Gateway Upgrade Project

15. Noise and Vibration

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15. Noise and Vibration

15.1 Introduction

TOR Requirements:

- Describe the existing environmental values that may be affected by noise and vibration from the Project in the context of environmental values as defined by the *Environmental Protection Act 1994* and Environmental Protection Policies;
- Determine compliance of the Project with the guidelines and standards in the Main Roads Road Traffic Noise - Code of Practice;
- If the proposed activity could adversely impact on the noise environment, baseline monitoring should be undertaken at a selection of sensitive sites affected by the proposed works. Noise sensitive places are defined in the *Environmental Protection (Noise) Policy 1997*. Long-term measured background noise levels that take into account seasonal variations are required;
- Identify locations of sensitive sites on a map at a suitable scale;
- Describe the results of any baseline monitoring of noise and vibration in the proposed vicinity of the Project;
- The daily variation of background noise levels at nearby sensitive sites should be monitored and reported in the EIS, with particular regard given to detailing variations at different periods of the night. Monitoring methods should adhere to relevant Environmental Protection Agency Guidelines and Australian Standards, and any relevant requirements of the *Environmental Protection (Noise) Policy 1997*; and
- Comment on any current activities near the project area that generate elevated noise and vibration background levels.

A noise and vibration assessment has been undertaken by Richard Heggie Associates Pty Ltd to provide information on the existing baseline environment and an assessment of the potential impacts from noise and vibration associated with the GUP during construction and operational phases. Mitigation and management measures have been recommended where appropriate to achieve compliance with applicable limits.

15.2 Noise Assessment

15.2.1 Acoustic Terminology

Standard Noise Indices

This section makes reference to certain noise level descriptors, in particular the L_{A1}, L_{A10}, L_{A90}, L_{Aeq} and L_{Amax} noise levels. Figure 15.1 is an example of a 24 hour noise graph from the noise monitoring undertaken at a residential dwelling adjacent to the Gateway Motorway. These noise level descriptors are defined as:

- The L_{A10} is the A-weighted sound pressure level exceeded 10% of a given measurement period and is utilised normally to characterise typical maximum noise levels.
- The L_{Aeq} is essentially the average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound over the same measurement period.
- The L_{A90} noise level is the A-weighted sound pressure level exceeded 90% of a given measurement period and is representative of the average minimum background sound level (in the absence of the source under consideration), or simply the “background” level.
- The L_{A1} noise level is the A-weighted sound pressure level exceeded 1% of a given measurement period.

- The L_{Amax} noise level is the maximum A-weighted noise level associated with road traffic movements.

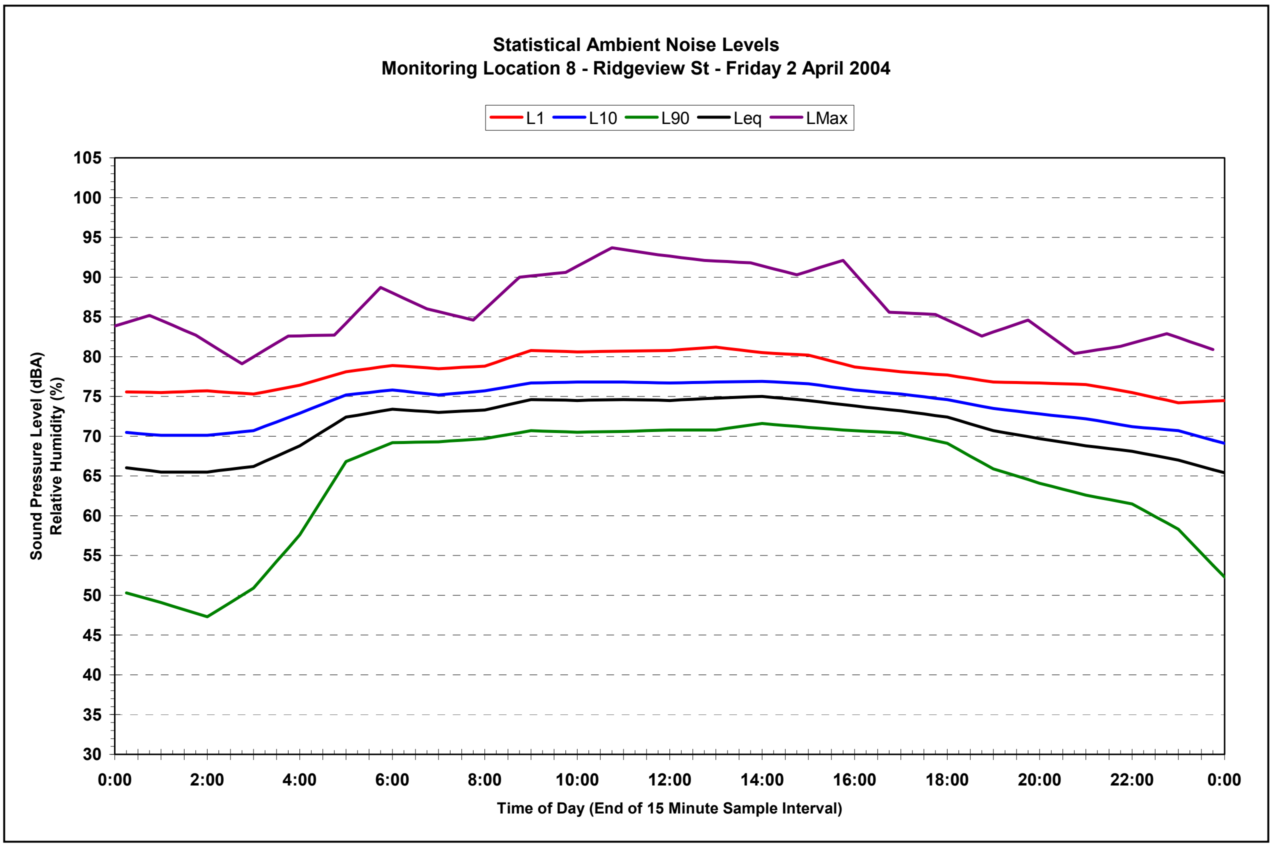

Figure 15.1 Graphical Display of Typical Noise Indices

Typical Noise Levels

Table 15.1 presents examples of typical noise levels.

Table 15.1 Typical Noise Levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130 120 110	Threshold of pain Heavy rock concert Grinding on steel	Intolerable Extremely noisy
100 90	Loud car horn at 3m Construction site with pneumatic hammering	Very noisy
80 70	Kerb side of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to Quiet

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
40 30	Inside private office Inside Bedroom	Quiet to Very quiet
20	Unoccupied recording studio	Almost silent

A-Weighting or dBA Noise Levels

The overall level of a sound is usually expressed in terms of dBA, as is the case in Australian Standards (AS) 1055 *Acoustics – Description and measurement of environmental noise*, AS 2702 *Acoustics – Methods for the measurement of road traffic noise*" and AS 3671 *Acoustics – Road traffic noise intrusion – Building siting and construction*", which is measured using the "A-weighting" filter incorporated in sound level meters.

These filters have a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (500Hz to 4000Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound.

Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (eg the loudness of human speech and a distant motorbike may be perceived differently, although they are of the same dBA level).

Sensitivity of People to Noise Level Changes

A change of up to 3dBA in the level of a sound is difficult for most people to detect, whilst a 3dBA to 5dBA change corresponds to a small but noticeable change in loudness. A 10dBA change corresponds to an approximate doubling or halving in loudness.

15.2.2 Applicable Noise Criteria

Construction

For construction work occurring during normal daytime hours and provided all mechanically powered plant is fitted with appropriate mufflers, specific noise limits are generally not warranted. In this regard it may be noted that the Queensland *Environmental Protection Policy (Noise) 1997* (EPP(Noise)) does not include construction noise or vibration limits (other than those which apply to blasting). Noise impacts are usually minimised by limiting hours of operation and, in particular circumstances, scheduling the noisiest activities to occur at times when they would generate least disruption. For example, pile driving should not generally be considered outside normal working hours. For construction works extending outside normal working hours, particular noise limits should be applied.

Where construction noise may affect adjacent residential premises or other residential accommodation (including hotels, motels, serviced units or backpacker accommodation), limitations to the hours of operation as stated below are recommended.

Monday to Friday:
7:00 am to 6:00 pm

Saturday:
7:00 am to 12 noon

For construction activities occurring outside these hours of operation, noise limits as detailed below are recommended.

Monday to Friday:
6:00pm to 10:00pm - background + 10dBA $L_{A10max\ adj,15min}$
10:00pm to 7:00am – sleep awakening criterion of 50dBA L_{Amax} internal

Saturday:
1:00pm to 10:00pm – background + 10dBA $L_{A10max\ adj,15min}$
10:00pm to 7:00am – sleep awakening criterion of 50dBA L_{Amax} internal

Sunday/Public Holidays:
Sleep awakening criterion of 50dBA L_{Amax} internal

The ($L_{A10max\ adj,\ 15min}$) noise limits refer to the average maximum (L_{10}) A-weighted noise level from the construction activity measured over a 15 minute period, with adjustments for tonality or impulsiveness as applicable.

Where tonality (whistles or hums), or impulsiveness (hammering, bangs) are present, the intrusiveness of the noise is increased. These characteristics should be accounted for by adding 5dBA to the measured level, this is then compared with the applicable noise limit. Thus for example, a compressor with a prominent tonal characteristic, would need to achieve a measured level 5dBA below the noise limit in order that its adjusted measured level comply with the limit.

