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Transportation Noise Assessment

Swan River Crossings

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1 INTRODUCTION

The existing Fremantle traffic and rail bridges, as shown in *Figure 1-1*, are to be redesigned and reconstructed to incorporate four traffic lanes, three rail lines (two passenger, one freight) and pedestrian cyclist facilities, all forming part of the Swan River Crossings (the project).

Lloyd George Acoustics has been commissioned to assess the noise and vibration impacts to sensitive premises adjacent to the project and to compare the results against relevant criteria. In addition, the results are also compared against the predicted noise and vibration levels should the project not proceed (existing bridge designs / No Build Scenario).

Where the project is found to exceed the relevant criteria, mitigation measures will be investigated.

Figure 1-1 Project Locality

Appendix B contains a description of some of the terminology used throughout this report.

2 CRITERIA

2.1 Noise

The criteria relevant to this assessment is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1 Noise Targets for Road and Rail Upgrades

Scenario	Outdoor Noise Target	
Road/Rail Upgrade	60 dB $L_{Aeq(Day)}$	55 dB $L_{Aeq(Night)}$

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of the noise sensitive building.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines. For instance, it is likely unreasonable for a transport infrastructure provider to achieve the outdoor targets at more than 1 or 2 floors of an adjacent development with direct line of sight to the traffic

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment is undertaken (2041 in this case). For freight railways, SPP 5.4 requires the assessment to assume one train per hour unless higher train movements are expected.

It is recognised that in some instances, it may not be reasonable and/or practicable to meet the outdoor noise targets. Where transport noise is above the noise targets, measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

[1] A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.

Discretion may be exercised by the decision-maker to take into consideration reasonable and practical matters including:

- the requirements of other relevant plans and policies; and
- the impact of proposed mitigation measures on the amenity of the built environment.

Justification as to why the noise targets cannot be achieved and whether the noise can be reduced to an acceptable level should be documented by the proponent and considered by the decision maker.

New or major upgrades of roads and railway construction proposals in existing reserves generally do not require planning approval as public works are exempt from the development assessment process under the deemed provisions of the *Public Works Act 1902*. However infrastructure providers, operators and governing bodies are encouraged to continuously enhance assets to reduce noise and to carry out works in a manner that is consistent with SPP 5.4.

Where new residential projects are constructed adjacent to transportation corridors, SPP 5.4 provides indoor noise criteria, where the outdoor noise targets cannot be reasonably achieved. As this area already experiences a high level of transportation noise, the buildings adjacent to the project would have been designed to achieve these indoor noise criteria, assuming the existing road and railway design and projected 2031 traffic volumes at the time of those projects. This assessment will determine if these indoor criteria can still be achieved for the project design and 2041 traffic volumes.

2.2 Vibration

SPP 5.4 does not consider vibration, however common criteria used in Western Australia for annoyance are the vibration curves 1.4 and 2 (Annex A) of Australian Standard 2670.2-1990 *Evaluation of human exposure to whole-body vibration Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz).* These criteria are compared against the R.M.S vibration levels.

For structural damage to buildings, the criterion of 5 mm/s, taken from the German standard DIN 4150, is generally accepted as the threshold above which superficial damage, such as cracking plaster, can occur. These criteria are compared against the Peak vibration levels.

3 METHODOLOGY

3.1 Noise Measurements

Noise measurements and modelling have been undertaken generally in accordance with the requirements of SPP 5.4 and associated Guidelines[2] as described in *Section 3.1* and *Section 3.2*.

Both short and long-term noise monitoring was undertaken at four (4) locations in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{Aeq(Day)}$ and $L_{Aeq(Night)}$); and
- Calibrate the noise model for existing conditions.

The instrumentation used was ARL Ngara noise data loggers located either on property balconies, with a view of the existing road and railway, or adjacent, to the property on ground floor. One noise data logger was placed within the rail corridor to capture the noise from passenger and freight trains at close distances and another was placed within the outdoor pool area of the Rivershores apartment to understand the impact to this recreation area.

At all locations the microphone was placed 1.4 metres above floor level (refer *Figure 3-1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

Figure 3-1 Typical Noise Logger Installation

The noise data collected was verified by inspection and professional judgement. Where hourly data was considered atypical, an estimated value was inserted and highlighted by bold italic lettering.

[2] Road and Rail Noise Guidelines, September 2019

The weather conditions during the measurement period were obtained from the Bureau of Meteorology's, Swanbourne station. This data was compared against the Main Roads specifications for measurement conditions and unacceptable conditions commented on.

