the heavy vehicle content within the traffic stream. To account for the large proportion of heavy vehicles in the night time traffic stream, the CoRTN assessment has been modified to incorporate three different source heights for emissions from truck engines, truck exhausts, and cars (1.5 m, 3.6 m and 0.5 m respectively).).
Traffic speed	An increase in traffic speed generally causes an increase in tyre noise. Traffic speeds (both for existing and upgrade) are incorporated into the noise model based on posted speeds and proposed speeds.. A sensitivity assessment is also undertaken to identify the potential impacts that would result from exceedances of the posted speed limit.
Road surface	Road surfaces vary depending on the design requirements of the project and can be rigid pavements such as concrete or flexible pavements such as asphalt. Regardless of the pavement type, the wearing surfaces of the pavement will dictate the noise generated by the tyre on the road. Each surface type generates different levels of tyre noise with the neutral or base case being dense grade asphalt. Surfaces such as tyned concrete would generate increased noise levels, while low noise pavements will generate less. Locations and types of pavements are presented for the assessments of each section of the project
Gradient of roadway	Noise levels change as a result of traffic going up or down hill when compared to traffic travelling along flat sections of the road. The noise model calculates the variation in noise levels from the road gradient, which is incorporated into the predicted noise levels. The noise model does not account for engine brake noise from heavy vehicles; however, since the road design has been optimised for the project, the effect of engine braking is minimised.
Surface terrain	Natural topographic features such as hills and valleys can shield sensitive receivers from traffic noise. These effects are automatically accounted for in the model using information on terrain which is generally resolved to 2m2 m contours or better for each of the 11 sections.
Building height	Buildings may be single or multiple storey; however many through the alignment are single storey residences. The height of the receiver influences the exposure to traffic noise and also the ability to mitigate adverse impacts.
Facade	For all buildings, a correction of +2.5 dB(A) has been added to the L_{Aeq}, period results

Parameter	Description
reflections	to correct for facade reflections in accordance with the RNP and ENMM guidelines.
Air and ground absorption	Noise levels reduce with increasing distance from the noise source due to absorption in the air and along the ground. While air absorption is calculated by the model, ground absorption can be specified separately. Much of the alignment is considered to be soft ground between the highway and receiver locations recognising the rural nature of the project. For larger communities such as Maclean, Harwood, Broadwater and Woodburn a modified ground absorption factor is applied to account for only 75% soft surfaces.

In addition to these factors, the modelled noise levels are predicted in terms of an L_{A10} parameter which needs to be converted to an L_{Aeq} level for comparison to the road noise criteria outlined in the RNP. The RMS and EPA recommend a general conversion factor between L_{A10} and L_{Aeq} of 3dB (A) where site specific details are not known.

The ability of the noise model to predict future traffic noise impacts is established on a project by project basis by calibration against known conditions (baseline noise and traffic data). The basic prediction algorithm used in noise modelling does not change from project to project and, therefore, the calibration of a noise model is primarily used to confirm the accuracy of the modelling data for a given project. A calibrated model is taken to be sufficiently accurate to predict noise levels for future situations.

Over longer distances between source and receiver (eg more than 600 metres), meteorological factors and ambient noise sources combine to reduce the level of predictive accuracy of the model, since the contribution of traffic to the overall noise level is diminished. Generally the calibration of the CoRTN model is expected to be accurate to ± 3dB(A) out to the 600 metres assessment boundary.

Following prediction of noise levels at the identified receiver locations for each of the scenarios, an assessment against the project criteria is undertaken. The predicted values are compared to the appropriate noise goals and, where exceedances are noted, additional assessments are undertaken to determine the level of exceedance. The process of assessment and consideration of mitigation is explained in **Section 3.1.5**.

In addition to operational traffic noise, the project would incorporate a number of rest areas, each with toilets, rest facilities and parking spaces for B-double truck and car parking. Locations for the rest areas include two on the northbound side at Tucabia and south of Old Bagotville Road. The southbound side has three rest areas identified at south of Old Bagotville Road, north of Mororo Road and at Tucabia. Indicative locations of rest areas are shown in Section 4 of the main environmental assessment and presented in **Appendix A** of this report. An analysis of impacts for each of the project sections (1-11) is presented in **Part B** of this report.

In addition to rest areas, a single heavy vehicle inspection station has been identified within the project. This will be located between STN 19.100 and STN 20.000 and will replace the current station operating near Glenigie State Forest (STN 26.600).

3.1.3. Traffic volumes and mix

The assessment of existing and future traffic volumes forms the basis of the noise modelling predictions. The traffic volumes used in this assessment are based on the traffic predictions for the future years of operation in accordance with the RNP, being the year of project opening and 10 years after opening, termed the design year.

The traffic models were developed for each of the project sections as part of the *Working .paper – Traffic and transport* The traffic models were based on current road network knowledge, with traffic demand being extrapolated from recent studies and available RMS traffic counts. For more information on the analysis and forecasting of traffic impacts refer to *Working Paper - Traffic and Transport*.

For the operational noise study, traffic forecasts are presented for each of the 11 sections in **Part B Section 4**. The traffic numbers used for the modelling are presented in Part B showing the day time and night time scenarios split into light and heavy vehicle categories. The percentage of heavy vehicles in the traffic mix are also calculated for the total traffic volumes and are identified for the calibration, build and no build scenarios.

The data are based on an assessment of average traffic flows over the whole year, with the traffic numbers used in the modelling representing the Annual Average Daily Traffic (AADT) flows, which are calculated from 2011 traffic counts for the project, SCATS data and RMS permanent counting stations. In practice, vehicle movements will vary on a daily, weekly and monthly basis depending on seasonal traffic flows and other factors..

3.1.4. Operational vibration

The purpose of the vibration study is to quantify the level of ground borne vibration to which residents and buildings are already exposed, and to predict and assess changes in these levels as a result of the project.

Ground borne vibration generated by road traffic is a function of the vehicle suspension reacting to irregularities in the road surface. The vibration from the vehicle is translated into the ground, which acts as a medium to transmit vibration to nearby residences. The effects of ground borne vibration are quickly dissipated and generally do not have an impact beyond five metres of the edge of the carriageway.

The potential for traffic induced operational vibration impacts is likely to be minimal for the project as the upgraded road surface would be of a high quality and the distance from the highway to the nearest receivers would generally be greater than five metres. Even at separation distances smaller than five metres, the vibration associated with traffic moving on a newly constructed road is expected to be minimal.

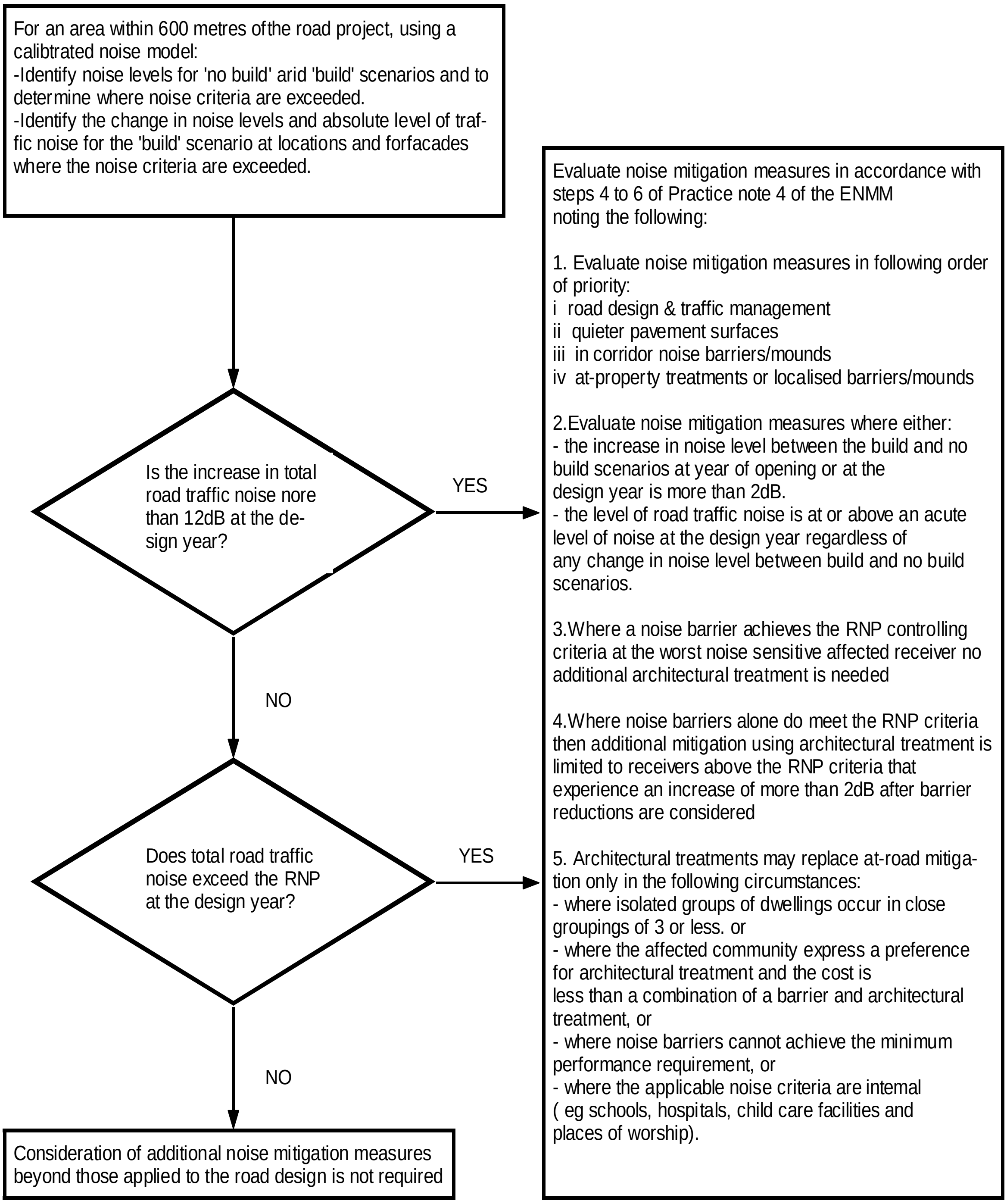
3.1.5. Mitigation recommendations and options

The RMS follows an accepted methodology for recommending and selecting the need for and type of mitigation associated with the project. In addition, the effectiveness of mitigation options such as low noise pavements and noise walls is undertaken at assessment stage..

Where sensitive receivers exceed the project specific noise levels, mitigation is considered to reduce the level of external impacts where possible. Where the external noise environment is unable to be controlled, options for treatment of individual properties may be necessary.

To determine where and how noise mitigation will be applied, the noise assessment follows the process of predicting noise levels for the year of opening and design year scenarios and comparing the outcomes of these assessments to the noise goals in **Table 2-3**. Where exceedances of base criteria are predicted, noise mitigation is further assessed according the RNP guidelines. The additional assessment methodology is outlined in the RMS interim approaches shown in **Figure 3-1**, which presents a flowchart of the assessment and mitigation process.

Figure 3-1: Assessment and mitigation process flow chart



For the purposes of mitigation assessment, the RMS have provide definitions for closely grouped and isolated receiver locations (part 5 of the evaluation procedure) to assist in the identification of mitigation strategies.

The definition of a closely spaced group of residences is useful as an initial test when locating noise barriers for a project. These receivers are typically characterised by separation distances of less than 20 metres between dwellings. In contrast, residences may also be categorised as isolated single residences or isolated groups of closely spaced residences when considering the implementation of noise barriers.

Receivers in these categories are considered isolated where single residences or closely spaced groups of residences in numbers of three or less are separated from other residences by more than 100 metres. Where individual residences are separated by distances of 50 to 100 metres they may be considered isolated however, this depends on examining the surrounding development more broadly. If the broader development comprises regular placement of residences at 50-100 metres separation then the residences are not considered to be isolated, but are also not considered to be closely spaced.

Where additional assessment of mitigation is indicated by modelling results, the evaluation and calculations of qualifying receiver locations are undertaken using spreadsheet calculations which are presented in **Appendix C.** Any recommendations for mitigation in **Appendix C** must be considered on the basis of practicality and cost of implementation which is commonly referred to as the feasible and reasonable test. In addition, mitigation measures would need to be developed in conjunction with other aspects of the project including urban design and community consultation.

The application of mitigation may be targeted at one or of the following:

- The source- Active reduction at the source of the noise emissions such as reducing vehicle noise emissions, low noise pavements, reduced speed zones.
- The path - Providing a barrier to the source of the emissions, which increases the distance the noise must travel to reach the receiver location. This is achieved by implementing noise walls or mounds between the receiver location and the noise source within the road boundary.
- The receiver - Providing a means of reducing noise emissions into a building's internal environment by applying architectural acoustic treatments. This form of mitigation can also include local (at dwelling) noise barriers to reduce impacts at receiver locations but would require further consideration for suitability on private property.

Of the three forms of mitigation, the source and path options have the potential to benefit a larger number of noise sensitive receivers compared to individual property treatments. Both at source and path mitigation measures benefit the outdoor environment and are therefore the preferred method of noise attenuation for the project. These three types of mitigation treatments are described in more detail below.

At source – low noise pavements

When discussion benefits of low noise pavement, the quoted noise reduction values are always in relation to a known standard, which in this case is Dense Grade Asphaltic Concrete (DGAC). The DGAC wearing surface is considered to be a neutral case whereby a ± 0 dB(A) correction is applied to predicted noise levels. It is important to note that the quoted values for pavement noise benefits are averages based on various studies and can vary between projects and specific site conditions.

Typical benefits for low noise pavements may range from reductions of about 4dB(A) for Open Grade Asphaltic Concrete (OGAC) to improvements of about 2 dB(A) for Stone Mastic Asphalt (SMA). Apart from the examples cited, there are also continuing improvements in pavement technologies that may provide viable options for the project, and would be assessed during detailed design phases as appropriate.

While low noise pavements may benefit affected receivers as well as the wider community, they do have limitations in their application including higher initial expense and ongoing maintenance costs. Low noise pavements are more cost effective when the number of receivers gaining a benefit is highest, which generally occurs where receivers are situated in close proximity to one another. Where receivers are isolated or have large separation distances, as with rural properties, the length of pavement required to offer adequate noise reductions at affected properties increases and the cost of the pavement would increase proportionally.

Low noise pavements have been proposed in certain locations in consideration of the surface durability requirements and as a noise reduction measure for the project and have been identified in **Table 3-2**. The effects of the low noise pavement have been included in the noise modelling for each section as appropriate however, The location and extents of low noise pavement recommended for the project 1 are subject to a cost benefit analysis and would be further investigated and confirmed at the detailed design stage.

Table 3-2 Location of low noise pavements

Location	Station start	Station finish	Length (m)
Section 1, Darlington Park:	200	1600	1400
Section 3, Tyndale:	66,400	68,300	1900
Section 4, Maclean	80,500	82,500	2000
Section 5, Harwood	85,900	88,000	2100
Section 8, Trustums Hill: (The Gap Rd)	127,000	128,000	1100
Section 10, Wardell Rd to Coolgardie interchange	155,400	157,700	2300

Transmission path – noise barriers

In a similar way to the application of low noise pavements, noise barriers must meet minimum operational requirements to remain a cost effective form of mitigation. This is based on the cost of construction and the overall benefit to the local community. Noise barriers are also subject to constructability and aesthetic considerations. The application of a noise barrier as mitigation to traffic noise would generally be reasonable where they meet the following performance criteria:

- Provide a benefit of at least 5 dB(A)
- For noise barriers more than three metres high, provide a benefit greater than 5 dB(A) at the most affected residence
- For barriers which are five metres high or higher, the benefit must be at least 10 dB(A) at the most affected residence

- Noise barriers more than eight metres high are generally considered visually unacceptable

The performance requirements for a noise wall in reducing traffic noise levels comes from the perceived benefit in combination with the degree of difficulty required to achieve the reduction in noise. This effect is demonstrated in **Table 3-3** which compares the reduction in noise level with the perceived benefit and degree of difficulty in implementing.

Table 3-3 Achievable noise reduction values – noise barriers

Noise level reduction	Perception	Degree of difficulty to achieve
Less than 3 dB(A)	Not normally noticeable in the field. Barely perceptible reduction.	Simple
3 to 5 dB(A)	Readily perceptible reduction.	Possible at a cost
10 dB(A)	Very noticeable. 'Half as .loud'.	Difficult and/or expensive
20 dB(A)	One quarter as loud	Almost impossible

The location of noise barriers are initially tested against the above performance criteria. Where a benefit is clearly available, and is determined to be feasible and reasonable, recommendations for mitigation will be made. Additional consideration of noise barrier performance for the project is provided in **Part B**.

At receiver – architectural treatments

Where at source or pathway transmission forms of noise mitigation are not considered practical or cost effective for the project, mitigation of noise impacts at affected dwellings using architectural treatments is recommended. The objective of this form of mitigation is to achieve noise reduction from outside to inside that would achieve an internal noise level within a habitable room at least 10 dB(A) below external noise goals. The type of building treatments applied to achieve these reductions is considered on a case by case basis. All architectural treatments are limited by the practical application of remedial measures such as constructability and cost, and are also considered in consultation with the landowner.

Practice note (iv) of the ENMM identifies that the treatments provided by the RMS would be limited to:

- Fresh air ventilation systems that meet Building Code of Australia requirements with the windows and doors shut
- Upgraded windows and glazing and solid core doors on the exposed facades of masonry structures only (these techniques would be unlikely to produce any noticeable benefit for light frame structures with no acoustic insulation in the walls)
- Upgrading window and door seals
- The sealing of wall vents
- The installation of external screen walls.

The application of the above building treatments requires the assessment of the individual properties to determine the appropriate measures. As a consequence, the cost of undertaking remedial works may vary between properties and is dependent on the level of impact to be mitigated. A discussion of typical building elements and treatment options follows.

- Windows: acoustic performance is controlled by the type of glazing and the use of acoustic/dust seals. High specification glazing offers the best value for noise reduction and thermal transmission options and often forms the main type of building treatments
- Doors are similar in character to windows and are equally important for treatment considerations. Generally the total area of external doors on a building is many times less than the window area and is prioritised accordingly. In the same way as windows, door seals would provide an improvement on the sound reduction properties of a door system
- Ventilation is considered in conjunction with other building treatments as this allows windows to remain closed thereby improving acoustic performance while still allowing fresh air into the building.

In the absence of noise walls or low noise pavements, the properties identified for mitigation for this project would receive one or more of the above forms of building mitigation.

3.2. Construction noise

3.2.1. Project staging

As described in **Chapter 1**, not all sections of the project would be constructed at once, with project staging likely to be comprised of one or more sections. Commencement of construction for any one section or combination of sections would be based on factors such as community benefits (travel time savings and improved safety or amenity), materials management (availability and use of excavated materials) and funding.

For the purposes of project planning and this assessment, the project staging has been assumed to occur in three stages:

- Stage 1 (section 3) – third quarter of 2013 commencement
- Stage 2 (sections 4, 5, 6) – third quarter of 2013 commencement
- Stage 3 (sections 8, 9, 10, 11) – first quarter if 2015
- Stage 4 (section 7) first quarter of 2015
- Stage 5 (section 1, 2) first quarter of 2015

Discrete parts of the project may be delivered as interim stage where this would facilitate more efficient delivery of subsequent works or where an identified need arises. Examples could include utility relocations, foundation treatments, the upgrade of a waterway crossing, fauna crossings, property accesses, local road adjustments or the upgrade of an intersection for safety reasons.

3.2.2. Construction activities

The anticipated construction activities proposed for the project have been identified in detail by the RMS. At this stage construction methods are indicative and may changed during detailed design. The activities assessed for the construction noise and vibration study are identified in **Table 3-4**.

Table 3-4 Summary of construction activities

Soft soil treatments (early and enabling works)	
Fill activities	Bulk earthworks including dumping of fill material, spreading and compaction. Works required to enable the main construction works to be undertaken. These works would be undertaken in specific areas only and not across the entire project corridor.
Formation, clearing and mulch	
Ground clearance	Clearing and grubbing of vegetation and processing of materials (such as timber for milling, use in erosion controls or stockpiling as mulch for use in landscaping and soil stabilisation). These works would be undertaken along the length of the project corridor.
Earthworks	
Earthworks and ground preparation	Excavation of cuttings, including processing, stockpiling or haulage of material, batter stabilisation (such as benching, rock bolting and / or soft seam treatment) and cut foundation treatments such as the installation of rock drainage blankets (where required). These works will be undertaken along the length of the project corridor. For the purpose of the assessment, earthworks does not include blasting as this is to be assessed separately.
Ancillary sites, compounds and concrete batch plants	
Construction compounds including site offices, stockpiles and concrete batch plants	Office activities, deliveries, preparation of services equipment (gantries, lighting rigs etc), equipment repairs, concrete production and dispatch, materials stockpiling. These works will be undertaken across around 90 ancillary sites covering the length of the project corridor. Some lie within the construction boundary whereas others lie at a short distance from the boundary.
Haulage Routes	
Heavy vehicle movements	Hauling fill between compounds, ancillary sites, quarries and work areas. Haul routes will be located between the project corridor and ancillary sites. Where possible, existing routes (including the existing and new alignment) are to be used as haul routes.
Blasting	
Cutting activities – specifically those related to blasting	This will be undertaken at specific cut locations along the length of the project corridor.
Bridge building	

Construction of small scale and large span bridges	Construction of bridges, including foundations (driven and / or bored piles, pile caps and pad footings), bridge abutments, bridge piers and pile caps, bridge superstructure (including bearings, girders, deck and parapets) and miscellaneous works such as deck water proofing, asphalt surfacing and the installation of bridge railings and anti-throw screens. There are approximately 15 bridges over 100m in length.
Paving and Asphalting	
Road Surface Construction	Laying of road surface including road cutting/milling, concreting, asphalt laying, rolling. These works will be undertaken along the length of the project.

For the purpose of the construction noise assessment, each of these activities has been considered separately to identify specific impacts associated with the woks. Where there is potential for simultaneous construction activities to occur, these have been assessed qualitatively. For the purpose of this assessment, construction works undertaken along the project corridor such as earthworks, formation and clearing and paving and asphalting will be referred to as 'linear construction works'.

3.2.3. Construction noise modelling and prediction

The noise emissions associated with each of the activities outlined in **Table 3-4** have been used to predict noise levels at each of the representative residential and commercial receivers within the 600 metre study area. Noise predictions have been undertaken in SoundPLAN (see **Section 3.2.3**).

Potential construction noise impacts were modelled at each sensitive receiver using the CONCAWE algorithm with the equipment outlined in **Section 3.2.3** positioned in likely operating areas to provide a reasonable prediction of noise impacts from construction activities. Noise emissions from individual plant items have been corrected for usage percentages; however as the ICNG assessment period is 15 minutes, the correction is often minimal.

Predictions incorporated shielding provided by existing topography; however buildings were not included in the noise model, with free-field point receivers at 1.5 metres height assumed. As such, the predicted noise levels should be seen as likely maximum impacts, particularly in built up areas where buildings would provide considerable screening of construction noise.

The construction noise models utilised the existing terrain along the project corridor, without future cuttings since this represents a conservative assessment. As construction works progress, cuttings are likely to reduce the noise emitted from certain activities.

Meteorology used in the assessment has been assumed to be adverse, with a light (two metres per second) breeze blowing from source to receiver. Night-time stability characteristics were assumed, i.e. temperature inversion. These weather conditions are likely to increase predicted noise levels at receivers located in excess of 500 metres from the noise source when compared to neutral weather conditions.

Although the equipment types and numbers would vary in practice, the modelling scenarios provide a suitable indication of the likely magnitude of noise impacts where construction activities are undertaken in close proximity to residential areas. A summary of modelling parameters is set out in **Table 3-5** with the plant specifications for each activity defined in **Section 3.2.3**.

Table 3-5 Summary of modelling inputs

Input variable	Modelling parameters
Construction equipment	As set out in Table 3-6
Receiver locations and land use	All identified residential properties located within 1 km of an early work site, identified through aerial photography
Ground topography	Large scale topography was generally sourced from previous environmental assessments and modelling was undertaken using best available terrain data.
Air and ground absorption	Ground surfaces were assumed as soft, and absorption as per SoundPLAN implementation of the CONCAWE algorithm
Height of receivers	1.5 m above ground terrain
Meteorology	Source-to-receiver breeze of 2 m/s and F-Class stability (3°C/100 m inversion)

The noise predictions for each construction activity will be assessed against NMLs for each section and, where impacts are unacceptable, mitigation measures and noise management procedures will be recommended. The NMLs have been derived from the baseline noise monitoring within the study area. It is impractical for monitoring to be performed at all locations so receivers have been grouped into noise catchment areas (NCAs) (see **Appendix B** for graphical presentation of NCAs). The noise environment at each of the receivers within a NCA is considered to have a similar noise environment to the unattended monitoring location within that NCA. As such each of these receivers is assigned the same RBL and NML.

The model noise emissions are based on a range of emission values from similar large infrastructure projects, *Australian Standard 2436 Guide to noise and vibration control on construction, demolition and maintenance sites* and other government-generated noise level databases. **Table 3-6** summarises the likely equipment to be used for each stage of construction and the achievable source sound power levels for plant items. The range and types of equipment used may be subject to change and would be confirmed during the detailed design phase. The table also identifies the modelling method used to predict noise levels.

Table 3-6 Proposed equipment and associated sound power levels (per area of works)

Activity	Plant noise source	L_{Aeq} Sound power level dB(A)	Modelling details
Site enabling works (soft soil treatments)	2 x Excavator – 30t 1 x Dozer – 20t 18 x Product truck - 4 axle, 25t 2 x Vibratory compactor - 12t 1 x Padfoot compactor 1 x Grader – 25t 1 x Smooth barrel roller – 18t 1 x Watercart – extracting water	103 103 108 112 107 114 107 107	Modelled as single point source at shortest separation to receivers taking account of plant operating duration.
Formation, Clearing and Mulch	2 x Excavator – 30t 1 x Dozer – 20t 18 x Product truck - 4 axle, 25t 2 x Vibratory compactor - 12t	103 103 108 112	Modelled as single point source at 25m intervals along project corridor with highest level at each receiver reported, taking

Activity	Plant noise source	L_{Aeq} Sound power level dB(A)	Modelling details
	1 x Padfoot compactor 1 x Grader – 25t 1 x Smooth barrel roller – 18t 1 x Watercart – extracting water 1 x Mulcher 1 x chipper	107 114 107 107 108 109	account of plant operating duration.
Earthworks	2 x Excavator – 30t 2 x Dozer – 20t 18 x Product truck - 4 axle, 25t 2 x Vibratory compactor - 12t 1 x Padfoot compactor 1 x Grader – 25t 1 x Smooth barrel roller – 18t 1 x Watercart – extracting water 1 x Backhoe 2 x Front End Loader 2 x Scrpaer	103 103 108 112 107 114 107 107 110 114 108	Modelled as single point source at 25m intervals along project corridor with highest level at each receiver reported, taking account of plant operating duration.
Paving and Asphalting	2 x Generator 2 x Backhoe 1 x Asphalt Paver 1 x Concrete Paver 1 x Concrete Truck 1 x Concrete Vibrator 2 x Concrete Saw 1 x Road Miller 2 x Bob Cat	111 110 111 111 111 110 105 115 104	Modelled as single point source at 25m intervals along project corridor with highest level at each receiver reported, taking account of plant operating duration.
Bridge Works	1 x Impact Piling Rig 1 x Bored Piling Rig 1 x Pneumatic Hammer 1 x Excavator 3 x Haul Trucks 2 x Generator 2 x Mobile Crane (45T) 1 x Concrete Truck 1 x Concrete Pump 2 x Air compressor 1 x air ratchet gun	121 114 113 112 112 111 105 110 107 105 101	Modelled as single point source at 10m intervals along bridge work boundary with highest level at each receiver reported, taking account of plant operating duration.
Haul Roads	25T Haul Trucks (various numbers)	108	Modelled as various point sources along haul road length, taken account of road length, assumed truck speed and truck Sound Exposure Level (SEL)
Ancillary Sites – Stockpiles	1 x Excavator – 30t 1 x Dozer – 20t	103 103	Modelled as area source from sum of all sound power of all plant

Activity	Plant noise source	L_{Aeq} Sound power level dB(A)	Modelling details
	2 x Product truck - 4 axle, 25t 1 x Watercart –(water bowser) 1 x Backhoe 2 x Front End Loader	108 107 110 114	operating, taking account of plant operating duration.
Ancillary Sites – Concrete Batching Plant	Batch Plant	120	Modelled as area source from sum of all sound power of all plant operating, taking account of plant operating duration.
Ancillary Sites – Site Offices	Office vehicles	-	Construction activity noise not anticipated.
Ancillary Sites – Plant Workshop	1 x Product Truck – 4 axle, 25T 1 x Front End Loader 2 x Fork Lift Trucks 3 x Powered hand tools	108 114 101 115	Modelled as area source from sum of all sound power of all plant operating, taking account of plant operating duration.

3.2.4. Proposed construction hours

To minimise the extent and degree of construction impacts, including noise and traffic delays related to the project, RMS is proposing to operate for two additional hours each weekday and four additional hours on Saturday for the duration of the project. The additional 14 hours of work per week has the potential to reduce overall construction works by up to 12 months and therefore allow restoration of amenity to the community a lot quicker. In addition the project has been identified as a State significant, critical infrastructure project and therefore all avenues to undertake and complete the project on time are to be investigated.

By reducing the overall build time and construction duration, these extra hours would provide substantial longer term benefits to the community adjacent to the project corridor as well as the through-traffic that uses the existing highway on a daily basis.

The proposed construction hours for the project are:

Monday to Friday – 6am to 7pm

Saturday – 8am to 5pm

Sunday and Public Holidays – no work

As these extended hours are proposed for the duration of the project, they will be referred to as the **'proposed hours''** for the remainder of the report. The adoption of the proposed hours for the project would be based on broad community acceptance and negotiation with potentially affected receivers. While the canvassing of all identified noise sensitive receivers is not possible prior to approval of the project, this report has identified methods for seeking community feedback during the project inception (see **Section 3.2.5**).

To provide an assessment of the proposed hours, the consideration of background noise levels outside the daytime period is required. Only one hour of each of the adjacent assessment periods is to be assessed and these are termed shoulder periods (6am-7am & 6pm-7pm Mon-Fri). Information outlined in the ICNG guidance does not provide a firm method of setting an NML for the shoulder periods; however, the application notes for the INP provides methods for assessing noise during these periods.

Deriving project-specific NML for the proposed hours involves the derivation of RBL for the shoulder periods from 6 am-7 am and 6 pm-7 pm in addition to the standard hours of 7 am-6 pm. The lowest of these three RBLs has been adopted for the entire proposed hours providing the most conservative and administratively simple NML. Saturdays fall under the nominal RBL values for a given location and the additional hours would be included within the existing daytime definition.

3.2.5. Proposed Hours Community Consultation

In order for the proposed hours to be applied for the duration of the project, community consultation would be required. Part 2.3 of the ICNG indicates that construction activities may be undertaken outside of standard hours for:

- public infrastructure works that shorten the length of the project and are supported by the affected community

Justification during the EIS stage of the project would be demonstrated with a campaign of community consultation to document opinion and provide options or alternatives in some instances. The graphic risk assessment should be used to provide initial information for this work.

The consultation strategy would follow a format similar to the method outlined below; however more detail of this process is presented in *Section 7 of the Working Paper Community Consultation.*

The community consultation would include the following aspects:

- Receivers potentially impacted up on by construction activities to be identified through EIS construction noise assessment. These will be based on the impact predicted as a result of the adopted hours.
- Identified receivers to be notified by letter of the proposed hours and asked for comment and feedback. This should include justification for the proposed hours along with the benefits to which the community can expect.
- Where the community or individual residents wish to receiver further clarification on the proposed hours, individual interviews or public meetings should be organised to address any further issues. Discussions should be sufficiently detailed to provide a general summary of the expected impacts but also how this relates to individual receivers. At this stage more detail should also be available as to the proposed construction activities to be undertaken in the extended hours.
- Property owners should also be provided with the complaints management procedures that will be in place during the works
- Collation of feedback should assist with determining the final adopted working hours for the project, with the community consultation ongoing throughout the project.

3.2.6. Out of hours works (beyond proposed hours)

Project construction works are expected to be undertaken during proposed hours; however major infrastructure projects require night time or out of hours work to be undertaken for health and safety reasons or construction requirements. Generally, out of hours works are considered reasonable where the works are inaudible at the nearest or most affected receiver locations. Sometimes out of hours works would have a noise impact associated with the activity.

Works and activities that may be undertaken outside the standard hours and have some level of noise impact include:

- Bridge works – where bridges are located or proposed for the existing alignment there is a potential that these works will need to be undertaken outside the proposed hours, including lifting and setting of bridge spans to reduce potential delay or impacts on existing traffic.
- Road tie-in works – The tie-in of the proposed upgrade with the existing road network may be required outside standard hour to minimise traffic disruption.
- The delivery of oversize elements of plant and large construction equipment.
- Emergency work.
- Public infrastructure work associated with the project.
- Utility adjustments – Where utility renewal or movement is required from the existing alignment, health and safety may dictate that traffic must be stopped. Doing so outside proposed hours may reduce the impact on traffic.
- Major traffic diversions, including full or partial road closures of the existing highway.
- Other works that are required outside standard hours and are approved by OEHEPA.

Due to the nature of these works and the scale of the project, it is not possible to accurately investigate and assess the impact of each out of hours activity. To provide information on the potential impacts for these works, a preliminary assessment has been prepared to identify potential areas of impact for construction activities when undertaken outside of proposed project hours. Once the details of specific of out of hours works are confirmed during construction, further assessment in accordance with the project requirements would be necessary. Indicative measures that are likely to be requirement in order to facilitate these hours are provided for the project.

The preliminary assessment is based on the activities identified in **Table 3-4** and the plant in **Table 3-6**

In practice, the scale of works is likely to be reduced during the night period and therefore this assessment may overstate the impacts in some instances.

The method provides a graphical indication of the likely impact, to indicate where out of hours works could be undertaken with minimal impact. However this does not necessarily mean that out of hours works would be undertaken in these areas, but purely an indication of impact. Where high impacts are predicted, and out of hours works are deemed necessary, targeted consultation and notification can be undertaken at the identified receivers.

In order to quantify the level of impact a risk matrix has been developed, which assigns a value for each stage of the works and categorises the risk level based on a comparison with the NML or the ICNG 'highly noise affected' criterion of 75dB(A). **Table 3-7** presents the out of hours risk matrix and indicates the level of impacts predicted. **Table 3-8** indicates the areas where out of hours works would be suitable, and what measures would be required to facilitate the works.

Out of hours works have the potential to be undertaken during both evening and night time periods, for up to 24 hours at a time. NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A).

Table 3-7 Out of hours risk matrix for impact

	Predicted noise levels			
	<(NML – 10)	(NML – 10) to NML	NML to (NML+5)	>(NML + 5)
	No Impact	**Low Impact**	**Moderate Impact**	**High Impact**
No Impact	Closest out of hour construction works predicted to be inaudible			
Low Impact	Construction levels equal to the out of hours NML are unlikely to cause significant disturbance to the majority of receivers, particularly for short term works.			
Moderate Impact	Levels exceeding the lowest out of hours NML by up to 5dB(A) would be perceptible by the majority of receivers. The impact will be greatest in highly populated areas. Where areas are less populated, the potential for mitigation is more achievable and therefore impacts may be mitigated.			
High Impact	Levels exceeding the lowest out of hours NML by more than 5dB(A) would be perceptible by almost all receivers. Receivers exposed to this magnitude of impact are likely to be significantly affected and potential for adverse community reaction is almost certain.			

Table 3-8 Out of hours risk matrix for identification of suitable work areas

Area classification	Requirements
Unrestricted	Closest out of hour construction works predicted to be inaudible and therefore work area is suitable for out of hours works without undertaking any specific consultation, assessment, management or mitigation measure.
Restricted with consultation	Area is suitable for out of hours works with consultation/notification at the nearest noise sensitive receivers. Implementation of all feasible and reasonable mitigation measures.
Restricted with further assessment and consultation	Out of hours construction works may be suitable for these areas, where reasonable justification can be made for their requirement. A detailed noise assessment and suitable targeted community consultation/notification will be required. This may result in the implementation of appropriate feasible and reasonable mitigation and management measures.
Highly restricted	Typical construction works are unlikely to be suitable for these areas for all but the most essential of works, i.e. one of the following: - Health & safety requirements - Work required by emergency services

Area classification	Requirements
	- Works required on existing highway where total road closures are required - Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm - Where prior agreement is provided from landowners (i.e. negotiated agreements) - For technical activities where works cannot be undertaken within the proposed hours of a single period i.e. 24 hour concrete pours within the project. It should be noted that even in the above circumstances, strong justification for the works would be required along with community consultation and implementation of mitigation/management measures.

As stated above, the results of the out of hours assessment have been translated to a graphical format for each section of the project, which presents the location and level of predicted impact and the associated section of the project corridor relating to the noise impact. The following considerations are included in the presentation of the graphical assessment of impacts:

- Linear construction works and ancillary sites such as bridge works have been predicted at all receivers within 600 metres of the proposed upgrade
- The study area is split into a grid of 200 metres x 200 metres
- The predicted noise levels from each of the project activities at each receiver location is assigned a value of No, Low, Moderate or High Impact based on a comparison with the NML as per the matrix in **Table 3-7**
- This impact has been transposed onto the alignment to identify potential out of hours work areas.

The graphical output of the assessment has been undertaken for paving and asphalting to present a mid range level of impacts of noise associated with the linear works. Paving and asphalting includes the use of concrete saw cutting and road milling. Earthworks will typically have a greater impact, with clearing and formation resulting in a lower impact.

The graphical output is displayed in **Appendix B** with a discussion of the out of hours assessment presented in each of the 11 sections assessed in **Part C** of this report.

Where linear works are proposed to be undertaken out of hours, there is a potential that ancillary facilities will also operate out of hours to support the linear works. Within Part C of the report, out of hours ancillary facility operations have also been assessed.

3.2.7. Out of hours community consultation and notification

Where out of hours works are proposed, and there is a potential that the community will be exposed to some form of resultant noise impact a consultation/notification exercise would be undertaken with the affected community. The level of consultation or notification would be dictated by the level of impact, scale of works, number of receivers impacted and the duration of the proposed works. The consultation or notification exercise would be undertaken with reference to the NSW ICNG, which in brief advises the following:

- engagement with affected land users when deciding about the aesthetic or other impacts of work practices/abatement measures
- early community consultation to identify practices/ mitigation measures with majority support from the affected community.
- Provide, reasonably ahead of time, information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur.
- For works outside standard hours, inform affected residents and other sensitive land use occupants between five and 14 days before commencement.
- Provide information to neighbours before and during construction through media such as letterbox drops, meetings or individual contact. In some areas, the proponent will need to provide notification in languages other than English. A website could also be established for the project to provide information.
- Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, hours of operation and regular information updates. This signage should be clearly visible from the outside and include after hours emergency contact details.
- Maintain good communication between the community and project staff.
- Appoint a community liaison officer where required.
- For larger projects consider a regular newsletter with site news, significant project events and timing of different activities.
- Provide a toll-free contact phone number for enquiries during the works.
- Facilitate contact with people to ensure that everyone can see that the site manager understands potential issues, that a planned approach is in place and that there is an ongoing commitment to minimise noise.
- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

3.2.8. Cumulative noise impacts

Simultaneous section/stage works

Although simultaneous construction staging of sections may occur (as per the five stages) the likelihood of these having a significant cumulative impact is minimal as the noise associated with linear works will be the dominant construction noise and is modelled within each section. Minor cumulative impacts may be seen at receivers which are located close to the end or beginning of a section and where this is identified, the cumulative impact will be looked at. The cumulative impacts associated with concurrent constructions activities within different sections is only likely to occur where there are non-linear works (bridge building, ancillary site operations and blasting) undertaken at the boundary between sections. The nature and method for modelling the noise associated with the construction of the linear alignment works is such that the assessment already takes account of the progressive nature of works. Cumulative impacts of neighbouring sections will also be reliant on adjoining sections being staged at the same time.

External projects

During the proposed construction period 2013-2015 the details relating to external construction works is limited. This makes the assessment of cumulative impact from such projects on this project difficult and highly indicative. For this reason the cumulative impact from this project and external projects has only been undertaken where detailed information is available and has been provided. In addition to this, only a qualitative assessment will be undertaken with a detailed assessment being required at detailed design following confirmation of construction techniques and staging. An over view of known projects is presented in

Table 3-9 Overview of external projects in close proximity to study area

Location	Potential impacts (assuming a staging scenario as described in the Submission to Infrastructure Australia, Pacific Highway upgrade, NSW Government, November 2011).
Arrawarra	Section 1 of the project would not start until Q1 2015. The Sapphire to Woolgoolga upgrade in construction to the south of Arrawarra is scheduled to finish in early 2014. Assuming these dates are met, it is unlikely there would be cumulative works near the tie in point. A tie-in with the interchange at Arrawarra would connect the Sapphire and Woolgoolga to Ballina projects. However, should Section 1 of the project start sooner than 2015, construction work for the Sapphire and Woolgoolga to Ballina projects could run together. If this is the case, there could be cumulative noise impacts near Eggins Drive, north of the interchange at Arrawarra.
Tyndale	Tyndale is located at the connection point between Section 3 and Section 4 of the project at STN 68.8. Both these sections are scheduled to start in Q3 2013. Therefore, cumulative noise issues from Section 3 and 4 works are possible north and south of the interchange at Tyndale.
Southern end of Devils Pulpit	The northern end of Section 6 of the project would tie-in to the southern end of the Devils Pulpit upgrade around STN 105.6. This is currently in construction. Assuming the Devils Pulpit upgrade is completed in mid 2013 (weather permitting), and Section 6 starts in Q3 2013, there could be a short overlap. This overlap could be longer if the Devils Pulpit upgrade finishes later than planned, and should Section 6 enabling works start early.
Northern end of Devils Pulpit	The northern end of the Devils Pulpit upgrade would tie-in to the southern end of Section 7 at STN 111.1. Section 7 is not scheduled to start until Q1 2015. As the Devils Pulpit upgrade is likely to be complete by this time, cumulative noise impacts are unlikely.

Location	Potential impacts (assuming a staging scenario as described in the Submission to Infrastructure Australia, Pacific Highway upgrade, NSW Government, November 2011).
Woodburn	Section 8, 9, 10 and 11 of the project are scheduled to start in Q1 2014. Therefore, Section 8 and Section 9 works, which are adjacent to each other, could happen at the same time. However, Woodburn is about 1.1 kilometres to the west of Section 8 of the project. This separation distance suggests cumulative noise impacts from construction works within the project boundary are not likely to affect Woodburn residents. There could, however, be construction vehicles travelling along the existing Pacific Highway to Section 8 and 9 of the project.
Ballina	Section 11 of the project is scheduled to start in Q1 2014. A tie-in to Ballina bypass is required around STN 164.0. The Ballina bypass has recently opened and so works will have finished by the time Section 11 starts. Therefore, cumulative noise impacts from these two neighbouring projects are unlikely.

Existing road traffic noise and construction

It should also be noted that the assessment only quantitatively assesses the cumulative impact of known construction noise. The cumulative impact of the noise from the construction works and the noise associated with existing road traffic noise has been predicted and qualified where appropriate but assessment in terms of absolute criteria has not been quantified.

As the main contributor to existing background noise at the majority of unattended monitoring positions is road traffic, particularly where the proposed upgrade does not deviate significantly from the existing alignment, the NML used for receivers already takes account of road traffic noise. Although the L_{A10} indices is usually used to account for the road traffic contribution at a measurement site, where the traffic noise is regular and dominant, the difference between $L_{A90,}$ L_{A10} and L_{Aeq} is smaller with the L_{A90} consisting primarily of traffic noise.

In order to provide some form of assessment to allow for worst case noise, it can be assumed that where predicted construction noise is equal to the proposed hours NML, there will be no cumulative impact as a result of existing highway traffic noise. Where construction predictions are less than the NML, in most cases the traffic noise will be the dominant noise source in the area or construction and traffic will contribute proportionally.

Therefore traffic noise will only increase construction noise levels when the NML is not exceeded, and in theory the worst case increase as a result of road traffic noise and construction noise would be 3dB(A) (i.e. addition of NML + “construction noise equal to NML” is equivalent to 3dB(A)).

For areas where road traffic noise is not the main contributor to the background noise, the cumulative impacts associated with existing alignment traffic noise and construction noise will be negligible as the construction noise will be more than 10dB(A) above existing alignment noise, therefore having no effect on construction noise levels.

3.2.9. Construction road traffic noise

The NSW Roads Noise Policy (RNP) does not provide a direct reference to the assessment of road traffic noise resulting from construction activities. As such, where construction traffic uses newly built haul roads, this will be assessed against the NMLs set out for general works. Where construction traffic utilises the existing road network or the existing alignment, in the absence of specific routes to and from the project area, it will be assumed the traffic numbers will be sufficiently small that they are absorbed into general traffic numbers.

In general, an increase in traffic numbers of at least 25per cent, or decrease by 20 per cent is required to change the noise level by 1dB(A). Therefore the noise associated with construction traffic along existing roads will not be quantitatively assessed. Once routing to and from the site has been confirmed, a more detailed assessment of associated noise may be required prior to the commencement of the construction phase.

Haulage of materials from stockpile sites to the alignment will generally be undertaken without the need for specifically built haul roads.

Confirmation of the source of imported materials is unlikely to be finalised until commencement of construction and as such the haul routes used for travel between external quarry sites and the construction area cannot yet be identified. However, the number of haul trucks moving between external sites and the construction area are not likely to be high enough to add to existing road traffic numbers that would generate significant noise increases.

In a similar way where haul trucks use the new formation/alignment, the truck numbers will be at such a level that these will not add to the noise associated with other construction activities within the area. Noise from the haul truck movements will blend in with general activities such as earthworks, ground clearance and asphalting. Therefore a quantitative assessment of haul trucks would only be undertaken in this report where a completely new haul road is constructed.

3.3. Construction vibration

3.3.1. Assessable activities

Ground-borne vibration tends to attenuate substantially over short distances. Therefore, only significant sources of vibration are likely to have an impact of nearby receivers. In particular, the vibration associated with pile driving, blasting and rock hammering/breaking should be considered and have been assessed in this report. Blasting is addressed separately in **Section 3.4.3**.

It is assumed that the main source of piling will be as a result of bridge construction and that piling will occur during the construction of each bridge. Although pile driving and other vibration activities will potentially occur at other areas along the route, this cannot be identified in detail at this stage. Therefore piling associated with bridge works will be the only source of vibration assessed quantitatively in this study.

The locations of rock hammering have not been nominated. The vibration associated with rock hammering has been predicted in generic terms and qualified in terms of potential impact.

For the purpose of assessment, predictions have been made for the propagation of ground borne vibration from the piling at a bridge site across the surrounding area. The output of the predictions will be graphically presented to highlight receivers which are potentially at risk and where an additional detailed assessment will be required prior to works. Where receivers are located within a high risk area, either as a result of structural damage criteria exceedance or human comfort criteria exceedance, the risk of both structural damage and impacts on human comfort will be quantified and possible mitigation measures identified.

3.3.2. Generic vibration wave propagation

In order to predict and assess the impact of bridge piling on surrounding receivers, the generic propagation of vibration waves resulting from different piling methods has been predicted based on generic pile drive types, worst case locations, uniform geology between source and receiver and uniform wave propagation.

The predictions used empirical formulae and file data from previous assessments to predict velocity (PPV) at given distances and then, using these predictions and assumptions in terms of work durations, acceleration and Vibration Dose Values (VDV) have been produced.

Table 3-10 to **Table 3-12** provide predictions of the wave propagation associated with different types of piling rigs and the activity of rock hammering. This identifies the vibration level prediction in terms of velocity (PPV) and the associated VDV. The VDV is calculated from the acceleration (converted from PPV using assumed frequency character) and based on an assumed total duration of any one vibration activity (time for which the vibration is actually produced). The total duration of vibration has been set at 2 hours in any working day. Given the stop start nature of piling works and rock hammering this is potentially an over estimation of time. It equates to the setting of up to 30-40 piles in a single day.

Table 3-10 Typical maximum vibration levels from rock hammering

Activity	Comment on vibration impacts						
Rock breaking	Typical rock breaking vibration levels are summarised below for increasing distance from the activity.						
		PPV vibration level (mm/s) at distance (m)					
	Distance from activity (m)	5	10	20	30	40	50
	Heavy rock hammer (1.5 t)	4.5	3	1.5	0.4	0.35	0.3
	Medium rock hammer (0.6 t)	0.2	0.06	0.02	0.01	-	-
		Estimated Vibration Dose Value					
	Heavy rock hammer (1.5 t)	2.9	1.9	1.0	0.3	0.2	0.2
	Medium rock hammer (0.6 t)	0.1	0.0	0.0	0.0	-	-

Table 3-11 Typical maximum vibration levels from concrete piling

Activity	Comment on vibration impacts						
Concrete Impact Piling	Typical concrete piling vibration levels are summarised below for increasing distance from the activity.						
		PPV vibration level (mm/s) at distance (m)					
	Distance from activity (m)	5	10	20	30	40	50
	Concrete Impact Piling Rig	21	9	3	2	1	0.2
		Estimated Vibration Dose Value					
	Concrete Impact Piling Rig	3.2	2.1	1.1	0.35	0.26	0.18

Table 3-12 Typical maximum vibration levels from vibratory sheet piling

Activity	Comment on vibration impacts						
Vibratory Sheet Piling	Typical rock breaking vibration levels are summarised below for increasing distance from the activity.						
		PPV vibration level (mm/s) at distance (m)					
	Distance from activity (m)	5	10	20	30	40	50
	Vibratory Piling rig	17	7	2.5	1.5	0.8	0.1
		Estimated Vibration Dose Value					
	Vibratory Piling rig	3.08	2.05	1.05	0.33	0.24	0.16

Using the predictions in **Table 3-10** to **Table 3-12** a risk matrix has been developed based on the activities and potential separation distances. This will be used to identify the risk of structural damage or risk to human comfort based on each activity for each proposed bridge location. The rock hammering data will be used to undertake a general qualitative assessment across the project.

Where an amber or red risk is identified at receivers, it will be recommended that an additional detailed assessment will be undertaken prior to commencement of the works. This would confirm exact source locations and schedule of works.

Table 3-13 Vibration risk matrix – Structural Damage

Activity	Lowest adopted criteria*	Separation distance from receiver / m					
		>50	40	30	20	10	5
Rock Hammering	3mms^{-1}	0.3	0.3	0.4	1.5	3	4.5
Concrete Impact Piling	3mms^{-1}	0.2	1	2	3	9	21
Vibratory Sheet Piling	3mms^{-1}	0.1	0.8	1.5	2.5	7	17

*Notes: Red indicates high risk of structural damage, amber indicates moderate risk, green indicates no risk. *Taken from heritage structural intermittent vibration damage criteria*

Table 3-14 Vibration risk matrix – Human Comfort (Daytime)

Activity	Lowest adopted criteria*	Separation distance from receiver / m					
		>50	40	30	20	10	5
Rock Hammering	0.2mms$^{-1.75}$	0.1	0.2	0.3	1.0	1.9	2.9
Concrete Impact Piling	0.2mms$^{-1.75}$	0.19	0.3	0.40	1.4	2.5	4.8
Vibratory Sheet Piling	0.2mms$^{-1.75}$	0.16	0.24	0.33	1.05	2.05	3.08

*Notes: Red indicates high risk of human disturbance, amber indicates moderate risk, green indicates no risk. *Taken from intermittent human comfort criteria*

Other sources of construction vibration include vibratory rollers and compactors. However the associated vibration from these is, in the main, more localised that the vibration experienced with piling and rock breaking. In addition the location of such activities is unlikely to be confirmed until construction and therefore an accurate assessment of the associated impacts is not possible or practical. Following approval, it is proposed that where vibrators rollers or compactors are confirmed for use within the project, an assessment of the potential vibration impacts on the community would be undertaken.

3.3.3. Blasting assessment

Blasting can result in impacts on nearby receivers due to:

- Air-blast overpressure - an air pressure wave that is generated by explosive movement of rock and gases at the triggering of a blast and is transmitted through the air
- Ground-borne vibration - generated at the moment of the blast and transmitted through the ground. The effects of vibration can be divided into three main categories:
  - Occupants or users of the building are disturbed or inconvenienced
  - The building contents may be affected
  - The integrity of the building or the structure itself may be prejudiced

Blasting will be primarily restricted to cuttings within the corridor. The activities associated with blasting, such as blasthole drilling, rock bolting, rock hammering and crushing are taken into account, in terms of noise impact, during other linear activities. RMS has identified several cuttings; however the nature of the blasting has not been detailed.

In order to provide an indication of the risks associated with blasting, a generic assessment looking at the number of receivers affected by different blast charges has been undertaken. Based on empirical formulae for the propagation of vibration and overpressure, the minimum separation distance between the blast site and receivers has been determined. The predictions forof blasting risk do not take account of site specific geology and therefore in all but the lowest of risk sites, a detailed blasting assessment will be required prior to undertaking the works.

It is important that the actual buffer distances associated with this project are identified and appropriate measures taken to limit overpressure and vibration to acceptable levels at critical locations. In addition, overly conservative estimates can increase the number of blasts required and can unnecessarily prolong the blast program. Blast charge and blast configurations must therefore be selected to ensure that objectives outlined above are not exceeded while maximising the material removal at a site.

The estimated maximum instantaneous charges (MIC) that should result in acceptable overpressure and vibration levels at increasing distances from a blast have been determined using formulae outlined in Australian Standard 2187.2-1993, applicable to free-face blasting in 'average field conditions' which state:

Ground-borne vibration as PPV, mm/s: $$V = 1140\left(\frac{R}{Q^{1/2}}\right)^{-1.6}$$

Overpressure in pascals: $$P = K_a\left(\frac{R}{Q^{1/3}}\right)^{-1.45}$$

Where:

R = distance between charge and point of measurement in metres
Q = effective charge mass per delay or maximum instantaneous charge in kilograms
K = site constant between 10 and 100 for confined blasts

The predictions listed in **Table 3-15** provide an indication of acceptable blast sizes, however nominated Maximum Instantaneous Charges may vary significantly depending on the geological conditions, local shielding and meteorological factors at the site. Therefore it is recommended that trials be undertaken to determine site specific blast response characteristics, and ensure that the vibration and overpressure objectives can be met.

Table 3-15 Summary of typical MIC and compliant separation distance

Criteria		Charge separation distance / m					
		1kg	5kg	10kg	15kg	20kg	25kg
Over pressure	Residential	175	290	375	440	490	530
	Commercial	80	138	172	190	220	230
Vibration	Residential	29	66	94	115	133	149
	Commercial	11	24	34	42	48	54

3.3.4. Construction mitigation

Where exceedances of the project NMLs, in terms of noise, or adopted construction criteria for vibration and blasting activities have been predicted, suitable mitigation measures would be recommended.. Each Section assessment will comprise of Sectionection and dwelling specific mitigation measures. In addition, below is a list of generic measures which are recommended for the project. In addition to this, prior to commencing construction, a Construction Noise and Vibration Management Plan (CNVMP) and Blast Management Plan would be prepared. These documents would detail how work is to be carried out to minimise the impacts of noise and vibration on adjacent properties. Details of project specific mitigation measures are provided in Appendix I.

Construction noise mitigation

Measures to reduce potential construction noise impacts could include general controls such as:

- Compliance with standard construction hours: 7am – 6pm (Monday-Friday), 8am-1pm (Saturday) and at no time Sundays and public holidays, unless otherwise approved through a CNVMP approved by the Department of Planning. Although proposed hours are sought, by adopting standard hours the potential for noise impacts is reduced
- Notifying the nearest noise receptors of the works plan and expected levels of noise well in advance of the works occurring, and responding to residents comments when planning construction timetables
- Construction timetabling to minimise noise impacts - this may include time and duration restrictions and respite periods, and should be considered after consultation with affected receivers
- Where reasonable and feasible, locating haulage routes as far away as possible from residential receivers
- Where possible, avoiding using noisy plant simultaneously and/or close together. This should include equipment operating at separate early work sites to avoid cumulative noise impacts
- Orienting equipment and excavation work sites where possible to reduce noise emissions to sensitive receivers
- Maintaining equipment in efficient working order
- Using quieter construction methods where required and where considered reasonable and feasible. This may include grinding, rock splitting or terrain levelling instead of hydraulic rock breaking where it is reasonable and feasible
- Where acceptable from an Occupational Health and Safety perspective, using quieter alternatives to reversing alarms (such as spotters, closed circuit television monitors and 'smart' reversing alarms), particularly during night time activities
- Dealing promptly with all noise complaints received. Construction methodologies may need to be altered to reduce noise impacts at the affected locations
- Machinery would not be turned on prior to the work hours outlined above. This would include the daily maintenance activities and/or 'warming up' of engines
- Truck movements would be restricted to identified haulage routes and the routes outlined in the Construction Traffic Management Plan
- Where it has been identified as necessary (eg in response to community complaints), noise monitoring would be undertaken to check that the noise mitigation measures are effective

- After community consultation, the use of temporary noise shielding should be considered at locations where substantial exceedances of noise criteria are predicted.
- Concentrated noise sources, such as site compounds and batch plants will be located as far as possible from sensitive receivers
- Regular noise measurement surveys to monitor compliance of construction activities with the guidelines to should be undertaken during the project proposed construction hours and at a representative receiver locations
- The selection of plant and equipment would be based on noise emission levels. This equipment would be operated and maintained so that noise emissions are minimised

Further construction noise mitigation methods are contained in Tables 4 to10 of the *Interim Construction Noise Guideline* (DECC, 2009) and Table 5.1 of the RMS Environmental Noise Management Manual (RTA, 2001).

Construction vibration mitigation

Given the proposed construction methodologies and the separation distance between work areas and sensitive receivers, vibration is considered unlikely to impact human comfort levels or building integrity; however where infrastructure and buried services are located in close proximity to vibration inducing activities, the following mitigation measures would be considered:

- Where piling, hydraulic hammering or dynamic compaction is proposed within 20 metres of any structure or service, a building condition survey would be conducted and preliminary vibration monitoring undertaken by a qualified contractor
- Where piling, hydraulic hammering or dynamic compaction is proposed within 30 metres of any heritage structure or potential structurally unsound service, a building condition survey would be conducted and preliminary vibration monitoring undertaken by a qualified contractor. A follow up survey would be conducted in response to any vibration complaints
- Appropriately sized equipment would be selected in order to minimise vibration emissions where required.

Construction blasting mitigation

The impacts of blasting are not able to be predicted without detailed blasting plans, including charge size, rock characteristics, spacing and burden thickness. As such further assessment will be required when specific blasting parameters are determined. General measures to reduce potential vibration and overpressure impacts from blasting are outlined below:

- A Blast Management Plan would be prepared prior to the start of construction
- Blasting must be avoided to the maximum extent possible

- Where sensitive receivers are located in close vicinity to the blast site, a series of trials would be undertaken at a reduced scale to determine site specific blast response characteristics, in order to define allowable blast sizes to occur within the criteria
- Blasting would only be undertaken between the hours of:
  - 9 am to 5 pm Monday to Friday
  - 9 am and 1pm Saturday
- A minimum of 48 hours notice would be provided to all residences locate within 500 metres of any blast, including an indication of blasting times and a contact name and telephone number. The advice would be provided at least five days prior to any potential blast
- Monitoring of overpressure and vibration levels would be undertaken for each blast at potentially affected receivers
- Building condition surveys would be undertaken for all buildings located within 200 metres of any blasting site area prior to the commencement of blasting and following blasting activities. The proponent would be responsible for rectifying any damages occurring as a result of the construction with the cost to be borne by the proponent
- The maximum instantaneous charge (MIC) would be reduced to the lowest possible level by use of delays, reduced hole diameter, and/or deck loading
- Adequate stemming would be provided and exposed detonating cord would be eliminated (by covering with at least 300 millimetres of quarry dust or road base)
- Secondary blasting would be eliminated. (A rock breaker or drop hammer would be used instead of popping). Effort would be made to eliminate the need for toe shots (eg by better control of drill patterns)
- Weather conditions at the time of the blast would be assessed. Blasting would be avoided where possible during heavy cloud cover and/or if a strong wind is blowing towards residences. Days of severe temperature inversion would be avoided where possible, or (if not possible) blasting would occur between 11 am and 1 pm
- Strict control would be exercised over the spacing and orientation of all blast drill holes. Holes would be spaced in such a manner that the explosive force is just sufficient to break the stone to the required size
- Blasting times would be determined in consideration of site-specific conditions and in consultation with affected residences and would take place, where possible, when impacts are likely to be the least intrusive (eg fire all blasts at a set time acceptable to residents and preferably when background noise is highest).

4. Existing environment

4.1. Noise sensitive receivers

The project corridor extends from the Coffs Harbour local government area (LGA) in the south to Ballina LGA in the north and comprises of regional urban communities such as Grafton and Maclean as well as smaller rural communities including Corindi,Tucabia, Ulmarra, Harwood, New Italy, Woodburn, Broadwater and Wardell.

With the project extending over such a large distance, the noise environment varies considerably over its length. With some notable exceptions such as the communities of Tucabia and Tyndale, most sensitive receivers identified in the project corridor would experience traffic noise emanating from the existing highway as the dominant influence on their noise environment. As the distance from the existing highway increases, other noise sources may become more dominant; however the highway would still be audible throughout most of the project study area with the exception of the off line Section 3 from Glenugie to Tyndale.

There are large portions of the study area that are comprised of national park (see Photo 1), state forest (see Photo 2) and nature reserves where there are few sensitive receivers. In the Richmond Valley LGA (see Photo 3), land use is predominantly rural with sugarcane growing centred on the lower river areas of Broadwater (see Photo 4) and Woodburn. During the sugar cane harvesting season, the 24 hour operations of heavy vehicles and harvesters may influence noise levels in the area.

Photo 1 – National Park within project area

Photo 2 State forest within project area

Photo 3 Richmond Valley – Agricultural land

Photo 4 Broadwater

Noise sensitive receivers for the project were identified by aerial photography taken in November 2011 and identification of all structures within the noise study area was undertaken through a visual mapping exercise. The location of the structures combined with cadastral information was then used to determine the initial classification of residential dwellings, industrial or commercial premises and unspecified buildings such as sheds..

There are 2548 residential receivers within the noise study area for both the upgrade project and existing highway alignments. These receivers were identified as being within 600 metres of the either the new or existing road centre line and therefore included in the assessment of noise impacts. Where some communities are on the edge of the study area, they have been included in the assessment for completeness.

The location of the noise sensitive receivers is presented in **Appendix A** and a summary of the receivers identified for each section is presented in **Table 4-1**.

