

KINGS HILL INTERCHANGE & DRAINAGE CHANNEL

TRAFFIC & CONSTRUCTION NOISE ASSESSMENT

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PREPARED FOR

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

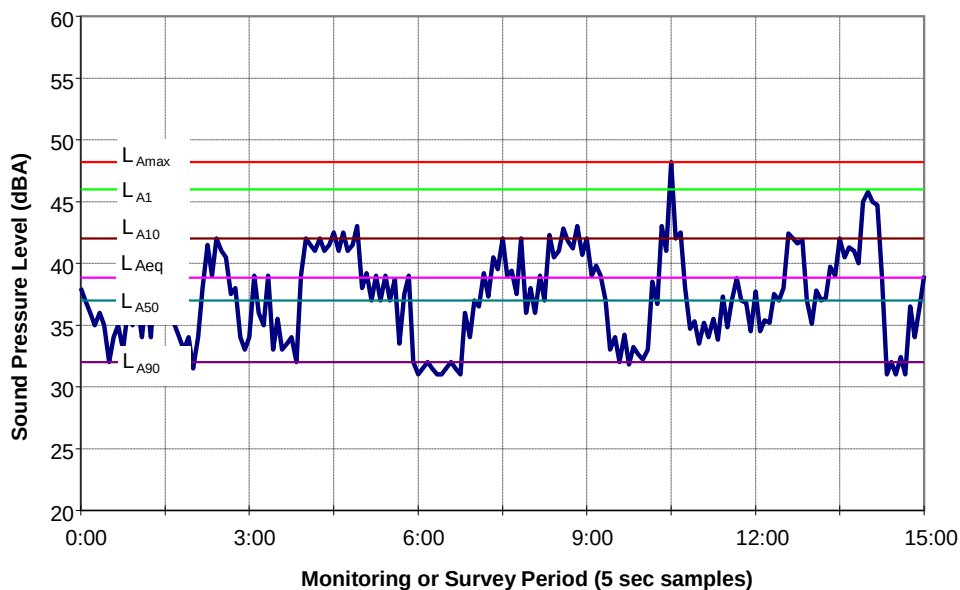
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

APP Corporation on behalf of Kings Hill Development Pty Ltd (KHD) has engaged Arcadis for the preparation of a Review of Environmental Factors (REF) for a new grade separated interchange on the Pacific Highway and a new drainage channel at Kings Hill, north of Raymond Terrace. Although the proposed interchange and drainage channel are seeking planning approval separately under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act), they will be constructed by the same proponent, within the same construction timeline and using the same site compounds, plant and equipment.

The area known as Kings Hill, located to the north of Raymond Terrace, has been rezoned for residential purposes and is expected to yield in excess of 3,500 residential dwellings over a 25-year period. Currently, there are only two buildings in the vicinity of the proposed interchange; the Riding for the Disabled property (3217 Pacific Highway, Raymond Terrace) and a rural residential property (3385 Pacific Highway), Eagleton). There are no buildings in the vicinity of the proposed drainage channel.

The Pacific Highway has two traffic lanes in each direction between Richardson Road and Six Mile Road, and a speed limit which varies between 100 km/h and 110 km/h. A full grade separated interchange and drainage channel is required to facilitate urban development in the Kings Hill release area as it will provide the primary and essential access for the entire release area.

Wilkinson Murray has been commissioned by Arcadis to undertake a traffic noise assessment for the operation of the interchange and a construction noise impact assessment for the proposed interchange and drainage channel.

Potential impacts at new residences within the future sub-division have not been addressed.

Due to the significant setback to only two existing properties potentially affected by the project, following discussion with RMS *Noise Policy*, a detailed desktop noise assessment has been undertaken, without the need to conduct baseline noise monitoring, although baseline noise monitoring is proposed prior to construction.

As the distance to the closest receivers is at least 300m away from the proposed interchange and drainage channel, vibration is not anticipated to be an issue and has not been considered in the assessment.

This assessment has been carried out primarily in accordance with the EPA *Road Noise Policy (RNP)*, the RMS *Noise Criteria Guideline (NCG)* and *Noise Mitigation Guideline (NMG)* and for construction noise the EPA *Interim Construction Noise Guideline (ICNG)* and *RMS Construction Noise and Vibration Guideline (CNVG)*.

Figure 1-1 Project Area



2 DESCRIPTION OF THE PROJECT & STUDY AREA

2.1 Pacific Highway Interchange

The Pacific Highway is a “freeway” with a plain concrete pavement and a speed limit of 110 km/h in the area of the development. Both road surface material and speed limit will remain after the interchange is built.

The proposed pavement for the interchange would be a dense grade asphaltic surface. The assumed speed limit for the link road, bridge and roundabout is 60 km/h.

The relevant elements of the proposal include:

- southbound on / off ramps: ‘trumpet’ configuration on the eastern side of the Highway, with free-flow movements on and off;
- northbound on / off ramps: a dual lanes roundabout within the interchange (referred to as the “Interchange Roundabout”) located along the East West Link Road; and
- a two lane bridge; one lane in each direction over the Pacific Highway.

The key project elements associated with the interchange are presented in **Figure 2-1**.

2.2 Drainage Channel

A new drainage channel is proposed to convey runoff from the Pacific Highway interchange and the Kings Hill development site to the Irrawang Swamp. The channel is needed to address Hunter Water Corporation requirements of preventing water entering into the dam for any rainfall event up to the 0.2% Annual Exceedance Probability (AEP) and maintaining access to the Grahamstown Dam in all storm events up to the 0.2% AEP rainfall event.

The drainage channel is proposed to be approximately 3,485m in length and run parallel to the Pacific Highway on the eastern side. It would have 1:5 side slopes for the full length and discharge below the old Grahamstown Dam Spillway.

The channel would cross beneath the access road to Grahamstown Dam via three 3.6x3.0m culverts running underneath this road. The swale services 8 stormwater inlets from the Pacific Highway and the proposed future residential development.

A 4m wide access track is to be built along the western side of the drainage channel with 4m wide turning bays at reasonable locations in order to meet Port Stephens Councils maintenance requirements for the drainage channel. In some areas the eastern side of the channel will be built up to ensure overtopping does not occur in the 0.2% AEP rainfall event.

The drainage channel construction would share the same timeline, activities, plant and equipment and construction sites used for the interchange and would be operating by 2017.

The key project elements associate with the drainage channel are presented in **Figure 2-2**.