Blasting
The *EPP(Noise) Environment Protection Amendment Regulation (No 2) 1999* contains the following blast emissions criteria:

> *"**6I** Noise from blasting is not unlawful environmental nuisance for an affected building if:*
>
> - *the airblast overpressure is no more than 115dB Linear Peak for 4 out of 5 consecutive blasts; and*
>
> *the ground vibration is:*
>
> - *for vibrations of more than 35Hz - no more than 25 m/s ground vibration, peak particle velocity; or*
> - *for vibrations of no more than 35Hz - no more than 10 mm/s ground vibration, peak particle velocity."*

Operational

The MR *"Road Traffic Noise Measurement: Code of Practice January 2000"* (Code of Practice) outlines the operational road traffic noise criteria applicable to this project. The Code of Practice provides road traffic noise criteria for proposed new roads, road upgrades, existing roads, residential land use developments as well as criteria for other noise sensitive land uses.

Table 15.2 presents relevant noise criteria for this project, from the Code of Practice.

Table 15.2 Main Roads' Code of Practice Noise Criteria

Description	Noise Criteria (within 10 years of completion of construction)
Existing Residences	*External Noise Level $L_{A10(18hour)}$*
Upgrading Existing Roads (Priority 2)	68dBA (or greater) and an increase of at least 3dBA above the pre-construction level. Measures for noise attenuation will be considered within the road reserve with the aim of reducing levels to 68dBA or less
Upgrading Existing Roads (Priority 3)	68dBA (or greater) and an increase of less than 3dBA above the pre-construction level. Measures for noise attenuation will be considered within the road reserve with the aim of reducing levels to 68dBA or less
Educational & Health Buildings	*Internal Noise Level $L_{A10(1hour)}$*
Upgrading Existing Access – Controlled Roads	55dBA $L_{A10(1hour)}$ or greater and an increase of less than 3dBA above the pre-construction level Measures for noise attenuation will be considered as part of initial planning and design, with the aim of reducing indoor noise levels to 55dBA or less
Parks, Outdoor Educational and Recreational Areas	*Free Field Noise Level $L_{A10(12hour)}$*
All Roads	63dBA

Therefore, the applicable criteria needing to be achieved for the GUP design are:

- 68dBA $L_{A10(18hour)}$ for residences;
- 55dBA $L_{A10(1hour)}$ internal for educational and health buildings; and
- 63dBA $L_{A10(12hour)}$ (free field) for parks, outdoor educational and recreational areas.

The 68dBA $L_{A10(18hour)}$ was adopted north of the river, where the upgrade deviates from the existing Motorway, for the entire Gateway (ie existing and proposed future deviation) as this was considered the only practical way to assess future noise levels via monitoring. For example, as all existing noise sensitive locations are west of the existing corridor, where the existing corridor will dominate road traffic noise levels, it would be impractical to undertake noise monitoring for the future deviation only.

Furthermore, from the residents perspective, all road traffic noise would be coming from the east and consequently it is unlikely that they would differentiate between the two corridors. Also, if a 60dBA or 63dBA $L_{A10(18hour)}$ criterion was adopted for the new corridor, with 68dBA $L_{A10(18hour)}$ applicable for the existing corridor, the resultant combined noise criterion would be (approximately) 69dBA $L_{A10(18hour)}$ for homes to the west of the existing Motorway. This was considered inappropriate.

In Table 15.2, the assessment location for residences is 1m from the most exposed facade of the "noise sensitive" building, and the assessment should consider the upper most floor of any dwelling.

It should be noted that the noise assessment criteria presented within Main Road's Code of Practice are guidelines for consideration of the impact of road traffic noise on noise sensitive development. Consideration needs to be given to technical feasibility, cost effectiveness, aesthetics, equity, community consultation and practicality in recommending noise attenuation measures. This acknowledges that in some instances, the department may not recommend certain noise attenuation measures.

15.2.3 Noise Monitoring Locations and Methodology

In order to characterise the existing noise environment adjacent to the GUP corridor, ambient noise monitoring was conducted at ten locations adjacent to the Gateway Motorway corridor listed in Table 15.3.

The monitoring locations were chosen based upon several factors:

- Each monitoring location was chosen as being representative of the receivers in the immediate surrounding area;
- Typically, the residences chosen for monitoring were the most exposed to road traffic noise from the Gateway Motorway within the relevant noise catchment area; and
- A review of previous noise assessments conducted by MR indicated areas where noise monitoring had already been undertaken. This information aided selection of likely noise monitoring locations in order to provide a complete picture of the current noise environment along the length of the motorway.

The location of the noise monitoring locations are shown in Figures 15.2a to 15.2d. Photographs showing the noise logger positions at each monitoring location are shown in Table 15.3 and Appendix K1 along with a detailed description of the microphone location at each site.

Table 15.3 GUP Noise Monitoring Locations

Location	Description	Photograph
Location 1 Brisbane Grammar School Playing Fields	Free field conditions, 1.5m above ground, approximately level with Motorway, deployed on Wednesday 31 March 2004.	

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Queensland Government
Australian Government Department of Transport and Regional Services
Connell Wagner

FIGURE 15.2a
Background Noise
Monitoring Locations

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Queensland Government Main Roads
Australian Government Department of Transport and Regional Services
Connell Wagner

FIGURE 15.2b
Background Noise Monitoring Locations

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Queensland Government
Australian Government Department of Transport and Regional Services
Connell Wagner

FIGURE 15.2c
Background Noise Monitoring Locations

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Queensland Government Department of Main Roads
Australian Government Department of Transport and Regional Services
Connell Wagner

FIGURE 15.2d
Background Noise Monitoring Locations

Location	Description	Photograph
Location 2 55 Webster Avenue, Hendra	2nd storey 1m from façade of residence, approximately 3.5m above ground, deployed on Wednesday 31 March 2004. Measurements included a façade correction.	
Location 3 125 Raceview Avenue, Doomben	Located on garage roof adjacent 2nd storey 1m from façade of residence, approximately 4m above ground and approximately 4m from the noise barrier. Measurements included a façade correction, deployed on Thursday 1 April 2004.	
Location 4 TAFE Gateway Campus Block S	Placed on the corner of an awning over front entrance of S Block, approximately 4.5m above ground. Located 2m from the façade perpendicular to the Motorway and thus under free field conditions, deployed on Thursday 1 April 2004.	

Location	Description	Photograph
Location 5 30 Boundary Road, Tingalpa	Located on 2nd storey 1m from façade of residence, approximately 4m above ground. Measurements included a façade correction, deployed on Thursday, 1 April 2004.	
Location 6 76 Brandella Place, Tingalpa	Located on ground floor 1m from façade of residence, approximately 1.5m above ground. Measurements included a façade correction, deployed on Thursday, 1 April 2004.	
Location 7 41 Ambara Street, Tingalpa	Located on 2nd storey 1m from façade of residence, approximately 4 m above ground. Measurements included façade correction, deployed on Friday, 2 April 2004.	

Location	Description	Photograph
Location 8 26 Ridgeview Street, Carindale	Located on 2nd storey 1m from façade of residence, approximately 4m above ground. Measurements included façade correction, deployed on Thursday, 1 April 2004.	
Location 9 56 Silky oak Crescent, Carindale	Located on ground floor 1m from façade of residence, approximately 1.5m above ground. Measurements included façade correction, deployed on Thursday, 1 April 2004.	
Location 10 47 Weedon Street East, Mackenzie	Located on 2nd storey 1m from façade of residence, approximately 4m above ground level and adjacent to the northern façade. Measurements include a façade correction, deployed on Thursday, 1 April 2004.	

15.2.4 Methodology and Instrumentation

All noise measurements were conducted in accordance with the EPA's Noise Measurement Manual. This included the exclusion of data collected during periods of rain or wind speeds greater than 5m/s.

Continuous unattended noise monitoring was conducted at the ten locations between Thursday, 1 April and Monday, 12 April 2004. It is noted that the Easter long weekend commenced on Friday, 9 April 2004. Due to equipment failure, additional noise monitoring was conducted at location 8 between Monday, 19 April and Sunday, 25 April 2004.

The monitoring was undertaken using Acoustic Research Laboratories Type EL-316 Environmental Noise Loggers programmed to record various statistical noise levels over consecutive one hour intervals. Each logger was checked for calibration before and after the survey with a Rion NC-73 Sound Level Calibrator and no significant drift in calibration was detected. A Davis Vantage Pro Weather Station was located at Location 10 (Weedon Street) for the duration of the unattended noise monitoring period apart from Thursday 1st April 2004 where weather data from the Brisbane Airport was utilised.

Unattended noise logging at representative receiver locations was conducted at 1 m from the most affected facades, and 1.5 m above floor level of the upper most storey (mid window height). Exceptions to this approach were at Location 1 - BGS Sports Field (free field) and Location 4 - Gateway TAFE (free field).

During the unattended noise monitoring period, 15-minute attended measurements using Rion NA-27 (checked for calibration using a Rion NC-73 Calibrator) and Brüel & Kjær 2260 (checked for calibration using a Brüel & Kjær 4231 Calibrator) Sound Level Meters were undertaken at each monitoring location during the day (7:00am – 6:00pm) and night (10:00pm – 7:00am) periods. The attended noise measurements were undertaken to accurately describe the ambient acoustic environment at each location during these times.

