Warrell Creek to Urunga
Upgrading the Pacific Highway

ENVIRONMENTAL ASSESSMENT

VOLUME 1 ENVIRONMENTAL ASSESSMENT

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14. Noise and vibration

Noise and vibration is identified as a key issue in the Director-General's requirements. A detailed noise and vibration assessment for the Proposal was undertaken and is presented in this chapter. This assessment is supported by Working paper 3 – Noise and vibration.

Director-General's requirements	Where addressed in the EA	
Noise and vibration – including but not limited to:		
▪ construction noise and vibration including construction traffic noise and blasting impacts;	Section 14.3.4	Construction noise and vibration
	Section 14.3.4.5	Blasting
	Section 14.5	Construction assessment
	Section 14.5.1	Typical construction activities
	Section 14.5.3	Construction noise from mobile activities
	Section 14.5.4	Noise and vibration from batch plants, construction compounds and deliveries
	Section 14.5.5	Construction vibration
	Section 14.5.6	Blasting
▪ operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any secondary noise impacts from proposed noise mitigation measures; and	Section 14.4	Operational noise assessment
	Section 14.4.4	Meteorological impact assessment
	Section 14.4.5	Secondary noise impacts
▪ consideration of the following guidelines as relevant: *Environmental Criteria for Road Traffic Noise* (EPA 1999), *Environmental Noise Management Manual* (RTA 2001), *Environmental Noise Control Manual* (EPA 1994) and *Assessing Vibration: A Technical Guideline* (DEC, 2006).	Section 14.1	Assessment approach
	Section 14.3	Assessment criteria
	Section 14.4	Operational noise assessment
	Section 14.6	Identification of appropriate noise mitigation

14.1 Assessment approach

The assessment of noise and vibration has been undertaken in accordance with the following guidelines and standards:

- *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA 1999).
- *NSW Industrial Noise Policy* (EPA 2000).
- *RTA Environmental Noise Management Manual* (ENMM) (RTA 2001a).
- *Interim Construction Noise Guideline* (ICNG) (DECCW 2009).

- *Assessing Vibration: A Technical Guideline* (DEC 2006).
- *British Standard 7385: Part 2 ""Evaluation and measurement of vibration in buildings"*.
- *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (1990) Australian and New Zealand Environment and Conservation Council (ANZECC).
- *Australian Standard AS2187.2-2006: "Explosives – Storage, Transport and Use"*.

The descriptors used to assess road traffic noise and vibration are those defined by the above guidelines. Definitions of these descriptors can be seen in the above text box. Figure 14-1 provides a schematic of the approach to the noise and vibration assessment.

The noise assessment identified and assessed potential noise impacts for each individual dwelling in the study area, which enabled a more detailed presentation of potential noise impacts. While all the identified receivers within the study area were included in the initial modelling runs, only those receivers that were predicted to exceed the relevant noise criteria were identified for additional assessment of potential noise impacts. From the 2,863 residences in the study area, approximately 1,600 were predicted to require further noise assessment.

Noise descriptor definitions

L_{A10} – the noise level exceeded for 10 per cent of the measurement interval, this is commonly referred to as the average-maximum level;

L_{A90} – the noise level exceeded for 90 per cent of the measurement interval. This is commonly referred to as the background noise level.

L_{Aeq} – the noise level having the same energy as the time varying noise level over the 15 minute interval. For traffic noise this descriptor is classified as LAeq 15 Hr and LAeq 9 Hr for the day and night-time noise levels respectively. This is commonly referred to as the ambient noise level.

L_{Amax} – the maximum noise level measured at a given location over the measurement interval.

RBL – The Rating Background Level (RBL) is the overall single-figure background level, which is the 10th percentile of the LA90 values for each of the day, evening and night-time periods over the whole monitoring period.

14.2 Existing noise environment

Noise monitoring was conducted at eight key representative locations along the existing highway to provide background noise levels, to set appropriate criteria for the noise assessment, and to allow validation of the noise model used to determine existing traffic noise levels at receivers. The monitoring locations were selected to be representative of receivers that would experience a noise impact from the existing highway or from the Proposal. The noise monitoring locations are illustrated in Figure 14-2 and Figure 2-1 in Working paper 3 - *Noise and vibration*.

The noise levels in terms of long term ambient traffic noise are provided in Table 14-1. The time periods are as defined in the NSW ECRTN.

Figure 14-1 Assessment approach of noise and vibration

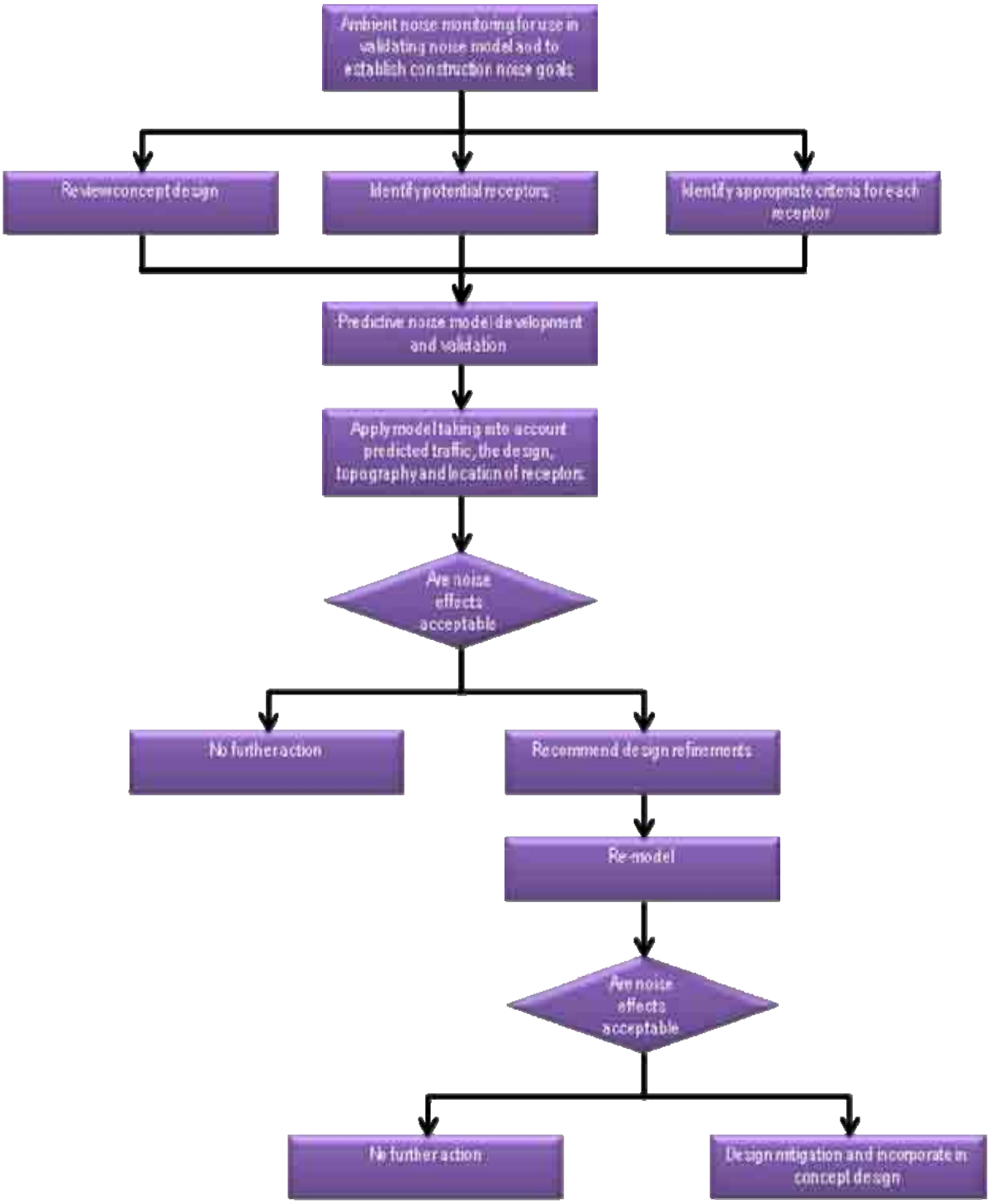


Table 14-1 Ambient noise monitoring results – traffic descriptors (dB(A))