Table 4-1 Summary of noise sensitive receivers per section

Project section	Description	Total number of structures identified	Number of redeveloped road receivers	Number of new road receivers
1	Woolgoolga to Halfway Creek	668	446	34
2	Halfway Creek to Glenugie	108	28	1
3	Glenugie to Tyndale	151	2	56
4	Tynedale to Maclean	589	404	45
5	Maclean to Iluka Road (Mororo)	299	159	0
6	Iluka Road to Devil's Pulpit	21	8	0

Project section	Description	Total number of structures identified	Number of redeveloped road receivers	Number of new road receivers
7	Devil's Pulpit to Trustrums Hill	77	30	0
8	Trustrums Hill to Broadwater National Park	110	31	10
9	Broadwater National Park to Richmond River	81	5	23
10	Richmond River to Coolgardie Road	229	20	83
11	Coolgardie Road to Ballina Bypass	160	31	0

4.2. Description of each section

The existing noise environment including land uses, receiver types and locations and dominant noise sources for each section are described below. For more detail on the existing environment refer to the working paper Land use and Property Assessment.

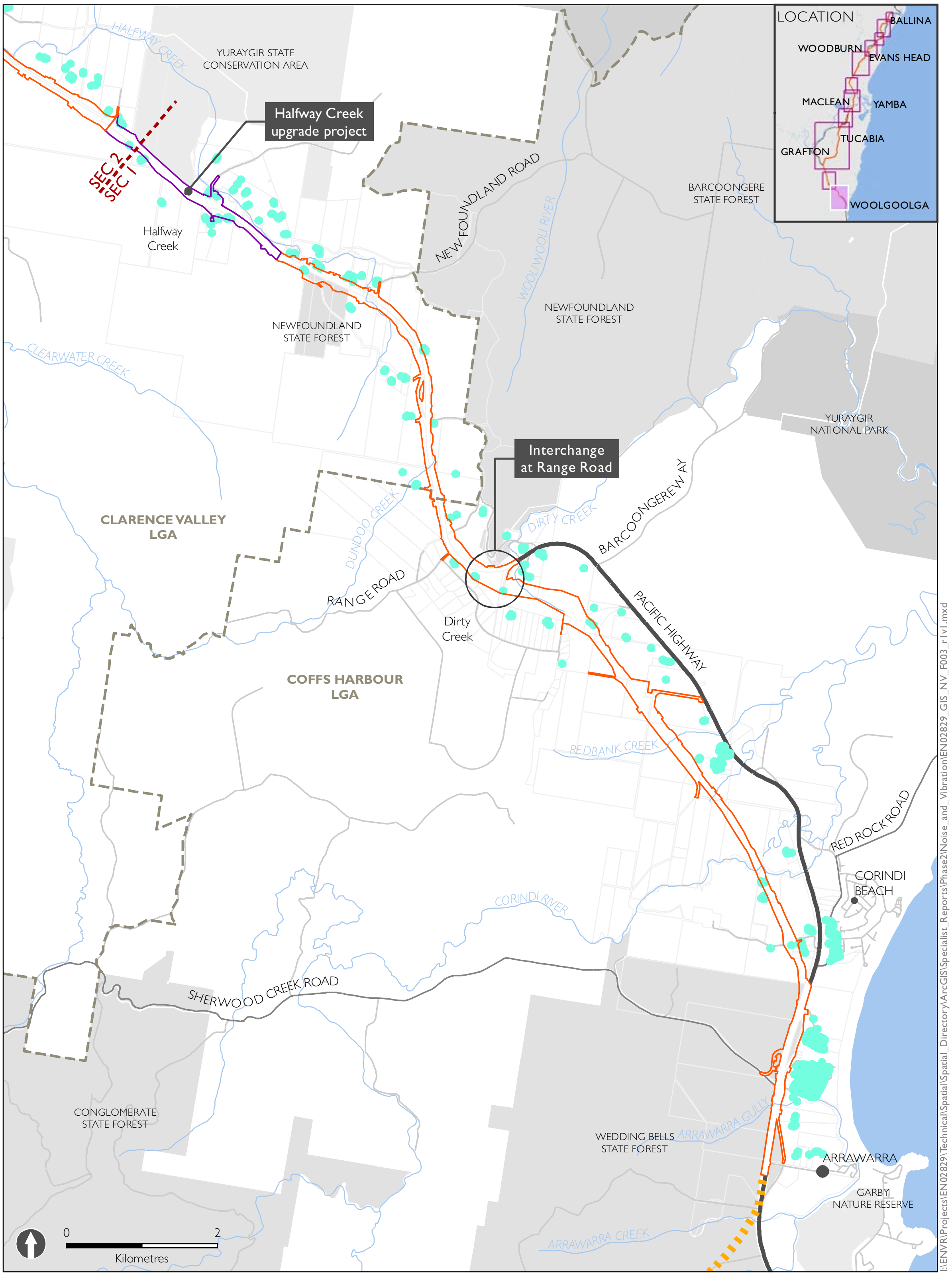
Section 1 – Woolgoolga to Halfway Creek

There are concentrated receiver locations in the south of the project corridor with scattered rural residential dwellings north of Corindi Beach. There are also several commercial and industrial receivers in this section. The RNP road categories would be a mixture of new and redeveloped road criteria for residential receivers.

From the project start south of Arrawarra, the proposed upgrade would be located within the existing corridor until south of Corindi Beach where the project corridor deviates to the west of the existing highway. Residences along this portion of the project corridor currently experience a noise environment that is influenced by road traffic. From Corindi Beach to just north of Dirty Creek, the project corridor passes through rural areas that are approximately 600 metres from the current highway corridor. Receivers in this area would currently experience only distant traffic noise influences.

Where the concept design rejoins the existing highway north of Dirty Creek it follows the existing highway to the end of this section at Halfway Creek. Noise sensitive receivers along this section of the project corridor would experience traffic noise as part of the existing environment. **Figure 4-1** presents the proposed upgrade for Section 1 and indicates the relative density of the existing structures (residential and commercial) for the project.

Figure 4-1 Section 1 - Woolgoolga to Halfway Creek



The project

Receiver location

Upgrade completed to dual carriageway

Upgrade under construction

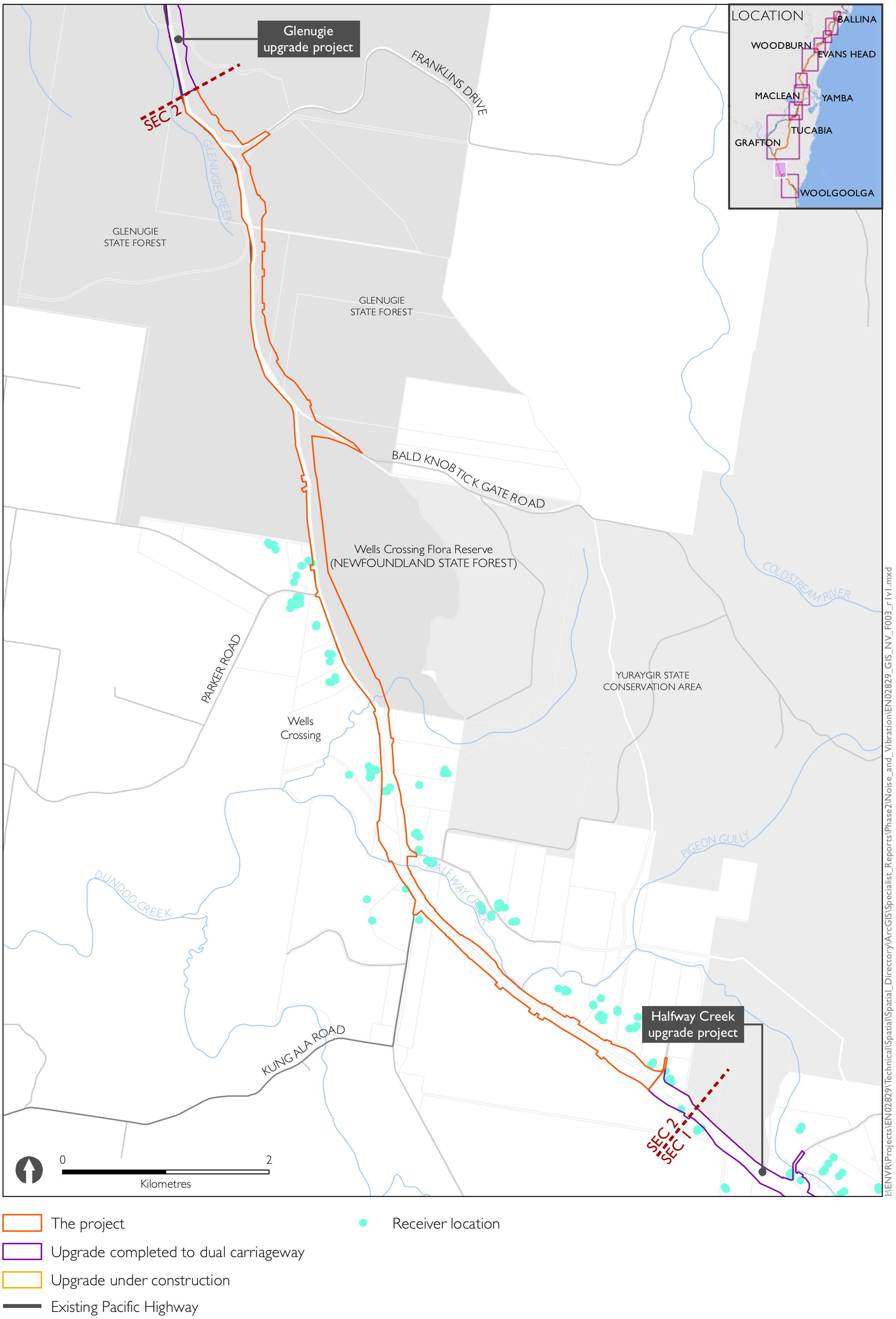
Existing Pacific Highway

Section 2 – Halfway Creek to Glenugie upgrade

The project corridor closely follows the existing highway through areas of national park, the Yuraygir Nature Reserve and the Glenugie State Forest. This section contains few receivers within 600 metres of the project corridor, and these are generally scattered throughout the southern part of the section, between the villages of Halfway Creek and Wells Crossing.

In the northern part of the corridor, the Glenugie upgrade has already been completed and therefore no additional assessment of receivers is required in the area. As the proposed and existing highway share the current road corridor to a large extent, the primary source of noise emissions experienced by receivers for this section is road traffic noise. The Road Noise Policy road category applicable for receivers in this section is redeveloped road criteria for residential receivers.

Figure 4-2 Section 2 - Halfway Creek to Glenugie upgrade

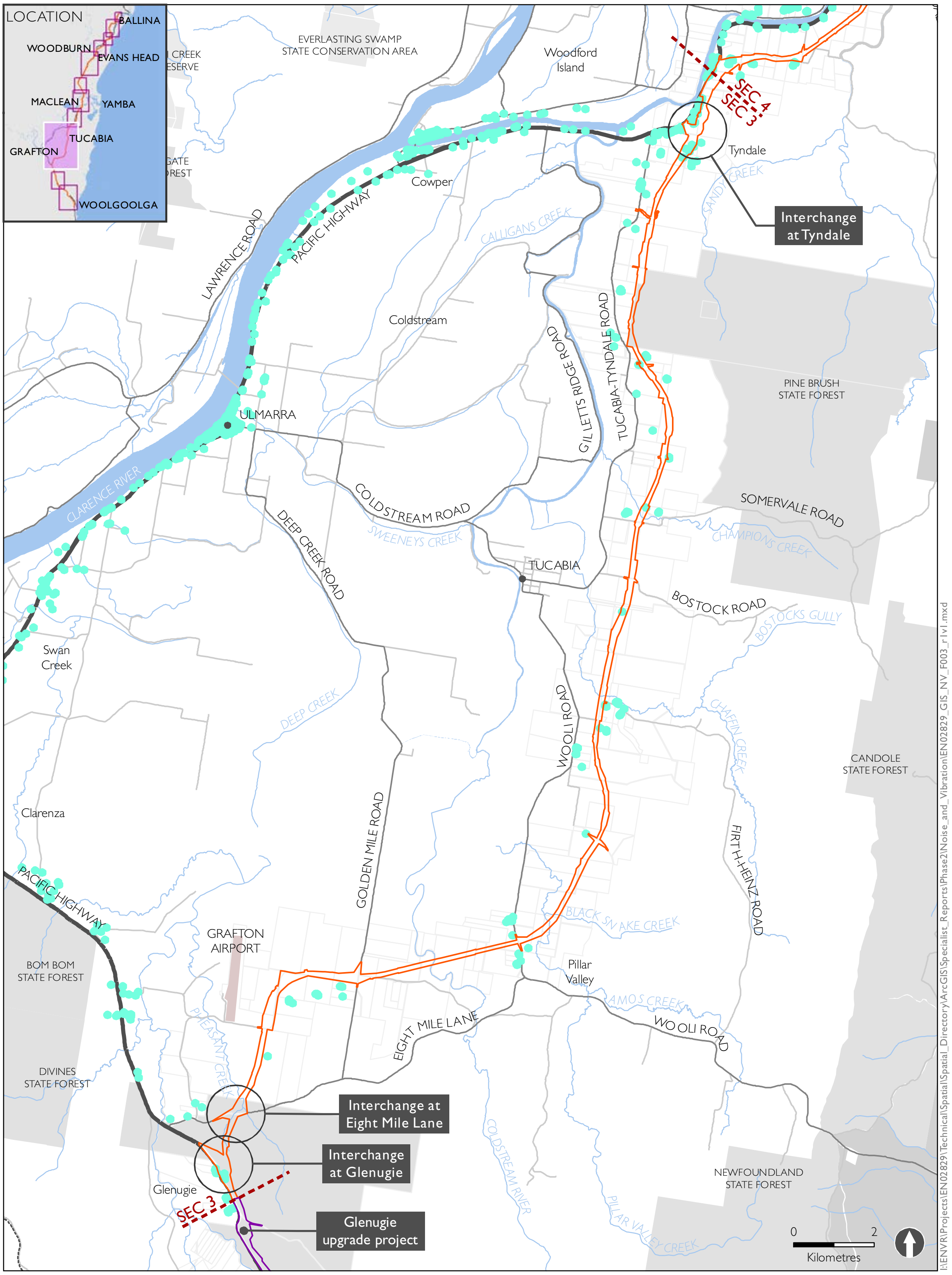


Section 3 – Glenugie upgrade to Tyndale

Section 3 is to the east of the existing highway, bypassing Grafton and Ulmarra. The project corridor would largely run through rural areas and national park. As such, there are few receivers near this section of the project. The village of Tucabia is located about two kilometres to the west of the project corridor. A total of around 37 residential receivers have been identified in this area.

The area surrounding the proposed corridor for Section 3 is currently national park and rural grazing land. No townships are located along the route and the noise environment would be expected to generally be influenced by rural noise sources such as dogs, livestock and tractors, in addition to natural noise sources including crickets, birds and frogs.

Figure 4-3 Section 3 - Glenugie upgrade to Tyndale



The project

Receiver location

Upgrade completed to dual carriageway

Upgrade under construction

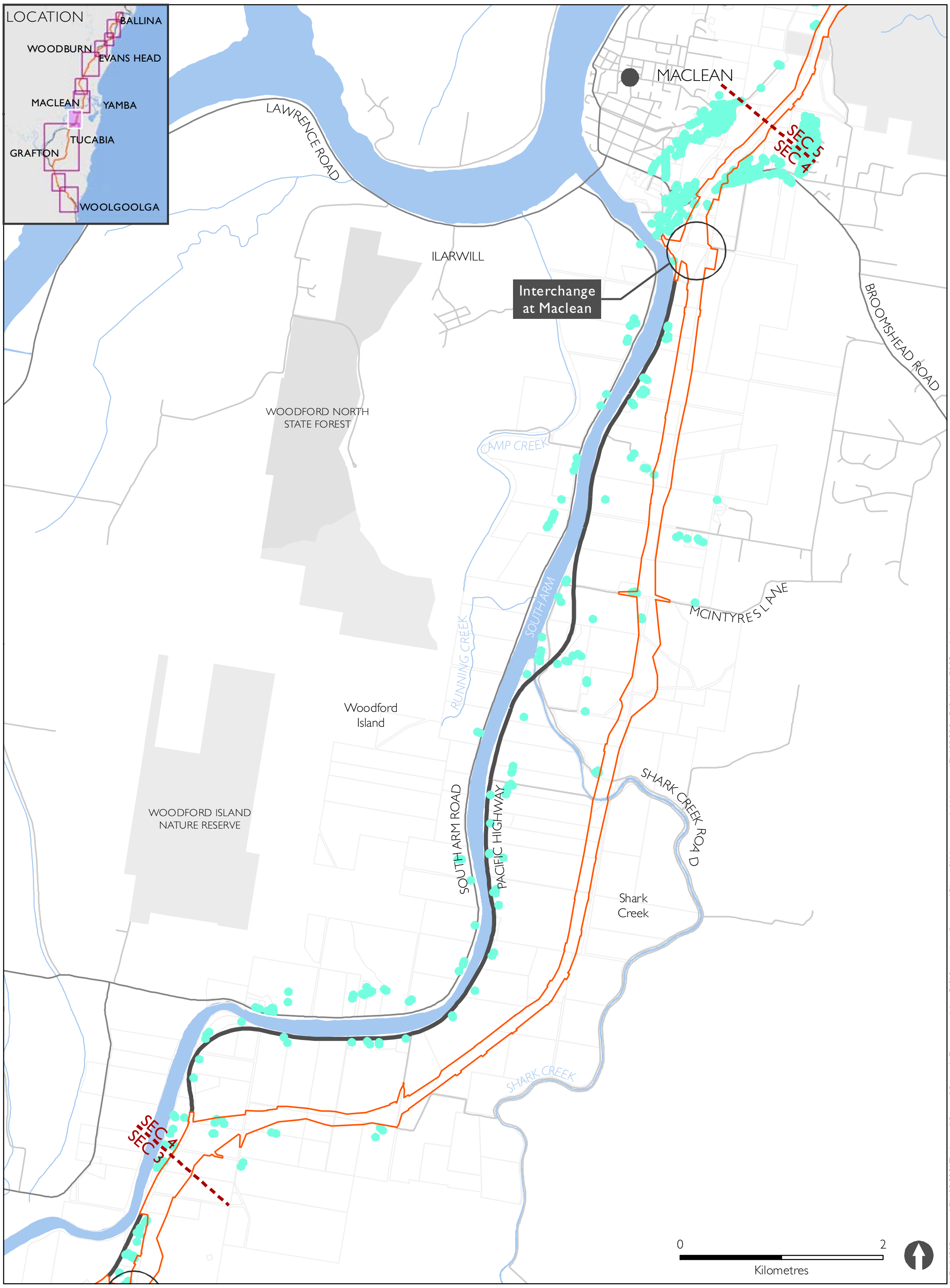
Existing Pacific Highway

Section 4 – Tyndale to Maclean

Section 4 is located between the northern extent of Tyndale and the southern area of Maclean. Noise sensitive receivers through this section are primarily residential. In the southern area, these residential properties are typically isolated rural residential properties, however, in the northern area, residential receivers are mainly located on the southern outskirts of Maclean and to the south west in Gulmarrad and Townsend. Maclean High School is located about 500 metres to the west of the existing highway. A total of 211 residential receivers have been identified in this area.

Land use through Section 4 is predominately related to sugar cane farming. Noise levels through most areas on the project corridor are strongly influenced by traffic noise from the existing highway, in addition to farming activities. During the cane harvesting season (typically July to November) these noise impacts extend throughout the 24 hour period. The main urban areas in this section are located in the far north and include Maclean and Townsend, whilst the western outskirts of Gulmarrad border the project corridor.

Figure 4-4 Section 4 - Tyndale to Maclean



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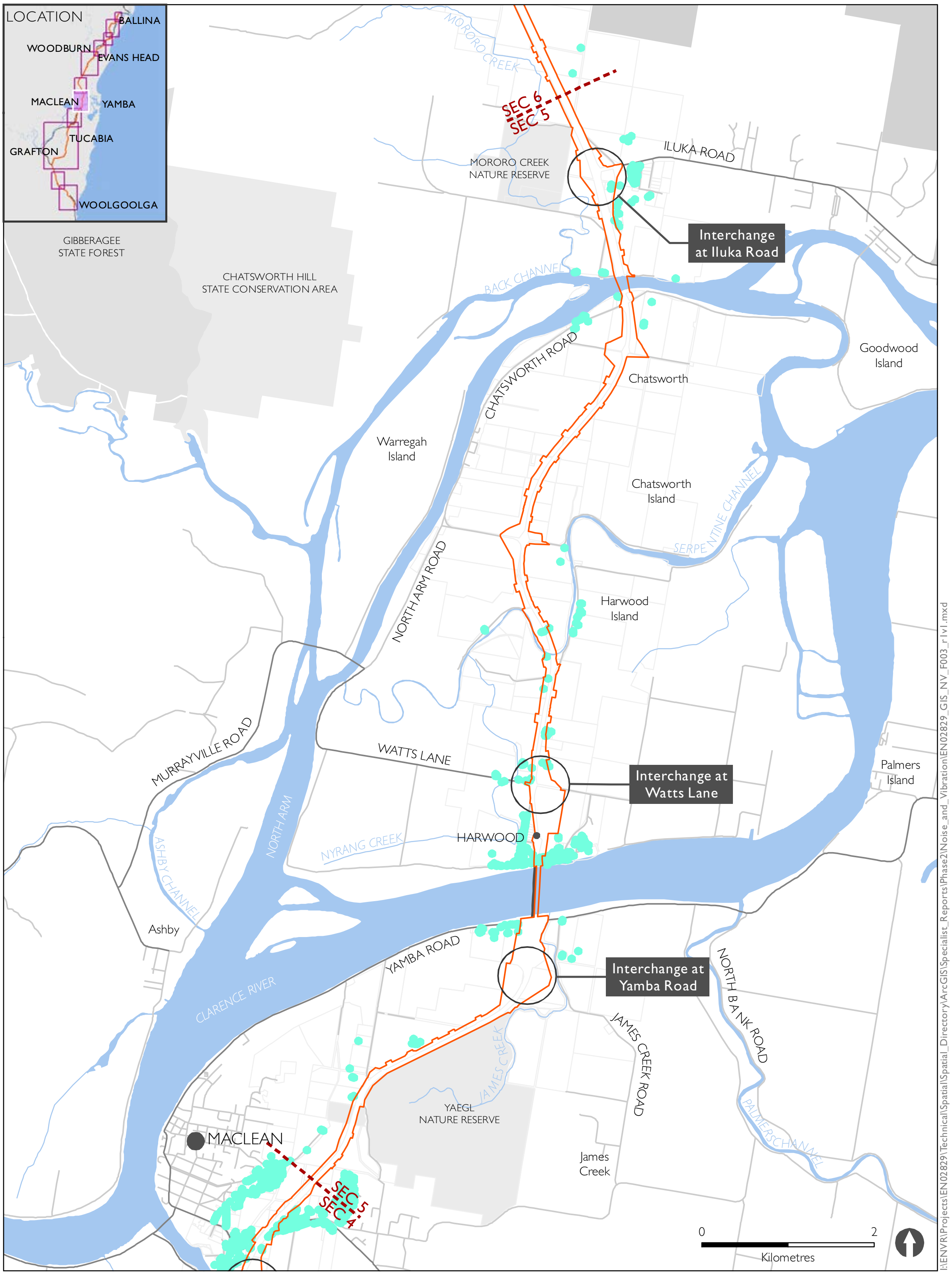
The project
Receiver location
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

Section 5 – Maclean to Iluka Road, Mororo

Section 5 runs from the southern area of Maclean to the north of the village of Chatsworth. The main built up area along this section is Harwood, which is located directly to the north of Harwood Bridge. Around 70 residential properties may be impacted by project related noise in this area. These receivers are primarily located along Morpeth Street and River Street and to the west of the existing Pacific Highway, in the vicinity of the existing sugar mill. In addition, Harwood Island Primary School is located on Morpeth Street.

Small clusters of residential properties are located on Serpentine Channel Road and on the north eastern outskirts of Chatsworth. It is noted the built up area of Chatsworth (including Chatsworth Primary School) is not expected to be impacted given that it is more than one kilometre from the project. A total of 104 residential receivers have been identified in this area.

Figure 4-5 Section 5 - Maclean to Iluka Road



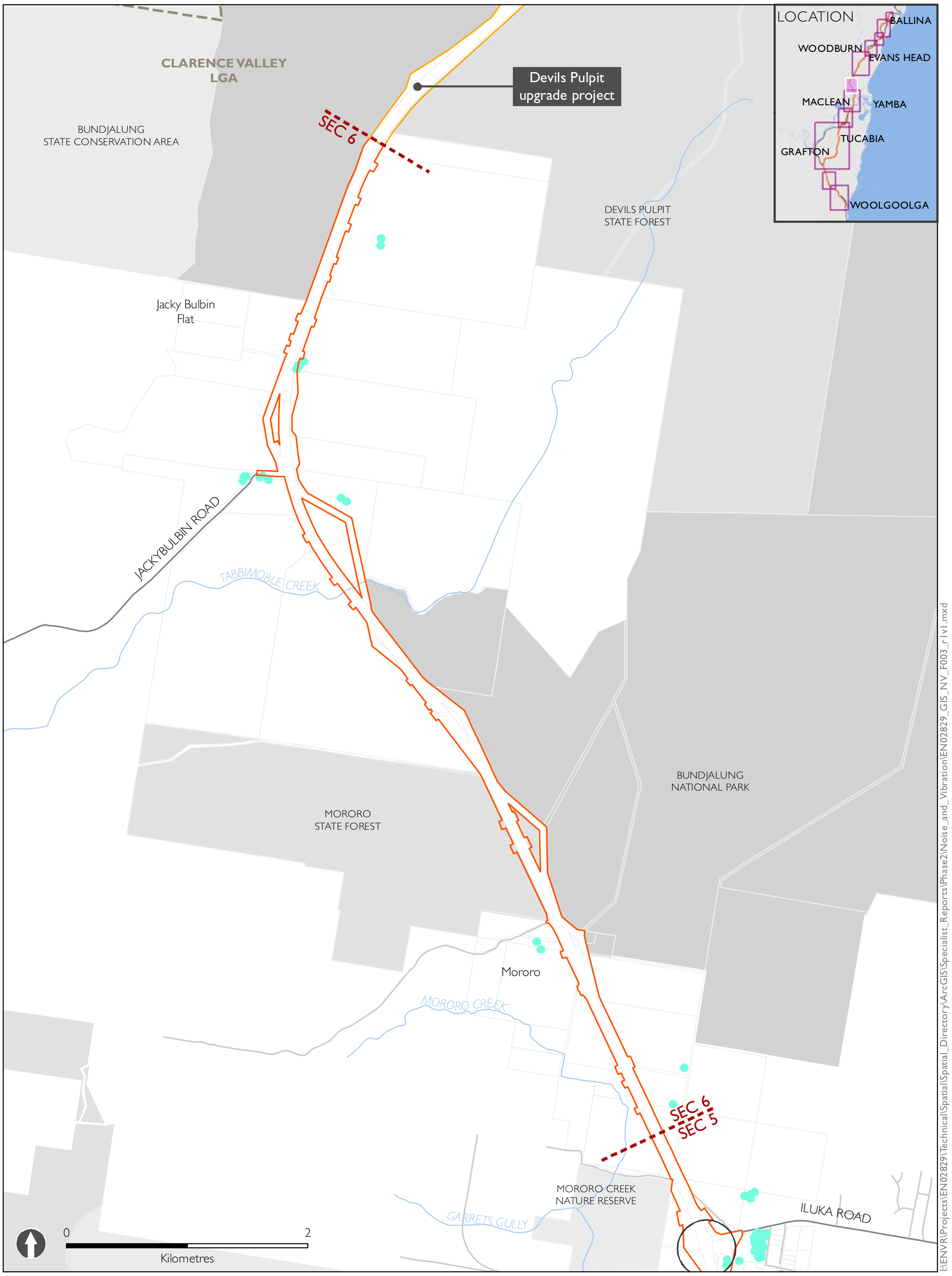
The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Receiver location

Sections 6 and 7 Iluka Road to Devils Pulpit and Devils Pulpit to Trustrums Hill,

Sections 6 and 7 of the project are located along the existing Pacific Highway, through Bundjalung National Park, and as such noise sensitive receivers are very sparsely distributed through these sections. There are no population centres nearby. A total of 36 residential receivers have been identified in this area.

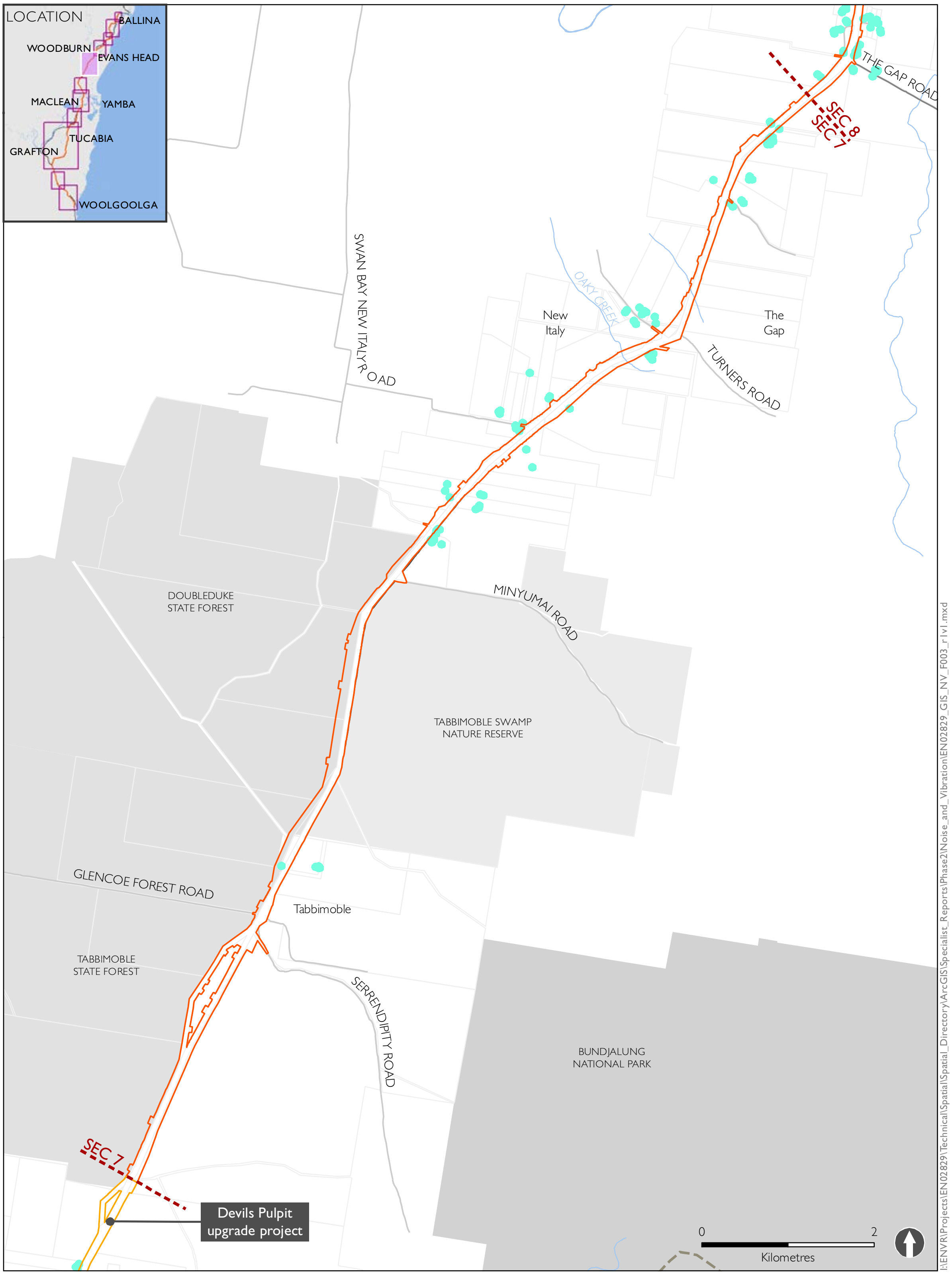
Sections 6 and 7 follow the existing highway and are predominantly bordered by national park and patches of grazing farmland. The noise environment is largely influenced by road traffic on the existing highway.

Figure 4-6 Section 6 - Iluka Road to Devils Pulpit upgrade



The project
Receiver location
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

Figure 4-7 Section 7 - Devils Pulpit upgrade to Trustums Hill



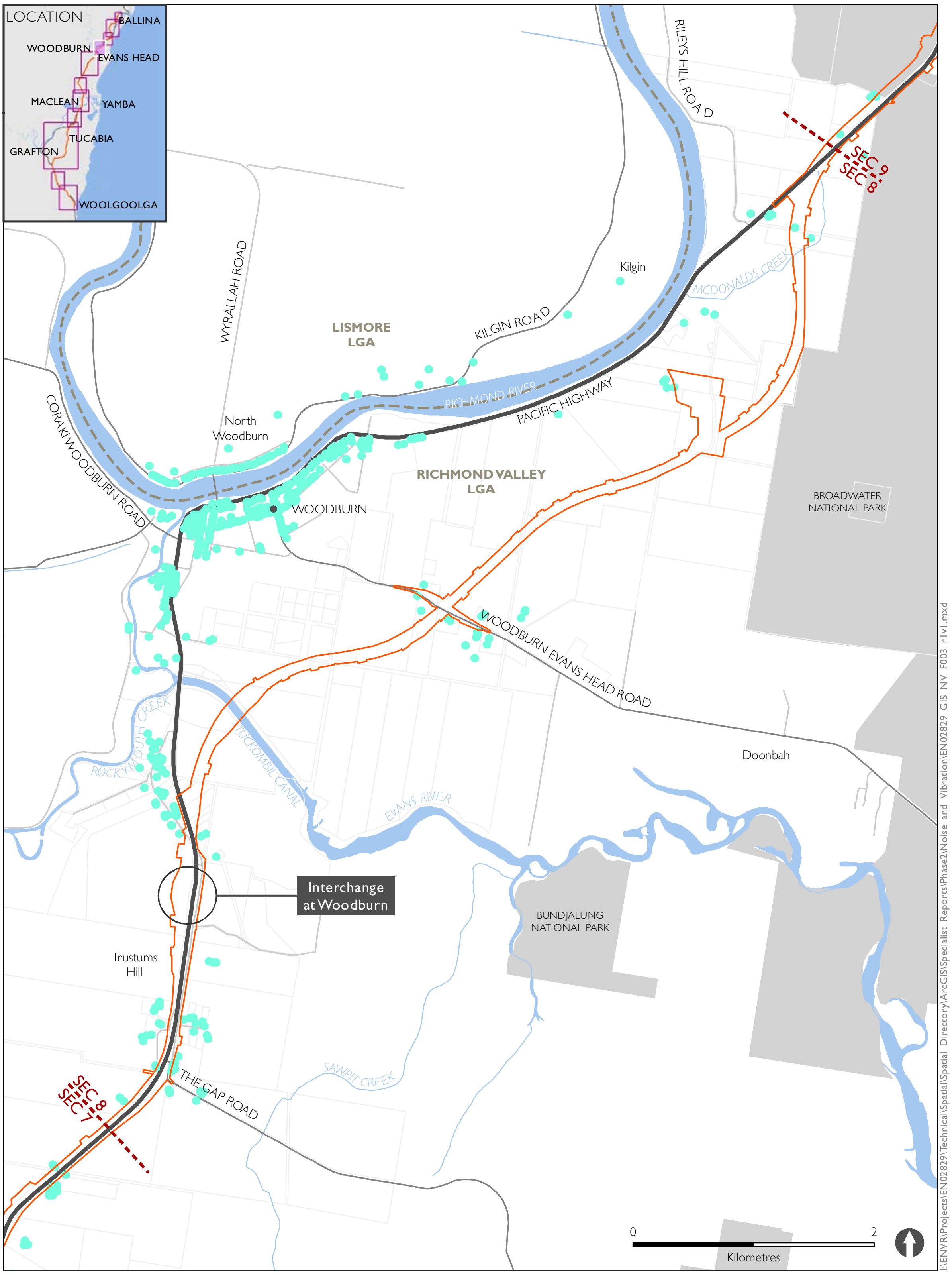
The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Receiver location

Section 8 – Trustrums Hill to Broadwater National Park

Noise sensitive receivers through Section 8 of the project are primarily located within the south eastern outskirts of Woodburn, although isolated rural properties are distributed throughout the area. The built up area of Woodburn is largely located outside the predicted area of noise impacts for the project, however Trustums Hill Road contains about 18 residential properties. In addition, Woodburn Public School is located adjacent to the existing Pacific Highway in the southern area of Woodburn. A total of 38 residential receivers have been identified in this area.

Land use through Section 8 is mixed, and contains areas of bushland in the south, whilst grazing and sugar cane farming dominates the northern areas. The project corridor through this section runs about 1.5 kilometres to the east of the existing highway, and as such existing noise levels would be dominated by local road traffic and rural noise sources such as dogs, cattle and tractors. During the sugar cane harvesting season, these rural noise impacts would extend throughout the 24 hour period. It is expected the existing highway would be audible along most of the route particularly during evening and night-time hours.

Figure 4-8 Section 8 - Trustums Hill to Broadwater National Park



The project

Receiver location

Upgrade completed to dual carriageway

Upgrade under construction

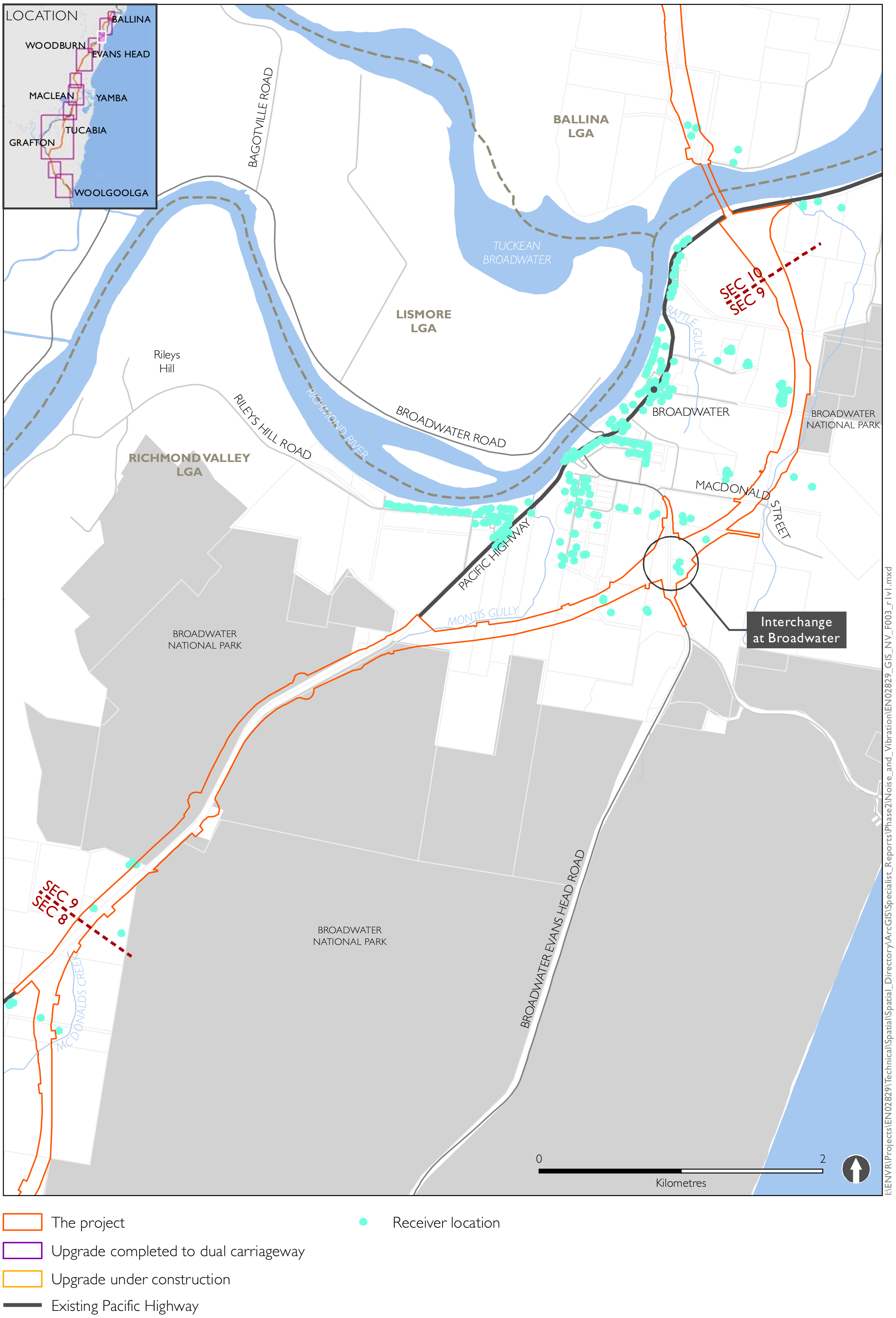
Existing Pacific Highway

Section 9 – Broadwater National Park to Richmond River

Section 9 of the project is located west of the town of Broadwater. Residential receivers are generally isolated rural properties, which are widely spread throughout the area, although the village of Rileys Hill is located in this section. A total of 12 residential receivers have been identified in this area.

Section 9 passes to the west of the existing Pacific Highway and moves north through a mix of land uses, including grazing, sugar cane farming and Broadwater National Park. Existing noise levels would primarily be influenced by rural and natural noise sources, in addition to traffic on local roads. During the sugar cane harvesting season, these rural noise impacts would extend throughout the 24 hour period.

Figure 4-9 Section 9 - Broadwater National Park to Richmond River

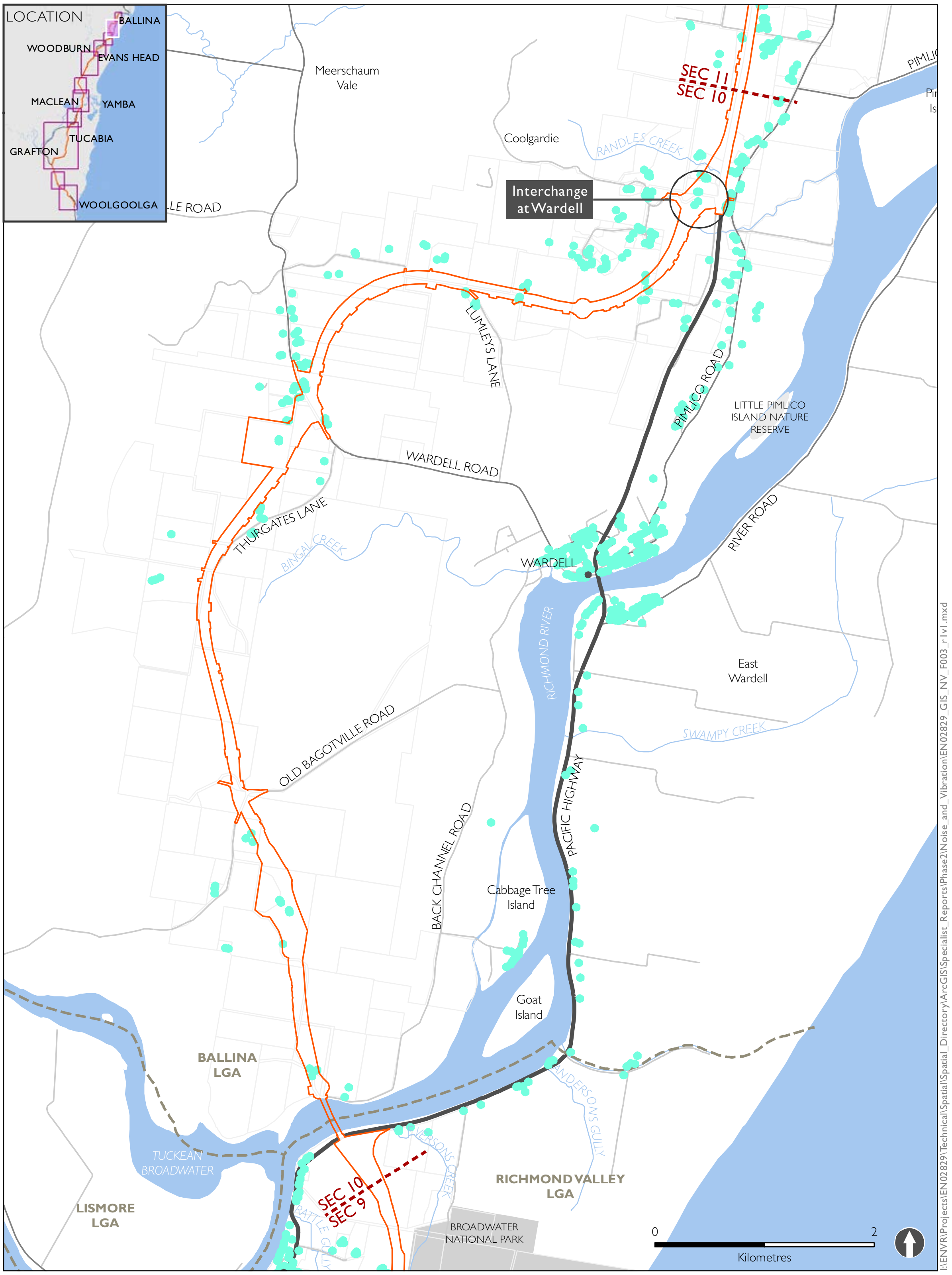


Section 10 – Richmond River to Coolgardie Road

Section 10 traverses farmland primarily used for sugar cane and grazing. Sensitive receivers in this area are generally classified as isolated rural properties. A small cluster of houses is located in the vicinity of the project where it crosses Wardell Road. A total of 63 residential receivers have been identified in this area.

Existing noise impacts would be primarily rural in nature, in addition to traffic passing on local roads. During the sugar cane harvesting season, these noise impacts would extend throughout the 24 hour period. The Pacific Highway is generally audible during the evening and night-time hours when other noise sources have decreased.

Figure 4-10 Section 10 - Richmond River to Coolgardie Road



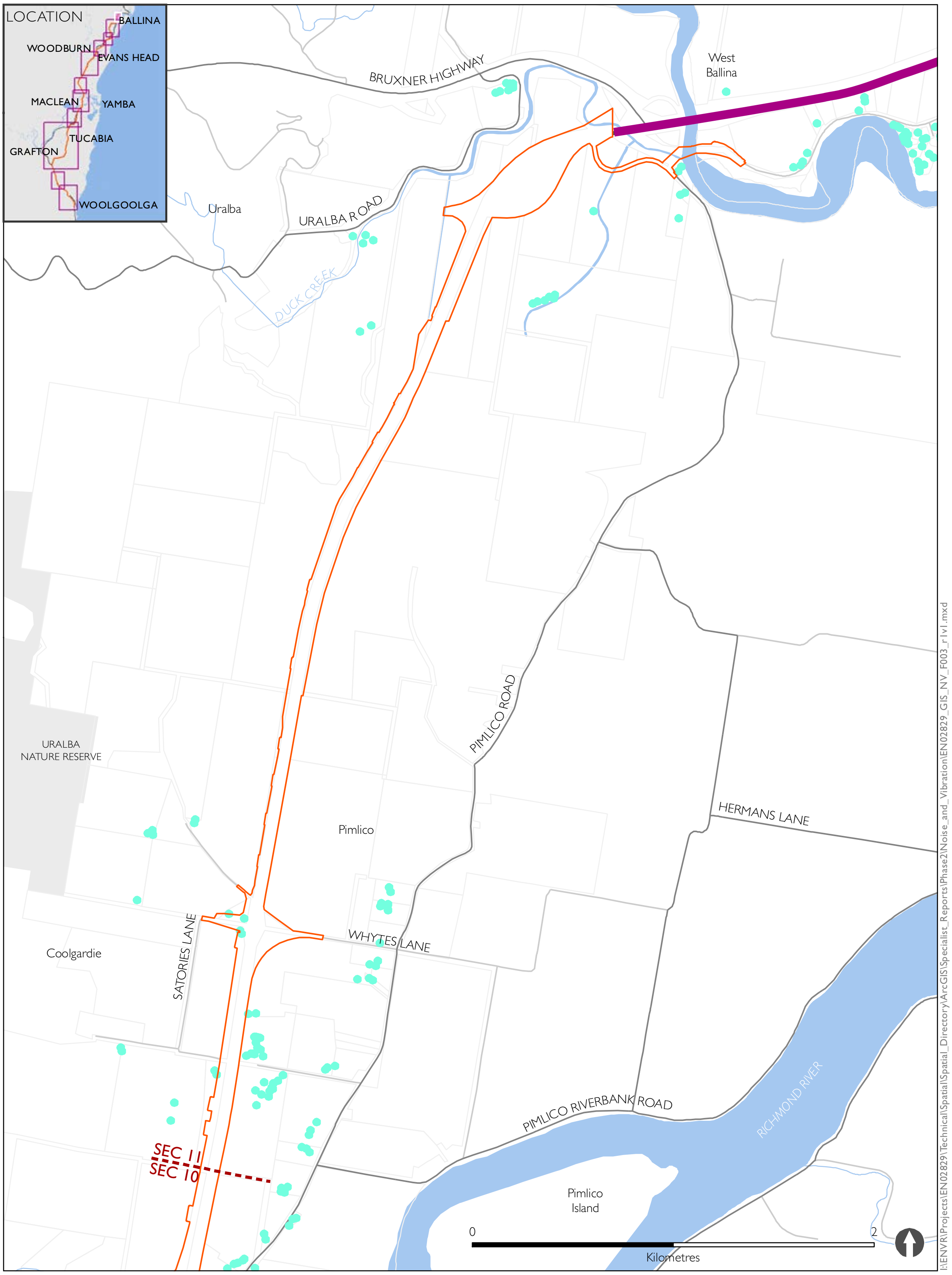
The project
Receiver location
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway

Section 11 – Coolgardie Road to Ballina bypass

Section 11 is located to the west of Pimlico, joining the southern extent of the Ballina bypass. Residential receivers are scattered throughout the area and are primarily located along Pimlico Road to the east or in the vicinity of Uralba to the west of the project. A total of around 24 residential receivers have been identified in this section.

Land use in Section 11 is dominated by sugar cane farming. Noise from the existing Pacific Highway dominates the noise environment through this section and, in the north of the project corridor, noise from heavy vehicles using the Bruxner Highway is also audible. During the sugar cane harvesting season, noise impacts from these activities would extend throughout the 24 hour period.

Figure 4-11 Section 11 - Coolgardie Road to Ballina bypass



The project
Upgrade completed to dual carriageway
Upgrade under construction
Existing Pacific Highway
Receiver location

4.3. Baseline noise monitoring locations

As described above, the project corridor supports a wide variety of land uses. While each section of the project will experience an influence from traffic noise on the existing highway to some degree, there may be other noise sources that need to be characterised for each section. Noise monitoring is used to identify existing noise levels at various locations through the project study area. The noise monitoring serves two purposes, both of equal importance.

- Combined with traffic counts and used in the calibration of the operational noise model to aid in the prediction of future noise levels;
- Used to establish background noise levels to identify appropriate construction noise goals for the project.

A summary of the number of attended and unattended noise monitoring locations adopted for this study is provided in **Table 4-2** and identification of each specific monitoring location is presented in **Table 4-3**.

Selection of each location is based on its proximity to the existing and proposed upgrade. In section 3, the number of locations is quite large compared to the other sections. While this is the longest section the project, it also deviates significantly from the existing highway, which means that the number of logger locations is effectively duplicated to capture the existing noise levels for each corridor. This is also true for section 10.

Table 4-2 Summary of noise monitoring sites by section

Section	Approximate Location	No. unattended monitoring locations	No. attended noise monitoring
1	Woolgoolga to Halfway Creek	6	1
2	Halfway Creek to Glenugie	2	1
3	Glenugie to Tyndale	6	2
4	Tynedale to Maclean	9	1
5	Maclean to Iluka Road (Mororo)	11	1
6	Iluka Road to Devil's Pulpit	1	2
7	Devil's Pulpit to Trustrums Hill	4	2
8	Trustrums Hill to Broadwater National Park	7	1
9	Broadwater National Park to Richmond River	3	2
10	Richmond River to Coolgardie Road	4	3
11	Coolgardie Road to Ballina Bypass	3	2

Due to the number of receivers in each section, it is impractical to undertake monitoring at all receivers within the study area and therefore necessary to group dwellings into NCA to allow a broader application of criteria for the operational and construction noise assessments.

Each of the 11 sections has been split into six NCA representing a typical background noise level measured along the project corridor. The NCA are based on a buffer that follows the proposed upgrade, as follows:

- 0-200 metres either side of alignment outer lane centreline
- 200 – 400 metres either side of alignment outer lane centreline
- 400 – 600 metres either side of the alignment outer lane centreline

NCAs adopted for this project are listed in **Table 4-3**, against each monitoring location. The specific NCA assigned for each section is shown graphically in **Appendix B**. The assignment of individual receivers to each catchment can be found within the results tables presented in **Appendix C** and **Appendix D.**

In some locations noise data is not available for each NCA. In these circumstances the data obtained from monitoring locations at other similar distances from the proposed upgrade will be set as the RBL and subsequent NML. This is based on the assumption that the noise environment at two receivers at different points along the section with the same separation distance from the proposed upgrade will be similar in ambient noise character.

Where noise monitoring has been undertaken, either unattended or attended, at a specific receiver, Noise Management Levels (NMLs) for construction have been derived using the ICNG guidelines for each assessment period, in line with the method set out in **Section 2.3.**

The unattended monitoring results will be used to assign each of the NCAs and therefore all receivers with a RBL and NML. This will be based on the data obtained during unattended monitoring at receivers within an NCA and also be influenced by the results and observations gained during attended noise monitoring undertaken at receivers within the same catchment. Adjustments in the NCA for specific receivers may be undertaken according to attended monitoring to take account of localised situations such as major terrain features, surrounding building structures or other dominant noise sources.

Table 4-3 Noise monitoring locations

Section	Logger ID	Distance from highway		Address	Project NCA
		Exist.	Upgrade		
1	1	175	124	47 Kangaroo Trail Road CORINDI BEACH	1-c
1	2	31	521	3674 Pacific Highway CORINDI BEACH	1-a
1	3	105	553	7 Dirty Creek Road DIRTY CREEK	1-a
1	4	35	46	4470 Pacific Highway Halfway Creek	1-c
1	5	238	240	4644 Pacific Highway Halfway Creek	1-b
1	6	79	80	4925 Pacific Highway Halfway Creek	1-d
2	7	251	266	5092 Pacific Highway Halfway Creek	2-b

Section	Logger ID	Distance from highway		Address	Project NCA
		Exist.	Upgrade		
2	8	130	188	5559 Pacific Highway Wells Crossing	2-d
3	9	158	216	6639 Pacific Highway Glenugie	3-e
3	10	8214	359	247 Wants Lane Glenugie	3-e
3	11	9456	243	961 Wooli Rd Pillar Valley	3-b
3*	12	154	8420	44 Edward Olgivie Drive Clarenza	-
3	13	11672	133	106 Firth-Heinz Road Pillar Valley	3-c
-*	14	47	11540	Candole street Tucabia	-
-*	15	39	11594	9 School Lane Swan Creek	-
3	16	5610	91	625 Tucabia-Tyndale Road Tucabia	3-d
-*	17	229	8268	1853 Pacific Highway	-
-*	18	66	4505	2319 Pacific Highway	-
4	19	629	370	130 Fitzgerald Ln, Tyndale	4-b
4	20	63	319	2991 Pacific Highway Tyndale	4-e
4	21	66	494	3358 Pacific Highway Tyndale	4-f
-*	22	65	669	425 Shark Creek Rd, Shark Creek	-
-*	23	98	1021	3718 Pacific Hwy, Shark Creek	-
-*	24	106	1014	86 O'maras Lane Gulmurrad	-
4	25	894	249	125 Clyde Essex Dr, Gulmarrad	4-b
4	26	354	1019	4 Highlands Gulmurrad	4-a
4	27	34	183	4064 Pacific Highway Gulmurrad	4-d
4	28	258	330	40 Cameron St, Maclean	4-e
4	29	58	77	9A Jubilee Street Townsend	4-c
4	30	466	485	13 Scullin Street Townsend	4-a
5	31	362	332	35 James Creek Rd, James Creek	5-b
5	32	320	353	8 Martins Point Rd, Harwood	5-e
5	33	204	170	1 Petticoat Lane Harwood	5-c
5	34	141	187	40 Morpeth Street Harwood	5-d
5	35	46	61	4928 Pacific Highway Harwood	5-c
5	36	25	7	5055 Pacific Highway Chatsworth	5-d
5	37	301	324	50 Serpentine Channel Rd, Harwood	5-d
5	38	597	600	389 Chatsworth Rd, Chatsworth	5-f
5	39	551	555	395 Chatsworth Road Chatsworth	5-f
5	40	109	105	53 Old Pacific Highway Woombah	5-c
5	41	466	479	Pacific Highway Mororo	5-a
6	42	47	64	6530 Pacific Highway Jackybulbin	6-c

Section	Logger ID	Distance from highway		Address	Project NCA
		Exist.	Upgrade		
-	43	59	68	7175 Pacific Highway Tabbimoble	-
7	44	168	208	8120 Pacific Highway Tabbimoble	7-c
7	45	214	217	Pacific Highway The Gap	7-c
7	46	373	337	65 Whites Road New Italy	7-e
7	47	56	72	8750 Pacific Highway The Gap	7-c
8**	48	83	75	60 The Gap Road Trustums Hill	8-b
8	49	383	384	60 The Gap Road Trustums Hill	8-b
8	50	139	140	20 The Gap Road Trustums Hill	8-c
8	51	65	146	32 Trustums Hill Rd, Woodburn	8-d
8	52	124	355	82 Trustums Hill Road Woodburn	8-e
8	53	26	1077	165 Woodburn Evans Woodburn	8-e
8*	54	34	1449	63 River Street Woodburn	-
-*	55	331	327	9810 Pacific Hwy, Woodburn	-
-*	56	381	1370	9810 Pacific Highway Broadwater	-
9	57	29	596	4 Pacific Highway Broadwater	9-f
9	58	100	757	85 Broadwater Evans Head Road Broadwater	
9*	59	39	486	10770 Pacific Highway Broadwater	9-d
9*	60	27	2171	10950 Pacific Highway East Wardell	-
10*	61	44	3137	11184 Pacific Highway East Wardell	-
10	62	3139	144	1202 Wardell Rd, Wardell	10-f
10	63	3251	201	1175 Wardell Road Wardell	10-e
-*	64	253	307	848 Pimlico Road Wardell	-
10	65	1118	351	109 Meridian Drive Coolgardie	10-e
11	66	67	35	3 McAndrews Lane Pimlico	11-d
11	67	589	571	55 Whytes Lane, Pimlico	11-f
11	68	570	554	151 Uralba Rd, Uralba	11-f

**Modelling calibration point for existing alignment.*
***Calibration point for proposed upgrade*

PART B – Operational noise and vibration assessment

For Agency review

5. Operational noise

The operational noise assessment and modelling exercise uses information from the existing no build situation as well as predictions of the future operational scenarios. Details such as the location of residential dwellings and the terrain adjacent to the project form the basis of the model while the concept design and the estimated future traffic volumes are elements that influence the predictive outcomes from the model.

The concept design used in the modelling of noise impacts is based on the three dimensional road model developed for the project. This design is incorporated into the noise model to replicate areas of shielding such as cuttings and embankments. **Appendix A** presents an overview of the concept design showing areas of cuts and fill and locations of residential dwellings.

Environmental noise influences

Observations regarding the influence of insects and amphibians on the measured noise levels for measurements undertaken in rural locations include the following generalisations:

- In areas where water provides a natural breeding ground, the influence of frogs and crickets was noticed during the night time hours. Where these locations, coincided with noise monitoring, these influences are thought to have the effect of increasing the measured L_{Aeq} level of the noise monitoring results during this time. In some cases this leads to the under prediction of traffic noise levels when compared to the measured data. Where this has occurred, a discussion of influences for the monitored noise levels has been included in the results
- In some areas along the alignment, the influence of cicadas was observed during the daytime and early evening. This influence has a similar effect to the frog noise, but affects the daytime monitoring results. Where this has been noted, a discussion of influences for the monitored noise levels has been included in the results.

Mitigation considerations

From Section 3.1.5 in Part A of this report, a discussion on mitigation options has been provided. This discussion includes information on the definition of closely spaced residences, which is used in the initial determination of the location of noise barriers and low noise pavement. Closely spaced groups of receivers are typically characterised by separation distances of less than 20 metres between dwellings. Where receivers are separated by distances of 100 metres or more, they are not considered to be closely spaced and it is unlikely that noise walls would be cost effective when compared to architectural treatments. Details of mitigation options have been discussed for each section following the prediction of noise impacts.

5.1. Section 1 (Woolgoolga to Halfway Creek)

5.1.1. Operational noise impact summary

Section 1 is around 17 kilometres long, from Arrawarra Beach Road, Arrawarra, about six kilometres north of Woolgoolga) to the northern end of the completed Halfway Creek upgrade at Lemon Tree Road, Halfway Creek. The location and extents of each of the project sections is presented Part A of this report in Figure 1-2.

A summary of operational noise impacts for this section are provided here:

- The project in this section would be a combination of road duplication within the existing road reserve and new road development in the realigned road boundary to the west of the existing Pacific Highway
- Under an initial class A scenario, there is one interchange located in this project stage at Range Road. There are no new rest areas identified in Section 1
- The majority of noise sensitive receivers identified in Section 1 currently experience noise from the existing Pacific Highway to some degree
- Some receivers in the southern part of this section south of Halfway Creek would experience a new noise impact from the relocation of the existing alignment to the west of its current location between Arrawarra and Halfway Creek. Many of these receivers would experience traffic noise on a previously unaffected facade of their home
- With the exception of the communities at Arrawarra, Corindi beach, and Cassons Creek which contain the largest communities in this section, receivers are located on large residential or rural blocks, typically with distances of greater than 100 meters separating the dwellings
- The location of receivers identified for noise mitigation is generally within 100 metres of the project
- The receivers requiring noise mitigation are separated by large distances and therefore the use of noise barriers and low noise pavement is not recommended. Architectural treatments would be considered to treat exceedances of the noise criteria in this section.

5.1.2. Receiver locations

The receiver locations of Section 1 are illustrated in the map series in Appendix A. In Section 1, the project passes through and near to the communities of Arrawarra, Corindi Beach, Casson’s Creek and Dirty Creek. There are around 596 structures identified within the study area, 394 of which have been identified as residential dwellings that fall inside the 600 metre assessment corridor. About 80 per cent of the identified receivers are located in the southern part of the project section around Arrawarra and Corindi Beach.

Six unattended monitoring locations were used to quantify the noise environment in this section. **Table 5-1** lists the locations and distance from the existing Pacific Highway included in the noise monitoring survey undertaken between 14 and 28 March 2012. The monitoring was designed to be representative of the Noise Catchment Areas (NCA) defined in the Part A, Section 4.3. Not all locations were available for monitoring, with the final locations based on prior access approval.