The attended measurements were all conducted at ground level. At Locations 1, 3 and 4 the measurements were free field (no facade correction) and at all other locations the measurements were conducted 1m from the most exposed facade to road traffic noise (including facade correction).

All measurements were conducted using the 'A-weighting' filter and 'fast' response. All items of acoustic instrumentation employed during the noise monitoring surveys were designed to comply with AS 1259.2 "Sound Level Meters" and carry current manufacturer calibration certificates.

15.2.5 Noise Monitoring Results

The ambient noise measurements were used to determine:

- existing $L_{A10(18hour)}$ noise levels adjacent to the existing Motorway (for the operational noise assessment); and
- existing L_{A90} background noise levels (for the construction noise assessment) for the:
  - day (7:00am to 6:00pm);
  - evening (6:00pm to 10:00pm); and
  - night (10:00pm to 7:00am) periods.

The ambient noise measurements were used to determine the existing $L_{A10(18hour)}$ noise levels adjacent to the existing Motorway as well as the background noise levels for the day (7:00am to 6:00pm), evening (6:00pm to 10:00pm) and night (10:00pm to 7:00am) periods.

Table 15.4 documents the $L_{A10(18hour)}$ noise levels throughout the noise monitoring period. The $L_{A10\ (18\ hour)}$ noise levels for each day were calculated from the (arithmetic) average of the eighteen $L_{A10\ (1\ hour)}$ noise levels measured by the noise loggers between 6:00am and 12:00am (midnight).

Table 11.5 documents the "minimum repeatable" (or 90th percentile of) the background (L_{A90}) noise levels over the day (7:00am to 6:00pm), evening (6:00pm to 10:00pm) and night (10:00pm to 7:00am) periods.

At each monitoring location, the ambient noise levels were dominated by traffic noise from the Gateway Motorway. Other sources of noise and vibration in the project area include the following:

- Vehicles travelling on the Port of Brisbane Motorway;
- Rail traffic operating on the Pinkenba and Cleveland Branch Rail Lines;
- Light industry and commercial activities located just south of the Brisbane River at Murarrie as well as several areas adjacent to the existing Motorway north of the river;
- Aircraft arriving and departing from the Brisbane Airport;
- Traffic travelling on major roads crossing the Gateway Motorway such as Mt Gravatt-Capalaba Road, Old Cleveland Road, Wynnum Road and Airport Drive; and
- Traffic travelling along local roads in the project area.

Graphs showing the statistical noise levels measured at the ten monitoring sites over the full monitoring period are presented in Appendix K2 for each 24 hour period. These graphs also show the weather conditions throughout the monitoring period.

The attended noise measurement results and observations undertaken throughout the day and night periods are documented in Appendix K3.

Table 15.4 Existing $L_{A10(18\ hour)}$ Noise Levels

Location	Thursday 1/04/04	Friday 2/04/04	Saturday 3/04/04	Sunday 4/04/04	Monday 5/04/04	Tuesday 6/04/04	Wednesday 7/04/04	Thursday 8/04/04	Average Weekday[1]
1	69.8	70.4	70.1	69.9	72.3	71.6	70.1	69.1	70.5
2	64.9	64.6	63.2	62.3	65.0	65.2	65.0	64.4	65
3		65.6	65.1	64.6	66.8	67.5	66.6	66.6	66.5
4		64.7	60.8	60.0	64.9	65.4	64.8	63.5	64.5
5		60.4	59.5	58.4	62.0	61.7	61.3	61.4	61.5
6		65.6	65.3	64.7	68.1	67.7	67.3	67.2	67
7			68.1	68.2	71.3	70.9	70.4	70.2	70.5
8		74.4	72.9	71.9	74.8	*Refer Note 2*			75
9		64.2	63.8	62.9	65.2	65.3	66.3	65.2	65.5
10		63.2	61.1	60.5	63.8	63.7	63.9	63.2	63.5
						Tuesday 20/05/04	**Wednesday 21/05/04**	**Thursday 22/05/04**	
8						74.9	75.6	75.6	

Table Notes:

1. Average values exclude weekends and have been rounded to the nearest 0.5dBA
2. Shaded area indicates dates where extra monitoring was required due to equipment failure.

Table 15.5 Existing Background (L_{A90}) Noise Levels

Location		Thursday 01/04/04	Friday 02/04/04	Saturday 03/04/04	Sunday 04/04/04	Monday 05/04/04	Tuesday 06/04/04	Wednesday 07/04/04	Thursday 08/04/04	Median[1]
1	day	60.2	61.2	63.5	64.1	66.1	60.5	63.8	64.0	63.5
	evening	57.1	59.9	58.8	58.5	59.8	59.5	44.3	58.0	58.5
	night	50.3	49.4	49.4	48.0	49.4	49.3	50.9	48.5	49.5
2	day	59.7	59.8	59.3	58.1	61.4	61.5	61.0	60.5	60
	evening	55.6	56.5	54.7	54.9	56.0	55.5	46.1	57.1	55.5
	night	47.7	47.1	44.8	43.8	46.8	46.1	46.5	46.6	46.5
3	day		60.3	60.0	59.0	63.0	62.3	61.7	61.7	61.5
	evening		56.5	55.5	57.0	57.0	55.5	46.4	58.3	56.5
	night	44.7	46.3	42.2	42.9	46.1	44.6	46.5	47.6	45.5
4	day		59.2	54.7	54.8	58.7	59.4	59.2	54.9	58.5
	evening	55.6	53.9	48.2	49.4	52.8	54.6	42.7	54.0	53.5
	night	50.1	50.2	41.9	48.4	49.2	48.9	50.4	42.8	49
5	day		53.9	52.9	52.8	56.4	54.0	54.6	54.6	54
	evening	52.7	49.5	50.5	49.7	52.3	51.9	46.7	53.7	51
	night	49.6	43.7	40.6	42.7	46.3	46.0	47.3	46.8	46

Table Notes:
1. Median values exclude weekends and have been rounded to the nearest 0.5dBA.

Location		Thursday 01/04/04	Friday 02/04/04	Saturday 03/04/04	Sunday 04/04/04	Monday 05/04/04	Tuesday 06/04/04	Wednesday 07/04/04	Thursday 08/04/04	Median[1]
6	Day		58.7	60.0	59.0	62.8	60.6	59.8	61.2	60.0
	evening	55.7	55.3	55.7	55.0	57.3	56.6	45.5	57.6	55.7
	night	45.3	44.1	37.5	41.0	46.8	46.5	45.5	46.8	45.4
7	day		63.9	63.0	63.8	64.8	65.7	65.4	65.6	64.8
	evening		58.0	57.7	57.6	59.2	59.4	47.1	60.2	58.0
	night		45.9	41.2	43.7	49.6	47.5	47.6	47.8	47.5
8	day		69.6	67.9	67.4	68.1	*Refer Note 2*			69.6
	evening		61.8	60.5	55.2	58.5				61.8
	night	48.7	44.8	41.6	44.4	45.7				44.8
9	day		59.2	58.2	58.1	58.9	59.6	60.4	60.4	59.2
	evening	55.6	52.6	55.4	52.4	54.7	54.3	46.5	55.6	54.5
	night	42.6	40.9	48.1	34.6	41.3	35.6	40.3	42.5	41.1
10	day		58.1	55.9	55.9	57.7	58.4	58.1	58.2	58.1
	evening	56.4	54.4	53.5	51.7	53.2	54.5	43.6	55.0	54.0
	night	46.5	44.5	36.7	42.6	44.3	42.7	42.3	43.9	43.3

Table Notes:
1. Median values exclude weekends.
2. Shaded area indicates dates where extra monitoring was required due to equipment failure.

Location		**Thursday 01/04/04**	**Friday 02/04/04**	**Saturday 03/04/04**	**Sunday 04/04/04**	**Monday 05/04/04**	**Tuesday 06/04/04**	**Wednesday 07/04/04**	**Thursday 08/04/04**	**Median[1]**
							Tuesday 20/04/04 [2]	**Wednesday 21/04/04 [2]**	**Thursday 22/04/04 [2]**	
8	day						70.	69.6	70.0	
	evening						61.0	63.8	64.1	
	night						46.0	44.9	44.0	

Table Notes:
1. Median values exclude weekends.
2. Shaded area indicates dates where extra monitoring was required due to equipment failure.

15.2.6 Noise Modelling Methodology

Construction

For the GUP there are expected to be six main components of construction work being:

- Bulk Earthworks – involving excavation and embankment work and the transportation of fill;
- Pavement Widening – involving the construction (levelling, compaction etc) of the cement treated base and asphalt;
- Bridge Approach Pavement Reconstruction – for 100m either side of a number of bridges within the southern section the pavement will be tapered down between the proposed overlay pavement height to the existing (bridge) pavement height;
- Asphalt Overlay and Finishing – overlaying of asphalt on top of existing pavement;
- Finishing Works – Including Electrical, Integrated Transport System (ITS), barrier installation; and
- Bridgeworks – the Gateway Bridge duplication, extension/modification of other existing bridges and culverts and substantial lengths of elevated roadway (on structure) through airport land.

A potential listing of significant equipment associated with each of these components of construction from an acoustic and vibration perspective is provided in Table 15.6.