Location	L_{Aeq} 15 hour	L_{Aeq} 9 hour	L_{Amax} Day	L_{Amax} Night
Location1	55	48	66	61
Location 2	59	51	68	62
Location 3	58	56	68	69
Location 4	53	53	65	65
Location 5	52	53	65	65
Location 6	55	57	68	70
Location 7	53	54	69	68
Location 8	46	46	59	54

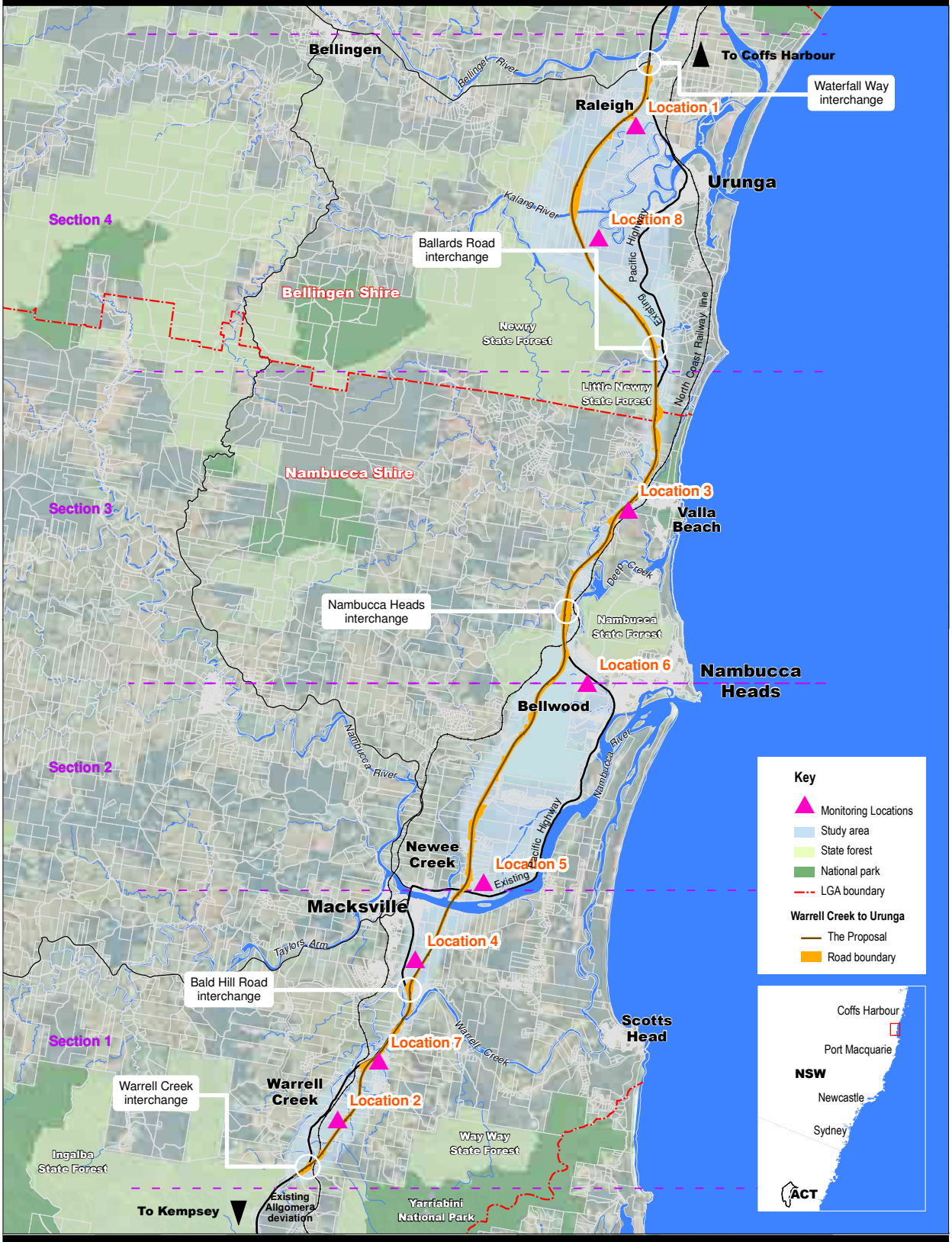
Observations during the site surveys at locations 2, 3, 4, 5, 6 and 7 confirmed that the monitored noise levels were dominated by road traffic noise on the Pacific Highway during the day time periods. It follows that these locations are also likely to have an ambient noise environment dominated by traffic noise during the night-time when other non-traffic noise sources are not present. At locations 1 and 8, the day time traffic noise was audible but did not provide a significant contribution to the noise environment. At these locations, traffic noise levels would tend to become more dominant during the evening and night-time as other non-traffic noise sources diminished in level.

Selected environmental noise parameters for each monitoring location are presented in Table 14-2. These are used for developing appropriate construction noise level criteria as discussed in Section 14.3.4. The maximum noise levels recorded at each site are noted as the L_{Amax} as well as the ambient L_{Aeq} noise level and the rating background level (RBL).

Table 14-2 Ambient noise monitoring results – environmental descriptors (dB(A))

Location	Day			Evening			Night		
	L_{Amax}	L_{Aeq}	RBL	L_{Amax}	L_{Aeq}	RBL	L_{Amax}	L_{Aeq}	RBL
Location 1	67	52	39	65	49	42	57	46	41
Location 2	69	58	42	65	52	41	61	51	40
Location 3	68	58	49	69	58	47	69	56	44
Location 4	64	53	48	65	54	45	65	53	40
Location 5	65	51	41	65	53	38	65	52	34
Location 6	68	53	43	67	56	39	71	56	32
Location 7	70	51	39	68	54	41	68	54	37
Location 8	61	44	37	55	44	41	54	44	40

FIGURE 14-2 | NOISE MONITORING LOCATIONS



14.3 Assessment criteria

14.3.1 Operational noise

Criteria for the assessment of road traffic noise are set out in the NSW Government's Environmental Criteria for Road Traffic Noise (EPA 1999) (ECRTN). The RTA has also published the Environmental Noise Management Manual (RTA 2001a) (ENMM) to assist in implementing the criteria.

Under the ECRTN, road projects are classified as either 'new road' or 'redevelopment of an existing road' (see Table 14-3). The ENMM Practice Note (i) assists in identifying which noise level criteria should apply for new roads and road upgrades. Further details regarding the application of the ENMM can be found in Section 3 of the Working paper 3 - *Noise and vibration*.

Table 14-3: Criteria for operational traffic noise for residents – ECRTN

Road category	Noise level criterion		Where criteria are already exceeded
	Day (7am-10pm)	Night (10pm-7am)	
New freeway or arterial road	55dbA (L_{Aeq}, 15 hr)	50dbA (L_{Aeq}, 9 hr)	The new road should be designed so as not to increase existing noise levels by more than 0.5dB.
Redevelopment of an existing freeway or arterial road	60dbA (L_{Aeq}, 15 hr)	55dbA (L_{Aeq}, 9 hr)	In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2dB. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies.

14.3.2 Nambucca Heads rest area

The character of noise from rest areas differs from general traffic noise and requires a different approach to assessment and management. Noise levels generated within the rest area have been assessed in accordance with the Industrial Noise Policy (EPA 2000) (INP). This policy requires that the L_{Aeq} noise level associated with the proposed operation (over a typical 15 minute period at any time) should not exceed the background L_{A90} noise level by more than 5 dB(A). Noise levels measured at Location 3 (see Table 14-2) are representative of the nearest sensitive receiver to the proposed rest area and are estimated to have a similar daily noise profile based on the distance from the road and the location in Section 3 of the Proposal. The background noise during the quietest period (night) at Location 3 is 49 dB(A). Based on the definition of a non intrusive noise impact, the noise goal for the operation of the rest area at the nearest receiver would be an $L_{Aeq\ 15\ min}$ of 54 dB(A).