3.2 Vibration Measurements

Vibration monitoring was undertaken using a Texcel ground vibration monitor connected to a geophone that was fixed to the ground using metal spikes. The geophone was positioned outside of 20 Kwong Alley facing the road and railway.

Figure 3-2 Typical Vibration Logger Installation

3.3 Noise Modelling

The computer program *SoundPLAN 8.2* was utilised to predict the noise from the road and rail for each of the four design options for the project.

The *Nordic Prediction Method for Train Noise* (NMT) algorithms were used to predict the noise from the railway and the *Calculation of Road Traffic Noise* (CoRTN) algorithms were used to predict the noise from the road traffic.

The *Calculation of Road Traffic Noise* (CoRTN) algorithms were modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered.
- Note that a -8.0 dB correction is applied to the exhaust and -0.8 dB to the engine (based on Transportation Noise Reference Book, Paul Nelson, 1987), so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;
- Adjustments of -1.7 dB have been applied to the predicted levels for the 'at facade' predictions, based on the findings of *An Evaluation of the U.K. DoE Traffic Noise Prediction*; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group (March 1983).

Predictions are made at heights of 1.4 m above floor level. The noise is predicted at 1.0 metre from an assumed building facade resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling such as ground topography, road design, rail design, traffic volumes etc. These model inputs are discussed in the following sections.

3.3.1 Ground Topography & Road/Rail Design

Topographical and project design data for this project were provided by Fremantle Bridges Alliance.

Buildings have also been included as these can provide barrier attenuation when located between a source and receiver, in much the same way as a hill or wall provides noise shielding. Note for new and upgraded roads and railways, the noise target applies to the first two floors, however, all floors will beconsidered in this instance.

3.3.2 Road Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown in *Table 3-1*.

Table 3-1 Noise Relationship Between Different Road Surfaces

Road Surfaces							
Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface is dense graded asphalt and is expected to remain unchanged into the future.

- Vehicle Speed – The existing and future posted speeds are 60km/hr.

- Traffic Volumes – Existing (2021), project opening (2024) and forecast (2041) traffic volumes were provided by Arup (Darryl Patterson 9/3/21). *Table 3-2* provides the traffic volume input data in the model.

Table 3-2 Road Traffic Information Used in the Modelling

Parameter	Scenario		
	Existing (2021)	Future (2024)	Future (2041)
24 Hour Volume	23,920	24,960	32,830
% Heavy	5.8	5.8	5.8

3.3.3 Rail Data

Railway movements are taken from the PTA timetable for passenger trains and from observations of existing freight movements and requirements under the Policy for future freight movements. *Table 3-3* provides the train numbers over a 24 hour period that were used in the model.

Table 3-3 Rail Information Used in the Modelling

Parameter	Scenario		
	Existing - 2021	Future 2024	Future - 2041
Passenger Trains	160	160	160
Freight Trains	4	24	24

3.3.4 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road and rail reserve as well as for water and 0.4 (40%) throughout the residential area. Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.3.5 Parameter Conversion

The CoRTN algorithms used in the *SoundPLAN* traffic noise modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. SPP 5.4 however uses $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles).

As noise monitoring was undertaken, the relationship between the parameters is based on the results of the monitoring – refer *Section 4.1*.

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised in *Table 4-1*.

Table 4-1 Measured Average Noise Levels

Location	Average Weekday Noise Level, dB	
	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Balcony of Unit 16 / 2 Doepel St	61.4	53.1
Pool Area of Rivershores (2 Doepel St)	59.4	53.2
Balcony of Unit 7 / 30 Kwong Alley	68.4	60.3
Within Rail Reserve opposite Kwong Alley	76.0	69.6
Backyard of 5 Pearse St	56.5	49.0

The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is greater than 5 dB at all locations. This same difference has been assumed to exist in future years. As such, it is the daytime noise levels that will dictate compliance with the Policy criteria.

The *Table 4-1* monitoring results are also compared against the noise modelling, assuming the existing design and traffic/train volumes to calibrate the model. It was found that modelling was predicting the noise levels accurately with results within 1 dB at all locations as shown in *Table 4-2*.

Table 4-2 Comparison between Measured and Predicted Noise Levels

Location	Noise Level $L_{Aeq\ (Day)}$ dB		
	Measured	Predicted	Difference
Trackside	76.0	76.2	+0.2
Balcony of Unit 16 / 2 Doepel St	61.4	62.1	+0.7
Balcony of Unit 7 / 30 Kwong Alley	68.4	67.9	-0.5
5 Pearse St	56.5	56.7	+0.2

Note: The predicted noise levels are a combination of road and rail noise.