Table 15.6 Anticipated Equipment to be used for the GUP Construction Phase

Construction Component	Anticipated (but not limited to) Equipment Used for the Component
Bulk Earthworks	1 40 tonne excavator 1 D8 Dozer 3 Dump trucks (~8m^3) plus Dogs (~4m^3) (significantly larger fleet will be required for the northern section). 1 Backhoe 1 Grader 1 Water truck 1 15t vibratory roller 1 Pile Driver (for pile rafting north of Brisbane River only)
Pavement Widening	1 Paver 3 Dump trucks (~8m^3) plus Dogs (~ 4m^3) 1 Pug Mill 1 Multi-tyre roller and 1 smooth drum roller 1 Water Truck 1 Concrete cutter 1 Grader 1 Generator

Construction Component	Anticipated (but not limited to) Equipment Used for the Component
Pavement Reconstruction (restricted to a number of bridges south of the Brisbane River)	2 Pavers 2 Excavators 6 Dump trucks (~8m^3) plus Dogs (~ 4m^3) 1 Concrete cutter 1 Grader 1 Water truck 1 Multi-tyre roller 1 Pug Mill 2 Generators 1 Jackhammer 1 Compressor
Asphalt Surfacing	1 Profiler 1 Paver 2 Bobcats 2 Asphalt delivery trucks 1 Generator
Finishing	3 Cement trucks (formation of concrete safety barriers only) 1 Backhoe (formation of concrete safety barriers only) 2 Excavators 1 Water Truck 1 Compressor 1 Crane (night only for erection works)
Bridgeworks Gateway Bridge Duplication Southern End	2 Cranes 3 Semi-trailers 2 Concrete cutters 2 Concrete pumps Concrete batching plant and casting yard 3 Concrete trucks 2 Excavators 1 Rotary Drill 3 Compressors

Construction Component	Anticipated (but not limited to) Equipment Used for the Component
Bridgeworks Gateway Bridge Duplication Northern End	3 Pile drivers 2 Cranes 3 Semi-trailers 2 Concrete pumps 3 Concrete trucks Concrete batching plant and casting yard 2 Excavators 2 Rotary Drill 3 Compressors
Extension / Modification of Existing Bridges and Culverts	2 semi-trailers 1 crane 1 Pile driver (except at the Old Cleveland Rd and Wynnum Rd overpasses) 1 Concrete pump (except at the Old Cleveland Rd and Wynnum Rd overpasses) 2 Jackhammers (except at the Old Cleveland Rd and Wynnum Rd overpasses) 1 Concrete Cutter (except at the Old Cleveland Rd and Wynnum Rd overpasses) 2 Compressors 2 Generators (night only for delivery and laying of bridge spans)
Elevated Motorway on Structure	3 Pile drivers 3 Semi-trailers 3 Cranes 3 Concrete Trucks 2 Compressors

Table 15.7 outlines the likely times of day that construction activities will be undertaken given the:

- required timeframe for completion of construction;
- need to keep 4 lanes of the Gateway Motorway open during the day and evening periods; and
- safety concerns for workers and motorists.

Table 15.7 Likely Hours of Operation of Construction Activities

Construction Activity	Section of Motorway	Expected Times of Construction	Explanation
Bulk Earthworks	Entire Corridor	Daytime	Enough road corridor to perform construction activities and keep 4 lanes open during the day
Pavement Widening	Mt Gravatt Capalaba Rd to Wynnum Rd	Night-time	Limited road corridor therefore will need to close lanes which will not be possible during the day as stipulated by the project team
	Wynnum Rd to Nudgee Road (end of project)	Daytime	Enough road corridor to perform construction activities and keep 4 lanes open during the day
Pavement Reconstruction	100m either side of Greendale Way Overpass, Old Cleveland Rd Overpass and Wynnum Rd Overpass	Day, Evening and Night	Over 2 – 4 weekends at each bridge/culvert working around the clock (24 hrs) due to the need to close multiple lanes of the Motorway
Asphalt Surfacing	Mt Gravatt Capalaba Rd to Gateway Bridge	Night	One traffic lane needs to be closed during this activity and this is only possible during the night period when there are lower traffic volumes
	Gateway Bridge to Nudgee Road (end of project)	Day	No existing traffic concerns or requirements
Finishing	Entire Corridor	Day – all activities except erection works at night	Enough road corridor to perform construction activities and keep 4 lanes open during the day
Bridges	Gateway Bridge	Day Except Pier 7	Pier 7 is expected to require significant work
	Greendale Way Overpass	Day – all activities expect driven piling and delivery and laying of bridge spans at night	Driven piling and delivery and laying of bridge spans will be required at night as one lane needs to be closed for safety reasons

Construction Activity	Section of Motorway	Expected Times of Construction	Explanation
	Old Cleveland Rd Overpass	Day – all activities expect delivery and laying of bridge spans at night	Delivery and laying of bridge spans will be required at night as one lane needs to be closed for safety reasons
	Wynnum Rd Overpass	Day – all activities expect delivery and laying of bridge spans at night	Delivery and laying of bridge spans will be required at night as one lane needs to be closed for safety reasons
	Elevated Roadway on Structure (through airport land)	Day	No existing traffic concerns or requirements

Table Notes:
Daytime = 7:00am to 6:00pm
Evening = 6:00pm to 10:00pm
Night time = 10:00pm to 7:00am

No blasting or rockbreaking is anticipated at any time during construction.

Based on the above likely construction stages, the following methodology was adopted for the prediction of construction noise levels:

- A representative maximum sound power level was assigned to all items of plant to be used in each construction scenario.

- To enable comparison of equipment noise levels to the project construction noise goal for the evening period ($L_{A10(15minute)}$ = background + 10dBA), the maximum sound power levels (refer Table 15.8) were converted to equivalent L_{A10} noise emissions.

  On the basis of previous field measurements of similar construction activities, Heggies has found that the average maximum (L_{A10}) noise levels of machinery operating under normal conditions are typically 5dBA lower than the L_{Amax} values documented in Table 15.8. This L_{Amax} to L_{A10} difference can range from as low as 3dBA for continuous plant (eg compressors) to 7dBA for plant involved in intermittent operations (eg graders, excavators).

- Finally, noise levels during evening and night periods were predicted for the various stages of the construction process. For each stage, all equipment belonging to a particular activity (eg pavement widening) was assumed to be operating concurrently at maximum capacity (ie in maximum noise generating mode).

- It should be appreciated therefore that, for extended periods of time, noise levels are likely to be considerably lower than the calculated levels derived for the "worst case" construction scenarios evaluated in this report.

Table 15.8 Summary of Sound Power Levels used for Construction Equipment

Plant Item	L_{Amax} Sound Power Level	Plant Item	L_{Amax} Sound Power Level
Bored Piling Rig	105dBA	Tub Grinder	112dBA
Driven Piling Rig	130dBA	651 Watercart	115dBA
Backhoe	107dBA	Truck and Dog	103dBA
Generator	107dBA	375 Excavator	111dBA
250 cfm Compressor	100dBA	Jackhammer	110dBA
Jackhammer	109dBA	16G Grader	110dBA
20t Crane	105dBA	30t Excavator	110dBA
70t Crane	107dBA	Asphalt Paver	114dBA
Concrete Pump	107dBA	825 Compactor	110dBA
Truck for Deliveries	111dBA	17t Smooth Drum Roller	110dBA
Girder Truck Delivery	111dBA		

Operational

Based on electronic data (eg topography and road design) a three dimensional (SoundPLAN) computer noise model has been developed for the GUP to predict existing Year 2004 and future design Year 2021 (ten years after completion of the upgrade in 2011) noise levels.

Building locations were initially located using the Planning Study data with additional buildings digitised from 2004 aerial photographs to reflect the existing situation. Approximate building heights were developed where building eave height information was not supplied based on site visit observations and the following generalisations:

- Single storey house – 2.5m high;
- Raised single storey house – 3.5m high; and
- Two storey house – 5.0m high.

Receivers were placed 0.5m below the building eave heights for the calculation of single point predictions. These single point calculations were used to assess each location against MR criteria and to design noise barriers where required.

Two dimensional existing noise barrier information was based on the most recent aerial photography. The approximate heights of these barriers were determined through site visit observations and drawings supplied by MR (for selected barriers in the southern section). All existing noise barriers were incorporated in the 2004 model. For the 2021 model, only those existing noise barriers not impacted upon by the GUP concept design were incorporated in the model including a proposed noise barrier to be constructed at Palm Lake Resort in Carindale.

SoundPLAN is a software package which enables compilation of a sophisticated computer model comprising a 3D ground map containing ground contours, the final 3D road design in (including gradients) and building locations, traffic volumes, mix and speed, road pavement characteristics and noise barriers.

The CORTN (Calculation of Road Traffic Noise) 1988 prediction technique was utilised within SoundPLAN to calculate the traffic noise emissions in accordance with the Code of Practice. These calculations account for intervening topography and ground cover, buildings or purpose built noise barriers. CORTN is a recommended road prediction technique in Main Roads' Code of Practice and has been the primary validated road traffic noise model used in within Australia for many years. All noise modelling that has been conducted for this study has had the Australian Road Research Board (ARRB) corrections applied to correct the CORTN calculation for Australian Conditions. These corrections are -1.7dBA for facades and -0.7dBA for free field predictions.

The model was constructed to account for the characteristics of the various noise emission components of road traffic. These component source characteristics are dependent on traffic speed, road gradient, tyre tread patterns and local or national regulations (eg manufacturer's design rules, minimum truck exhaust heights). Table 15.9 illustrates the dissection for road traffic vehicle source heights and relative emission level.