14.3.3 Maximum noise level assessment – sleep disturbance

The ECRTN provides guidance in assessing the likelihood of sleep disturbance due to traffic noise impacts. The cause of sleep disturbance varies between studies. However, it is largely recognised that the maximum noise level of an event (i.e. vehicle pass-by), the number of occurrences, the duration of the event, and the noticeable

difference in noise between the maximum noise level and the background or ambient noise levels, are key factors. Not all people are affected to the same degree or by the same noise exposure and findings from studies of sleep disturbance measured by an awakening, change in sleep state or after-effects, and reflect the considerable variation in the population's response to noise. For assessment purposes, at locations where the traffic noise is continuous rather than intermittent, the RTA ENMM employs a methodology to assess these impacts based on the emergence of the L_{Amax} over the $L_{Aeq\ (1hr)}$ noise level. Any vehicle pass-bys where the L_{Amax} noise level is 15 dB(A) or more above the $L_{Aeq\ (1hr)}$ noise level is considered to be a maximum noise event.

14.3.4 Construction noise and vibration

The noise and / or vibration impacts which may be encountered by sensitive receivers during the construction stage of the Proposal include the operation of heavy plant and machinery during the road works; bridge works and piling during construction. These activities have the potential to generate both airborne noise impacts and vibration impacts during construction.

14.3.4.1 Construction noise guidelines

The DECCW (2009) has established an Interim Construction Noise Guideline (ICNG) that supersedes any previous guidance on management of construction noise impacts. This Proposal has been assessed in accordance with the ICNG and management of noise impacts has been recommended when guideline noise levels are expected to be exceeded.

This risk of adverse impact of construction noise within 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. In view of this, the DECCW has identified two forms of assessment based on the expected duration of the works. For new public infrastructure or major developments, a quantitative assessment is required. For shorter duration works such as maintenance and repair, a qualitative assessment may be satisfactory.

The ICNG recommends standard hours for construction work as summarised in Table 14-4. Although these hours may be varied where necessary to undertake work for safety or accessibility reasons, which may include:

- Delivery of oversized plant or structures;
- Emergency work; and
- Work where the proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Table 14-4 Recommended standard hours for construction work

Work type	Recommended standard hours of work
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

Recommended noise levels for airborne noise at sensitive receivers and advice on how they should be applied are provided in Table 14-5. The RBL described in the table is the overall single-figure background noise level measured in each relevant assessment period (during or outside the approved construction hours).

Table 14-5 Recommended noise management levels (DECCW 2009)

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 LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ■ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	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 feasible and reasonable work practices to meet the noise affected level. ■ Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. ■ For guidance on negotiating agreements see section 7.2.2, ICNG.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

-Noise levels may be higher at upper floors of the noise affected residence.

The ICNG states that the noise management level applies at any property boundary that is most exposed to the construction noise, at a height of 1.5 m above ground level. In cases where the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within

30 m of the residence. It is also noted that noise levels may be higher at upper floors of the noise affected residence and therefore should be considered where necessary in an impact assessment.

In addition to the management level provided in Table 14-5, management levels for noise at other sensitive land uses are presented in Table 14-6. These levels are applicable only when the property is being used. Levels indicated as internal are measured in the centre of the occupied room, whilst those marked as external are to be measured inside the affected property, within 50 m of the boundary.

Table 14-6 Construction noise goals – other sensitive land uses

Land use	Management level, LAeq (15 min) – when land is utilised
Class rooms at schools and other educational institutions	Internal noise level – 50 dB(A)
Hospital wards and operating theatres	Internal noise level – 40 dB(A)
Places of worship	Internal noise level –45 dB(A)
Active recreation areas (such as parks and sports grounds or playgrounds)	External noise level – 65 dB(A)
Passive recreation areas (such as outdoor grounds used for teaching, outdoor cafes or restaurants)	External noise level – 60 dB(A)

For the Proposal there are no non-residential sensitive land uses (listed in Table 14-6) currently identified that may be impacted by construction noise. These management levels should however be referred to during the detail design and construction phase to ensure any future changes of land use would be accounted for.

For other land uses such as commercial and industrial premises, there are three categories of noise management levels, measured externally at the most affected occupied point of the premises:

- Industrial premises: external $L_{Aeq(15min)}$ 75 dB(A).
- Offices, retail outlets: external $L_{Aeq(15min)}$ 70 dB(A).
- Other business that may be sensitive to noise: project specific.
  (Internal noise levels from AS2107 *Acoustics – Recommended design sound levels and reverberation times for building interiors* (Standards Australia 2000) may assist.)

The noise goals for residential, other sensitive land uses and industrial/commercial premises would be adopted as project specific criteria for the proposed upgrade.

14.3.4.2 Construction hours

Construction would normally be limited to the following hours:

- Between 6am and 6pm Monday to Friday.
- Between 7am and 4pm Saturday.

There would be no works outside these hours or on Sundays or public holidays except:

a) Works that do not cause construction noise to be audible at any sensitive receivers.

b) For the delivery of materials required outside these hours by the Police or other authorities for safety reasons.

c) Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

d) Any other work as agreed through negotiations between the RTA and potentially affected sensitive receivers. Any such agreement must be recorded in writing and a copy kept on site for the duration of the works.

e) Where the work is identified in the CNVMP and approved as part of the CEMP.

f) As agreed by the DECCW.

Local residents and the DECCW must be informed of the timing and duration of work approved under items (d) and (e) at least 48 hours before that work commences.

Construction hours would be addressed in the CNVMP for the Proposal. The CNVMP would be finalised in consultation with the Department of Planning and DECCW.

14.3.4.3 Project-specific construction noise criteria

Based on measured noise levels described in Section 14.2, the project-specific construction noise objectives for each representative monitoring location have been determined and are presented in Table 14-7. Considering the possibility that works would be undertaken outside standard construction hours additional management levels for these times are also included in the construction noise objectives.

Table 14-7 Project-specific construction noise objectives

Location	Setback from existing highway (m)	Standard hours 7am – 6pm M-F 8am – 1pm Sat		Extended hours 6am – 7am M-F 7am – 8am Sat		Extended hours 6pm – 7pm M-F 1pm – 4pm Sat	
		RBL dB(A)	Noise objective	RBL dB(A)	Noise objective	RBL dB(A)	Noise objective
1	620	39	49	42	47	41	46
2	400	42	52	41	46	40	45
3	80	49	59	47	52	44	49
4	250	48	58	45	50	40	45
5	380	41	51	38	43	34	39
6	200	43	53	39	44	32	37
7	160	39	49	41	46	37	42
8	1300	37	47	41	46	40	45

14.3.4.4 Vibration

Assessing Vibration: A Technical Guideline (DECC 2006) was used to assess potential vibration impacts associated with the Proposal. It considers impacts from vibration in terms of effects on building occupants (human comfort).

The Australian Standard AS2187.2-2006 *Explosives – Storage, Transport and Use* (Appendix J) 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*". The Australian Standard should be used as a guide to assess the likelihood of building damage from ground vibration including piling, compaction, construction equipment and road and rail traffic.

For the purpose of this report, vibration can be defined as follows (DECC 2006):

- Continuous – where vibration occurs uninterrupted for a defined period (usually throughout the day-time and/or night-time) and can include sources such as machinery and steady road traffic.
- Impulsive – where vibration occurs as a rapid build up of the vibration energy to a peak followed by a decay that may or may not involve several cycles of vibration (depending on the frequency of the system). It can also consist of a sudden application of several cycles at approximately the same amplitude, provided that the duration is short, typically less than 2 seconds. This may include activities such as occasional dropping of heavy equipment or loading / unloading activities.
- Intermittent – where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and passing heavy vehicles or trains.

The criteria for continuous and impulsive vibration, intermittent vibration impacts and structural damage criteria are provided in Table 14-5, Table 14-6 and Table 14-7 respectively.

Table 14-8 Continuous and impulsive vibration acceleration criteria (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					
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
		0.04	0.029	0.080	0.058
Workshops	Day or Night-time	0.04	0.029	0.080	0.058
Impulsive Vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous Vibration					
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

Table 14-9 Intermittent vibration impacts criteria (m/s^2) 1-80Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Table 14-10 Structural damage criteria

Group	Type of Structure	Peak Component Particle Velocity, 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

14.3.4.5 Blasting

Blasting activities produce ground-borne vibration and air blast overpressure, both of which can cause discomfort and, at higher vibration levels, potential damage to property.

The ANZECC Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration have been adopted by the DECCW and establish ground vibration and airblast over-pressure criteria for potentially effected locations.