Detailed results are provided in *Appendix A.*

4.2 Noise Modelling

The results of the predictive road traffic noise modelling assuming the proposed design, for the year 2024 when the project is expected to open, and 2041, which is the future noise levels as required under the Policy, are compared against the predicted noise levels for the same years should the project not proceed. These results are presented in *Table 4-3* and *Table 4-4.*

The results of the future rail noise levels assuming the proposed design are compared against the predicted noise levels for the same years should the project not proceed. These results are presented in *Table 4-5.* It should be noted that for the rail noise assessment, the 2024 and 2041 train volumes are the same and therefore the predicted levels are also the same.

The noise sensitive receiver locations are shown in *Figure 4-1*.

Future traffic noise and railway noise levels are shown as noise level contour maps in *Figure 4-2* and *Figure 4-3* respectively.

Table 4-3 Comparison between Existing and Design Options – Road Traffic 2024

Floor	Address	Predicted Noise Level $L_{Aeq\ (Day)}$ dB		Difference
		Existing Design 2024	Proposed Design 2024	
GF	2 Pensioner Guard Rd	73	71	-2
F 1	2 Pensioner Guard Rd	72	71	-1
GF	8 Pensioner Guard Rd	59	57	-2
F 1	8 Pensioner Guard Rd	61	59	-2
GF	5 Swan St	59	58	-1
F 1	5 Swan St	61	60	-1
GF	16 Bick Lane	73	71	-2
GF	12 Pensioner Guard Rd	58	57	-1
GF	4 Swan St	57	56	-1
F 1	4 Swan St	59	58	-1
GF	2 Kwong Ally	71	69	-2
F 1	2 Kwong Ally	71	70	-1
GF	10 Kwong Ally N	71	70	-1
F 1	10 Kwong Ally N	71	70	-1

Floor	Address	Predicted Noise Level $L_{Aeq\ (Day)}$ dB		Difference
		Existing Design 2024	Proposed Design 2024	
GF	10 Kwong Ally S	70	69	-1
F 1	10 Kwong Ally S	70	70	0
GF	12 Kwong Ally	69	69	0
F 1	12 Kwong Ally	70	70	0
GF	20 Kwong Alley North*	-	-	-
F 1	20 Kwong Alley North	69	68	-1
F 2	20 Kwong Alley North	69	69	0
F 3	20 Kwong Alley North	69	69	0
GF	20 Kwong Alley South*	-	-	-
F 1	20 Kwong Alley South	67	65	-2
F 2	20 Kwong Alley South	68	67	-1
F 3	20 Kwong Alley South	68	68	0
GF	30 Kwong Alley	64	62	-2
F 1	30 Kwong Alley	67	65	-2
GF	2 Doepel St Facing Rd*	-	-	-
F 1	2 Doepel St Facing Rd	65	63	-2
F 2	2 Doepel St Facing Rd	67	64	-3
F 3	2 Doepel St Facing Rd	67	65	-2
-	2 Doepel St Pool Area	59	57	-2
GF	2 Doepel St*	-	-	-
F 1	2 Doepel St Balcony	61	57	-4
F 2	2 Doepel St Balcony	62	58	-4
F 3	2 Doepel St Balcony	62	60	-2
GF	2 Burt St	69	69	0

*Car Parking Area

Table 4-4 Comparison between Existing and Design Options – Road Traffic 2041

Floor	Address	Predicted Noise Level $L_{Aeq\ (Day)}$ dB		Difference
		Existing Design 2041	Proposed Design 2041	
GF	2 Pensioner Guard Rd	74	72	-2
F 1	2 Pensioner Guard Rd	73	72	-1
GF	8 Pensioner Guard Rd	60	59	-2
F 1	8 Pensioner Guard Rd	62	61	-1
GF	5 Swan St	60	59	-1
F 1	5 Swan St	62	61	-1
GF	16 Bick Lane	74	73	-1
GF	12 Pensioner Guard Rd	59	58	-1
GF	4 Swan St	58	57	-1
F 1	4 Swan St	60	59	-1
GF	2 Kwong Ally	72	70	-2
F 1	2 Kwong Ally	72	71	-1
GF	10 Kwong Ally N	72	71	-1
F 1	10 Kwong Ally N	72	71	-1
GF	10 Kwong Ally S	71	70	-1
F 1	10 Kwong Ally S	72	71	-1
GF	12 Kwong Ally	71	70	-1
F 1	12 Kwong Ally	71	71	0
GF	20 Kwong Alley North*	-	-	-
F 1	20 Kwong Alley North	70	69	-1
F 2	20 Kwong Alley North	70	70	0
F 3	20 Kwong Alley North	70	70	0