The locations of the noise monitoring sites are presented in the receiver location map series in Appendix **A**.

Table 5-1 Summary of unattended noise monitoring locations – Section 1

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
335	145	Kangaroo Trail Road, Corindi Beach	1-c
414	21	Pacific Highway, Corindi Beach	1-a
468	95	Dirty Creek Road, Dirty Creek	1-a
495	25	Pacific Highway, Halfway Creek	1-c
526	220	Pacific Highway, Halfway Creek	1-b
575	69	Pacific Highway, Halfway Creek	1-d

5.1.3. Monitoring results

Observations during the survey period indicate the primary noise source along the existing highway was traffic on the Pacific Highway. There were no industrial noise influences noted at any of the monitoring sites. As the distance from the highway increased, other sources of noise such as birdsong, crickets and frogs were noted as contributing to the background noise levels.

Results of the traffic noise monitoring at these locations are provided in **Table 5-2**, which presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time. The L_{A10} results provide a correlation to the CoRTN day and night time periods while the L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-6**.

Table 5-2 Summary of traffic noise monitoring descriptors – Section 1

Receiver Identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
335	63.6	63.9	62.2	59.0	76.4	73.3
414	72.6	69.7	69.2	68.8	86.6	87.1
468	60.0	60.5	57.8	55.9	73.4	71.5
495	69.4	69.8	66.6	66.2	82.8	83.0
526	59.3	59.1	55.8	55.2	75.9	68.8
575	59.3	59.5	58.5	55.5	81.0	78.0

The recorded data for all sites are consistent with expectations of traffic noise levels at the distances identified in **Table 5-1**, with the exception of Receiver 526. The noise levels at this location are higher than expected and while the data follows reasonable trends for daily variations in noise levels, the resulting levels may be overly influenced by frog and insect noise at night.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Grafton weather station for the month of March to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.1.4. Modelled traffic scenarios

The predicted traffic data for Section 1 for the year of opening and the design year scenarios and build and no build options are presented in **Table 5-3**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-3 Road traffic data input to noise model for Section 1

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	2881	774	3655	21%	425	464	889	52%
Year opening no build (south bound)	3243	907	4150	22%	411	324	735	44%
Year opening build (north bound)	2547	754	3300	23%	376	451	827	55%

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening build (south bound)	2902	880	3782	23%	368	314	682	46%
Design year no build (north bound)	3211	1014	4226	24%	474	608	1081	56%
Design year no build (south bound)	3609	1187	4797	25%	458	424	881	48%
Design year build (north bound)	2828	988	3816	26%	417	592	1009	59%
Design year build (south bound)	3220	1154	4374	26%	408	412	820	50%

Section 1 has an interchange at Range Road, Dirty Creek for traffic access to what would become the former Pacific Highway. **Table 5-4** presents the predicted hourly average volumes for the on and off ramps and service roads with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts. The predicted data indicates only light usage of the on and off ramps during the night time hours for this interchange.

Table 5-4 Summary of on and off ramp traffic for Section 1

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Range Road interchange east	Southbound off-ramp	14	7	2	4
	Service road	12	7	2	4
	Range Road interchange Link	12	10	2	6
Range Road interchange west	Range Road interchange Link	8	2	2	2
	WB off-ramp	12	8	2	8
2026 Traffic Volumes					
Range Road interchange east	Southbound off-ramp	16	9	3	5
	Service road	13	8	2	5
	Range Road interchange link	12	10	2	6

Range Road interchange west	Range Road interchange link	9	3	2	3
	WB off-ramp	12	8	2	8

5.1.5. Calibration of the noise model

Traffic count data used in the calibration of the noise model were collected in March 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-5**.

Table 5-5 Noise model calibration data for Section 1

Description	Traffic count data							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 1 calibration (Northbound)	3281	617	3898	16%	308	346	654	53%
Section 1 calibration (Southbound)	3207	619	3826	16%	409	225	634	35%

Table 5-6 presents the predicted noise levels from the validation scenario and the measured noise levels from unattended monitoring at the survey locations. The results include a -3dB(A) L_{A10} to L_{Aeq} conversion and a 2.5 dB(A) facade correction where appropriate. The road surface is noted as spray seal and has been given a nominal +3dB(A) correction for noise to correlate with measured data. However; the surface was noted as having a large degree of variability in condition in this section with older portions of the road potentially influencing the noise levels to greater extent.

The model assumes 90 per cent soft ground for the calibration scenario in recognition of the highly vegetated and well covered ground for the majority of the study area at the time of monitoring. A correction for 75 per cent soft ground for the 2016 and 2026 scenarios has been incorporated in the modelling to account for variation in seasonal conditions. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-6 Comparison of measured and modelled road traffic noise levels – Section 1

Receiver identification	Day LAeq(15h) dB(A)			Night LAeq(9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
335	59.9	59.6	-0.3	59	57.3	-1.7
414	69.2	71.5	2.3	68.8	69	0.2
468	57.8	58.7	0.9	55.9	56.3	0.4
495	66.6	68.5	1.9	66.2	66.1	-0.1
526	55.8	55.6	-0.2	55.2	53	-2.2
575	58.5	59.1	0.6	55.5	56.8	1.3
Median of results			**0.8**			**0.0**
Standard Deviation			**1.1**			**1.3**

Daytime levels are generally more variable than the night time noise levels both being within less than ±3 dB(A) of the measured levels for all locations. The predicted noise levels indicate that the accuracy of the noise model is acceptable for the future year noise predictions. As noted earlier, the night time levels at Receiver 526 may be influenced by sources other than road traffic but the results at this location are still within acceptable limits.

The RNP criteria for the day are 5 dB(A) higher than for the night in acknowledgement of the change in domestic activity for the two periods. Since the measured night time noise levels in this area are less than 5 dB(A) below the day time levels, any future increase in traffic noise is likely to result in an exceedance of the night criteria before those of the day period.

5.1.6. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the proposal. Both the day and night periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken (see Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-7**. The location of all receivers in Section 1, including those identified for mitigation can be seen in **Appendix A**.

Table 5-7 Summary of noise modelling results – Section 1

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	199	75	10

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
b	166	166	19
c	17	17	15
d	3	3	2
e	7	6	4
f	2	1	1
Total	**394**	**268**	**51**

The majority of receivers in Section 1 are located in the Arrawarra and Corindi Beach communities, which generally experience a 2 dB(A) reduction in noise levels due to the realignment of the project.

In NCA b and c, the receivers considered for mitigation are to the east of the project with about half of these adjacent to the realigned section of the highway and having a new noise exposure on the opposite facade to the existing highway. Five of the identified receivers would experience noise levels that exceed the acute noise criteria, although four of these currently already exceed this criterion.

The impacted receiver locations are spread along the length of the project and cover a distance of around 15 kilometres, typically being individual residences separated by distances of greater than several hundred metres. At station 5100, a small community of 11 dwellings is situated between 300-400 metres to the east of the project. This group of residences represents the largest cluster of receivers identified for consideration of noise mitigation.

5.1.7. Mitigation measures

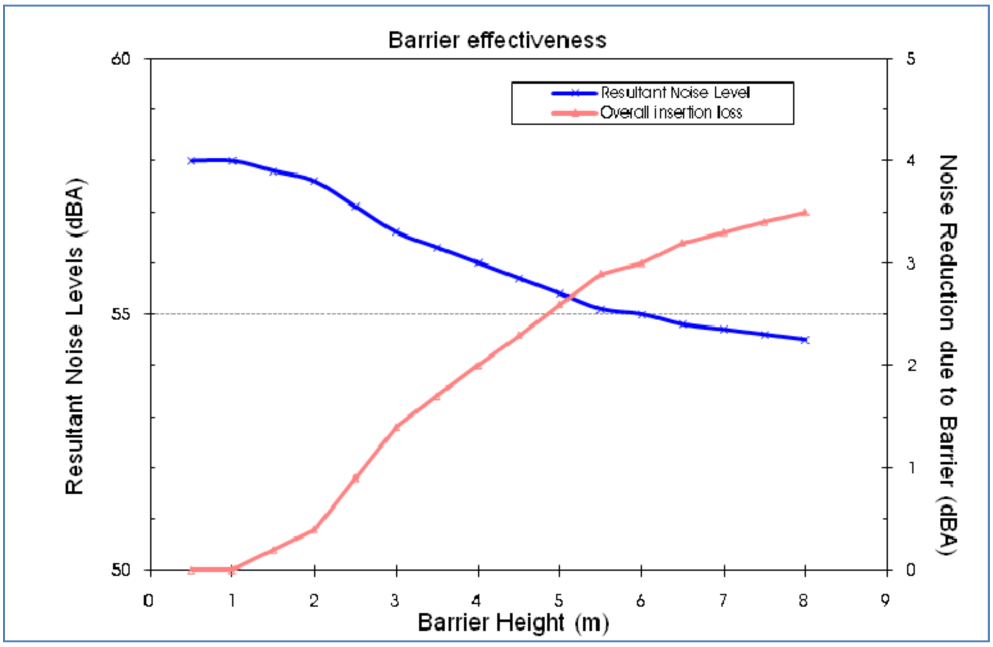
The selection of mitigation measures for this section of the project was undertaken by initially examining the location of residences that have been identified for additional consideration. This is done to determine the feasibility of implementing low noise pavements, noise barriers or architectural treatment options. The feasible and reasonable application of mitigation is discussed further in Part A, Section 3.1.5 and these principles are applied to residences with exceedances of the noise criteria as the result of this assessment.

Low noise pavements are recommended for receivers 7-322 in this section of the project to mitigate exceedances of receivers located in Darlington Park. Low noise pavement in this location would provide a benefit to over three hundred receivers.

At station 2400 receivers 335, 344, and 351 are located about 10 metres higher than the alignment. Noise barriers in this location do not provide the minimum performance requirements for feasible and reasonable application in addition, the application of low noise pavements do not reduce noise levels to below the more stringent night time project criteria.

Between stations 4600 – 5500 low noise pavement would not reduce the predicted noise level to below the project night time criteria at all locations. A barrier assessment from station 4600 – 5500 was undertaken to determine the effectiveness of a barrier for the receivers in this location. These receivers are located about six metres above the project's vertical alignment making the implementation of a noise barrier ineffective in meeting the minimum performance requirements. **Figure 5-1** presents a graph of barrier height versus noise reduction for this location.

Figure 5-1 Barrier effectiveness - station 4800 – 5200



A summary of the mitigation options for Section 1 are presented in **Table 5-1**.

Table 5-8 Summary of traffic noise mitigation measures – Section 1

Receivers	Assessed mitigation measures	Recommended mitigation measures
7-322	Low noise pavement, Architectural treatments	Low noise pavement
335, 344, 351	Low noise pavement, noise barrier, Architectural treatment	Architectural treatment to residential dwelling.
396-423	Low noise pavement, noise barrier, Architectural treatment	Architectural treatment to residential dwelling.
All other receivers	Architectural treatment	Architectural treatment to residential dwelling.

The location and extents of low noise pavement recommended for Section 1 are subject to a cost benefit analysis and would be further investigated and confirmed at the detailed design stage.

In Section 1, the receiver at 495 identified for architectural treatment is a heritage item (see Working paper 8 -Historical (non-Aboriginal) Heritage Assessment, item 2). Architectural noise treatment to this receiver would be developed in consultation with a qualified heritage consultant to minimise impacts on the heritage significance of the dwelling, and undertake any further assessment required.

5.2. Section 2 (Halfway Creek to Glenugie upgrade)

5.2.1. Operational noise summary

Halfway Creek to Glenugie upgrade (Section 2) of the project is around 12 kilometres long, from the northern end of the Halfway Creek upgrade at Lemon Tree Road to the southern end of the Glenugie upgrade at Franklins Road. The location and extents of this stage is presented in Part A of this report in Figure 1-2.

A summary of operational noise impacts for this section are provided here:

- The project in this section is designated road duplication within the existing road boundary
- The project passes through the Yuraygir National Park and the Glenugie State Forest and is heavily vegetated
- At station 19, 400 there is a new heavy vehicle checking station
- The majority of noise sensitive receivers identified in Section 2 currently experience noise from the existing highway and from the same direction as the project
- Receivers in this stage are sparsely populated typically with distances of greater than 100 meters separating the dwellings
- The location of receivers identified for noise mitigation is within 100 metres of the project
- The receivers requiring noise mitigation are separated by large distances and therefore the use of noise barriers and low noise pavement is not recommended. Architectural treatment is recommended to mitigate exceedances of the noise criteria in this stage of the works.

5.2.2. Receiver locations

The receiver locations for Section 2 of the project are shown in Appendix A. In this section the project passes through the Yuraygir National Park and the Glenugie State Forest in the north. The majority of the receivers in this location are located in the southern half of the project section around Halfway Creek. There are around 29 structures within the study area, 22 of which have been identified as residential dwellings that fall inside the 600 metre boundary.

There are 3 unattended monitoring locations used to quantify the noise environment in this section. **Table 5-9** lists the locations used in the noise monitoring survey undertaken between 14 and 28

March 2012. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-9 Summary of unattended noise monitoring locations – Section 2

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
575	69	Pacific Highway, Halfway Creek	2-d
597	241	Pacific Highway, Halfway Creek	2-b
651	120	Pacific Highway, Wells Crossing	2-d

5.2.3. Monitoring results

The monitoring was undertaken at various distances from the existing highway outlined in **Table 5-9** and design to be representative of the of Noise Catchment Areas (NCA) defined for use in the assessment of operational and construction noise impacts (see Part A, Section 4.3).

Observations during the survey periods indicate that the primary noise source along the existing Pacific Highway was due to traffic with other noise sources such as birdsong and frogs audible above the traffic noise as the distance from the highway increased.

The results of the traffic noise monitoring at these locations are provided in **Table 5-10**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods. The L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and nine hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-15**.

Table 5-10 Summary of traffic noise monitoring descriptors – Section 2

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
575	59.3	59.5	58.5	55.5	81.0	78.0
597	58.7	59.9	56.1	56.0	70.5	68.5
651	58.9	58.7	56.6	54.2	78.6	71.4

The recorded data for all sites are consistent with expectations of traffic noise levels at the distances identified in **Table 5-9** with the exception of location 597 which indicates a higher night time noise level than expected for this distance from the project. This night time influence is due to the active insect and mammal life that contributes to the night time noise environment in addition to the road traffic noise in the area.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Grafton weather station for the month of March 2012 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.2.4. Modelled traffic scenarios

The predicted traffic data for Section 2 for the year of opening and the design year scenarios and build and no build options are presented in **Table 5-11**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-11 Road traffic data input to noise model for Section 2

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	2809	748	3557	21%	254	491	745	66%
Year opening no build (south bound)	3187	922	4109	22%	240	361	601	60%
Year opening build (north bound)	2783	744	3527	21%	252	489	741	66%
Year opening build (south bound)	3169	922	4091	23%	239	361	600	60%
Design year no build (north bound)	3116	979	4095	24%	282	643	925	70%
Design year no build (south bound)	3534	1206	4740	25%	266	473	739	64%
Design year build (north bound)	3086	974	4060	24%	279	640	919	70%
Design year build (south bound)	3516	1206	4722	26%	265	473	738	64%

Section 2 also has a heavy vehicle checking located at station 19,400. The checking station is situated around 550 metres away from the nearest receiver.

The assessment for noise emissions from the checking station considers intrusive noise impacts such as low speed truck movements, and sleep disturbance from maximum noise level events such as the use of air brakes. The assessment for intrusiveness is taken from the NSW, *Industrial Noise Policy* (INP), while the assessment of potential sleep disturbance is taken from the Environmental Criteria for Road traffic noise (ECRTN) both of these assessment methods use information on the existing environment to determine the appropriate noise criteria. For more detail on the assessment of Heavy vehicle checking stations and rest areas see **Section 2.2.5** in Part A of this report.

The assessment of intrusive noise impacts in accordance with the INP requires that the $L_{Aeq\ 15\ min}$ noise emissions from the activity being assessed are no more than 5 dB(A) above the quietest Rating Background Level (RBL). The RNP identifies a methodology from the superseded *Environmental Criteria for Road Traffic Noise* to assess impacts from maximum noise events based on the emergence of the L_{A1} noise level over the $L_{A90\ (15\ min)}$ noise level. The maximum noise event is assessed by comparing predicted noise levels to the L_{A1} criterion as an indication of the potential for sleep disturbance from noise events. The sleep disturbance assessment for the project assumes an RBL value instead of the $L_{A90\ (15\ min)}$ and is calculated as follows:

$L_{A1} \geq L_{A(RBL)}$ + 15 dB(A)

From data obtained at receiver 597 which is the nearest receiver to the checking station, the day evening and night time environmental noise levels for L_{Aeq} and RBL have been determined and are presented in **Table 5-12**.

Table 5-12 Environmental noise levels – Section 2

Receiver Identification	L_{Aeq} Day dB(A)	L_{Aeq} Evening dB(A)	L_{Aeq} Night dB(A)	L_{A90} RBL Day dB(A)	L_{A90} RBL Evening dB(A)	L_{A90} RBL Night dB(A)
597	55.1	58.4	56.0	44.7	42.3	35.4

The night time noise levels at this location are influenced by the existing highway. The RBL for the night time of 35.4 dB(A) has been adopted for the assessment of noise impacts from the proposed rest area. The RBL for night evening provides an assessment level of 40 dB(A) to meet the intrusive noise goals, and an L_{A1} noise level of 50 dB(A) to meet the sleep disturbance criterion.

The assessment of noise impacts for the checking station has been based on normal utilisation of during the day or night for any given fifteen minute period. **Table 5-46** presents the data used to estimate the noise impacts from the rest area.

Table 5-13 Noise data for Section 2 heavy vehicle checking station assessment

Activity	Estimated noise level at 10 m
Truck air brake (bleed off)	88 dB(A)
Truck movement (accelerating)	85 dB(A)
Truck door	76 dB(A)

The intrusive noise level at the nearest receiver has been estimated based on one of each of the events in **Table 5-46** occurring twice in any fifteen minute period, and sleep disturbance has been assessed against an air brake bleed off. This results in an $L_{Aeq\ 15\ minute}$ noise level at the closest receiver location of less than 30 dB(A), which is lower than the project noise goal of 40 dB(A) for intrusive noise.

The L_{A1} noise level from the rest area has been predicted based on the worst case event from **Table 5-46** due to the exhaust bleed off from truck brakes. The estimated noise level resulting from this impact is predicted to be around 46 dB(A), which is below the calculated threshold for sleep disturbance impacts of 50 dB(A) for this location.

5.2.5. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in March 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-14**.

Table 5-14 Noise model calibration data for Section 2

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 2 Calibration north bound	4239	566	4805	12%	522	362	884	41%
Section 2 Calibration north bound	4289	808	5097	16%	424	227	651	35%

Table 5-15 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3dB (A) L_{A10} to L_{Aeq} conversion and a 2.5 dB(A) facade correction where appropriate. The road surface was noted as spray seal and given a nominal +2.5dB (A) correction for noise.

The calibration model assumes 90 per cent soft ground in recognition of the highly vegetated and well covered study area and 75 per cent soft ground is assumed for future year scenarios. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-15 Comparison of measured and modelled road traffic noise levels – Section 2

Receiver identification	Day LAeq(15h) dB(A)			Night LAeq(9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
575	58.5	60.1	1.6	55.5	57.5	2
597	56.1	55.2	-0.9	56	52.5	-3.5
651	56.6	57.9	1.3	54.2	55.3	1.1
Median of results			**1.3**			**1.5**
Standard Deviation			**1.4**			**0.6**

*Receiver 597 night time value removed from calculation

Predicted noise levels are generally higher than the measured levels and with the exception of receiver 597 (located 240 metres from the project) are within ±2 dB(A) of the measured levels for day and night time. The predicted noise levels indicate that the accuracy of the noise model is acceptable for the future year noise predictions.

The RNP criteria for day are 5 dB(A) higher than for night in acknowledgement of the change in domestic activity for the two periods. Since the measured night time noise levels in this area are less than 5 dB(A) below the day time levels, any future increase in traffic noise is likely to result in an exceedance of the night criteria before those of the day period.

5.2.6. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the proposal. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-16**. The location of all receivers in Section 2, including those identified for mitigation can be seen in **Appendix A**.

Table 5-16 Summary of noise modelling results – Section 2

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	3	2	2
b	7	7	3

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
c	2	2	2
d	3	3	1
e	4	4	1
f	3	0	0
Total	**22**	**18**	**9**

There is one property acquisition and four commercial receivers identified for the Halfway Creek to Glenugie upgrade (Section 2). The receiver locations predicted to exceed the criteria are distributed along the length of the project on both the east and west side of the carriageway, covering a distance of around 15 kilometres. These receivers are typically individual residences separated by distances of greater than several hundred metres.

There are three receivers identified as exceeding the acute night time noise level criteria for the design year in this section. Two of these receivers are predicted to exceed this criterion for the existing highway operation with the third indicating only a marginal compliance under the no build scenario. The majority of the receiver locations predicted to exceed the base criteria for the design year are only marginal exceedances of 1-2 dB(A).

5.2.7. Mitigation measures

The selection of mitigation measures for the Halfway Creek to Glenugie upgrade (Section 2) was undertaken with respect to the proximity of the affected receiver locations, which are typically greater than 100 metres apart.

The implementation of low noise pavement in this section does not reduce noise levels to the project criteria and the majority of affected residences would still therefore require additional treatments. Due to the distances between the affected residences, noise barriers are not a feasible or reasonable option for noise mitigation.

Table 5-17 Summary of traffic noise mitigation measures – Section 2

Receivers	Assessed mitigation measures	Recommended mitigation measures
All identified receivers	Low noise pavement, noise barriers, Architectural treatment	Architectural treatment at residential dwellings

In Section 2, the residential dwelling at 616 identified for architectural treatment is a heritage item (see Working paper 8 -Historical (non-Aboriginal) Heritage Assessment, item 7). Architectural noise treatment to this receiver would be developed in consultation with a qualified heritage consultant to minimise impacts on the heritage significance of the dwelling, and undertake any further assessment required.

5.3. Section 3 (Glenugie upgrade to Tyndale)

5.3.1. Operational noise summary

Section 3 is around 35 kilometres long, extending from the northern end of the current Glenugie upgrade (located just south of Eight Mile Lane) to Tyndale. The location and extents of each of the project sections is presented Part A of this report in Figure 1-2.

A summary of operational noise impacts for this section are provided here:

- The development of the highway in this section is designated new road and has the potential to include the relative increase criteria for road developments in previously unaffected areas
- The project is located in rural areas as well as the Pine Brush State Forest and is generally quite heavily vegetated
- The project has an on ramp and off ramp at Glenugie, Eight Mile Lane, and Tyndale. There is a rest area identified at station 6800 incorporating a car and truck stop with public amenities
- The majority of noise sensitive receivers identified in this section currently experience no noise from road traffic other than local traffic on Eight Mile Lane, Wooli Road and the Tucabia-Tyndale Road
- Receivers in this stage are sparsely populated for the majority of the project with population densities increasing significantly around Tyndale. Rural properties have dwellings separated by distances in excess of 150 metres in most instances
- The location of receivers identified for noise mitigation extends to greater than 600 metres from the project due to the requirements of the relative increase criteria
- The receivers requiring noise mitigation are separated by large distances extending the length of the project. The recommendation for low noise pavements is limited to the more densely populated section of the project, in the northern section below Tyndale to the end of the project. Architectural treatment is recommended to mitigate exceedances of the noise criteria in this section of the works.

5.3.2. Receiver locations

The receiver locations for Section 3 of the project are shown in Appendix A. In this section, the project passes near to the communities of Sandy Crossing, Pillar Valley, Tucabia and Tyndale. There are 62 structures identified within the study area, 52 of which have been identified as residential dwellings that fall inside the project study area (600 meters)..

There are seven unattended monitoring locations used to quantify the noise environment in this section although traffic noise is present only at the extremities of the alignment where the project ties in with the existing highway in the south and where it passes to the east of the existing highway at Tyndale. **Table 5-18** lists the locations used in the noise monitoring survey undertaken between 22 February and 14 March 2012. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-18 Summary of unattended noise monitoring locations – Section 3

Receiver Identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
678	210	Pacific Highway, Glenugie	e
S3_1	-	Wants Lane, Glenugie	a
703	-	Wooli Road, Pillar Valley	b
729	-	Firth-Hinze Road,Pillar Valley	c
S3_2	-	Candole Street, Tucabia	f
748	-	Tucabia-Tyndale Road, Tucabia	d

5.3.3. Monitoring results

As there is no existing highway traffic in Section 3, the monitoring was designed to be representative of receiver locations for the Noise Catchment Areas (NCA) used in the assessment of operational and construction noise impacts (see Part A, Section 4.3) and also to provide additional information on the wider noise environment adjacent to the project.

Observations during the survey period at receiver 678 indicate that the primary noise source at the start of Section 3 was due to traffic on the existing Pacific Highway. At all other locations, noise influences were due to the natural environment including birds, frogs, crickets wind in trees and occasional local traffic.

The results of the noise monitoring at these locations are provided in **Table 5-19**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment however, the reported influences are not due to road traffic at locations other than the receiver at 678. At this location the L_{A10} results provide a correlation to the CoRTN day and night time periods although these values are not considered in the noise assessment. The L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment.

Table 5-19 Summary of traffic noise monitoring descriptors – Section 3

Receiver Identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
678	50.6	49.7	48.7	46.7	68.5	62.5
S3_1	36.9	30.3	41.5	31.9	66.1	59.5
703	46.4	40.8	52.2	43.0	74.2	68.9
729	42.7	35.3	51.1	39.3	71.8	67.6
S3_2	48.9	39.0	51.7	42.9	72.3	64.9
748	47.8	47.8	53.9	47.7	75.4	66.3

The measured noise data for these sites are consistent with expectations of the noise environment in Section 3 that has little to no influence from road traffic noise. At receiver location 678 located on the existing Pacific Highway in Glenugie, measured traffic noise levels are consistent with earlier monitoring undertaken at this location.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Grafton weather station for the month of March 2012 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.3.4. Modelled traffic scenarios

The predicted traffic data for Section 3 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-20**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-20 Road traffic data input to noise model for Section 3

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	3487	726	3487	21%	302	509	812	63%
Year opening no build (south bound)	3633	942	3633	26%	345	341	686	50%
Year opening build (north bound)	1717	605	1717	35%	149	424	573	74%

Year opening build (south bound)	1753	811	1753	46%	167	294	461	64%
Design year no build (north bound)	3770	952	3770	25%	327	668	995	67%
Design year no build (south bound)	3986	1233	3986	31%	379	447	826	54%
Design year build (north bound)	1855	793	1855	43%	161	557	718	78%
Design year build (south bound)	1904	1060	1904	56%	181	384	565	68%

Section 3 has off ramps at Eight Mile Lane and Glenugie. **Table 5-21** presents the predicted hourly average volumes for the on and off ramps and service roads with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts. The predicted data indicates only light usage of the on and off ramps during the night time hours for this interchange. The noise modelling has incorporated the following traffic data into the modelling of the 2016 and 2026 scenarios.

Table 5-21 Summary of on and off ramp traffic for Section 3

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Eight Mile Lane interchange east	Southbound off-ramp	12	10	2	6
	Service road	31	1	5	1
	Range road	31	1	5	2
Eight Mile Lane interchange east	Eight Mile Lane east	31	1	5	1
	Eight Mile Lane west	32	1	5	2
2026 Traffic Volumes					
Eight Mile Lane interchange east	Southbound off-ramp	12	10	2	6
	Service road	34	2	5	1
	Range road	35	2	5	3
Eight Mile Lane interchange east	Eight Mile Lane east	34	2	5	1
	Eight Mile Lane west	36	2	5	3

Section 3 has a rest area located at station 63,800. The rest area is located in an area of agricultural farms and bushland around 800 metres south and about 500 metres to the south west of the nearest receivers in Section 3.

The assessment for noise emissions from the rest area considers intrusive noise impacts such as the operation of truck mounted refrigeration units and low speed truck movements, and sleep disturbance from maximum noise level events such as the use of air brakes. The assessment for intrusiveness is taken from the NSW, *Industrial Noise Policy* (INP), while the assessment of potential sleep disturbance is taken from the Environmental Criteria for Road traffic noise (ECRTN) both of these assessment methods use information on the existing environment to determine the appropriate noise criteria. For more detail on the assessment of rest areas see **Section 2.2.5** in Part A of this report.

The assessment of intrusive noise impacts in accordance with the INP requires that the $L_{Aeq\ 15\ min}$ noise emissions from the activity being assessed are no more than 5 dB(A) above the quietest Rating Background Level (RBL). The RNP identifies a methodology from the superseded *Environmental Criteria for Road Traffic Noise* to assess impacts from maximum noise events based on the emergence of the L_{A1} noise level over the $L_{A90\ (15\ min)}$ noise level. The maximum noise event is assessed by comparing predicted noise levels to the L_{A1} criterion as an indication of the potential for sleep disturbance from noise events. The sleep disturbance assessment for the project assumes an RBL value instead of the $L_{A90\ (15\ min)}$ and is calculated as follows:

$L_{A1} \geq L_{A(RBL)} + 15$ dB(A)

From data obtained at Receiver 1874 which has a similar noise environment to receivers nearest the rest areas, the day evening and night time environmental noise levels for L_{Aeq} and RBL have been determined and are presented in **Table 5-22**.

Table 5-22 Environmental noise levels – Section 3

Receiver identification	L_{Aeq} Day dB(A)	L_{Aeq} Evening dB(A)	L_{Aeq} Night dB(A)	L_{A90} RBL Day dB(A)	L_{A90} RBL Evening dB(A)	L_{A90} RBL Night dB(A)
748	54	52	48	34	39	42

The increased noise levels at night are due to the activity of the wildlife in the area and therefore the daytime RBL of 34 dB(A) has been adopted for assessment purposes. The day time background level of 34 dB(A) provides a night time assessment level of 39 dB(A) to meet the intrusive noise goals, and an L_{A1} noise level of 49dB(A) to meet the sleep disturbance criterion.

The layout of the northbound and south bound rest areas is shown in **Figure 5-6**, which includes space for around 10 B-Doubles, as well as car parking bays. The assessment of noise impacts for the rest area has been based on a typical usage of either the north bound or south bound rest areas over any given fifteen minute period, at any time of the day or night. **Table 5-23** presents the data used to estimate the noise impacts from the rest area.

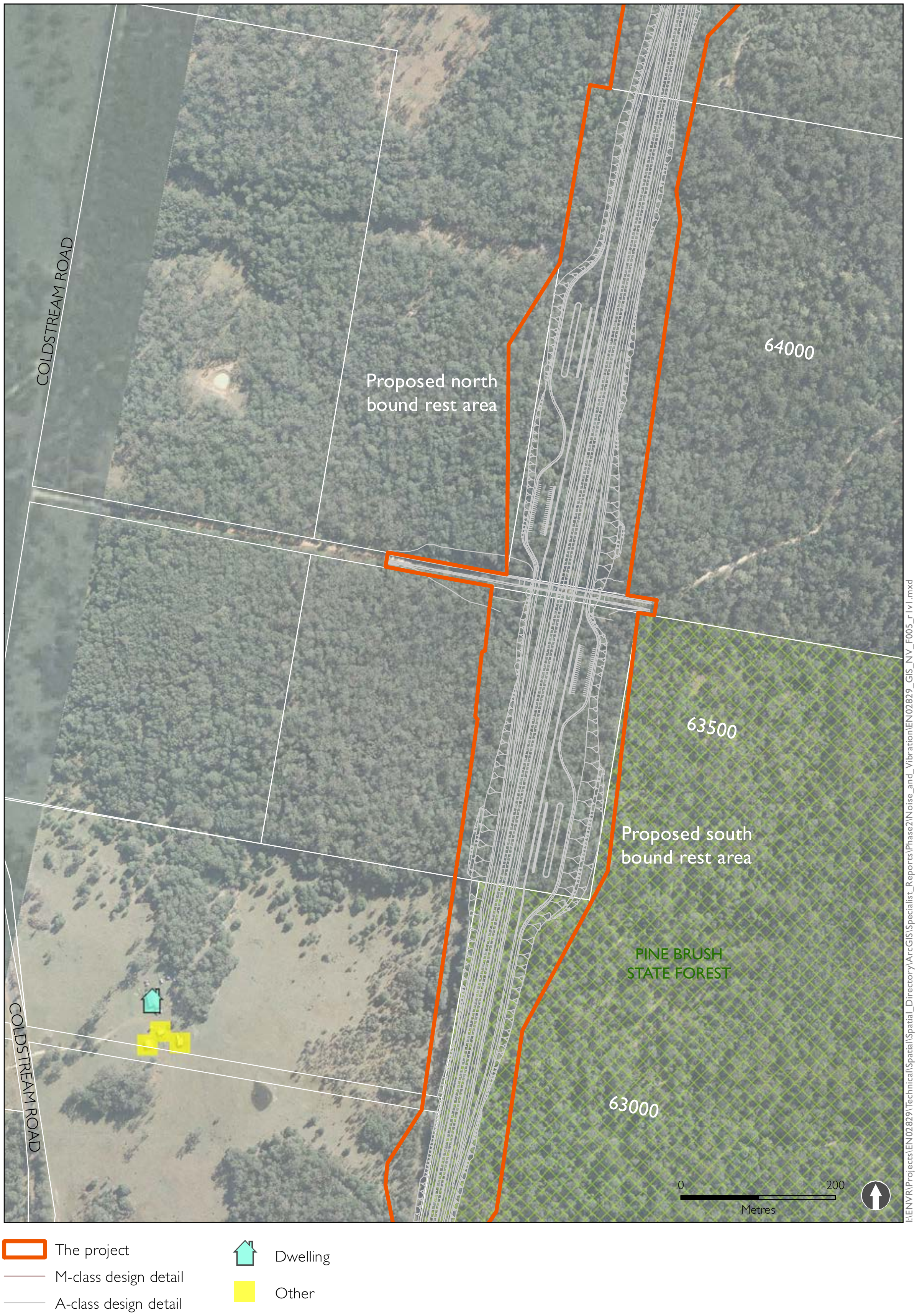
Table 5-23 Noise data for Section 3 rest area assessment

Activity	Estimated Noise Level at 10 m
Truck air brake (bleed off)	88 dB(A)
Truck movement (accelerating)	85 dB(A)
Truck refrigeration unit (continuous)	77 dB(A)
Truck door	76 dB(A)
Car starting	76 dB(A)

The resulting $L_{Aeq\ 15\ minute}$ noise level predicted at the closest receiver location has been estimated based on one of each of the above events occurring in any fifteen minute period. The predicted level for the closest receiver location for the south bound rest area is 32 dB(A). This level is lower than the project noise goal for intrusive noise impacts of 39 dB(A) at this location.

The L_{A1} noise level from the rest area has been predicted based on the worst case event from the above table being the exhaust bleed off from truck brakes. The estimated noise level resulting from this impact is 40 dB(A), and is below the calculated threshold for sleep disturbance impacts of 48 dB(A) for this location.

Figure 5-2 Section 3 rest area location and layout



5.3.5. Calibration of the noise model

The noise model for Section 3 has not been calibrated to the impacts from the existing highway as the receivers for this section would experience new arterial road noise.

5.3.6. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the "build" option for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the table in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-24**. The location of all receivers in section 3, including those identified for mitigation can be seen in **Appendix A**.

Table 5-24 Summary of noise modelling results – Section 3

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	6	6	6
b	9	9	9
c	2	2	2
d	10	10	8
e	8	6	6
f	17	15	10
Total	**52**	**48**	**41**

The receivers in Section 3 of the project are mostly defined by the new road criteria having a night time noise goal of 50 dB(A). Where these receivers are located north of the existing Pacific Highway at Glenugie and south of Tyndale, the Relative Increase Criteria (RIC) would apply providing a lower noise goal based on the existing traffic noise level in this location.

5.3.7. Mitigation measures

The selection of mitigation measures for this section of the project was undertaken by first examining the proximity of residences that have been identified for additional consideration to one another. This is used to determine the feasibility of implementing low noise pavements and/or noise barriers.

For receivers 689 to 767, north of the Glenugie interchange and south of the Tyndale interchange, the distance separating dwellings is generally in excess of 150 metres. These separation distances do not to meet the criteria for closely spaced residences and implementation of noise walls.

At station 45,500 there is a group of seven receivers split by the alignment into three on the western side and four on the eastern side that are spaced over a short distance along the project however the predicted levels for these receivers varies from 5 dB(A) over the base night time noise criterion to 1 dB(A) below with four of these being only marginal exceedances. Low noise pavement in this location would reduce six of the identified receivers to below the project noise goals.

Table 5-25 Summary of traffic noise mitigation measures – Section 3

Receivers	Assessed mitigation measures	Recommended mitigation measures
689-767	Low noise pavement, noise barriers, Architectural Treatment	Architectural treatment to dwellings
772-884	Low noise pavement reduces 23 receivers to night time base noise criterion for the design year	Low noise pavement from station 66,400 to 68,300

The location and extents of low noise pavement recommended for Section 3 are subject to a cost benefit analysis and would be further investigated and confirmed at the detailed design stage.

In Section 3, the residential dwelling at 813 identified for architectural treatment is a heritage item (see Working paper 8 -Historical (non-Aboriginal) Heritage Assessment, item 11). Architectural noise treatment to this receiver would be developed in consultation with a qualified heritage consultant to minimise impacts on the heritage significance of the dwelling, and undertake any further assessment required.

5.4. Section 4 (Tyndale to Maclean)

5.4.1. Operational noise summary

Section 4 is 13 kilometres long, extending from Tyndale to Maclean from station 68,800 to 82,000. The project is located to the east of the existing highway and re-joining it at station 81,200. The location and extents of each of the project sections is presented in Part A, Figure 1-4.

A summary of operational noise impacts for this section are provided here:

- The project in this section is defined as a new road development up to Townsend at station 81,200 where the existing and project alignments merge. From this point north the redeveloped road criteria would apply to adjacent receiver locations

- There are two interchanges located in this stage at Tyndale and McLean. There are no new rest areas identified in Section 4
- The majority of noise sensitive receivers identified in Section 4 are located in Mclean and Townsend
- Some receivers currently experience noise from the existing highway on the opposite side of the dwelling to the new road
- The community of Gulmarrad is located on the eastern boundary of the study area about three kilometres south of Townsend
- The receivers requiring noise mitigation below McLean/Townsend are typically separated by large distances and therefore the use of noise barriers and low noise pavement is not recommended
- Low noise pavements are recommended for use north of the Mclean interchange. Architectural treatments are recommended to treat all other exceedances of the noise criteria in this section.

5.4.2. Receiver locations

The receiver locations for Section 4 of the project are shown in Appendix A. In this section the project passes through and near to the communities of Gulmarrad, Townsend and Mclean. There are around 271 structures identified within the study area, 207 of which have been identified as residential dwellings that fall inside the project boundary. About 90 percent of the identified structures are located in the communities of Maclean and Townsend.

There were seven unattended monitoring locations used to quantify the noise environment in this section. **Table 5-26** lists the locations used in the noise monitoring survey undertaken between February and March 2012. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-26 Summary of unattended noise monitoring locations – Section 4

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
842	58	Pacific Highway , Tyndale	e
849	47	Pacific Highway , Tyndale	f
S4_1	106	O'maras Lane, Gulmarrad	f
892	34	Pacific Highway, Gulmarrad	d
1026	51	Jubilee Street, Townsend	c
1080	411	Scullin Street, Townsend	a

5.4.3. Monitoring results

The monitoring was designed to be representative of Noise Catchment Areas (NCA) defined for use in the assessment of operational and construction noise impacts (see Part A, Section 4.3). Observations during the survey periods indicate that the primary noise source along the existing alignment was from traffic on the existing Pacific Highway.

The results of the traffic noise monitoring at these locations are provided in **Table 5-27**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods and the L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period. The L_{Aeq} descriptors provide information on the existing day and night time noise levels for this section of the project. In particular, the L_{Aeq} 15 hour and nine hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-31**.

Table 5-27 Summary of traffic noise monitoring descriptors – Section 4

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
842	66.9	65.8	65.6	65.0	71.5	74.1
849	69.8	69.2	65.9	64.9	75.1	76.9
S4_1	63.8	63.5	60.0	58.9	68.2	70.4
892	70.3	67.9	67.1	66.4	83.9	84.3
1026	65.0	64.0	61.7	59.8	75.8	75.5
1080	54.0	52.8	57.6	50.1	79.5	76.1

The recorded data for all sites are consistent with expectations of traffic noise levels at the distances identified in **Table 5-26**, with the exception of receiver 1080. At approximately 400 metres from the project, daytime noise levels are higher than expected as the result of bird activity in the area. Maximum noise levels at this distance are not associated with road traffic noise for the day or night measurement periods.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Evans Head weather station for the months of February and March 2012 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.4.4. Modelled traffic scenarios

The predicted traffic data for Section 4 of the project for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-28**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-28 Road traffic data input to noise model for Section 4

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	3469	731	4200	17%	320	496	816	61%
Year opening no build (south bound)	3554	924	4477	21%	348	342	691	50%
Year opening build (north bound)	3469	731	4200	17%	320	496	816	61%
Year opening build (south bound)	3554	924	4477	21%	348	342	691	50%
Design year no build (north bound)	3751	955	4706	20%	346	649	995	65%
Design year no build (south bound)	3862	1211	5073	24%	378	449	827	54%
Design year build (north bound)	3751	955	4706	20%	346	649	995	65%
Design year build (south bound)	3862	1211	5073	24%	378	449	827	54%

Section 4 has a major interchange at Maclean to service the large population in this area. **Table 5-29** presents the predicted hourly average volumes for the on and off ramps with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts for Section 4. The predicted data indicates a heavy usage of the interchange and highway crossing during the day and night.

Table 5-29 Summary of on and off ramp traffic for Section 4

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Maclean interchange east	Service road north	24	20	4	12
	Goodwood Road	204	18	33	13
	Service road south	24	18	4	14
	Maclean interchange link	222	21	34	20
Maclean interchange west	Maclean interchange link	118	11	19	8
	North bound off-ramp	73	11	11	12
	Service road south	18	12	3	12
	Cameron Street	60	10	9	10
2026 Traffic Volumes					
Maclean interchange east	Service road north	24	20	4	12
	Goodwood Road	224	26	36	18
	Service road south	24	18	41	14
	Maclean interchange link	224	32	37	30
Maclean interchange west	Maclean interchange link	129	13	21	10
	Northbound off-ramp	79	14	12	15
	Service road south	18	12	3	12
	Cameron Street	65	12	10	12

5.4.5. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in February 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-30**.

Table 5-30 Noise model calibration data for Section 4

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 4 Calibration - north bound	2876	547	3423	16%	335	396	731	54%
Section 4 Calibration - south bound	2769	791	3560	22%	405	210	615	34%

Table 5-31 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3 dB(A) L_{A10} to L_{Aeq} conversion and a 2.5 dB(A) facade correction where appropriate. The road surface in Section 4 was generally in good condition with areas north of the Maclean turn off up to the bridge crossing of the Clarence River exhibiting signs of age and wear.

In Section 4, the road surface is generally spray seal with a few small areas of dense grade asphalt. The modelling was given a nominal +2.5 dB(A) correction for the spray seal and 0 dB(A) correction for the dense grade sections. The model assumed 90 per cent soft ground for the calibration based on the location of the noise loggers in well vegetated areas. A correction of 75 per cent soft ground for the modelling of the 2016 and 2026 scenarios has been assumed to account for drier seasonal variation. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-31 Comparison of measured and modelled road traffic noise levels – Section 4

Receiver identification	Day L_{Aeq} (15h) dB(A)			Night L_{Aeq} (9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
842	65.6	66.6	1	65	64.1	-0.9
849	65.9	67	1.1	64.9	64.5	-0.4
S4_1	60	61.8	1.8	58.9	59.3	0.4
892	67.1	68.8	1.7	66.4	66.3	-0.1
1026	61.7	63.5	1.8	59.8	61	1.2
1080	57.6	53.6	-4	50.1	51	0.9
Median of results			**1.4**			**0.1**
Standard Deviation			**2.3**			**0.8**

The differences between the predicted daytime noise levels are generally higher than those for night time. Greater variability is expected for daytime noise levels which are less likely to have free flowing traffic at the posted speeds due to the single north bound and south bound lanes for most of this section. At night time traffic is more likely to reach posted speeds and therefore provide a better correlation between traffic numbers and predicted levels.

The receiver at location 1080 is over 400 metres from the project. At this distance, other non traffic related noise sources provide a higher contribution to the measured noise level making calibration at these distances ineffective.

5.4.6. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-32**. The location of all receivers in Section 4, including those identified for mitigation can be seen in **Appendix A**.

Table 5-32 Summary of noise modelling results – Section 4

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	21	1	1
b	20	2	2
c	23	19	6
d	27	17	9
e	80	5	1
f	79	4	2
Total	**250**	**48**	**21**

The modelling results include the application of low noise pavement from station 80,500 to 82,500 resulting in 11 properties requiring additional noise mitigation.

5.4.7. Mitigation measures

The selection of noise reduction measures for the Tyndale to Maclean (Section 4) of the Project, considers the close proximity of residences in Townsend that have been identified for further assessment of mitigation options. A low noise pavement from station 80,500 to 82,500 for Section 4 would result in 28 properties having the predicted noise levels reduced below the night time nose criteria and would provide additional benefit to other receivers in this catchment area. This reduces the number of receivers requiring additional mitigation for Section 4 to 17 dwellings. These receivers are located sporadically throughout this section of the project and therefore architectural treatment is recommended to mitigate these additional exceedances.

Table 5-33 Summary of traffic noise mitigation measures – Section 4

Receivers	Assessed mitigation measures	Recommended mitigation measures
898-1238	Low noise pavement, Architectural treatment	Low noise pavement, Architectural treatment

Receivers	Assessed mitigation measures	Recommended mitigation measures
All other receivers	Architectural treatment	Architectural treatment

The location and extents of low noise pavement recommended for Section 4 are subject to a cost benefit analysis and would be further investigated and confirmed at the detailed design stage.

In Section 4, the residential dwelling at 1026 identified for architectural treatment is a heritage item (see Working paper 8 -Historical (non-Aboriginal) Heritage Assessment, item 34). Architectural noise treatment to this receiver would be developed in consultation with a qualified heritage consultant to minimise impacts on the heritage significance of the dwelling, and undertake any further assessment required.

5.5. Section 5 (Maclean to Iluka Road, Mororo)

5.5.1. Operational noise summary

Maclean to Iluka Road, Mororo (Section 5) is about 13 kilometres long, extending from Maclean to Iluka Road, Mororo between station 82,000 km and 94,600 km. The project follows the existing Pacific Highway in this section, crossing the Clarence River to the south and north of Chatsworth Island. For the project location of this section, refer to Part A, Figure 1-2.

A summary of operational noise impacts for Section 5 are provided here:

- The project in this section follows the existing alignment and is defined as a road redevelopment
- There are existing north and south bound on and off ramps on the southern side of the existing bridge at Harwood, and two interchanges located at Harwood and Iluka Road, Mororo. A further high level bridge crossing would be constructed to the east of the existing bridge crossing of the Clarence River at Harwood.
- The existing bridge at Harwood would remain in its current location, continuing to open and close for water traffic, as necessary
- Noise sensitive receivers identified in Section 5 are largely concentrated in Harwood and Mororo with some receivers in the northern half of Townsend not included in the Section 4 assessment. At Mororo, the majority of receivers identified are located within the Woombah Woods Caravan Park
- Receivers in Section 5 currently experience noise from the existing highway

- Low noise pavements are recommended for receivers requiring noise mitigation in Townsend and Harwood. Architectural treatments are recommended to treat all other exceedances of the noise criteria in this section.

5.5.2. Receiver locations

The receiver locations for Section 5 of the project are shown in Appendix A. In this section the project passes through and near to the communities of Townsend and Harwood and Mororo/Woombah. There are around 243 structures identified within the study area, 215 of which have been identified as residential dwellings that fall inside the 600 metre study boundary and are eligible for assessment.

There are 7 unattended monitoring locations used to quantify the noise environment in this section. **Table 5-34** lists the locations used in the noise monitoring survey undertaken in February 2012. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-34 Summary of unattended noise monitoring locations – Section 5

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
1331	69	Petticoat Lane, Harwood	d
1396	141	Morpeth Street, Harwood	c
1438	16	Pacific Highway, Chatsworth	d
1461	460	Chatsworth Road, Chatsworth	f
1471	109	Old Pacific Highway, Woombah	c
1523	490	Iluka Road, Woombah	a

5.5.3. Monitoring results

The monitoring was undertaken at locations designed to be representative of the Noise Catchment Areas (NCA) defined for use in the assessment (see Part A, Section 4.3).

Observations during the survey periods indicate that the primary noise source along the Pacific Highway was due to road traffic. At receiver 1523, the dwelling is located around 490 metres from the existing highway and is surrounded by thick bush. Traffic noise from the highway was not the dominant influence at this location and therefore it has not been used in the calibration of the noise model.

The results of the traffic noise monitoring at these locations are provided in **Table 5-35**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods and the L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-39**.

Table 5-35 Summary of traffic noise monitoring descriptors – Section 5

Receiver Identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
1331	61.7	62.8	59.3	58.6	76.6	75.2
1396	59.0	58.1	57.4	55.1	82.2	78.3
1438	75.9	70.3	72.3	71.4	87.2	87.6
1461	50.1	44.6	53.3	45.5	73.3	60.4
1471	60.4	61.9	57.7	58.1	69.1	69.8
1523	49.8	53.0	48.1	52.5	58.9	57.7

The recorded data for all sites are generally consistent with expectations of traffic noise levels at the distances identified in **Table 5-34**. As with the most locations beyond about 250 metres, day or night noise levels may be inconsistent with predicted traffic noise levels due to the influence of other non-vehicle based sources such as birds, insects and wind effects on trees. Locations 1461 and 1523 are both located at distances of greater than 400 metres from the existing Pacific Highway and are therefore not used in the calibration of the noise model.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Grafton weather station for the month of February 2012 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.5.4. Modelled traffic scenarios

The predicted traffic data for Section 5 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-36**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-36 Road traffic data input to noise model for Section 5

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	4418	828	5246	16%	405	518	923	56%
Year opening no build (south bound)	4508	1087	5595	19%	393	364	757	48%
Year opening build (north bound)	2847	657	3505	19%	261	412	673	61%
Year opening build (south bound)	3065	875	3940	22%	268	293	561	52%
Design year no build (north bound)	4757	1084	5841	19%	436	678	1114	61%
Design year no build (south bound)	4872	1427	6298	23%	425	477	902	53%
Design year build (north bound)	3089	859	3948	22%	283	538	821	66%
Design year build (south bound)	3336	1144	4479	26%	291	383	674	57%

There are no new rest areas planned for the Maclean to Iluka Road, Mororo (Section 5) upgrade, which has two new interchanges planned for the Harwood and Mororo areas. The existing on and off ramps on the southern side of the proposed bridge crossing of the Clarence River would remain with an additional interchange about 550 metres north of the Harwood Bridge. At Mororo an additional interchange allows vehicles to enter and exit to and from Iluka Road

Table 5-37 presents the predicted hourly average volumes for the on and off ramps and service roads with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts. The predicted data indicates only light usage of the on and off ramps during the night time hours for this interchange.

Table 5-37 Summary of on and off ramp traffic for Section 5

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Watts Lane interchange east	SB off-ramp	52	6	7	3
	Watts Lane	141	20	20	11
	Watts Lane Interchange	116	15	17	9
Watts Lane interchange west	Watts Lane Interchange	49	18	8	15
	Service Road South	24	16	4	16
	Watts Lane West	18	12	3	12
	Service Road North	24	17	4	15
Watts Lane/ service road	Service Road North	12	10	2	6
	Watts Lane East	143	25	21	14
	Watts Lane West	46	20	22	21
Middle Street service road	Middle Street East	76	12	11	7
	Service Road	12	9	2	7
	Middle Street west	76	11	12	9
Illuka interchange east	SB off-ramp	22	12	3	7
	Middle Street	70	7	10	4
	Illuka Interchange Link	66	10	10	8
Illuka interchange east	Illuka Interchange Link	28	13	4	9
	NB off-ramp	78	17	12	17
	Service Road North	18	12	3	12
2026 Traffic Volumes					
Watts Lane interchange east	SB off-ramp	58	10	8	5
	Watts Lane	155	35	23	19
	Watts Lane Interchange	128	27	19	15
Watts Lane interchange west	Watts Lane Interchange	52	22	8	18
	Service Road South	24	26	4	16
	Watts Lane West	18	12	3	12
	Service Road North	24	17	4	15
Watts Lane/ service road	Service Road North	12	10	2	6
	Watts Lane East	157	39	23	22
	Watts Lane West	160	32	25	34
Middle Street/service Road	Middle Street East	82	18	12	10
	Service Road	12	9	2	7
	Middle Street west	83	15	12	14
Illuka	SB off-ramp	23	13	4	8

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
interchange east	Middle Street	77	13	12	7
	Illuka Interchange Link	72	13	11	11
Illuka interchange east	Illuka Interchange Link	30	16	5	12
	NB off-ramp	84	20	13	20
	Service Road North	18	12	3	12

5.5.5. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in February 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-38**.

Table 5-38 Noise model calibration data for Section 5

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 5 Calibration (north bound)	3254	542	3796	14%	341	380	721	53%
Section 5 Calibration (south bound)	2342	1725	4067	42%	236	349	585	60%

Table 5-39 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3dB(A) L_{A10} to L_{Aeq} conversion and a +2.5 dB(A) facade correction where appropriate. The road surface was noted as spray seal for the section with some plain concrete pavement at Iluka Road. A +2.5 dB(A) correction for spray seal was applied and a +3 dB(A) correction was added for concrete.

The calibration model assumes 90 per cent soft ground in recognition of the highly vegetated and well covered study area and 75 per cent soft ground is assumed for future year scenarios. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-39 Comparison of measured and modelled road traffic noise levels – Section 5

Receiver identification	Day L_{Aeq} (15h) dB(A)			Night L_{Aeq} (9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
1331	59.3	61.9	2.6	58.6	59.2	0.6
1396	57.4	58.9	1.5	55.1	55.7	0.6
1438	72.3	73.9	1.6	71.4	69.8	-1.6
1471	57.7	60.6	2.9	58.1	56.9	-1.2
Median of results			**2.1**			**-0.3**
Standard Deviation			**0.7**			**1.2**

Generally consistent results for each location for the day and night time indicate that the model predictions are acceptable. As with the Section 4, the day time results are higher at all locations. This is expected to be due to a combination of the volume of traffic on the road and the single lane north and south bound carriageways causing restricted movement of some vehicles. These restrictions may cause some variation to the posted speeds during the daytime whereas night time traffic is able to flow more freely at highway speeds resulting in a better correlation.

5.5.6. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the proposal. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table** 5-40. The location of all receivers in section 5, including those identified for mitigation can be seen in **Appendix A**.

Table 5-40 Summary of noise modelling results – Section 5

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	64	1	0
b	65	6	0
c	23	8	8
d	30	9	5
e	23	2	0

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
f	10	0	0
Total	215	26	13

There are potentially 11 required property acquisitions and 17 commercial receivers identified in Section 5. The noise modelling for this section includes the application of low noise pavement from the southern end of the bridge crossing over the Clarence River at Harwood to the new Harwood interchange. After the application of the low noise pavement, 10 receiver locations have been identified as requiring additional mitigation to reduce noise levels to the base criteria.

All of the 10 receiver locations are predicted to experience an acute noise impact for the 2026 build option. Of these eight receivers are predicted to already exceed the acute night time noise criteria as the result of the existing traffic noise levels from the no build option.

5.5.7. Mitigation measures

There are around 10 properties along the project that would require additional treatment after the application of the low noise pavement through Harwood from station 85,900 to 88,000 however; none of the properties requiring additional mitigation are located in the Harwood community.

The selection of mitigation measures for these receivers is influenced by their proximity to each other and their location with respect to the project. Five of the 10 receivers requiring additional mitigation that are predicted to experience acute noise levels are located in Iluka Road, Woombah.

In this location the application of low noise pavement from the northern approach to the bridge crossing of the Clarence River up to Iluka road would reduce all five receivers to below the project base criteria. Where the application of low noise pavement is not feasible or reasonable, a dense grade asphaltic concrete in place of low noise pavement would reduce noise impacts at 4 of the receiver locations to levels below the night time acute noise criterion.

The benefits of pavement selection in this location would also be shared by an additional six residences not requiring mitigation as well as the guests and residents of the Woombah Woods Caravan Park. Noise walls in this location do not provide the minimum noise reduction due to the height of receivers being on average 12 metres higher than the road.

The balance of receivers requiring additional mitigation is single residences and therefore architectural treatment is recommended to achieve internal noise level goals.

Table 5-41 Summary of traffic noise mitigation measures – Section 5

Receivers	Assessed mitigation measures	Recommended mitigation measures
1259-1407	Low noise pavement, Noise barriers, Architectural treatment	Low noise pavement between station 85,900 and 88,000
1471-1483	Low noise pavement, Noise barriers, Architectural treatment	Low noise pavement between station 85,900 and 88,000
All other receivers	Low noise pavement, Noise barriers, Architectural treatment	Architectural treatment to dwellings

The location and extents of low noise pavement recommended for Section 5 are subject to a cost benefit analysis and would be further investigated and confirmed at the detailed design stage.

5.6. Section 6 (Iluka Road to Devils Pulpit upgrade)

Iluka Road to Devils Pulpit upgrade (Section 6) is around nine kilometres long, extending from Iluka Road, Mororo to the southern end of Devils Pulpit upgrade. For a location of this section in graphical terms, refer to Part A, Figure 1-2.

A summary of operational noise impacts for Section 6 are provided here:

- The project in this section follows the existing alignment and is defined as a road redevelopment
- There is a new rest areas identified in Section 6 at station 100,400
- Noise sensitive receivers identified for the Iluka Road to Devils Pulpit upgrade are concentrated at each end of the project study area
- Receivers in Section 6 currently experience noise from the existing highway
- Low noise pavements are not recommended for receivers requiring noise mitigation due to the distances between dwellings. Architectural treatments are recommended to treat exceedances of the noise criteria in this section.

5.6.1. Receiver locations

The receiver locations for section 6 of the project are shown in Appendix A. In this section the project passes through the community of Mororo as well as the Mororo State Forest and the Devils Pulpit State Forest.

Seven residential dwellings that fall inside the project study area have been identified for Section 6. Five of these receivers are located in the northern third of the project with the remaining two receivers in the southern third. The middle third is dedicated to the Mororo State Forest and is densely vegetated.

There was one unattended monitoring location used to quantify the noise environment in this section, which has been listed in **Table 5-42**. This receiver is located approximately 75 metres from the existing highway and is the closest receiver within this section. The location of the noise monitoring site for Section 6 is presented in the receiver location map series in Appendix A.

Table 5-42 Summary of unattended noise monitoring locations – Section 6

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
1542	75	Pacific Highway, Jackybulbin	c

5.6.2. Monitoring results

Observations during the survey period indicate that the primary noise source at this location is due to traffic on the existing Pacific Highway. The results of the traffic noise monitoring at this location are provided in **Table 5-43**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time and the L_{Amax} noise levels provide an indication of the maximum noise levels recorded at the monitoring site. The L_{Aeq} descriptors provide information on the day and night time noise levels attributed to traffic noise at this location. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-48**.

Table 5-43 Summary of traffic noise monitoring descriptors – Section 6

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
1542	65.6	64.4	62.5	61.3	73.4	74.0

The recorded data for this site is consistent with expectations of traffic noise levels at this distance. The consistent L_{Amax} noise levels for both day and night provide an indication of traffic noise

Meteorology

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Evans Head weather station for the month of February 2012 to determine the influence of adverse weather on the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered invalid due to unfavourable weather conditions were removed from the data set.

5.6.3. Modelled traffic scenarios

The predicted traffic data for Section 6 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-44**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-44 Road traffic data input to noise model for Section 6

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	2495	684	3179	22%	206	426	632	67%
Year opening no build (south bound)	2513	906	3418	26%	221	307	529	58%
Year opening build (north bound)	2495	684	3179	22%	206	426	632	67%
Year opening build (south bound)	2513	906	3418	26%	221	307	529	58%
Design year no build (north bound)	2733	896	3629	25%	225	558	783	71%
Design year no build (south bound)	2765	1183	3948	30%	244	401	645	62%
Design year build (north bound)	2733	896	3629	25%	225	558	783	71%
Design year build (south bound)	2765	1183	3948	30%	244	401	645	62%

Section 6 has no interchange but has a south bound rest area located at station 100,400 km. The rest area is situated at the edge of the Mororo State Forest and is located around 1.8 kilometres the south and about 2 kilometres to the north of the nearest receivers in Section 6.

The assessment for noise emissions from the rest area considers intrusive noise impacts such as the operation of truck mounted refrigeration units and low speed truck movements, and sleep disturbance from maximum noise level events such as the use of air brakes. The assessment for intrusiveness is taken from the NSW, *Industrial Noise Policy* (INP), while the assessment of potential sleep disturbance is taken from the Environmental Criteria for Road traffic noise (ECRTN) both of these assessment methods use information on the existing environment to determine the appropriate noise criteria. For more detail on the assessment of rest areas see **Section 2.2.5** in Part A of this report.

The assessment of intrusive noise impacts in accordance with the INP requires that the $L_{Aeq\ 15\ min}$ noise emissions from the activity being assessed are no more than 5 dB(A) above the quietest Rating Background Level (RBL). The RNP identifies a methodology from the superseded *Environmental Criteria for Road Traffic Noise* to assess impacts from maximum noise events based on the emergence of the L_{A1} noise level over the $L_{A90\ (15\ min)}$ noise level. The maximum noise event is assessed by comparing predicted noise levels to the L_{A1} criterion as an indication of the potential for sleep disturbance from noise events. The sleep disturbance assessment for the project assumes an RBL value instead of the $L_{A90\ (15\ min)}$ and is calculated as follows:

$L_{A1} \geq L_{A(RBL)} + 15$ dB(A)

From data obtained at receiver 1874 which has a similar noise environment to receivers nearest the rest areas, the day evening and night time environmental noise levels for L_{Aeq} and RBL have been determined and are presented in **Table 5-78**.

Table 5-45 Environmental noise levels – Section 6

Receiver Identification	L_{Aeq} Day dB(A)	L_{Aeq} Evening dB(A)	L_{Aeq} Night dB(A)	L_{A90} RBL Day dB(A)	L_{A90} RBL Evening dB(A)	L_{A90} RBL Night dB(A)
1542	64	61	62	46	42	46

The night tie noise levels at this location are heavily influenced by the existing highway. The RBL for evening of 42dB(A) has been adopted for the assessment of noise impacts from the proposed rest area. The RBL for evening provides a night time assessment level of 47 dB(A) to meet the intrusive noise goals, and an L_{A1} noise level of 59 dB(A) to meet the sleep disturbance criterion.