Figure 2-1 Key Project Elements – Interchange

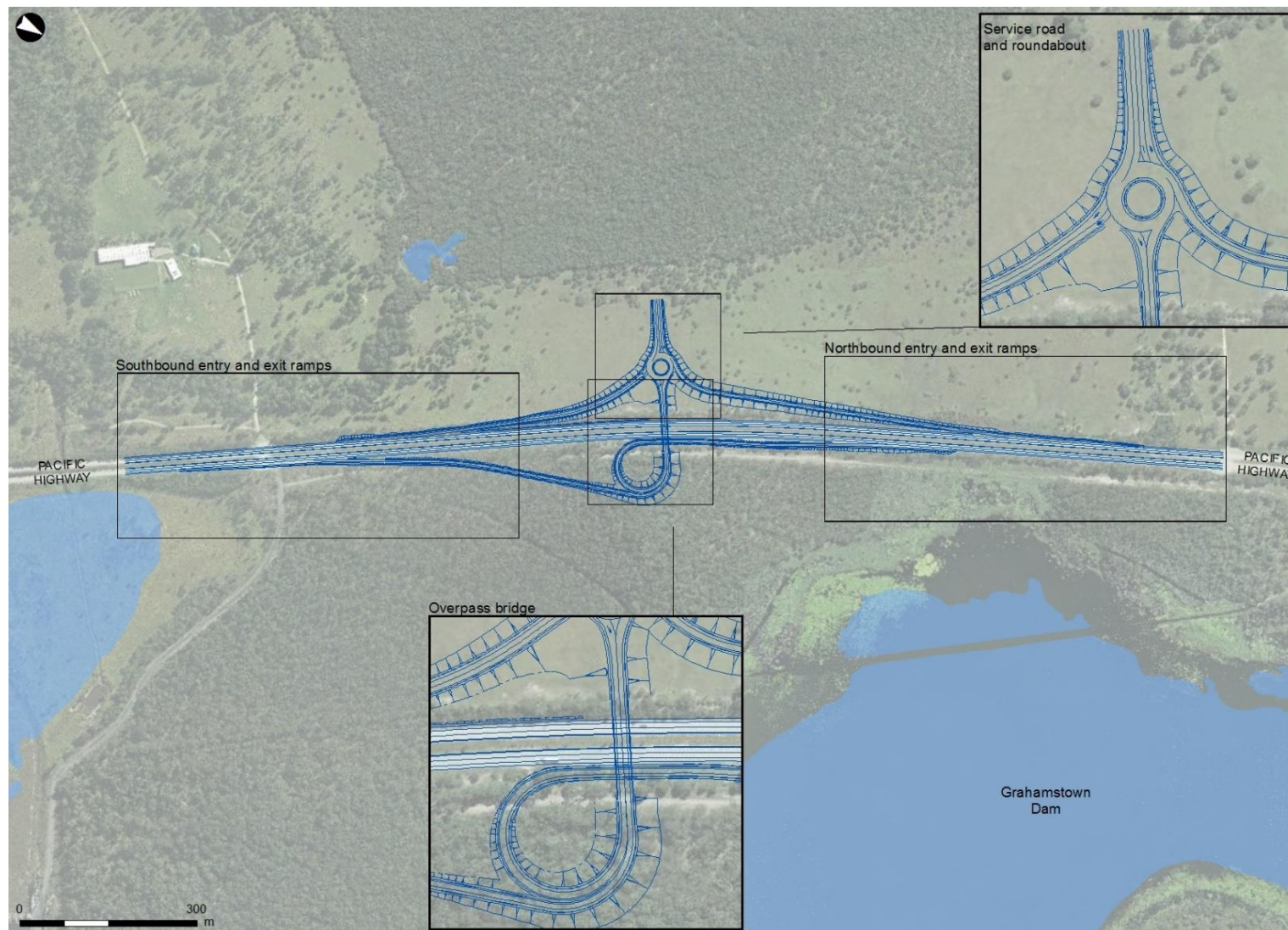
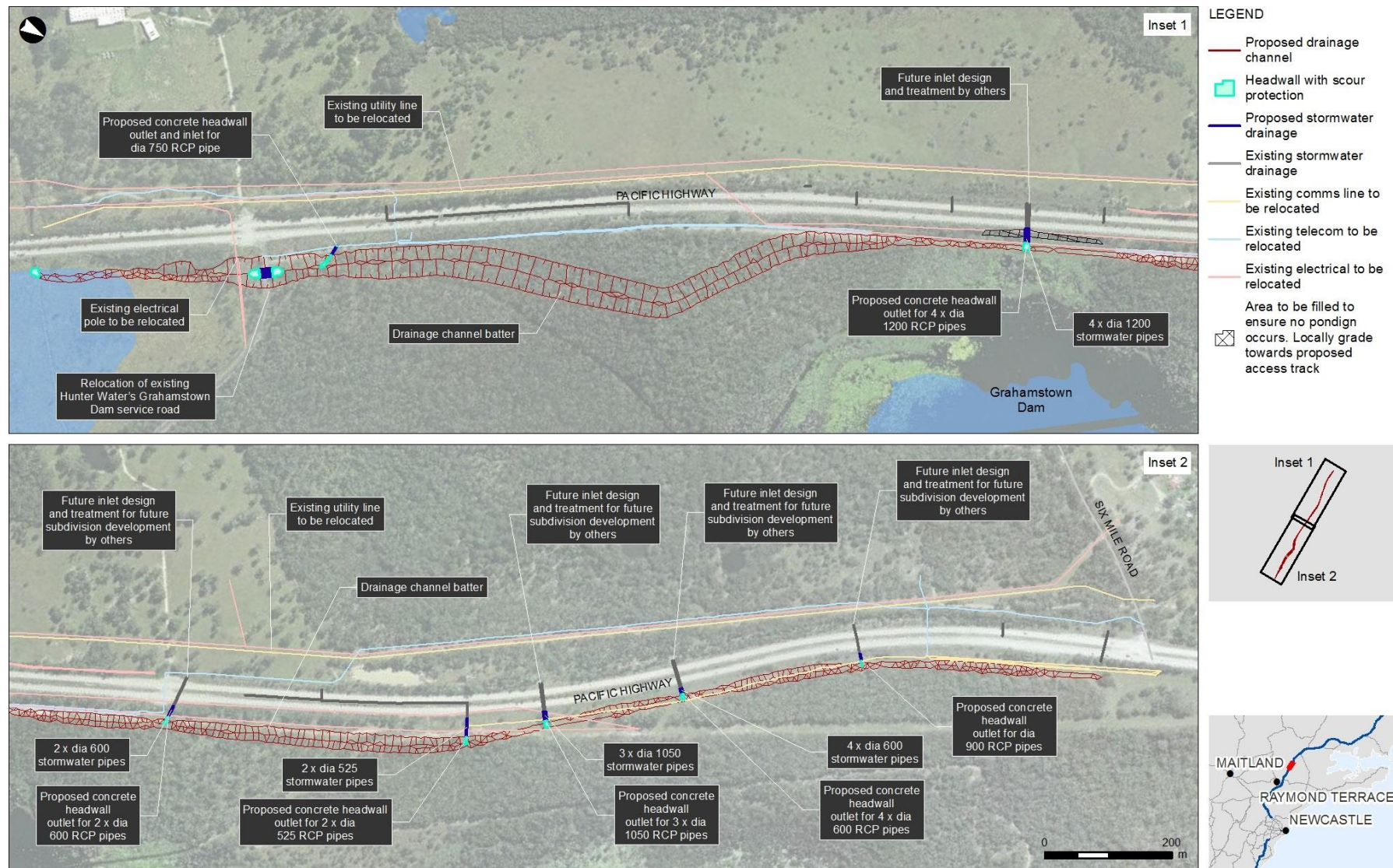