*Car Parking Area

Floor	Address	Predicted Noise Level $L_{Aeq\ (Day)}$ dB		Difference
		Existing Design 2041	Proposed Design 2041	
GF	20 Kwong Alley South*	-	-	-
F 1	20 Kwong Alley South	68	67	-1
F 2	20 Kwong Alley South	69	68	-1
F 3	20 Kwong Alley South	69	69	0
GF	30 Kwong Alley	65	63	-2
F 1	30 Kwong Alley	68	66	-2
GF	2 Doepel St Facing Rd*	-	-	-
F 1	2 Doepel St Facing Rd	66	64	-2
F 2	2 Doepel St Facing Rd	68	65	-3
F 3	2 Doepel St Facing Rd	68	66	-2
-	2 Doepel St Pool Area	60	58	-2
GF	2 Doepel St*	-	-	-
F 1	2 Doepel St Balcony	62	58	-4
F 2	2 Doepel St Balcony	63	60	-3
F 3	2 Doepel St Balcony	63	61	-2
GF	2 Burt St	70	70	0

*Car Parking Area

Table 4-5 Comparison between Existing and Design Options – Future Rail

Floor	Address	Predicted Noise Level $L_{Aeq (Day)}$ dB		Difference
		Existing Design Future	Proposed Design Future	
GF	9 Pearse St	56	56	0
GF	7 Pearse St	56	56	0
GF	5 Pearse St	56	56	0
GF	3a Pearse St	55	55	0
GF	2 Pensioner Guard Rd	50	51	0
F 1	2 Pensioner Guard Rd	52	52	0
GF	8 Pensioner Guard Rd	45	45	0
GF	8 Pensioner Guard Rd	46	46	0
F 1	8 Pensioner Guard Rd	49	49	0
GF	12 Pensioner Guard Rd	56	56	0
GF	16 Bick Lane	58	57	-1
GF	5 Swan St	47	47	0
F 1	5 Swan St	49	49	0
GF	4 Swan St	56	55	-1
F 1	4 Swan St	56	56	0
GF	2 Kwong Ally	61	61	0
F 1	2 Kwong Ally	62	62	-1
GF	10 Kwong Ally N	62	61	0
F 1	10 Kwong Ally N	62	62	-1
GF	10 Kwong Ally S	62	61	0
F 1	10 Kwong Ally S	63	63	-1
GF	12 Kwong Ally	62	61	0
F 1	12 Kwong Ally	63	63	-1

Floor	Address	Predicted Noise Level $L_{Aeq\,(Day)}$ dB		Difference
		Existing Design Future	Proposed Design Future	
GF	20 Kwong Alley North*	-	-	-
F 1	20 Kwong Alley North	63	62	-1
F 2	20 Kwong Alley North	64	64	0
F 3	20 Kwong Alley North	64	64	0
GF	20 Kwong Alley South*	-	-	-
F 1	20 Kwong Alley South	63	61	-1
F 2	20 Kwong Alley South	63	64	0
F 3	20 Kwong Alley South	64	64	0
GF	2 Doepel St Facing Rd*	-	-	-
F 1	2 Doepel St Facing Rd	61	56	-4
F 2	2 Doepel St Facing Rd	62	61	0
F 3	2 Doepel St Facing Rd	62	63	1
-	2 Doepel St Pool Area	57	58	1
GF	2 Doepel St*	-	-	-
F 1	2 Doepel St Balcony	50	45	-5
F 2	2 Doepel St Balcony	50	48	-2
F 3	2 Doepel St Balcony	51	52	1
GF	2 Burt St	55	55	0

*Car Parking Area

Figure 4-1

Length Scale

0 35 70 140 210

Swan River Crossings, Fremantle
Receiver Locations

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Figure 4-2

Noise level $L_{Aeq,(day)}$ dB

= 55
= 60
= 65
= 70

Length Scale

0 35 70 140 210 m

Swan River Crossings, Fremantle - Proposed Design - Road Traffic Noise - 2041

Predicted $L_{Aeq,(day)}$ Noise Levels - First Floor

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(08) 9401 7770

Figure 4-3

Noise level $L_{Aeq,(day)}$ dB

- = 55
- = 60
- = 65
- = 70

Length Scale

0 35 70 140 210 m

Swan River Crossings, Fremantle - Proposed Design - Railway Noise - Future

Predicted $L_{Aeq,(day)}$ Noise Levels - First Floor

Lloyd George Acoustics

www.lgacoustics.com.au

(08) 9401 7770

4.3 Vibration Measurements

The results of the vibration measurements are presented in *Figure 4-4* and *Figure 4-5,* being for R.M.S. and peak vibration levels respectively.