The blast charge configuration should be selected to ensure that the DECCW goals are not exceeded. Before blasting can commence at a site, critical locations should be identified and appropriate measures taken to limit over

pressure and vibration to acceptable levels. Blasts should be monitored initially at these locations to ensure that predicted over-pressure and vibration levels are not exceeded.

The recommended goals for blasting during the Project are based on the ANZECC guidelines, Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration. These state that: "Blasting should generally only be permitted during the hours of 9:00am to 5:00pm Mondays to Saturday" and that "Blasting should not take place on Sundays or Public Holidays".

Table 14-11 shows the limiting blast over-pressure and ground vibration for the control of blasting impact on residential premises.

Table 14-11 Limiting criteria for the control of blasting impact at residences

Day	Time of Blasting	Blast Over Pressure Level, dB (linear)	Ground Vibration, Peak Particle Velocity, (mm/sec)
Monday to Saturday	9am-5pm	115	5
Sunday, Public Holiday	Anytime	0	0

In addition, any exceedance above an over pressure of 115dB (linear) should be limited to not more than 5% of the total number of blasts. On these infrequent occasions a maximum limit of 120dB (linear) should not be exceeded at any time. Ground vibrations above 5 mm/sec should also be limited to not more than 5% of the total number of blasts. On these infrequent occasions a maximum limit of 10 mm/sec should not be exceeded at any time.

14.4 Operational noise assessment

14.4.1 Modelling results

In consideration of the potential for traffic noise to impact residential dwellings, noise modelling was undertaken to predict the noise level for key milestones. The following scenarios were modelled in accordance with the ENMM:

- Existing conditions. Existing noise levels were calculated and used to test the integrity of the noise models by comparing the predicted levels with measured levels.
- Year 2013 "Future existing". In this scenario, noise levels were calculated for traffic on the existing road network immediately prior to the nominal date of opening for the Proposal.
- Year 2023. Noise levels were calculated for the Proposal 10 years after the anticipated opening date.

Assessment of the year 2023 traffic data provides the expected future noise levels so that mitigation measures designed for this scenario are still valid for at least 10 years after the opening of the Proposal. The initial predictions were made without the inclusion of any noise mitigation measures and were based on the parameters for the modelling inputs in Table 14-12 and the traffic data in Working paper 6 - *Traffic and transport*.

Table 14-12 Summary of modelling inputs

Input variable	Modelled Data
Traffic numbers and mix	Traffic numbers forecast for the years 2013 and 2023. See Section 6 of Working paper 6 - *Traffic and transport*.
Ground topography	Obtained from aerial photogrammetry, two metre increments
Gradient of roadway	Taken from a 3D model of the design alignment
Air and ground absorption	Ground absorption as per SoundPLAN implementation of the CoRTN Algorithm
Height of receivers	1.5 metres above ground terrain
The acoustic properties of the road pavement surfaces	Tyned asphaltic concrete assumed for the whole alignment
Traffic speed	110 km/h throughout the Proposal
Attenuation due to building structures	Building structures have not been included in the noise model due to the rural residential nature of the study area
Facade reflection	+2.5 dB (A)
LA_{10} to LA_{eq} conversion	Generally a reduction of 3 dB (A) from LA_{10} to LA_{eq} but can be site specific.

Of the 2,863 potential receivers modelled, 374 are predicted to experience an exceedance of the noise criterion for the Proposal in the absence of mitigation and management measures (specific details are provided in Tables 4-8 and 4–9 of Working paper 3 - *Noise and vibration*). These receivers, therefore, required further assessment for mitigation and management measures in accordance with ECRTN and ENMM guidelines.

The noise mitigation and management measures which have been included in the design of the Proposal to address these exceedances are described in Sections 14.6 and 14.7.1.

It is important to recognise that the Proposal would have a positive noise effect in some sections of the study area. The benefit to existing receivers would result primarily from the reduction in traffic currently using the existing highway. The reduction in traffic noise expected for the residents adjacent to the existing highway has been based on the change in the amount of traffic numbers. This reduction is estimated to be approximately 7 dB(A) for both the daytime and night-time periods. A reduction of this magnitude is considered to be significant and would, therefore, provide a noticeable change in noise levels at residential locations near the existing highway.

14.4.2 Nambucca Heads rest area

An assessment of the rest area was undertaken to determine the potential for the use to cause an adverse noise impact at a nearby receiver. Where the closest receiver is predicted to be lower than the most stringent of the operational noise criteria, the activities within the rest area would comply with the INP noise guidelines at all locations. Receiver number 801 from the assessment table of Working paper 3 - *Noise and vibration* is the closest residence located approximately 170 metres away from the rest area, on the eastern side of the existing highway. The noise monitoring has been used to identify a Rating Background Level (RBL) for this receiver. The RBL for the

most stringent of the assessment periods, being night-time, is 49 dB(A), which forms the basis of the intrusive noise goals.

The assessment of the rest area has been undertaken against the guideline noise levels from the INP intrusiveness noise goals, which requires that the $L_{Aeq\ 15\ min}$ noise emissions from the Proposal are no more than 5 dB(A) above the RBL. In accordance with the INP, the noise goal for the nearest sensitive receiver would be 54 dB(A) between 10pm and 7am each day, representing the quietest assessment period. The noise levels used to assess the potential for impacts have been identified based on typical activities and their duration and listed in Table 4-12 of Working paper 3 - *Noise and vibration*. The typical $L_{Aeq\ 15\ minute}$ noise level at the nearest receiver is estimated to be 49 dB(A) and, therefore, below the INP noise goals of 54 dB(A) for this location.

During the night-time, when background levels are low and noise emissions from the rest area may be the most noticeable, it is possible for maximum noise levels from the rest area to create sleep disturbance impacts. To assess this potential, the maximum noise level emissions from rest area activities have also been predicted at the nearest receiver. The maximum estimated noise level would likely be associated with the use of exhaust brakes and at the most affected location would be approximately L_{Amax} 57 dB(A). This level is estimated to be below the definition level of a L_{Amax} noise event and would generally result in noise levels inside a dwelling of less than 50 dB(A) for this location.

14.4.3 Maximum noise level assessment

The assessment of maximum noise impacts for the Proposal was undertaken by sampling night-time traffic noise at a representative site along the Pacific Highway (on the existing highway at Waterfall Way). The measurements made at the Waterfall Way interchange, north of Urunga, are expected to be representative of the Proposal having the same traffic profile, pavement surface, a dual lane carriageway in each direction, and flat terrain with no hills or bends.

The predictions of the noise model for maximum noise levels at all locations have been included in the analysis summarised in Section 4.10 of Working paper 3 - *Noise and vibration*. Predicted noise levels inside a dwelling with the windows open for ventilation have been assumed to be 10 dB(A) lower than the external noise level. Where windows are closed, a greater degree of attenuation would be expected. The ECRTN guidelines state that maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions. One or two noise events per night with maximum internal noise levels of 65-70 dB(A) are not likely to significantly affect health and well being. As such, where the predicted maximum levels modelled are greater than or equal to 65 dB(A) (the lower end of the guideline figure has been used) additional acoustic investigations for these properties would be considered during the detailed design phase.

14.4.4 Meteorological impact assessment

The Director General's requirements include consideration of local meteorological conditions (as relevant). It is important to note that when undertaking an assessment of traffic noise impacts, that the incorporation of meteorological data into the CoRTN modelling algorithm is not possible. Furthermore, the results of modelling (if

possible) cannot be compared to any valid criteria, as the assessment of adverse weather conditions are not supported the DECCW ECRTN.

To respond to the Director General's requirements, the assessment team endeavoured to establish the significance of temperature inversions and wind patterns for the study area, in order to quantify the potential for noise impacts from these effects. An investigation of local meteorology was undertaken, however, meteorological stations in the area could not provide the appropriate data for this form of assessment. Nearby weather stations were also reviewed, but either could not supply appropriate data or were not representative of the area being investigated.

Without the relevant historical meteorological data for an area, it is impossible to ascertain the frequency and strength of temperature inversions. In general, inversions may increase noise levels by between 3-5 dB(A) depending on conditions. Although an estimate of impacts may be made to account for potential increases in noise levels, these estimates have no valid basis and may ultimately be an under or over estimate of noise impacts from these weather conditions.