Figure 2-2 Key Project Elements – Drainage Channel

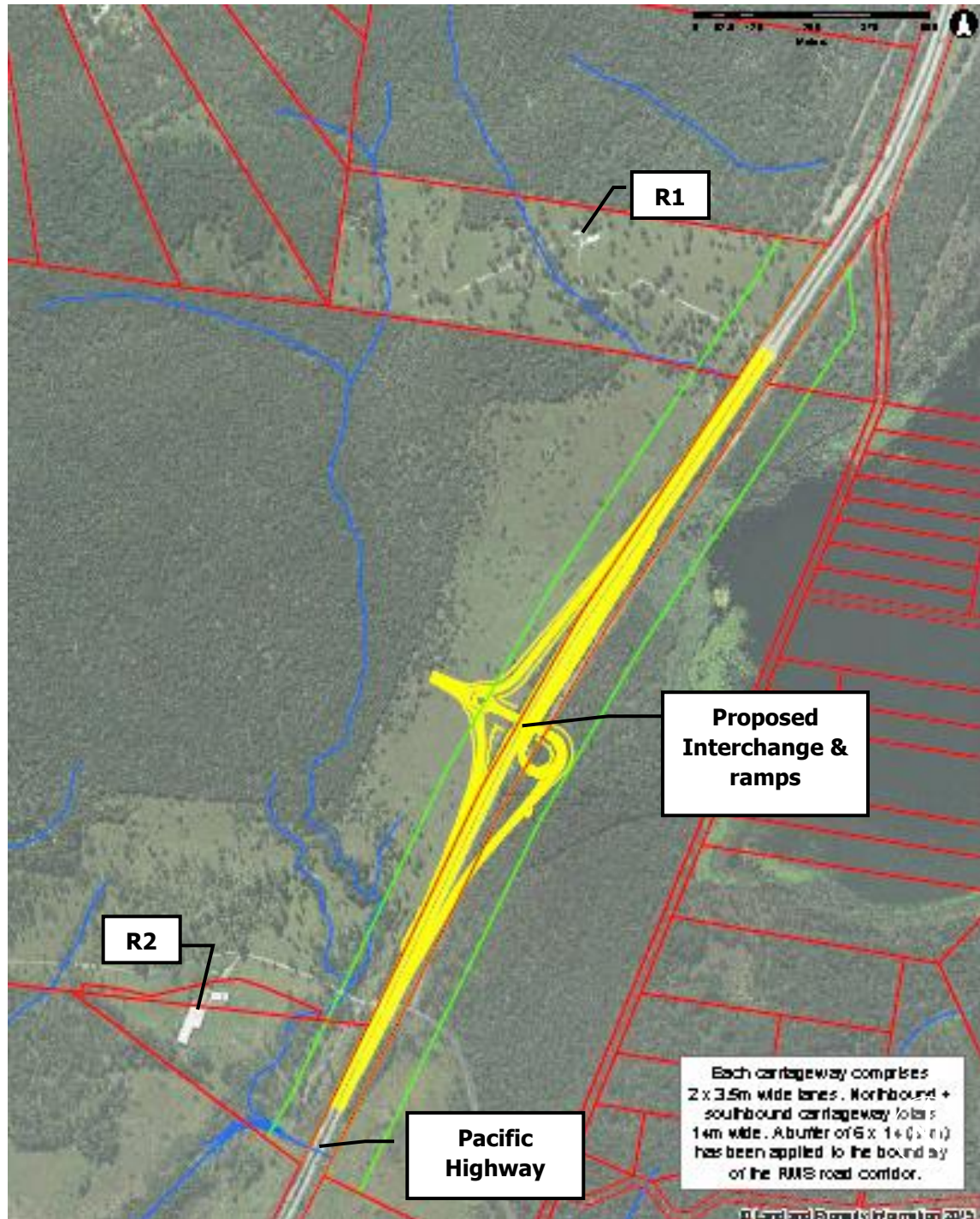


2.3 Noise Sensitive Receivers

The potentially most affected noise sensitive receivers include a residence (R1), and a riding school (R2).

Figure 2-3 shows the location of the two noise sensitive receivers considered in this assessment.

Figure 2-3 Surrounding Noise Sensitive Receivers



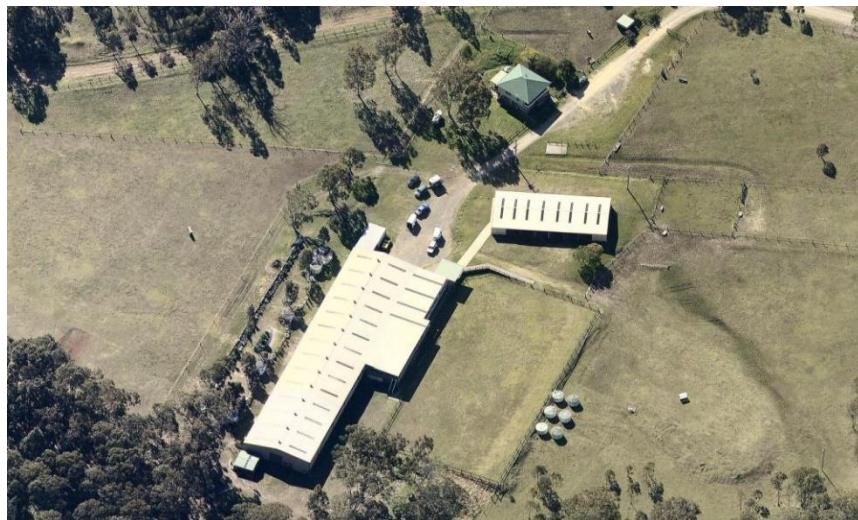
R1 is an existing residential development located at 3385 Pacific Highway Eagleton. This is a one storey house located at 420m from the western side of the Pacific Highway.

Figure 2-4 View of Receiver R1



R2 is an existing riding school located at 3217 Pacific Highway, Raymond Terrace. It is a one storey dwelling known as "Riding for the Disabled" and is located at 330m from the western side of the Pacific Highway. There is also a cottage on the site which we understand is primarily used as an administration office.

Figure 2-5 View of Receiver R2



3 ROAD TRAFFIC NOISE GOALS

Three documents require consideration to set road traffic noise criteria and decide whether mitigation is necessary. These are the *EPA – Road Noise Policy* and the *RMS – Noise Criteria Guideline* and *Noise Mitigation Guideline*.

3.1 Road Noise Policy & Noise Criteria Guideline

The EPA's *Road Noise Policy (RNP)* in Table 3 sets out criteria for assessment of noise from vehicles on public roads at existing residences. Part of Table 3 for Freeways is reproduced below.

Road Category	Type of Project / Land Use	Assessment Criteria – dBA	
		Day (7am-10pm)	Night (10pm-7am)
Freeway / arterial / sub-arterial roads	1. Existing residences affected by noise from new freeway / arterial / sub-arterial road corridors	L _{Aeq,15hr} 55 (external)	L _{Aeq,9hr} 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway / arterial / sub-arterial roads	L _{Aeq,15hr} 60 (external)	L _{Aeq,9hr} 55 (external)
	3. Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments		

Note: Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near busy roads (see Appendix C10) for details.

The *RNP* sets out noise criteria for 'freeways', 'arterial', 'sub-arterial' and 'local roads'. The highway and all associated ramps are considered to be in the 'freeways' category.

Under the *RNP*, road projects are classified as either "new road" or "redevelopment of an existing road". The *NCG* outlines a process for determining which of these criteria should apply, based on the proximity of the project to the existing road corridor.

Figure 2-2 shows the existing highway carriageways, road corridor boundaries (red) and the green line which is the set back from the edge of the existing road corridor equivalent to six times the total carriageway widths as required by the *NCG*. In this case this is calculated as 84m (6 x 2 x 7m lane widths).