The layout of the south bound rest area is shown in **Figure 5-6** includes space for 10 B-Double trucks and additional car parking bays. The assessment of noise impacts for the rest area has been based on normal utilisation of south bound rest area during the day or night for any given fifteen minute period.

Table 5-46 presents the data used to estimate the noise impacts from the rest area.

Table 5-46 Noise data for Section 6 rest area assessment

Activity	Estimated noise level at 10 m
Truck air brake (bleed off)	88 dB(A)
Truck movement (accelerating)	85 dB(A)
Truck refrigeration unit (continuous)	77 dB(A)
Truck door	76 dB(A)
Car starting	76 dB(A)

The nearest receivers are located between 1.8 and 2 kilometres away from the rest areas in Section 6. The noise level has been estimated based on one of each of the events in **Table 5-46** occurring once in any fifteen minute period. This results in an $L_{Aeq\ 15\ minute}$ noise level at the closest receiver location of less than 30 dB(A), which is lower than the project noise goal of 47 dB(A) for intrusive noise.

The L_{A1} noise level from the rest area has been predicted based on the worst case event from **Table 5-46** due to the exhaust bleed off from truck brakes. The estimated noise level resulting from this impact is predicted to be less than 30 dB(A), and is below the calculated threshold for sleep disturbance impacts of 59 dB(A) for this location.

Figure 5-3 Section 6 rest area location and layout

5.6.4. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in February 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-47**.

Table 5-47 Noise model calibration data for Section 6

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 6 calibration (north bound)	2751	570	3321	17%	334	366	700	52%
Section 6 calibration (south bound)	2722	828	3550	23%	379	199	578	34%

Table 5-48 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3dB(A) L_{A10} to L_{Aeq} conversion and a 2.5 dB(A) facade correction where appropriate. The road surface was noted as spray seal and given a nominal +2.5 dB(A) correction for noise. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-48 Comparison of measured and modelled road traffic noise levels – Section 6

Receiver identification	Day L_{Aeq} (15h) dB(A)			Night L_{Aeq} (9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
1542	62.5	61.9	-0.6	61.3	59	-2.3

At the logger location traffic noise is the primary noise source however, during the quieter periods at night, frog and insect noise contribute to the ambient noise environment to maintain higher L_{Aeq} noise levels. Where these effects are present, they artificially increase the night time noise levels and would tend to cause an under prediction in the model when calibrated for traffic noise alone.

A review of the monitoring data for this location indicates that other non vehicle based noise influences are present in the measurements for night time impacts. While the contribution of these influences is not able to be specifically confirmed, the calibration of the model for traffic noise alone is considered to be appropriate for the prediction of future noise levels.

5.6.5. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the "build" and "no build" options for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-49**. The location of all receivers in Section 6, including those identified for mitigation can be seen in **Appendix A**.

Table 5-49 Summary of noise modelling results – Section 6

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	1	1	0
b	2	2	0
c	1	1	1
d	0	0	0
e	3	3	0
f	0	0	0
Total	**7**	**7**	**1**

There are no property acquisitions or commercial receivers in this section with all the receivers identified as residential dwellings. The noise modelling predictions indicate that there would be one exceedance of the base noise goals. This receiver location currently exceeds the night time criteria for acute noise impacts, and the future noise levels are also predicted to exceed for the 2026 design year.

5.6.6. Mitigation measures

The selection of mitigation measures for the single residence is limited to architectural treatments (see Part A, Section 3.1.5).

Table 5-50 Summary of traffic noise mitigation measures – Section 6

Receivers	Assessed mitigation measures	Recommended mitigation measures
1542	Architectural treatment	Architectural treatment to dwelling

5.7. Section 7 (Devils Pulpit upgrade to Trustums Hill)

Section 7 is around 15.3 kilometres long, extending from the northern end of Devils Pulpit upgrade to just south of Gap Road, Trustrums Hill. For a location of this section in graphical terms, refer to Part A, Figure 1-7.

A summary of operational noise impacts for this section are provided here:

- The project in this section follows the existing alignment and is defined as a road redevelopment
- There are no new rest areas or interchanges identified in Section 7
- The majority of the noise sensitive receivers identified for the Devils Pulpit upgrade to Trustums Hill (Section 7), are located in the northern half of the project study area
- Receivers in Section 7 currently experience noise from the existing highway
- Low noise pavements are not recommended for receivers requiring noise mitigation due to the distances between dwellings. Architectural treatments are recommended to treat exceedances of the noise criteria in this section.

5.7.1. Receiver locations

The receiver locations for Section 7 of the project are shown in Appendix A. In this section the project alignment passes through and near to the communities of New Italy and The Gap. This section also takes in the Tabbimoble State Forest in the southern end of the study area and covers about half of the alignment between the Devils Pulpit upgrade to Trustums Hill.

There are 32 structures identified within the study area, 30 of which have been identified as residential dwellings that fall inside the project study boundary. About 28 of the identified dwellings are located in the northern half of Section 7.

There are four unattended monitoring locations used to quantify the noise environment in this section. **Table 5-51** lists the locations used in the noise monitoring survey undertaken during February 2012. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-51 Summary of unattended noise monitoring locations – Section 7

Receiver Identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
1546	47	Devils Pulpit	d
1557	25	Pacific Highway, Tabbimoble	c

Receiver Identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
1591	68	The Gap	c
1592	310	Whites Road, New Italy	e

5.7.2. Monitoring results

The monitoring was undertaken various distances from the existing highway outlined in **Table 5-51** and design to be representative of the of Noise Catchment Areas (NCA) defined for use in the assessment of operational and construction noise impacts (see Part A, Section 4.3).

Observations during the survey periods indicate that the primary noise source along the existing alignment was due to traffic on the Pacific Highway. At further distances traffic noise was still audible but was not always the dominant noise source.

The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time and the L_{Amax} noise levels provide an indication of the maximum noise levels recorded at the monitoring site. The L_{Aeq} descriptors provide information on the day and night time noise levels attributed to traffic noise at this location. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in

The results of the traffic noise monitoring at these locations are provided in **Table 5-52**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods although these values are not considered in the noise assessment. The L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-55**.

Table 5-52 Summary of traffic noise monitoring descriptors – Section 7

Receiver Identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
1546	63.1	60.3	59.7	58.0	71.7	71.9
1557	68.0	64.6	65.9	63.8	79.0	79.4
1591	63.9	61.6	60.9	59.4	74.2	74.1
1592	55.3	55.0	53.7	53.3	60.7	60.3

The receiver at 1546 is located in the Devils Pulpit upgrade area and is situated around 60 metres from the road. This receiver is located outside of the project study area for this section and has been included for information only on noise levels for this section. The recorded data for the other three sites are consistent with expectations of traffic noise levels at the distances identified in **Table 5-51**. The recorded L_{Amax} noise levels are consistent for both day and night indicating that road traffic is the primary influence at these sites.

At receiver 1592 noise levels at night time were influenced by frogs and other insects, which is expected to provide an over estimate of noise attributable to road traffic during this time.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Grafton weather station for the month of February 2012 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.7.3. Modelled traffic scenarios

The predicted traffic data for Section 7 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-53**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-53 Road traffic data input to noise model for Section 7

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	2522	685	3208	21%	179	425	603	70%
Year opening no build (south bound)	2510	902	3412	26%	224	311	535	58%
Year opening build (north bound)	2522	685	3208	21%	179	425	603	70%
Year opening build (south bound)	2510	902	3412	26%	224	311	535	58%
Design year no build (north bound)	2762	898	3660	25%	196	556	752	74%
Design year no build (south bound)	2763	1178	3940	30%	246	406	653	62%

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Design year build (north bound)	2762	898	3660	25%	196	556	752	74%
Design year build (south bound)	2763	1178	3940	30%	246	406	653	62%

5.7.4. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in February 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-54**.

Table 5-54 Noise model calibration data for Section 7

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 7 Calibration north bound	2751	570	3321	17%	334	366	700	52%
Section 7 Calibration (SB)	2722	828	3550	23%	379	199	578	34%

Table 5-55 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3dB(A) L_{A10} to L_{Aeq} conversion and a 2.5 dB(A) facade correction where appropriate. The road surface in Section 7 typically is in fair condition with pot hole repairs apparent around New Italy also occurring occasionally north to The Gap. The modelling was given a nominal +2.5 dB(A) correction to account for a spray seal surface. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-55 Comparison of measured and modelled road traffic noise levels – Section 7

Receiver Identification	Day L_{Aeq}(15h) dB(A)			Night L_{Aeq}(9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
1557	65.9	66.2	0.3	63.8	63.3	-0.5
1591	60.9	62.6	1.7	59.4	60.1	0.7
1592	53.7	54.7	1.0	53.3	52.2	-1.1
Median of results			**1.0**			**-0.5**
Standard Deviation			**0.7**			**0.9**

The calibration exercise indicates the noise model predictive accuracy is acceptable for use in the prediction of future impacts for this section. As noted earlier, the receiver at location 1592 experiences a contribution to the night time noise levels from the local wildlife. The calibration at this location is however, still within modelling tolerances.

5.7.5. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**., A summary of the results presented in **Table 5-56**. The location of all receivers in Section 7, including those identified for mitigation can be seen in **Appendix A**.

Table 5-56 Summary of noise modelling results includes – Section 7

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	0	0	0
b	6	5	3
c	10	10	10
d	8	8	8
e	2	1	0
f	3	0	0
Total	**29**	**24**	**21**

The number of receivers predicted to require noise mitigation in this section is evenly split on opposite sides of the highway. These receivers are distributed over about six kilometres adjacent to the project, generally being single residences with distances of greater than 200 metres separating the dwellings. At station 119,500 there are three residences within about 180 metres of each other and are not considered to be closely spaced.

Of the 17 identified receivers, only five are predicted to have noise levels below the night time acute noise criterion for the design year for the no build scenario.

5.7.6. Mitigation measures

The selection of mitigation measures for this section of the project considers the separation distance of residences that have been identified for further assessment of mitigation measures. The application of low noise pavements would reduce the predicted noise levels to below the night time base noise criteria at all but one receiver location. **Table 5-57** lists the assessed and recommended noise mitigation measures for Section 7 of the project.

Table 5-57 Summary of traffic noise mitigation measures for Section 7

Receivers	Assessed mitigation measures	Recommended mitigation measures
All	Low noise pavements, noise walls, Architectural treatment	Architectural treatments to dwellings

5.8. Section 8 (Trustums Hill to Broadwater National Park)

Section 8 is around 11 kilometres long, extending from just south of Gap Road to Broadwater National Park. This section of the project leaves the existing highway at Trustums Hill and crosses the Tuckomobil Canal to bypass the township of Woodburn to the south. The highway passes to the west of Broadwater National Park and re-joins the existing highway before entering the park. For the location of this section refer to Part A, Figure 1-8.

A summary of operational noise impacts for this section are provided here:

- The project in Section 8 would be a combination of road duplication within the existing boundary and new road development in a realigned road boundary to the east of the existing highway, which bypasses the town of Woodburn
- There is one new interchange located just south of Trustums Hill. There are no new rest areas in Section 8
- The majority of noise sensitive receivers are located in the southern third of the section. These receivers are located near the existing highway and therefore currently experience noise from road traffic to some degree

- Some receivers currently experience noise from the existing highway on the opposite side of the dwelling to the project
- The community of The gap and Trustums Hill is located on the eastern boundary of the 600 metre study area about three kilometres south of Townsend
- The receivers requiring noise mitigation are typically separated by large distances and therefore the use of noise barriers and low noise pavement is not recommended.
- Architectural treatments are recommended to treat exceedances of the noise goals in this section.

5.8.1. Receiver locations

The receiver locations for Trustums Hill to Broadwater National Park (Section 8) project are shown in Appendix A. In this section the project passes through and near to the communities of The Gap, Trustums Hill and the western outskirts of Doonbah. There are structures identified within the 600 metre study area, 40 of which have been identified as residential dwellings that fall inside the study area.

There are eight unattended monitoring locations used to quantify the noise environment in this section. **Table 5-58** lists the locations used in the noise monitoring survey undertaken between February and March 2012. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-58 Summary of unattended noise monitoring locations – Section 8

Receiver identification	Distance to existing highway Highway	Location	Represented noise catchment area (NCA)
S8_1	650	The Gap Road, Trustums Hill	-
1624	350	The Gap Road, Trustums Hill	b
1631	120	The Gap Road, Trustums Hill	c
1698	85	Trustums Hill Road, Woodburn	e
1724	1200	Woodburn Evans Head Road, Woodburn	e
S8_2	350	Pacific Highway, Broadwater	f

5.8.2. Monitoring results

The monitoring was undertaken at generally larger distances from the existing highway in Section 8. The project in this section deviates from the existing alignment to bypass Woodburn and does not re join the existing highway until the end of the section within Broadwater National Park. The monitoring undertaken for this section represents some locations with highway noise influences and some with levels affected by other smaller arterial roads.

The results of the traffic noise monitoring at these locations are provided in **Table 5-59**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods although these values are not considered in the noise assessment. The L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-63**.

Table 5-59 Summary of traffic noise monitoring descriptors – Section 8

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
S8_1	49.6	51.4	49.5	51.8	60.3	57.5
1624	49.2	50.9	51.1	50.8	61.4	56.4
1631	60.0	53.6	60.8	53.7	68.9	62.4
1698	63.4	60.5	59.7	57.9	72.6	72.8
1724	54.8	54.8	55.2	53.4	65.7	63.1
S8_2	53.3	50.2	54.1	49.7	68.3	61.9

The recorded data for all sites are consistent with expectations of traffic noise levels at the closer distances. Receivers at S8_1, 1624 and 1631 are located perpendicular to the highway at the Gap Road. These receivers have distances of 650, 350 and 120 metres from the highway respectively. It is important to note that the receivers at 650 and 350 have very similar noise levels with the furthest receiver recording marginally higher levels. At Receiver 1631 daytime noise levels were affected by cicadas and crickets causing an abnormal day time noise level when compared to traffic noise alone.

At distances beyond about 300 metres from the highway, traffic noise tends to become a contributing noise source rather than a primary or dominant noise source. During the survey, road traffic noise from the existing highway was audible at S8_1 and 1624 as a low rumble for most heavy vehicle movements during the night time. Maximum noise events from road traffic were not observed at the further distances. Car movements were not able to be distinguished at the further distances.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Evans Head weather station for the month of March 2012 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.8.3. Modelled traffic scenarios

The predicted traffic data for Section 8 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-60**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-60 Road traffic data input to noise model for Section 8

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	3080	714	3794	19%	284	470	754	62%
Year opening no build (south bound)	3062	1055	4117	26%	304	333	637	52%
Year opening build (north bound)	1991	592	2583	23%	184	389	573	68%
Year opening build (south bound)	2042	866	2908	30%	203	273	476	57%
Design year no build (north bound)	3375	935	4311	22%	312	616	927	66%
Design year no build (south bound)	3362	1382	4744	29%	334	436	770	57%
Design year build (north bound)	2195	774	2969	26%	203	509	712	72%
Design year build (south bound)	2258	1131	3389	33%	224	356	581	61%

Section 8 has an interchange at station 128,500. **Table 5-61** presents the predicted hourly average volumes for the on and off ramps for this interchange, with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts.

Table 5-61 Summary of on and off ramp traffic for Section 8

Interchange Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Woodburn interchange eastern roundabout	SB off-ramp	24	20	4	12
	Service road north	18	15	3	9
	Service road south	18	15	3	9
	Wardell interchange link	57	13	9	10
Woodburn interchange western roundabout	Wardell interchange link	18	14	3	10
	Northbound off-ramp	69	18	9	19
	Service road south	18	12	3	12
	Service road north	58	12	7	12
Evans Head Broadwater Road/ service link road	Evans Head Broadwater Road west	59	12	9	10
	Service road north	18	14	3	10
	Evans Head Broadwater Road east	57	12	9	10
	Service road south	18	13	3	11
2026 Traffic Volumes					
Woodburn interchange eastern roundabout	Southbound off-ramp	24	20	4	12
	Service road north	18	15	3	9
	Service road south	18	15	3	9
	Wardell interchange link	62	17	9	12
Woodburn interchange western roundabout	Wardell interchange link	18	14	3	10
	Northbound off-ramp	74	23	10	23
	Service road south	18	12	3	12
	Service road north	63	15	8	15
Evans Head Broadwater Road/ service link road	Evans Head Broadwater Road west	65	14	10	13
	Service road north	18	14	3	10
	Evans Head Broadwater Road east	62	14	10	12
	Service road south	18	13	3	11

5.8.4. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in February/March 2012 to coincide with the noise monitoring survey for this section and are presented in **Table 5-62**.

Table 5-62 Noise model calibration data for Section 8

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 8 (Sth Woodburn) calibration (north bound)	2751	570	3321	17%	334	366	700	52%
Section 8 (Sth Woodburn) calibration (south bound)	2722	828	3550	23%	379	199	578	34%
Section 8 (Nth Woodburn) calibration (north bound)	3570	613	4184	15%	471	420	891	47%
Section 8 (Nth Woodburn) calibration (south bound)	3594	955	4550	21%	450	255	705	36%

Table 5-63 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations.

The results include a -3 dB(A) L_{A10} to L_{Aeq} conversion and a +2.5 dB(A) facade correction where appropriate. The road surface in Section 8 is typically in good condition south of Woodburn. The modelling was given a nominal +1 dB(A) correction for the road surface in this area. North of Woodburn, the road surface is in average condition showing signs of wear and repairs. The road surface was noted as dense grade asphalt and therefore no correction to the road surface was used in the modelling. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-63 Comparison of measured and modelled road traffic noise levels – Section 8

Receiver identification	Day L_{Aeq} (15h) dB(A)			Night L_{Aeq} (9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
1631	60.8	58.2	-2.6	53.7	55.1	1.4
1698	59.7	60.5	0.8	57.9	57.3	-0.6
S8_2	54.1	53.2	-0.9	49.7	49.9	0.2
Median of results			**-0.9**			**0.2**
Standard Deviation			**1.7**			**1.0**

At receiver 1631, daytime noise levels are affected by insect noise. Notwithstanding this the correlation of predicted and measured noise levels is considered acceptable for modelling future impacts in Section 8.

5.8.5. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the proposal. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-64**. The location of all receivers in section 8, including those identified for mitigation can be seen in **Appendix A**.

Table 5-64 Summary of noise modelling results – Section 8

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	2	2	2
b	5	1	1
c	10	7	2
d	8	7	5
e	12	12	2
f	3	1	1
Total	**40**	**30**	**13**

The results of the noise modelling indicate that nine of the 12 receivers identified for mitigation would experience an acute noise impact as the result of the project. Of these, five receivers currently experience noise levels in excess of the night time acute criterion.

There are five receivers south of Woodburn, four on the western side of the project and one on the eastern side that require mitigation measures. These receivers are spread over around two and a half kilometres. There are also six receivers at the interchange of the project and the Woodburn – Evans Head Road that are separated by distances of 200-300 metres. The other receiver requiring mitigation is a single dwelling north of Tuckombil Canal.

5.8.6. Mitigation measures

The selection of mitigation measures for this section of the project has considered low noise pavement and architectural treatments for the affected properties. Noise barriers are not considered for this section of the project due to their distribution along the project and the distance between dwellings in a related area of impact.

The application of low noise pavements would reduce all affected dwellings to within the night time acute noise level criteria and nine of these to the night time base noise criteria. The application of low noise pavements is not recommended due to the non continuous nature of the application required to benefit all receivers.

The recommended form of noise mitigation for all receivers in Section 8 is architectural treatments to the dwelling.

Table 5-65 Summary of traffic noise mitigation measures – Section 8

Receivers	Assessed mitigation measures	Recommended mitigation measures
1623-1657	Low noise pavements, noise walls, Architectural treatments.	Low noise pavements
All other receivers	Low noise pavements, Noise walls, Architectural treatment	Architectural treatments to dwellings

The location and extents of low noise pavement recommended for Section 8 are subject to a cost benefit analysis and would be further investigated and confirmed at the detailed design stage.

5.9. Section 9 (Broadwater National Park to Richmond River)

Section 9 is around 12 kilometres long, from Broadwater National Park to Richmond River. The project passes through the south western corner of the park and emerges to the south west of Broadwater. The project bypasses Broadwater to the south and east before crossing the Richmond River. The location and extent of Section 9 is presented in Part A of this report in Figure 1-2**.**

A summary of operational noise impacts for this section are provided here:

- The project in this section would be a combination of road duplication within the existing road reserve and new road development in the realigned road boundary to bypass Broadwater
- There is a north bound on-ramp and a south bound off-ramp that connect to the Broadwater - Evans Head-Road. There are no new rest areas identified in Section 9.

- Most receivers in this section will experience a new noise impact from the relocation of the alignment to the east of its current location through the township of Broadwater. The majority of receivers will experience traffic noise on a previously unaffected facade of their home
- Receivers are mostly located on large rural lifestyle blocks, typically with distances of greater than 100 meters100m separating the dwellings
- The receivers requiring noise mitigation are separated by large distances and therefore the use of noise barriers and low noise pavement is not recommended. Architectural treatments are recommended to treat exceedances of the noise criteria in this section.

5.9.1. Receiver locations

The receiver locations for Section 9 of the project are shown in Appendix A. In this section the project passes to the south of the township of Broadwater and continues to flank the town to the east before crossing the Richmond River. There are around 21 structures within the study area, 20 of which have been identified as residential dwellings that fall inside the study area.

There are 2 unattended monitoring locations used to quantify the noise environment in this section. **Table 5-66** lists the locations used in the noise monitoring survey undertaken between 7 and 19 December. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-66 Summary of unattended noise monitoring locations – Section 9

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
1756	18	Pacific Highway, Broadwater	f
1766	780	Broadwater Evans Head Road, Broadwater	d

5.9.2. Monitoring results

The monitoring was undertaken to determine the influence of the existing highway and rural areas for use in the assessment of operational and construction noise impacts (see Part A, Section 4.3).

Observations during the existing survey periods indicate the primary noise source at Receiver 1756 was due to traffic on the Pacific Highway. At Receiver location 1766 noise from the existing highway was almost inaudible with only occasional frog and insect noise being observed.

The results of the traffic noise monitoring at these locations are provided in **Table 5-67**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods although these values are not considered in the noise assessment. The L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-71**.

Table 5-67 Summary of traffic noise monitoring descriptors – Section 9

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
1756	66.9	63.4	64.2	63.3	80.6	80.4
1766	49.4	43.8	50.6	45.3	64.3	59.4

The recorded data for these sites are consistent with expectations of traffic noise levels at the distances noted in **Table 5-66**.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Lismore weather station for the month of December 2011 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.9.3. Modelled traffic scenarios

The predicted traffic data for Section 9 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-68**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-68 Road traffic data input to noise model for Section 9

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	3237	721	3959	18%	314	463	776	60%
Year opening no build (south bound)	3285	1054	4339	24%	337	344	681	51%
Year opening build (north bound)	1843	592	2436	24%	179	380	559	68%
Year opening build (south	2099	854	2953	29%	215	279	494	56%

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
bound)								
Design year no build (north bound)	3554	945	4499	21%	344	606	950	64%
Design year no build (south bound)	3612	1379	4991	28%	371	450	821	55%
Design year build (north bound)	2044	775	2818	27%	198	497	695	71%
Design year build (south bound)	2331	1114	3445	32%	239	364	603	60%

Section 9 has a north bound on-ramp and a south bound off-ramp, which connect to the Broadwater - Evans Head Road. **Table 5-69** presents the predicted hourly average volumes for the on and off ramps with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts. The predicted data indicates only light usage of the on and off ramps during the night time hours for this interchange.

Table 5-69 Summary of on and off ramp traffic for Section 9

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Broadwater interchange south	Broadwater interchange link	21	3	3	2
	WB off-ramp	31	6	5	3
	Evans Head Broadwater Road	51	7	8	7
Broadwater interchange north	Broadwater interchange link	27	8	4	5
	Evans Head Broadwater Road	44	2	7	3
2026 Traffic Volumes					
Broadwater interchange south	Broadwater interchange link	23	6	4	3
	WB off-ramp	35	6	6	3
	Evans Head Broadwater Road	56	9	6	3
Broadwater interchange north	Broadwater interchange link	33	15	6	8
	Evans Head Broadwater Road	7	5	5	4

5.9.4. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in December 2011 to coincide with the noise monitoring survey for this section and are presented in **Table 5-70**.

Table 5-70 Noise model calibration data for Section 9

Description	Predicted traffic flows							
	Daytime (15hour)				Night-time (9hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 9 (Sth Broadwater) Calibration (north bound)	3570	613	4184	15%	471	420	891	47%
Section 9 (Sth Broadwater) Calibration (south bound)	3594	955	4550	21%	450	255	705	36%
Section 9 (Nth Broadwater) Calibration (north bound)	3539	613	4152	15%	516	397	912	43%
Section 9 (Nth Broadwater) Calibration (south bound)	3766	810	4576	18%	502	228	730	31%

Table 5-71 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3dB(A) L_{A10} to L_{Aeq} conversion and a 2.5 dB(A) facade correction where appropriate. The road surface on the Broadwater town boundary changes from a coarse spray seal to a dense grade asphalt, which has been accounted for in the modelling. For calibration purposes the model assumed a 0 dB(A) correction for the road wearing surface for the dense grade asphalt.

A limited calibration was undertaken with the single receiver at Broadwater as the identified receivers for this section would be newly affected by the project. The results from the calibration exercise are used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-71 Comparison of measured and modelled road traffic noise levels – Section 9

Receiver Identification	Day LAeq (15h) dB(A)			Night LAeq (9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
1756	64.6	65.5	0.9	63.7	63	-0.7

The modelled traffic data for Section 9 represents an acceptable level of tolerance for the noise modelling calibration and therefore the predictive accuracy for future year assessments is considered to be adequate.

5.9.5. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-72**. The location of all receivers in Section 9, including those identified for mitigation can be seen in **Appendix A**.

Table 5-72 Summary of noise modelling results – Section 9

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	0	0	0
b	2	2	2
c	1	1	1
d	2	2	2
e	6	6	6
f	10	9	6
Total	**21**	**20**	**17**

The noise modelling predictions indicate that two receivers would experience noise levels in excess of the acute night time criterion, one of which is a redeveloped road receiver that currently exceeds this criterion as a result of noise from the existing highway. The balance of receivers are assessed under the new road criteria which has a night time noise goal of 50 dB(A). These receivers are predicted to exceed the night time noise goals by between 3-7 dB(A). The affected receivers are distributed along the new alignment over a distance of 1400 metres from station 142,000 and 143,400. Two other receivers identified for mitigation are located at approximately station 144,500.

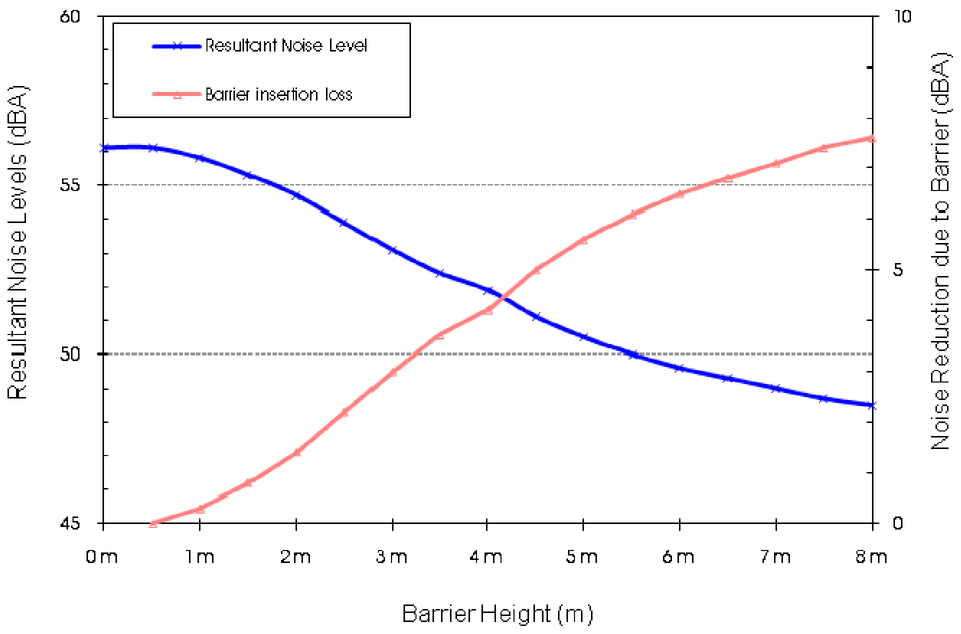
5.9.6. Mitigation measures

The application of low noise pavement between station 141,600 and 144,500 would reduce the predicted impacts of 13 of the 16 affected receivers to within the night time base noise criteria, and two receivers to below the night time acute noise level criteria. This form of mitigation benefits receivers on both sides of the highway.

There are ten affected receiver locations to the west of the highway between stations 141,500 to 143,000. At this location a 4.5 metre noise wall provides the minimum insertion loss of 5 dB(A) for the most affected receiver but does not reduce the other nine receivers to below the night time noise criteria. A target barrier of greater than 8 metres in this location would be required to reduce all exceedances of the noise criteria to below guideline levels. As the target barrier exceeds 8 metres in height, this would not be considered as a feasible or reasonable mitigation option.

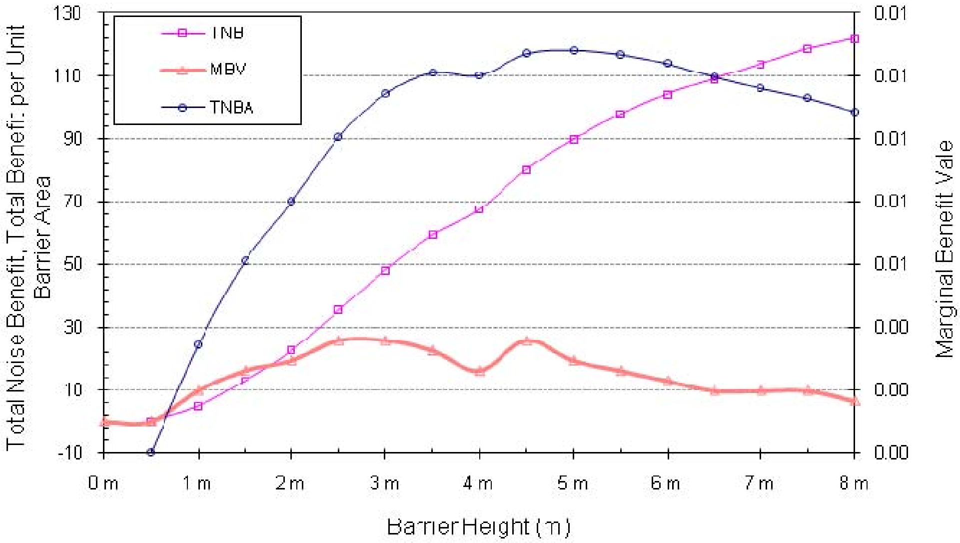
The assessment of barriers has been further reviewed using a barrier effectiveness and benefit analysis presented in **Figure 5-4** and **Figure 5-5**.

Figure 5-4 Noise barrier effectiveness – Section 9



The graph indicates that the minimum insertion loss for barrier consideration is achieved at 4.5 metres. Barriers over 5 metres do not provide a minimum insertion loss of 10 dB(A).

Figure 5-5 Noise barrier benefit – Section 9



In **Figure 5-5** the Marginal Benefit Value (MBV) peaks at 2, 3 and 4.5 metres. As the minimum insertion loss of 5 dB(A) is not achieved by the 2 and 3 metre noise barriers, these options are not considered feasible or reasonable. A 4.5 metre noise wall MBV coincides with a peak in the Total Noise Benefit per Unit Area (TNBA) curve at this height. Implementation of a 4.5 metre noise wall would require residual exceedances of the noise criteria at up to seven of the 10 receiver locations to be mitigated with architectural treatments.

Both low noise pavements and noise walls have the potential to reduce noise levels for this section of the highway. The implementation of noise barriers would require mitigation of residual exceedances to be architecturally treated. The application of a low noise pavement would benefit the greatest number of receivers however, the cost of noise mitigation for a noise barrier or low noise pavement versus implementation of architectural treatments should be further considered during detailed design.

Table 5-73 Summary of traffic noise mitigation measures – Section 9

Receivers	Assessed mitigation measures	Recommended mitigation measures
All	Low noise pavements, noise walls, Architectural treatments	Architectural treatment

In Section 9, the residential dwelling at 1739 identified for architectural treatment is a heritage item (see Working paper 8 -Historical (non-Aboriginal) Heritage Assessment, item 26). Architectural noise treatment to this receiver would be developed in consultation with a qualified heritage consultant to minimise impacts on the heritage significance of the dwelling, and undertake any further assessment required.

5.10. Section 10 (Richmond River to Coolgardie Road)

Section 10 is around 14 kilometres long, extending from the southern side of the Richmond River just east of Broadwater, to Coolgardie Road, Coolgardie. Section 10 is a new road corridor with a new bridge crossing of the Richmond River North of Broadwater and re-joining the existing highway at Pimlico, north of Wardell. The location and extents of Section 10 is presented Part A of this report in **Figure 1-2**.

A summary of operational noise impacts for this section are provided here:

- The project in this section is mostly new road development with a tie in to the existing highway at the northern end of the section
- There is a rest area and truck stop/ weigh bridge in Section 10 between station 147,250 and 148,200. There are on and off ramps located at the interchange of the Pacific Highway and Coolgardie Road
- Most receivers in this section would experience a new noise impact from the relocation of the alignment to the east of its current location thorough the communities of Meerschaum Vale and Coolgardie
- Receivers are mostly located on rural farms or large rural lifestyle blocks, typically with distances of greater than 100 meters separating the dwellings
- Many of the receivers requiring noise mitigation are situated on high ground overlooking the project separated by large distances and therefore the use of noise barriers is not recommended. Low noise pavement and architectural treatments are recommended to mitigate noise impacts in this section.

5.10.1. Receiver locations

The receiver locations for Section 10 of the project are shown in Appendix A. In this section the project crosses the Richmond River east of Broadwater. The project traverses large areas of rural land before passing through the southern extremities of the communities of Meerschaum Vale and Coolgardie, by-passing Wardell to the north. There are 98 structures identified within the study area, 83 of which have been identified as residential dwellings.

There are five unattended monitoring locations used to quantify the noise environment in this section. The project from Richmond River to Coolgardie Road does not share the study area with the existing alignment and therefore a limited calibration of the noise model is undertaken for Section 10 only for those parts of the existing alignment within the study area.

Table 5-74 lists the locations used in the noise monitoring survey undertaken between 7 and 19 December. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-74 Summary of unattended noise monitoring locations – Section 10

Receiver identification	Distance to existing highway (m)	Location	Represented noise catchment area (NCA)
1817	32	Pacific Highway, Broadwater	a
S10_1	90	Pacific Highway, East Wardell	-
1874	3200	Wardell Road, Wardell	e
S10_2	112	Pimlico Road, Wardell	-
1914	930	Meridian Drive, Coolgardie	e

5.10.2. Monitoring results

The monitoring was undertaken to determine the influence of the existing highway noise on nearby receivers and rural areas, for use in the assessment of operational and construction noise impacts (see Part A, Section 4.3).

Observations during the survey periods indicate that locations 1817, S10_1, and S10_2 the primary noise source influence was due to traffic on the Pacific Highway. At receiver 1914, traffic noise was clearly audible during the day and night time periods.

The results of the traffic noise monitoring at these locations are provided in **Table 5-75**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods and the L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period. The L_{Aeq} descriptors provide information on the day and night time noise levels used in the assessment of traffic noise impacts for this section. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-78**.

Table 5-75 Summary of traffic noise monitoring descriptors – Section 10

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
1817	72.6	70.5	68.9	68.7	83.1	84.0
S10_1	63.6	64.5	59.9	59.7	71.9	72.7
1874	52.0	54.0	52.0	52.0	63.0	59.8
S10_2	58.2	58.3	54.7	54.6	65.1	65.7
1914	52.4	49.4	50.8	48.1	60.9	60.7

The recorded data for all sites are consistent with expectations of noise levels affected by road traffic and rural areas at the distances from the existing highway identified in **Table 5-74**. At location 1874 the noise logger was located around 35 metres from Wardell Road. At this location, the traffic during the night time is infrequent and the measured noise levels are primarily influenced by crickets and frogs. At receiver 1914 traffic noise is audible from the existing highway with noise associated with truck movements easily distinguishable during the day and night time.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Lismore weather station for the month of December 2011 to determine the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.10.3. Modelled traffic scenarios

The predicted traffic data for Section 10 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-76**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-76 Road traffic data input to noise model for Section 10

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build (north bound)	3600	724	4324	17%	365	452	817	55%
Year opening no build (south bound)	3600	1043	4643	22%	381	355	736	48%
Year opening build (north bound)	1836	651	2486	26%	186	406	593	69%
Year opening build (south bound)	2186	845	3031	28%	231	288	519	55%
Design year no build (north bound)	3975	946	4920	19%	403	590	994	59%
Design year no build (south bound)	3974	1365	5339	26%	420	464	884	52%
Design year build (north bound)	2035	850	2886	29%	207	531	737	72%
Design year build (south bound)	2421	1104	3525	31%	256	376	632	59%

Section 10 has an interchange at station 157,500 for north and south bound vehicles having both on and off ramps connecting to Coolgardie Road. **Table 5-77** presents the predicted hourly average volumes for the on and off ramps with splits for light and heavy vehicles that have been incorporated in to the modelling of noise impacts. The predicted data indicates a moderate usage of the on and off ramps during the night time hours for this interchange.

Table 5-77 Summary of on and off ramp traffic for Section 10

Interchange description	Approach	Daytime average hourly volume		Night time average hourly volume	
		LV	HV	LV	HV
2016 Traffic Volumes					
Wardell Road interchange east	Wardell SB off-ramp	106	21	19	13
	Service road	123	8	22	4
	Wardell interchange link	12	10	2	6
Wardell Road interchange west	Wardell interchange link	124	6	21	6
	Wardell NB off-ramp	18	12	3	12
	Service road	12	9	2	7
Wardell interchange/ service road/ (Existing Pacific Highway)/ Pimlico Road	Service road north	18	14	3	10
	Pimlico Road	18	14	3	10
	Service road south	129	11	23	9
	Wardell Road Interchange Road Link	106	19	19	15
2026 Traffic Volumes					
Wardell Road interchange east	Wardell SB off-ramp	130	35	22	17
	Service road	145	9	26	5
	Wardell interchange link	12	10	2	6
Wardell Road interchange west	Wardell interchange link	146	8	25	8
	Wardell NB off-ramp	18	12	3	12
	Service road	12	9	2	7
Wardell interchange/ service road/ (Existing Pacific Highway)/ Pimlico Road	Service road north	18	14	3	10
	Pimlico Road	18	14	3	10
	Service road south	151	12	27	10
	Wardell road interchange link	124	28	22	29

Section 10 has a rest area located between station 147,500 and 148,200 for both north bound and south bound traffic. The rest area is situated amid farming land with the nearest receivers located on the western side of the project around 520 metres from the rest area.

The assessment for noise emissions from the rest area considers intrusive noise impacts such as the operation of truck mounted refrigeration units and low speed truck movements, and sleep disturbance from maximum noise level events such as the use of air brakes. The assessment for intrusiveness is taken from the NSW, *Industrial Noise Policy* (INP), while the assessment of potential sleep disturbance is taken from the Environmental Criteria for Road traffic noise (ECRTN) both of these assessment methods use information on the existing environment to determine the appropriate noise criteria. For more detail on the assessment of rest areas see **Section 2.2.5** in Part A of this report.

The assessment of intrusive noise impacts in accordance with the INP requires that the $L_{Aeq\ 15\ min}$ noise emissions from the activity being assessed are no more than 5 dB(A) above the quietest Rating Background Level (RBL). The RNP identifies a methodology from the superseded *Environmental Criteria for Road Traffic Noise* to assess impacts from maximum noise events based on the emergence of the L_{A1} noise level over the $L_{A90\ (15\ min)}$ noise level. The maximum noise event is assessed by comparing predicted noise levels to the L_{A1} criterion as an indication of the potential for sleep disturbance from noise events. The sleep disturbance assessment for the project assumes an RBL value instead of the $L_{A90\ (15\ min)}$ and is calculated as follows:

$$L_{A1} \geq L_{A(RBL)} + 15 \text{ dB(A)}$$

From data obtained at receiver 1874 which has a similar noise environment to receivers nearest the rest areas, the day evening and night time environmental noise levels for L_{Aeq} and RBL have been determined and are presented in **Table 5-78**.

Table 5-78 Environmental noise levels – Section 10

Receiver identification	L_{Aeq} Day dB(A)	L_{Aeq} Evening dB(A)	L_{Aeq} Night dB(A)	L_{A90} RBL Day dB(A)	L_{A90} RBL Evening dB(A)	L_{A90} RBL Night dB(A)
1817	50	53	52	33*	38	46

Note: * Daytime noise level is used to for the night time period for the assessment of sleep disturbance impacts.

The increased noise levels at night are due to the activity of the wildlife in the area and therefore the daytime RBL of 33dB(A) has been adopted for assessment purposes. The day time background level of 33 dB(A) provides a night time assessment level of 38 dB(A) to meet the intrusive noise goals, and an L_{A1} noise level of 48dB(A) to meet the sleep disturbance criterion.

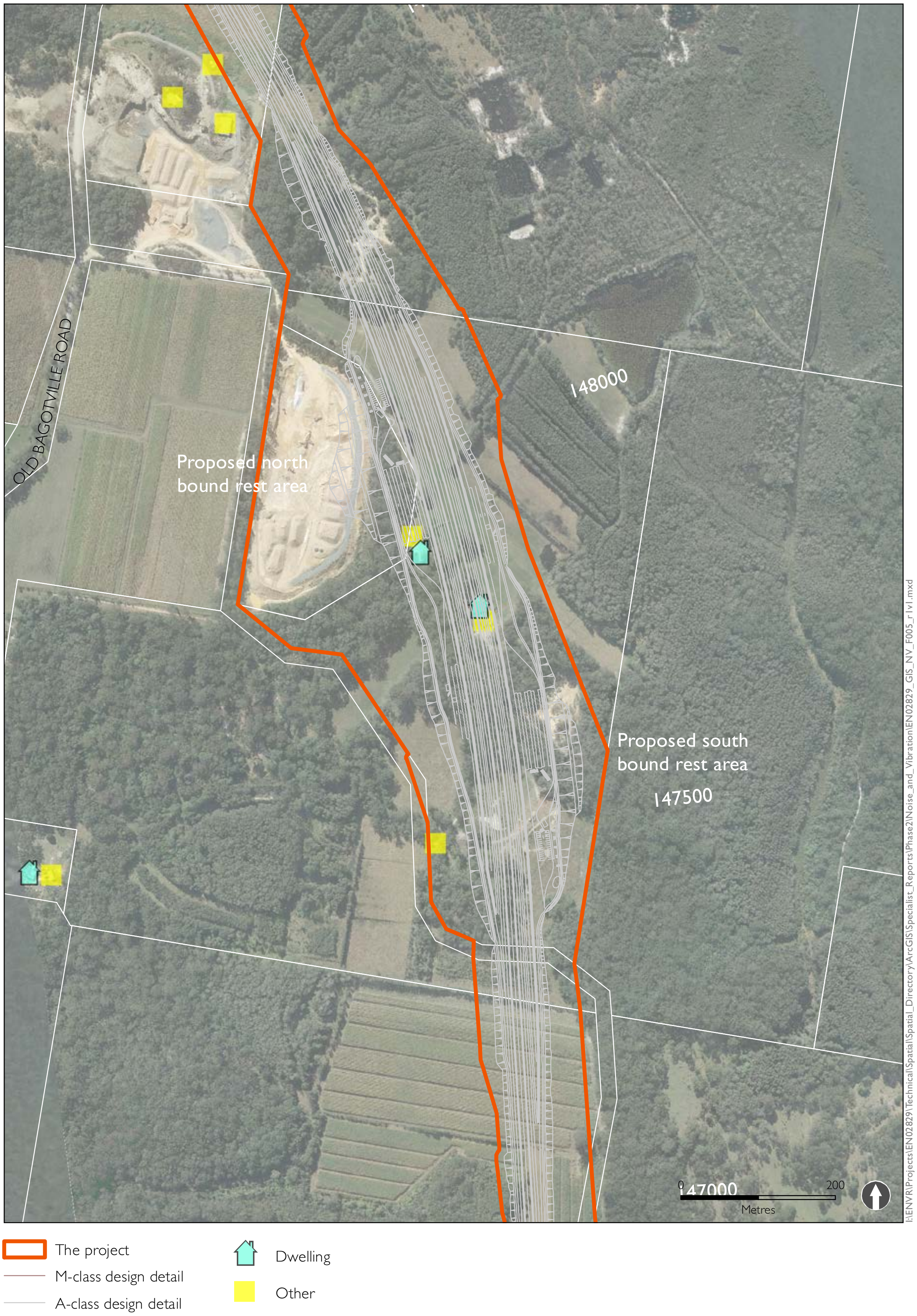
The layout of the northbound and south bound rest areas is shown in **Figure 5-6**, which includes space for 10 B-Doubles and additional car parking bays. The assessment of noise impacts for the rest area has been based on X% utilisation of either north bound or south bound rest areas at any time **Table 5-79** presents the data used to estimate the noise impacts from the rest area.

Table 5-79 Noise data for Section 10 rest area assessment

Activity	Estimated Noise Level at 10 m
Truck air brake (bleed off)	88 dB(A)
Truck movement (accelerating)	85 dB(A)
Truck refrigeration unit (continuous)	77 dB(A)
Truck door	76 dB(A)
Car starting	76 dB(A)

The resulting $L_{Aeq\ 15\ minute}$ noise level at the closest receiver location is predicted to be 35 dB(A), which is lower than the project noise goal for intrusive noise of 38 dB(A). The predicted L_{A1} noise level from the rest area is predicted to be 39 dB(A), which is below the project threshold for sleep disturbance impacts of 48 dB(A).

Figure 5-6 Section 10 rest area location and layout



5.10.4. Calibration of the noise model

The noise model for Section 10 has not been calibrated to the impacts from the existing highway as the majority of receivers for this section are located away from the highway and therefore would experience a new road noise source.

5.10.5. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the “build” and “no build” options for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D**, with a summary of the results presented in **Table 5-80**. The location of all receivers in Section 10, including those identified for mitigation can be seen in **Appendix A**.

Table 5-80 Summary of noise modelling results – Section 10

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	7	2	0
b	17	9	3
c	7	7	7
d	7	7	7
e	24	15	8
f	22	15	5
Total	**84**	**55**	**30**

There are potentially 12 property acquisitions and 3 commercial receivers identified in Section 10 which were not included in the assessment of operational noise impacts. The results for the noise modelling for Section 10 include the application of low noise pavement from station 155,400 to 157,700. After the application of the low noise pavement, 30 receiver locations have been identified as requiring additional mitigation to reduce noise levels to the base criteria.

5.10.6. Mitigation measures

The selection of mitigation measures for Section 10 includes consideration and assessment of low noise pavement, noise barriers, and architectural treatments. A noise barrier assessment for two areas in Section 10 was undertaken to identify mitigation options for receivers at Meerschaum Vale and Coolgardie.

An initial assessment of low noise pavements between station 152,400 and 157,700 provide noise reductions over the unmitigated noise levels of approximately 7 dB(A) for around 76 receivers in this section. In addition to low noise pavements, noise barriers were assessed for effectiveness in reducing noise levels at affected receivers.

An eight metre noise barrier for residences at Coolgardie between station 155,400 and 157,700 on the western side of the highway, did not provide the minimum noise reduction required for noise barrier implementation. At this location a noise barrier is not effective in reducing noise levels due to the relative difference in elevation between the highway and the receivers typically about 100 metres in height.

For 11 receivers on Wardell Road at Meerschaum Vale, receivers are generally located several metres higher than the alignment. The preliminary assessment of noise walls indicate that a three metre noise wall and five metre noise wall between station 152,400 and 153,500 do not provide the minimum insertion loss for a noise wall. Low noise pavement options for this section would be subject to further assessment during the detailed design phase to determine the cost/benefit ratio.

A combination of low noise pavements and architectural treatments are recommended to mitigate noise impacts in Section 10.

Table 5-81 Summary of traffic noise mitigation measures – Section 10

Receivers	Assessed mitigation measures	Recommended mitigation measures
1819-2008	Low noise pavements, noise walls, Architectural treatments.	Low noise pavements between 155.4 and 157.7 combined with Architectural treatments to dwellings

In Section 10, the residential dwelling at 1906 identified for architectural treatment is a heritage item (see Working paper 8 -Historical (non-Aboriginal) Heritage Assessment, item 29). Architectural noise treatment to this receiver would be developed in consultation with a qualified heritage consultant to minimise impacts on the heritage significance of the dwelling, and undertake any further assessment required.

5.11. Section 11 (Coolgardie Road to Ballina Bypass)

Coolgardie Road to Ballina Bypass (Section 11) is around six kilometres long, extending from Coolgardie Road to the Ballina bypass at the northern abutment of the Duck Creek Bridge. For a location of this section in graphical terms, refer to Part A, Figure 1-2. A summary of operational noise impacts for this section are provided here:

- The project in this section would be a road duplication within the existing boundary
- There are no interchanges in this section. There are no new rest areas identified in Section 11
- Most receivers in this section would experience a noise impacts from the existing alignment
- Receivers are mostly located on farms or large rural lifestyle blocks, typically with distances of greater than 100 metres separating the dwellings
- The receivers requiring noise mitigation are generally located away from the highway and are separated by large distances and therefore the use of noise barriers is not recommended. Low noise pavements would reduce noise levels in this section. Architectural treatments are the recommended form of mitigation to treat exceedances of the noise criteria in this section.

5.11.1. Receiver locations

The receiver locations for Section 11 of the project are shown in Appendix A. In this section the project alignment passes through the community of Pimlico and to the east of Uralba. There are 25 structures within the study area with three property 3 acquisitions, 13 commercial properties and 9 residential properties identified within the 600 metre study boundary.

There are two unattended monitoring locations used to quantify the noise environment in this section. **Table 5-82** lists the locations used in the noise monitoring survey undertaken between 7 and 19 December 2011. The locations of the noise monitoring sites are presented in the receiver location map series in Appendix A.

Table 5-82 Summary of unattended noise monitoring locations – Section 11

Receiver identification	Distance to existing highway	Location	Represented noise catchment area (NCA)
2068	60	McAndrews Lane, Pilmlico	d
2072	550	Whytes Lane, Pimlico	f

5.11.2. Monitoring results

Observations during the survey period indicate that the primary noise source at the monitoring locations was due to road traffic on the Pacific Highway.

The results of the traffic noise monitoring at these locations are provided in **Table 5-83**. The table presents the L_{A10}, L_{Aeq} and the L_{Amax} noise descriptors that represent the acoustic environment due to road traffic for the day and night time at each location. The L_{A10} results provide a correlation to the CoRTN day and night time periods although these values are not considered in the noise assessment. The L_{Amax} noise levels provide an indication of the maximum noise levels recorded at each of the monitoring sites over the survey period, and the L_{Aeq} descriptors provide information on the day and night time noise levels used for this assessment. In particular, the L_{Aeq} 15 hour and 9 hour data are used to correlate traffic noise levels against the noise modelling predictions in **Table 5-86**.

Table 5-83 Summary of traffic noise monitoring descriptors – Section 11

Receiver identification	L_{A10} 18 hour	L_{A10} 1 hour	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} 15 hour	L_{Amax} 9 hour
2068	64.7	62.0	61.2	59.2	76.3	75.7
2072	50.2	47.5	48.6	45.9	63.8	61.5

The recorded data for all sites are consistent with expectations of traffic noise levels at the distances identified in **Table 5-82**.

Meteorological data were obtained from Bureau of Meteorology (BoM) for the Lismore weather station for the month of December 2011 to confirm the quality of the monitored data. The meteorological data were incorporated into the analysis of the measured noise levels and any days considered to be invalid due to adverse weather were removed from the data set.

5.11.3. Modelled traffic scenarios

The predicted traffic data for Section 11 for the both year of opening and the design year scenarios and build and no build options are presented in **Table 5-84**. The traffic data are split into daytime and night time flows for the north bound and south bound lanes and indicate light and heavy vehicle numbers.

Table 5-84 Road traffic data input to noise model for Section 11

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening no build south bound	9193	1061	10254	10%	842	449	1291	35%
Year opening no build south bound	9402	1402	10804	13%	725	272	997	27%

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Year opening build north bound	9193	1061	10254	10%	842	449	1291	35%
Year opening build south bound	9402	1402	10804	13%	725	272	997	27%
Design year no build north bound	10244	1383	11627	12%	938	586	1524	38%
Design year no build south bound	10479	1826	12305	15%	808	354	1162	30%
Design year build north bound	10244	1383	11627	12%	938	586	1524	38%
Design year build south bound	10479	1826	12305	15%	808	354	1162	30%

5.11.4. Calibration of the noise model

Traffic counts used in the calibration of the noise model were undertaken in December 2011 to coincide with the noise monitoring survey for this section and are presented in **Table 5-85**.

Table 5-85 Noise model calibration data for Section 11

Description	Predicted traffic flows							
	Daytime (15 hour)				Night-time (9 hour)			
	Light	Heavy	Total	% Heavy	Light	Heavy	Total	% Heavy
Section 11 calibration (north bound)	4239	566	4805	12%	522	362	884	41%
Section 11 calibration (south bound)	4289	808	5097	16%	424	227	651	35%

Table 5-86 presents the predicted noise levels from the validation scenario and the measured noise levels from the unattended monitoring at the survey locations. The results include a -3dB(A) L_{A10} to L_{Aeq} conversion and a + 2.5 dB(A) facade correction where appropriate. The road surface was observed to spray seal, in good condition and a nominal +2.5 dB(A) correction for noise was applied to the modelling to account for the surface roughness. The median of the results from the calibration exercise is used to correct the predicted daytime and night time noise levels from the noise model for existing scenarios.

Table 5-86 Comparison of measured and modelled road traffic noise levels – Section 11

Receiver identification	Day L_{Aeq} (15h) dB(A)			Night L_{Aeq} (9h) dB(A)		
	Measured	Predicted	Difference	Measured	Predicted	Difference
2068	61.2	63.3	2.1	59.2	60.6	1.4
2072	48.6	49.2	0.6	45.9	47.4	1.5
Median of results			**1.4**			**1.5**

The modelling indicates an acceptable level of accuracy for the future scenario predictions.

5.11.5. Modelling results

In accordance with the Road Noise Policy, each scenario for the year of opening and the design year was assessed for the "build" and "no build" options for the project. Both the day and night time periods were then compared to the noise goals for new and redeveloped road receivers to identify any exceedances.

Where exceedances of the base noise goals are identified, further consideration of noise impacts is undertaken in accordance with the RMS interim noise guidelines (Part A, Section 3.1.5). The additional assessment is calculated according to the RMS methodology and the results of the calculations are included in the full assessment table presented in **Appendix D,** with a summary of the results presented in **Table 5-87**. The location of all receivers in Section 11, including those identified for mitigation can be seen in **Appendix A**.

Table 5-87 Summary of noise modelling results – Section 11

NCA	Number of receivers	Number exceeding base criteria	Number of receivers considered for mitigation
a	4	0	0
b	0	0	0
c	0	0	0
d	1	1	1
e	3	3	1
f	1	0	0
Total	**9**	**4**	**2**

The modelling of noise impacts indicates that two receivers would require noise mitigation as the result of the project in this section.

5.11.6. Mitigation measures

The receivers identified for mitigation are situated between station 158,900 and 159,100. The application of low noise pavement is not recommended for two dwellings or for short distances, however, implementation would reduce both receivers to the night time base noise goals. Noise barriers are not recommended for the properties due to the distance between them (250 metres) and the number of receivers that would benefit from a noise wall in this location. The recommend form of treatment for the receivers is architectural treatment to the dwelling.

Table 5-88 Summary of traffic noise mitigation measures – Section 11

Receivers	Assessed mitigation measures	Recommended mitigation measures
All	Architectural treatment	Architectural treatment to the dwelling

5.12. Maximum noise level assessment

An analysis of the measured maximum noise events was undertaken at six separate locations along for the existing alignment to characterise the noise environment due to road traffic.

The locations of the maximum event assessments are divided into two categories those up to about 20 metres from the road and those up to about 160 metres from the road. The assessments were undertaken for the same days of the week (Monday night/Tuesday morning) to provide consistent traffic patterns for correlation.

The graphs for each location are presented separately showing the distribution of the identified events for the receivers up to 30 metres from the road with night time hours shown in **Figure 5-7** and the range of noise levels in **Figure 5-8**.

Figure 5-7 indicates that the maximum noise event profile for each of the sites generally have higher levels at the start and end of the night time period and lower levels during the early morning and therefore correspond to increases and decreases in traffic movements throughout the night. Variability in the frequency of these events for each site is expected to be due in part to the specific road the conditions and driver practices at the monitoring locations.

Figure 5-8 demonstrates how the maximum level events are distributed into distinct groups. The groups are expected to represent truck movements for the higher levels and of other vehicles for the others.

At these locations the night time LAeq levels range from 66 to 71 dB(A) and therefore levels between 81 to 86 dB(A) would meet the criteria for a maximum noise level event. From the graphs it is apparent that the majority of maximum noise events for these locations are at the lower end of this range however, the number of events may be in the hundreds each night. This is a pattern of events is expected to continue with similar traffic profiles for the project however, a realignment of the existing highway and a revised road boundary would mean receivers are generally located at further distances form the road than those used for this study.