Temperature inversions (increase in temperature with height) arise from the cooling of the land surface which, in turn, cools the near surface air faster than the layers aloft. Temperature inversions can occur any time of the year, but usually at night when the sky is clear and winds are light. Since sound waves travel faster through warmer air, the sound "rays" from a ground based noise source can effectively be reflected back towards the ground thereby adding to the noise levels received directly from the source.

It is expected that where temperature inversions are experienced in an area it would affect residences at distances greater than approximately 100 metres from the road. Due to the nature of the weather conditions during an inversion, it is likely that residences would have windows and doors closed to assist in heat retention during the cooler months, and therefore the effects of the increase in noise levels from an inversion would be negated by the additional attenuation provided to the building by the closed windows and doors.

14.4.5 Secondary noise impacts

Noise mitigation measures including the provision of noise barriers (including mounds or walls) is discussed in Section 14.6. The noise impacts from reflections off noise barriers can have the potential to increase local noise levels in some instances. These increases occur when traffic noise reflects off one noise barrier onto a parallel barrier reinforcing noise levels and thereby reducing the benefit from noise walls. For the Proposal, the proposed locations of noise walls do not have walls on the opposite carriageway. The instances of noise walls on only one side of the carriageway are, therefore, not expected to cause any secondary noise impacts at residential locations.

14.5 Construction assessment

14.5.1 Construction traffic

14.5.1.1 Construction programming and temporary roadworks

The proposed construction works would be programmed to minimise the interaction between the construction works and the local and regional road network. This would minimise disruption to local and through traffic. Construction of the northern and southern interchanges would enable traffic to be switched between the existing highway and the Proposal to facilitate the continual flow of traffic through around the Proposal corridor.

Spoil haulage

As outlined in Section 7.3.4, the proposal is not likely to generate excess spoil as the design seeks to achieve balanced earthworks. If spoil haulage is required, vehicles would use the proposed construction haul roads and the existing road network. Vehicle movements would be relatively small and difficult to detect above normal daily fluctuations in traffic.

Access impacts

Ancillary facilities

Section 7.3.7 details the possible locations of ancillary facilities and environmental and social criteria for selection of preferred sites. The location of ancillary facilities would be near transport facilities for delivery and access reasons and therefore the additional vehicle movements are not likely to present a significant noise or vibration impact on sensitive receivers.

Construction access

Access points at the northern and southern tie-ins would be required to facilitate construction activities. Right-turn lanes and widened shoulders would be provided at the site compound entry, and where construction turning volumes are likely to be high or where adverse geometry exists. All access points would:

- Have safe intersection sight distances.
- Accommodated the turning movements of the largest heavy vehicles.

Local Roads

During construction, some temporary changes to access arrangements may be needed for local roads in and around the Proposal. Temporary changes to access arrangements would consider the turning requirements of school buses and would be finalised during the detailed design.

Properties

Property access would be maintained for the duration of the construction. If required temporary or alternative access would be provided in consultation with the affected landowner(s).

14.5.2 Typical construction activities

This construction noise and vibration assessment has been undertaken based on the assumption that the equipment used to construct the Proposal would be similar to that used on other highway projects. An assessment of the actual construction noise and vibration impacts would require information on the specific equipment used, detailed construction methodology and final locations of construction compounds. At this time, these details have not been determined for the Proposal. Accordingly, an assessment has been undertaken based on typical construction equipment for previous road construction projects.

14.5.3 Construction noise from mobile activities

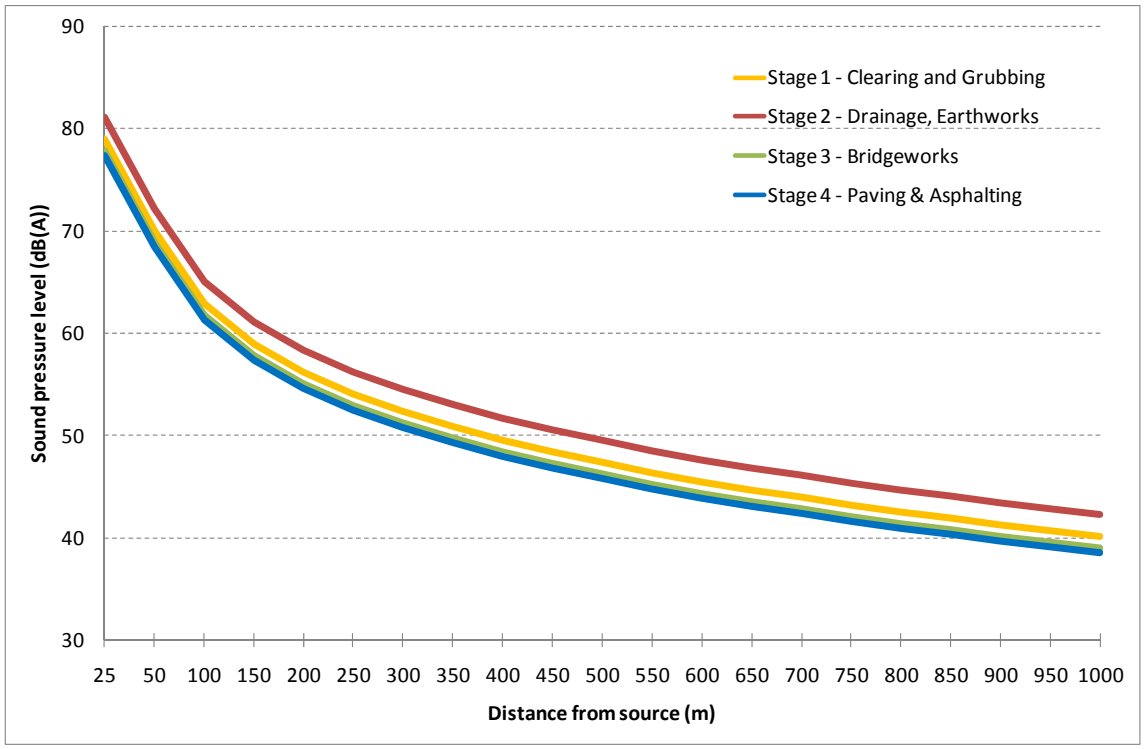
Total sound power levels for various mobile construction activities have been predicted based on the typical construction equipment required for each identified road construction activity and are noted in Table 14-10.

Based on the noise emissions outlined in Table 14-13, a graph of expected noise levels has been generated in Figure 14-3. The graph estimates the resultant sound pressure level for given distances from the construction works. These are indicative levels only, which provide information on the level of noise to be expected where no mitigation is present. Specific noise levels at a noise sensitive receiver would be determined as part of the CNVMP. The CNVMP would include monitoring, noise mitigation and community consultation as a minimum as well as measures to address unforseen significant noise sources.

Table 14-13 Summary of predicted noise levels for typical road construction activities and associated works

Activity	Description	L_{Aeq} Sound Power Level range (dB(A))
Clearing and grubbing	Felling of trees and shrubs as well as removal of man-made structures; removing stumps, roots and general vegetation.	103-114
Earthworks (including drainage)	Bulk earthworks including rock hammering, topsoil stripping, cut and fill (which may include blasting), excavation of culverts and basins, construction of batters and landscaping. Culvert construction, drainage installation, diversion drains to sedimentation basins.	107-114
Bridgeworks	Casting and formwork, piling, concrete pouring, pre-cast element installation and demolition as required.	105-121
Paving and asphalting	Application of road surface pavement to road base slab including batch plants, pouring of concrete base and sub-base, supplication of sprayed bitumen seals; laying of asphalt, saw cutting, finishing open drains and installation of road furniture and medians.	104-111

Figure 14-3 Estimated reduction of construction noise with distance from the source



14.5.4 Noise and vibration from batching plants, construction compounds and deliveries

Noise emissions from batching plants are typically dominated by associated vehicle movements and use of plant and equipment. Predicted noise contours for the batching plants are provided in Section 6.3 of Working paper 3 – Noise and vibration. The modelling indicates that within 250 m of the plant, the L_{Aeq} noise levels noise levels are likely to be approximately 55 dB(A), whilst at 500 m, the noise levels is expected to be approximately 48 dB(A); and at 1000 m, the predicted noise level is 41 dB(A). Specific consideration of noise effects and management measures would be completed during the development of the CNVMP when specific compound sites and activities have been determined by the appointed construction contractor.