Projects or parts of projects within this set back would be classified as "redevelopment". Projects or parts of projects outside this setback would be classified as "new". All of the proposed ramps are wholly within this 84m set back, with only a small section of the interchange roundabout to the west and link road outside the set.

Given there are some sections of the project which need to be considered as a redevelopment and a small component which needs to be considered as a new road then the "Transition Zone" concept within the *NCG* needs to be utilised.

From a review of the site geometry, traffic volumes and speeds, the contribution of noise from the “new” sections of road will be greater than 3dBA lower than the contribution from the “redeveloped” sections of road. In this situation the L_{Aeq} criteria of 60dBA daytime and 55dBA night time apply.

The *RNP* also provides criteria for open space (active use) which is appropriate for the riding school. **Table 3-1** sets out the assessment criteria for non-residential receivers.

Table 3-1 *RNP* Criteria for Non-Residential Land Uses

Existing Sensitive Land Use	Assessment Criteria – dB(A)	
	Day (7am-10pm)	Night (10pm-7am)
4. Open space (active use)	$L_{Aeq,15hr}$ 60 (external) when in use	-

3.2 Assessment Timeframe

For road projects, the *RNP* requires assessment in two timeframes:

- Timeframe 1 – within one year of changed traffic conditions. This is generally referred to as the Opening Year.
- Timeframe 2 – for design year (typically 10 years) after changed traffic conditions. This is generally referred to as the Assessment Year.

For each timeframe the *RNP* requires comparison between:

- the road traffic noise levels if the project proceeds (termed the “build” option).
- the corresponding road traffic noise levels, due to general traffic growth, that would have occurred if the project had not proceeded (termed the “no build” option).

For this report timeframe 1 will refer to 2017 and timeframe 2 will refer to 2027.

3.3 Noise Mitigation Guideline

Where predicted noise levels exceed the assessment criteria, all feasible and reasonable mitigation options should be considered. The *RNP* states that “an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person”. These requirements are described in more detail in the *Noise Mitigation Guideline (NMG)*.

Once traffic noise predictions for the “no build” and “build” scenarios have been assessed against the requirements of the *NCG* for the two timeframes it is then necessary to consider section 6.2 of the *NMG* extracted below.

Where the total noise level for the ‘build’ year exceeds the controlling criterion established using the NCG, and there is an increase of more than 2.0dBA (i.e. 2.1dBA or greater), relative to the ‘no-build’ year, then a receiver qualifies for consideration of noise mitigation. This includes the situation where the ‘no-build’ noise level is below the criterion value.

4 NOISE MODELLING

4.1 Purpose of Noise Modelling

The purpose of noise modelling is to predict traffic noise levels at sensitive receivers.

A noise model takes inputs, such as road alignment, topography, traffic flow and receiver location, and predicts noise levels.

An assessment of a new road or road redevelopment requires prediction of existing and future traffic noise. Hence at all residences and other sensitive receivers the model should predict noise levels for both the "Build" and "No-Build" options.

4.2 Modelling Procedure & Assumptions

Noise levels from the existing and proposed road alignments were calculated using procedures based on the *Calculation of Road Traffic Noise (CoRTN)* prediction algorithms using SoundPlan noise modelling software. The standard *CoRTN* prediction procedures were modified in the following ways:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the *CoRTN* algorithms using the well-validated approximation $L_{Aeq,1hr} = L_{A10,1hr} - 3dB$;
- noise source heights were set at 0.5m for cars, 1.5m for heavy vehicle engines and 3.6m for heavy vehicle exhausts, representing typical values for Australian vehicles. Noise from a heavy vehicle exhaust was assessed as 8dBA lower than the noise from the engine. The combined noise from heavy vehicle exhaust and engine gives the sound level as defined in *CoRTN*. The acoustical energy for the various sources is then derived from speed, road surface and traffic volume; and
- a ground factor of 0.75 has been considered for vegetated areas.

4.3 Model Inputs

4.3.1 Road Alignment & Topography

Details of topography and road design were based on data supplied by Arcadis.

4.3.2 Traffic Speed

The modelled speed of the roads is as follows:

- Pacific Highway: 110 km/h for all vehicles; and
- Proposed interchange (ramps): 80 km/h for all vehicles.
- Link Road and Bridge: 60 km/h for all vehicles

4.3.3 Road Surface Correction

Surface corrections for various surfaces are given in **Table 4-1**.

Table 4-1 Road Surface Corrections

Road Surface Type	Percentage Heavy Vehicle	Vehicle Speed km/h		
		60	80	100/110
Dense Graded Asphaltic Concrete (DGAC)	10%	-1	0	0
Average Concrete (PCC)	10%	+1.5	+1.5	+2

4.3.4 Receiver Heights

Receiver heights used were:

- existing residential receiver – 1.5m;
- Riding for the Disabled property – 1.5m.

4.3.5 Facade Reflections

For prediction of operational noise to facades of residences, a 2.5dBA correction was added to the noise results.

4.3.6 Australian Conditions

The Australian correction of -1.7dBA was applied to facade predictions and -0.7 to free field predictions (April 1983 Australian Road Research Board report – Research Report ARR No.122).

5 OPERATIONAL NOISE ASSESSMENT

This section assesses the noise impacts resulting from the traffic using the interchange once it is in operation. Note the drainage channel is unlikely to generate noise levels perceivable by sensitive receivers during its operation hence the drainage channel has not been further considered for the operational noise assessment.

Future traffic volumes for the M1 Pacific Highway interchange at Kings Hill (Kings Hill interchange) were prepared by Arcadis for 2017 and 2027 for the following scenarios:

- “No Build” option: traffic volumes were prepared for the Pacific Highway for background traffic growth without the new Kings Hill interchange and without the Kings Hill development in place. The background traffic growth on the Pacific Highway was assumed to be 2% per annum until 2027; and
- “Build” option: This assumes background growth (2%) plus Kings Hill interchange and Kings Hill development traffic. In 2017, about 20% of Kings Hill development (700 new dwellings and 1.5ha of mixed-use / retail) has been assumed. The 2017 model assumed new Kings Hill interchange is in place. In 2027, full Kings Hill developments (3,500 new dwellings and 7.5ha of mixed-use / retail) are assumed. The 2027 model assumed new Kings Hill interchange is in place.

5.1 Traffic Volumes “No Build” Option

The traffic volumes used in the noise model are shown in **Table 5-1** and **Table 5-2**.

Table 5-1 Traffic Counts for “No Build” Option in 2017

Direction	Day			Night			Percent Heavy	
	7am-10pm			10pm-7am			Day	Night
	Light	Heavy	Total	Light	Heavy	Total		
Pacific Hwy Northbound	7200	1700	8900	1400	300	1700	19.1	17.7
Pacific Hwy Southbound	6400	1500	7900	1200	300	1500	19.0	20.0

Table 5-2 Traffic Counts for “No Build” Option in 2027

Direction	Day			Night			Percent Heavy	
	7am-10pm			10pm-7am			Day	Night
	Light	Heavy	Total	Light	Heavy	Total		
Pacific Hwy Northbound	8500	2000	10500	1600	400	2000	19.1	20.0
Pacific Hwy Southbound	7500	1800	9300	1500	300	1800	19.4	16.7

5.2 Traffic Volumes "Build" Option

The traffic volumes used in the noise model are shown in **Table 5-3** and **Table 5-4**. **Figure 5-1** shows the sections of the road considered in the calculations.