Figure 5-7 Maximum events by the hour for receivers up to 30 metres

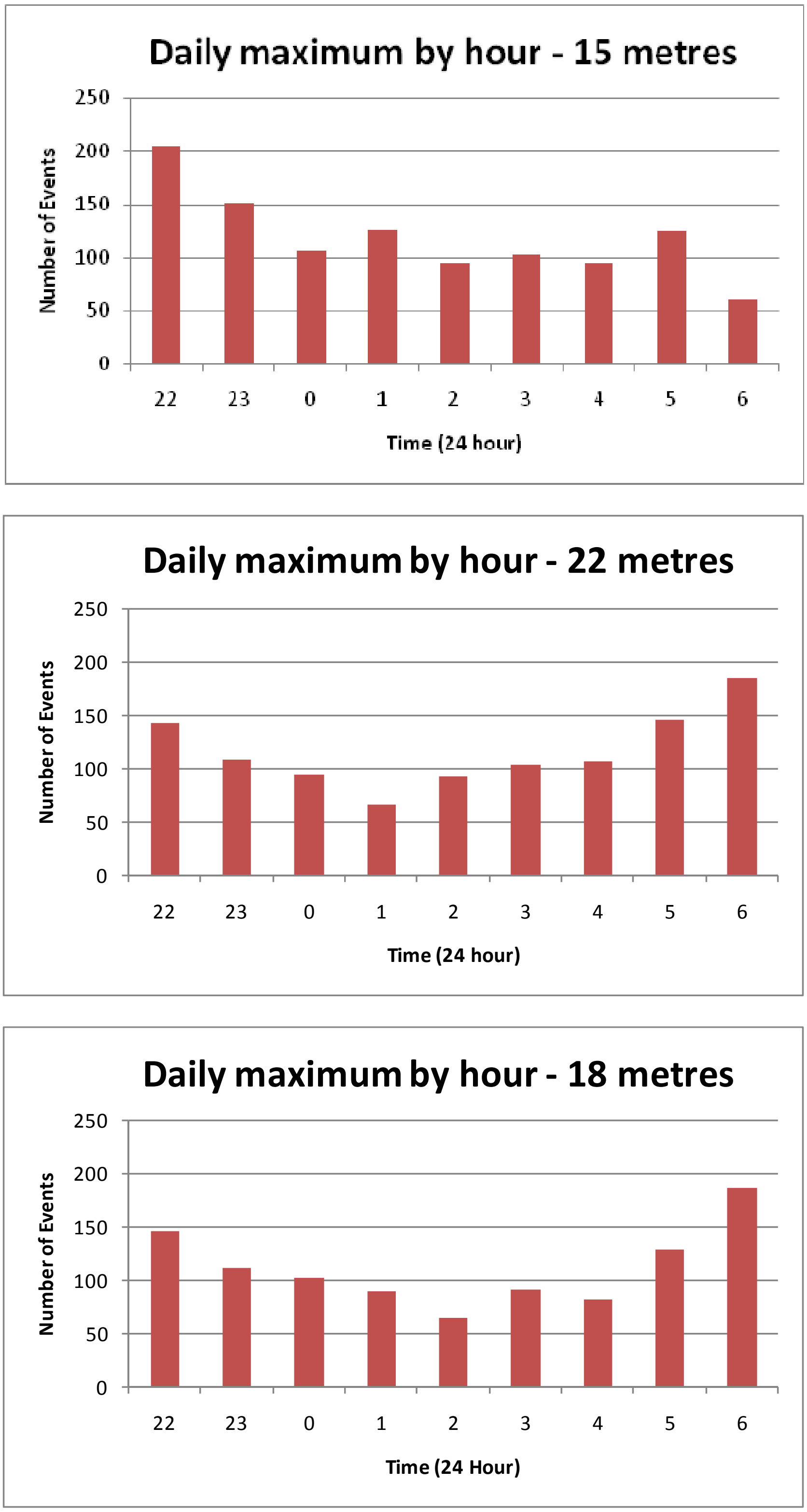
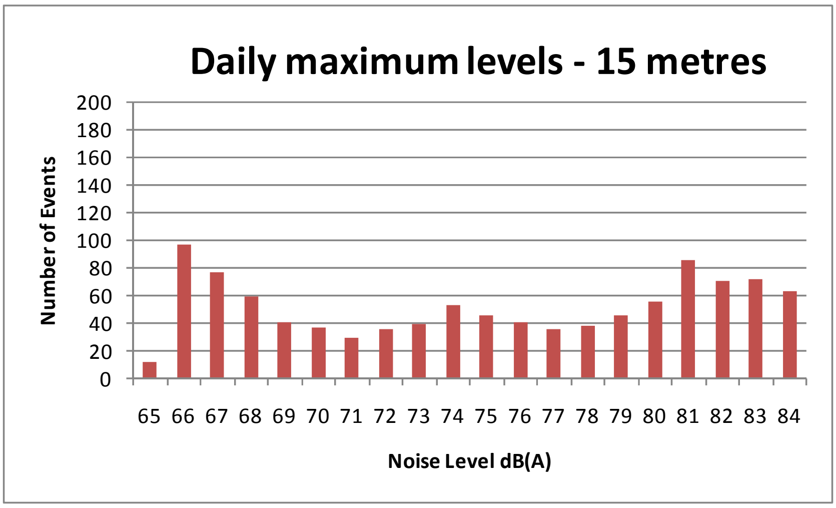
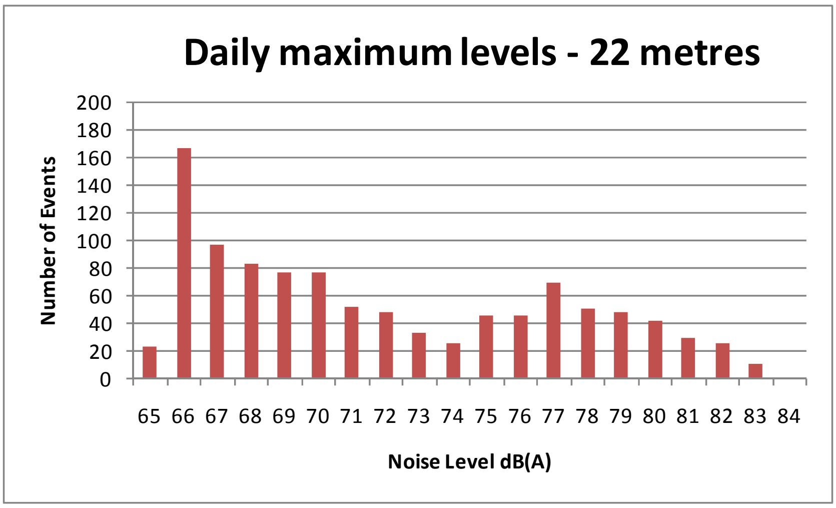
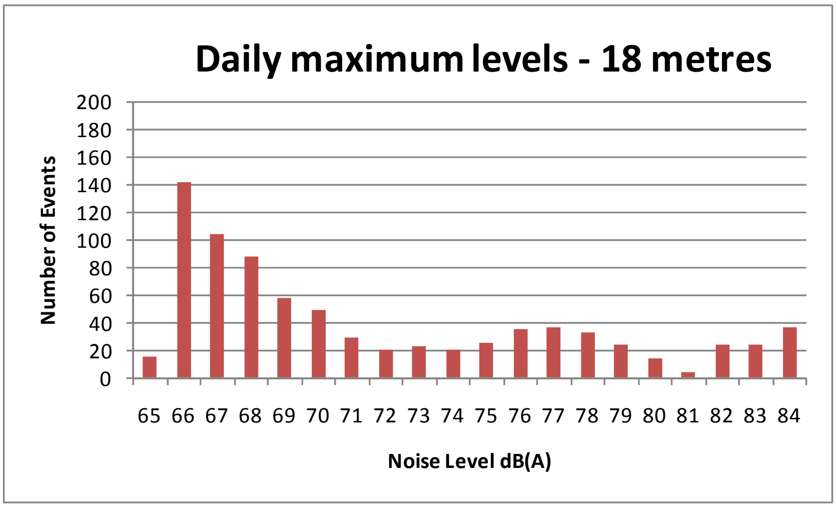


Figure 5-8 Maximum event noise levels for receivers up to 30 metres





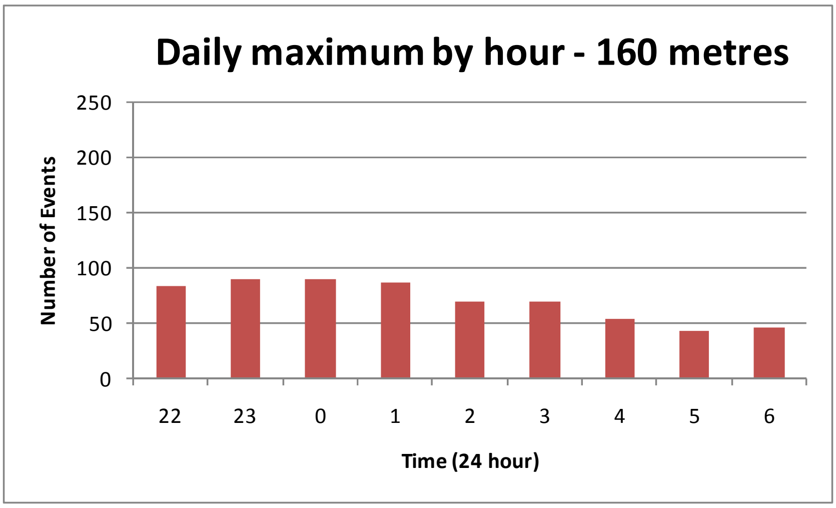


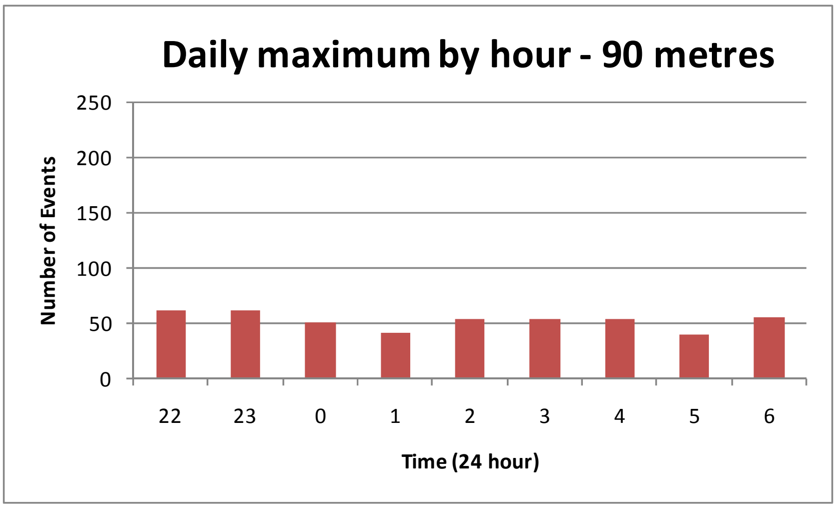
The graphs for each location for the receivers up to about 160 metres from the road are shown in **Figure 5-9** and **Figure 5-10**.

Figure 5-9 indicates that the maximum noise event profile for each of the sites generally have less distinction between the frequency of these events throughout the night with only slight trends noticeable. The average of noise levels for these events shown in **Figure 5-10** are typically at the lower end of the range just above the reportable level for an event of 65 dB(A).

At these more distant locations, the night time L_{Aeq} levels range from about 58 to 59 dB(A) and therefore levels between 73 to 74 dB(A) would meet the criteria for a maximum noise level event. From the graphs it is apparent that the majority of maximum noise events for these locations would fall below this range. This pattern of maximum noise events is expected to continue for the project where receivers are located at similar distances from the project alignment. As the distance from the alignment increases, the occurrence of noise levels that meet the criteria for a maximum noise event would decrease.

Figure 5-9 Maximum events by the hour for receivers up to 160 metres





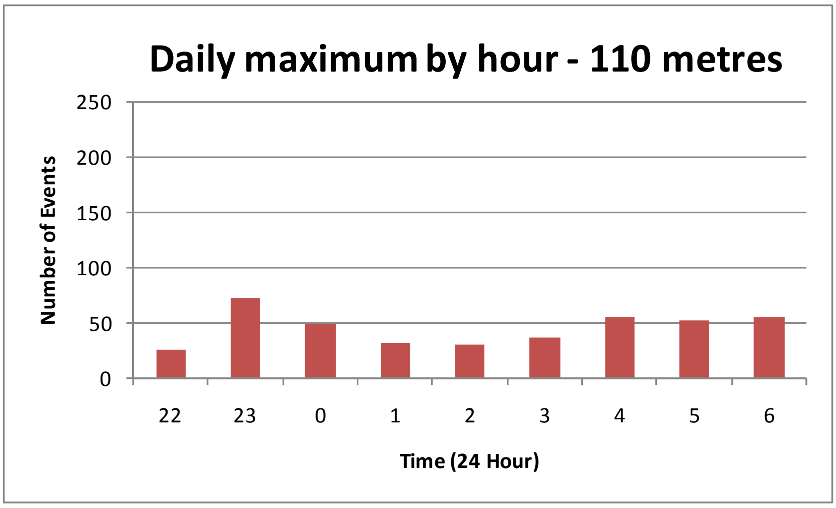
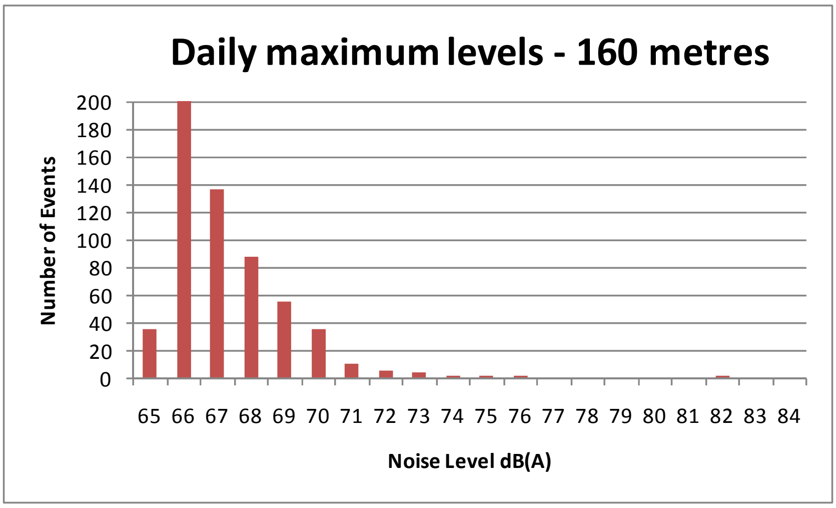
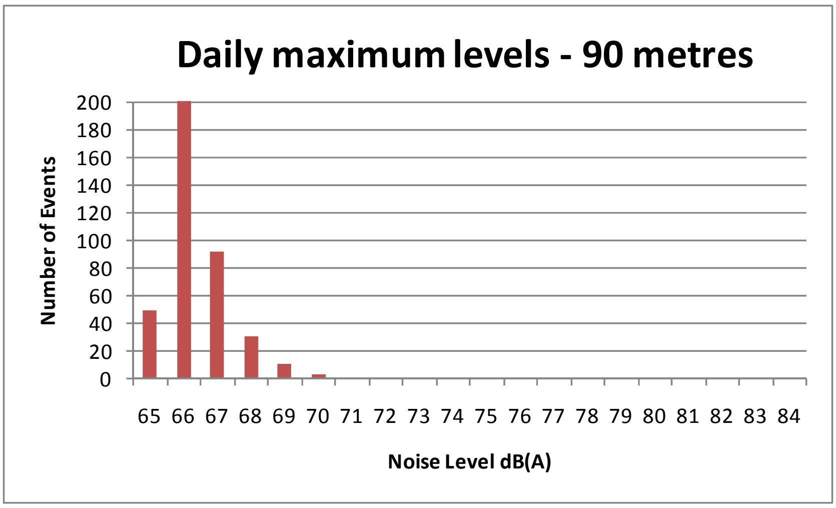
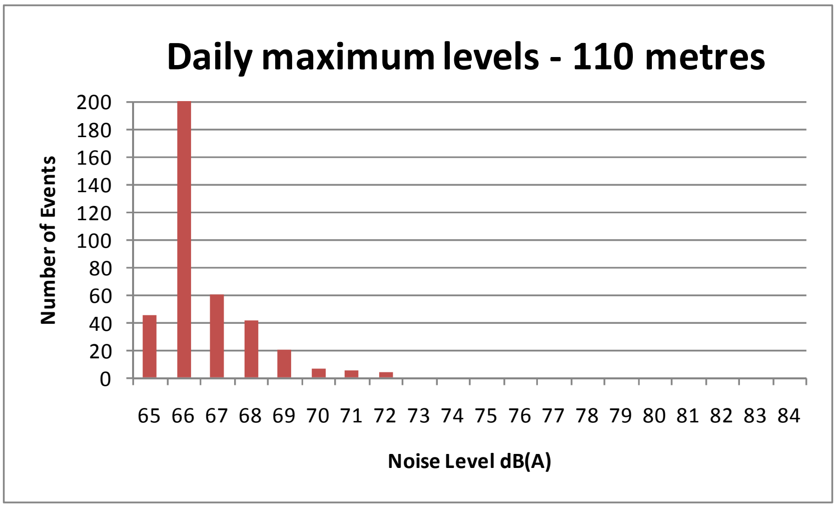


Figure 5-10 Maximum event noise levels for receivers up to 160 metres







PART C - Construction noise and vibration assessment

6. Construction Assessment

6.1. Section 1 (Woolgoolga to Halfway Creek)

6.1.1. Section 1 assessment summary

Section 1 (Woolgoolga to Halfway Creek) of the project is around17 kilometres long, from Arrawarra Beach Road, Arrawarra (about six kilometres north of Woolgoolga) to the northern end of the completed Halfway Creek upgrade at Lemon Tree Road, Halfway Creek. The extent of this project section is shown in Part A, Figure 1-2.

The construction works proposed for Section 1 includes all activities identified within Part A, Section 3.3.1, Table 3-6; with the exception of treatment of soft soils as this has been identified as not being required in Section 1. An assessment has determined the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- During the site clearing, earthworks and paving activities, over 40 per cent of the receivers within Section 1 are likely to experience noise levels above the respective noise management level (NML). In addition, one receiver is predicted to exceed the 'highly noise affected' criterion
- Predicted noise levels from the operation of ancillary facilities are below the respective noise management levels at all but four receivers, and the potential for disturbance is minimal. Where noise management levels are exceeded this is where receivers are located on land that would potentially be acquired for ancillary facilities
- Predicted noise levels from the operation of the proposed Corindi access road are below the noise management levels at all individual receivers and therefore the potential for disturbance is minimal
- The construction of highway over bridges in Section 1, and the construction of the bridge crossing of Corindi Creek are likely to result in exceedances of the NML at some of the closest receivers. This is mainly as a result of the assumed need for an impact piling rig at each of the bridge sites
- The construction of the twin bridges across the Corindi floodplain is unlikely to cause any exceedances of the NML if works are restricted to the proposed hours.
- Where work on the twin bridges across the Corindi floodplain is required outside of proposed hours up to nine receivers may experience noise levels above the night time

noise management level with a further four receivers experiencing construction noise that may be audible by residents

- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation would be undertaken prior to commencement of works to confirm the impact on human occupants and the potential for structural damage
- Where additional piling sites are identified within 50 metres of receivers, further assessment would be undertaken prior to commencement of works
- Blasting at specified road cutting sites along the project may result in some receivers being exposed to vibration and overpressure levels above adopted project criteria. Therefore detailed assessment and mitigation/management measures would be required prior to construction.

The exceedance of noise management levels is primarily from the short separation distance between the project and receivers within Section 1. Although noise management levels are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers would experience these levels would be short as the works progress along the project. Also, the noise management levels for noise catchment area (NCA) have been derived from up to two monitoring locations (depending on number of logger locations in NCA) and therefore the noise management levels may be lower than in practice due to a non-uniform noise environment around some receivers.

6.1.2. Background noise monitoring and noise management levels

There are around 424 receivers within 600 metres of Section 1 of the project. Of these receivers, six are within the boundary of the project and therefore would be acquired. For this reason, these six receivers have been identified but have not been assessed. In addition to the 424 receivers, 23 commercial/non-residential receivers have been identified. Also, within Section 1 an area of archaeological/heritage importance has been identified on land surrounding R495 (shown graphically in Appendix C). In terms of assessment, a qualitative approach has been undertaken to determine the impacts associated with vibration as a result of bridge works and blasting at the heritage site. See Section Part A, 4.1 for further information on the assessment method for archaeological/heritage site.

Receivers identified for the construction noise and vibration assessment are shown in Appendix C and listed in Appendix E.

Unattended monitoring has been undertaken at six receivers within Section 1. The locations of these are presented in **Table 6-1** alongside measured ‘rating background level’ (RBL) and derived construction noise management level, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. **Table 6-1** also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-1 Section 1 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am -6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML*, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
R228	49	59	50	55	52	57	55	1-b, 1-e
R414	48	58	50	55	52	57	55	1-a, 1-f
R468	46	56	46	51	50	55	51	1-a, 1-f
R481	48	58	50	55	51	56	55	1-c
R526	45	55	46	51	47	52	51	1-b, 1-e
R575	43	53	46	51	47	52	51	1-d

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in **Table 6-1Error! Reference source not found.**. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G with the attended monitoring results presented in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in **Table 6-2** alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) will be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of unattended monitoring however some have been adjusted following attended monitoring.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-2 Section 1 – NCA noise management levels

Noise catchment area	Project NML, dB(A)	Night-time/out if hours noise management level, dB(A)
NCA 1-a	51	38
NCA 1-b	51	42
NCA 1-c	55	40
NCA 1-d	51	42
NCA 1-e	51	42
NCA 1-f	51	38

6.1.3. Construction noise assessment – Section 1

Section 1 soft soil treatments

There are no soft soil treatments proposed within Section 1 of the project

Section 1 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-3, Table 6-4 and Table 6-5. These tables summarise the number of receivers which are exposed to varying levels of construction noise from each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in **Appendix E**.

Table 6-3 Section 1 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
1-a	203	51	48	0	0	-
1-b	181	51	58	40	0	-
1-c	21	55	72	15	0	-
1-d	8	51	66	5	0	-
1-e	8	51	51	0	0	-
1-f	2	51	44	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-4 Section 1 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
1-a	203	51	53	7	0	-
1-b	181	51	63	150	0	-
1-c	21	55	77	17	1	R495
1-d	8	51	71	5	0	-
1-e	8	51	56	1	0	-
1-f	2	51	49	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-5 Section 1 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
1-a	203	51	51	23	0	-
1-b	181	51	61	101	0	
1-c	21	55	75	17	1	R522
1-d	8	51	69	5	0	-
1-e	8	51	54	1	0	-
1-f	2	51	47	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 1 (Woolgoolga to Halfway Creek); with one receiver predicted to be exposed to levels above the highly noise affected criteria of 75dB(A) during earthworks and asphalting.

The impacts summarised in the above tables are representative of the worst case 15-minute period of each activity and daily noise levels are predicted to be lower than these in practice. These predictions include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required. These will be detailed further in Appendix I.

The Interim Construction Noise Guideline (ICNG) states that where a receiver is exposed to noise levels of 75dB (A) or greater, as a result of construction activities, the receiver is to be classed as 'highly noise affected' and must be afforded additional consideration. Receivers R495 and R522 would potentially experience levels in excess of 75dB (A) from earthworks, paving and asphalting noise. These receivers are shown in Appendix C. The higher levels are primarily from the short separation distance assumed between the receiver and the proposed works; 60 metres at the shortest distance.

In 'highly noise affected' areas, additional measures are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Such measures will be discussed in more detail in Appendix I.

Section 1 ancillary facilities

Within Section 1 of the project (Woolgoolga to Halfway Creek), the ancillary facilities presented in Table 6-6 have been identified and quantitatively assessed. This includes around 15 stockpile sites, two multi-use sites (including concrete batch plants, workshops and site offices) and one stand alone office compound. The location of these sites and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled using SoundPlan noise software, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facility locations and site layouts, a more detailed assessment would be undertaken.

Table 6-6 Section 1 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1a	STN2.5 to STN3.4	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 1b	STN3.3 to STN3.4	Stockpile site.
Site 2	STN.5.2 to STN5.4	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 3	STN7.45 to STN7.65	Stockpile site.
Site 4a	STN9.5 to STN9.57	Main site office and compound area.
Site 4b	STN9.43 to STN9.6	Stockpile
Stockpile Site 1a	STN2.5 to STN3.4	Stockpile
Stockpile Site 1b	STN3.3 to STN 3.4	Stockpile
Stockpile Site 2	STN5.2 to STN5.4	Stockpile
Stockpile Site 3	STN7.45 to STN7.65	Stockpile
Stockpile Site 4b	STN9.43 to STN9.6	Stockpile
Stockpile Site	STN10.45 to STN10.6	Stockpile
Stockpile Site	STN10.85 to STN11.05	Stockpile
Stockpile Site	STN11.98 to STN12.38	Stockpile
Stockpile Site	STN12.45 to STN12.8	Stockpile
Stockpile Site	STN12.95 to STN13.25	Stockpile

Site no.	Location (Station)	Proposed use
Stockpile Site	STN13.4 to STN13.8	Stockpile
Stockpile Site	STN13.85 to STN14.0	Stockpile
Stockpile Site	STN14.05 to STN14.8	Stockpile
Stockpile Site	STN10.45 to STN10.6	Stockpile

A summary of the results from the modelling of Section 1 (Woolgoolga to Halfway Creek) ancillary facilities is presented in Table 6-7. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-7 Section 1 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
1-a	203	51	51	0	0	-
1-b	181	51	55	1	0	-
1-c	21	55	55	1	0	-
1-d	8	51	82	4	2	R386, R575
1-e	8	51	48	0	0	-
1-f	2	51	24	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 1 of the project, including concrete batch plants, stockpile sites, office compounds and works shops is not expected to exceed the NML at the majority of the receivers. Exceedances of the NML are predicted at only six receivers. However of these six receivers, two are expected to experience noise levels above the 75dB (A) ‘highly noise affected’ criteria.

The main reason for exceedances of the 75dB (A) is the close proximity of the receivers. These two receivers are located outside the project boundary but within areas designated for ancillary facilities; R386 in stockpile site 1a and R575 in Section 2 (Halfway Creek to Glenugie upgrade), batch plant 1a. Due to their location it is reasonable to assume these receivers are highly likely to be acquired or be temporarily leased for the duration of the project. Therefore, these would no longer be classed as sensitive receivers.

There is the potential that some ancillary facilities would operate 24 hours a day to support construction works along the project. The operation of ancillary facilities during out of hours is assessed below.

Section 1 bridge works

Within Section 1 of the project (Woolgoolga to Halfway Creek), eight main bridges have been identified, comprising of four over bridges and four road bridges. This includes the 300 metre long bridge which would span the Corindi flood plain and the shorter Corindi creek bridge. The location and description of each bridge within Section 1 is presented in Table 6-8 and shown graphically in Appendix C.

Table 6-8 Section 1 bridge locations

Bridge reference	Location (Station)	Details	Bridge length / metres	Distance and direction to nearest receiver (metres)
Sherwood Creek Road over bridge	STN1.0	Over bridge linking Sherwood Creek Road to Eggins Close	50	200 south
Kangaroo Trail Road over bridge	STN2.5-STN2.6	Kangaroo Trail Road over bridge	80	90 east
Corindi Creek bridge	STN3.5 to STN3.7	Short road bridge crossing Corindi Creek	90	306 south
Corindi flood plain bridge	STN4.0 to STN4.3	Road bridge crossing Corindi River flood plain	300	600 south east
Cassons Creek road bridge	STN4.6	Cassons Creek road bridge	75	450 north
Corindi local access road bridge	STN6.1	-	77	650 north east
Twin bridges at Range Road interchange	STN9.0	Over bridge linking Kathleen Drive and Lookout Road	-	135 west
McPhillips Road over bridge	STN13.6	Over bridge over	60	100 north

The construction method used to construct the main road bridge within Section 1 of the project (Woolgoolga to Halfway Creek), the Corindi flood plain bridge, at this stage within the concept design is likely to be precast concrete driven piles with precast road platform sections being lifted into place to form the base of the concrete pour. Where the concrete pour for the road base is required to be undertaken in a single 24 hour period, there is the potential for work to be undertaken outside proposed construction hours.

At each of the other Section 1 bridges (road and over bridges); driven piles are assumed to be used along with other plant identified in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, in the absence of a more detailed construction method, will ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 1 bridge works (between Woolgoolga to Halfway Creek) is presented in Table 6-9. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous construction of Section 1 bridges. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-9 Section 1 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
1-a	203	51	51	0	0	-
1-b	181	51	56	1	0	Sherwood Creek over bridge,
1-c	21	55	63	3	0	Sherwood Creek over bridge,, Kangaroo Trail Road over bridge, McPhillips Road over bridge
1-d	8	51	51	0	0	-
1-e	8	51	43	0	0	-
1-f	2	51	37	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As shown in Table 6-9, four receivers would experience noise levels above the NML as a result of bridge works, and the highly noise affected criteria' is not predicted to be exceeded at any of receivers. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The primary cause for the exceedances of the NML is a result of the works for over bridges. Exceedances of the NML are not predicted during the works at the bridge crossing of Corindi flood plain, bridge crossing of Corindi Creek or bridge crossing of Cassons Creek.

The exceedances of the NML during general daytime works of the bridges in Section 1 of the project are primarily from noise associated with piling works assumed to occur at each of the bridge sites. Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore administrative measures are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

The bridge noise predictions assume a piling rig would be operational at each bridge site, in reality this may not occur as piling may not be required or would be restricted in its operation (i.e. daytime only).The predictions also assume an impact piling rig is to be used, whereas in practice, quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to four dB(A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during construction within proposed hours.

Where construction is required outside proposed works hours on the Corindi flood plain bridge there is a high risk that a number of receivers will experience noise above night time NMLs with the works most certainly being audible by some residents. A summary of the number of receivers which would experience impact associated with night time works at the Corindi Flood Plains Bridge is presented in Table 6-10. A general out of hours assessment for the remainder of the Section 1 bridges is undertaken later in this section.

Table 6-10 Section 1 out of hours noise summary – Bridge crossing of Corindi flood plain

NCA	Night-time NML, dB(A)	No of receivers exposed to >30dB(A)	Maximum predicted noise level in NCA, dB(A)	Receivers exceeding NML
1-a	38	10	45	9
1-b	42	3	41	0
1-c	40	0	0	0
1-d	42	0	0	0
1-e	42	0	0	0
1-f	38	0	0	0

Where work is required to be undertaken during night time periods at the Corindi flood plain bridge, up to nine receivers may experience noise levels higher than the night-time NML. Also, a further four receivers are likely to experience noise associated with the bridge works that would be audible outside of the dwelling. For this reason where out of hours works are required for the Corindi flood plain, community consultation would be required, along with approval from the Department of Planning and Infrastructure and the Environment Protection Authority.

Potential mitigation and management measures for general piling and bridge construction works are discussed further in Section 6.1.1 and Appendix I.

Section 1 haulage routes

Within Section 1 of the project (Woolgoolga to Halfway Creek), haulage routes would follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. However the proposed Corindi local access road may serve as a temporary haul road for construction. This would link the construction site with the existing Pacific Highway at STN 8.95.

Truck numbers using this proposed access road would be based on the quantity of materials required for the construction of the embankments between Corindi Creek and Corindi River, and also for the relocation of material to the north of the Corindi River. At this stage, a total of 65,000 cubic metres of materials would need to be transported along this access road. This equates to approximately 52,000 tonnes of material or 1500-1800 truck loads. Given that this stage of works is estimated to take up to 12 months to complete, there is a potential for up to 50 trucks per day (one way, 100 movements per day) hauling material on this route.

There are around five residential receivers within 500 metres of the potential haul road, with the closest of these being approximately 200 metres from the access road. The movement of these trucks has been modelled along the haul route to predict the noise at the identified receivers. Due to the low anticipated vehicle speeds and low traffic flow, calculations have been based on point source emissions from trucks rather than Calculation of Road Traffic Noise (CORTN) calculations. These emissions have in turn been calculated from general Sound Exposure Level (SEL) of truck movements and adjusted to take account of access road length, vehicle speeds and duration. The results of these predictions are presented in Table 6-11. These highlight the highest anticipated 15 minute period during the truck movements at any one receiver.

Table 6-11 Corindi access road haul route noise predictions

Receivers	NCA	NML, dB(A)	Predicted noise level $L_{Aeq,15min}$/ dB(A)
R455	1-b	51	33
R453	1-c	51	30
R458 (commercial)	1-d	70	25
R459 (commercial)	1-d	70	24
446	1-e	51	46

The results in Table 6-11 show that as a result of haul trucks moving along the proposed Corindi access road, noise levels at the closest receivers are predicted to be below the NML and in most case are likely to be inaudible. Therefore the potential for impact at receivers from the use of this haul road is considered to be low for proposed hours.

The movement of trucks and plant to and from the project and ancillary facilities along the existing road network and along the project have not been quantitatively assessed. The noise associated with these movements is likely to be small relative to existing flows and therefore would blend in with existing emissions, with no net increase in noise. See Part A, Section 3.2.6 for more details on construction traffic.

Section 1 out of hours works assessment

It is anticipated a number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage, the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought and make certain that all potentially affected receivers are included in the process.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example, the activities associated with utility adjustments and ad-hoc oversized deliveries. However, such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods:

- Clearing and formation
- Earthworks
- Paving and asphalting

- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore, this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as the duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas, this method would provide a worst-case assessment.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

A summary of the impacts associated with each activity is presented in Table 6-12 to Table 6-16. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

Table 6-12 Section 1 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-a	203	38	48	200	200	0
1-b	181	42	58	179	179	0
1-c	21	40	72	17	17	0
1-d	8	42	66	5	5	0
1-e	8	42	51	7	7	0
1-f	2	38	44	2	1	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-13 Section 1 out of hours noise summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-a	203	38	53	200	200	0
1-b	181	42	63	179	179	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-c	21	40	77	17	17	1
1-d	8	42	71	5	5	0
1-e	8	42	56	7	7	0
1-f	2	38	49	2	2	0

Table 6-14 Section 1 out of hours noise summary – asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-a	203	38	51	200	200	0
1-b	181	42	61	179	179	0
1-c	21	40	75	17	17	1
1-d	8	42	69	5	5	0
1-e	8	42	54	7	7	0
1-f	2	38	47	2	2	0

Table 6-15 Section 1 out of hours noise summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-a	203	38	51	198	198	0
1-b	181	42	56	172	169	0
1-c	21	40	63	10	10	0
1-d	8	42	51	3	3	0
1-e	8	42	43	2	1	0
1-f	2	38	37	1	0	0

Table 6-16 Section 1 out of hours noise summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-a	203	38	51	83	58	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
1-b	181	42	55	19	6	0
1-c	21	40	55	8	4	0
1-d	8	42	82	5	4	2
1-e	8	42	48	2	1	0
1-f	2	38	24	0	0	0

Table 6-12 to Table 6-16 identify the number of receiver which are predicted to exceed the night – time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without affecting receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 1 per cent and 73 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only 13 receivers. As a result of ancillary site operations, construction noise is predicted to be inaudible at over 300 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The figures show three aspects of out of hours works:

1) The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
2) Identification of sections along the project where out of hours works would be suitable without the need for residential receiver consultation
3) Identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 1 (Woolgoolga to Halfway Creek), no areas of the project would be suitable for out of hours paving works, without causing some level of impact on the community. This is due to the relatively densely populated area surrounding the project and relatively even spread of dwellings along the Section 1 area. However this does not necessarily restrict all out of hours works but merely recommends where community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions for the activity of paving and asphalting and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with OEH and justification as to why these works are necessary outside of the proposed construction hours. These areas of works and the processes for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 1 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes that there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at a receiver more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 1. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 1.

A summary of the number of receivers within Section 1 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-17.

Table 6-17 Section 1 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
1-a	203	0
1-b	181	55
1-c	21	17
1-d	8	5
1-e	8	0
1-f	2	0

Table 6-17 shows that a number of receivers within Section 1 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 1 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore, the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. Also, the cumulative impact of simultaneous construction activities does not result in any additional receivers being categorised as 'highly noise affected'.

For Sections 1 (Woolgoolga to Halfway Creek) and 2 (Halfway Creek to Glenugie upgrade), both sections could commence in 2015, based on assumptions from the NSW Government's submission to Infrastructure Australia (November 2011). Therefore, there is a potential for there to be a cumulative impact for receivers at the northern extent of Section 1 and southern extent of Section 2. However, at the boundary of Section 1 and 2 the location of high noise emitting non-linear works is such they do not have a discernible impact on the highest noise levels already predicted at receivers within the vicinity, or have already been taken into account such as the Section 2 batch plant which is located within both Sections 1 and 2. Therefore, the cumulative impacts are considered to be minimal between different sections.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.1.4. Section 1 construction vibration assessment

The main sources of vibration within this section of the project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.1.5.

Piling induced vibration at bridge sites presented in Table 6-8 has been assessed, with a summary of impacts being provided in Table 6-18. This may be an over estimation of vibration however would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-18 is based on the matrix set out in Part A, Section 3.2.2. In summary, the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-18 Section 1 bridge construction vibration summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Sherwood Creek over bridge	0	0	0	0	0	0
Kangaroo Trail Road over bridge	1	0	0	0	0	0
Corindi Creek bridge	0	0	0	0	0	0
Corindi flood plain bridge	0	0	0	0	0	0
Cassons Creek Road bridge	0	0	0	0	0	0
Corindi local access road bridge	0	0	0	0	0	0
Twin bridges at range road interchange	0	0	0	0	0	0
McPhillips Road over bridge	0	0	0	0	0	0

Table 6-18 identifies there is only one dwelling (R351) within 50 metres of any of the Section 1 (Woolgoolga to Halfway Creek) bridges. Receiver R351 is around 40 metres from the Sherwood

Creek Over bridge. However, at this distance assuming generic vibration wave propagation, vibration predictions are predicted to be considerably below structural damage and human comfort criteria. This confirms the risk to structures and occupants is low in Section 1 (Woolgoolga to Halfway Creek) and in practice vibration as a result of piling would not be perceived by any of the identified receivers. Following confirmation of each individual pile location, a further detailed assessment may be required, but only where this is within 50 metres of the closest receiver.

Table 6-19 presents the potential risk associated with rock hammering. As the locations of this activity were no known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which would require a more detailed vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-19 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver (metres)		
	Low Risk	Medium Risk	High Risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

Two items of heritage importance have been identified in Section 1 (Woolgoolga to Halfway Creek), these being the “house, sheds and stockyards’ adjacent to R495 (NCA 1-c) and the actual residential house at R575 (NCA 1-d).

Due to the lack of information in relation to the site at R495, a quantified assessment cannot be undertaken. In addition to this, guidance and criteria does not allow for assessment of buried archaeological artefacts and as such the recommendation, at this stage, is where piling works or other vibratory plant used within 50 metres of the sensitive site, further detailed assessment would be undertaken. However, within Section 1 (Woolgoolga to Halfway Creek), the closest piling works are expected to be undertaken approximately 3 kilometres south and therefore impacts would be unlikely.

The heritage property at R575 is approximately 880 metres north of Lemon Tree Overbridge and, is at such a distance that impacts associated with vibration are predicted to be minimal. However due to the unknown structural condition of the property at R575, where piling works or other vibratory plant is used within 50 metres of the sensitive site, further detailed assessment would be undertaken post approval.

6.1.5. Section 1 construction blasting assessment

Within Section 1 (Woolgoolga to Halfway Creek), a number of cut and fill sites have been identified, however only a selection of these would potentially require blasting. These potential blast sites are identified in Table 6-20 along with potential materials requiring processing.

Table 6-20 Potential blast sites – Section 1

Cut location:	Blasting (bank) m^3	Processing (loose) m^3
STN2.3 to 2.7 (at Kangaroo Trail Road)	25,000	50,000
STN7.6 to STN8.4 (at Dirty Creek Range)	680,000	930,000
STN8.75 to STN8.9	25,000	35,000
STN9.1 to STN9.5 (combines two cuts)	10,000	15,000
STN9.75 to STN10.0 (at Range Road)	25,000	45,000
Estimated total quantities for Section 1:	765,000	1,075,000

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason, only an indication of the risk associated with blasting at these sites on surrounding receivers can be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

Table 6-21 and Table 6-22 present the prediction of vibration and overpressure, from different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report, with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A). Exceedances of the criteria are highlighted in red.

Table 6-21 Closest sensitive receiver overpressure prediction – Section 1

Cut/blasting site	Receiver	Receiver type	Separation distance / metres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN2.3 to 2.7 (at Kangaroo Trail Road)	344	Residential	210	113	119	122	124	125	126
	359	Commercial	540	101	108	110	112	113	114
STN7.6 to STN8.4(at Dirty Creek Range)	439	Residential	190	114	121	124	125	126	127

Cut/blasting site	Receiver	Receiver type	Separation distance / metres	Overpressure according to charge / dB					
				1	5	10	15	20	25
	-	Commercial	-	-	-	-	-	-	-
STN8.75 to STN8.9	446	Residential	230	112	118	121	123	124	125
	456	Comm.	560	100	107	110	112	113	114
STN9.1 to STN9.5 (combines two cuts)	455	Residential	180	115	121	124	126	127	128
	458	Commercial	-	-	-	-	-	-	-
STN9.75 to STN10.0(at Range Road)	474	Residential	800	96	103	105	107	108	109
	459	Commercial	250	110	117	120	122	123	124

Table 6-22 Closest sensitive receiver vibration prediction – Section 1

Cut/Blasting Site	Receiver	Receiver type	separation distance / metres	Vibration according to charge (Peak particle velocity- PPV) / dB					
				1	5	10	15	20	25
STN2.3 to 2.7 (at Kangaroo Trail Road)	344	Residential	240	0.2	0.6	1.1	1.5	1.9	2.3
	359	Commercial	540	0.05	0.2	0.3	0.4	0.5	0.6
STN7.6 to STN8.4 (at Dirty Creek Range)	439	Residential	190	0.25	0.9	1.6	2.2	2.8	3.4
	-	Commercial	-	-	-	-	-	-	-
STN8.750 to	446	Residential	230	0.2	0.7	1.2	1.7	2.1	2.5

Cut/Blasting Site	Receiver	Receiver type	separation distance / metres	Vibration according to charge (Peak particle velocity- PPV) / dB					
				1	5	10	15	20	25
	456	Commercial	560	0.05	0.2	0.3	0.4	0.5	0.6
STN9.100 to STN9.500 (combines two cuts)	455	Residential	180	0.25	0.9	1.6	2.2	2.8	3.4
	-	Commercial	-	-	-	-	-	-	-
STN9.750 to STN10.000 (at Range Road)	474	Residential	800	0.03	0.1	0.2	0.2	0.3	0.3
	459	Commercial	250	0.03	0.6	1.0	1.4	1.8	2.2

Table 6-21 indicates that there is a potential for the overpressure to be exceeded at a number of the closest receivers following blasting at Section 1 cut site, even as a result of the smallest blast charge. Although this does not necessarily mean that blasting cannot be undertaken, further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

Table 6-22 indicate that where a charge of less than 25 kilograms is used at the Section 1 (Woolgoolga to Halfway Creek) cut sites, the potential for exceeding the vibration criteria at the closest receivers is low. This is due to the relatively large separation distances between the blast area and receiver. Where charges higher than 25 kilograms are used, further assessment would be required to determine impact.

In terms of blasting impacts on the heritage items identified in Section 1 (Woolgoolga to Halfway Creek), being the "house, sheds and stockyards' adjacent to R495, a quantified blasting assessment cannot be undertaken (see vibration assessment). Within Section 1 (Woolgoolga to Halfway Creek), the closest blasting areas have been identified as being approximately 2.3 kilometres south and therefore associated impacts would be unlikely. Where blasting is undertaken within 500 metres of the sensitive site, further detailed assessment should be undertaken prior to the commencement of works, following approval.

The heritage property at R575 is over 4 kilometres from the nearest identified blasting/cut sites and, is at such a distance that impacts associated with blasting vibration are predicted to be minimal. However due to the unknown structural condition of the property at R575, where blasting is undertaken within 500 metres of the sensitive site, further detailed assessment would be undertaken post approval.

6.1.1. Section 1 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 1 of the project (Woolgoolga to Halfway Creek) construction works is provided in Table 6-23

In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3, Section 3.3.4.

Table 6-23 Section 1 Specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and Formation	-	60	See Appendix I
Earthworks	R522	180	See Appendix I
Paving and Asphalting	R495	147	See Appendix I
Bridge Works - Noise	-	4	See Appendix I
Ancillary facilities	R575 R386	6	R575 is located on land that would potentially be acquired for ancillary facilities. R575 located on land proposed for Ancillary Site 1a (Section 2), R386 in Stockpile Site 1a. Temporary occupant relocation, temporary land lease/acquisition should be considered. Noise barriers and respites periods are unlikely to be effective or feasible in the longer term operation of the site.
Blasting	R344, R439, R446, R455	-	Prior to the blasting at Section 1 cut sites, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers

6.2. Section 2 (Halfway Creek to Glenugie upgrade)

6.2.1. Section 2 assessment summary

Section 2 (Halfway Creek to Glenugie upgrade) of the project is around 12 kilometres long, from the northern end of the Halfway Creek upgrade at Lemon Tree Road to the southern end of the Glenugie upgrade at Franklins Road. For a location of this section in graphical terms, refer to Part A, Figure 1-3.

The construction works proposed for Section 2 of the project (Halfway Creek to Glenugie upgrade) includes all activities identified within Part A, Table 3-6 in Section 3.3.1, with the exception of soft soil treatments (not identified by RMS as being required). An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of the site clearing, earthworks and paving, over 46 per cent of the receivers within Section 2 are likely to experience noise levels above the noise management level (NML). However none are predicted to exceed the 'highly noise affected' criterion
- Predicted noise levels from the operation of ancillary facilities are below the NMLs at all but nine receivers, and therefore the potential for disturbance is minimal. However, one receiver is predicted to experience noise levels above the 'highly noise affected' criteria
- Section 2 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements are predicted to be minimal
- The construction of road and over bridges within Section 2 would result in exceedances of the NML at 18 of the 28 receivers
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation would be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within Section 2, where receivers are within 50 metres of the site, further assessment would be undertaken
- The closest receiver identified to either of the two blasting sites in Section is over 3.5 kilometres away and therefore the potential for impact is deemed to be minimal.

The exceedance of NMLs is primarily from the short separation distance between the project and receivers within Section 2 (Halfway Creek to Glenugie upgrade). Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means the duration at which receivers would experience these levels would be short as the works progress along the project. The NMLs for noise catchment area (NCA) have also been derived from as many as four monitoring locations (depending on number of noise monitoring locations within NCA) and therefore the NMLs may be lower in practice due to a non-uniform noise environment around some receivers.

6.2.2. Background noise monitoring and noise management levels

There are around 28 receivers identified within the 600 metres project in this section. Of these receivers one has been identified as being located within the project boundary and has been identified but not assessed. The 28 receivers include four commercial/non-residential receivers. Also within Section 2 of the project, an area of archaeological/heritage importance has been identified on land surrounding Receiver R616. In terms of assessment, a qualitative approach has been undertaken to determine the impacts associated with vibration as a result of bridge works and blasting at the heritage site. See Part A, Section 4.1 for further information on the assessment method for archaeological/heritage land.

A definitive list of all receivers identified for the noise and vibration assessment, both operational and construction is provided in Appendix E and displayed graphically in Appendix C.

Unattended monitoring has been undertaken at two receivers within Section 2 of the project. The locations of these are presented in **Table 6-24** alongside measured 'rating background level' (RBL) and derived construction NML, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. **Table 6-24** also displays which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been looked at separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-24 Section 2 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am - 6pm)		Extended hours (morning shoulder period 6-7am)		Extended hours (evening shoulder period 6-7pm)		Proposed hours NML*, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML dB(A)		
597	48	58	43	53	44	54	53	2-b, 2-e
651	46	56	46	56	46	56	56	2-d, 2-c, 2-a, 2-f

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-24. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 2 of the project (Halfway Creek to Glenugie upgrade) are provided in provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-25 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-25 Section 2 – NCA noise management levels (NMLs)

Noise catchment area	Project NML, dB(A)	Night-time/out of hours NML, dB(A)
NCA 2-a	56	38
NCA 2-b	53	42
NCA 2-c	56	40
NCA 2-d	56	42
NCA 2-e	53	42
NCA 2-f	56	38

6.2.3. Section 2 construction noise assessment

Section 2 soft soil treatments

There are no soft soil treatments proposed or deemed required within Section 2 of the project.

Section 2 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted from the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-26, Table 6-27 and Table 6-28. These tables summarise the number of receivers which are exposed to varying levels of construction noise from each phase of works. A complete list of individual receivers and the levels predicted for construction noise associated with each activity is provided in Appendix E.

Table 6-26 Section 2 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
2-a	3	56	43	0	0	-
2-b	8	53	65	1	0	-
2-c	4	56	66	3	0	-
2-d	6	56	59	2	0	-
2-e	5	53	51	0	0	-
2-f	2	56	44	0	0	-

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

Table 6-27 Section 2 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
2-a	3	56	48	0	0	-
2-b	8	53	70	4	0	-
2-c	4	56	71	4	0	-
2-d	6	56	64	4	0	-
2-e	5	53	59	1	0	-
2-f	2	56	49	0	0	-

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

Table 6-28 Section 2 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
2-a	3	56	56	0	0	-
2-b	8	53	68	2	0	-
2-c	4	56	69	4	0	-
2-d	6	56	62	3	0	-
2-e	5	53	54	1	0	-
2-f	2	56	47	0	0	-

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 2 of the project (Halfway Creek to Glenugie upgrade); with no receivers being predicted to be exposed to levels above the highly noise affected criteria of 75dB (A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels will be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required. These are discussed in Appendix I.

Section 2 ancillary facilities and compounds

Within Section 2 of the project (Halfway Creek to Glenugie upgrade), the ancillary facilities presented in Table 6-29 have been identified and quantitatively assessed. This includes 15 stockpile sites, five multi-use sites (including concrete batch plants, workshops and site offices). The location of these sites and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled using SoundPlan noise software, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore, it is recommended that following the finalisation of ancillary site internal layouts, a more detailed assessment should be undertaken to determine impact.

Table 6-29 Section 2 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1a	STN16.7 to STN17.1	Main office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 1b	STN17.15 to STN17.45	Main office and compound area. Batch plant area. Plant workshop Materials storage.
Site 2	STN 9.3 to STN19.6	Batch plant area. Plant workshop Materials storage.
Site 3	STN20.4 to STN20.5	Satellite site compound. Materials storage.
Site 4	STN21. 7 to STN22.2	Stockpile site.
Site 5	STN23. 5 to STN23.8	Main office and compound area. Batch plant area. Plant workshop Materials storage.
Site 6	STN25.7 to STN25.9	Stockpile site.

Site no.	Location (Station)	Proposed use
Stockpile Site 1a	STN16.7 to SN17.1	Stockpile site.
Stockpile Site 1b	STN17.1 to STN17.5	Stockpile site.
Stockpile Site	STN17.0 to SN18.0	Stockpile site.
Stockpile Site	STN18.2 to STN18.75	Stockpile site.
Stockpile Site	STN18.8 to STN19.2	Stockpile site.
Stockpile Site 2	STN19. 1 to SN19.9	Stockpile site.
Stockpile Site	STN19.2 to STN20.3	Stockpile site.
Stockpile Site 3	STN20.5 to STN20.5	Stockpile site.
N/A	STN21.2 to SN21.7	Stockpile site.
Stockpile Site 4	STN21. 7 to STN22.2	Stockpile site.
Stockpile Site	STN21.7 to STN22.2	Stockpile site.
Stockpile Site 5	STN23. 5 to STN23.8	Stockpile site.
Stockpile Site 6	STN25.7 to STN25.9	Stockpile site.

A summary of the results from the modelling of ancillary facilities is presented in Table 6-30. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-30 Section 2 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
2-a	3	56	52	0	0	-
2-b	8	53	68	1	0	-
2-c	4	56	75	3	1	R581
2-d	6	56	67	3	0	-
2-e	5	53	67	2	0	-
2-f	2	56	41	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 2 of the project (Halfway Creek to Glenugie upgrade), including concrete batch plants, stockpile sites, office compounds and works shops is predicted to exceed the NML at less than a third of the total receivers. Of these receivers, only one is expected to experience noise levels above the 75dB (A) ‘highly noise affected’ criteria; this being receiver R581.

The main reason for exceedances of the 75dB (A) is the result of the receiver locations. Receiver R581 is located within an area designated for an ancillary site; this being ancillary site 3 which comprises of materials storage and compound. Due to its location, it is reasonable to assume that this receiver would form part of the acquisition process to facilitate the operation of the proposed ancillary site, and therefore no longer be classes as a sensitive receiver.

For the general NML exceedances, at this stage due to the lack of detail in layouts of ancillary facilities and the areas of plant operation contained within the ancillary facilities, predictions have been based on total area sources for the site. This may prove to slightly under predict levels at receivers located within a short separation distance to sites. Therefore, it is recommended that following the finalisation of ancillary site internal layouts, a more detailed assessment should be undertaken.

There is the potential that some ancillary facilities would operate 24 hours a day to provide services to construction works along the project. The out of hours operation of Section 2 ancillary facilities will be assessed below.

Section 2 bridge works

Within Section 2 of the project (Halfway Creek to Glenugie upgrade), eight main bridges have been identified, comprising of four over bridges and four road bridges. This includes the Lemon Tree access road bridge, and the twin bridges at Halfway Creek and Wells Crossing. None of these bridges have been identified by RMS as being significant in terms of their size or the construction technique proposed to construct these. Therefore these have been modelled and assessed as being constructed simultaneously. The location and description of each bridge within Section 2 is presented in Table 6-31 and shown graphically in Appendix C.

Table 6-31 Section 2 bridge locations

Bridge reference	Location (Station)	Details	Bridge length	Distance and direction to nearest receiver
Grays Road over bridge	STN15.7	Over bridge over Grays Road	66	120 metres west
Lemon Tree access over Bridge	STN17.8	Overpass bridges on embankment	66	200 metres west
Halfway Creek over bridge	STN20.7	-	64	220 metres south
Halfway Creek twin bridges	STN20.7	Project road bridge at Halfway bridge	50.5	220 metres south
Luthers Road Underpass Bridge	STN21.3	Underpass for Luthers Road	11	250 metres west
Wells Crossing twin bridges	STN22.4	Project road bridge at Franklins Road	60	450 metres north-west
Bald Knob Tick Gate over bridge	STN25.1	Over bridge in cutting	75	1.2 kilometres south
Franklins Road over	STN21.3	Over bridge in cutting	75	230 metres south-

Bridge reference	Location (Station)	Details	Bridge length	Distance and direction to nearest receiver
bridge				east

The construction method used to construct the bridges within Section 2 of the project, has been identified as precast driven piling. The plant associated with these works, as detailed in Table 3-6 in Part A, have been modelled, with the results being presented in Table 6-32. This highlights the number of receivers potentially exceeding NMLs as a result of the works. The noise prediction at each individual receiver is presented in Appendix E. In practice, alternate methods of construction to piling may be identified and therefore the levels presented are considered worst case.

Table 6-32 Section 2 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
2-a	3	56	45	2	0	Franklins Road over bridge
2-b	8	53	55	6	0	Franklins Road over bridge, Lemon Tree Access over bridge
2-c	4	56	61	4	0	Lemon Tree access over bridge
2-d	6	56	52	1	0	Halfway Creek twin road bridge and over bridge
2-e	5	53	50	3	0	Halfway Creek twin road bridge and over bridge
2-f	2	56	21	2	0	Halfway Creek twin road bridge and over bridge

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-32 shows that 18 receivers will experience noise levels above the NML as a result of bridge works, and the highly noise affected criteria' is not predicted to be exceeded at any of receivers. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The primary cause for the exceedances of the NML is a result of the works at Franklins Road over bridge, Lemon Tree access road over bridge and Halfway Creek twin road bridge / over bridge. Exceedances of the NML are not predicted during the works at the Bald Knob Tick Gate over bridge.

The exceedances of the NML during general daytime works of the bridges in Section 2 of the project (Halfway Creek to Glenugie upgrade) are primarily from the noise associated with the piling works assumed to occur at each of the bridge sites. Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore administrative measures (e.g. providing respite periods) are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

The bridge noise predictions assume a piling rig would be operational at each bridge site, in reality this may not occur as piling may not be required or would be restricted in its operation (i.e. daytime only). The predictions also assume an impact piling rig is to be used whereas in practice quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to 4dB (A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during operations within proposed hours.

It is not anticipated that any out of hour works will be required at any of the individual bridges within Section 2 of the project. Therefore individual assessments of each bridge have not been undertaken. However, a general out of hours assessment has been undertaken to take account of all Section 2 bridges. This is presented later within Section 6.2.3.

Where out of hours works are later shown to be required on bridges within Section 2, additional detailed noise assessment will be undertaken prior to the commencement of works to determine community impact.

Haul routes noise

Within Section 2 of the project (Halfway Creek to Glenugie upgrade), haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway alignment and other local roads. At this stage it is not anticipated that any new haul roads would be required in Section 2, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the proposed upgrade.

Section 2 out of hours works

It is anticipated that a number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage, the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. The activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended. However, such works are likely to be similar in nature to those above and would have a similar impact. It is envisaged the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as ‘highly noise affected’ for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-33 to Table 6-37. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-33 Section 2 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
2-a	3	38	43	3	0	0
2-b	8	42	65	8	1	0
2-c	4	40	66	5	4	0
2-d	6	42	59	4	3	0
2-e	5	42	51	5	0	0
2-f	2	38	44	2	0	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-34 Section 2 out of hours noise summary –earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
2-a	3	38	48	3	3	0
2-b	8	42	70	8	8	0
2-c	4	40	71	5	4	0
2-d	6	42	64	4	4	0
2-e	5	42	56	5	5	0
2-f	2	38	49	2	2	0

Table 6-35 Section 2 out of hours noise summary –asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
2-a	3	38	46	3	2	0
2-b	8	42	68	8	7	0
2-c	4	40	69	4	4	0
2-d	6	42	62	4	4	0
2-e	5	42	54	5	5	0
2-f	2	38	47	2	2	0

Table 6-36 Section 2 out of hours noise summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
2-a	3	38	45	3	2	0
2-b	8	42	55	8	6	0
2-c	4	40	61	5	4	0
2-d	6	42	52	4	1	0
2-e	5	42	50	5	3	0
2-f	2	38	51	2	2	0

Table 6-37 Section 2 out of hours noise summary –ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
2-a	3	38	52	3	2	0
2-b	8	42	68	8	7	0
2-c	4	40	75	5	4	1
2-d	6	42	68	4	4	0
2-e	5	42	67	5	5	0
2-f	2	38	41	2	2	0

Table 6-33 to Table 6-37 identify the number of receivers which are predicted to exceed the night – time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without receiver impact.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 4 per cent and 14 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only one receiver. As a result of ancillary site operations, construction noise is predicted to be inaudible at over four receivers.

Following the assessment against RBLs, a graphical interpretation of out of hour works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The figures show three aspects of out of hours works;

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise are presented
- Identification of sections along the project where out of hours works would be suitable without the need for residential dwelling consultation (i.e. potential 24 hour construction works)
- Identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The output of the assessment in Appendix B show that in Section 2, approximately 4.6 kilometres of the project would be suitable for out of hours paving works, without causing impacts on the community. Therefore, works could potentially be undertaken 24 hours a day without further consultation (this is presented by un-shaded areas along the project centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for the activity of [paving and asphalting, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with Environment Protection Authority and justification as to why these works are necessary outside proposed construction hours. It is likely these areas of works and the process for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 2 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance from maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011)

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at a receiver more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 2. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 2.

A summary of the number of receivers within Section 2 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-38.

Table 6-38 Section 2 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
2-a	3	0
2-b	8	0
2-c	4	4
2-d	6	4
2-e	5	2
2-f	2	0

Table 6-38 shows that a number of receivers within Section 2 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 2 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore, the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. Also, the cumulative impact of simultaneous construction activities does not move any additional receivers into the category of ‘highly noise affected’.

For Sections 1 (Woolgoolga to Halfway Creek) and 2 (Halfway Creek to Glenugie upgrade) of the project, both sections are envisaged to start in 2015 and therefore there is a potential for there to be a cumulative impact for receivers at the northern extent of Section 1 and southern extent of Section 2. However, at the boundary of Section 1 and 2 the location of high noise emitting non-linear works is such that they do not have a discernible impact on the highest noise levels already predicted at receivers within the vicinity, or have already been taken into account such as the Section 2 batch plant which is located within both Sections 1 and 2. Therefore, the cumulative impacts are considered to be minimal between these sections.

To the northern extent of Section 2 of the project, the impact of simultaneous construction in both sections is minimal as Section 2 is due to start in 2015 whereas Section 3 works are due to start in early 2014. Where Section 3 works overlap into 2015, the works at the Section2/3 boundary could be staged to avoid simultaneous working.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.2.4. Section 2 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.2.5.

Piling induced vibration at bridge sites presented in Table 6-8 has been assessed, with a summary of impacts being provided in Table 6-39. This may be an over estimation of vibration, however, would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-39 is based on the matrix set out in Part A, Section 3.2.2. In summary, the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-39 Section 2 bridge construction vibration summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Grays Road over bridge	0	0	0	0	0	0
Lemon Tree Access over bridge	0	0	0	0	0	0
Halfway Creek over bridge	0	0	0	0	0	0
Halfway Creek twin road bridge	0	0	0	0	0	0
Luthers Road Underpass Bridge	0	0	0	0	0	0
Wells Crossing road bridge	0	0	0	0	0	0
Bald Knob Tick Gate over bridge	0	0	0	0	0	0
Franklins Road over bridge	0	0	0	0	0	0

Table 6-39 identifies there are no dwellings within 50 metres of any of the Section 2 (Halfway Creek to Glenugie upgrade) bridges. This confirms that the risk to structures and occupants is low and in practice vibration from piling would not be perceived by any of the identified receivers. The closest receiver/structure to any of the Section 2 bridges is R582 approximately 200 metres to Lemon Tree access road bridge. This is at such a distance that the risk of damage is minimal and therefore in Section 2, no additional assessment work is considered to be required for piling work at any of the bridges.

Table 6-40 presents the potential risk associated with rock hammering. As the locations of this activity were unknown at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-40 Generic vibration Impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

In terms of piling/vibration impacts on the heritage items identified in Section 2 of the project, being the "Service Station Complex" on land at receiver R616, a quantified assessment cannot be undertaken. This is due to the lack of information in relation to this site, in terms of the actual structures or artefacts. Also, guidance and criteria does not allow for assessment of buried archaeological artefacts and as such the recommendation, at this stage, is where piling works or other vibratory plant used within 50 metres of the sensitive site, further detailed assessment should be undertaken. The project in Section 2 also runs through part of the area classed with heritage potential and therefore it is likely the impact associated with general construction works (earthworks, clearing etc) would prove more disruptive than from identified Section 2 construction induced piling activities.

6.2.5. Section 2 construction blasting assessment

Within Section 2 of the project (Halfway Creek to Glenugie upgrade), a number of cut and fill sites have been identified, however only a selection of these would potentially require blasting. These potential blast sites are identified in Table 6-41 along with potential materials requiring processing.
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Table 6-41 Section 2 potential blast sites

Cut location:	Blasting (bank) / m^3	Processing (loose) / m^3
STN26.800 to STN27.300	10,000m^3	25,000m^3
STN27.500 to STN28.700	45,000m^3	70,000m^3
Estimated total quantities for Section 2:	55,000m^3	95,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason, only an indication of the risk associated with blasting at these sites on surrounding receivers can only be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

The closest receivers to the Section 2 (Halfway Creek to Glenugie upgrade) blast sites are around 3 kilometres away and as such the predicted ground borne vibration and overpressure, even as a result of a 25 kilogram charge are considerably below the project criteria. Therefore, the potential for impact from blasting at the cuts identified in Section 2 of the project is minimal. However, consideration should still be given to any non-residential structures/buildings within 500 metres of the blast sites to ensure the risk of damage is taken into account.

In terms of blasting impacts on the heritage items identified in Section 2 of the project, a quantified blasting assessment cannot be undertaken (see vibration assessment). Within Section 2, the closest blasting areas have been identified as being around 3 kilometres south and therefore associated impacts would be negligible. Where blasting is undertaken within 500 metres of the sensitive site, further detailed assessment should be undertaken

6.2.6. Section 2 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 1 construction works is provided in Table 6-42.

In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-42 Section 2 Specific Mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	-	6	See Appendix I
Earthworks	-	13	See Appendix I
Paving and asphalting	-	10	See Appendix I
Bridge works – noise	-	5	See Appendix I

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Ancillary facilities	R581	9	R581 is located on land proposed for Ancillary site 3. Temporary occupant relocation, temporary land lease/acquisition should be considered. Noise barriers and respites periods are unlikely to be effective or feasible in the longer term operation of the site.

6.3. Section 3 (Glenugie upgrade to Tyndale)

6.3.1. Section 3 assessment summary

Section 3 of the project is around 35 kilometres long, extending from the northern end of the current Glenugie upgrade (located just south of Eight Mile Lane) to Tyndale. For a location of this section in graphical terms, refer to Part A, Figure 1-3.

The construction works proposed for Section 3 of the project includes all activities identified within Part A, Table 3-6; with the exception of soft soil treatments (not identified by RMS as being required in Section 3). . An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of the site clearing, earthworks and paving, over 40 per cent of the receivers within Section 3 are likely to experience noise levels above the noise management level (NML). However, no exceedances of the 'highly noise affected' criteria are predicted
- Predicted noise levels as a result of the operation of ancillary facilities show that up to 17 receivers may experience noise levels above NMLs. However, no exceedances of the 'highly noise affected' criteria are expected
- Section 3 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements is predicted to be minimal
- The simultaneous construction of the bridges within Section 3 result in 12 receivers experiencing noise levels above the NML. However, no exceedances of the 'highly noise affected' criteria are expected
- Where work on the Coldstream River bridges is required outside of proposed hours, (works are likely to be audible at one receiver
- Where work on the Pillar Valley Creek bridges is required outside of proposed hours, i.e. at night, works are likely to be audible at up to six receivers

- Where work on the North of Pillar Valley bridge is required outside of proposed hours, i.e. at night, works are unlikely to be audible at any receiver within Section 3 and therefore 24 hour work on this bridge is possible
- Where work on the property overpass at STN63.7 is required outside of proposed hours, i.e. at night, works are likely to be audible at up to two receivers
- In terms of piling, one receiver has been identified within a distance of 50 metres from one of the proposed over bridge/ piling sites (bridge sites), however, predicted vibration levels are such that the risk of exceeding structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of potential work sites, further investigation should be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within 50 metres of receivers, further assessment should be undertaken prior to the commencement of works
- Blasting at specified cut sites along the project may result in some receivers being exposed to vibration and overpressure levels above adopted project criteria. Therefore, detailed assessment and mitigation/management measures would be required prior to construction.

The exceedance of NMLs is primarily from the short separation distance between the project and receivers within Section 3 of the project (Glenugie upgrade to Tyndale). Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means the duration at which receivers would experience these levels would be short as the works progress along the project. The NMLs for noise catchment area (NCA) have also been derived from up to two monitoring locations (dependent on number of monitoring locations within NCA) and therefore the NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.3.2. Background noise monitoring and noise management levels

There are around 62 receivers within 600 metres of the project in Section 3. Of these receivers, seven are within the boundary of the project and therefore would be acquired. For this reason, these seven receivers have been identified but have not been assessed. Of the 62 receivers, two commercial/non-residential receivers have been identified. Also, within Section 3 an area of archaeological/heritage importance has been identified on land surrounding Receiver 813 as shown graphically in Appendix B. In terms of assessment, a qualitative approach has determined the impacts from vibration as a result of bridge works and blasting at the heritage site. See Section Part A, 2.4.2 for further information on the assessment method for archaeological/heritage land.