The impact of noise and vibration from the establishment and operation of site compounds on nearby sensitive receivers is unlikely to be significant. However, noise and vibration would be considered during siting and commissioning of the compound(s).

During establishment of the site, anticipated activities include clearing and grading and the installation of pre-fabricated portable site offices and a maintenance workshop area. Sources of noise during this time, although typically relatively noisy, are anticipated to be of limited duration. They include mobile machinery (e.g. scrapers, graders compactors and mobile cranes) and stationary plant (e.g. generators, compressors). Vibration sources are not likely to be significant and would be rapidly attenuated with distance.

Operation of the site compounds would be required to support construction activities for the Proposal and the predominant noise source would likely be vehicle movements (e.g. staff transport and delivery of construction materials and consumables). However, these vehicle movements are not likely to present a significant noise or vibration impact on sensitive receivers. The use of hand tools during vehicle maintenance may result in audible noise at sensitive receivers. However, their use would reflect the existing rural land use and would not be a continual noise source. Any noise and vibration generated during the operation of the site compound would be managed under the CNVMP.

14.5.5 Construction vibration

This section provides guidance on the vibration impacts that may be expected from the construction activities associated with the Proposal. Table 14-14 summarises the anticipated level of vibration for the various construction activities. It can be assumed that activities such as compaction and rolling, as well as ripping would be the dominant sources of vibration during the construction of the Proposal.

Table 14-14 Summary of anticipated vibration levels for various construction activities.

Activity	Description	Vibration guidance
Clearing and grubbing	Clearing of vegetation, trunk and root removal, processing of timber waste	In general, the activities carried out during this stage of works generate low levels of vibration and areas close to residences are generally already cleared. Vibration impact is considered unlikely.
Earthworks	Bulldozers ripping	1mm/s to 2mm/s at distances of approximately 5 metres. At distances greater than 20 metres, vibration is usually below 0.2mm/s.
	Compactors	20mm/s at distances of approximately 5 metres, 2mm/s at distances of 15 metres. At distances greater than 30 metres, vibration is usually below 0.3mm/s.
	Vibratory rollers	Up to 1.5mm/s at distances of 25 metres. Higher levels could occur at closer distances, however, no damage would be expected for any building at distances greater than approximately 12 metres (for a medium to heavy roller).
	Truck traffic (on normal smooth road)	0.01mm/s to 0.2mm/s at the footings of buildings located 10m-20 metres from a roadway (note that very large surface irregularities can cause levels up to five to ten times higher).
Bridgeworks	Impact piling	The typical levels of ground vibration from pile driving range from 1 mm/s to 3 mm/s at distances of 25 metres to 50 metres, depending on ground conditions and the energy of the pile driving hammer.
Paving and asphalting	Paver, concrete cutter	None of the construction plant used during paving and asphalting would be major sources of ground vibration.

There is a possibility that annoyance as a result of earthworks or bridgeworks activity may occur for residents within 20 metres and up to 100 metres from road works although only during ripping or use of vibratory rollers or during bridge piling. Beyond 100 metres there is a low probability of annoyance for all activities. Property damage to

nearby residences as a result of these works is unlikely. With respect to annoyance from ramp/bridge construction, there is a possibility of complaints from residents but structural damage is unlikely.

Vibration monitoring would be undertaken during works within 50 metres of residences where vibration may be generated by equipment.

14.5.6 Blasting

Blasting activities produce ground-borne vibration and air blast overpressure, both of which can cause discomfort and at higher vibration levels, potential damage to property. At this stage of the development of the Proposal, data are not available to quantify specific blasting information and seismic details of the study area. Table 14-15 provides general guidance for estimating the likely minimum distance from blasting that may be required to meet over-pressure and vibration criteria described in Section 14.3.5.2 for a range of Maximum Instantaneous Charge (MIC) values.

Table 14-15 Minimum distances to comply with blasting vibration and over-pressure limits for various MIC values

Maximum instantaneous charge (MIC)	Minimum distance Limits (metres)	
	Vibration	Over pressure
5	70	290
10	100	350
20	140	430
50	220	560
100	300	670
200	430	750

The above distances are estimates and should only be referred to for guidance. However, it is evident that the degree of impact is strongly dependent on the size of the blast and that a greater separation distance is required to comply with the over-pressure limit than the vibration limit. In terms of buffer distances, the over-pressure limit is more stringent than the vibration limit and, therefore, would become the limiting blast criterion for the Proposal. As there are a number of cuttings on the Proposal, it is expected that blasting may be required during the earthworks phase. Where blasting is necessary within the minimum buffer distances, additional management strategies would be required and would be detailed within the CNVMP.

14.6 Identification of appropriate noise mitigation

Before including noise barriers/mounds into the Proposal, an assessment was undertaken of the effective use of low noise pavements along the Proposal. The incorporation of low noise pavements was assessed at locations where clusters (groups) of residents would benefit having regard to the predicted noise criterion exceedances outlined in Section 14.4.1. The proposed sections of low noise pavement for the Proposal are shown in Table 14-16, Figure 14-4 a-d and illustrated in Working paper 3 – *Noise and vibration*.

The inclusion of low noise pavements at the locations in Error! Reference source not found. was included in the noise model and the predictions re-assessed for the design year (2022) operational scenario. The results of the remodelled impacts are shown in Table 14-17 along with the reduction of noise level impacts in each range.

After the implementation of low noise pavements, the total number of exceedances is reduced by 53 receivers. However, 220 noise sensitive receivers still remained above the ECRTN criterion for night-time noise levels.

The inclusion of additional mitigation measures as part of the Proposal such as noise walls/mounds and architectural treatments were, therefore, assessed in accordance with Practice note IV of the ENMM. Other considerations include the general cost/benefit guide in Practice note (IV) of the ECRTN.

Modelling of noise barriers concluded that many of the locations along the Proposal precluded the effective use of noise barriers due to topographic effects or large distances between receivers. Topographic constraints occur when a residential receiver is located higher than the road carriageway and therefore looks down on the traffic stream over the top of the barrier. In these instances, noise barriers do not block the line of sight of traffic and the minimum noise reduction of 5 dB(A) required in the design of a noise barrier cannot be achieved.