Figure 5-1 Road Sections (Traffic Volumes Only)

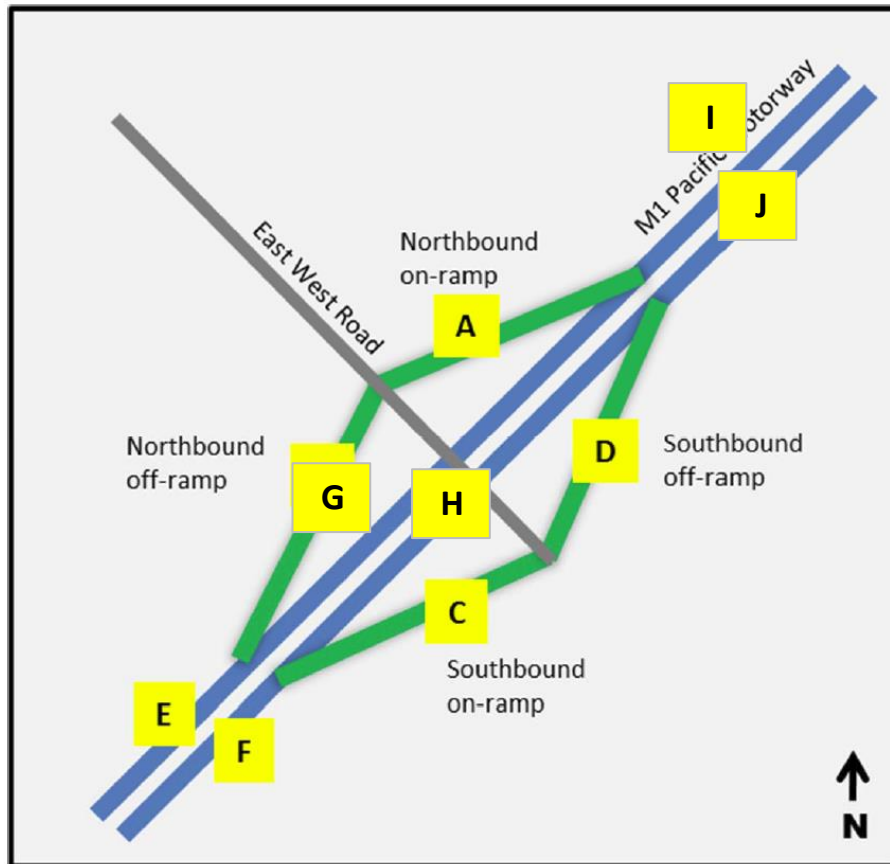


Table 5-3 Traffic Counts for "Build" Option in 2017

ID	Direction	Day			Night			Percent Heavy	
		7am-10pm			10pm-7am			Day	Night
		Light	Heavy	Total	Light	Heavy	Total		
A	Northbound on-ramp	116	6	122	22	1	23	4.9	4.3
B	Northbound off-ramp	1691	89	1780	323	17	340	5.0	5.0
C	Southbound on-ramp	1715	90	1805	327	17	344	5.0	4.9
D	Southbound off-ramp	108	6	114	21	1	22	5.3	4.5
E	Pacific Hwy Northbound	8891	1789	10680	1723	317	2040	16.8	15.5
F	Pacific Hwy Southbound	8115	1590	9705	1527	317	1844	16.4	17.2
G	Pacific Hwy Northbound	7200	1700	8900	1400	300	1700	19.1	17.6
H	Pacific Hwy Southbound	6400	1500	7900	1200	300	1500	19.0	20.0
I	Pacific Hwy Northbound	7316	1706	9022	1422	301	1723	18.9	17.5
J	Pacific Hwy Southbound	6508	1506	8014	1221	301	1522	18.8	19.8

Table 5-4 Traffic Counts for “Build” Option in 2027

ID	Direction	Day			Night			Percent Heavy	
		7am-10pm			10pm-7am			Day	Night
		Light	Heavy	Total	Light	Heavy	Total		
A	Northbound on-ramp	578	30	608	110	6	116	4.9	5.2
B	Northbound off-ramp	8457	445	8902	1613	85	1698	5.0	5.0
C	Southbound on-ramp	8576	451	9027	1636	86	1722	5.0	5.0
D	Southbound off-ramp	539	28	567	103	5	108	4.9	4.6
E	Pacific Hwy Northbound	16957	2445	19402	3213	485	3698	12.6	13.1
F	Pacific Hwy Southbound	16076	2251	18327	3136	386	3522	12.3	11.0
G	Pacific Hwy Northbound	8500	2000	10500	1600	400	2000	19.0	20.0
H	Pacific Hwy Southbound	7500	1800	9300	1500	300	1800	19.4	16.7
I	Pacific Hwy Northbound	9078	2030	11108	1710	406	2116	18.3	19.2
J	Pacific Hwy Southbound	8039	1828	9867	1603	305	1908	18.5	16.0

5.3 Predicted Noise Levels for 2017 & 2027 “No Build” & “Build” Options

Table 5-5 summarises the predicted daytime and night time noise levels at representative receivers and criteria determined in accordance with *RNP* and *NCG*.

A review of **Table 5-5** indicates neither of the existing noise sensitive receivers would experience exceedances of the *NCG* or require consideration for mitigation in line with the *NMG*.

Table 5-5 Predicted Noise Levels for 2017 & 2027 “No Build” & “Build” Options

Scenario	Day 15hr Night 9hr	Year 2017 R1: 3385 Pacific Hwy	Year 2017 R2: Riding School	Year 2027 R1: 3385 Pacific Hwy	Year 2027 R2: Riding School
Assessment criteria	L _{Aeq,15hr}	60	60	60	60
	L _{Aeq,9hr}	55	-	55	-
“No Build”	L _{Aeq,15hr} Day	57.6	59.9	58.3	60.7
If Acute, then bold	L _{Aeq,9hr} Night	52.6	54.9	53.3	55.6
“Build”	L _{Aeq,15hr} Day	57.3	60.3	58.3	62.3
If Acute, then bold	L _{Aeq,9hr} Night	52.3	55.2	53.3	57.3
“No Build”	L _{Aeq,15hr} Day	No	No	No	Yes
Noise levels exceed criteria?	L _{Aeq,9hr} Night	No	-	No	-
If Acute, then bold					
“Build”	L _{Aeq,15hr} Day	No	No	No	Yes
Noise levels exceed criteria?	L _{Aeq,9hr} Night	No	Yes	No	-
If Acute, then bold					
Difference in noise levels between “Build” & “No Build”	L _{Aeq,15hr} Day	-0.3	0.4	0.0	1.6
If greater than 2, then bold	L _{Aeq,9hr} Night	-0.3	0.3	0.0	1.7
Consider noise mitigation?		No	No	No	No

5.4 Mitigation Option Review

The existing riding school and residence would not be exposed to noise levels that exceed a L_{Aeq} of 65dBA and 60dBA for the day and night time periods respectively. In addition, the increase in noise levels between the “Build” and “No Build” option is less than 2dB. Therefore, these receivers do not require any further noise mitigation review as they satisfy the *RNP* and *NCG and NMG* requirements.

Whilst this assessment has not considered the proposed residences within the new sub-division, they will be affected by road traffic noise from the existing M1 Freeway and proposed ramps and interchange.