A definitive list of all receivers identified for the construction noise and vibration assessment is displayed graphically in Appendix C and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at four receivers within Section 3 of the project. The locations of these are presented in Table 6-43 alongside measured ‘rating background level’ (RBL) and derived construction NML, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-43 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-43 Section 3 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am -6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
703	48	58	49	59	48	58	58	3-b, 3-a
729	45	55	45	55	47	57	55	3-c
748	34	44	40	50	38	48	44	3-d
678	45	55	45	55	46	56	55	3-e, 3-f

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-43. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring data are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-44 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-44 Section 3 – NCA Noise Management Levels (NML)

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 3-a	55	40
NCA 3-b	58	41
NCA 3-c	55	40
NCA 3-d	44	47

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 3-e	55	44
NCA 3-f	55	50

6.3.3. Construction noise assessment

Section 3 soft soil treatments

There are no soft soil treatments proposed within Section 3 of the project (Glenugie upgrade to Tyndale).

Section 3 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted from the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-45, Table 6-46 and Table 6-47. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-45 Section 3 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
3-a	6	55	45	0	0	-
3-b	9	58	53	1	0	-
3-c	5	55	64	2	0	-
3-d	15	44	63	10	0	-
3-e	8	55	55	2	0	-
3-f	19	55	49	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-46 Section 3 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
3-a	6	55	50	0	0	-
3-b	9	58	58	5	0	-
3-c	5	55	69	2	0	-

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
3-d	15	44	68	11	0	-
3-e	8	55	60	6	0	-
3-f	19	55	54	3	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-47 Section 3 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
3-a	6	55	48	0	0	-
3-b	9	58	56	3	0	-
3-c	5	55	67	2	0	-
3-d	15	44	66	11	0	-
3-e	8	55	58	6	0	-
3-f	19	55	52	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 3 of the project (Glenugie upgrade to Tyndale). However, no receivers are predicted to be exposed to levels above the highly noise affected criteria of 75dB (A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity. This includes all plant identified in Table 3-6 in Part A operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary and as the work is linear, the time at which each receiver is exposed to such levels would be short. As the work progresses along the proposed upgrade, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures will be required. These would be detailed further in Appendix I.

Section 3 ancillary facilities and compounds

Within Section 3 of the project, the ancillary facilities presented in Table 6-48 have been identified and assessed. This includes 11 stockpile sites, 13 multi-use sites (including concrete batch plants, workshops and site offices). The location of these sites and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan noise software, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facilities locations and internal layouts, a more detailed assessment should be undertaken prior to the commencement of works.

Table 6-48 Section 3 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN34.3 to STN34.5	Main office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 2	STN39.6 to STN40.2	Satellite site compound area.
Site 3a	STN41.1 to STN41.4	Satellite site compound area. Batch plant area. Plant workshop.
Site 3b	STN41.1 to STN41.5	Stockpile site.
Site 4	STN45.5 to STN45.9	Satellite site compound area. Batch plant area. Plant workshop.
Site 5	STN49.4 to STN49.6	Satellite site compound area.
Site 6a	STN51.4 to STN51.5	Stockpile site.
Site 6b	STN51.9	Satellite site compound area.
Site 7a	STN55.5 to STN56.0	Stockpile site.
Site 7b	STN56.1 to STN56.3	Stockpile site.
Site 8	STN61.1 to STN61.4	Satellite site compound area. Batch plant area. Plant workshop.
Site 9	STN62.0 to STN62.3	Satellite site compound area. Batch plant area.
Site 10	STN67.2 to STN67.4	Main site office and compound area. Batch plant area. Plant workshop.
Stockpile Site 2	STN39.6 to STN40.2	Stockpile
Stockpile Site 3a	STN41.1 to STN41.4	Stockpile
Stockpile Site 3b	STN41.1 to STN41.5	Stockpile
Stockpile Site 4	STN45.5 to STN45.9	Stockpile
Stockpile Site 5	STN49.4 to STN49.6	Stockpile
Stockpile Site 6a	STN51.4 to STN51.5	Stockpile
Stockpile Site 7a	STN55.5 to STN56.0	Stockpile
Stockpile Site 7b	STN56.1 to STN56.3	Stockpile
Stockpile Site 8	STN61.1 to STN61.4	Stockpile
Stockpile	STN62.0 to STN62.3	Stockpile

Site no.	Location (Station)	Proposed use
Site 9		
Stockpile Site 10	STN67.2 to STN67.4	Stockpile

A summary of the results from the modelling of ancillary facilities is presented in Table 6-49. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-49 Section 3 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
3-a	6	55	53	1	0	-
3-b	9	58	60	3	0	-
3-c	5	55	67	0	0	-
3-d	15	44	67	2	0	-
3-e	8	55	67	6	0	-
3-f	19	55	62	5	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

The noise associated with the operation of ancillary facilities within Section 3 of the project, including concrete batch plants, stockpile sites, office compounds and works shops is expected to exceed the NML at just under half of the receivers with a maximum 15 minute L_{Aeq} of 67 dB (A) predicted at some receivers within NCA 3-c, 3-d and 3-e. However of these receivers, none are expected to exceed the 'highly noise affected criteria' of 75dB (A).

For the general NML exceedances, at this stage due to the lack of detail in layouts of ancillary facilities and the areas of operation of plant contained within, predictions have been based on total area sources for the site. This may prove to slightly under predict levels at receivers located within a short separation distance to sites. Therefore it is recommended following the finalisation of ancillary facilities internal layouts, a more detailed assessment should be undertaken prior to the commencement of works.

There is the potential that some ancillary facilities would operate 24 hours a day to provide service to construction works along the project. The out of hours operation of Section 3 ancillary facilities is assessed below

Section 3 bridge works

Within Section 3 of the project, 17 main bridges have been identified, comprising of 13 over bridges and four road bridges. This includes the Coldstream River Bridges, Pillar Valley Creek bridges, North of Pillar Valley Bridge and the 100 metres long property over bridge. The location and description of each bridge within Section 3 is presented in Table 6-50 and shown graphically in Appendix C.

Table 6-50 Section 3 bridge locations

Bridge reference	Location (Station)	Details	Bridge length / metres	Distance and direction to nearest receiver
Glenugie southbound loading ramp over bridge -	STN 34.9	Access road over bridge	60.6m	420 metres north
Eight Mile Lane over bridge -	STN 36.0	Access road over bridge	99.6m	850 metres west
Old Six Mile Road – over bridge	STN 38.3	Access road over bridge	60.6m	880 metres north-east
Avenue Road over bridge -	STN 41.5	Access road over bridge	60.6m	480 metres south-west
Coldstream River bridge (1-3)	STN42.6 – STN44.0	3 bridges crossing the Coldstream river and tributaries	1 – 135.5m 2 – 315.5m 3-180.5m	1.5 kilometres west 1.9 kilometres east 1.3 kilometres east
Wooli Road over bridge	STN45.5		60.5m	225 metres north
Pillar Valley Creek bridge	STN46.1 – STN46.5	2 road bridges over Pillar Valley Creek	1 -100.6m 2 - 100.6m	540 metres south-west 770 metres south-west
North of Pillar Valley bridge	STN49.3-49.5	-	120 m	1.6 kilometres north
Firth Heinz Road over bridge	STN51.9	Access road over bridge	60.6m	310 metres south-east
Bostock Road over bridge -	STN55.5	Access road over bridge	60.6m	1.7 kilometres north
Somervale Road under pass	STN56.9	Access road under pass	31.5m	350 metres west
North of Champions Creek twin bridges	STN58.6	Access road twin bridges	75.5m	40 metres east
Property access	STN61.1	Access road twin bridges with underpass underneath	35.5m	70 metres west
Property access	STN63.7 – 63.8	Access road over bridge	100 m	610 metres south
Crowleys Road property access	STN64.9	Access road over bridge	60.6m	572 metres west
Tyndale	STN67.4	Access road bridge	36.5m	320 metres west

Bridge reference	Location (Station)	Details	Bridge length / metres	Distance and direction to nearest receiver
Southbound unloading ramp				

The construction method used to construct the main road bridges within Section 3 is likely to be precast concrete driven piles with precast road platform sections being lifted into place to form the base of the concrete pour. Where the concrete pour for the road base is required to be undertaken in a single 24 hour period, there is the potential for work to be undertaken outside proposed construction hours.

At each of the other Section 3 (Glenugie upgrade to Tyndale) bridges (road and over bridges); driven piles are assumed to be used along with other plant identified in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, in the absence of a more detailed construction method, would ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 3 bridge works is presented in Table 6-51. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous construction of Section 3 bridges. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-51 Section 3 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
3-a	6	55	53	1	0	Wooli Road over bridge
3-b	9	58	60	3	0	Avenue Road over bridge , Wooli Road over bridge, Firth Heinz Road over bridge
3-c	5	55	69	1	0	Firth Heinz Road over bridge, North of Champions Creek twin bridges, Tyndale Southbound unloading ramp
3-d	15	44	65	2	0	Wooli Road over bridge, Tyndale

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
						Southbound unloading ramp
3-e	8	55	55	4	0	Somervale Road under pass, Tyndale Southbound unloading ramp
3-f	19	55	53	1	0	Tyndale Southbound unloading ramp

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As shown in Table 6-51,a number of receivers would experience noise levels above the NML as a result of bridge works, however the highly noise affected criteria' is not predicted to be exceeded at any of receivers. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The construction of the major bridges (>100 metres in length) within Section 3 of the project (Glenugie to Tyndale) is not shown to be the major source of noise at receivers during proposed construction hours.

The exceedances of the NML during general daytime works of the bridges in Section 3 of the project are primarily from noise associated with the piling works assumed to occur at each of the bridge sites. Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore administrative measures are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

The bridge noise predictions assume a piling rig would be operational at each bridge site, in reality this may not occur as piling may not be required or would be restricted in its operation (i.e. daytime only). The predictions also assume an impact piling rig is to be used whereas in practice quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to 4dB (A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during construction within proposed hours. Potential mitigation, administrative and management measures for general piling activities are discussed further in Appendix I.

Where construction is required outside proposed works hours on the Coldstream River bridges, Pillar Valley Creek bridges, North of Pillar Valley bridge and the property overpass bridge at STN63.7, as indicated at this stage there is a high risk that a number of receivers would experience noise above night time NMLs with the works most certainly being audible by some residents. A summary of the number of receivers which would experience impact associated with night time works at these bridges is presented in Table 6-52 to Table 6-55. A general out of hours assessment for the remainder of the Section 3 bridges is undertaken later in Section 6.3.3.

Table 6-52 Section 3 out of hours noise summary - Coldstream River bridges

NCA	Night-time NML, dB(A)	No. Receivers exposed to >30dB(A)	Maximum predicted noise level in NCA, dB(A)	Receivers Exceeding NML
3-a	40	0	<30	0
3-b	41	0	<30	0
3-c	40	0	<30	0
3-d	47	1	36	0
3-e	44	0	<30	0
3-f	40	0	<30	0

Where work is required to be undertaken during night time periods at the Coldstream Rivers bridges, no receivers are predicted to experience noise levels higher than the night time NML. It is also likely only one receiver would potentially hear the works. Therefore, it is reasonable for works associated with the Coldstream Rivers bridges to be undertaken outside of proposed hours.

Table 6-53 Section 3 out of hours noise summary - Pillar Valley Creek bridges

NCA	Night-time NML, dB(A)	No. Receivers exposed to >30dB(A)	Maximum predicted noise level in NCA, dB(A)	Receivers exceeding NML
3-a	40	2	45	2
3-b	41	2	51	2
3-c	40	0	<30	0
3-d	47	1	49	1
3-e	44	0	<30	0
3-f	40	1	49	1

Where work is required to be undertaken during out of hours periods at the Pillar Valley bridges, up to six receivers are predicted to experience noise levels higher than the night time NML. It is also unlikely that these works would be audible by any other receiver in the area. Therefore, it is reasonable for works associated with the Coldstream River bridges to be undertaken outside of proposed hours, assuming consultation and prior agreement is made with the affected receiver (R699, R700, R701, R703, R704 and R707) and Department of Planning and Infrastructure.

Table 6-54 Section 3 out of hours noise summary - North of Pillar Valley bridge

NCA	Night-time NML, dB(A)	No. Receivers exposed to >30dB(A)	Maximum predicted noise level in NCA, dB(A)	Receivers exceeding NML
3-a	40	0	<30	0
3-b	41	0	<30	0
3-c	40	0	<30	0

NCA	Night-time NML, dB(A)	No. Receivers exposed to >30dB(A)	Maximum predicted noise level in NCA, dB(A)	Receivers exceeding NML
3-d	47	0	<30	0
3-e	44	0	<30	0
3-f	40	0	<30	0

Where work is required during night time periods at the North of Pillar Valley bridges, no receivers are predicted to experience noise levels higher than the night time NML. It is also unlikely these works would be audible by any other receiver in the area. Therefore, it is reasonable for works associated with the Coldstream River bridges to be undertaken outside of proposed hours, without disturbance being caused.

Table 6-55 Section 3 out of hours noise summary - property over bridge at STN 63.7

NCA	Night-time NML, dB(A)	No. Receivers exposed to >30dB(A)	Maximum predicted noise level in NCA, dB(A)	Receivers exceeding NML
3-a	40	0	<30	0
3-b	41	0	<30	0
3-c	40	0	<30	0
3-d	47	0	<30	0
3-e	44	0	<30	0
3-f	40	2	46	2

Where work is required to be undertaken during night time periods at the property over bridge, two receivers are predicted to experience noise levels higher than the night time NML. It is also unlikely that these works would be audible by any other receiver in the area. Therefore, it is reasonable for works associated with the Coldstream River bridges to be undertaken outside of proposed hours, assuming consultation and prior agreement is made with the affected receiver (R760 and R762) and Department of Planning and Infrastructure.

Section 3 haulage routes

Although the Section 3 (Glenugie upgrade to Tyndale) section of the project is away from the existing highway, (haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. At this stage, it is not anticipated any specific new haul roads would be required in Section 3, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the proposed upgrade.

Section 3 out of hours works assessment

A number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hours periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example, the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended. However, such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore, this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as the duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst-case assessment

A summary of the impacts associated with each activity is presented in Table 6-54 to Table 6-58. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-56 Section 3 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
3-a	6	40	45	6	6	0
3-b	9	41	53	9	9	0
3-c	5	40	64	2	2	0
3-d	15	47	63	11	11	0
3-e	8	44	55	8	7	0
3-f	19	40	49	19	19	0

Table 6-57 Section 3 out of hours noise summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
1-a	6	40	50	6	6	0
1-b	9	41	58	9	9	0
1-c	5	40	69	2	2	0
1-d	15	47	68	11	11	0
1-e	8	44	60	8	8	0
1-f	19	40	54	19	19	0

Table 6-58 Out of hours construction summary – asphalting noise summary

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
1-a	6	40	48	6	6	0
1-b	9	41	56	9	9	0
1-c	5	40	67	2	2	0
1-d	15	47	66	11	11	0
1-e	8	44	58	8	8	0
1-f	19	40	52	19	19	0

Table 6-59 Out of hours construction summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
1-a	6	40	53	6	6	0
1-b	9	41	60	9	9	0
1-c	5	40	69	2	2	0
1-d	15	47	65	7	7	0
1-e	8	44	55	8	8	0
1-f	19	40	63	18	19	0

Table 6-60 Out of hours construction summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
1-a	6	40	53	6	4	0
1-b	9	41	60	9	5	0
1-c	5	40	34	2	0	0
1-d	15	47	67	11	5	0
1-e	8	44	67	8	7	0
1-f	19	40	62	19	13	0

Table 6-56 to Table 6-60 identify the number of receivers which are predicted to exceed the night – time NML and RBL from different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact at receivers

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 11 per cent and 20 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only seven receivers. As a result of bridge construction, noise is predicted to be inaudible at 12 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The figures show three aspects of out of hours works:

- the areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- identification of sections along the proposed upgrade where out of hours works would be suitable without the need for residential receiver consultation
- identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 3 of the project, around 15.4 kilometres of the project would be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken 24 hours per day without further consultation (this is presented by un-shaded areas along the project centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for the activity of paving & asphalting, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially included negotiated agreements with the community, consultation with Environment Protection Authority and justification as to why these works are necessary outside proposed construction hours. These areas of works and the process for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This will be discussed further in Appendix I.

Section 3 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state

- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at a receiver more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 3. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 3.

A summary of the number of receivers within Section 3 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-61.

Table 6-61 Section 3 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
3-a	0	0
3-b	9	4
3-c	5	2
3-d	15	11
3-e	8	7
3-f	19	3

Table 6-61 shows that a number of receivers within Section 3 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 3 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

To the southern extent of Section 3 of the project (Glenugie upgrade to Tyndale), the impact of simultaneous construction in both Section 2 and 3 is minimal as Section 2 is due to commence in 2015 whereas Section 3 works are due to start in early 2014 (based on staging assumptions from the Submission to Infrastructure Australia, NSW Government, November 2011). Where Section 3 works overlap into 2015, the works at the Section2/3 boundary could be staged to avoid simultaneous working.

To the northern extent of Section 3 of the project, on the border with Section 4, there is a Section 4 over bridge.   This is located around 500 metres north of the closest receivers within Section 3, and therefore the potential for cumulative impact is minimal. In addition to this, the works in Section 4 are expected to commence one year prior to Section 3 in 2013.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.3.4. Section 3 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 00.

Piling induced vibration at bridge sites presented in Table 6-50 has been assessed, with a summary of impacts being provided in Table 6-62. This may be an over estimation of vibration however would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment will be required to confirm impacts and mitigation needs.

Table 6-62 is based on the matrix set out in Part A, Section 3.2.2. In summary, the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-62 Bridge building vibration impact summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Glenugie southbound loading ramp over bridge -	0	0	0	0	0	0
Eight Mile Lane over bridge -	0	0	0	0	0	0

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Old Six Mile Road – over bridge	0	0	0	0	0	0
Avenue Road over bridge -	0	0	0	0	0	0
Coldstream River bridge (1-3)	0	0	0	0	0	0
Wooli Road over bridge - -	0	0	0	0	0	0
Pillar Valley Creek bridge	0	0	0	0	0	0
North of Pillar Valley bridge	0	0	0	0	0	0
Firth Heinz Road over bridge	0	0	0	0	0	0
Bostock Road over bridge -	0	0	0	0	0	0
Somervale Road under pass	0	0	0	0	0	0
North of Champions Creek twin bridges	1 (R742)	0	0	0	0	0
Property access STN61.1	0	0	0	0	0	0
Property access	0	0	0	0	0	0
Crowleys Road property access STN63.7 – 63.8	0	0	0	0	0	0
Glenugie southbound loading ramp over bridge -	0	0	0	0	0	0

Table 6-62 identifies that there is only one dwelling (R742) within 50 metres of any of the Section 3 bridges (Glenugie upgrade to Tyndale). Receiver R742 is around 40 metres east from the edge of North of Champions Creek twin bridges However, at this distance assuming generic vibration wave propagation, vibration predictions are predicted to be considerably below structural damage and human comfort criteria. This confirms the risk to structures and occupants is low in Section 3 of the project, and in practice vibration as a result of piling would not be perceived by any of the identified receivers. Following confirmation of each individual pile location, a further detailed assessment may be required, but only where this is within 50 metres of the closest receiver.

Table 6-63 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which would require a more detailed vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-63 Generic Vibration Impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural Damage	>20	10-20	<10
Human Comfort	>40	30-40	<30

Within Section 3 only one property has been identified of heritage importance, this being the residence at R813 (NCA 3-d) within Tyndale. This property is located over 500 metres from the closest piling site at Old Six Mile Overbridge and therefore the potential for impacts associated with piling induced vibration are considered to be minimal. However due to the unknown structural condition of the property at R813 and potential for other piling sites, where piling works or other vibratory plant is used within 50 metres of the sensitive site, further detailed assessment would be undertaken post approval.

6.3.1. Section 3 construction blasting assessment

Within Section 3 of the project a number of cut and fill sites have been identified, however only a selection of these would potentially require blasting. These potential blast sites are identified in Table 6-64 along with potential materials requiring processing.

Table 6-64 Potential Blast Sites – Section 3

Cut Location:	Blasting (bank)	Processing (loose)
Section 3		
STN48.1 to STN48.6 south of Mitchell Road	25,000m^3	55,000m^3
STN51.6 to STN52.3 south of Firth Heinz Road	65,000m^3	115,000m^3
STN53.8 to STN54.6 south of waterway bridges east of Tucabia	110,000m^3	220,000m^3
STN57.5 to STN58.2 north of Champion Creek	10,000m^3	25,000m^3
STN59.4 to STN60.0 north of Campbells Road	50,000m^3	115,000m^3
STN63.0 top STN63.9 in	75,000m^3	155,000m^3

Cut Location:	Blasting (bank)	Processing (loose)
Pine Brush State Forest (includes proposed northbound and southbound rest areas)		
STN64.7 to STN65.3 at Crowleys Road	35,000m^3	75,000m^3
STN66.5 to STN67.0 south of Sheeys Lane	380,000m^3	650,000m^3
STN67.6 to STN68.0 north of Tyndale south interchange	110,000m^3	210,000m^3
STN68.1 to STN68.8 at Tyndale	15,000m^3	30,000m^3
Estimated total quantities:	875,000m^3	1,650,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason, only an indication of the risk associated with blasting at these sites on surrounding receivers can be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

Table 6-65 and Table 6-66 present the prediction of vibration and overpressure, as a result of different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report, with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A). Exceedances of the criteria are highlighted in red.

Table 6-65 Section 3 closest sensitive receiver overpressure prediction

Cut/Blasting Site	Receiver	Receiver type	separation distance / metres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN48.1 to STN48.6 south of Mitchell Road	-	Residential	> 2 kilometres	84	91	94	96	97	98
	-	Comm.	> 3 kilometres	79	86	89	91	92	93

Cut/Blasting Site	Receiver	Receiver type	separation distance / metres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN51.6 to STN52.3 south of Firth Heinz Road	R729	Residential	270 metres	109	116	119	121	122	123
	-	Comm.	> 3 kilometres	79	86	89	91	92	93
STN53.8 to STN54.6 south of waterway bridges east of Tucabia	R729	Residential	1.4 kilometres	89	96	98	100	101	102
	-	Comm.	> 3 kilometres	79	86	89	91	92	93
STN57.4 to STN58.2 north of Champion Creek	R742	Residential	380 metres	105	112	115	117	118	119
	-	Comm.	> 3 kilometres	79	86	89	91	92	93
STN59.4 to STN60.0 north of Campbells Road	R747	Residential	450 metres	103	110	113	114	116	117
	-	Comm.	> 3 kilometres	79	86	89	91	92	93
STN63.0 top STN63.9 in Pine Brush State Forest (includes proposed northbound and southbound rest areas)	R760	Residential	300 metres	108	115	118	120	121	122
	-	Comm.	> 3 kilometres	79	86	89	91	92	93
STN64.7 to STN65.3 at Crowleys Road	R764	Residential	450 metres	103	110	113	114	116	117
	-	Comm.	> 2 kilometres	84	91	94	96	97	98
STN66.5 to STN67.0 south of Sheeys Lane	R793	Residential	350 metres	106	113	116	118	119	120
	-	Comm.	430 metres	104	110	113	115	116	117

Cut/Blasting Site	Receiver	Receiver type	separation distance / metres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN67.5 to STN68.0 north of Tyndale south interchange	R813*	Residential	160 metres	116	123	126	127	129	130
	R811	Comm.	180 metres	115	121	124	126	127	128
STN68.1 to STN68.8 at Tyndale	R818	Residential	80 metres	125	132	134	136	137	138
	R811	Comm.	360 metres	106	113	116	117	118	119

**Identified as heritage importance*

Table 6-66 Section closest sensitive receiver vibration prediction

Cut/Blasting Site	Receiver	Receiver type	separation distance / m	Vibration according to charge (peak particle velocity- PPV) / dB					
				1	5	10	15	20	25
STN48.1 to STN48.6 south of Mitchell Road	-	Residential	> 2 kilometres	0.0	0.0	0.0	0.1	0.1	0.1
	-	Comm.	> 3 kilometres	0.0	0.0	0.0	0.0	0.0	0.0
STN51.6 to STN52.3 south of Firth Heinz Road	R729	Residential	270 metres	0.1	0.5	0.9	1.3	1.6	1.9
	-	Comm.	> 3 kilometres	0.0	0.0	0.0	0.0	0.0	0.0
STN53.8 to STN54.6 south of waterway bridges east of Tucabia	R729	Residential	1.4 kilometres	0.0	0.0	0.1	0.1	0.1	0.1
	-	Comm.	> 3 kilometres	0.0	0.0	0.0	0.0	0.0	0.0
STN57.4 to STN58.2 north of Champion Creek	R742	Residential	380 metres	0.1	0.3	0.5	0.7	0.9	1.1
	-	Comm.	> 3 kilometres	0.0	0.0	0.0	0.0	0.0	0.0

Cut/Blasting Site	Receiver	Receiver type	separation distance / m	Vibration according to charge (peak particle velocity- PPV) / dB					
				1	5	10	15	20	25
STN59.4 to STN60.0 north of Campbells Road	R747	Residential	450 metres	0.1	0.2	0.4	0.6	0.7	0.9
	-	Comm.	> 3 kilometres	0.0	0.0	0.0	0.0	0.0	0.0
STN63.0 top STN63.9 in Pine Brush State Forest (includes proposed northbound and southbound rest areas)	R760	Residential	300 metres	0.1	0.4	0.8	1.1	1.4	1.6
	-	Comm.	> 3 kilometres	0.0	0.0	0.0	0.0	0.0	0.0
STN64.7 to STN65.3 at Crowleys Road	R764	Residential	450 metres	0.1	0.2	0.4	0.6	0.7	0.9
	-	Comm.	> 2 kilometres	0.0	0.0	0.0	0.1	0.1	0.1
STN66.5 to STN67.0 south of Sheeys Lane	R793	Residential	350 metres	0.1	0.4	0.6	0.8	1.1	1.3
	-	Comm.	430 metres	0.1	0.3	0.4	0.6	0.8	0.9
STN67.5 to STN68.0 north of Tyndale south interchange	R813*	Residential	160 metres	0.3	1.2	2.1	3.0**	3.7**	4.5**
	R811	Comm.	180 metres	0.3	1.0	1.8	2.5	3.1**	3.7**
STN68.1 to STN68.8 at Tyndale	R818	Residential	80 metres	1.0	3.7	6.5	9.0	11.3	13.5
	R811	Comm.	360 metres	0.1	0.3	0.6	0.8	1.0	1.2

**Identified as heritage importance, ** lower limit of 3mms^{-1} for heritage structure adopted in line with DIN Standards (see vibration section)*

Table 6-65 and Table 6-66 indicate that where a charge of less than 25 kilograms is used at the cut sites within Section 3 of the project (Glenugie upgrade to Tyndale), there is a potential that overpressure and vibration criteria may be exceeded at some of the closest receivers.

At the STN68.1 to STN 68.8 cut site, where a charge of 5 kg or greater is used, the associated ground borne vibration would be above the structural damage criteria at receiver R818 (within 100 metres of the proposed site) and therefore the risk of damage increases.

Over pressure at the closest residential receivers will potentially be exceeded as a result of blasting at a number of cut site. The level of exceedance is depend on the blast charge used and therefore prior to the blasting at Section 3 cut sites, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers. . However, this does not necessarily mean that blasting cannot be undertaken, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

The heritage property at R813 is approximately 160 metres from the cut site at STN67.5 to STN68.0, is at such a distance that impacts associated with blasting induced vibration are predicted to have a potential impact for charges greater than 15 kilogram’s. Therefore due to the unknown structural condition of the property at R813, where blasting is undertaken within 500 metres of the sensitive site, a detailed blasting assessment would be undertaken post approval.

6.3.2. Section 3 specific mitigation (proposed hours)

Based on the above assessment, a summary of specific measures recommended for Section 3 construction works is provided in Table 6-67. Generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours. However, many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-67 Section 3 Specific mitigation

Activity	Receivers ‘highly noise affected’ or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers ‘highly noise affected’ or those exceeding vibration/blasting limit
Blasting	R729, R742, R747, R760, R764, R793, R813, R11, R818	-	Prior to the blasting at Section 3 cut sites, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers. In addition where overpressure is exceeded at the closest receivers, consultation should be undertaken to discuss temporary exceedances of the overpressure criteria with residents.

6.4. Section 4 (Tyndale to Maclean)

6.4.1. Section 4 assessment summary

Section 4 is about 13 kilometres long, extending from Tyndale to Maclean. The extent of this project section is shown in Part A, Figure 1-4.

The construction works proposed for Section 4 includes all activities identified within Part A, Table 3-6 in Section 3.3.1. An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of the proposed soft soil treatments for Section 4, six receivers are predicted to be exposed to noise levels exceeding the NML. However, no receivers are predicted to exceed the 'highly noise affected' criteria of 75dB(A)
- As a result of site clearing, earthworks and asphalting, over 32 per cent of the receivers within Section 4 are likely to experience noise levels above the NML. During earthworks one receiver has been predicted to exceed the 'highly noise affected' criteria
- Predicted noise levels from the operation of ancillary facilities are below the NMLs at all individual receivers with the exception of receiver R886 and R892. Both these receivers exceed the NML and are classed as 'highly noise affected'. This is as a result of being located on land which would potentially be acquired for ancillary facilities
- Section 4 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements is predicted to be minimal
- The construction of Section 4 bridges is likely to result in exceedances of the NML at eight of the closest receivers. The 'highly noise affected criteria' of 75dB(A) is not expected to be exceeded at any of these eight, although a prediction of 74dB(A) is shown at the closest receiver to the bridge crossing of Shark Creek
- Where work on the Shark Creek Bridge is required to be undertaken outside of proposed hours, i.e. at night, the closest receiver would experience noise levels considerably above the night-time NML with a further one receiver experiencing construction noise that may be audible
- In terms of piling, one receiver has been identified within a distance of 50 metres from Shark Creek bridge, although predicted ground borne vibration is at the receiver is considerably below structural damage and human comfort criteria
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within 50 metres of Section 4 receivers, further assessment should be undertaken prior to the commencement of works

- Blasting at specified road cutting sites along the project may result in some receivers being exposed to vibration and overpressure levels above adopted project criteria. Therefore detailed assessment and mitigation/management measures would be required prior to construction.

The exceedance of NMLs is primarily a result of the short separation distance between the proposed upgrade and receivers within Section 4. Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers will experience these levels will be short as the works progress along the project.

6.4.2. Section 4 background noise monitoring and noise management levels

There are around 271 receivers within 600 metres of Section 4 (Tyndale to Maclean) of the project. Of these, five are classed as commercial/non-residential receivers. Also 12 receivers have been identified as being located within the boundary of the project and as such would be acquired. These 12 receivers have been identified but the noise associated with construction has not been predicted. A definitive list of all receivers identified in Section 4 for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at nine receivers within Section 4. The locations of these are presented in Table 6-68 alongside measured 'rating background level' (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-68 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-68 Section 4 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am -6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
866	-	-	-	-	-	-	-	4-a
1080	43	53	45	55	46	56	45	4-a
823	35	45	40	50	42	52	45	4-b
865	42	52	44	54	44	54	52	4-b
1026	44	54	42	52	50	60	52	4-c
892	43	53	44	54	47	57	53	4-d
842	47	57	51	61	51	61	57	4-e
903	47	57	50	60	52	62	57	4-e
849	44	54	44	54	45	55	54	4-f

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-68. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 4 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-69 alongside the night-time NML**.** Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-69 Section 4 – NCA noise management levels (NML)

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 4-a	45	44
NCA 4-b	45	35
NCA 4-c	52	41
NCA 4-d	53	44
NCA 4-e	57	43
NCA 4-f	54	42

6.4.3. Section 4 construction noise assessment

Section 4 soft soil treatments

Within Section 4, 3 sites have been identified as requiring soft soil treatments to allow for Section 4 (Tyndale to Maclean) bridge and embankment construction. These sites are presented in Table 6-70.

Table 6-70 Section 4 – Soft soil treatments sites

Construction ID	Approximate Location	Works
SS-01	STN73.0 – STN74.8	Consolidation of soft soils below embankment
SS-02	STN77.2 - STN77.5	Consolidation of soft soils below embankment

Construction ID	Approximate Location	Works
SS-03	STN78.4 – STN80.9	Consolidation of soft soils below embankment

The construction plant modelled during the soft soil treatments includes all plant identified in Part A, Table 3-6. A summary of the noise levels predicted as a result of the Section 4 soft soil treatments are shown in Table 6-71. This table summarise the number of receivers which are exposed to varying levels of construction noise. A complete list of individual receivers and the levels predicted construction noise associated with each activity is provided in Appendix E.

Table 6-71 Section 4 proposed hours construction –soft soil treatments

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
4-a	22	45	41	0	0	-
4-b	20	45	46	1	0	-
4-c	31	52	41	0	0	-
4-d	32	53	66	5	0	-
4-e	84	57	50	0	0	-
4-f	82	54	44	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of the Section 4 (Tyndale to Maclean) soft soil treatments, six receivers have been predicted to exceed the NML, however no receivers are predicted to be exposed to levels above the highly noise affected criteria of 75dB(A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity. This includes all plant operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary and as the work is relatively linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along each of the three soft soil treatments segments, noise exposure at each receiver would reduce.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, management or mitigation measures would be require. These are detailed further in Section 6.3.2 and Appendix I.

Section 4 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-72 to Table 6-74. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-72 Section 4 proposed hours construction – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
4-a	22	45	48	22	0	-
4-b	20	45	60	19	0	-
4-c	31	52	70	23	0	-
4-d	32	53	64	23	0	-
4-e	84	57	54	0	0	-
4-f	82	54	53	0	0	-

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

Table 6-73 Proposed operational hours construction – Section 4 earthworks noise summary

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
4-a	22	45	53	22	0	-
4-b	20	45	65	20	0	-
4-c	31	52	75	23	1	R1000
4-d	32	53	69	27	0	-
4-e	84	57	59	1	0	-
4-f	82	54	58	23	0	-

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

Table 6-74 Proposed operational hours construction – Section 4 asphalting noise summary

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
4-a	22	45	51	22	0	-
4-b	20	45	63	19	0	-
4-c	31	52	73	13	0	-
4-d	32	53	67	25	0	-
4-e	84	57	57	1	0	-
4-f	82	54	56	13	0	-

Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 4 (Tyndale to Maclean); with one receiver (R1000) being predicted to be exposed to levels above the highly noise affected criteria of 75dB (A) during earthworks and asphalting. The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required. These are detailed further in Appendix I.

The ICNG states that where a receiver is exposed to noise levels of 75dB (A) or greater, as a result of construction activities, the receiver is to be classed as ‘highly noise affected’ and must be afforded additional consideration. Receivers R495 and R522 would potentially experience levels in excess of 75dB (A) as a result of noise emitted from the activity of earthworks and paving and asphalting. The higher levels are primarily from the short separation distance assumed been the receiver and the project; 60 metres at the shortest distance.

‘Highly noise affected’, additional measures are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Such measures will be discussed in more detail in Appendix I.

Section 4 ancillary facilities and compounds

Within Section 4 (Tyndale to Maclean) the ancillary facilities presented in Table 6-75 have been identified and quantitatively assessed. This includes nine stockpile sites and ten multi-use sites (concrete batch plant/workshop sites/office etc.). The location of these sites and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan noise software, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facilities internal layouts, a more detailed assessment should be undertaken prior to the commencement of works.

Table 6-75 Section 4 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN69.3 to STN69.6	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 2	STN73.4 to STN74.0	Stockpile site.
Site 3	STN75.5 to STN75.8	Satellite site compound area. Batch plant area.
Site 4a	STN76.8 to STN77.1	Stockpile site.
Site 4b	STN77.0 to STN77.1	Stockpile site.
Site 4c	STN77.0 to STN77.2	Main site office and compound area.

Site no.	Location (Station)	Proposed use
		Batch plant area Plant workshop. Materials storage.
Site 5	STN78.2 to STN78.4	Stockpile site.
Site 6	STN79.4 to STN79.9	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 7a	STN80.6 to STN81.1	Stockpile site.
Site 7b	STN80.6 to STN80.8	Stockpile site.
Site 1	STN69.3 to STN69.6	Stockpile
Site 2	STN73.4 to STN74.0	Stockpile
Site 3	STN75.5 to STN75.8	Stockpile
Site 4a	STN76.8 to STN77.1	Stockpile
Site 4b	STN77.0 to STN77.1	Stockpile
Site 5	STN78.2 to STN78.4	Stockpile
Site 6	STN79.4 to STN79.9	Stockpile
Site 7a	STN80.5 to STN81.1	Stockpile
Site 7b	STN80.5 to STN80.8	Stockpile

A summary of the results from the modelling of ancillary facilities is presented in Table 6-76. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-76 Section 4 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
4-a	22	45	46	6	0	-
4-b	20	45	52	15	0	-
4-c	31	52	59	14	0	-
4-d	32	53	82	13	2	R886, R892
4-e	84	57	53	0	0	-
4-f	82	54	58	2	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 4, including concrete batch plants, stockpile sites, office compounds and works shops is not expected to exceed the NML at the majority of the receivers. Exceedances of the NML are predicted at only 20 per cent of receivers. However of these, two are expected to experience noise levels above the 75dB (A) ‘highly noise affected’ criteria.

The main reason for exceedances of the 75dB (A) is a result of receiver location. These two receivers are located outside the project boundary but within areas designated for ancillary facilities; both within ancillary site 6 (batch plant). Due to their location it is highly likely that these receivers will form part of the acquisition process or be temporarily leased for the duration of the project. Therefore these would no longer be classed as sensitive receivers.

There is the potential that some ancillary facilities would operate 24 hours a day to support construction works along the project. The operation of Section 4 ancillary facilities out of hours is assessed below.

Section 4 bridge works

Within Section 4, four main bridges have been identified, comprising of three over bridges (OB) and one road bridge. This includes the 450 metres Shark Creek road bridge. The location and description of each bridge within Section 4 is presented in Table 6-77 and shown graphically in Appendix C.

Table 6-77 Section 4 bridge locations

Bridge reference	Location (Station)	Details	Bridge length / metres	Distance and direction to nearest receiver (metres)
Local road -	STN69.1	Access road over bridge	70.6 m	190 west
Byrons Lane -	STN71.1	Access road over bridge	60.6m	200 south-west
Shark Creek bridge crossing	STN74.8 – STN75.3	Twin bridges	448.6 m	50 west
Interchange at Maclean -	STN80.5	Access road over bridge	60.6 m	280 west

At this stage, the construction method used to construct the bridge crossing of Shark Creek has been confirmed as precast concrete driven piles providing the road support with precast road platform sections being lifted into place to form the base of the concrete pour. Where the concrete pour for any of the bridges road base is required to be undertaken in a single 24 hour period, there is the potential for work to be undertaken outside proposed construction hours.

At each of the other Section 4 (Tyndale to Maclean) bridges (over bridges); driven precast piles are also assumed to be the method of construction and would be used along with other plant identified in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, and in the absence of a more detailed construction method, would ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 4 bridge works is presented in Table 6-78. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous bridge construction. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-78 Section 4 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
4-a	22	45	40	0	0	-
4-b	20	45	44	17	0	OB3
4-c	31	52	57	22	0	OB3
4-d	32	53	74	17	0	OB1, OB3, Shark Creek bridge,
4-e	84	57	56	5	0	OB3
4-f	82	54	48	4	0	OB3

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As shown in Table 6-78 a number of receivers would experience noise levels above the NML as a result of bridge works, however the highly noise affected criteria' is not predicted to be exceeded at any of receivers. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The primary cause for the exceedances of the NML is a result of the works at the Interchange at Maclean bridge.-

The construction of the bridge crossing of Shark Creek has a significant impact on only one receiver (R851), however at this receiver the 'highly noise affected' criteria is almost exceeded with a prediction of 74dB (A). As a result of this it is unlikely that general out of hours works would be suitable on the bridge crossing of Shark Creek due to the close proximity of receiver R851. Where out of hours work is required for practical reasons such as 24 hour concrete pours or delivery of oversized girders, it is recommended consultation and prior agreement is made with the affected receiver at R851 and Department of Planning and Infrastructure. A general out of hours assessment for the remainder of the Section 4 bridges is undertaken later in this section.

The exceedances of the NML during general daytime works of the bridges in Section 4 are primarily as a result of the noise associated with the piling works assumed to occur at each of the bridge sites. Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore administrative measures are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

The bridge noise predictions assume a piling rig would be operational at each bridge site, in reality this may not occur as piling may not be required or would be restricted in its operation (i.e. daytime only). In addition to this, the predictions assume an impact piling rig is to be used whereas in practice quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to 4dB (A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during operations within proposed hours.

Potential mitigation and management measures for general piling activities are discussed further in Appendix I.

Haulage routes noise

Within Section 4, haulage routes would in the main follow the new alignment formation, although some traffic will utilise the existing Pacific Highway alignment and other local roads. At this stage RMS have not anticipated that any new haul roads will be required in Section 4, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the proposed upgrade.

Section 4 out of hours works assessment

It is anticipated several activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example, the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and will have a similar impact. In addition to this, it is envisaged the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Soft soil treatments
- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method would provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-79 to Table 6-84. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-79 Section 4 out of hours construction noise summary – soft soil treatments

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-a	22	44	41	1	0	0
4-b	20	35	46	8	1	0
4-c	31	41	41	15	0	0
4-d	32	44	66	20	5	0
4-e	84	43	50	8	0	0
4-f	82	42	44	5	0	0

Table 6-80 Section 4 out of hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-a	22	44	48	22	16	0
4-b	20	35	60	20	20	0
4-c	31	41	70	24	23	0
4-d	32	44	64	28	28	0
4-e	84	43	54	71	47	0
4-f	82	42	53	72	69	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-81 Section 4 out of hours construction noise summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-a	22	44	53	22	22	0
4-b	20	35	65	20	20	0
4-c	31	41	75	23	23	1
4-d	32	44	69	28	28	0
4-e	84	43	59	83	71	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-f	82	42	58	75	72	0

Table 6-82 Section 4 out of hours construction noise summary – asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-a	22	44	51	22	22	0
4-b	20	35	63	20	20	0
4-c	31	41	73	23	23	0
4-d	32	44	67	28	28	0
4-e	84	43	57	81	59	0
4-f	82	42	56	72	72	0

Table 6-83 Section 4 out of hours construction noise summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-a	22	44	40	7	0	0
4-b	20	35	44	18	17	0
4-c	31	41	57	23	22	0
4-d	32	44	74	25	17	0
4-e	84	43	56	50	5	0
4-f	82	42	48	39	4	0

Table 6-84 Section 4 out of hours construction noise summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-a	22	44	46	22	4	0
4-b	20	35	52	20	19	0
4-c	31	41	59	23	22	0
4-d	32	44	82	28	23	2

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
4-e	84	43	53	71	19	0
4-f	82	42	58	56	10	0

Table 6-79 to Table 6-84 identify the number of receivers which are predicted to exceed the night – time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 7 per cent and 21 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only 20 receivers. As a result of soft soil treatments, construction noise is predicted to be inaudible at over 214 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works..

The graphic shows three aspects of out of hours works:

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise are presented
- Identification of sections along the project where out of hours works would be suitable without consultation (i.e. potential 24 hour construction works)
- Identification of areas along the project where consultation should be targeted prior to out of hours works being permitted.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 4, around 1.4 kilometres of proposed upgrade will be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken over a 24 hours period without further consultation (this is presented by un-shaded areas along the proposed upgrade centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for paving and asphalting activities, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potential negotiated agreements with the community, consultation with Environment Protection Authority and justification as to why these works are necessary outside of the proposed construction hours. It is likely these areas of works and the process for undertaking the outside proposed hours assessment will be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 4 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at a receiver more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 4. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 4.

A summary of the number of receivers within Section 4 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-85.

Table 6-85 Section 4 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
4-a	22	0
4-b	20	16
4-c	31	24
4-d	32	24
4-e	84	1
4-f	82	4

Table 6-85 shows that a number of receivers within Section 4 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number will be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment will be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 4 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of ‘highly noise affected’.

To the southern extent of Section 4 (Tyndale to Maclean), on the border with Section 3 (Glenugie upgrade to Tyndale), there is an over bridge (Section 4Local Road STN 69.1). This is located around 500 metres north of the closest receivers within Section 3, and therefore the potential for cumulative impact is minimal. In addition to this the works in Section 4 are expected to commence one year prior to Section 3 in 2013.

To the southern extent of Section 5 there are no non-linear activities and therefore the cumulative impact of simultaneous working in Sections 4 and 5 has already been taken account for in the above assessment.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.4.4. Section 4 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.4.5.

Piling induced vibration at bridge sites presented in Table 6-77 has been assessed, with a summary of impacts being provided in Table 6-86. This may be an over estimation of vibration however would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-86 is based on the matrix set out in Part A, Section 3.2.2. In summary, the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-86 Bridge building vibration impact summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Local road -	0	0	0	0	0	0
Byrons Lane -	0	0	0	0	0	0
Shark Creek bridge crossing	1 (R851)	0	0	0	0	0
Interchange at Maclean -	0	0	0	0	0	0

Table 6-86 identifies there is only one dwelling (R851) within 50 metres of any of the Section 4 (Tyndale to Maclean) bridges. Receiver R851 is approximately 50 metres from the edge of the bridge crossing of Shark Creek. However, at this distance assuming generic vibration wave propagation, vibration predictions are predicted to be considerably below structural damage and human comfort criteria. This confirms that the risk to structures and occupants is low in Section 4 and in practice vibration as a result of piling would not be perceived by any of the identified receivers. Following confirmation of each individual pile location, a further detailed assessment may be required, but only where this is within 50 metres of the closest receiver.

Table 6-87 presents the potential risk associated with rock hammering. As the locations of this activity were unknown at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. Table 6-87 where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-87 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

6.4.5. Section 4 construction blasting assessment

Within Section 4 a number of cut and fill sites have been identified, however only a selection of these will potentially require blasting. These potential blast sites are identified in Table 6-88 along with potential materials requiring processing.

Table 6-88 Potential blast sites – Section 3

Cut location:	Blasting (bank)	Processing (loose)
Section 4		
STN69.1 – STN69.4 (Tyndale north interchange)	110,000m^3	175,000m^3
STN75.9 – STN76.4 (between Shark Creek and McIntyres Lane)	220,000m^3	370,000m^3
STN76.5 – STN77.1 (south of McIntyres Lane)	20,000m^3	50,000m^3
Estimated total quantities:	355,000m^3	595,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason only an indication of the risk associated with blasting at these sites on surrounding receivers can be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; the numbers of properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

Table 6-89 and

Table 6-90 present the prediction of vibration and overpressure, as a result of different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report, with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A)

Table 6-89 Section 4 overpressure prediction

Cut/blasting Site	Receiver	Receiver type	separation distance / metres, kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN48.1 to STN48.6 south of Mitchell Road	842	Residential	270 metres	109	116	119	121	122	123
	-	Commercial	> 2 kilometres	84	91	94	96	97	98
STN51.6 to STN52.3 south of Firth Heinz Road	854	Residential	440 metres	103	110	113	115	116	117
	-	Commercial	> 2 kilometres	84	91	94	96	97	98
STN53.8 to STN54.6south of waterway bridges east of Tucabia	854	Residential	950 metres	94	100	103	105	106	107
	-	Commercial	> 2 kilometres	84	91	94	96	97	98

Table 6-90 Section 4 vibration (PPV) prediction

Cut/blasting Site	Receiver	Receiver type	separation distance / metres, kilometres	Vibration according to charge (peak particle velocity- PPV) / dB					
				1	5	10	15	20	25
STN48.1 to STN48.6 south of Mitchell Road	842	Residential	270 metres	0.1	0.5	0.9	1.3	1.6	1.9
	-	Commercial	> 2kilometrees	0	0	0	0.1	0.1	0.1
STN51.6 to STN52.3 south of Firth Heinz	854	Residential	440 metres	0.1	0.2	0.4	0.6	0.7	0.9

Cut/blasting Site	Receiver	Receiver type	separation distance / metres, kilometres	Vibration according to charge (peak particle velocity- PPV) / dB					
				1	5	10	15	20	25
STN53.8 to STN54.6 south of waterway bridges east of Tucabia	-	Commercial	> 2 kilometres	0	0	0	0.1	0.1	0.1
	854	Residential	950 metres	0	0.1	0.1	0.2	0.2	0.3
	-	Comm.	> 2 km	0	0	0	0.1	0.1	0.1

Table 6-89 shows that the overpressure criteria may be exceeded at some of the closest receivers as a result of blasting at STN48.1 to STN48.6 and STN51.6 to STN52.3. The level of exceedance will be dependent on the blast charge used, and therefore further assessment should be undertaken prior to blasting at these cut sites. However this does not necessarily mean that blasting cannot be undertaken, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

Table 6-90 indicates that there where a charge of less than 25 kilograms is used at the cut sites within Section 4, the potential for exceeding the vibration criteria at the closest receivers is low. All ground borne vibration predictions are considerably below the relevant criteria. For this reason, the blasting undertaken at cuts within Section 4 is unlikely to cause any noticeable vibration impact to any of the closest receivers.

6.4.6. Section 4 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 1 construction works is provided in Table 6-91In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-91 Section 4 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML (approximate)	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Soft soil treatments	-	6	See Appendix I

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML (approximate)	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	-	87	See Appendix I
Earthworks	R1000	116	See Appendix I
Paving and asphalting	-	93	See Appendix I
Bridge works – noise	-	65	See Appendix I
Ancillary facilities	R886, R892	50	Both receivers are located on land proposed for ancillary site 6. Temporary occupant relocation, temporary land lease/acquisition should be considered. Noise barriers and respites periods are unlikely to be effective or feasible in the longer term operation of the site.
Bridge works - vibration	R851	-	Confirm separation distance between piling works and receiver prior to construction. Where within 50 metres a detailed assessment should be undertaken prior to the commencement of works and, accompanied with possible attended monitoring during works.
Blasting	R842, R854	-	Prior to the blasting at STN48.1 to STN48.6, and STN51.6 to STN52.3 a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers.

6.5. Section 5 (Maclean to Iluka Road)

6.5.1. Section 5 assessment summary

Section 5 is about 14 kilometres long, extending from Maclean to Iluka Road, Mororo. For a location of this section in graphical terms, refer to Part A, Figure 1-2.

The construction works proposed for Section 5 includes all activities identified within Part A, Table 3-6 in Section 3.3.1. An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of soft soil treatments two receivers are predicted to exceed the NML, with no receivers exceeding the 'highly noise affected' criteria
- As a result of the linear construction works (site clearing, earthworks and paving), over 70 per cent of the receivers within Section 5 are likely to experience noise levels above the NML. Of these receivers, two are predicted to be exposed to construction noise above the 'highly noise affected' criteria
- Predicted noise levels from the operation of ancillary facilities are predicted to exceed the NMLs at around 46 receivers, however the 'highly noise affected' criteria is not predicted to be exceeded
- Section 5 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements is predicted to be minimal
- The construction of Section 5 bridges will result in exceedances of the NML at some of the closest receivers. This is mainly as a result of the construction of the bridge crossing of the Clarence River in the moderately populated area of Harwood
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 40 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures prior to the commencement of works
- Where additional piling sites are identified within 50 metres of Section 5 receivers, further assessment should be undertaken prior to the commencement of works
- Blasting at specified road cutting sites along the project may result in some receivers being exposed to vibration and levels above adopted project criteria; and therefore detailed assessment and mitigation/management measures would be required prior to construction.

The exceedance of NMLs is primarily a result of the short separation distance between the project and receivers within Section 5. Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers would experience these levels would be short as the works progress along the project. The NMLs for noise catchment area (NCA) have been derived from one monitoring location and therefore the NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.5.2. Background noise monitoring and noise management levels

There are around 243 receivers within 600 metres of Section 5 (Maclean to Iluka Road, Mororo) of the project. Of these, two are classed as commercial/non-residential receivers. Seven receivers have also been identified as being located within the boundary of the project and as such would be acquired. These seven receivers have been identified but the noise associated with construction has not been predicted. A definitive list of all receivers identified in Section 5 for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

A definitive list of all receivers identified for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at 10 receivers within Section 5. The locations of these are presented in Table 6-92 alongside measured 'rating background level' (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-92 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately. (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-92 Section 5 – unattended noise monitoring summary

Receiver identification	Standard construction hours (7am - 6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML*, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
R1523	36	47	42	52	40	50	47	5-a
R1256	46	56	46	56	47	57	56	5-b
R1331	48	58	48	58	49	59	58	5-c
R1428	-	-	-	-	-	-	-	5-c
R1471	43	53	44	54	46	56	53	5-c
R1396	44	54	43	53	44	54	53	5-d
R1438	45	55	45	55	44	54	54	5-d
R1283	45	55	46	56	47	57	55	5-e
R1457	36	46	40	50	42	52	46	5-f
R1461	37	47	40	50	42	52	47	5-f

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in **Table 6-92**. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 5 (Maclean to Iluka Road, Mororo) are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in **Table 6-93** alongside the night-time NML**.** Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) will be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-93 Section 5 – NCA noise management levels (NML)

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 5-a	37	50
NCA 5-b	56	50
NCA 5-c	53	46
NCA 5-d	53	35
NCA 5-e	55	40
NCA 5-f	46	34

6.5.1. Section 5 construction noise assessment

Section 5 soft soil treatments

Within Section 5, four sites have been identified as requiring soft soil treatments to allow for Section 5 bridge and embankment construction. These sites are presented in Table 6-94.

Table 6-94 Section 5 – soft soil treatment sites

Construction ID	Approximate location	Works
SS-04	STN85.0– STN86.0	Consolidation of soft soils below embankment, drainage layer
SS-05	STN87.2 – STN87.7	Consolidation of soft soils below embankment, drainage layer

Construction ID	Approximate location	Works
SS-06	STN89.1 – STN89.6	Consolidation of soft soils below embankment, drainage layer
SS-07	STN92.5 – STN93.3	Consolidation of soft soils below embankment, drainage layer

The construction plant modelled during the soft soil treatments includes all plant identified in Part A, Table 3-6. A summary of the noise levels predicted as a result of the Section 5 (Maclean to Iluka Road, Mororo) soft soil treatments are shown in Table 6-95. This table summarise the number of receivers which are exposed to varying levels of construction noise. A complete list of individual receivers and the levels predicted construction noise associated with each activity is provided in Appendix E.

Table 6-95 Section 5 proposed hours construction –soft soil treatments

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
5-a	70	37	39	2	0	-
5-b	66	56	39	0	0	-
5-c	30	53	40	0	0	-
5-d	37	53	40	0	0	-
5-e	28	55	40	0	0	-
5-f	12	46	39	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of the Section 5 (Maclean to Iluka Road, Mororo) soft soil treatments, two receivers have been predicted to exceed the NML; however no receivers are predicted to be exposed to levels above the highly noise affected criteria of 75dB(A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity. This includes all plant operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary and as the work relatively linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along each of the three soft soil treatments segments, noise exposure at each receiver will reduce.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, it is inevitable that some form of management or mitigation measures will be required; these will be detailed further in Appendix I.

Section 5 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-96, Table 6-97 and Table 6-98. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels predicted construction noise associated with each activity is provided in Appendix E.

Table 6-96 Section 5 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
5-a	70	37	47	68	0	-
5-b	66	56	56	1	0	-
5-c	30	53	74	23	0	-
5-d	37	53	68	30	0	-
5-e	28	55	56	7	0	-
5-f	12	46	46	2	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-97 Section 5 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
5-a	70	37	52	68	0	-
5-b	66	56	61	16	0	-
5-c	30	53	79	23	2	R1441, R1427
5-d	37	53	73	31	0	-
5-e	28	55	61	23	0	-
5-f	12	46	51	11	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-98 Section 5 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
5-a	70	37	50	68	0	-
5-b	66	56	59	7	0	-
5-c	30	53	77	23	1	R1441
5-d	37	53	71	31	0	-
5-e	28	55	59	17	0	-
5-f	12	46	49	10	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 5 (Maclean to Iluka Road, Mororo); with up to two receivers (R1441 and R1427) being predicted to be exposed to levels above the 'highly noise affected' criteria of 75dB (A) during earthworks and asphalting. The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along the project, noise exposure at each receiver will reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required; these will be detailed further in Appendix I.

The ICNG states that where a receiver is exposed to noise levels of 75dB (A) or greater, as a result of construction activities, the receiver is to be classed as 'highly noise affected' and must be afforded additional consideration. Receivers R1441 and R1427 would potentially experience levels in excess of 75dB (A) as a result of noise emitted from the activity of earthworks and paving and asphalting. The higher levels are primarily as a result of the short separation distance assumed been the receiver and the proposed works; 50 metres at the shortest distance.

'Highly noise affected', additional measures are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Such measures are discussed in more detail in Appendix I.

Section 5 ancillary facilities and compounds

Within Section 5 (Maclean to Iluka Road, Mororo) the ancillary facilities presented in Table 6-99 have been identified and assessed. This includes eight stockpile sites and 13 multi-use sites (concrete batch plant/workshop sites/office etc.). The location of these sites and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facilities internal layouts, a more detailed assessment should be undertaken prior to the commencement of works.

Table 6-99 Section 5 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN83.3 to STN83.6	Satellite site compound Batch plant area. Plant workshop.
Site 2a	STN85.8 to STN86.0	Stockpile site.

Site no.	Location (Station)	Proposed use
Site 2b	STN85.8 to STN86.1	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 2c	STN85.9 to STN86.0	Stockpile site.
Site 2d	STN86.0 to STN86.2)	Bridge compound. Bridge materials storage area.
Site 3a	STN86.9 to STN87.3	Bridge compound. Bridge materials storage area.
Site 3b	STN87.2 to STN87.7	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 4a	STN90.8 to STN90.9	Satellite site compound. Materials storage.
Site 4b	STN90.5 to STN90.9	Stockpile site.
Site 5a	STN93.3 to STN93.4	Main site office and compound area. Materials storage.
Site 5b	STN90.7 to STN90.7	Batch plant area. Plant workshop.
Site 5c	STN93.3 to STN93.4	Stockpile site.
Site 6	STN95.5 to STN96.0	Satellite site compound. Materials storage.
Site 2a	STN85.8 to STN86.0	Stockpile
Site 2c	STN85.9 to STN86.0	Stockpile
Site 3b	STN87.2 to STN87.8	Stockpile
Site 4a	STN90.8 to STN90.9	Stockpile
Site 4b	STN90.5 to STN90.9	Stockpile
Site 5a	STN93.3 to STN93.4	Stockpile
Site 5c	STN93.3 to STN93.4	Stockpile
Site 6	STN95.5 to STN96.0	Stockpile

A summary of the results from the modelling of ancillary facilities is presented in Table 6-100. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-100 Section 5 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
5-a	70	37	55	9	0	-
5-b	66	56	55	0	0	-
5-c	30	53	55	9	0	-
5-d	37	53	58	17	0	-
5-e	28	55	56	3	0	-
5-f	12	46	49	8	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 5 (Maclean to Iluka Road, Mororo), including concrete batch plants, stockpile sites, office compounds and works shops is not expected to exceed the NML at the majority of the receivers. Exceedances of the NML are predicted at only 20 per cent of receivers. None of these receivers are predicted to exceed the ‘highly noise affected criteria’ of 75dB (A).

For the general NML exceedances, at this stage due to the lack of detail in layouts of ancillary facilities and the areas of operation of plant contained within, predictions have been based on total area sources for the site. This may prove to slightly under predict levels at receivers located within a short separation distance to sites. Therefore, it is recommended following the finalisation of ancillary facilities locations and internal layouts, a more detailed assessment should be undertaken prior to the commencement of works.

There is the potential that some ancillary facilities would operate 24 hours a day to provide service to construction works along the upgrade. The out of hours operation of Section 5 ancillary facilities is assessed below.

Section 5 bridge works

Within Section 5 six main bridges have been identified, comprising of four over bridges and two road bridges. This includes the 1.3 kilometres long crossing of the Clarence River and the 200 metre long crossing of the north arm of the Clarence River. The location and description of each bridge within Section 5 is presented in Table 6-101 and shown graphically in Appendix C. The bridge over the Clarence River is the longest within the project and would potentially have the greatest impact due to its close proximity to the residential area of Harwood. A number of other small bridges, including pipe/utility bridges and fauna bridges, have been identified in Section 5; however due to their scale have not been assessed directly within the bridge noise works. The noise and impact associated with the construction of these smaller bridges will be similar to those predicted for Section 5 linear works.

Table 6-101 Section 5 bridge locations

Bridge reference	Location (Station)	Details	Bridge length / metres	Distance and direction to nearest receiver /metres
Bridge crossing of the Clarence River at Harwood	STN 86.1 – STN 87.5	Bridge comprising of 33 spans, being longest bridge on project.	1320 m	100 metres east
Watts Lane	STN 87.8	Access road over bridge	40.6 m	180 metres east
Serpentine Channel Road north	STN 90.8	Access road over bridge	-60.6 m	1,000 metres south-east
Bridge crossing of Clarence River - north arm	STN 94.0 – STN 94.3	8 kilometres north of the Clarence River	220 m	80 metres west
Interchange at Iluka Road	STN 95.4	Access road over bridge	55.6 m	200 metres south-east

The construction method used to construct the bridge crossing of the main Clarence River and north arm of the Clarence River could potentially require bored (uncased piles) to be placed within the support the bridge piers. At the banks of the river, driven piles may be required. The construction of the bridge crossing of the Clarence River is also likely to use small boats/barges in order to provide build materials and plant to the central bridge piers. A concrete pour would also be required to form the road surface base. Where this concrete pour is required to be undertaken in a single 24 hour period or where there is a requirement to deliver oversized girders to the site outside of peak traffic hours, there is the potential for work to be undertaken outside proposed construction hours.

At each of the other Section 5 (Maclean to Iluka Road, Mororo) bridges (road and over bridges); driven precast piles are also assumed to be the method of construction and would be used along with other plant identified in Table 3-6 of Part A. This would potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, and in the absence of a more detailed construction method, would ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 5 (Maclean to Iluka Road, Mororo) bridge works is presented in Table 6-102. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous bridge construction. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-102 Section 5 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
5-a	70	37	56	34	0	OB3, Clarence River bridge
5-b	66	56	64	15	0	Clarence River bridge, OB3
5-c	30	53	72	16	0	Clarence River bridge, OB3
5-d	37	53	74	28	0	Clarence River bridge, Clarence River North Arm bridge, OB1, OB3
5-e	28	55	65	26	0	Clarence River bridge
5-f	12	46	56	9	0	Clarence River bridge

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As shown in Table 6-102 a number of receivers would experience noise levels above the NML as a result of bridge works, however the highly noise affected criteria' is not expected to be exceeded at any of the receivers within Section 5 (Maclean to Iluka Road, Mororo). The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The primary cause for the exceedances of the NML is a result of the works at OB3, and works to construct the bridge crossing of the Clarence River.