Table 15.9 Road Traffic Noise Source Components

Source Characteristic	Cars	Truck Tyres	Truck Engines	Truck Exhausts
Height above Pavement	0.5m	0.5m	1.5m	3.5m
Ratio of Relative Sound Powers		2	4	1
Relative Emission Level		-5.4dBA	-2.4dBA	-8.5dBA

As shown in Table 15.9, 2/7th of the total acoustic energy associated with heavy vehicles is attributable to the tyre/road interaction. Similarly 4/7th of the total acoustic energy is attributable to truck engines and 1/7th is attributable to truck exhausts (under typical operating conditions, that is no engine braking).

Table 15.10 documents the traffic speeds modelled for the 2004 and 2021 models. This information is based on the existing (2004) and expected (2021) posted speed limits.

Table15.10 Modelled Traffic Speeds

Section of Road	Modelled Speed
2004	
Mt Gravatt Capalaba Rd to Bulimba Creek	100km/hr
Bulimba Creek to Lytton Rd	80km/hr
Lytton Rd (through tolls) to foot of Gateway Bridge	60km/hr
Gateway Bridge to Fison Ave exit	80km/hr
Fison Ave exit to Nudgee Rd (end of project)	90km/hr

Section of Road	Modelled Speed
2021	
Mt Gravatt Capalaba Rd to foot of Gateway Bridge	100km/hr
Over Gateway Bridge	80km/hr
Gateway Bridge to 100 m before expanded toll plaza	100km/hr
100 m before expanded toll plaza to expanded toll plaza	80km/hr
Through expanded toll plaza	60km/hr
End of expanded toll plaza to Nudgee Rd (end of project) – Existing corridor – New corridor	 90km/hr 100km/hr
On ramps	60km/hr to posted traffic speed on Motorway
Off ramps	80km/hr to 60km/hr at merge with local streets
Port of Brisbane Motorway and Airport Northern Access Interchange Ramps	80km/hr

Table 15.11 documents the road pavement types for the existing Motorway and the appropriate road surface correction applied during the modelling.

Table 15.11 Road Surface Types and Corrections (Existing Motorway)

Chainage	Road Surface	Road Surface Correction (dBA)
Northbound Carriageway		
CH5160 to CH10450	Dense Graded Asphalt	0
CH10450 to CH14620	Stone Mastic Asphalt	-2
CH14620 to CH15090	Dense Graded Asphalt	0
CH15090 to CH15150	Stone Mastic Asphalt	-2
CH15150 to CH15755	Dense Graded Asphalt	0
CH15755 to CH15825	Stone Mastic Asphalt	-2
Southbound Carriageway		
CH1560 to CH6860	Dense Graded Asphalt	0
CH6860 to CH7470	Stone Mastic Asphalt	-2
CH7470 to CH8240	Dense Graded Asphalt	0
CH8240 to CH10330	Dense Graded Asphalt	0
CH10330 to CH14350	Stone Mastic Asphalt	-2
CH14350 to CH14522	Dense Graded Asphalt	0

Chainage	Road Surface	Road Surface Correction (dBA)
CH14522 to CH14623	Spray Seal (10-14mm aggregate)	+4
CH14623 to CH15890	Dense Graded Asphalt	0

The roadworks associated with the GUP (and all on and off ramps), Stone Mastic Asphalt (-2dBA) has been modelled.

Verification of the Year 2004 (existing) SoundPLAN model against the measurement data was initially undertaken to ensure the validity of the noise model. In accordance with Section C3 of the MR Code of Practice a model is considered verified when the predicted noise levels are within ± 2dBA of the measured levels.

Once the 2004 model was verified, the 2021 model (utilising much of the same information) was used to predict traffic noise levels at all noise sensitive locations within the study area to determine which locations are likely to experience noise levels exceeding the applicable noise criterion in the design year.

15.2.7 Construction Noise

TOR Requirements:

- Define the potential impacts of the project on existing noise and vibration levels;
- Identify proposed mitigation measures to mitigate identified impacts and to provide recommendations for future monitoring (if required);
- Quantify in terms of objectives, standards to be achieved and measurable indicators the potential environmental harm of noise and vibration at all potentially sensitive places, in particular, any places of work, residence, recreation, or worship. This should also include potential impact on avifauna, particularly migratory bird species; and
- Provide strategies to minimise or eliminate noise and vibration impacts should be provided.

Overview

Predicted construction noise levels will inevitably depend upon the number of plant items and equipment operating at any one time and their precise location relative to the receiver(s) of interest. Therefore a receiver will experience a range of values representing "minimum" and "maximum" construction noise emissions resulting from the variations in construction noise depending upon:

- The location of the particular construction activity, ie if the plant of interest (graders, trucks, etc) were as close as possible or further away from the receiver of interest; and
- The likelihood of the various items of plant and equipment of interest operating simultaneously.

For the GUP, a series of construction scenarios have been developed representing a series of *worst case scenarios*. These occur when different construction activities are coincident or when particular activities are closest to receivers of interest. It is also noted that the predicted noise levels assume no shielding from topography, buildings or noise barrier between the construction activity and the receiver.

In addition, the predicted noise levels do not assume that any special mitigation measures have been employed to limit noise emissions (eg enclosures around compressors).

Table 15.12 details estimated "worst case" construction noise levels at various distances based on the data contained in Section 15.3.1. These predictions are applicable along the entire GUP route.

Table 15.12 Estimated "Worst Case" Construction Noise Levels at Various Offset Distances (No Special Mitigation Assumed)

Construction Activity	Predicted Noise Level (dBA)							
	25m Offset		50m Offset		100m Offset		200m Offset	
	L_{A10}	L_{Amax}	L_{A10}	L_{Amax}	L_{A10}	L_{Amax}	L_{A10}	L_{Amax}
Bulk Earthworks (North)	89	94	83	88	77	82	71	76
Bulk Earthworks (South)	78	83	72	77	66	71	60	65
Pavement Widening	81	86	75	80	69	74	63	68
Pavement Reconstruction	80	85	74	79	68	73	62	67
Asphalt Overlay	80	85	74	79	68	73	62	67
Finishing	77	82	71	76	65	70	59	64
Bridgeworks								
- Gateway Bridge – Southern End	83	88	77	82	71	76	65	70
- Gateway Bridge – Northern End	94	99	88	93	82	87	76	81
Modification of Existing Bridges								
Old Cleveland Rd & Wynnum Rd Overpass	89	94	83	88	77	82	71	76
All other existing bridges	75	80	69	74	63	68	57	62
Elevated Motorway	94	99	88	93	82	87	76	81

Table Notes:
Assumes no shielding (ie from topography, buildings or noise barriers etc) between construction activity and receiver.

Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line

Prediction and Assessment

Tables 15.13 and 15.14 detail estimated "worst case" construction noise levels at the nearest noise sensitive locations for the section of motorway between Mt Gravatt-Capalaba Road and Cleveland Branch Rail Line based on offset distances determined from the electronic data and aerial photography. Once again, it is noted that no special mitigation measures (eg enclosures) have been assumed in these predictions.

Table 15.13 Estimated "Worst Case" L_{A10} Construction Noise Levels at Nearest Receivers – Applicable to the "Evening" Period (Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line)

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{A10} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Mt Gravatt-Capalaba Road to Wecker Road	30	23	Bulk Earthworks	76	79	64	6-12	9-15
			Pavement Widening	79	81		9-15	11-17
			Asphalt Overlay	79	81		9-15	11-17
			Finishing	76	78		6-12	8-14
Wecker Road to Greendale Way	94	25	Bulk Earthworks	66	78	65	0-1	5-13
			Pavement Widening	69	81		0-4	8-16
			Asphalt Overlay	69	80		0-4	7-15
			Finishing	66	77		0-1	4-12
			Greendale Way Overpass Pavement Reconstruction	56	72		0-9	0-7
			Greendale Way Overpass Extensions	65	82		0	9-17
Greendale Way to Old Cleveland Road	43	28	Bulk Earthworks	73	77	68	0-5	1-9
			Pavement Widening	76	80		0-8	4-12
			Asphalt Overlay	76	79		0-8	3-11
			Finishing	73	76		0-5	0-8
			Old Cleveland Road Overpass Extensions	79	83		4-11	7-15

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{A10} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Old Cleveland Road to Meadowlands Road	26	11	Bulk Earthworks	77	85	68	2-9	10-17
			Pavement Widening	80	88		5-12	13-20
			Asphalt Overlay	80	88		5-12	13-20
			Finishing	77	85		2-9	10-17
			Old Cleveland Road Overpass Pavement Reconstruction	70	74		0-2	0-6
Meadowlands Road to Wynnum Road	17.5	N/A	Bulk Earthworks	81	-	66	11-15	-
			Pavement Widening	84	-		14-18	-
			Asphalt Overlay	83	-		13-17	-
			Finishing	81	-		11-15	-
			Modify Culvert CH13100	77	-		7-11	-
Wynnum Road to Cleveland Rail Line	196	80	Wynnum Road Overpass Extension	72	79	61	8-11	15-18
			Bulk Earthworks	60	68		0	4-7
			Pavement Widening	63	71		0-2	7-10
			Asphalt Overlay	62	70		0-1	6-9
			Finishing	60	67		0	3-6
			Bulimba Ck Bridge Extensions	58	63		0	0-2
			Modify Culvert CH14300	64	64		0-3	0-3
			Wynnum Road Overpass Pavement Reconstruction	62	69		0-1	5-8