The results show that the existing R.M.S. vibration levels are generally under the threshold that would result in annoyance, particularly as the vibration source is intermittent and not continuous. The peak vibration levels are well below levels that are likely to result in structural damage.

The design options being considered are unlikely to result in a significant increase in vibration levels at the buildings located adjacent to the project route.

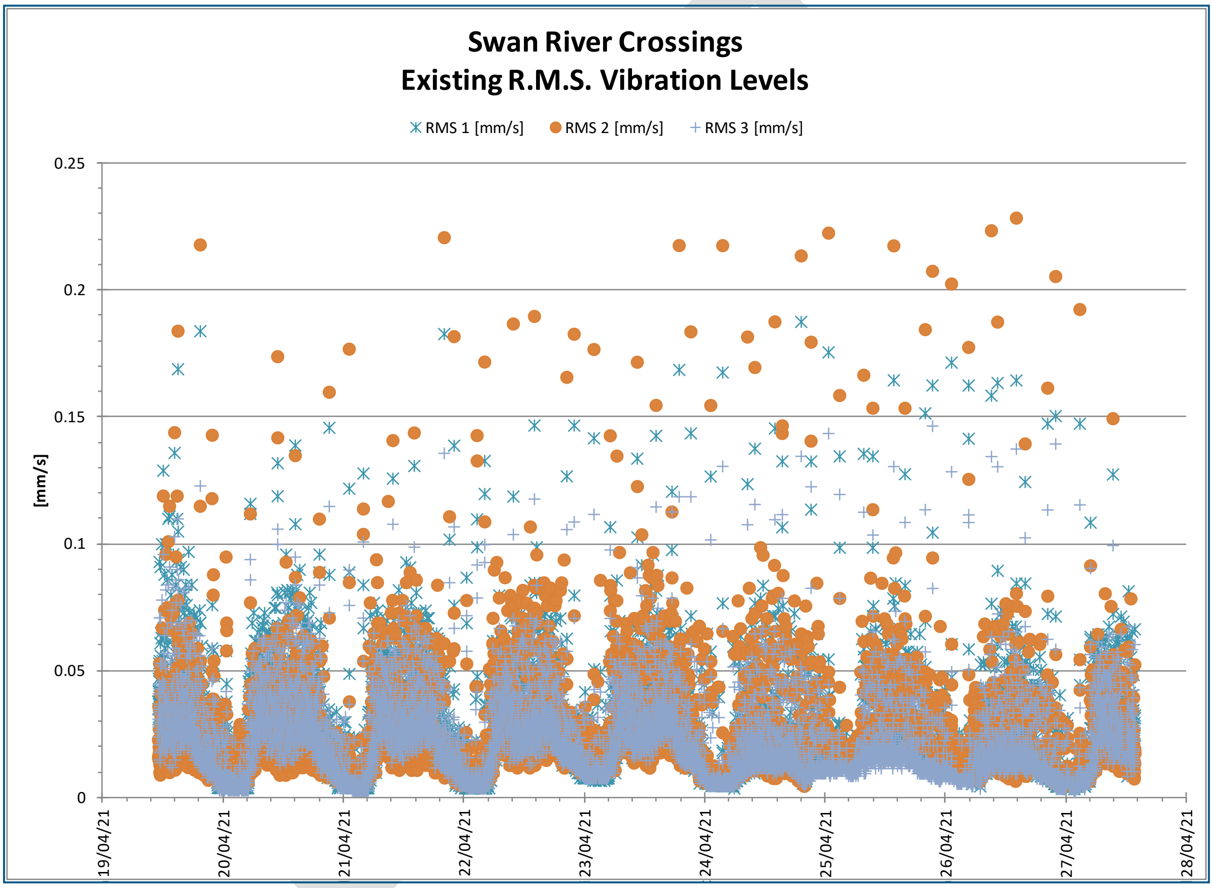


Figure 4-4 Existing R.M.S. Vibration Levels

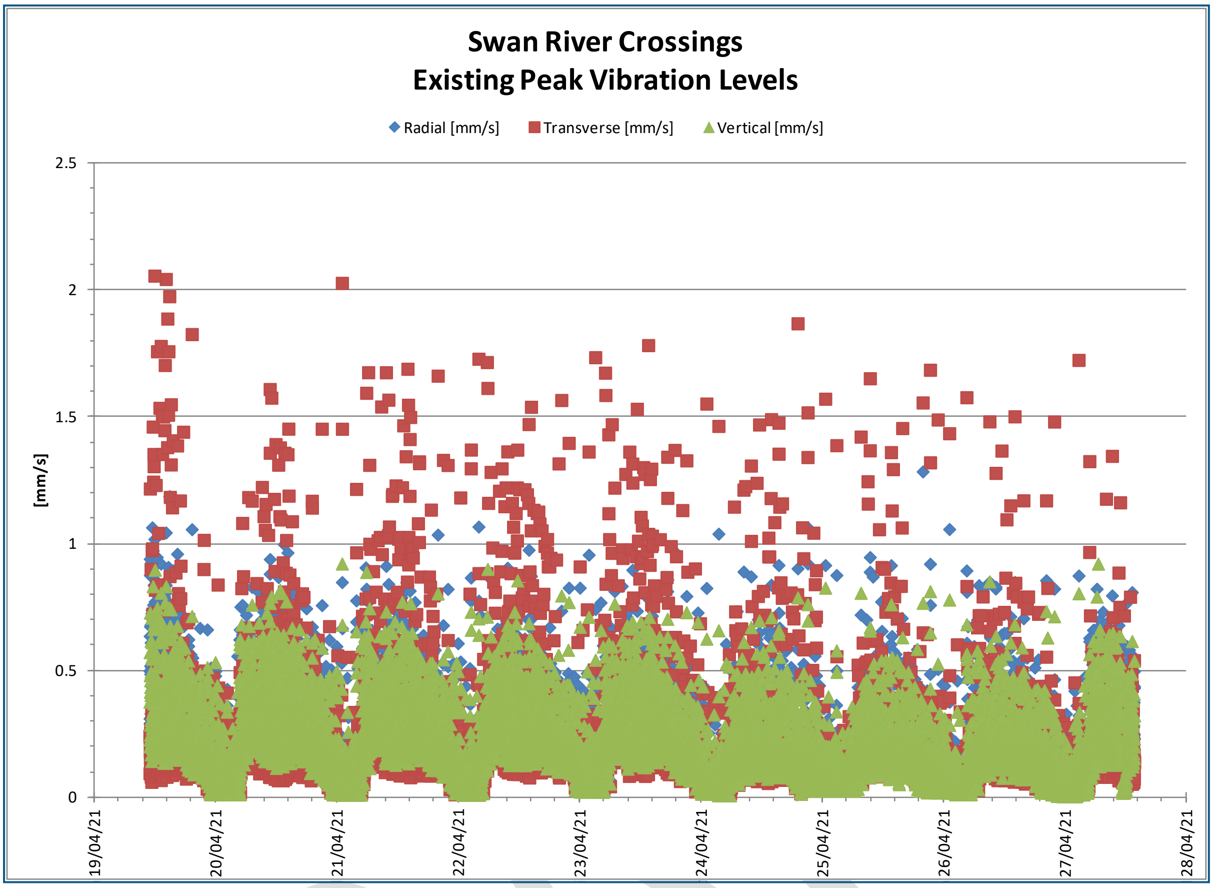


Figure 4-5 Existing Peak Vibration Levels

5 DISCUSSION & RECOMMENDATIONS

From the results of the assessment, presented in *Table 4-3* to *Table 4-5*, it can be seen that the project has no significant impact when compared with the "no build" scenario and, in fact, shows a reduction in noise levels in a number of cases as a result of the change in alignment or shielding of the railway line as a result of the elevated road bridge section.

In addition, the results show that it is the road traffic that will dominate the overall noise level received at sensitive residents.

Whilst the project is not necessarily increasing noise levels, SPP 5.4 does require noise mitigation to be considered, where future transportation noise levels exceed the outdoor noise target of 60 dB $L_{Aeq(Day)}$, which is the case whether the project proceeds or not.

Given the close proximity of the project to multi-storey noise sensitive premises, use of noise barriers would need to be significant in height and will detract from the visual amenity of residents and the aesthetics of the project. As such, barriers are not considered to be practicable in this project, especially given the project tends to reduce noise levels and adjoining residences would have been built to accommodate transport noise.