Feasible and reasonable noise mitigation measures should therefore be considered in the detailed design stage for both the interchange ramps and sub-division. This may include:

- In corridor noise barriers / mounds; and
- At property treatments or localised barriers/ mounds.

6 CONSTRUCTION NOISE ASSESSMENT

This chapter considers the requirements of the EPA *Interim Construction Noise Guideline (ICNG)* and the RMS *Construction Noise and Vibration Guideline (CNVG)*.

Although the proposed interchange and drainage channel are seeking planning approval separately under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act), they will be constructed by the same proponent, within the same construction timeline and using the same site compounds, plant and equipment. The proposed construction period is expected to be approximately 14 months. The bulk of the construction activities are proposed to be completed during standard working hours

- 7.00am to 6.00pm Monday to Friday; and
- 8.00am to 1.00pm on Saturdays.
- Sundays and public holidays: no work.

There would be certain activities that would need to be carried out outside of these standard working hours. These 'out of hours' periods would be needed to reduce disruption for the Pacific Highway users. Such activities may include:

- Bridge erection over the Pacific Highway. Bridge lifts would likely occur at night and might require lane closures and/or road detours;
- Delivery of the oversized bridge structural elements (girders) requiring police or other professional escorts;
- Tying in the project with the existing Pacific Highway (tie-in work would need to maintain the safety of the travelling public), some tie-in works including grade correction asphaltting or asphalt tie-ins to existing roads;
- Managing traffic and traffic switches to reduce inconvenience to road users, avoid traffic delays during daytime or peak traffic periods, and provide safety for construction workers working on the existing highway;
- Relocating utilities to avoid and minimise disruptions for utility customers;
- Construction compound operations to support any activities that may be undertaken out of hours;
- Refuelling activities and plant maintenance;
- Work required in an emergency to avoid the loss of lives, property and/or to prevent harm.
- Short-term traffic diversions, including full or partial lane closures;
- Work that would not cause construction noise disturbance at any sensitive receivers; and
- Deliveries to the site compounds.

Table 6-1 provides details of both the proposed construction activities and the type of plant and equipment to be used. It gives an indication on the duration each construction activity is expected. The works would be undertaken by the Contractor who would be responsible for planning all construction processes, including scheduling and overall timing of works.

Where works would be required outside of the standard working hours outlined above, the procedure contained in Figure 2 of the CNVG would be followed. This requires consideration of sleep disturbance impacts. This report therefore focuses on the more typical works during standard construction hours, but also considers night-time activities.

Table 6-1 Proposed Construction Activities

Activity	Major Plant & Equipment Required	Approximate Duration
Mobilisation and site establishment	Plant: Small cranes and lifting equipment, excavators, front end loaders, road trucks, light vehicles Equipment: Fences, portable sheds, portable ablutions, fuel storage, generators, waste tanks	1 – 2 months
Relocation and protection of existing services	Plant: Small cranes, excavators, backhoes, front end loaders, trenching machines, dump trucks, road trucks, light vehicles, agitator trucks Equipment: Jack hammers, concrete saws and other small handheld equipment	2 – 3 months
Clearing, grubbing and topsoil stripping	Plant: Excavators, bulldozers, graders, watercarts, front end loaders, dump trucks, fuel trucks, road trucks, scrapers, light vehicles	<1 month
Bulk earthworks and materials haulage including basins and diversion drains	Plant: Excavators, bulldozers, graders, watercarts, front end loaders, vibratory rollers, dump trucks, road trucks, scrapers, fuel trucks, light vehicles Equipment: Hand held compactors	8 – 10 months
Road pavement construction	Plant: Excavators, bulldozers, graders, watercarts, front end loaders, Bomags, road sweepers, fuel trucks, asphalt pavers, bituminous spray sealing trucks, vibratory rollers, road trucks, linemarking machines, light vehicles Equipment: Hand held compactors, jack hammers, concrete saws and other small handheld equipment	1 – 3 months
Drainage structures construction (if required)	Plant: Underborers, excavators, mobile cranes, front end loaders, vibratory rollers, road trucks, light vehicles Equipment: Hand held compactors and other small tooling	2 – 3 months
Bridge construction works including heavy vehicle deliveries of over-size loads	Plant: Hydraulic Hammer, Excavators, elevated work platforms, mobile cranes, agitator trucks, pile drivers, concrete pumps, vibratory rollers, road trucks, light vehicles Equipment: Hand held compactors and other small tooling	10 - 12 months
Signposting	Plant: Excavators, elevated work platforms, mobile cranes, agitator trucks, road trucks, light vehicles Equipment: Hand held compactors, jack hammers and other small tooling	< 1 month
Lighting and roadside furniture installation	Plant: Excavators, elevated work platforms, mobile cranes, agitator trucks, road trucks, light vehicles Equipment: Hand held compactors and other small tooling	1 – 2 months
Landscaping, waste disposal and rehabilitation of disturbed areas with no future use	Plant: Excavators, bulldozers, watercarts, front end loaders, graders, road trucks, light vehicles Equipment: Small tooling	1 – 2 months

6.1 Construction Noise Criteria for Residences

The *NSW Interim Construction Noise Guideline (ICNG)* presents the process to assess construction in NSW. The *ICNG* was developed by the Department of Environment Climate Change & Water (DECCW) taking into consideration that construction is temporary, noisy and difficult to ameliorate. As such, the *ICNG* was developed to focus on applying a range of work practices most suited to minimising construction noise impacts, rather than focusing only on achieving a numeric noise level.

The *ICNG* recommends that standard construction work hours should typically be as follows:

- Monday to Friday 7.00am to 6.00pm;
- Saturday 8.00am to 1.00pm; and
- No work on Sundays or public holiday.

Additionally, it recommends quantitative noise management levels (NML) at residences as presented in **Table 6-2**.

Table 6-2 Noise at Residences using Quantitative Assessment

Time of Day	Management Level LAeq,15 min	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dB(A)	- The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured LAeq,15min is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. - 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.
Outside recommended standard hours	Highly noise affected 75dB(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 may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noisy such as before and after schools, or mid-morning or mid-afternoon for works near residences; and - 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 + 5dBA	- 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 5dBA above the noise affected level, the proponent should negotiate with the community.

In addition to the above criteria, where any work is conducted during the night time period (10.00pm to 7.00am), the EPA recommends as a screening criterion, that to protect against sleep disturbance, $L_{A1,1min}$ noise levels should not exceed the background level by more than 15dBA at any residence. In practice, the $L_{A1,1min}$ level can be represented by the typical maximum noise level.

The ICNG presents the following noise management levels for non-residential premises:

- Active recreation areas (such as parks) external L_{Aeq} (15 min) 65dBA
- Passive Recreation areas external L_{Aeq} (15 min) 60dBA
- Industrial premises: external L_{Aeq} (15 min) 75dBA
- Offices, retail outlets external L_{Aeq} (15 min) 70dBA
- Classrooms, hospitals, places of worship internal L_{Aeq} (15 min) 45dBA

The CNVG identifies in Section 5.2 the "assessment type" based on the likelihood of potential noise and vibration impacts.