Table Note: Assumes no shielding (ie from topography, buildings or noise barriers etc) between construction activity and receiver

Table 15.14 Estimated "Worst Case" L_{Amax} Construction Noise Levels at Nearest Receivers – Applicable to the "Night" Period – Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{Amax} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Mt Gravatt-Capalaba Road to Wecker Road	30	23	Bulk Earthworks	81	84	50	31	34
			Pavement Widening	84	86		34	36
			Asphalt Overlay	84	86		34	36
			Finishing	81	83		31	33
Wecker Road to Greendale Way	94	25	Bulk Earthworks	71	83	50	21	33
			Pavement Widening	74	86		24	36
			Asphalt Overlay	74	85		24	35
			Finishing	71	82		21	32
			Greendale Way Overpass Pavement Reconstruction	61	77		11	27
			Greendale Way Overpass Extensions	70	87		20	37
Greendale Way to Old Cleveland Road	43	28	Bulk Earthworks	78	82	50	28	32
			Pavement Widening	81	85		31	35
			Asphalt Overlay	81	84		31	34
			Finishing	78	81		28	31
			Old Cleveland Road Overpass Extensions	84	88		34	38

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level LAmax (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Old Cleveland Road to Meadowlands Road	26	11	Bulk Earthworks	82	90	50	32	40
			Pavement Widening	85	93		35	43
			Asphalt Overlay	85	93		35	43
			Finishing	82	90		32	40
			Old Cleveland Road Overpass Pavement Reconstruction	75	79		25	29
Meadowlands Road to Wynnum Road	17.5	N/A	Bulk Earthworks	86	-	50	36	-
			Pavement Widening	89	-		39	-
			Asphalt Overlay	88	-		38	-
			Finishing	86	-		36	-
			Modify Culvert CH13100	82	-		32	21
Wynnum Road to Cleveland Rail Line	196	80	Wynnum Road Overpass Extension	77	84	50	27	34
			Bulk Earthworks	65	73		15	23
			Pavement Widening	68	76		18	26
			Asphalt Overlay	67	75		17	25
			Finishing	65	72		15	22
			Bulimba Creek Bridge Extensions	63	68		13	18
			Modify Culvert CH14300	69	69		19	19
			Wynnum Road Overpass Pavement Reconstruction	67	74		17	24

Table Note: Assumes no shielding (ie from topography, buildings or noise barriers etc) between construction activity and receive

The evening noise criteria used in this assessment have been determined from the "minimum repeatable" (or 90th percentile of) the background (L_{A90}) noise levels, ie representative of the quietest period of the evening period. However, for the evening period, a range of exceedances has been calculated based upon the known fluctuations of background noise level during this period as shown in Table 15.13.

A review of the measured noise levels revealed that the background noise level varies during the night period, sometimes by up to 15dBA, with typically the 2:00am to 3:00am period being the quietest.

Recommended Mitigation Measures

Given the number and degree of potential exceedances discussed above, comprehensive noise mitigation strategies should be implemented wherever possible, especially during any evening and night work periods.

AS2436-1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions.

A summary of the strategies to be implemented on the GUP are provided in Section 15.2.8.

Cleveland Branch Rail Line to Pinkenba Rail Line

Prediction and Assessment

Tables 15.15 and 15.16 detail estimated "worst case" construction noise levels at the nearest noise sensitive locations between Cleveland Branch Rail Line and Pinkenba Rail Line based on offset distances determined from the electronic data and aerial photography. It is noted that no special mitigation measures (eg enclosures) have been assumed in these predictions.

The evening noise criteria used in this assessment have been determined from the "minimum repeatable" (or 90th percentile of) the background (L_{A90}) noise levels, ie representative of the quietest period of the evening period. However, for the evening period, a range of exceedances has been calculated based upon the known fluctuations of background noise level during this period as shown in Table 15.15.

A review of the measured noise levels revealed that the background noise level varies during the night period, sometimes by up to 15dBA, with typically the 2:00am to 3:00am period being the quietest.

Table 15.15 Estimated "Worst Case" L_{A10} Construction Noise Levels at Nearest Receivers – Applicable to the "Evening" Periods (Cleveland Branch Rail Line to Pinkenba Rail Line)

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{A10} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Cleveland Rail Line to Lytton Road	N/A	142	Bulk Earthworks	-	63	61	-	0-2
			Pavement Widening	-	66		-	2-5
			Asphalt Overlay	-	65		-	1-4
			Finishing	-	62		-	0-1
Lytton Road to Brisbane River	N/A	142	Bulk Earthworks	-	63	61	-	0-2
			Pavement Widening	-	66		-	2-5
			Asphalt Overlay	-	65		-	1-4
			Finishing	-	62		-	0-1
			Gateway Duplication-South	-	66		-	2-5
Brisbane River to Pinkenba Rail Line (Existing Alignment)	N/A	57	Bulk Earthworks	-	82	64	-	15-18
			Pavement Widening	-	74		-	7-10
			Asphalt Overlay	-	73		-	6-9
			Finishing	-	70		-	3-6
			Gateway Duplication-North	-	57		-	0
Brisbane River to Pinkenba Rail Line (New Alignment)	N/A	1147	Bulk Earthworks	-	56	64	-	0
			Pavement Widening	-	48		-	0
			Asphalt Overlay	-	47		-	0
			Finishing	-	44		-	0

Table Note: Assumes no shielding (ie from topography, buildings or noise barriers etc) between construction activity and receiver

Table 15.16 Predicted "Worst Case" L_{Amax} Construction Noise Levels at Nearest Receivers – Applicable to the "Night" Periods (Cleveland Branch Rail Line to Pinkenba Rail Line)

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{Amax} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Cleveland Rail Line to Lytton Road	N/A	142	Bulk Earthworks	-	68	50	-	18
			Pavement Widening	-	71		-	21
			Asphalt Overlay	-	70		-	20
			Finishing	-	67		-	17
Lytton Road to Brisbane River	N/A	142	Bulk Earthworks	-	68	50	-	18
			Pavement Widening	-	71		-	21
			Asphalt Overlay	-	70		-	20
			Finishing	-	67		-	17
			Gateway Duplication-South	-	71		-	21
Brisbane River to Pinkenba Rail Line (Existing Alignment)	N/A	57	Bulk Earthworks	-	87	50	-	37
			Pavement Widening	-	79		-	29
			Asphalt Overlay	-	78		-	28
			Finishing	-	75		-	25
			Gateway Duplication-North	-	62		-	12
Brisbane River to Pinkenba Rail Line (New Alignment)	N/A	1147	Bulk Earthworks	-	61	50	-	11
			Pavement Widening	-	53		-	3
			Asphalt Overlay	-	52		-	2
			Finishing	-	49		-	0

Table Note: Assumes no shielding (ie from topography, buildings or noise barriers etc) between construction activity and receiver

Recommended Mitigation Measures

The construction noise mitigation measures described in Section 15.2.8 should be implemented where appropriate for the Cleveland Branch Rail Line to Pinkenba Rail Line section.

Pinkenba Rail Line to Nudgee Road

Prediction and Assessment

Tables 15.17 and 15.18 detail estimated “worst case” construction noise levels at the nearest noise sensitive locations for the section of Motorway between Pinkenba Rail Line and Nudgee Road based on offset distances determined from the electronic data and aerial photography. It is noted that no special mitigation measures (eg enclosures) have been assumed in these predictions.

The evening noise criteria used in this assessment have been determined from the “minimum repeatable” (or 90th percentile of) the background (L_{A90}) noise levels, ie representative of the quietest period of the evening period. However, for the evening period, a range of exceedances has been calculated based upon the known fluctuations of background noise level during this period as shown in Table 15.17.

A review of the measured noise levels revealed that the background noise level varies during the night period, sometimes by up to 15dBA, with typically the 2:00am to 3:00am period being the quietest.

Table 15.17 Estimated "Worst Case" L_{A10} Construction Noise Levels at Nearest Receivers – Applicable to the "Evening" Period (Pinkenba Rail Line to Nudgee Road)

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{A10} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Pinkenba Rail Line to Intersection with Existing Motorway	N/A	885	Bulk Earthworks	-	54[1]	66	-	0
			Pavement Widening	-	45[1]		-	0
			Asphalt Overlay	-	45[1]		-	0
			Finishing	-	42[1]		-	0
			Elevated Motorway on Structure	-	57[1]		-	0
Intersection with Existing Motorway to Nudgee Road (end of Project)	N/A	138	Bulk Earthworks	-	75[2]	69	-	0-6
			Pavement Widening	-	66[2]		-	0
			Asphalt Overlay	-	65[2]		-	0
			Finishing	-	63[2]		-	0

Table Notes:
1. Assumes no shielding (ie from topography, buildings or noise barriers etc) between construction activity and receiver
2. Assumes distance attenuation. It is also noted that many residences in this area are located behind existing road traffic noise barriers and as such additional shielding (possibly in the order of 10dBA) is expected.