The exceedances of the NML during general daytime works at the remainder of the bridges in Section 5 are primarily as a result of the noise associated with the piling works assumed to occur at each of the bridge sites. Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore management measures are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

The above results assume an impact piling rig would be operational at each bridge site, in reality this may not occur as piling may not be required or would be restricted in its operation (i.e. during potential night time periods). The predictions also assume an impact piling rig is to be used whereas in practice quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to 4dB (A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during operations within proposed hours.

Due to the close proximity of the bridge crossings of the Clarence River and its north arm to residential receivers, RMS has identified that out of hours works are unlikely to be undertaken on these bridges. This would be with the exception of short term works such as oversized deliveries and 24 hour concrete pours. When these tasks have been identified, the associated noise should be assessed to take account of proposed plant, plant locations and work durations. It is likely that some form of consultation and prior agreement is made with the affected receivers and Department of Planning and Infrastructure.

Potential mitigation and management measures for general piling activities are discussed further in Appendix I.

Section 5 haulage routes noise

Within Section 5 (Maclean to Iluka Road, Mororo), haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. At this stage RMS have not anticipated that any new haul roads would be required in Section 5, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the project.

Section 5 out of hours works assessment

It is anticipated a number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought.   Targeted community consultation will also enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and will have a similar impact. It is envisaged linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Soft soil treatments
- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore, this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-103 to Table 6-107. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-103 Section 5 out of hours noise construction summary – soft soil treatments

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-a	70	50	39	0	0	0
5-b	66	50	39	0	0	0
5-c	30	46	40	0	0	0
5-d	37	35	40	13	10	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-e	28	40	40	15	0	0
5-f	12	34	39	6	0	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-104 Section 5 out of hours noise construction summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-a	70	50	47	25	0	0
5-b	66	50	56	46	18	0
5-c	30	46	74	23	23	0
5-d	37	35	68	31	31	0
5-e	28	40	56	27	27	0
5-f	12	34	46	11	11	0

Table 6-105 Section 5 out of hours noise construction summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-a	70	50	52	68	25	0
5-b	66	50	61	59	45	0
5-c	30	46	79	23	23	2
5-d	37	35	73	31	31	0
5-e	28	40	61	27	27	0
5-f	12	34	51	11	11	0

Table 6-106 Section 5 out of hours noise construction summary – asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-a	70	50	50	67	0	0
5-b	66	50	59	59	42	0
5-c	30	46	77	23	23	1

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-d	37	35	71	31	31	0
5-e	28	40	59	27	27	0
5-f	12	34	49	11	11	0

Table 6-107 Section 5 out of hours noise construction summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*
5-a	70	50	55	8	8	0
5-b	66	50	55	15	13	0
5-c	30	46	55	16	16	0
5-d	37	35	58	31	31	0
5-e	28	40	56	27	27	0
5-f	12	34	49	11	10	0

Table 6-103 to Table 6-107 identify the number of receiver which are predicted to exceed the night –time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 10 per cent and 76 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only 24 receivers. As a result of soft soil treatments, construction noise is predicted to be inaudible at over 209 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works. In addition, given the scale of the project it would be impractical to present all assessed activities graphically.

The figures show three aspects of out of hours works:

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise

- Identification of sections along the project where out of hours works would be suitable without the need for residential receiver consultation (i.e. potential 24 hour construction works)
- Identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 5 (Maclean to Iluka Road, Mororo), approximately 2.4 kilometres of the project would be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken 24 hours without further consultation (this is presented by un-shaded areas along the proposed upgrade centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the proposed upgrade which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for paving and asphalting activities, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with Environment Protection Authority and substantial justification as to why these works are necessary outside proposed construction hours. These areas of works and the process for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 5 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state

- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at a receiver more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 5. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 5.

A summary of the number of receivers within Section 5 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-108.

Table 6-108 Section 5 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
5-a	70	0
5-b	66	19
5-c	30	24
5-d	37	30
5-e	28	28
5-f	12	0

Table 6-108 shows that a number of receivers within Section 5 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 5 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore, the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

To the southern extent of Section 5/northern extent of Section 4 (Tyndale to Maclean) there are no non-linear activities and therefore the cumulative impact of simultaneous section working has already been taken account of in the above assessment. This is the same for the Section 5/Section 6 (Iluka Road to Devils Pulpit) boundary.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.5.2. Section 5 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.5.3.

Piling induced vibration at bridge sites presented in Table 6-101 has been assessed, with a summary of impacts being provided in Table 6-109. This may be an over estimation of vibration however would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-18 is based on the matrix set out in Part A, Section 3.2.2. In summary, the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-109 Section 5 bridge construction vibration summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Bridge crossing of the Clarence River at Harwood	0	0	0	0	0	0
Watts Lane	0	0	0	0	0	0
Serpentine Channel Road north	0	0	0	0	0	0
Bridge crossing of Clarence River - north arm	0	0	0	0	0	0

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Interchange at Iluka Road	0	0	0	0	0	0

Table 6-109 identifies that there are no residential dwellings located within 50 metres of any of the Section 5 bridges. Therefore the levels predicted at Section 5 receivers, as a result of impact piling from bridge construction, are predicted to below the structural damage and human comfort criteria. This confirms that the risk to structures and occupants within Section 5 is low and in practice vibration as a result of piling will not be perceived by any of the identified receivers. Therefore in Section 5, in terms of residential or commercial disturbance, no additional assessment work is considered to be required for piling work at any of the bridges.

Table 6-110 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which would require a more detailed vibration assessment, i.e. where rock hammering is undertaken within 30m of an occupied premises or 10m of a structure.

Table 6-110 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

6.5.3. Section 5 construction blasting assessment

Within Section 5 a number of cut and fill sites have been identified, however only 1 of these would potentially require blasting. The potential blast site is identified in **Table 6-111** along with potential materials requiring processing.

Table 6-111 Potential blast sites – Section 5

Cut location:	Blasting (bank)	Processing (loose)
Section 3		
STN82.4 – STN83.1 (east of the Maclean lookout)	5,000m^3	10,000m^3
Estimated total quantities:	5,000m^3	10,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason only an indication of the risk associated with blasting at these sites on surrounding receivers can be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

Table 6-112 and Table 6-113 present the prediction of vibration and overpressure, as a result of different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A). Exceedances of the criteria are highlighted in red.

Table 6-112 Closest sensitive receiver Section 5 overpressure prediction

Cut/blasting Site	Receiver	Receiver type	Separation distance / metres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN82.4 – STN83.1 (east of the Maclean lookout)	1244	Residential	110	121	128	130	132	133	134
	1096	Commercial	670	98	105	108	109	111	112

Table 6-113 Closest Sensitive Receiver Section 5 Vibration PPV Prediction

Cut/Blasting Site	Receiver	Receiver type	Separation distance / m						
				1	5	10	15	20	25
STN 82.4 – STN 83.1 (east of the Maclean lookout)	1244	Residential	110	0.6	2.2	3.9	5.4	6.8	8.1
	1096	Commercial	670	0	0.1	0.2	0.3	0.4	0.5

Table 6-112 shows that the potential for exceeding the overpressure criteria at R1244 following blasting at STN82.4 to STN 83.1 is high for even the smallest blasting charges. Table 6-113 also indicates that where a charge of 15 kilograms or greater is used at this cut site, the closest receiver R1244, may experience blast induced vibration above the criteria. Therefore prior to the blasting at

STN82.4 – STN83.1, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers and be carried out prior to the commencement of works. The exceedance of overpressure criteria does not necessarily mean that blasting cannot be undertaken, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

6.5.4. Section 5 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 5 construction works is provided in Table 6-114

In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-114 Section 5 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Soft soil treatments	-	2	See Appendix I
Clearing and Formation	-	131	See Appendix I
Earthworks	R1427, R1441	172	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation
Paving and asphalting	R1441	156	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation
Bridge Works - noise	-	128	See Appendix I
Ancillary facilities	-	46	-
Blasting	R1244	-	Prior to the blasting at STN82.4 – STN83.1, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers

6.6. Section 6 (Iluka Road to Devils Pulpit upgrade)

6.6.1. Section 6 construction assessment summary

Section 6 is nine kilometres long, extending from Iluka Road, Mororo to the southern end of Devils Pulpit upgrade. The extent of this project section is shown in Part A, Figure 1-2.

The construction works proposed for Section 6 includes all activities identified within Part A, Table 3-6 in Section 3.3.1; with the exception of soft soil treatments and blasting (not identified by RMS as being required in Section 6). An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of site clearing, earthworks and paving over 40 per cent of the receivers within Section 6 are likely to experience noise levels above the NML. However, no receivers are predicted to experience noise levels above the 'highly noise affected' criteria
- Predicted noise levels from the operation of ancillary facilities are predicted to be above the NML at one receiver (R1542), with this receiver also being above the 'highly noise affected' criteria. This is a direct result of the receiver being located on land that would potentially be acquired for ancillary facilities
- Section 6 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements is predicted to be minimal
- The construction of bridges within Section 6, including the bridge crossing of Tabbimoble Creek, result in no exceedances of the NML or 'highly noise affected' criteria
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures prior to the commencement of works
- Where additional piling sites are identified within 50 metres of Section 6 receivers, further assessment should be undertaken prior to the commencement of works
- There are no road cuttings identified for blasting in Section 6 and therefore the impacts associated with blast induced overpressure and vibration is negligible.

The exceedance of NMLs is primarily a result of the short separation distance between the proposed upgrade and receivers within Section 6. Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers would experience these levels will be short as the works progress along the project. The NMLs for noise catchment area (NCA) have been derived from one monitoring locations and therefore the NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.6.2. Background noise monitoring and noise management levels (NML)

There are seven receivers within 600 metres of Section 6 (Iluka Road to Devils Pulpit) of the project. Of these, none are classed as commercial/non-residential receivers and each lies outside the project boundary. A definitive list of all receivers identified in Section 6 for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at one receiver within Section 6. The locations of this receiver is presented in Table 6-115 alongside measured 'rating background level' (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML (from either the shoulder or daytime periods) from any of the monitored assessment periods. Table 6-115 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been looked at separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-115 Section 6 – unattended noise monitoring summary

Receiver identification	Standard construction hours (7am -6pm)		Extended hours (morning shoulder period 6-7am)		Extended hours (evening shoulder period 6-7pm)		Lowest NML for proposed hours / dB(A)	Represented noise catchment area (NCA)
	RBL / dB(A)	NML dB(A)	RBL / dB(A)	NML dB(A)	RBL / dB(A)	NML dB(A)		
1542	46	56	44	54	45	55	54	6-a, 6-b, 6-c, 6-d, 6-e, 6-f

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-115. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA.A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 6 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-116 alongside the night-time NML**.** Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-116 Section 6 – NCA noise management levels (NML)

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 6-a	54	47
NCA 6-b	54	47
NCA 6-c	54	47
NCA 6-d	54	47
NCA 6-e	54	47
NCA 6-f	54	47

6.6.3. Section 6 construction noise assessment

Section 6 soft soil treatments

There are no soft soil treatments proposed within Section 6 of the project

Linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-117, Table 6-118 and Table 6-47. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-117 Section 6 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
6-a	1	54	49	0	0	-
6-b	2	54	53	0	0	-
6-c	1	54	64	1	0	-
6-d	0	54	0	0	0	-
6-e	3	54	57	2	0	-
6-f	0	54	0	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-118 Section 6 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
6-a	1	54	54	0	0	-
6-b	2	54	58	2	0	-
6-c	1	54	69	1	0	-
6-d	0	54	0	0	0	-
6-e	3	54	62	3	0	-
6-f	0	54	0	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-119 Section 6 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
6-a	1	54	52	0	0	-
6-b	2	54	56	1	0	-
6-c	1	54	67	1	0	-
6-d	0	54	0	0	0	-
6-e	3	54	60	3	0	-
6-f	0	54	0	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, an exceedance of NMLs has been predicted at all but one receiver within Section 6, however no receivers are predicted to be exposed to noise levels above the 'highly noise affected' criteria of 75dB(A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels will be short. As the work progresses along the proposed upgrade, noise exposure at each receiver will reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures will be required; these will be detailed further in Appendix I.

Section 6 ancillary facilities and compounds

Within Section 6 the ancillary facilities presented in Table 6-120 have been identified and assessed. This includes three stockpile sites and four multi-use sites (concrete batch plant/workshop sites/office etc.). The location of these sites, use and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6.The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facilities internal layouts, a more detailed assessment should be undertaken.

Table 6-120 Section 6 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN98.1 to STN98.4	Stockpile site.
Site 2	STN100.1 to STN100.5	Main office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 3	STN103.0 to STN103.750	Main office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 4	STN108.5 to STN108.81	Stockpile site.
Stockpile Site 1	STN98.1 to STN98.34	Stockpile
Stockpile Site 3	STN103.0to STN103.8	Stockpile
Stockpile Site 4	STN108.50to STN108.9	Stockpile

A summary of the results from the modelling of ancillary facilities is presented in Table 6-121. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-121 Proposed hours – Section 6 ancillary site operations noise predictions

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
6-a	1	54	26	0	0	0
6-b	2	54	49	0	0	0
6-c	1	54	82	1	1	R1542
6-d	0	54	0	0	0	0

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
6-e	3	54	51	0	0	0
6-f	0	54	0	0	0	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 6 (Iluka Road to Devils Pulpit upgrade), including concrete batch plants, stockpile sites, office compounds and works shops is predicted to exceed the NML at only one receiver (R1542), however the 'highly noise affected criteria' is also exceeded at this receiver.

The main reason for exceedances of the 75dB (A) is a result of receiver location. Receiver R1542 is located on land designated for Section 6 ancillary site 3. Due to its location it is highly likely that the receiver would form part of the acquisition process or be temporarily leased for the duration of the project. Therefore these would no longer be classed as sensitive receivers.

There is also the potential that some ancillary facilities would operate 24 hours a day to provide service to construction works along the upgrade. The out of hours operation of Section 6 (Iluka Road to Devils Pulpit upgrade) ancillary facilities is assessed below.

Section 6 bridge works

Within Section 6 (Iluka Road to Devils Pulpit upgrade), only one major bridge has been identified over 100 metres in length, this being the road bridge at Tabbimoble Creek. The location and description of this bridge is presented in Table 6-122 and shown graphically in Appendix C. A further 6 smaller bridges have also been identified within Section 6 however due to the small scale of these; they have not been assessed independently within the bridge noise or vibration assessment. The noise associated with the construction of the smaller Section 6 bridges will be similar in magnitude, and therefore, impact as the linear works.

Table 6-122 Section 6 Bridge Locations

Bridge reference	Location (Station)	Details	Bridge length (metres)	Distance and direction to nearest receiver (metres)
Bridge crossing of Tabbimoble Creek	STN101.6-STN101.7	Road bridge running parallel to existing highway	132	670 north

The construction method used to construct the bridge crossing of Tabbimoble Creek, has been confirmed as precast concrete driven piles providing the road support with precast road platform sections being lifted into place to form the base of the concrete pour. Where the concrete pour for any of the bridge base is required to be undertaken in a single 24 hour period, there is the potential for work to be undertaken outside proposed construction hours.

A summary of the noise impacts associated with the construction of the bridge crossing of Tabbimoble Creek Bridge is presented in Table 6-123. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-123 Section 6 proposed hours construction noise summary – Tabbimoble Creek bridge construction

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
6-a	1	54	0	0	0	-
6-b	2	54	46	0	0	-
6-c	1	54	0	0	0	-
6-d	0	54	0	0	0	-
6-e	3	54	41	0	0	-
6-f	0	54	0	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As shown in Table 6-123no receivers are predicted to experience noise levels above the NML as a result of the Tabbimoble Creek bridge works, and no receiver would experience noise levels above the 'highly noise affected criteria'. Therefore, the impact of works on the Tabbimoble Creek bridge during proposed hours is predicted to be minimal.

Where construction is required on the bridge crossing of Tabbimoble Creek outside of proposed works hours, there is a risk that the works may be audible at the external facade of up to three receivers. This would be as a result of the noise associated with the piling rig. Where out of hours works were undertaken in the absence of a piling rig, works are likely to be inaudible at all receivers within Section 6 (Iluka Road to Devils Pulpit upgrade). However, for completeness it is recommended that prior to out of hours works being undertaken a detailed assessment is undertaken at the Tabbimoble Creek bridge to assess the impact at receivers R1532, R1535 and R1536.

Potential mitigation and management measures for general piling activities are discussed further in Appendix I.

Section 6 haulage routes

Within Section 6 (Iluka Road to Devils Pulpit upgrade), haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. At this stage it is not anticipated that any new haul roads would be required in Section 6, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the project.

Section 6 out of hours works

A number of activities may need to be undertaken outside of the proposed construction hours as a result of safety, engineering practicalities and timetable feasibility. At this stage the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. As discussed in Section 3.2.3 of Part A of this report, the output of the out of hours assessment provides an indication of the impact at each receiver and areas along the Section 6 part of the project that would be suitable for out of hours construction works.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For examples the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged that the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods. The assessment of works on the Tabbimoble Creek bridge out of hours has been undertaken above.

- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as ‘highly noise affected’ for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-124 to Table 6-127. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-124 Out of hours construction summary – Section 6 formation, clearing and mulching noise predictions

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
6-a	1	47	49	1	1	-
6-b	2	47	53	2	2	-

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
6-c	1	47	64	1	1	-
6-d	0	47	0	0	0	-
6-e	3	47	57	3	3	-
6-f	0	47	0	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-125 Out of hours construction summary – Section 6 earthworks noise predictions

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
6-a	1	47	54	1	1	0
6-b	2	47	58	2	2	0
6-c	1	47	69	1	1	0
6-d	0	47	0	0	0	0
6-e	3	47	62	3	3	0
6-f	0	47	0	0	0	0

Table 6-126 Out of hours construction summary – Section 6 asphalting noise predictions

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
6-a	1	47	52	1	1	0
6-b	2	47	56	2	2	0
6-c	1	47	67	1	1	0
6-d	0	47	0	0	0	0
6-e	3	47	60	3	3	0
6-f	0	47	0	0	0	0

Table 6-127 Out of hours construction summary – Section 6 ancillary facilities noise predictions

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
6-a	1	47	26	0	0	0
6-b	2	47	49	2	1	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
6-c	1	47	82	1	1	1
6-d	0	47	0	0	0	0
6-e	3	47	51	3	3	0
6-f	0	47	0	0	0	0

Table 6-124 to Table 6-127 identify the number of receiver which are predicted to exceed the night –time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 0 per cent and 39 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at none of the receivers. As a result of ancillary site operations, construction noise is predicted to be inaudible at just two receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The figures show three aspects of out of hours works;

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- identification of sections along the project where out of hours works would be suitable without the need for residential dwelling consultation
- identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and ‘highly noise affected criteria’), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 6, approximately 3.2 kilometres of proposed upgrade would be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken 24 hours without further consultation (this is presented by un-shaded areas along the project centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for paving and asphalting activities, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potential negotiated agreements with the community, consultation with the Environment Protection Authority and substantial justification as to why these works have to be undertaken outside proposed construction hours. It is likely that these areas of works and the process for undertaking the outside proposed hours assessment will be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 6 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at receiver more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 6. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 6.

A summary of the number of receivers within Section 6 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-128.

Table 6-128 Section 6 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
6-a	1	0
6-b	2	1
6-c	1	1
6-d	0	0
6-e	3	3
6-f	0	0

Table 6-128 shows that a number of receivers within Section 6 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 6 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore, the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

To the southern extent of Section 6, the impact of simultaneously construction in both Section 5 and 6 is minimal as the closets non-linear works in Section 5 is on the Section 5 Interchange at Iluka Road Bridge(STN95.4) over 800 metres from the closest Section 6 receiver. As such noise levels at the Section 6 receiver would be minimal and significantly lower than the Section 6 linear contribution at this receiver.

Section 6 is due to commence in the latter half of 2013 whereas Section 7 works are due to start in early 2015 (based on staging information in the Submission to Infrastructure Australia, NSW Government, November 2011) therefore the possibility of cumulative impacts as a results of simultaneous section working at the Section 6 northern extent is minimal. Even if Section 6 works were to overrun, Section 6 and Section 7 are separated by the Devil's Pulpit Upgrade (not part of this project) and therefore a distance of over 5.5 kilometres.

The Devil's Pulpit upgrade construction works has the potential to occur simultaneously with some of the works scheduled within Section 6. Therefore noise levels at some receivers to the northern end of Section 6, during simultaneous project works, may increase slightly. However the magnitude of increases will be heavily dependent on location and type of works within either project. Based on the highest construction predictions for linear works within Section 6 of this project, should the same works be undertaken in the Devil's Pulpit project, in a similar proximity to Section 6 receivers, resultant cumulative levels would increase by up to 3dB(A).

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.6.4. Section 6 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.6.5.

Piling induced vibration at bridge sites presented in Table 6-122 has been assessed, with a summary of impacts being provided in Table 6-129. This may be an over estimation of vibration however will ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment will be required to confirm impacts and mitigation needs.

Table 6-18 is based on the matrix set out in Part A, Section 3.2.2. In summary the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10m of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-129 Bridge building vibration impact summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Tabbimoble Creek bridge	0	0	0	0	0	0

Table 6-129 identifies that there are no dwellings located within 50 metres of the Tabbimoble Creek bridge, and as such the risk of vibration induced structural damage at receivers is minimal. The closest receiver to the Tabbimoble Creek bridge is over 600 metres away. At this distance the vibration from piling will be considerably below discernible levels. Therefore in Section 6, no additional assessment work is considered to be required for piling work at the Tabbimoble Creek bridge.

Table 6-130 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-130 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20 m	10-20	<10
Human comfort	>40	30-40	<30

6.6.5. Section 6 construction blasting assessment

Within Section 6 no cuts requiring blasting have been identified and as such no impacts from blast induced overpressure and vibration has been predicted. Where blasting is proposed for other locations along the proposed upgrade, additional detailed assessment should be undertaken.

6.6.6. Section 6 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 6 construction works is provided in Table 6-131. Generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-131 Section 6 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	-	3	See Appendix I
Earthworks	-	6	See Appendix I
Paving and asphalting	-	5	See Appendix I
Bridge Works - noise	-	0	See Appendix I

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Ancillary facilities	R1542	1	R1542 is located on land proposed for Ancillary Site 3. Temporary occupant relocation, temporary land lease/acquisition should be considered. Noise barriers and respites periods are unlikely to be effective or feasible in the longer term operation of the site.

6.7. Section 7 (Devils Pulpit upgrade to Trustums Hill)

6.7.1. Section 7 construction assessment summary

Section 7 is around 15.3 kilometres long, extending from the northern end of Devils Pulpit upgrade to just south of Gap Road, Trustums Hill. For a location of this section in graphical terms, refer to Part A, Figure 1-7.

The construction works proposed for Section 7 includes all activities identified within in Part A, Table 3-6; with the exception of soft soil treatments and blasting (not identified by RMS as being required). . An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of site clearing, earthworks and paving, over 80 per cent of the receivers within Section 7 are likely to experience noise levels above the noise management level (NML). In addition to this, five of these receivers are predicted to experience noise levels above the 'highly noise affected' criteria
- Predicted noise from the operation of ancillary facilities is predicted to be above NMLs at only six receivers, with the 'highly noise affected' criteria not predicted to be exceeded
- Section 7 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements is predicted to be minimal
- The construction of bridges within Section 7 would not exceed the NML or 'highly noise affected' criteria at any receiver
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures prior to the commencement of works
- Where additional piling sites are identified within 50 metres of Section 7 receivers, further assessment should be undertaken prior to the commencement of works
- There are no cuts identified for blasting in Section 7 and therefore the impacts associated with blast induced overpressure and vibration is negligible.

The exceedance of NMLs is primarily a result of the short separation distance between the project and receivers within Section 7. Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers would experience these levels would be short as the works progress along the project. The NMLs for the noise catchment area (NCA) have been derived from up to three monitoring locations (dependent on number of monitoring locations in each NCA) and therefore the NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.7.2. Section 7 background noise monitoring and noise management levels (NML)

Within Section 7 (Devils Pulpit upgrade to Trustums Hill) there are around 31 receivers within 600 metres of the project. Of these, five are classed as commercial/non-residential receivers and all of the Section 7 receiver lie outside the project boundary. Three heritage structures have been identified within Section 7, all of which are commercial, and lie within the New Italy Settlement. These three receivers (R1572, R1573 and R1576) will be looked at individually for potential vibration impacts associated with piling and blasting.

A definitive list of all receivers identified for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at 6 receivers within Section 7. The locations of these are presented in Table 6-132 alongside measured 'rating background level' (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML (from either the shoulder or daytime periods) from any of the monitored assessment periods. Table 6-132 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-132 Section 7 – Unattended noise monitoring summary

Receiver Identification	Standard construction Hours (7am - 6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
1557	45	55	47	57	46	56	55	7-c, 7-d
1591	44	54	44	54	45	55	54	7-c, 7-d
1619	-	-	-	-	-	-	-	7-c, 7-d
1592	45	55	46	56	45	55	55	7-e, 7-f, 7-a, 7-b

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-132. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 7 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-133 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-133 Section 7 – NCA noise management levels (NML)

NCA	Project NML, dB(A)	Night-time/out of hours NML, dB(A)
NCA 7-a	55	42
NCA 7-b	55	42
NCA 7-c	54	42
NCA 7-d	54	42
NCA 7-e	55	42
NCA 7-f	55	42

6.7.3. Section 7 construction noise assessment

Section 7 soft soil treatments

There are no soft soil treatments proposed or deemed required within Section 7 (Devils Pulpit upgrade to Trustums Hill) of the project

Section 7 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-134, Table 6-135 and Table 6-136. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels predicted construction noise associated with each activity is provided in Appendix E.

Table 6-134 Section 7 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
7-a	0	55	0	0	0	-
7-b	6	55	57	2	0	-
7-c	10	54	73	10	0	-
7-d	10	54	75	10	1	R1621
7-e	2	55	51	0	0	-
7-f	3	55	46	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-135 Section 7 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
7-a	0	55	0	0	0	-
7-b	6	55	62	4	0	-
7-c	10	54	78	10	3	R1561, R1616, R1620
7-d	10	54	80	10	2	R1552, R1621,
7-e	2	55	56	1	0	-
7-f	3	55	51	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-136 Section 7 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
7-a	0	55	0	0	0	-
7-b	6	55	60	3	0	-
7-c	10	54	76	10	2	R1561, R1620
7-d	10	54	78	10	2	R1552, R1621,
7-e	2	55	54	0	0	-
7-f	3	55	49	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 7 (Devils Pulpit upgrade to Trustums Hill); with up to five receivers being predicted to be exposed to levels above the highly noise affected criteria of 75dB (A) during earthworks and asphalting. The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures will be required; these will be detailed further in Appendix I.

The ICNG states that where a receiver is exposed to noise levels of 75dB (A) or greater, as a result of construction activities, the receiver is to be classed as 'highly noise affected' and must be afforded additional consideration. Receivers R495 and R522 would potentially experience levels in excess of 75dB (A) as a result of noise emitted from the activity of earthworks and paving and asphalting. The higher levels are primarily as a result of the short separation distance assumed been the receiver and the proposed works; 60 metres at the shortest distance.

'Highly noise affected', additional measures are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Such measures will be discussed in more detail in Section 6.7.6 and Appendix I.

Section 7 ancillary facilities and compounds

Within Section 7 the ancillary facilities presented in Table 6-137 have been identified and assessed. This includes four stockpile sites and three multi-use sites (concrete batch plant/workshop sites/office etc.). The location of these sites, use and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan noise software, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facilities internal layouts, a more detailed assessment should be undertaken prior to the commencement of works.

Table 6-137 Section 7 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN109.9 to STN110.3	Main office and compound area. Batch plant area. Plant workshop. Materials storage. Stockpile site.
Site 2a	STN114.1 to STN114.3	Stockpile area.
Site 2b	STN114.2 to STN114.5	Main office and compound area.
Site 3	STN121.2 to STN121.7	Satellite site compound. Batch plant area. Plant workshop. Materials storage.
Stockpile Site 1	STN109.9 to STN110.3	Stockpile Site
Stockpile Site 3	STN121.2 to STN121.7	Stockpile Site
Stockpile Site 4	STN125.3 to STN125.6	Stockpile Site

A summary of the results from the modelling of ancillary facilities is presented in Table 6-138. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-138 Section 7 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
7-a	0	55	0	0	0	-
7-b	6	55	52	0	0	-
7-c	10	54	55	1	0	-
7-d	10	54	62	5	0	-
7-e	2	55	49	0	0	-
7-f	3	55	50	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 7, including concrete batch plants, stockpile sites, office compounds and works shops is predicted to exceed the NML at the majority of the receivers. Of these receivers, none are expected to exceed the 'highly noise affected criteria' of 75dB (A).

There is the potential that some ancillary facilities will operate 24 hours a day to provide service to construction works along the upgrade. The out of hours operation of Section 1 ancillary facilities will be assessed below.

Bridge Works - Noise

Within Section 7 (Devils Pulpit upgrade to Trustums Hill), one main bridge has been identified, comprising of the over bridge at STN118.800 (Tabbimoble Nature Reserve fauna bridge 72.6 metres long). RMS has not identified any significant road bridges within Section 7. The location of the over bridge is shown graphically in Appendix B. A number of other small bridges have been identified in Section 7 but the scale of these means the resultant impact from works will be less and similar in magnitude to the noise associated with linear works in Section 7.

At the main Section 7 bridge, driven piles are assumed to be used along with other plant identified in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges will be constructed without the requirement to drive piles. However, this approach, in the absence of a more detailed construction method, will ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 7 bridge works is presented in Table 6-139. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous construction of Section 7 bridges. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-139 Section 7 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
7-a	0	55	0	0	0	-
7-b	6	55	36	0	0	-

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
7-c	10	54	47	0	0	-
7-d	10	54	39	0	0	-
7-e	2	55	0	0	0	-
7-f	3	55	0	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-139 shows that no receivers are predicted to experience noise levels above the 'highly noise affected' criteria or the NML, as a result of works at the Section 7 over bridge (STN118.800). The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. Due to the small scale of the over bridge in Section 7, it is unlikely that out of hour works will be required.

Potential mitigation and management measures for general piling activities are discussed further in Appendix I.

Haulage routes noise

Within Section 7 (Devils Pulpit upgrade to Trustums Hill), haulage routes would in the main follow the project formation, although some traffic will use the existing Pacific Highway and other local roads. At this stage RMS have not anticipated that any new haul roads will be required in Section 7, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the project.

Section 7 out of hours works – construction noise

A number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage, the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged that the linear activities will take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks

- Paving and asphalting
- Ancillary site operation.

Bridge works has not been assessed for out of hours works as it is unlikely that the construction of the one main over bridge within this section would require 24 hour working.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-140 to Table 6-143. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-140 Section 7 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
7-a	0	42	0	0	0	0
7-b	6	42	57	6	6	0
7-c	10	42	73	10	10	0
7-d	10	42	75	10	10	0
7-e	2	42	51	2	2	0
7-f	3	42	46	3	3	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-141 Section 7 out of hours noise summary –earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
7-a	0	42	0	0	0	0
7-b	6	42	62	6	6	0
7-c	10	42	78	10	10	3
7-d	10	42	80	10	10	2
7-e	2	42	56	2	2	0
7-f	3	42	51	3	3	0

Table 6-142 Section 7 out of hours noise summary –asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
7-a	0	42	0	0	0	0
7-b	6	42	60	6	6	0
7-c	10	42	76	10	10	2
7-d	10	42	78	10	10	2
7-e	2	42	54	2	2	0
7-f	3	42	49	3	3	0

Table 6-143 Section 7 out of hours noise summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
7-a	0	42	0	0	0	0
7-b	6	42	52	4	4	0
7-c	10	42	55	3	5	0
7-d	10	42	62	7	9	0
7-e	2	42	49	2	2	0
7-f	3	42	50	2	3	0

Table 6-140 to Table 6-143 identify the number of receiver which are predicted to exceed the night –time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise

(RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 0 per cent and 26 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at none of the Section 7 (Devils Pulpit upgrade to Trustums Hill) receivers. As a result of ancillary site operations, construction noise is predicted to be inaudible at just 8 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. The out of hours graphic for the activity of paving and asphalting is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The graphic shows three aspects of out of hours works:

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- Identification of sections along the proposed upgrade where out of hours works would be suitable without the need for residential dwelling consultation
- Identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and ‘highly noise affected criteria’), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 7 (Devils Pulpit upgrade to Trustums Hill), around 6.8 kilometres of the project would be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken 24 hours without further consultation (this is presented by un-shaded areas along the proposed upgrade centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, of paving & asphalting works, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with the Environment Protection Authority and justification as to why these works are necessary outside of the proposed construction hours. It is likely these areas of works and the processes for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 7 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes that there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at receivers more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 7. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 7.

A summary of the number of receivers within Section 7 that would potentially experience external maximum noise events above 65dB (A) are presented in Table 6-144.

Table 6-144 Section 7 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
7-a	0	0
7-b	6	6
7-c	10	10
7-d	10	10
7-e	2	2
7-f	3	3

Table 6-144 shows that a number of receivers within Section 7 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number will be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment will be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 7 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

Section 6 is due to commence in 2013 whereas Section 7 (Devils Pulpit upgrade to Trustums Hill) works are due to start in early 2015 therefore the possibility of cumulative impacts as a results of simultaneous section working at the Section 6 northern extent is minimal. Even if Section 6 works were to overrun, Section 6 (Iluka Road to Devils Pulpit upgrade) and Section 7 (Devils Pulpit upgrade to Trustums Hill) are separated by the Devil's Pulpit Upgrade (not part of this project) and therefore a distance of over 5.5 kilometres.

To the northern extent of Section 7, on the border with Section 8 (Trustums Hill to Broadwater National Park), there are no non-linear activities within 1 kilometre in either section. As such the potential for a cumulative impact on receivers within the Section 7/8 boundary area is considered to be minimal. The way in which the impact associated with linear works has been assessed already takes account of the impact associated with linear works being undertaken in two sections simultaneously. The works in Section 7 are also expected to commence one year later to Section 8 works.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.7.4. Section 7 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 0.

Piling induced vibration at bridge sites presented above have been assessed, with a summary of impacts being provided in Table 6-145. This may be an over estimation of vibration however will ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment will be required to confirm impacts and mitigation needs.

Table 6-145 is based on the matrix set out in Part A, Section 3.2.2. In summary the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-145 Section 7 - bridge building vibration impact summary

Bridge Reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Tabbimoble Nature Reserve fauna over bridge	0	0	0	0	0	0

Table 6-145 identifies that there are no residential dwellings or commercial buildings located within 50 metres of the Section 7 bridge. The closest receiver to the bridge location is receiver R1557, which is located over 500 metres to the north. At this separation distance, ground borne vibration levels as a result of impact piling will be considerably below those classed as perceptible. As such, the impacts associated with identified vibration plant sources within Section 7 are minimal. Therefore in Section 7, no additional assessment work is considered to be required for piling work at any of the bridges. However, where other piling works is identified, where this is located within 50 metres of a sensitive receiver or structure, additional assessments should be undertaken.

Table 6-146 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or ten metres of a structure.

Table 6-146 Generic Vibration Impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

The heritage properties at R1572, R1573 and R1576 are approximately 2.4 kilometres north of the Tabbimoble Nature Reserve fauna over bridge. This is such a distance that impacts associated with vibration are predicted to be minimal. However due to the unknown structural condition of these receivers, where piling works or other vibratory plant is used within 50 metres of the sensitive site, further detailed assessment would be undertaken post approval.

6.7.5. Section 7 blasting assessment

Within Section 7, three road cuttings have been identified however none of these will require blasting. Therefore the potential impact of blasting induced overpressure and ground borne vibration is not applicable.

6.7.6. Section 7 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 7 construction works is provided in Table 6-147 In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-147 Section 7 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	R1621	22	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation
Earthworks	R1561, R1616, R1620, R1552, R1621	25	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation
Paving and asphalting	R1561, R1620, R1552, R1621	23	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation
Ancillary facilities	-	6	-

6.8. Section 8 (Trustums Hill to Broadwater National Park)

6.8.1. Section 8 construction assessment summary

Section 8 is around 11 kilometres long, extending from just south of Gap Road to Broadwater National Park. For a location of this section in graphical terms, refer to Part A, Figure 1-8.

The construction works proposed for Section 8 includes all activities identified within Part A, Table 3-6 construction overview. An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of Section 8 soft soil treatments, three receivers are predicted to be exposed to noise levels above the NML, however no receivers are predicted to exceed the 'highly noise affected' criteria
- As a result of site clearing, earthworks and paving, 67 per cent of the receivers within Section 8 are likely to experience noise levels above the NML, with one of these predicted to experience noise above the 'highly noise affected' criteria
- Predicted noise from the operation of ancillary facilities are above the NML at 12 receivers, with two of these experiencing noise levels above the 'highly noise affected' criteria. The exceedance of the 'highly noise affected criteria' is a direct result of the receivers (R1716, R1721) being located on land proposed for potential ancillary facilities.
- Section 8 does not contain any newly constructed access roads/haul roads and therefore the impacts associated with construction traffic movements is predicted to be minimal
- The construction of bridges within Section 8, including the construction of the Tuckombil Creek road bridge would result in exceedances of the NML at seven of the closest receivers. This is mainly as a result of the assumed operation of an impact piling rig at each of the bridge sites
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 40 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within 50 metres of Section 8 receivers, further assessment should be undertaken prior to the commencement of works
- Blasting at specified road cutting sites along the project may result in some receivers being exposed to vibration and overpressure levels above adopted project criteria. Therefore

detailed assessment and mitigation/management measures would be required prior to construction.

The exceedance of NMLs is primarily a result of the short separation distance between the proposed upgrade and receivers within Section 8 (Trustums Hill to Broadwater National Park). Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers will experience these levels will be short as the works progress along the proposed upgrade. The NMLs for noise catchment area (NCA) have been derived from up to two monitoring locations (dependent on the number of monitoring locations in each NCA) and therefore the NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.8.2. Section 8 background noise monitoring and noise management levels

Within Section 8 there are around 49 receivers within 600 metres of the project. Of these, ten are classed as commercial/non-residential receivers. Of the 49 receivers, one lies within the project boundary and would not be quantitatively assessed.

A definitive list of all receivers identified for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at five receivers within Section 8. The locations of these are presented in Table 6-148 alongside measured 'rating background level' (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-148 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-148 Section 8 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am -6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
1624	45	55	47	57	40	50	50	8-b, 8-a
1631	44	54	45	55	45	55	54	8-c
1676	45	55	46	56	46	56	55	8-d
1698	48	58	47	57	48	58	57	8-e
1724	45	55	46	56	45	55	55	8-e, 8-f

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-148. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 8 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-149 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-149 Section 8 – NCA Noise management levels

NCA	Project NML, dB(A)	Night-time/out of hours NML, dB(A)
NCA 8-a	50	50
NCA 8-b	50	50
NCA 8-c	54	46
NCA 8-d	55	36
NCA 8-e	55	50
NCA 8-f	55	55

6.8.3. Section 8 construction noise assessment

Section 8 soft soil treatments

Within Section 8 (Trustums Hill to Broadwater National Park), one site has been identified as requiring soft soil treatments to allow for Section 8 bridge and embankment construction. The single site is presented in Table 6-150.

Table 6-150 Section 8 –soft soil treatment sites

Construction ID	Approximate location	Works
SS-08	STN129.8 – STN130.7	Consolidation of soft soils below embankment, drainage layer

The construction plant modelled during the soft soil treatments includes all plant identified in Part A, Table 3-6 with a summary of predicted noise levels shown in Table 6-151. This table summarise the number of receivers which are exposed to varying levels of construction noise. A complete list of individual receivers and the levels predicted construction noise associated with soft soil treatments is provided in Appendix E.

Table 6-151 Section 8 proposed hours construction noise summary – soft soil treatments

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
8-a	2	50	0	0	0	-
8-b	6	50	0	0	0	-
8-c	11	54	0	0	0	-
8-d	12	55	40	3	0	-
8-e	14	55	44	0	0	-
8-f	4	55	43	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of the Section 8 soft soil treatments, three receivers have been predicted to exceed the NML; however no receivers are predicted to be exposed to levels above the 'highly noise affected' criteria of 75dB(A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity. This includes all plant identified in Part A, Table 3-6 operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary and as the work relatively linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along each of the three soft soil treatments segments, noise exposure at each receiver will reduce.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures will be required; these would be detailed further in Appendix I.

Linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-152, Table 6-153 and Table 6-154. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-152 Section 8 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
8-a	2	50	44	0	0	-
8-b	6	50	55	2	0	-
8-c	11	54	70	9	0	-
8-d	12	55	67	6	0	-
8-e	14	55	52	0	0	-
8-f	4	55	46	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-153 Section 8 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
8-a	2	50	49	0	0	-
8-b	6	50	60	6	0	-
8-c	11	54	75	11	1	R1637
8-d	12	55	72	11	0	-
8-e	14	55	57	5	0	-
8-f	4	55	51	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-154 Section 8 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
8-a	2	50	47	0	0	-
8-b	6	50	58	5	0	-
8-c	11	54	73	11	0	-
8-d	12	55	70	10	0	-
8-e	14	55	55	1	0	-
8-f	4	55	49	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 8 (Trustums Hill to Broadwater National Park); with one receiver being predicted to be exposed to levels above the ‘highly noise affected’ criteria of 75dB (A) during earthworks. The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required; these would be detailed further in Appendix I.

The ICNG states that where a receiver is exposed to noise levels of 75dB (A) or greater, as a result of construction activities, the receiver is to be classed as ‘highly noise affected’ and must be afforded additional consideration. Receiver R1637 would potentially experience levels in excess of 75dB (A) as a result of noise emitted from the activity of earthworks. The higher levels are primarily as a result of the short separation distance assumed been the receiver and the proposed works; 60 metres at the shortest distance.

'Highly noise affected', additional measures are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Such measures will be discussed in more detail in Section 6.1.1 and Appendix I.

Section 8 ancillary facilities and compounds

Within Section 8, the ancillary facilities presented in Table 6-155 have been identified and quantitatively assessed. This includes four stockpile sites and three multi-use sites (including concrete batch plants, workshops and site offices). The location of these sites, use and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan noise software, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary facilities locations and internal site layouts, a more detailed assessment should be undertaken prior to the commencement of works.

Table 6-155 Section 8 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN129.7 to STN130.1	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 2a	STN131.2 to STN132.2	RMS site office. Materials storage. Stockpile site.
Site 2b	STN131.8 to STN132.1	Main site office and compound area. Batch plant area. Plant workshop.
Site 2c	STN132.1 to STN132.3	Stockpile site.
Stockpile Site 1	STN129.7 to STN130.1	Stockpile site.
Stockpile Site 2a	STN131.2 to STN132.2	Stockpile site.
Stockpile Site 3	STN134.8 toSTN135.1	Stockpile site.

A summary of the results from the modelling of ancillary facilities is presented in Table 6-156. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-156 Section 8 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
8-a	2	50	53	1	0	-
8-b	6	50	56	2	0	-
8-c	11	54	81	1	1	R1716
8-d	12	55	78	1	1	R1721
8-e	14	55	61	7	0	-
8-f	4	55	54	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 8, including concrete batch plants, stockpile sites, office compounds and works shops is not expected to exceed the NML at the majority of the receivers. Exceedances of the NML are predicted at only 12 receivers. However, of these 12 receivers, two are expected to experience noise levels above the 75dB (A) 'highly noise affected' criteria.

The main reason for exceedances of the 75dB (A) is a result of receiver location. These two receivers are located outside the project boundary but within areas designated for ancillary facilities; R1716 in Site 2b and R1721 in Site 2c. Due to their location it is highly likely that these receivers would form part of the acquisition process or be temporarily leased for the duration of the project. Therefore these would no longer be classed as sensitive receivers.

There is the potential that some ancillary facilities will operate 24 hours a day to provide service to construction works along the upgrade. The operation of Section 1 ancillary facilities activities out of hours will be assessed below.

Section 8 bridge works – construction noise

Within Section 8, three main bridges have been identified, comprising of two over bridges and one road bridge; this includes the bridge crossing of Tuckombil Creek. The location and description of each bridge within Section 8 is presented in Table 6-157 and shown graphically in Appendix C. A number of other smaller bridges have been identified within Section 8; however the scale of these in terms of size or structure means the noise and vibration impacts are likely to be low. Noise associated with the construction of the smaller bridges in Section 8 will be similar or lower in magnitude to the noise predicted for Section 8 linear works.

Table 6-157 Section 8 bridge locations

Bridge reference	Location (Station)	Details	Bridge Length / metres	Distance and direction to nearest receiver
Woodburn – Evans Head Road over bridge	STN 136.7	Access road over bridge	60.6m	370 m north-east
Tuckombil Creek Road bridge	STN130.2 – STN130.3	Tuckombil Canal bridge	150.5 m	400 m west

Bridge reference	Location (Station)	Details	Bridge Length / metres	Distance and direction to nearest receiver
MacDonald Creek Bridge	STN 138.3	Access road over bridge	18 m	100 m south

The construction method used to construct the main road bridge within Section 8, Tuckombil Creek Road bridge, has been confirmed as precast concrete driven piles with precast road platform sections being lifted into place to form the base of the concrete pour. Where the concrete pour for the road base is required to be undertaken in a single 24 hour period, there is the potential for work to be undertaken outside proposed construction hours.

At each of the other Section 8 (Trustums Hill to Broadwater National Park), bridges (road and over bridges); driven piles are assumed to be used along with other plant identified in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, in the absence of a more detailed construction method, would ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 8 bridge works is presented in Table 6-158. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous construction of Section 8 bridges. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-158 Section 8 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
8-a	2	50	52	1	0	-
8-b	6	50	57	3	0	-
8-c	11	54	70	1	0	Tuckombil Creek dual bridges
8-d	12	55	60	1	0	-
8-e	14	55	58	1	0	-
8-f	4	55	54	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-9 shows that only seven receivers would experience noise levels above the NML as a result of bridge works, and the highly noise affected criteria' is not predicted to be exceeded at any of receivers. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The primary cause for the exceedances of the NML is a result of the works at the bridge crossing of Tuckombil Creek.

Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore administrative measures are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

The bridge noise predictions assume a piling rig would be operational at each bridge site, in reality this may not occur as piling may not be required or will be restricted in its operation (i.e. daytime only). The predictions also assume an impact piling rig is to be used whereas in practice quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken, or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to 4dB (A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during operations within proposed hours.

It is not envisaged that general out of hours works would be required on bridges within Section 8, including the bridge crossing of Tuckombil Creek. However, deliveries of oversized plant and girders may be required outside of hours to avoid traffic disruptions on existing routes. Out of hours noise for bridge works would be assessed later in Section 6.8.3.

Haulage routes noise

Within Section 8 (Trustums Hill to Broadwater National Park), haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. At this stage RMS have not anticipated that any new haul roads would be required in Section 8, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the project.

Section 8 out of hours works assessment

A number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage, the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged that the linear activities will take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks
- Paving and asphalting

- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity will be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-159 to Table 6-164. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-159 Section 8 out of hours noise summary – soft soil treatments

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-a	2	50	0	0	0	0
8-b	6	50	0	0	0	0
8-c	11	46	0	0	0	0
8-d	12	36	40	3	0	0
8-e	14	50	44	0	0	0
8-f	4	55	43	0	0	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-160 Section 8 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-a	2	50	44	0	0	0
8-b	6	50	55	6	2	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-c	11	46	70	11	11	0
8-d	12	36	67	11	11	0
8-e	14	50	52	13	5	0
8-f	4	55	46	0	0	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-161 Section 8 out of hours noise summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-a	2	50	49	2	0	0
8-b	6	50	60	6	6	0
8-c	11	46	75	11	11	1
8-d	12	36	72	11	11	0
8-e	14	50	57	14	13	0
8-f	4	55	51	2	0	0

Table 6-162 Section 8 out of hours noise summary –asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-a	2	50	47	2	0	0
8-b	6	50	58	6	5	0
8-c	11	46	73	11	11	0
8-d	12	36	70	11	11	0
8-e	14	50	55	14	9	0
8-f	4	55	49	0	0	0

Table 6-163 Section 8 out of hours noise summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-a	2	50	52	2	1	0

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-b	6	50	57	4	3	0
8-c	11	46	70	2	2	0
8-d	12	36	60	10	9	0
8-e	14	50	58	11	1	0
8-f	4	55	54	1	0	0

Table 6-164 Section 8 out of hours noise summary –ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
8-a	2	50	53	2	1	0
8-b	6	50	56	3	2	0
8-c	11	46	81	2	2	1
8-d	12	36	78	6	6	1
8-e	14	50	61	11	11	0
8-f	4	55	54	3	0	0

Table 6-159 to Table 6-164 identify the number of receiver which are predicted to exceed the night –time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works will be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without any impact at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 6 per cent and 94 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at 8 receivers. As a result of ancillary site operations, construction noise is predicted to be inaudible at 46 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities out of hours is presented in Appendix B. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3.

The figures show three aspects of out of hours works:

- the areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- identification of sections along the project where out of hours works would be suitable without the need for residential dwelling consultation
- identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 8, around 3.0 kilometres of proposed upgrade will be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken 24 hours without further consultation (this is presented by un-shaded areas along the project centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for paving and asphalting activities, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with the Environment Protection Authority and justification as to why these works are necessary outside of the proposed construction hours. It is likely that these areas of works and the process for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 8 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at receivers more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 8. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 8.

A summary of the number of receivers within Section 8 that would potentially experience external maximum noise events above 65 dB (A) are presented in Table 6-165.

Table 6-165 Section 8 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
8-a	2	2
8-b	6	2
8-c	11	11
8-d	12	9
8-e	14	7
8-f	4	0

Table 6-165 shows that a number of receivers within Section 8 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number will be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment will be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 8 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

To the southern extent of Section 8 (Trustums Hill to Broadwater National Park), on the border with Section 7, there are no non-linear activities within 1 kilometre in either section. As such the potential for a cumulative impact on receivers within the Section7/8 boundary area is considered to be minimal. The way in which the impact associated with linear works has been assessed already takes account of the impact associated with linear works being undertaken in two sections simultaneously. The works in Section 7 (Devils Pulpit upgrade to Trustums Hill) are expected to commence one year later to Section 8 (Trustums Hill to Broadwater National Park) works.

On the Section 8/9 boundary to the north of Section 8, the closest non-linear works within Section 9 to Section 8 receivers is Section 9 Ancillary Site 1. This site would comprise of a batch plant, workshops and site offices. As both Section 8 and 9 will be undertaken in 2014, there is a potential for works to be undertaken simultaneously on the Section8/9 boundary.

The noise associated with the Section 9 (Broadwater National Park to Richmond River) ancillary site would potentially affect the most northern Section 8 receivers, these being R1727, R1729, R1730, R1731 and R1732. The noise associated with the highest predicted noise from Section 8 linear works may increase by up to 3dB (A) at these receivers as a result of Section 9 Ancillary facility site 1 operating. However, this increase is only likely to be experienced during the earthworks immediately adjacent to those receivers. Following the confirmation of the layout of Section 9 ancillary site 1, a more detailed assessment should be undertaken to confirm the noise contribution at Section 8 receivers. This would be undertaken prior to the commencement of works.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.8.4. Section 8 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.8.5.

Piling induced vibration at bridge sites presented in Section 6.8.3 has been assessed, with a summary of impacts being provided in Table 6-166. This may be an over estimation of vibration however, would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-157 is based on the matrix set out in Part A, Section 3.2.2. In summary, the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-166 Section 8 bridge construction vibration summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Woodburn – Evans Head Road over bridge	0	0	0	0	0	0
Tuckombil Creek Road bridge	0	0	0	0	0	0
MacDonald Creek Bridge	0	0	0	0	0	0

Table 6-166 identifies that there are no dwellings located within 50 metres of any of the Section 8 bridges. Receiver R1716 is the closest to with Section 8, being around 100 metres from Tuckombil Creek bridge. The levels predicted at R1716 as a result of impact piling are considerably below the structural damage and human comfort criteria, and would almost certainly be below the levels of human perception. This confirms that the risk to structures and occupants within Section 8 is low and in practice vibration as a result of piling will not be perceived by any of the identified receivers. Therefore in Section 8, no additional assessment work is considered to be required for piling work at any of the bridges.

Table 6-167 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-167 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

6.8.5. Section 8 construction blasting assessment

Within Section 8 (Trustums Hill to Broadwater National Park), a number of cut and fill sites have been identified, however only a selection of these will potentially require blasting. These potential blast sites are identified in Table 6-168 along with potential materials requiring processing.

Table 6-168 Potential blast sites – Section 8

Cut location:	Blasting (bank)	Processing (loose)
Section 3		
STN128.1 to STN128.8 (at Woodburn interchange area)	40,000m^3	85,000m^3
STN134.7 to STN135.1 (at Lang Hill)	70,000m^3	140,000m^3
Estimated total quantities:	110,000m^3	225,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason, only an indication of the risk associated with blasting at these sites on surrounding receivers can be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

Table 6-169 and Table 6-170 present the prediction of vibration and overpressure, as a result of different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report, with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A). Exceedances of the criteria are highlighted in red.

Table 6-169 Closest sensitive receiver overpressure prediction – Section 8

Cut/blasting Site	Receiver	Receiver type	separation distance metres / kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN128.1 to STN128.8(at	R1665	Residential	250 metres	110	117	120	122	123	124

Cut/blasting Site	Receiver	Receiver type	separation distance metres / kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
Woodburn interchange area)	R1667	Commercial	210 metres	113	119	122	124	125	126
STN134.7 to STN135.1 (at Lang Hill)	R1730	Residential	1.7 kilometres	86	93	96	98	99	100
	R1727	Commercial	1.5 kilometres	88	95	98	99	100	101

Table 6-170 Closest sensitive receiver vibration prediction – Section 8

Cut/blasting Site	Receiver	Receiver type	separation distance / metres / kilometres	Vibration according to charge (Peak Particle Velocity- PPV) / dB					
				1	5	10	15	20	25
STN128.1 to STN128.8 (at Woodburn interchange area)	R1665	Residential	250 metres	0.2	0.6	1.0	1.4	1.	2.4
	R1667	Commercial	210 metres	0.2	0.8	1.4	1.9	2.4	2.9
STN134.7 to STN135.1 (at Lang Hill)	R1730	Residential	1.7 kilometres	0	0	0.1	0.1	0.1	0.1
	R1727	Commercial	1.5 kilometres	0	0	0.1	0.1	0.1	0.1

Table 6-169 shows that there is a potential that overpressure criteria will be exceeded as a result of blasting using charges greater than 1kg at cut site STN128.1-STN128.8. However this does not necessarily mean that blasting cannot be undertaken, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

Table 6-170 indicate that where a charge of less than 25 kilograms is used at the Section 8 (Trustums Hill to Broadwater National Park) cut sites, the potential for exceeding the vibration criteria at the closest receivers is low. This is due to the relatively large separation distances between the blast area and receiver. Where charges higher than 25 kilograms are used, further assessment prior to commencement of works would be required to determine impact.

6.8.6. Section 8 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 8 construction works is provided in Table 6-171In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-171 Section 8 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Soft soil treatments	-	3	See Appendix I
Clearing and formation	-	17	See Appendix I
Earthworks	R1637	33	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation.
Paving and asphalting	-	12	See Appendix I
Bridge Works - noise	-	12	See Appendix I
Ancillary facilities	R1716, R1721	12	R1716 is located on land proposed for Ancillary Site 2b, R1721 in Site 2c. Temporary occupant relocation, temporary land lease/acquisition should be considered. Noise barriers and respites periods are unlikely to be effective or feasible in the longer term operation of the site.
Blasting	R1665	-	Prior to the blasting at STN128.1 – STN128.8, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers. However this does not necessarily mean that blasting cannot be undertaken, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

6.9. Section 9 (Broadwater National Park to Richmond River)

6.9.1. Section 9 construction assessment summary

Section 9 is around 17.5 kilometres long, extending from Broadwater National Park (STN 137.6) to the Richmond River. For a location of this section in graphical terms, refer to Figure 1-9 in Part A of this report.

The construction works proposed for Section 9 includes all activities identified within Part A, Table 3-6 construction overview; with the exception of soft soil treatments (not identified by RMS as being required in Section 9). An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of site clearing, earthworks and paving, over 30 per cent of the receivers within Section 9 are likely to experience noise levels above the NML. However no receivers are predicted to experience noise levels above the ‘highly noise affected’ criteria
- Predicted noise from the operation of ancillary facilities are above the NMLs at 11 of the 24 receivers. However, no receivers are predicted to experience noise levels above the ‘highly noise affected’ criteria
- The construction the Broadwater Evans Head access road will not result in exceedances of the NML or ‘highly noise affected’ criteria at any of the closest receivers
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within 50 metres of Section 9 receivers, further assessment should be undertaken prior to the commencement of works
- Blasting at specified cut sites along the proposed upgrade may result in some receivers being exposed to vibration levels close to adopted project criteria; and therefore detailed assessment and mitigation/management measures will be required prior to construction.

The exceedance of NMLs is primarily a result of the short separation distance between the proposed upgrade and receivers within Section 9. Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers will experience these levels will be short as the works progress along the project. The NMLs for noise catchment area (NCA) have been derived from one monitoring locations and therefore the

NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.9.2. Section 9 background noise monitoring and noise management levels

Within Section 9 (Broadwater National Park to Richmond River) there are 24 receivers within 600 metres of the project. Of these, one is classed as a commercial/non-residential receiver. Two receivers lie inside the boundary of the project. A definitive list of all receivers identified in Section 9 for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Also within Section 9 an area of archaeological/heritage importance has been identified on at Broadwater (STN144.8), and a residence of heritage importance identified at R1739. In terms of assessment, a qualitative approach has been undertaken to determine the impacts associated with vibration as a result of bridge works and blasting at the heritage land. See Part A, Section 4.1 for further information on the assessment method for archaeological/heritage site.

Unattended monitoring has been undertaken at six receivers within Section 9. The locations of these are presented in Table 6-172 alongside measured ‘rating background level’ (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-172 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been looked at separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-172 Section 9 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am - 6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
1766	42	52	44	54	44	54	52	9-d, 9-c, 9-b
1756	45	55	44	54	46	56	54	9-f, 9-a, 9-e

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-172. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 9 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-173 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise; however, some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-173 Section 9 – NCA noise management levels

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 9-a	54	41
NCA 9-b	52	41
NCA 9-c	54	41
NCA 9-d	52	41
NCA 9-e	54	41
NCA 9-f	54	41

6.9.3. Section 9 construction noise assessment

Section 9 soft soil treatments

There are no soft soil treatments proposed within Section 9 (Broadwater National Park to Richmond River) of the project.

Section 9 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-174, Table 6-175 and Table 6-176. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-174 Section 9 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
9-a	0	54	0	0	0	-
9-b	2	52	65	2	0	-
9-c	3	54	52	0	0	-

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
9-d	3	52	58	1	0	-
9-e	6	54	48	0	0	-
9-f	10	54	60	1	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-175 Section 9 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
9-a	0	54	0	0	0	-
9-b	2	52	70	2	0	-
9-c	3	54	57	2	0	-
9-d	3	52	63	1	0	-
9-e	6	54	53	0	0	-
9-f	10	54	65	2	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-176 Section 9 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
9-a	0	54	0	0	0	-
9-b	2	52	68	2	0	-
9-c	3	54	55	1	0	-
9-d	3	52	61	1	0	-
9-e	6	54	51	0	0	-
9-f	10	54	63	2	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a small number of exceedances in the NMLs have been predicted within Section 9; however no receivers are predicted to be exposed to levels above the highly noise affected criteria of 75dB(A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity. This includes all plant identified operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary and as the work is linear, the time at which each receiver is exposed to such levels would be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required; these will be detailed further in Appendix I.

Section 9 ancillary facilities and compounds

Within Section 9 the ancillary facilities presented in Table 6-177 have been identified and quantitatively assessed. This includes three stockpile sites and three multi-use sites (including concrete batch plants, workshops and site offices). The location of these sites, use and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6.The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However, this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary locations and internal layouts, a more detailed assessment should be undertaken.

Table 6-177 Section 9 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1	STN136.7 to STN137.1	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 2	STN137.3 to STN142.8	Satellite site compound. Materials storage.
Site 3	STN142.2 to STN142.8	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Stockpile Site 1	STN142.1 to STN142.8	Stockpile site.
Stockpile Site 2	STN137.3 to STN142.8	Stockpile site.
Stockpile Site 3	STN142.2 to STN142.8	Stockpile site.

A summary of the noise results from the modelling of Section 9 ancillary facilities is presented in Table 6-178. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-178 Proposed hours – Section 9 ancillary facility operations noise predictions

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
9-a	0	54	0	0	0	-
9-b	2	52	60	2	0	-
9-c	3	54	54	1	0	-
9-d	3	52	55	2	0	-
9-e	6	54	57	3	0	-
9-f	10	54	55	3	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 9, including concrete batch plants, stockpile sites, office compounds and works shops is not expected to exceed the NML at the majority of the receivers. Exceedances of the NML are predicted at only 11 receivers however the 'highly noise affected criteria' is not exceeded at any receiver.

Section 9 bridge works - noise

Within Section 9, one main bridge has been identified, comprising of the overpass required to take Broadwater Evans Head Road across the new highway; located at STN142.7. The location of this bridge is shown graphically in Appendix B.

The construction method used to construct this bridge, will include the driving of precast concrete piles. Additional plant for bridge construction will also include those identified in Part A, Table 3-6.

A summary of the noise impacts associated with the construction of the single Section 9 bridge is presented in Table 6-179. The noise prediction at each individual receiver is presented in Appendix E. A number of other smaller bridges have been identified within Section 9 however the scale and nature of these is such that the associated noise and vibration impacts are expected to minimal. Noise predictions from smaller bridges are likely to be similar or lower than those predicted for Section 9 linear works.

Table 6-179 Proposed hours – Section 9 bridge works noise summary

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
9-a	0	54	0	0	0	-
9-b	2	52	47	0	0	-
9-c	3	54	44	0	0	-
9-d	3	52	51	0	0	-
9-e	6	54	50	0	0	-
9-f	10	54	45	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-9 shows that no receivers will experience noise levels above the NML as a result of bridge works in Section 9. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E.

Given the scale of the bridge works in Section 9, it is not anticipated that out of hours works would be required during construction and therefore the potential for disturbance to receivers is minimal and no forms of non-standard mitigation will be required.

Haulage routes noise

Within Section 9, haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. At this stage RMS have not anticipated that any new haul roads would be required in Section 9, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the project.