For instance, Lloyd George Acoustics was involved in both the 2 Doepel Street apartments (Rivershores) and 20 Kwong Alley apartments, both of which considered road traffic noise. For the property at 20 Kwong Alley, the predicted future noise level at the facade is up to 70 dB $L_{Aeq(Day)}$ depending on the floor level. The internal design sound level range for living areas of apartments near major roads, as specified in Table 1 of *Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors* is L_{Aeq} 35-45 dB. From information on file, this property was designed with a facade system achieving an $R_w + C_{tr}$ 35, which would result in an internal noise level of L_{Aeq} 43 dB, which is within the recommended design sound levels, albeit 3 dB above the SPP 5.4 target.

For the property at 2 Doepel Street, the predicted future noise level at the facade is up to 66 dB $L_{Aeq(Day)}$ depending on the floor level. This property was designed with 10.5mm thick *VLam Hush* glazing achieving an $R_w + C_{tr}$ 34, which would result in an internal noise level of L_{Aeq} 40 dB. Therefore compliance with the acceptable internal noise level for living areas would be achieved for this property.

While the predictions do show that internal noise levels may be higher than desired, SPP 5.4 does state that measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

The predicted traffic noise level assumes a dense graded road surface, which is common for this category of road within the Perth metropolitan area. However, a reduction in traffic noise of 1.5 dB could be achieved using a stone-mastic road surface and a 2.5 dB reduction for an open-graded asphalt road surface (see *Table 3-1*). The use of these road surfaces, particularly adjacent to the properties on Queen Victoria Street should be considered.

Vibration levels are below the level that would generally be considered as annoying and are extremely unlikely to result in structural damage to buildings. We do not expect these values to significantly change as a result of the project.

Appendix A

Noise Measurement Data

Unit 16 / 2 Doepel Street

Date	$L_{A10(18hour)}$	$L_{Aeq(24hour)}$	$L_{Aeq(16hour)}$	$L_{Aeq(8hour)}$
20/04/2021	62.5	60.3	61.8	52.8
21/04/2021	62.6	60.3	61.8	53.3
22/04/2021	61.6	59.1	60.5	52.4
23/04/2021	62.7	59.9	61.3	53.7
26/04/2021*	59.2	56.4	57.7	50.4
Average	**62**	**60**	**61**	**53**

*Data Unreliable

2 Doepel Street Pool Area

Date	$L_{A10(18hour)}$	$L_{Aeq(24hour)}$	$L_{Aeq(16hour)}$	$L_{Aeq(8hour)}$
20/04/2021	60.2	58.5	59.6	54.5
21/04/2021	60.1	58.5	59.8	53.3
22/04/2021	59.5	57.4	58.7	51.6
23/04/2021	60.0	58.1	59.3	53.3
26/04/2021*	56.7	55.2	56.1	52.5
Average	**60**	**58**	**59**	**53**

*Data Unreliable

Unit 7 / 30 Kwong Alleyt

Date	$L_{A10(18hour)}$	$L_{Aeq(24hour)}$	$L_{Aeq(16hour)}$	$L_{Aeq(8hour)}$
20/04/2021	69.9	67.2	68.7	60.4
21/04/2021	69.6	67.3	68.8	59.9
22/04/2021	69.2	66.3	67.8	59.7
23/04/2021	69.6	66.9	68.3	61.1
26/04/2021*	66.2	63.3	64.7	57.4
Average	**70**	**67**	**68**	**60**

*Public hol

Rail Reserve

Date	$L_{A10(18hour)}$	$L_{Aeq(24hour)}$	$L_{Aeq(16hour)}$	$L_{Aeq(8hour)}$
22/04/2021	63.3	74.9	76.2	68.9
23/04/2021	62.1	75.0	76.1	71.7
27/04/2021	63.7	74.4	75.8	68.0
Average	**63**	**75**	**76**	**70**

5 Pearse Street

Date	$L_{A10(18hour)}$	$L_{Aeq(24hour)}$	$L_{Aeq(16hour)}$	$L_{Aeq(8hour)}$
20/04/2021	52.6	55.5	56.9	49.3
21/04/2021	50.7	55.1	56.5	48.6
22/04/2021	49.7	54.6	56.1	47.8
23/04/2021	50.7	55.2	56.4	50.4
26/04/2021*	47.9	52.6	54.1	45.4
Average	**51**	**55**	**56**	**49**

*Public Hol

Appendix B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)