"The project duration and number of receivers identify the type of construction noise assessment to be carried out for the project. Different assessment types require different amounts of modelling detail and reporting. There are three tiers of approaches based on the number of receivers:

- *No receivers with noise levels above the NML (Section 5.3 of CNVG)*
- *Few receivers above the NML (Section 5.4 of CNVG)*
- *Many receivers above the NML (Section 5.5 of CNVG)*

And three tiers of noise assessment which reflects the project duration:

- *Projects less than 3 weeks duration*
- *Projects 3 to 6 weeks duration;*
- *Projects greater than 6 weeks duration"*

Since there is only one residential receiver (R1) and one commercial operator (R2) which are both some distance from the proposed works we expect there are no receivers where typical noise levels will be above the NML, however the project duration is greater than 3 weeks. This requires as a minimum the documentation of background noise levels and prediction of noise levels.

The background noise level (RBL) was estimated from short term attended background noise monitoring undertaken outside of the peak periods between 10.45am and 11.45am on Tuesday 10 October 2017.

The measurements were conducted using a NTi XL2 Sound Level Meter which conforms to Australian Standard 1259 *Acoustics - Sound Level Meters* as a Type 1 Precision Sound Level Meter. The A-Weighting filter of the meter was selected and the time weighting was set to "Fast". The calibration of the meter was checked before and after the measurements with a Brüel and Kjær Type 4231 sound level calibrator and no significant drift was noted.

The NTi XL2 and Brüel and Kjær Type 4231 have been laboratory calibrated within the previous two years in accordance with our in-house Quality Assurance Procedures.

Over three consecutive 15-minute periods, the background L_{A90} noise level was fairly consistent and controlled by traffic noise. Noise levels of 50, 51 and 52dBA were measured. The background noise levels for the recommended standard hours at the existing residential receiver has been calculated using an internal calculation procedure which is based on parameters such as speed limit, traffic volumes, percentage of heavy vehicles and distance receiver-road. A background noise level of 50dBA was adopted for the recommended standard hours, whilst a conservative background noise level of 30dBA has been adopted for the outside recommended standard hours.

For information purposes the background noise level was also measured at location R2. Between 12.10am and 12.25am a background L_{A90} noise level of 52dBA was measured.

The construction noise criteria are shown in **Table 6-3**.

Table 6-3 L_{Aeq} Construction Noise Criteria

Receiver	Background Level	Background Level	Management Levels		Criteria
	Recommended Standard Hours	Outside Recommended Standard Hours	L_{Aeq} dBA		L_{Amax} dBA
	L_{A90} dBA	L_{A90} dBA	Recommended Standard Hours	Outside Recommended Standard Hours	Night Time
R1 3385 Pacific Hwy	50	30 (est)	60	35	45
R2 Riding School	52	-	65	65	-

Note: - indicates not applicable.

6.2 Mobile Plant Source Noise Levels

Sound levels of typical equipment are listed in **Table 6-4**. The Table gives both Sound Power Level (SWL) and Sound Pressure Level (SPL) at 7m for the equipment. SWL is independent of measurement position. Verification of plant noise is typically done by measuring the SPL at 7m.

Table 6-4 Typical Construction Plant Sound Levels

Plant	Sound Power Level (dBA)	Sound Pressure Level at 7m (dBA)
Front End Loader	111	86
Grader	107	82
Smooth Drum Roller	107	82
Spoil, Materials or Concrete Truck	109	84
Tower Crane or Mobile Crane	105	80
Truck-mounted Shotcrete Pump	106	81
Excavator or Bobcat	107	82
Concrete Pump	105	80
Concrete Vibrator	103	78
Concrete Cutter	109	84
Large Bored Drilling Rig	112	87

Plant	Sound Power Level (dBA)	Sound Pressure Level at 7m (dBA)
Small Bored Drilling Rig	108	83
Powered Hand Tools	109	84
30t Excavator operating with Hydraulic hammer	122	97
Rock Saw	116	91
Water Cart	110	85
Kerbing Machine	99	74
Chainsaw	106	81
Forklift	106	81
Mulcher	106	81
Articulated Dump Truck	113	88
Handheld Jackhammer	113	88
Air Compressor (Power Tools)	98	73
Asphalt Paving Plant	114	89

Based on the above, noise from some example activities has been predicted. The stages shown in Subject to background noise levels, some activities such as saw cutting, hydraulic hammering and impact piling activities may need a 5dBA modifying factor adjustment for annoying characteristics as required by the *ICNG*.

Table 6-5 are considered representative of the majority of activities. Typical worst-case activities are presented in the table. Some activities with low impact, such as traffic control installation and line marking, have not been presented.

Subject to background noise levels, some activities such as saw cutting, hydraulic hammering and impact piling activities may need a 5dBA modifying factor adjustment for annoying characteristics as required by the *ICNG*.

Table 6-5 Calculation of Total Sound Power Level (SWL)

Activity	Total $L_{Aeq,15min}$ Sound Power Level (SWL) used for Calculations
Site Establishment	110
Clearing	110
Earthworks	116
Hydraulic Hammering	122
Paving	110
Piling	115 (bored)
Drainage Works	112
Bridge Craning at night time	$110 L_{Aeq} - 116 L_{Amax}$
Sawcutting	115
Landscaping	110

6.3 Predicted Noise Levels at Receivers

The noise level experienced at any receiver will depend upon many factors, such as distance to the construction site, sound exposure time and the activity occurring at the construction site. As the construction activities move, three scenarios have been considered in the calculations as follows:

- Zone A: construction works concentrated in the south area of the proposed works;
- Zone B: construction works concentrated in the interchange area (includes hydraulic hammering); and
- Zone C: construction works concentrated to the north area of the interchange.

Figure 6-1 shows the constructions zones considered in this assessment.

Construction noise emissions were modelled using the ISO 9613 algorithm implemented in the SoundPlan and based on the model used for road traffic noise assessment. The predicted $L_{Aeq,15min}$ noise levels from construction stages are shown in **Table 6-6** and **Table 6-7**.

Due to the significant distance between construction works and existing receivers, it is expected that construction noise levels would comply with the noise criteria. It should be noted that the presented noise levels represent the typical worst-case use of plant and thus noise levels would be expected to be lower than those presented for much of the construction period. In addition, noise generated during construction works is likely to be masked by traffic noise levels.