Table 14-16 Proposed sections of low noise pavement

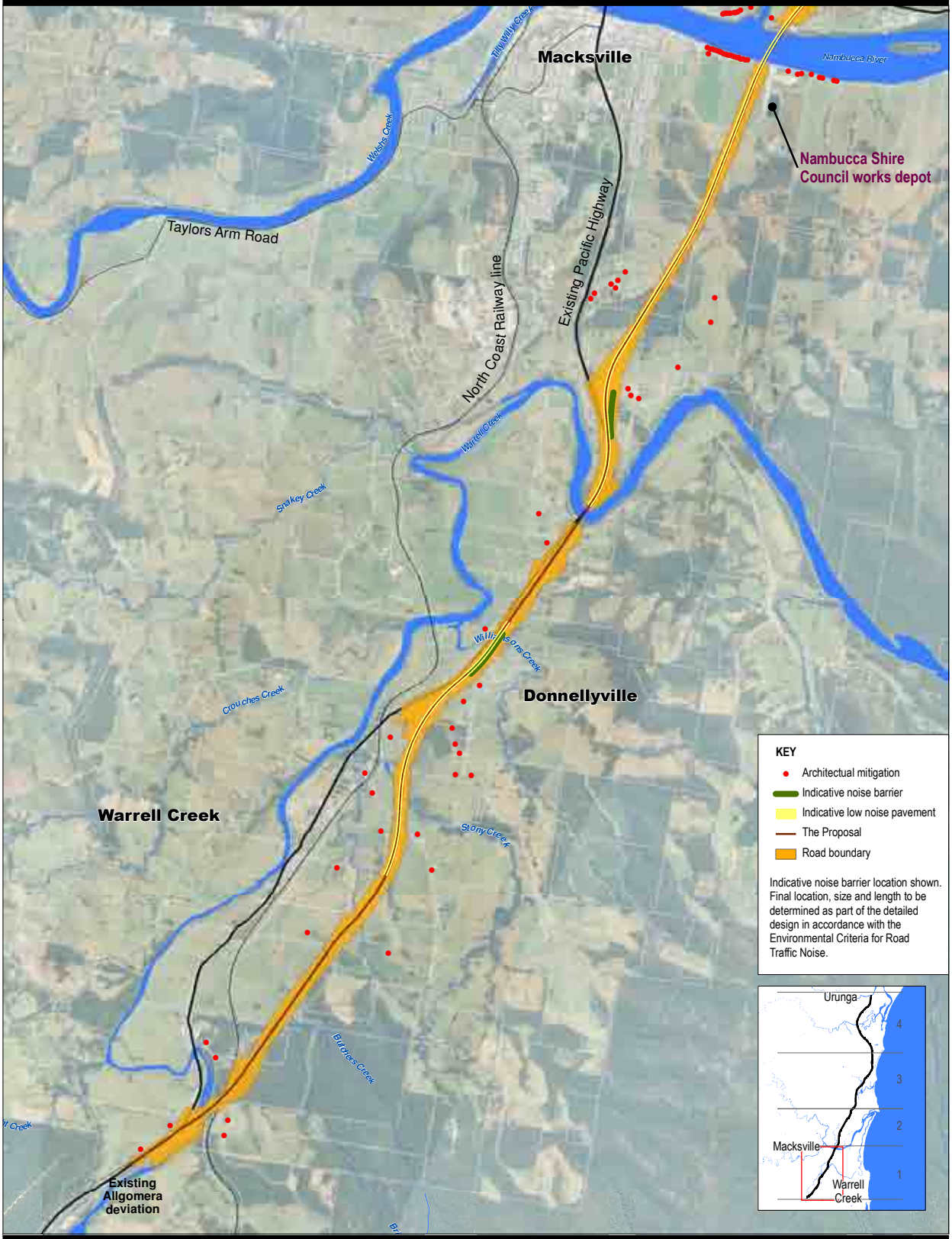
General location	Chainage[1]	Length
Warrell Creek	Ch. 3,100 to Ch. 5,400	2,300 metres
Northern abutment Bridge over Warrell Creek to Old Coast Road	Ch. 6,600 to Ch. 11,750	5,150 metres
North and south of East West Road at Valla Beach	Ch. 25,100 to Ch. 26,800	1,700 metres
Northern end of Proposal – Ridgewood Drive to end of Proposal	Ch. 38,800 to Ch. 41,000	2,200 metres

[1] To be refined during detailed design

Table 14-17 Number of exceedances – low noise pavement

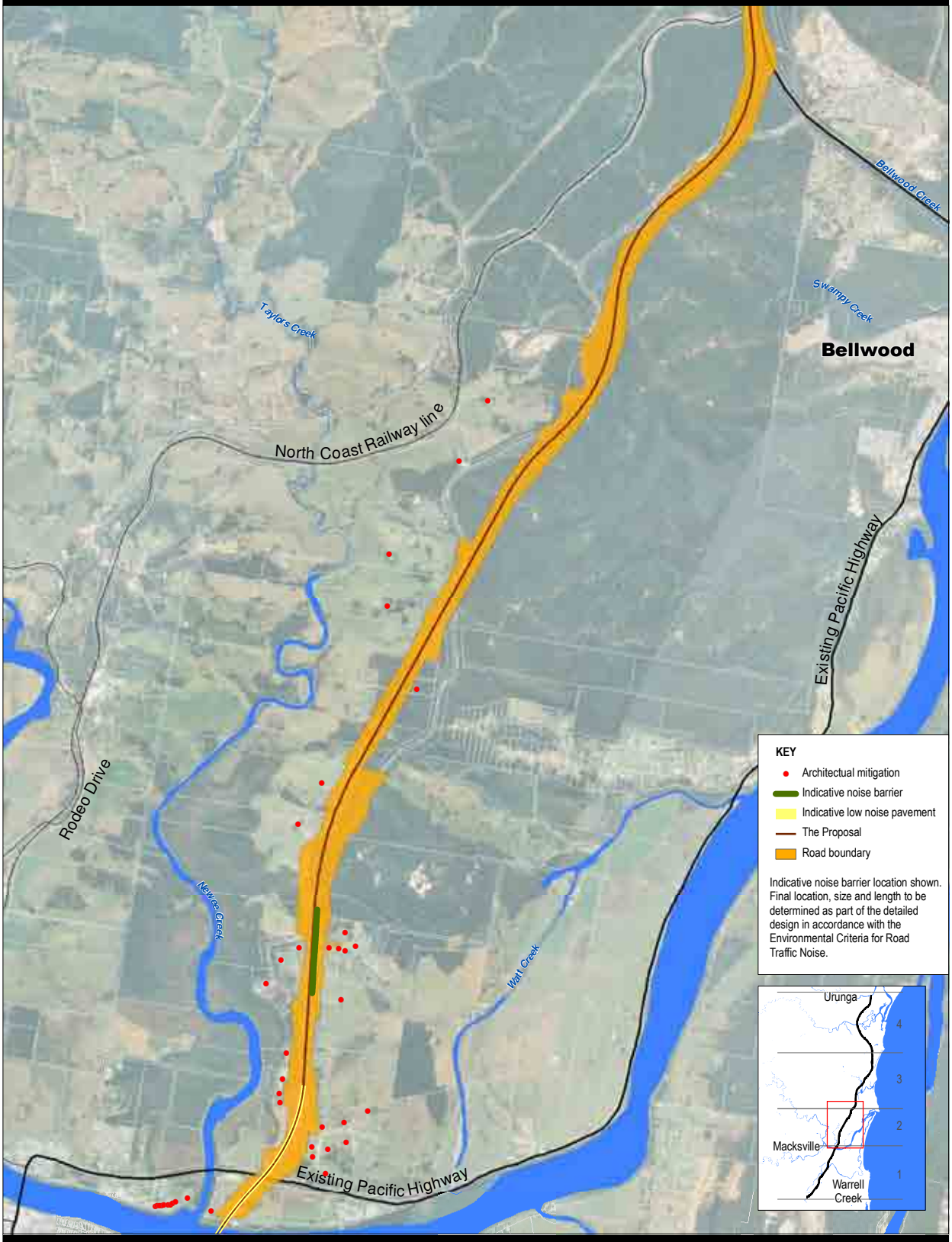
Range of exceedance (dB(A))	Number of receivers exceeding without low noise pavement	Number of receivers exceeding with low noise pavement	Difference after mitigation
1-2	170	65	101
3-5	100	79	18
6-10	89	68	21
>10	15	8	7
Total	273	220	53