Out of hours works – construction noise

It is anticipated a number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage, the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example, the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged that linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks
- Paving and asphalting
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-180 to Table 6-183. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-180 Section 9 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
9-a	0	41	0	0	0	0
9-b	2	41	65	2	2	0
9-c	3	41	52	2	2	0
9-d	3	41	58	3	3	0
9-e	6	41	48	5	5	0
9-f	10	41	60	10	10	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-181 Section 9 out of hours noise summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
9-a	0	41	0	0	0	0
9-b	2	41	70	2	2	0
9-c	3	41	57	2	2	0
9-d	3	41	63	3	3	0
9-e	6	41	53	5	5	0
9-f	10	41	65	10	10	0

Table 6-182 Section 9 out of hours noise summary – asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
9-a	0	41	0	0	0	0
9-b	2	41	68	2	2	0
9-c	3	41	55	2	2	0
9-d	3	41	61	3	3	0
9-e	6	41	51	5	5	0
9-f	10	41	63	10	10	0

Table 6-183 Section 9 out of hours noise summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
9-a	0	41	0	0	0	0
9-b	2	41	60	2	2	0
9-c	3	41	54	2	2	0
9-d	3	41	55	3	3	0
9-e	6	41	57	4	4	0
9-f	10	41	55	9	8	0

Table 6-180 to Table 6-183 identify the number of receiver which are predicted to exceed the night –time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impacts at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 8 per cent and 17 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only 2 receivers. As a result of ancillary site operations, construction noise is predicted to be inaudible at 4 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. The out of hours graphic for the activity of paving and asphalting is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The graphic shows three aspects of out of hours works:

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- Identification of sections along the proposed upgrade where out of hours works would be suitable without the need for residential dwelling consultation
- Identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 9, around 2.6 kilometres of the project would be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken over a 24 hour period without further consultation (this is presented by un-shaded areas along the project centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the proposed upgrade which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for paving and asphalting activities, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with the Environment Protection Authority and justification as to why these works are necessary outside proposed construction hours. These areas of works and the process for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This would be discussed further in Appendix I.

Section 9 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at receivers more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 9. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 9.

A summary of the number of receivers within Section 9 that would potentially experience external maximum noise events above 65 dB (A) are presented in Table 6-184.

Table 6-184 Section 9 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
9-a	0	0
9-b	2	2
9-c	3	1
9-d	3	1
9-e	6	0
9-f	10	0

Table 6-184 shows that a number of receivers within Section 9 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 9 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

The closest receivers within Section 9 to the Section 8/9 boundary are within 100 metres of ancillary site 1 (Section 9) and over 500 metres from Section 8 works, and therefore the contribution of ancillary site noise would be considerably higher than noise from Section 8 construction. For this reason the cumulative effect of Section 8 and 9 works is predicted to be negligible.

In terms of Section 9 and 10 simultaneous working, both sections are scheduled to commence in 2014, therefore there is a potential for cumulative impact. There is an ancillary site in Section 10 which is approximately 500-600 metres from the closest receivers within Section 9. The noise associated with this may contribute to linear construction noise at Section 9 receivers but this would be in the region of 1dB(A) addition at the most and would not change the number of receivers identified as being 'highly noise affected'.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.9.4. Section 9 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.9.5.

Piling induced vibration at has been assessed at the single over bridge in Section 9, with a summary of impacts being provided in Table 6-185. This may be an over estimation of vibration however will ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment will be required to confirm impacts and mitigation needs.

Table 6-185 is based on the matrix set out in Part A, Section 3.2.2. In summary the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-185 Bridge building vibration impact summary

Bridge reference	No. receivers within separation distance from bridge works (metres)					
	50-40	40-30	30-20	20-10	10-5	<5
Broadwater Evans Head Road over bridge	0	0	0	0	0	0

Table 6-185 identifies that no dwellings are located within 50 metres of the single Section 9 bridge. Receiver R1766 is the closest to the bridge, being approximately 200 metres from the proposed upgrade and 80m from the proposed bridge layout. The levels predicted at R1766 as a result of impact piling is considerably below the structural damage and human comfort criteria, and will almost certainly be below the levels of human perception. This confirms that the risk to structures and occupants within Section 9 is low and in practice vibration as a result of piling will not be perceived by any of the identified receivers. Therefore in Section 9, no additional assessment work is considered to be required for piling work at the Broadwater Evans Head road overpass bridge.

Table 6-186 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-186 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

In terms of piling/vibration impacts on the heritage area identified in Section 9, being those located at, Broadwater (STN144.8), a quantified assessment cannot be undertaken. This is due to the lack of information in relation to this site, in terms of the actual structures or artefacts at the site. Guidance and criteria does not allow for assessment of buried archaeological artefacts and as such the recommendation, at this stage, is where piling works or other vibratory plant used within 50 metres of the sensitive site, further detailed assessment should be undertaken. However, within Section 9, the closest piling works are expected to be undertaken around 1.1 kilometres south and therefore impacts would be unlikely.

The project runs through part of the area classed with heritage potential and therefore it is likely the impact associated with general construction works (earthworks, clearing etc) would prove more disruptive than from Section 9 piling activities.

In terms of the impact on the residential heritage structure at R1739, the nearest piling works have been identified over 600m north at Broadwater Evans Head Road over bridge. This is such a distance that impacts associated with vibration are predicted to be minimal. However due to the unknown structural condition of the property at R1739, where piling works or other vibratory plant is used within 50 metres of the sensitive site, further detailed assessment would be undertaken post approval.

6.9.5. Section 9 construction blasting assessment

Within Section 9 a number of cut and fill sites have been identified, however only a selection of these will potentially require blasting. These potential blast sites are identified in Table 6-187 along with potential materials requiring processing.

Table 6-187 Potential blast sites – Section 9

Cut location:	Blasting (bank)	Processing (loose)
Section 9		
STN142.100 to STN142.200	5,000m^3	10,000m^3
STN144.800 to STN144.900	5,000m^3	10,000m^3
Estimated total quantities:	10,000m^3	20,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason only an indication of the risk associated with blasting at these sites on surrounding receivers can be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the start of works so that specific site geology can be taken into account.

Table 6-188 and Table 6-189 present the prediction of vibration and overpressure, as a result of different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report, with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A). Exceedances of the criteria are highlighted in red.

Table 6-188 Section 9 blasting overpressure predictions

Cut/blasting site	Receiver	Receiver type	separation distance / metres / kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN142.1 to STN142.2	R1739*	Residential	150 metres	117	124	127	128	129	130
	-	Comm.	> 2.5 kilometres	81	88	91	93	94	95

Cut/blasting site	Receiver	Receiver type	separation distance / metres / kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN144.8 to STN144.9	R1800	Residential	420 metres	104	111	114	115	117	117
	-	Comm.	> 2.5 kilometres	81	88	91	93	94	95

**Heritage item*

Table 6-189 Section 9 blasting vibration predictions

Cut/blasting Site	Receiver	Receiver type	separation distance / metres / kilometres	Vibration according to charge (Peak Particle Velocity- PPV) / dB					
				1	5	10	15	20	25
STN142.1 to STN142.2	R1739*	Residential	150 metres	0.4	1.4	2.4	3.3**	4.1**	4.9**
	-	Comm.	> 2.5 kilometres	0.0	0.0	0.0	0.0	0.0	0.0
STN144.8 to STN144.9	R1800	Residential	420 metres	0.1	0.3	0.5	0.6	0.8	1.0
	-	Comm.	> 2.5 kilometres	0.0	0.0	0.0	0.0	0.0	0.0

**Heritage item, ** As this receivers has been identified as of heritage importance the criteria has been lowered to 3mms in line with the DIN standard*

Table 6-188 identifies that during blasting at STN142.1 to STN142.2 and STN144.8 to STN144.9, overpressure criteria will be exceeded at the closest residential receiver (R1739). The level of exceedance is dependent on the magniyude of the blast charge used. However this does not necessarily mean that blasting cannot be undertaken, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

Table 6-189 indicates that there where a charge of less than 25 kilograms is used at the cut sites within Section 9, the potential for exceeding the vibration criteria at the closest receivers is low. However, the ground borne vibration associated with blasting at STN142.1 – STN142.2 comes close to exceeding the 5mms^{-1} structural damage criteria as a result of charges greater than 25 kilograms. Therefore it is recommended that a detailed assessment of blasting is undertaken at this site prior to work starting. This would take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers.

In terms of piling/vibration impacts on the heritage area identified at STN144.8, a quantified assessment cannot be undertaken. This is due to the lack of information in relation to this site, in terms of the actual structures or artefacts. Guidance and criteria does not allow for assessment of buried archaeological artefacts. The location of this sensitive area is such that it lies less than 150 metres from a proposed cut site and therefore the potential risk of damage is greatly increased. Vibration levels, as a result of blasting, can be estimated across this sensitive site; however there is no guidance or criteria for this prediction to be assessed against. Therefore, to avoid damage potential heritage items, it is recommended that a detailed blasting assessment be undertaken before the start of works.

The heritage property at R1739 is approximately 150 metres south of the blasting at STN142.1 to STN142. At this distance the impacts associated with blasting induced vibration are increased for charges greater than 15 kilograms, therefore where blasting is undertaken within 500 metres of the sensitive site, a detailed blasting assessment would be undertaken post approval.

6.9.6. Section 9 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 1 construction works is provided in Table 6-190. In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-190 Section 9 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	-	4	See Appendix I
Earthworks	-	7	See Appendix I
Paving and asphalting	-	6	See Appendix I
Ancillary facilities	-	11	-
Blasting	R1739		Prior to the blasting at STN142.1 to STN142.2 and STN144.8 to STN144.9, a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers.

6.10. Section 10 (Richmond River to Coolgardie Road)

6.10.1. Section 10 construction assessment summary

Section 10 is around 14 kilometres long, extending from the southern side of the Richmond River just east of Broadwater, to Coolgardie Road, Coolgardie. For a location of this section in graphical terms, refer to Part A, Figure 1-2.

The construction works proposed for Section 10 includes all activities identified within Part A, Table 3-6; with the exception of soft soil treatments (not identified by RMS as being required). An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of the linear construction works (site clearing, earthworks and paving), over 85 per cent of the receivers within Section 10 are likely to experience noise levels above the NML. Of these up to 5 receivers are predicted to experience levels which exceed the 'highly noise affected' criteria of 75dB (A)
- Noise predictions as a result of the operation of ancillary facilities exceed the NMLs at just over half of Section 10 receivers. However, the' highly noise affected' criteria of 75dB (A) is not exceeded at any receiver as a result of ancillary site operations
- No new access/haulage roads are proposed to be constructed within Section 10, with construction traffic using existing road networks and the project. Therefore noise associated with construction traffic would blend in with existing road traffic noise and noise associated with linear construction works
- The construction of Section 10 bridges, including the crossing of the Richmond River, would result in exceedances of the NML at just under half of receivers. Exceedances are primarily shown as a result of noise associated with works at the crossing of the Richmond River and over bridge Coolgardie Road over bridge
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal
- In terms of rock hammering/breaking, where habitable receivers are within 30 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within 50 metres of Section 10 receivers, further assessment should be undertaken prior to the commencement of works
- Blasting at specified cut sites along the project may result in some receivers being exposed to vibration levels above adopted project criteria; and therefore detailed assessment and mitigation/management measures will be required prior to construction.

The exceedance of NMLs is primarily a result of the short separation distance between the proposed upgrade and receivers within Section 10 (Richmond River to Coolgardie Road). Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means that the duration at which receivers would experience these levels will be short as the works progress along the proposed upgrade. The NMLs for noise catchment area (NCA) have been derived from up to two monitoring locations (dependent on number of monitoring locations in each NCA) and therefore the NMLs may be lower than in practice due to a non-uniform noise environment around some receivers.

6.10.2. Section 10 background noise monitoring and Noise Management Levels (NML)

There are around 98 receivers within 600 metres of the project. Of the receivers, 12 are within the boundary of the project and therefore would be acquired. For this reason these 12 receivers have been identified but have not been assessed. In addition, three receivers have been identified as commercial/non-residential. No heritage/archaeological areas have been identified in Section 10.

A definitive list of all receivers identified for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at four receivers within Section 10 of the project. The locations of these are presented in Table 6-191 alongside measured 'rating background level' (RBL) and derived construction NM, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-191 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been assessed separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-191 Section 10 – unattended noise monitoring summary

Receiver identification	Standard Construction Hours (7am -6pm)		Morning shoulder period 6-7am)		Evening shoulder period 6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL / dB(A)	NML dB(A)	RBL / dB(A)	NML dB(A)	RBL / dB(A)	NML dB(A)		
R1817	43	53	44	54	43	53	53	10-a,
R1874	33	43	40	50	38	48	43	10-e, 10-b, 10-c, 10-d
R1914	41	51	43	53	42	52	51	10-e, 10-b, 10-c, 10-d
R1654	35	45	40	50	39	49	45	10-f

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Appendix G. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendix F and Appendix G.

The results of the attended monitoring for Section 10 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-192 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise however some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-192 Section 10 – NCA noise management levels

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 10-a	53	44
NCA 10-b	43	41
NCA 10-c	43	41
NCA 10-d	43	41
NCA 10-e	43	41
NCA 10-f	45	43

6.10.1. Section 10 construction noise assessment

Section 10 soft soil treatments

There are no soft soil treatments proposed within Section 10 (Richmond River to Coolgardie Road) of the project.

Section 10 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-193**,** Table 6-194 and Table 6-195. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-193 Section 10 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
10-a	7	53	81	4	1	R1817
10-b	19	43	74	17	0	-
10-c	11	43	72	6	0	-
10-d	16	43	68	7	0	-
10-e	24	43	80	20	1	R1815
10-f	21	45	86	16	1	R1900

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-194 Section 10 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
10-a	7	53	86	7	2	R1817, R1885
10-b	19	43	79	20	1	R1984
10-c	11	43	77	6	1	R1895
10-d	16	43	73	7	0	-
10-e	24	43	85	23	1	R1815
10-f	21	45	91	20	1	R1900

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-195 Section 10 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
10-a	7	53	84	5	2	R1817, R1885
10-b	19	43	77	20	1	R1984
10-c	11	43	75	6	0	-
10-d	16	43	71	4	0	-
10-e	24	43	83	22	1	R1815
10-f	21	45	89	20	1	R1900

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, a number of exceedances of NMLs have been predicted within Section 10 (Richmond River to Coolgardie Road); with up to six receivers predicted to be exposed to levels above the highly noise affected criteria of 75dB(A) during earthworks and asphalting. The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels will be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures will be required; these will be detailed further in Appendix I.

The ICNG states that where a receiver is exposed to noise levels of 75dB (A) or greater, as a result of construction activities, the receiver is to be classed as ‘highly noise affected’ and must be afforded additional consideration. Receivers R1817, R1885, R1984, R1895, R1815 and R1900 would potentially experience levels in excess of 75dB (A) as a result of noise emitted from the activity of earthworks. Paving and asphalting, along with site clearing also show exceedances of the ‘highly noise affected’ criteria at receivers. The higher levels are primarily as a result of the short separation distance assumed been the receiver and the proposed works; 55 metres at the shortest distance.

‘Highly noise affected’, additional measures are likely to include consultation with residents, substitution of noisy plant, provision of temporary barriers, potential reduced hours of work and the provision of respite periods. Such measures will be discussed in more detail in Section 6.10.46.1.1 and Appendix I.

Section 10 ancillary facilities and compounds

Within Section 10 (Richmond River to Coolgardie Road) the ancillary facilities presented in Table 6-196 have been identified and quantitatively assessed. This includes five stockpile sites and six multi-use sites (including concrete batch plants, workshops and site offices). The location of these sites, use and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore it is recommended that following the finalisation of ancillary locations and internal layouts, a more detailed assessment should be undertaken. This would be undertaken prior to the commencement of works.

Table 6-196 Section 10 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1a	STN145.3 to STN145.6	Bridge compound. Bbatch plant area. Bridge materials storage area. Materials storage.

Site no.	Location (Station)	Proposed use
Site 1b	STN146.2 to STN146.5	Bridge compound. Bridge materials storage area. Materials storage.
Site 2	STN147.8 to STN148.2	Stockpile area.
Site 3a	STN152.1 to STN152.5	Earthworks borrow area. Batch plant area. Plant workshop. Materials storage.
Site 3b	STN152.5 to STN152.7	Main site office and compound area. Materials storage
Site 4	STN156.0 to STN156.5	Stockpile site.
Site 5	STN157.3 to STN157.5	Main site office and compound area. Batch palnt area. Plant workshop.
Site 6	STN158.2 to STN158.6	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Stockpile site 1a	STN145.3 to STN145.6	Stockpile
Stockpile site 3a	STN152.1 to STN152.5	Stockpile
Stockpile site 6	STN158.2 to STN158.6	Stockpile

A summary of the results from the modelling of Section 10 ancillary facilities is presented in Table 6-197. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-197 Section 10 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
10-a	7	53	59	4	0	-
10-b	19	43	60	20	0	-
10-c	11	43	57	4	0	-
10-d	16	43	62	5	0	-
10-e	24	43	56	3	0	-
10-f	21	45	60	14	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Noise associated with the operation of ancillary facilities within Section 10 (Richmond River to Coolgardie Road), including concrete batch plants, stockpile sites, office compounds and works shops is predicted to exceed the NML at just over half of the receivers. However, no exceedances of the ‘highly noise affected’ criteria are predicted.

There is the potential that some ancillary facilities will operate 24 hours a day to provide service to construction works along the upgrade. The operation of Section 10 ancillary facilities out of hours is assessed below.

Section 10 bridge works

Within Section 10 (Richmond River to Coolgardie Road), five main bridges have been identified, comprising of four over bridges (OB) and one road bridge. This includes the 790 metre long bridge which will span the Richmond River. The location and description of each bridge within Section 10 is presented in Table 6-198 and shown graphically in Appendix C. In addition to these, a number of other smaller bridges have been identified in Section 10. The scale and nature of the smaller bridges is such that the noise and vibration associated with their construction is likely to be minimal and therefore these have not been independently assessed. The noise associated with their construction will be similar or lower to the noise predicted for Section 10 linear works.

Table 6-198 Section 10 bridge locations

Bridge reference	Location (Station)	Details	Bridge length / metres	Distance and direction to nearest receiver (metres)
Bridge crossing of the Richmond River	STN.143.4 – STN146.2	Multi-span concrete viaduct over the Richmond River	800 m	160 east
Old Bagotville Road over bridge	STN149.9	Access over bridge	-	360 south
Wardell Road over bridge	STN152.9	Access over bridge	-	70 west
North Wardell fauna over bridge	STN156.0	Access over bridge	-	340 north
Coolgardie Road over bridge	STN157.5	Access over bridge	-	250 east

The construction method used to construct the main road bridge within Section 10, the major bridge crossing of the Richmond River has been confirmed at this stage as precast concrete driven piles with precast road platform sections being lifted into place to form the base of the concrete pour. Where the concrete pour for the road base is required to be undertaken in a single 24 hour period, there is the potential for work to be undertaken outside proposed construction hours.

At each of the other Section 10 bridges (road and over bridges); driven piles are assumed to be used along with other plant identified in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, in the absence of a more detailed construction method, would ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with Section 10 bridge works is presented in Table 6-199. This highlights the number of receivers potentially exceeding NMLs as a result of simultaneous construction of Section 10 bridges. The noise prediction at each individual receiver is presented in Appendix E.

Table 6-199 Section 10 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
10-a	7	53	51	0	0	-
10-b	19	43	57	18	0	Coolgardie Road over bridge
10-c	11	43	49	2	0	Richmond River bridge, North Wardell fauna over bridge
10-d	16	43	72	6	0	Old Bagotville Road over bridge, Wardell Road over bridge, North Wardell fauna over bridge, Coolgardie Road over bridge
10-e	24	43	63	8	0	Richmond River bridge, Coolgardie Road over bridge
10-f	21	45	58	12	0	Richmond River bridge, Coolgardie Road over bridge

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As shown in Table 6-199, a number of receivers will experience noise levels above the NML as a result of bridge works in Section 10 (Richmond River to Coolgardie Road). However, the 'highly noise affected' criteria is not predicted to be exceeded at any of receivers. The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E. The primary cause for the exceedances of the NML is a result of the works at Richmond River bridge and Coolgardie Road over bridge.

The exceedances of the NML during general daytime works of the bridges in Section 10 are primarily as a result of the noise associated with the piling works assumed to occur at each of the bridge sites. Piling noise emissions occur at such a height where standard mitigation measures such as barriers are unsuitable and therefore management measures are likely to be the only option. This would potentially include respite periods and restricting piling activities to the least intrusive times of day, i.e. middle of daytime periods.

It should be noted that the bridge noise predictions assume a piling rig will be operational at each bridge site, in reality this may not occur as piling may not be required or will be restricted in its operation (i.e. daytime only). The predictions assume an impact piling rig is to be used whereas in practice quieter piling techniques such as augered or hydraulic piling may be suitable. Where alternative piling techniques are undertaken or no pile driving is required, noise levels emitted from each bridge works site may reduce by up to 4dB (A) during the highest predicted 15 minute periods. This would halve the number of receivers exceeding the NML during operations within proposed hours. Potential mitigation and management measures for general piling and bridge construction works are discussed further in Section **6.10.4**6.10.4 and Appendix I.

Due to the closes proximity of the bridge crossing of Richmond River to receivers, it is not envisaged that standard works on the bridge would be proposed for out of hours works. However, there may be occasions when short term out of hours works would be required for activities such as concrete pours and the delivery of oversized plant/materials. As the details surrounding these potential out of hours works are not yet known, only a general out of hours assessment has been undertaken. This is presented later in this section.

Section 10 haulage routes

Within Section 10 (Richmond River to Coolgardie Road), haulage routes would in the main follow the project formation, although some traffic will utilise the existing Pacific Highway and other local roads. At this stage no new access roads have been identified as being required. Therefore the movement of trucks and plant to and from the proposed upgrade and ancillary facilities along the existing road network and along the project have not been quantitatively assessed. The noise associated with these movements is likely to be small relative to existing traffic flows and therefore resultant noise will blend in with existing emissions, with no net increase in noise. See Part A, Section 3.2.6 for more details on construction traffic.

Section 10 out of hours works assessment

It is anticipated a number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the proposed upgrade that will be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and will have a similar impact.   It is also envisaged that the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation.

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (.i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-200 to Table 6-204. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-200 Section 10 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
10-a	7	44	81	7	7	1
10-b	19	41	74	20	20	0
10-c	11	41	72	6	6	0
10-d	16	41	68	7	7	0
10-e	24	41	80	23	22	1
10-f	21	41	86	20	16	1

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-201 Section 10 out of hours noise summary – earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
10-a	7	44	86	7	2	1
10-b	19	41	79	20	1	20
10-c	11	41	77	6	1	6
10-d	16	41	73	7	0	1
10-e	24	41	85	24	1	23
10-f	21	41	91	20	1	20

Table 6-202 Section 10 out of hours noise summary –asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
10-a	7	44	84	7	7	2
10-b	19	41	77	20	20	1
10-c	11	41	75	6	6	0
10-d	16	41	71	7	7	0
10-e	24	41	83	23	24	1
10-f	21	41	89	20	20	1

Table 6-203 Section 10 out of hours noise summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
10-a	7	44	51	6	7	2
10-b	19	41	57	20	20	1
10-c	11	41	49	4	6	1
10-d	16	41	72	6	7	0
10-e	24	41	63	17	23	1
10-f	21	41	58	17	20	1

Table 6-204 Section 10 out of hours noise summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
10-a	7	44	6	7	5	0
10-b	19	41	20	20	20	0
10-c	11	41	4	4	2	0
10-d	16	41	6	6	6	0
10-e	24	41	3	17	9	0
10-f	21	41	14	15	12	0

Table 6-200 to Table 6-204 identify the number of receiver which are predicted to exceed the night –time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works will be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 14 per cent and 30 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only 14 receivers. As a result of ancillary site operations, construction noise is predicted to be inaudible at 29 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities during out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works.

The figures show three aspects of out of hours works;

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- Identification of sections along the project where out of hours works would be suitable without the need for residential dwelling consultation (i.e. potential 24 hour construction works)
- Identification of areas along the proposed upgrade where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and ‘highly noise affected criteria’), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 10 (Richmond River to Coolgardie Road), around 2.2 kilometres of the project would be suitable for out of hours paving works, without causing any impacts on the surrounding community, and therefore could potentially be undertaken 24 hours without further consultation (this is presented by un-shaded areas along the proposed upgrade centre line). Where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions, for paving and asphalting works, and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the alignment.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potentially including negotiated agreements with the community, consultation with Environment Protection Authority and justification as to why these works are necessary outside proposed construction hours. It is likely that these areas of works and the process for undertaking the outside proposed hours assessment will be developed within a project specific Construction Noise Management Plan (CNVMP). This will be discussed further in Appendix I.

Section 10 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes that there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it would be assumed that maximum noise events could occur at receivers more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 10. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 10.

A summary of the number of receivers within Section 10 that would potentially experience external maximum noise events above 65 dB (A) are presented in Table 6-205.

Table 6-205 Section 10 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
10-a	7	4
10-b	19	10
10-c	11	4
10-d	16	6
10-e	24	8
10-f	21	8

Table 6-205 shows that a number of receivers within Section 10 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 10 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

In terms of Section 9 (Broadwater National Park to Richmond River) and 10 (Richmond River to Coolgardie Road) simultaneous working, both sections are scheduled to commence in 2014, therefore there is a potential for cumulative impact. There is an ancillary site in Section 10 which is approximately 500-600 metres from the closest receivers within Section 9. The noise associated with this may contribute to linear construction noise at Section 9 receivers but this would be in the region of 1dB(A) addition, at most, and would not change the number of receivers identified as being 'highly noise affected'.

Within Section 11 (Coolgardie Road to Ballina bypass) of the project, to the north of Section 10, the closest non-linear construction works, an ancillary site, is located over 500 metres away from the closest Section 10 receivers. The noise contribution of this ancillary site on Section 10 receivers would be negligible in comparison with the contribution from Section 10 linear works. Therefore the cumulative impact of Section 11 works on Section 10 receivers is minimal.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.10.2. Section 10 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.10.3.

Piling induced vibration at bridge sites presented in Table 6-198 has been assessed, with a summary of impacts being provided in Table 6-206. This may be an over estimation of vibration however would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-206 is based on the matrix set out in Part A, Section 3.2.2. In summary the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-206 Section 10 bridge construction vibration summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Bridge crossing of the Richmond River	0	0	0	0	0	0
Old Bagotville Road over bridge	0	0	0	0	0	0
Wardell Road	0	0	0	0	0	0
North Wardell fauna over bridge	0	0	0	0	0	0

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Coolgardie Road	0	0	0	0	0	0
Bridge crossing of the Richmond River	0	0	0	0	0	0

Table 6-206 identifies that there are no dwellings within 50 metres of any of the Section 10 bridges. This confirms that the risk to structures and occupants is low and in practice vibration as a result of piling will not be perceived by any of the identified receivers. The closest receiver/structure to any of the Section 10 bridges is R1866 which is approximately 70 metres from the proposed piling locations at bridge Old Bagotville Road over bridge. This is at such a distance that the risk of damage is minimal and therefore in Section 10, no additional assessment work is considered to be required for piling work at any of the bridges.

Table 6-19 presents the potential risk associated with rock hammering. As the locations of this activity are not know at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-207 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

6.10.3. Section 10 construction blasting assessment

Within Section 10 (Richmond River to Coolgardie Road), a number of cut and fill sites have been identified, however only a selection of these will potentially require blasting. These potential blast sites are identified in Table 6-208 along with potential materials requiring processing. This data has been provided by RMS.

Table 6-208 Potential blast sites – Section 10

Cut location:	Blasting (bank)	Processing (loose)
Section 10		
STN146.1 to STN146.3 (north of Richmond River)	5,000m^3	5,000m^3
STN147.3 to STN148.0 (proposed rest areas south of Old Bagotville Road)	45,000m^3	125,000m^3
STN148.3 to STN148.5 (south of Old Bagotville Road)	5,000m^3	5,000m^3
STN152.2 to STN152.5 (borrow area west of Wardell at old quarry site)	Nil	10,000m^3
Estimated total quantities: Section 10	55,000m^3	145,000m^3

Although locations for possible blasting have been identified, further details as to the required charges in terms of quantity and size have not, and are unlikely to be defined until works commence. For this reason, an indication of the risk associated with blasting at these sites on surrounding receivers can only be provided. Using the generic predictions for blasting induced overpressure and vibration presented in Part A, Section 3.3.3; the numbers of properties which may be impacted upon by the proposed blasting locations have been identified.

Where a blast location is predicted to have an impact on a receiver, a detailed blasting assessment would be undertaken prior to the commencement of works so that specific site geology can be taken into account.

Table 6-209 and Table 6-210 present the prediction of vibration and overpressure, as a result of different charges, at the closest receivers to each cut/blast site. Where an exceedance in the criteria is observed, these are highlighted in red. Receivers are separated into commercial and residential as the criteria set for each is different, with the overpressure and vibration limit being set marginally higher for non-habitable receivers. Criteria are presented in Section 2.4.3 of Part A of this report, with these being applied to the closest receivers at each cut/blast site. The overpressure predictions are based on neutral meteorological conditions. Where conditions are conducive to noise propagation predictions have the potential to increase by up to 20 dB (A). Exceedances of the criteria are highlighted in red.

Table 6-209 Closest sensitive receiver overpressure prediction

Cut/blasting site	Receiver	Receiver type	Separation distance / metres / kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN146.1 to STN146.3 (north of Richmond River)	R1819	Residential	200 metres	113	120	123	125	126	127
	R1835	Comm.	3 kilometres	79	86	89	91	92	93

Cut/blasting site	Receiver	Receiver type	Separation distance / metres / kilometres	Overpressure according to charge / dB					
				1	5	10	15	20	25
STN147.3 to STN148.0 (proposed rest areas south of Old Bagotville Road)	R1833	Residential	550 metres	101	107	110	112	113	114
	R1835	Comm.	450 metres	103	110	113	114	116	117
STN148.3 to STN148.5 (south of Old Bagotville Road)	R1833	Residential	550 metres	101	107	110	112	113	114
	R1835	Comm.	110 metres	121	128	130	132	133	134
STN152.2 to STN152.5 (borrow area west of Wardell at old quarry site)	R1853	Residential	90 metres	123	130	133	135	136	137
	R1835	Comm.	> 3 kilometres	79	86	89	91	92	93

Table 6-210 Closest sensitive receiver vibration prediction

Cut/blasting site	Receiver	Receiver type	separation distance / metres / kilometres	Vibration according to charge (Peak Particle Velocity- PPV) / dB					
				1	5	10	15	20	25
STN146.1 to STN146.3 (north of Richmond River)	R1819	Residential	200 m	0.2	0.9	1.5	2.1	2.6	3.1
	R1835	Commercial	> 3 kilometres	0	0	0	0	0	0
STN147.350 to STN148.050 (proposed rest areas south of Old Bagotville Road)	R1833	Residential	550 metres	0.1	0.2	0.3	0.4	0.5	0.6
	R1835	Commercial	450 metres	0.1	0.2	0.4	0.6	0.7	0.9
STN148.3 to STN148.5 (south of Old Bagotville Road)	R1833	Residential	550 metres	0	2.2	0.3	0.4	0.5	0.6
	R1835	Commercial.	110 metres	0.6	3.1	3.9	5.4	6.8	8.1

Cut/blasting site	Receiver	Receiver type	separation distance / metres / kilometres	Vibration according to charge (Peak Particle Velocity- PPV) / dB					
				1	5	10	15	20	25
STN152.2 to STN152.5 (borrow area west of Wardell at old quarry site)	R1853	Residential	90 metres	0.9	3.1	5.4	7.4	9.4	11.2
	R1835	Commercial.	> 3 kilometres	0	0	0	0	0	0

Table 6-209 shows that the overressure criteria will potentially be exceeded at some of the closest receivers during blasting at three of the Section 10 cut sites. The level of exceedance is dependent on the blast charge used. However this does not necessarily mean that blasting cannot be undertaken at these locations, but further assessment should be undertaken prior to blasting along with consultation with the closest affected receivers.

Table 6-210 ishows that in terms of vibration, blast charges greater than 5 kilograms are likely to exceed structural damage criteria at the closest residential receivers. The closest receiver (R1853) is within 90 metres of the proposed blast site at STN152.2; however this receiver is also located within an area proposed as a stockpile site. Although this receiver may be temporarily leased by RMS throughout the duration of the project to avoid noise exceedances, this would have no effect on the exceedance of structural damage criteria as a result of blasting. Prior to the start of blasting at STN152.2, or where higher charges than 25 kilograms are used at other cuts, a detailed blasting assessment would be undertaken. This should also include a buildings condition survey prior to and following blasting at the closest sensitive receivers.

6.10.4. Section 10 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 10 construction works is provided in Table 6-211. In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3 and Section 3.3.4 and Appendix I.

Table 6-211 Section 10 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	R1817, R1815, R1900	70	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation.
Earthworks	R1817, R1815, R1900, R1895, R1894, R1885	83	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation.

Activity	Receivers ‘highly noise affected’ or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers ‘highly noise affected’ or those exceeding vibration/blasting limit
Paving and asphalting	R1817, R1815, R1900, R1894, R1885	80	Community consultation, temporary barriers, respite periods, alternate quieter construction methods, occupant temporary relocation.
Bridge Works - noise	-	46	See Appendix I
Ancillary facilities	-	50	See Appendix I
Blasting	R1853, R1819,R1835	-	Prior to the blasting at STN146.1 – STN146.3, STN148.3 to STN148.5 and STN152.2 to STN152.5 , a detailed blast assessment should be undertaken to take account of site specific geology, exact blast locations and proposed charges. This would determine the suitability of the site for blasting and quantify the impact on the closest receivers

6.11. Section 11 (Coolgardie Road to Ballina bypass)

Section 11 is six kilometres long, extending from Coolgardie Road to the Ballina bypass at the northern abutment of the Duck Creek Bridge. The extent of this project section is shown in Part A, Figure 1-11.

The construction works proposed for Section 11 includes all activities identified within Table 3-6 in Section 3.3.1 of the Part A construction overview; with the exception blasting. An assessment has been undertaken to determine the impact at each receiver, from each construction activity. A summary of impacts is summarised below:

- As a result of soft soil treatments, no receivers within Section 11 are likely to experience noise levels above the NML
- As a result of site clearing, earthworks and paving, over 80 per cent of the receivers within Section 11 are likely to experience noise levels above the NML. However, no receivers are predicted to exceed the 'highly noise affected' criteria
- Predicted noise from the operation of ancillary facilities are above the NMLs at 14 out of the 25 receivers within Section 11
- Section 11 does not contain any newly constructed access roads/haul roads and therefore the impacts from construction traffic movements is predicted to be minimal
- The construction of the main Section 11 bridge crossing of Whytes Lane would result in no exceedances of the NML
- In terms of piling, no receivers have been identified within a distance of 50 metres from any proposed piling site (bridge sites) and therefore the risk from vibration in terms of structural damage or human comfort is minimal.
- In terms of rock hammering/breaking, where habitable receivers are within 430 metres of the work site, further investigation should be undertaken to confirm the impact on human occupants and on structures
- Where additional piling sites are identified within 50 metres of Section 11 receivers, further assessment should be undertaken prior to the commencement of works.

The exceedance of NMLs is primarily a result of the short separation distance between the project and receivers within Section 11. Although NMLs are predicted to be exceeded as part of these specific works, the linearity of these works means the duration at which receivers would experience these levels would be short as the works progress along the project. The NMLs for noise catchment area (NCA) have been derived from up to three monitoring locations (dependent on number of monitoring locations in each NCA) and therefore the NMLs may be lower in practice due to a non-uniform noise environment around some receivers.

6.11.1. Section 11 background noise monitoring and Noise management levels (NML)

There are around 25 receivers within 600 metres of the project. Of the receivers, three are within the boundary of the project and therefore would be acquired. For this reason these three receivers have been identified but have not been assessed. In addition to the 25 receivers, 13 commercial/non-residential receivers have been identified.

A list of receivers identified for the construction noise and vibration assessment is displayed graphically in Appendix B and in tabulated form in Appendix E.

Unattended monitoring has been undertaken at three receivers within Section 11 (Coolgardie Road to Ballina bypass). The locations of these are presented in Table 6-212 alongside measured 'rating background level' (RBL) and derived construction NML, as described in Part A, Section 2.3.1. The proposed hours NML is shown as the lowest NML from any of the monitored assessment periods. Table 6-212 also identifies which NCA is represented by the measurement data as not all NCAs necessarily have a monitoring point. Although the proposed hours also apply to Saturday afternoon periods, the RBL and subsequent NML for Saturday afternoon periods are similar in magnitude to those measured during weekday, daytime periods. For this reason, unlike the weekday shoulder periods, the RBL for the extended hours on a Saturday has not been looked at separately (See Part A, Section 3.2.2 for further details on shoulder periods).

Table 6-212 Section 11 – unattended noise monitoring summary

Receiver identification	Standard construction Hours (7am - 6pm)		Morning shoulder period (6-7am)		Evening shoulder period (6-7pm)		Proposed hours NML, dB(A)	Represented noise catchment area (NCA)
	RBL, dB(A)	NML, dB(A)	RBL, dB(A)	NML dB(A)	RBL, dB(A)	NML, dB(A)		
R2068	-	-	-	-	-	-	-	11-d, 11-c
R2072	39	49	50	60	45	55	49	11-f, 11-a, 11-b, 11-d, 11-e
R2087	38	48	48	58	45	55	48	11-f, 11-a, 11-b, 11-d, 11-e

**lowest NML from shoulder periods and standard hours*

Attended monitoring has also been undertaken in addition to the unattended monitoring shown in Table 6-212. Attended monitoring locations were chosen following analysis of the unattended monitoring, or within an NCA where unattended monitoring has not been undertaken. The attended monitoring data provides additional confidence in the NMLs assigned to each NCA. A detailed presentation of the unattended monitoring data is provided in Appendices F and G.

The results of the attended monitoring for Section 11 are provided in Appendix G.

The adopted noise management level (NML) for each NCA is summarised in Table 6-213 alongside the night-time NML. Where two or more unattended monitoring locations are located within a particular NCA, the lowest NML (from either the shoulder or daytime periods) would be adopted for the noise NCA to provide a worst case assessment. The NMLs are primarily based on the results of the unattended monitoring exercise; however, some have been adjusted following the attended monitoring exercise.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-213 Section 11 – NCA noise management levels (NML)

NCA	Project NML, dB(A)	Night-time/out of hours project NML, dB(A)
NCA 11-a	48	36
NCA 11-b	48	36
NCA 11-c	48	36
NCA 11-d	48	36
NCA 11-e	48	36
NCA 11-f	48	36

6.11.2. Section 11 construction noise assessment

Section 11 soft soil treatments

Within Section 11 (Coolgardie Road to Ballina bypass), one site has been identified as requiring soft soil treatments to allow for Section 11 bridge and embankment construction. The single site is presented in Table 6-214.

Table 6-214 Section 11 – Soft soil treatments sites

Construction ID	Approximate location	Works
SS-11	STN160.0 – STN164.0	Consolidation of soft soils below embankment, drainage layer

The construction plant modelled during the soft soil treatments includes all plant identified in Part A, Table 3-6. A summary of the noise levels predicted as a result of the Section 11 soft soil treatments are shown in Table 6-151. This table summarise the number of receivers which are exposed to varying levels of construction noise. A complete list of individual receivers and the levels predicted construction noise associated with soft soil treatments is provided in Appendix E.

Table 6-215 Section 11 proposed hours construction noise summary – soft soil treatments

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
11-a	8	48	43	0	0	-
11-b	3	48	<30	0	0	-

NCA	Total no. receivers	Assumed NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
11-c	5	48	<30	0	0	-
11-d	4	48	39	0	0	-
11-e	3	48	40	0	0	-
11-f	2	48	40	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of the Section 11 (Coolgardie Road to Ballina bypass) soft soil treatments, no receivers have been predicted to exceed the NML or the 'highly noise affected' criteria of 75dB (A). The impacts summarised above are representative of the worst case 15 minute period of the works. This includes all plant identified in Part A, Table 3-6 operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary and as the works are relatively linear in nature, the time at which each receiver is exposed to such levels would be short. As the work progresses along each of the three soft soil treatments segments, noise exposure at each receiver would reduce.

Section 11 linear construction works (site clearing, earthworks, paving and asphalting)

A summary of the noise levels predicted as a result of the main linear construction activities, including site clearing, earthworks and paving and asphalting are shown in Table 6-216, Table 6-217 and Table 6-218. These tables summarise the number of receivers which are exposed to varying levels of construction noise as a result of each phase of works. A complete list of individual receivers and the levels associated with each activity is provided in Appendix E.

Table 6-216 Section 11 proposed hours construction noise summary – formation, clearing and mulching

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
11-a	8	48	46	0	0	-
11-b	3	48	53	3	0	-
11-c	5	48	67	5	0	-
11-d	4	48	66	1	0	-
11-e	3	48	54	2	0	-
11-f	2	48	43	11	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-217 Section 11 proposed hours construction noise summary – earthworks

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
11-a	8	48	51	7	0	-
11-b	3	48	58	3	0	-
11-c	5	48	72	5	0	-
11-d	4	48	71	1	0	-
11-e	3	48	59	3	0	-
11-f	2	48	48	20	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-218 Section 11 proposed hours construction noise summary – paving and asphalting

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level typical works, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
11-a	8	48	49	2	0	-
11-b	3	48	56	3	0	-
11-c	5	48	70	5	0	-
11-d	4	48	67	1	0	-
11-e	3	48	57	3	0	-
11-f	2	48	46	14	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

As a result of each linear construction activity, the NML is predicted to be exceeded at a number of receivers within Section 11 (Coolgardie Road to Ballina bypass). However, no receivers are predicted to be exposed to levels above the highly noise affected criteria of 75dB (A). The impacts summarised in the above tables are representative of the worst case 15 minute period of each activity and daily noise levels are predicted to be lower than these. These predictions also include all plant identified for each activity operating simultaneously and at the shortest separation distance to each sensitive receiver. In reality, separation distances are likely to vary between plant and as the works are linear in nature, the time at which each receiver is exposed to such levels will be short. As the work progresses along the project, noise exposure at each receiver would reduce and eventually diminish to levels considerably below the NML.

Where receivers are predicted to be exposed to levels exceeding the adopted NML, some form of management or mitigation measures would be required; these are detailed further in Appendix I.

Section 11 ancillary facilities and compounds

Within Section 11 the ancillary facilities presented in Table 6-219 have been identified and quantitatively assessed. This includes three stockpile sites and two multi-use sites (including concrete batch plants, workshops and site offices). The location of these sites, use and relative distance from receivers is shown graphically in Appendix B.

The construction plant assumed to be operational for each ancillary site is presented in Part A, Table 3-6. The plant noise emissions have been added and converted to an area source, based on the area of the proposed ancillary site. These area sources have then been modelled in SoundPlan, with predictions being made for a worst case 15 minute L_{Aeq} period at each of the surrounding receivers. In the absence of specific areas of work for different plant items on each ancillary site, this is considered the most suitable and accurate method for assessing the noise associated with their operation. However this may prove to slightly under-predict levels at receivers located within a short separation distance to sites. Therefore, it is recommended that following the finalisation of ancillary facility locations and internal layouts, a more detailed assessment would be undertaken.

Table 6-219 Section 11 – identified ancillary facilities

Site no.	Location (Station)	Proposed use
Site 1a	STN159.4 to STN159.8	Main site office and compound area. Batch plant area. Plant workshop. Materials storage.
Site 2	STN163.6 to STN164.4	Satellite site compound. Batch plant area. Plant workshop. Materials storage.
Site 1a	STN159.4 to STN159.8	Stockpile site.
Site 1b	STN159.7 to STN156.0	Stockpile site.
Site 2	STN163.7 to STN164.4	Stockpile site.

A summary of the results from the modelling of Section 11 (Coolgardie Road to Ballina bypass) ancillary facilities is presented in Table 6-220. A more detailed output which quantifies resultant levels at each individual receiver is presented in Appendix E.

Table 6-220 Section 11 proposed hours construction noise summary – ancillary facilities

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Highly noise affected receivers
11-a	8	48	53	4	0	-
11-b	3	48	49	3	0	-
11-c	5	48	59	5	0	-
11-d	4	48	52	1	0	-
11-e	3	48	48	1	0	-
11-f	2	48	48	14	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

The noise associated with the operation of ancillary facilities within Section 11, including concrete batch plants, stockpile sites, office compounds and works shops is predicted to exceed the NML at the half of the receivers. However, none of the receivers are predicted to be exposed to ancillary site noise at levels above the 75dB (A) 'highly noise affected' criteria.

There is the potential that some ancillary facilities will operate 24 hours a day to provide service to construction works along the upgrade. The out of hours operation of Section 11 ancillary facilities would be assessed later in Section 6.11.3.

Section 11 bridge works

Within Section 11, one bridge has been identified, comprising of a single over bridge (Whytes Lane over bridge) at STN159.8. The location of the bridge is shown graphically in Appendix B.

The construction method used to construct the Whytes Lane over bridge, assumes driven piles would be used in some form. Other plant assumed for the bridge construction is presented in Part A, Table 3-6. This may potentially be an over estimation of noise emissions as some bridges would be constructed without the requirement to drive piles. However, this approach, and in the absence of a more detailed construction method, would ensure the highest potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified and therefore are unable to be assessed.

A summary of the noise impacts associated with the Section 11 bridge work is presented in Table 6-221. The noise prediction at each individual receiver as a result of Section 11 bridge works is presented in Appendix E.

Table 6-221 Section 11 proposed hours construction noise summary – bridge works

NCA	Total no. receivers	NML, dB(A)	Maximum predicted noise level in NCA / dB(A)	No. receivers exceeding NML	No. receivers highly noise affected*	Primary bridge noise source
11-a	8	48	37	0	0	-
11-b	3	48	28	0	0	-
11-c	5	48	35	0	0	-
11-d	4	48	29	0	0	-
11-e	3	48	47	0	0	-
11-f	2	48	46	0	0	-

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-221 shows that no receivers will experience noise levels above the NML as a result of Section 11 bridge works, and the highly noise affected criteria' is not predicted to be exceeded at any of receivers. This is a result of the relatively large separation distance between the bridge works and the closest receiver (>600 metres). The noise prediction at each individual receiver and identification of exceedance is presented in Appendix E.

Section 11 haulage routes

Within Section 11 (Coolgardie Road to Ballina bypass), haulage routes would in the main follow the project formation, although some traffic would use the existing Pacific Highway and other local roads. At this stage RMS have not anticipated that any new haul roads would be required in Section 11, and therefore no further assessment has been undertaken. Please refer to Section 3.2.6 in Part A for the assessment methodology to take account of the use of existing roads and the proposed upgrade.

Section 11 out of hours works assessment

It is anticipated that a number of activities may need to be undertaken outside of the proposed construction hours (known as '*out of hours'* – see Part A, Section 3.2.3) as a result of safety, engineering practicalities and timetable feasibility. At this stage the actual construction activities, timescales and areas of work have not been confirmed and therefore an assumption has been made as to the works being proposed for out of hour periods. The output of the out of hours assessment not only quantifies the predicted noise at receivers but more importantly provides an indication of areas along the project that would be suitable for out of hours construction works, without impacting upon receivers. The output can be used to effectively target community consultation exercises where out of hours works are sought. Targeted community consultation will enable the affected community to be specifically consulted rather than undertaking blanket consultation.

Due to the number of potential variables, it is not possible to provide an accurate indication of all associated impacts with all potential out of hours activities. For example the activities associated with utility adjustments and ad-hoc oversized deliveries contain too many variables and could potentially occur in various locations making the assessment open-ended; however such works are likely to be similar in nature to those above and would have a similar impact. It is also envisaged that the linear activities would take account of the majority of out of hours works and include activities such as road tie in works. Therefore only the following activities have been assessed for out of hours periods.

- Clearing and formation
- Earthworks
- Paving and asphalting
- Bridge works
- Ancillary site operation

In line with good practice, an assumption has been made that no blasting activity would be undertaken outside of the proposed construction hours. Therefore this activity has not been assessed as part of the out of hours assessment.

The noise associated with each of the assessed out of hours activities has been modelled consistently with the proposed construction hour methods (i.e. proposed hours construction plant is the same as out of hours construction plant). This results in the same receivers being identified as 'highly noise affected' for both proposed and out of hours works. The only change is the assessment of predictions against night-time NMLs rather than proposed hours NMLs. This method of assessment may over estimate the impacts associated with out of hours works, as duration of works and the equipment used may be reduced for out of hours works. However, in the absence of specific work schedules, plant lists and work areas this method will provide a worst case assessment

A summary of the impacts associated with each activity is presented in Table 6-12 to Table 6-16. The results are shown for each activity, at each receiver alongside NMLs in Appendix E.

NMLs for the assessment of out of hours works are based on the lowest out of hours level (i.e. night time rather than evening). The night time NMLs have been derived using the ICNG and the lowest measured RBL for a night time period. The night-time NML is equivalent to the RBL + 5 dB (A). Additional detail on the derivation of NMLs is presented in Part A Sections 3.2.4 and 3.2.6.

Table 6-222 Section 11 out of hours noise summary –soft soil treatments

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
11-a	8	36	43	4	4	0
11-b	3	36	<30	0	0	0
11-c	5	36	<30	0	0	0
11-d	4	36	39	2	2	0
11-e	3	36	40	2	2	0
11-f	2	36	40	2	2	0

Table 6-223 Section 11 out of hours noise summary – formation, clearing and mulching

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
11-a	8	36	46	8	8	0
11-b	3	36	53	3	3	0
11-c	5	36	67	5	5	0
11-d	4	36	66	1	1	0
11-e	3	36	54	3	3	0
11-f	2	36	43	2	2	0

**Highly noise affected is considered to be 75 dB (A) in accordance with the ICNG.*

Table 6-224 Section 11 out of hours noise summary –earthworks

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
11-a	8	36	51	8	8	0
11-b	3	36	58	3	3	0
11-c	5	36	72	5	5	0
11-d	4	36	71	1	1	0
11-e	3	36	59	3	3	0
11-f	2	36	48	2	2	0

Table 6-225 Section 11 out of hours noise summary –asphalting

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
11-a	8	36	49	8	8	0
11-b	3	36	56	3	3	0
11-c	5	36	70	5	5	0
11-d	4	36	69	1	1	0
11-e	3	36	57	2	3	0
11-f	2	36	46	2	2	0

Table 6-226 Section 11 out of hours noise summary – bridge works

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
11-a	8	36	37	0	1	0
11-b	3	36	28	0	0	0
11-c	5	36	35	0	0	0
11-d	4	36	29	0	0	0
11-e	3	36	47	1	1	0
11-f	2	36	46	2	2	0

Table 6-227 Section 11 out of hours noise summary – ancillary facilities

NCA	Total no. receivers	Out of hours NML, dB(A)	Maximum predicted noise level typical works / dB(A)	No. receivers exceeding RBL, dB(A)	No. receivers exceeding NML	No. receivers highly noise affected
11-a	8	36	53	8	8	0
11-b	3	36	49	3	3	0
11-c	5	36	59	5	5	0
11-d	4	36	52	1	1	0
11-e	3	36	48	2	2	0
11-f	2	36	48	2	2	0

Table 6-222 to Table 6-227 identify the number of receiver which are predicted to exceed the night – time NML and RBL as a result of different out of hours activities. At receivers where the night-time RBL is exceeded, this is an indication that the construction works would be audible inside the dwelling. This is based on theoretical inaudibility being equal to 10dB (A) below background noise (RBL) and an open window provides a minimum sound reduction of 10dB (A). The importance of the inaudibility assessment is it identifies where out of hours works can be undertaken without impact at receivers.

Using the above tables, depending on the construction activity, works are predicted to be inaudible and therefore suitable for out of hours works, at between 12 per cent and 60 per cent of receivers. As a result of linear works, construction noise is predicted to be inaudible at only three receivers. As a result of soft soil treatments, construction noise is predicted to be inaudible at just 15 receivers.

Following the assessment against RBLs, a graphical interpretation of out of hours works has been produced. Figures showing the impact of paving and asphalting activities out of hours is presented in Appendix B. This graphic is based on the methodology and matrix developed in Part A, Section 3.2.3. The activity of paving and asphalting has been used for display purposes as this emits noise between the highest and lowest linear construction activities and therefore gives a good indication of the overall impacts of out of hours construction works. In addition, given the scale of the project it would be impractical to present all assessed activities graphically.

The figures show three aspects of out of hours works:

- The areas within 600 metres of the project which would potentially see the greatest impacts of out of hours construction noise
- Identification of sections along the project where out of hours works would be suitable without the need for residential dwelling consultation
- Identification of areas along the project where consultation should be targeted prior to out of hours works being approved.

The assessment depicted in these figures is based on a comparison of modelled noise predictions at every receiver within 600 metres of the project and a range of assessment values (including RBLs, NMLs and 'highly noise affected criteria'), shown in Part A, Section 3.2.3.

The outputs of the assessment in Appendix B show that in Section 11 (Coolgardie Road to Ballina bypass), there are no areas of the project which would be suitable for out of hours paving works, without causing some level of impact on the community. However this does not restrict the potential for all out of hours works, but merely advises that further assessment and consultation would be required prior to the commencement of works in this area. For example where receivers are located in shaded areas, community consultation and detailed assessments can be targeted to determine suitability of out of hours works.

For linear activities which emit a total sound power equal to or less than for paving and asphalting (See Part A, Table 3-6), the graphic output presented in Appendix B can be used. For activities which emit higher amounts of noise than paving and asphalting, such as earthworks, the areas along the project which would be suitable for out of hours works would be fewer.

The out of hours assessment has been based on worst case assumptions and therefore with the reduction in scale of out of hours works, in terms of the plant used, further areas of work may be possible along the project.

Once the detailed method and activities for out of hours work are confirmed, and where they differ from those assessed within this report, a detailed noise impact assessment or an update to

Appendix B would be required to determine areas suitable for working. This detailed assessment would also detail proposed mitigation measures, potential negotiated agreements with the community, consultation with the Environment Protection Authority and substantial justification as to why these works have to be undertaken outside standard construction hours. It is likely that these areas of works and the process for undertaking the outside proposed hours assessment would be developed within a project specific Construction Noise Management Plan (CNVMP). This is discussed further in Appendix I.

Section 11 maximum construction noise assessment

In accordance with the ICNG, the maximum noise assessment for construction works is considered applicable where works would potentially be undertaken over two or more consecutive nights. This is to assess the potential for sleep disturbance as a result of maximum noise levels, not just average noise levels. Although the ICNG does not specifically provide criteria for assessing maximum noise events, it does refer to methods within the NSW Road Noise Policy (RNP - DECCW, 2011).

The RNP discusses the potential for disruption of normal sleep patterns due to irregular noise events, but concludes there is insufficient evidence to assist in setting trigger levels for this type of impact. The work to date on the subject specifies that:

- Maximum noise levels below 50-55 dB(A) are unlikely to cause an awakening from a sleep state
- One or two noise events per night with maximum noise levels of 65-70 dB(A) are not likely to affect the health and wellbeing significantly.

Maximum noise emissions from construction works usually result from unforeseen and sporadic incidents such as the dropping of an excavator bucket, rock dropping into metal containers or metal plant hitting hidden metal/rock ground conditions. These events and the magnitude of emission are heavily dependent on the types of activities undertaken, plant being used, materials being processed and a number of other variables.

The one off nature of maximum noise emissions means the accurate prediction of maximum noise emissions for a particular activity is relatively difficult. In addition to the magnitude of the maximum noise emission, the frequency and number of events over a particular night time period is also important when determining sleep disturbance. The accurate determination of the number of maximum noise events in a particular night time period, as a result of construction works is not practical. Therefore for worst case assessment it will be assumed that maximum noise events could occur at receivers more than two times in one night.

For the purpose of this project an estimation of maximum noise emissions from general construction activities have been predicted at each receiver within Section 11. These are presented in Appendix E.

Predictions are based on file data collected during construction activities throughout different projects. On average, for one off events such as bucket drops and truck filling, maximum noise levels are up to 8dB(A) higher than the $L_{Aeq,T}$ value. This has been the process used for estimating the maximum noise levels at receivers within Section 11.

A summary of the number of receivers within Section 11 that would potentially experience external maximum noise events above 65 dB (A) are presented in Table 6-228.

Table 6-228 Section 11 construction maximum noise summary

NCA	Total no. receivers	Number of receivers exposed to L_{Amax} above 65dB(A) in a night time period
11-a	8	0
11-b	3	1
11-c	5	5
11-d	4	1
11-e	3	1
11-f	2	0

Table 6-228 shows that a number of receivers within Section 11 have the potential to be exposed to maximum noise levels above the adopted criteria. However the actual number would be dependent on the variables outlined above and are unlikely to be calculated accurately prior to the finalising of construction methods and commencement of works. An additional detailed assessment would be undertaken following approval and prior to the commencement of construction works to provide further information on maximum noise impacts.

Section 11 cumulative noise assessment

For receivers which are located in close proximity to linear and non-linear construction activities, the maximum construction noise experienced at identified receivers may increase by between 0 and 3dB(A). For the majority of these receivers, the predicted noise levels from earthworks alone or bridge/ancillary works alone is already above the NML. Therefore, the number of receivers shown to be impacted by simultaneous working remains consistent with those identified for the main activities on their own. The cumulative impact of simultaneous construction activities does not move any additional receivers into the category of 'highly noise affected'.

The works within Section 10 (Richmond River to Coolgardie Road) and 11 (Coolgardie Road to Ballina bypass) are both scheduled to start within 2014 based on current staging assumptions and therefore the potential of cumulative impact on receivers on the Section10/11 boundary is increased. However, in Section 10, to the south of Section 11, the closest non-linear construction works, an ancillary site, is located over 500 metres away from the closest Section 11 receivers. The noise contribution of this ancillary site on Section 11 receivers would be negligible in comparison with the contribution from Section 11 linear works. Therefore the cumulative impact of Section 11 works on Section 10 receivers is minimal.

For all other project wide cumulative impacts, please refer to Part A, 3.2.5.

6.11.3. Section 11 construction vibration assessment

The main sources of vibration within this project would be impact piling, rock hammering and blasting. Blasting is addressed in Section 6.11.4.

The piling induced vibration at the single Section 11 bridge site has been assessed, with a summary of impacts being provided in Table 6-229. This may be an over estimation of vibration however would ensure all potential impacts are assessed. Although piling works may potentially occur throughout other areas of the project, at this stage these areas have not been identified.

In terms of rock hammering/breaking, locations are less easily identified and therefore a qualitative assessment has been undertaken. This identified at what separation distances, detrimental impacts are predicted. This can be used during construction to identify where a detailed vibration assessment would be required to confirm impacts and mitigation needs.

Table 6-229 is based on the matrix set out in Part A, Section 3.2.2. In summary the matrix outlines that where a receiver is located within 20 metres of a piling/bridge site, there is a medium to high risk of exceeding human comfort criteria. Where a receiver or structure is located within 10 metres of a piling/bridge site there is a high risk of causing some form of structural or cosmetic damage.

Table 6-229 Section 11 bridge construction vibration summary

Bridge reference	No. receivers within separation distance from bridge works					
	50-40 metres	40-30 metres	30-20 metres	20-10 metres	10-5 metres	<5 metres
Whytes Lane over bridge	0	0	0	0	0	0

Table 6-229 identifies that there are no dwellings within 50 metres of any of the Section 1 bridges. This confirms that the risk to structures and occupants is low and in practice vibration as a result of piling will not be perceived by any of the identified receivers. The closest receiver/structure to any of the Section 11 bridges is a *'non-specified'* structure approximately 100 metres to Whytes Lane over bridge. This is at such a distance that the risk of damage is minimal and therefore in Section 11, no additional assessment work is considered to be required for piling work at any of the bridges. This assumes the locations assumed for piling works are representative of those to be used in practice. Following confirmation of each individual pile location, a further detailed assessment may be required, but only where this is within 50 metres of the closest receiver.

Table 6-230 presents the potential risk associated with rock hammering. As the locations of this activity were not known at the time of this assessment, the table identifies at what distances an impact is likely to occur. Given this data, when detailed design of construction methods and locations is confirmed, this can be used to identify areas of work which will require a more detail vibration assessment, i.e. where rock hammering is undertaken within 30 metres of an occupied premises or 10 metres of a structure.

Table 6-230 Generic vibration impact associated with rock hammering/breaking

Activity	Separation distance from receiver / metres		
	Low risk	Medium risk	High risk
Structural damage	>20	10-20	<10
Human comfort	>40	30-40	<30

6.11.4. Section 11 construction blasting assessment

At this stage RMS have advised it is unlikely that blasting would be required in Section 11 (Coolgardie Road to Ballina bypass). Therefore the potential impact of blasting induced overpressure and ground borne vibration is not applicable. Should this change prior to construction, an additional blasting assessment would be required to predict and determine impact.

6.11.5. Section 11 specific mitigation (proposed hours)

As a result of the above assessment, a summary of specific measures recommended for Section 11 construction works is provided in Table 6-231. In addition to these measures, generic measures which should be implemented across the project for both noise and vibration are provided in Appendix I. The measures below look specifically at works undertaken during proposed hours, however many would also be applicable, amongst others, for out of hours works. For out of hours management measures and assessment procedures please refer to Part A, Section 3.2.3, Section 3.3.4 and Appendix I.

Table 6-231 Generic Section 11 specific mitigation

Activity	Receivers 'highly noise affected' or exceeding vibration/blasting limit	No. receivers exceeding NML	Possible measures for receivers 'highly noise affected' or those exceeding vibration/blasting limit
Clearing and formation	-	11	See Appendix I
Earthworks	-	20	See Appendix I
Paving and asphalting	-	14	See Appendix I
Ancillary facilities	-	14	See Appendix I

7. References

DECC (2006). *Assessing Vibration: A Technical Guideline.* Department of Environment and Climate Change (DECC),

DECC (2009). *Interim Construction Noise Guideline*. Department of Environment and Climate Change (DECC), now the Department of Environment, Climate Change and Water: Sydney.

DECCW (2011). *Road Noise Policy (RNP).* Office of Environment and Heritage (OEH), Sydney.

EPA (2000). *NSW Industrial Noise Policy (INP).* Environmental Protection Authority (EPA), now the Department of Environment, Climate Change and Water: Sydney.

RTA (2008a). *Woolgoolga to Wells Crossing Concept Design Report*, April 2008. Roads and Traffic Authority of NSW: Sydney.

RTA (2008b). *Iluka Road to Woodburn Preferred Concept Design Report*, July 2008. Roads and Traffic Authority of NSW: Sydney.

RTA (2008c). *Woodburn to Ballina upgrade Concept Design Report*, March 2008. Roads and Traffic Authority of NSW: Sydney.

RTA (2009). *Wells Crossing to Iluka Road Concept Design Report*, January 2009. Roads and Traffic Authority of NSW: Sydney.

RTA (2001). *Environmental Noise Management Manual.* Roads and Maritime Services of NSW: Sydney

German standard DIN 4150: Part 3 – 1999 *Effects of Vibration on Structures*

British Standard BS 6472: - 1992 Evaluation of Human Exposure to Vibration in Buildings