The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1

An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}

An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}

An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}

The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$

The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$

The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$

The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$

The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

Noise-sensitive land use and/or development

Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

About the Term 'Reasonable'

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

About the Term 'Practicable'

'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

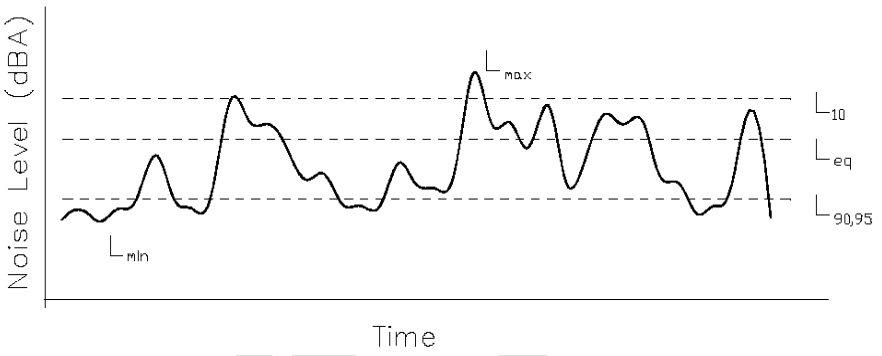
R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

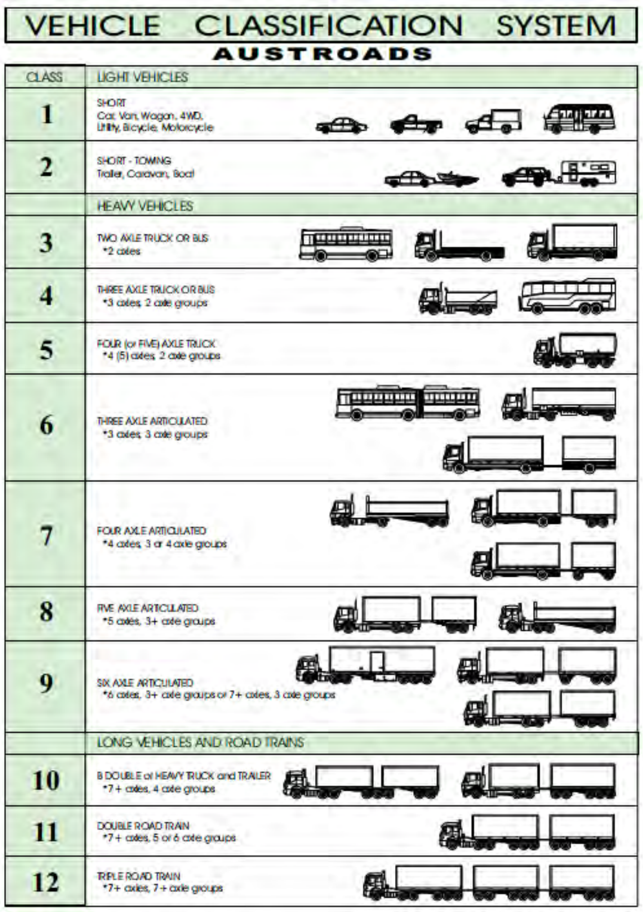
C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

Chart of Noise Level Descriptors



Austroads Vehicle Class



VEHICLE CLASSIFICATION SYSTEM
AUSTROADS

CLASS	LIGHT VEHICLES
1	SHORT Car, Van, Wagon, 4WD, Utility, Bicycle, Motorcycle
2	SHORT - TOWING Trailer, Caravan, Boat
	HEAVY VEHICLES
3	TWO AXLE TRUCK OR BUS *2 axles
4	THREE AXLE TRUCK OR BUS *3 axles, 2 axle groups
5	FOUR (or FIVE) AXLE TRUCK *4 (5) axles, 2 axle groups
6	THREE AXLE ARTICULATED *3 axles, 3 axle groups
7	FOUR AXLE ARTICULATED *4 axles, 3 or 4 axle groups
8	FIVE AXLE ARTICULATED *5 axles, 3+ axle groups
9	SIX AXLE ARTICULATED *6 axles, 3+ axle groups or 7+ axles, 3 axle groups
	LONG VEHICLES AND ROAD TRAINS
10	B DOUBLE or HEAVY TRUCK and TRAILER *7+ axles, 4 axle groups
11	DOUBLE ROAD TRAIN *7+ axles, 5 or 6 axle groups
12	TRIPLE ROAD TRAIN *7+ axles, 7+ axle groups

Typical Noise Levels