FIGURE 14-4a | LOW NOISE PAVEMENT AND NOISE BARRIER LOCATIONS **SECTION 1 OF 4**



Warrell Creek to Urunga - Upgrading the Pacific Highway

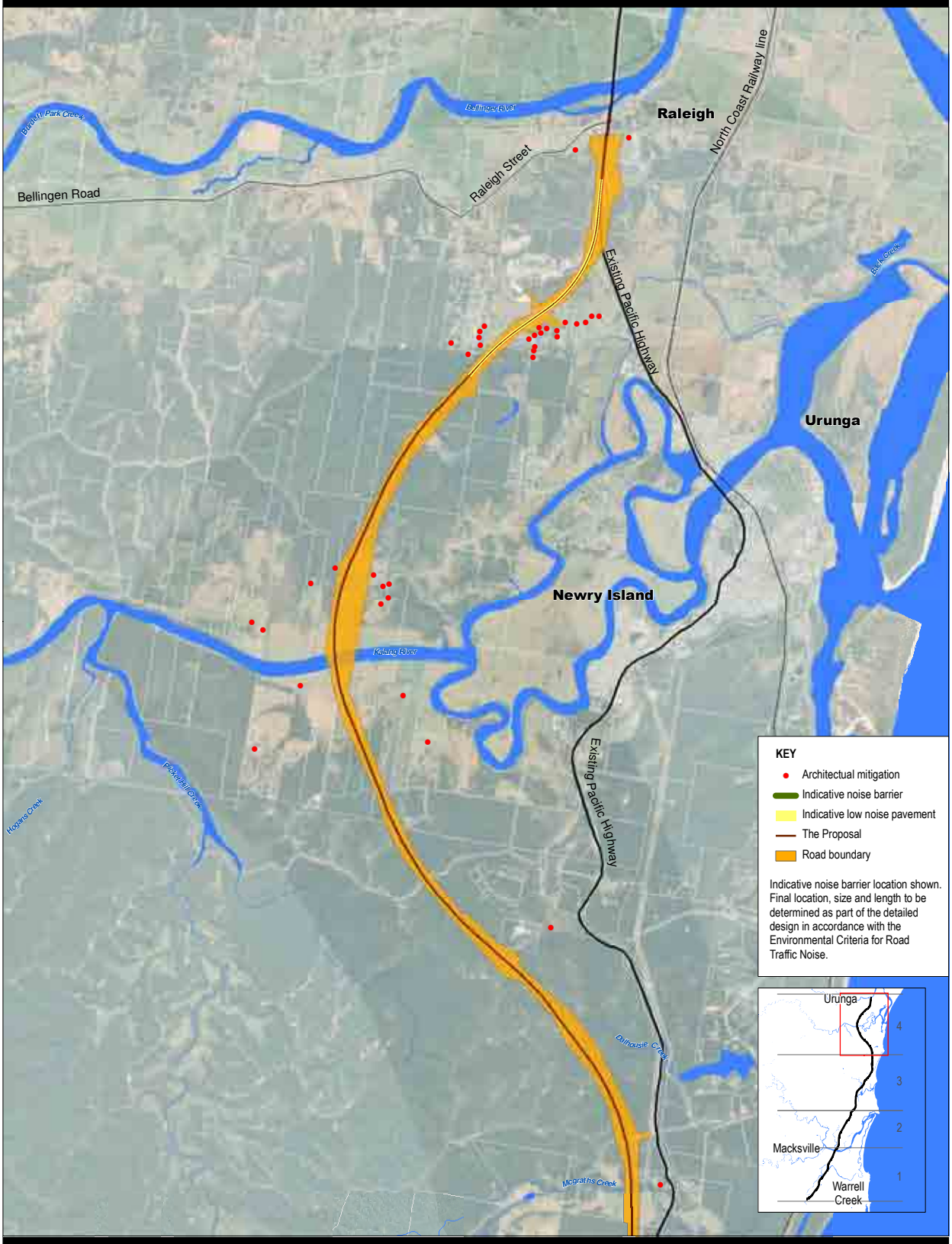
FIGURE 14-4b | LOW NOISE PAVEMENT AND NOISE BARRIER LOCATIONS **SECTION 2 OF 4**



Warrell Creek to Urunga - Upgrading the Pacific Highway

FIGURE 14-4c | LOW NOISE PAVEMENT AND NOISE BARRIER LOCATIONS **SECTION 3 OF 4**

FIGURE 14-4d | LOW NOISE PAVEMENT AND NOISE BARRIER LOCATIONS **SECTION 4 OF 4**



Warrell Creek to Urunga - Upgrading the Pacific Highway

Where barriers can be successfully implemented, an assessment of their effectiveness versus the cost to build and the number of residences that would benefit was undertaken. The locations where barriers were considered to provide a noise benefit and were cost-effective can be seen in Table 14-18. These were also illustrated in Working paper 3 – *Noise and vibration*.

Table 14-18 Noise barrier locations

Location	Type	Chainages[1]	Height above pavement
Albert Drive to Donnellyville	Wall	4500 – 5000 eastern side	4.5 metres
Donnellyville, adjacent to south bound lane	Wall	5000 – 5300 eastern side	4 metres
Bald Hill interchange, adjacent to South bound on ramp	Wall	7100 – 7450 eastern side	4 metres
Mattick Road	Wall	12325 – 12900 eastern side	4.5 metres

[1] To be refined during detailed design; it is noted that earth mounds may be constructed on land acquired for the Proposal should surplus spoil be available.

Table 5-4 and Table 5-5 of Working paper 3 - *Noise and vibration* show which properties are to be considered for architectural treatment to mitigate noise impacts from the Proposal. The number of properties to be considered for treatments has been summarised in Table 14-19 for each section of the Proposal.

Architectural treatments can include treatment of the building or local noise mounds or barriers, where residents prefer this option. However, the use of local noise barriers would be subject to a cost/benefit analysis to determine their appropriate application. The recommendations for noise mitigation are based on the current road alignment and road surface type, and should be flexible in their application to allow alternatives that may provide additional benefits to noise affected locations in the future.

Table 14-19 Proposed architectural (on property) noise treatments

Location	Number of residences at which treatment is proposed[1]
Allgomera deviation to Nambucca River	65
Nambucca River to Nambucca Heads	39
Nambucca Heads to Ballards Road	40
Ballards Road to Waterfall Way interchange	37

[1] To be refined during detailed design (data sourced from GIS information).

14.7 Proposed management measures

14.7.1 Operational noise

In order to manage the predicted operational noise impacts of the Proposal, assessment of the eligibility for noise treatments at sensitive receiver locations was completed, in accordance with the ENMM. Consideration of other reasonable and feasible actions to reduce predicted noise levels was also undertaken in accordance with the ECRTN. The range of operational noise mitigation and management measures proposed includes:

- Low- noise pavement is proposed at the locations identified in this environmental assessment (see Figure 14-4 a-d).
- Noise barriers are proposed at the locations and to the specifications identified in this environmental assessment, subject to detailed design, noise modelling and assessment against the criteria (see Figure 14-4 a-d).
- Architectural treatments would be considered at properties identified in this environmental assessment, where reasonable and feasible (see Figure 14-4 a-d).
- A reasonable and feasible approach has been adopted and would continue to limit operational noise impacts in accordance with the ECRTN. The approach to the mitigation of operational noise impacts would be developed further during detailed design and in consultation with relevant property owners.
- Monitoring of operational noise would be undertaken within one year after opening along the Proposal. Should the monitoring indicate that traffic noise levels exceed the relevant noise level criteria in the ECRTN, the RTA would investigate and implement further reasonable and feasible mitigation measures. The selection of these measures would be undertaken in consultation with affected property owners. The proposed operation phase noise management measures are also included in Appendix D - *Draft Statement of Commitments*.

14.7.2 Construction noise and vibration

In order to appropriately manage construction noise and vibration impacts of the Proposal the following mitigation and management measures would be implemented:

- Construction activities would generally be restricted to the following hours
  - Between 6am and 6pm Monday to Friday.
  - Between 7am and 4pm Saturday.
- Works outside the proposed construction hours would be limited to:
  - Works that do not cause construction noise to be audible at any sensitive receivers.
  - For the delivery of materials required outside these hours by the Police or other authorities for safety reasons.
  - Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.
  - Any other work as agreed through negotiations between the RTA and potentially affected sensitive receivers. Any such agreement must be recorded in writing and a copy kept on site for the duration of the works.
  - Where the work is identified in the CNVMP and approved as part of the CEMP.
  - As agreed by the DECCW.
- Rock breaking, rock hammering, sheet piling, pile driving and any similar activity would be scheduled only between the hours of 9am to 12pm and 2pm to 5pm, Monday to Friday; and 9am to 12pm, Saturday except where works are to be undertaken outside proposed construction hours as outlined above. All plant and

equipment would be well maintained and fitted with adequately maintained silencers which meet the vehicle design specifications.

- Prior consultation and notification would be undertaken with nearby residents that may be affected by noise or vibration generating activities that exceed the relevant criteria.
- Public address systems used at any construction site would not be used outside normal construction hours as indicated above, except where prior consultation has been undertaken with affected residents as outlined above. Public address systems would be designed to limit noise spillage off-site.
- Blasting trials would be undertaken if blasting is to be used, with results from the trials used to determine site-specific blast designs to satisfy relevant performance criteria.
- All reasonable attempts would be made to contact sensitive receivers located within 500 metres of a blast location. The contact would be made at least 48 hours before a blast and advice given to the receiver would include a schedule of blast time(s) and a telephone number and contact name.
- Noise and vibration monitoring would be undertaken during construction to determine the effectiveness of mitigation strategies.

The proposed pre-construction and construction phase noise and vibration management measures are outlined in the Appendix D - *Draft Statement of Commitments*.

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