Table 15.18 Estimated "Worst Case" L_{Amax} Construction Noise Levels at Nearest Receivers - Applicable to the "Night" Period (Pinkenba Rail Line to Nudgee Road)

Road Segment	Distance to Closest Noise Sensitive Location		Construction Activity	Predicted Noise Level L_{A10} (dBA)		Criteria (dBA)	Exceedance (dBA)	
	East of Motorway	West of Motorway		East	West		East	West
Pinkenba Rail Line to Intersection with Existing Motorway	N/A	885	Bulk Earthworks	-	59[1]	50	-	9
			Pavement Widening	-	50[1]		-	0
			Asphalt Overlay	-	50[1]		-	0
			Finishing	-	47[1]		-	0
			Elevated Motorway on Structure	-	63[1]		-	13
Intersection with Existing Motorway to Nudgee Road (end of Project)	N/A	138	Bulk Earthworks	-	80[2]	50	-	30
			Pavement Widening	-	71[2]		-	21
			Asphalt Overlay	-	70[2]		-	20
			Finishing	-	68[2]		-	18

Table Notes:

1 Assumes no shielding (ie from topography, buildings or existing road traffic noise barriers etc) between construction activity and receiver.

2 Assumes distance attenuation. It is also noted that many residences in this area are located behind existing road traffic noise barriers and as such additional shielding (possibly in the order of 10dBA) is expected.

Recommended Mitigation Measures

The construction noise mitigation measures described in Section 15.2.8 will be implemented where appropriate for the Pinkenba Rail Line to Nudgee Road section.

15.2.8 Construction Noise Mitigation Measures

The following construction noise mitigation measures are recommended for the GUP construction phase.

Source Noise Control Strategies

- Quietest plant and equipment that can economically undertake the work should be selected wherever possible.
- Regular maintenance of equipment to keep it in good working order.

Work Practice Control Strategies

- Construction work to occur wherever possible within the day (7:00am to 6:00pm) period.
- Where possible, avoid the coincidence of plant and equipment working simultaneously close together and near sensitive sites.
- Maintenance work and access points to the alignment to be located as far as possible from sensitive areas wherever feasible.
- Operators of construction equipment to be made aware of potential noise problems and of techniques to minimise noise emission through a continuous process of operator education.

Noise Barrier Control Strategies

- Where possible, consider the installation of operational (ie permanent works) noise barriers as early as possible to provide additional construction phase noise mitigation.
- Where possible, use hoarding stockpiles and site sheds/buildings as noise barriers between equipment and sensitive areas.

Community Liaison Strategies

- Active community consultation and the maintenance of positive relations with residents.
- Where construction noise levels exceed the recommended criteria or in the event of complaints, a detailed investigation of construction noise will be required.

Further details on the strategies outlined are contained in the EMP (refer Section 23).

15.2.9 Operational Noise

Verification of GUP Noise Model

Table 15.19 compares the measured $L_{A10(18hour)}$ noise levels against the predicted noise levels utilising the 2004 SoundPLAN model which was developed using the data contained in Section 15.2.6.

Table 15.19 Comparison of Measured and Predicted Noise Levels in 2004

Location	$L_{A10(18hour)}$ Noise Level		
	Measured	Predicted	Difference
1	71dBA	69dBA	-2dBA
2	65dBA	64dBA	-1dBA
3	67dBA	65dBA	-2dBA
4	65dBA	65dBA	0dBA
5	61dBA	64dBA	3dBA
6	67dBA	67dBA	0dBA
7	71dBA	71dBA	1dBA [1]
8	75dBA	74dBA	-1dBA
9	65dBA	64dBA	-1dBA
10	64dBA	65dBA	1dBA

Table Note:
1. Difference due to rounding dBA

All the predicted $L_{A10(18hour)}$ noise levels are within ± 2dBA of the measured levels except for location 5 where the predicted noise level was 3dBA above that measured. The model has predicted conservatively high, 1dBA above the accepted variance of ± 2dBA, at this location. This small over prediction at one location out of ten, which also was the furthest location from the Motorway at more than 200m, was not determined to be significant and as such the model was considered to be verified.

Based on the differences shown in Table 15.19 the following corrections have been applied to the SoundPLAN model:

- Between Mt Gravatt-Capalaba Road and Wynnum Road apply +1 dBA to all predicted noise levels; and
- Between Brisbane River and Nudgee Road apply +2 dBA to all predicted noise levels.

The application of these corrections ensures conservatism in the SoundPLAN modelling as the predictions are equal to or greater than the measurement results at all 10 monitoring locations.

The 2021 noise model (including corrections discussed above) was then utilised to predict noise levels at all noise sensitive locations adjacent to the motorway corridor. Appendix K4 contains plans showing all the noise sensitive locations assessed as part of the EIS.

Appendix K5 contains future (2021) predicted $L_{A10(18hour)}$ noise levels for all residences, $L_{A10(12hour)}$ noise levels for all parks and outdoor educational and $L_{A10(1hour)}$ internal noise levels for all health and educational facilities based on the EIS concept design.

Road traffic noise emission contours for the year 2021 with no mitigation may be seen in Appendix K6 and K7. These contour maps indicate façade noise levels, including a 2.5dBA façade correction, for single storey (2m) and two storey (4.5m) residences.

Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line

Prediction and Assessment

Table 15.20 documents all the residential locations where predicted noise levels in 2021 are greater than 68dBA $L_{A10(18hour)}$.

Table 15.20 Residential Locations Exceeding 68dBA $L_{A10(18hour)}$ in 2021 (Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line)

Location	Predicted 2021 Noise Level $L_{A10(18hour)}$ (dBA)	Location	Predicted 2021 Noise Level $L_{A10(18hour)}$ (dBA)
Between Mt Gravatt – Capalaba Road and Old Cleveland Road			
Carindale - 1	69	Ridgeview St - 22	69
Coventry Ct - 7	71	Ridgeview St - 30	69
Coventry Ct - 8	71	Ridgeview St - 31	69
Coventry Ct - 9	70	Ridgeview St - 32	70
Coventry Ct - 10	71	Ridgeview St - 33	70
Coventry Ct - 29	69	Ridgeview St - 34	71
Coventry Ct - 30	70	Ridgeview St - 35	70
Coventry Ct - 31	71	Ridgeview St - 36	70
Coventry Ct - 32	69	Ridgeview St - 37	70
Coventry Ct - 33	69	Silky Oak Cr- 1	72
Coventry Ct - 34	69	Silky Oak Cr - 2	69
Coventry Ct - 37	69	Silky Oak Cr - 29	69
Cribb Road - 2	70	Silky Oak Cr - 36	69
Mt Petrie Rd – 9 b	70	Silky Oak Cr - 55	69
Mt Petrie Rd - 21	69	Silky Oak Cr - 56	70
Mt Petrie Rd - 25	69	Silky Oak Cr - 57	71
Ridgeview St - 1	72	Silky Oak Cr - 58	70
Ridgeview St - 3	70	Silky Oak Cr - 59	70
Ridgeview St - 4	69	Silky Oak Cr - 60	69
Ridgeview St - 5	69	Silky Oak Cr - 74	70
Ridgeview St - 6	70	Silky Oak Cr - 75	70
Ridgeview St - 7	74	Silky Oak Cr - 76	69
Ridgeview St - 9	70	Silky Oak Cr - 77	69

Location	Predicted 2021 Noise Level $L_{A10(18hour)}$ (dBA)	Location	Predicted 2021 Noise Level $L_{A10(18hour)}$ (dBA)
Ridgeview St - 10	72	Stockton Cl - 6	70
Ridgeview St - 11	75	Stockton Cl - 7 b	69
Ridgeview St - 12	75	Wecker Rd - 1	69
Ridgeview St - 13	74	Wecker Rd - 3	71
Ridgeview St - 14	76	Wecker Rd - 5	69
Ridgeview St - 15	77	Wecker Rd - 6	76
Ridgeview St - 16	75	Weedon St East - 2 a	72
Ridgeview St - 17	76	Weedon St East - 2 b	72
Ridgeview St - 18	71	Weedon St West - 3	74
Ridgeview St - 19	76		
Between Old Cleveland Road and Cleveland Branch Rail Line			
Ambara St - 1 a	71	Brandella Pl - 29	69
Ambara St - 2	74	Brandella Pl - 30	69
Ambara St - 3	74	Brandella Pl - 31	70
Ambara St - 4	75	Brandella Pl - 32	70
Ambara St - 5	73	Brandella Pl - 35	69
Ambara St - 6	74	Brandella Pl - 36	69
Ambara St - 7	73	Cross St - 1	69
Ambara St - 8	74	Cross Street - 4	70
Ambara St - 9	77	Cross Street - 5	70
Ambara St - 10	74	Cross Street - 8	70
Ambara St - 11	73	Cross Street - 10	71
Ambara St - 12	74	Glenavon St - 1	71
Ambara St - 13	72	Glenavon St - 2	72
Ambara St - 14	72	Glenavon St - 3	72
Ambara St - 15	72	Glenavon St - 4	70
Ambara St - 16	73	Glenavon St - 5	70
Ambara St - 17	75	Glenavon St - 6	69
Ambara St - 18	73	Palm Lake Resort - 1	72
Ambara St - 19	72	Palm Lake Resort - 2	70
Ambara St - 20	74	Palm Lake Resort - 3	71
Belmont Villas - 14	69	Palm Lake Resort - 4	72
Belmont Villas - 15	70	Palm Lake Resort - 5	73
Belmont Villas - 16	69	Palm Lake Resort - 6	72