Figure 6-1 Construction Zones

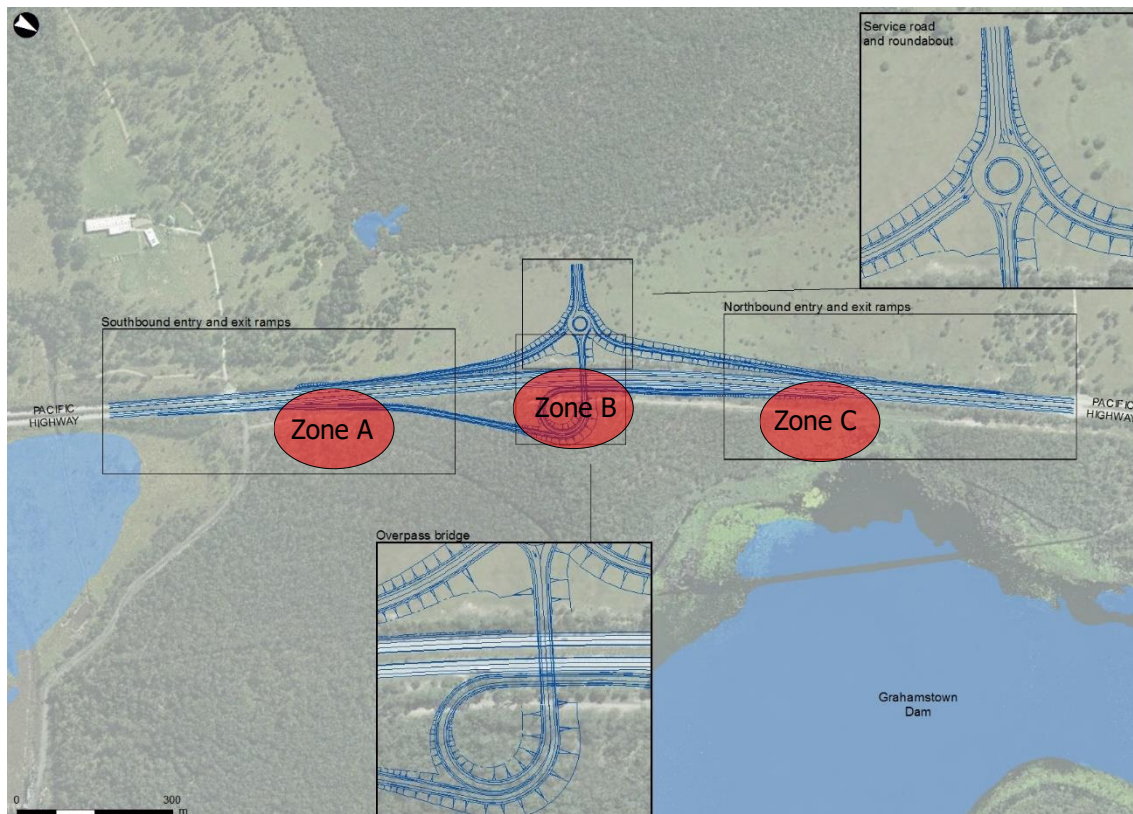


Table 6-6 Predicted Construction Noise Levels for Standard Recommended Hours

Scenario			Predicted $L_{Aeq,15min}$	
			R1: 3385 Pacific Hwy	R2: Riding School
Management Levels $L_{Aeq,15min}$ (dBA)			60	65
Recommended Standard Hours				
Activity	SWL	Zone		
Establishment Clearing Paving, Landscaping	110 SWL dB(A)	Zone A	31	44
		Zone B	35	37
		Zone C	42	32
Earthworks 116 SWL dB(A)	116 SWL dB(A)	Zone A	37	48
		Zone B	41	41
		Zone C	48	36
Hydraulic Hammering	122 SWL dB(A)	Zone A	-	-
		Zone B	47	52
		Zone C	-	-
Piling Sawcutting	115 SWL dB(A)	Zone A	36	52
		Zone B	40	45
		Zone C	47	40
Drainage Works	112 SWL dB(A)	Zone A	33	49
		Zone B	37	42
		Zone C	44	37

Table 6-7 Predicted Construction Noise Levels for Outside Standard Recommended Hours

Receiver	Management Levels (dBA)		Bridgeworks at Zone B Predicted Noise Levels (dBA)	
	$L_{Aeq,15min}$	L_{Amax}	$L_{Aeq,15min}$	L_{Amax}
			110 SWL	116 SWL
R1: 3385 Pacific Hwy	35	45	35	41
R2: Riding School	65	-	37	-

Note: - indicates not applicable.

6.4 Construction Noise Mitigation Options

Any mitigation measures provided to control construction noise impacts shall be implemented as early as practicable to provide a benefit during some of the construction phase. A range of possible approaches to reducing the impact of construction noise when operations are undertaken outside recommended standard hours is described below. It is proposed that these "on site" strategies be applied to areas of potential exceedance identified in the preceding section.

Appendix B (standard mitigation measures) and Appendix C (additional mitigation measures) of the CNVG provide details of the feasible and reasonable mitigation options. In addition, the CNVG discusses the feasible and reasonable concept. The main mitigation measures are discussed below.

- *Equipment Selection* – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines.
- *Site Noise Planning* – Where practical, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels.
- *Operator Instruction* – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission. This is particularly relevant for night time works
- *Plant Noise Audit* – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be established with the contractor.
- *Respite Periods* – Where predicted noise levels exceed the highly noise affected category it may be necessary to provide respite periods for percussive activities (ie hydraulic hammer).

6.4.1 Community Liaison & General Approaches to Mitigation

An effective community relations programme should be put in place to keep potentially affected receivers appraised of progress of the works, and to forewarn potentially affected groups of any anticipated changes in noise and vibration emissions prior to critical stages of the works (particularly out of hours works), and to explain complaint procedures and response mechanisms.

Close liaison should be maintained between the residents living in the area and the parties associated with the construction works to provide effective feedback in regard to perceived emissions. In this manner, equipment selections and work activities can be coordinated where necessary to minimise disturbance to neighbouring receivers, and to ensure prompt response to complaints, should they occur.

7 CONCLUSIONS & RECOMMENDATIONS

Noise impacts from the construction and operation of the proposed interchange and drainage channel has been assessed primarily in accordance with the NSW EPA *Road Noise Policy (RNP)*, the RMS *Noise Criteria Guideline (NCG)* and *Noise Mitigation Guideline (NMG)* and NSW EPA *Interim Construction Noise Guideline (ICNG)* and *RMS Construction Noise and Vibration Guideline (CNVG)*.

Potential impacts at relevant noise sensitive receivers have been quantified and where required, mitigation measures have been proposed to minimise the potential impact. The assessment can be summarised as follows:

7.1 Operational Noise

The project consists in developing an interchange comprising southbound on / off ramps, northbound on / off ramps and a two lane bridge. The Pacific Highway is classified in the 'freeways' category and the project mainly constitutes a "redevelopment" for assessment according to the guidelines of the *NCG*. Whilst the "Transition Zone" requirements have been considered the noise criteria do not require adjustment.

The total traffic noise level from the existing road and the development should comply at all residential receivers with the assessment criteria of 60dB $L_{eq,15hr}$ daytime and 55dBA $L_{eq,9hr}$ night time. In addition, a noise criterion of 60dBA $L_{eq,15hr}$ has been adopted for the existing "Riding for the Disabled" property when in use.

In addition, increases in noise level should be limited to no more than 2.0dB.

Predicted noise levels are shown to be within the assessment criteria limits or result in increases in noise of less than 2dB, hence no mitigation is warranted.

As agreed with RMS, baseline noise monitoring should be conducted at the two existing properties prior to construction.

Whilst not a requirement of the REF assessment, minimising traffic noise should be considered further in the detailed design of the interchange ramps and new sub-division.

7.2 Construction Noise

Construction noise during standard daytime hours is predicted to comply with the *ICNG* noise criteria at the two affected properties. Proposed works which are likely to occur outside of standard hours are also predicted to comply with the *ICNG* management levels.

It is recommended the appointed construction contractor will prepare a Construction Noise and Management Plan. The plan will include but not limited to the following:

- Roles and responsibilities
- Noise-sensitive receiver locations and impacts
- Mitigation strategy
- Monitoring methodology
- Community engagement strategy.

Workers and contractors will be inducted and trained (such as through toolbox talks) in the use of construction equipment in ways that minimise noise.

The following approaches to reduce the impact of construction noise during outside recommended standard hours would be applied by the construction contractor where feasible and reasonable:

- Equipment Selection;
- Site Noise Planning;
- Operator Instruction;
- Plant Noise Audit;
- Localised Barrier;
- Respite Periods; and
- Community Liaison & General Approaches to Mitigation.