Location	Predicted 2021 Noise Level $L_{A10(18hour)}$ (dBA)	Location	Predicted 2021 Noise Level $L_{A10(18hour)}$ (dBA)
Belmont Villas - 17	70	Palm Lake Resort - 7	70
Belmont Villas - 18	69	Palm Lake Resort - 8	70
Belmont Villas - 19	69	Palm Lake Resort - 9	70
Belmont Villas - 20	71	Palm Lake Resort - 10	71
Belmont Villas - 21	71	Palm Lake Resort - 11	71
Belmont Villas - 22	72	Palm Lake Resort - 21	69
Belmont Villas - 23	72	Palm Lake Resort - 24	69
Belmont Villas - 24	73	Palm Lake Resort - 25	69
Belmont Villas - 25	73	Palm Lake Resort - 26	70
Belmont Villas - 26	73	Palm Lake Resort - 27	71
Brandella Pl - 5	69	Palm Lake Resort - 28	69
Brandella Pl - 6	70	Palm Lake Resort - 29	69
Brandella Pl - 7	69	Palm Lake Resort - 30	69
Brandella Pl - 8	73	Palm Lake Resort - 31	69
Brandella Pl - 9	73	Palm Lake Resort - 32	69
Brandella Pl - 10	75	Palm Lake Resort - 34	69
Brandella Pl - 11	72	Stanton Rd - 1	71
Brandella Pl - 12	71	Stanton Rd - 2	71
Brandella Pl - 13	71	Stanton Rd - 3	70
Brandella Pl - 14	72	Stanton Rd - 4	70
Brandella Pl - 15	73	Stanton Rd - 5	70
Brandella Pl - 16	73	Stanton Rd - 6	69
Brandella Pl - 17	72	Stanton Rd - 7	69
Brandella Pl - 18	72	Stanton Rd - 8	70
Brandella Pl - 19	73	Villas of Carindale - 2	69
Brandella Pl - 20	72	Wright St - 1	71
Brandella Pl - 21	71	Wright St - 6	69
Brandella Pl - 22	70	Wright St - 7	71
Brandella Pl - 23	71	Wynnum Rd - 1	73
Brandella Pl - 27	69	Wynnum Rd - 2 a	72
Brandella Pl - 28	69	Wynnum Rd - 2 b	71

Table 15.21 documents the predicted 2021 $L_{A10(12hour)}$ noise levels at all parks and outdoor educational areas adjacent to the Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line section of the GUP.

CoRTN does not predict $L_{A10(12hour)}$ noise levels therefore a correction factor was determined from the measurement data to take the output of CoRTN and equate it to MR $L_{A10(12hour)}$ descriptor for parks and outdoor educational areas. The process for determining this correction factor was to:

- Calculate the daily weekday difference between the $L_{A10(18hour)}$ and $L_{A10(12hour)}$ noise levels; and
- Average the daily (weekday) differences to determine a single correction factor.

The above process resulted in a +1dBA correction to the $L_{A10(18hour)}$ noise levels for predicting $L_{A10(12hour)}$ noise levels.

Table 15.21 Predicted (2021) Noise Levels at Parks and Outdoor Educational Areas (Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line)

Location	Description	Predicted Noise Level $L_{A10(12hour)}$
Weedon Street Sports Ground 1	Sporting Field located at Weedon Street West, Mansfield	67dBA
Weedon Street Sports Ground 2		66dBA
Weedon Street Sports Ground 3		66dBA
Weedon Street Sports Ground 4		66dBA
Weedon Street Sports Ground 5		65dBA
Weedon Street Sports Ground 6		65dBA
Weedon Street Sports Ground 7		65dBA
Weedon Street Sports Ground 8		65dBA

Table 15.22 documents the predicted 2021 $L_{A10(1hour)}$ internal noise levels at all health and educational facilities (including halls and churches) adjacent to the Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line section.

The am and pm peak one hour traffic volumes were reviewed for this analysis. It was determined that the am peak one hour traffic volumes represented the worst case acoustic conditions as the percentage of heavy vehicles was typically higher. Therefore, the am peak one hour traffic volumes were included in the SoundPLAN model and CoRTN was used to predict $L_{A10(1hour)}$ noise levels at all health and educational facilities.

The process for determining the internal noise levels from the external predictions was as follows:

- As the external predictions include a facade correction, 2.5dBA was deducted from the predicted level as the internal noise level is determined by the noise level impinging on the building façade; and

- A notional 10dBA facade noise reduction (for partially open windows) was applied to the free field noise level impinging on the facade in accordance with AS 3671-1989 "*Acoustics – Road traffic noise intrusion – Building siting and construction*".

The above process resulted in a -12.5dBA correction to the $L_{A10(1hour)}$ external noise predictions (which include a facade correction) for predicting internal $L_{A10(1hour)}$ noise levels.

It is recommended that actual facade noise reduction measurements be undertaken during detailed design to determine the specific noise reduction for each health and educational building.

Table 15.22 Predicted (2021) Internal Noise Levels at Health and Educational Facilities (Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line)

Location	Description	Predicted Internal Noise Level $L_{A10(1hour)}$
Between Mt Gravatt - Capalaba Road and Old Cleveland Road		
Weedon St East - 3 Church	Church located on Weedon Street East in Mackenzie	54dBA
Between Old Cleveland Road and Cleveland Branch Rail Line		
Wright St - 2 Church Hall	Church and Hall located on Old Cleveland Road in Carindale	62dBA
Wright St - 3 Church		58dBA
Wright St - 4 Vintage Car Club	Vintage Car Club located on Old Cleveland Road in Carindale	62dBA
Wright St - 5 Jehovah's Witnesses	Jehovah's Witnesses worship hall located on Wright Street, Carindale	59dBA
Wright St – 12 Belmont Girl Guides	Girl Guide Club House located on Wright Street, Carindale	58dBA

Recommended Mitigation Measures

The results of the road traffic noise modelling highlighted several areas where the predicted noise levels in 2021 exceed the project noise criteria (as indicated in Tables 15.20, 15.21 and 15.22). Noise mitigation design to meet the noise criteria has been undertaken as part of the EIS.

Proposed noise barriers were incorporated into the SoundPLAN model and located where determined to be most effective based upon topography, existing barriers and the GUP concept design. In certain areas existing noise barriers were modified and/or extended to enable compliance with noise criteria.

Table 15.23 documents the required noise barrier heights and extents to achieve compliance with the noise criteria. The recommended barrier locations are illustrated in Appendix K12.

Table 15.23 Recommended Noise Barriers (Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line)

Location	Approximate Chainage		Recommended Barrier Height	Notes
	Start	End		
Between Mt Gravatt-Capalaba Road and Old Cleveland Road – West of Motorway				
Weedon Street West	CH5160	CH5400	2.5m	Adjacent to main carriageway
	CH5300	CH5450	2m	Adjacent to on ramp
	CH5520	CH5650	3.8m	Adjacent to on ramp following rising topography
Wecker Road	CH5950	CH6050	3.5m	
	CH6050	CH6250	3.8m	
	CH6250	CH6400	2m	
Silky Oak Crescent	CH6930	CH7090	3m	
	CH7090	CH7300	3.5m	
Cribb Road	CH7460	CH7760	3.8m	
Ridgeview Street	CH8280	CH8360	3.5m	Following rising topography
	CH8350	CH8690	5.5m	Requires modification of existing barrier
	CH8600	CH8760	5m	Adjacent to main carriageway
	CH8760	CH8790	3.1m	Reduction in height over structure
	CH8790	CH8880	4.5m	Adjacent to main carriageway
Carindale Lone House	CH9400	CH9520	2m	Adjacent to main carriageway
Between Mt Gravatt-Capalaba Road and Old Cleveland Road – East of Motorway				
Weedon Street East	CH5630	CH5800	3.5 m	
Weedon Street East	CH5800	CH6050	4 m	
Mt Petrie Road	CH6550	CH6720	2 m	
	CH9300	CH9520	3 m	Requires modification of existing barrier
	CH9520	CH9790	4.5 m	
	CH9790	CH9880	4 m	

Location	Approximate Chainage		Recommended Barrier Height	Notes
	Start	End		
Between Old Cleveland Road and Wynnum Road – West of the Motorway				
Wright Street	CH10020	CH10190	4m	Adjacent to main carriageway
	CH10150	CH10230	4m	Continuation of existing barrier, adjacent to on ramp
	CH10230	CH10430	3.5m	Adjacent to on ramp
Palm Lake Resort	CH10550	CH10600	3m	Requires modification of existing barrier
	CH10600	CH10620	4.5m	
	CH10620	CH10890	5m	
Wynnum Road	CH13290	CH13400	4m	Adjacent to main carriageway
	CH13400	CH13470	3.1m	Reduction in height over structure
	CH13470	CH13620	4m	Adjacent to main carriageway
Between Old Cleveland Road and Wynnum Road – East of the Motorway				
Cross Street	CH10100	CH10560	2.5m	Adjacent to main carriageway and extending in front of existing barrier.
	CH10560	CH10800	3m	Adjacent to main carriageway and parallel to existing noise barrier.
Belmont Villas	CH10800	CH11070	4m	Adjacent to main carriageway and parallel to existing noise barrier
Ambara Street	CH11100	CH11300	5m	Adjacent to main carriageway
	CH11300	CH11500	5.5m	Adjacent to main carriageway replacing existing barrier
	CH11500	CH11780	4m	Following rising topography

Location	Approximate Chainage		Recommended Barrier Height	Notes
	Start	End		
Brandella Place	CH12170	CH12220	4m	Replacing existing barrier
	CH12220	CH12300	6m	
	CH12300	CH12400	4.5m	Partially replacing existing barrier and extending adjacent to main carriageway
	CH12400	CH12520	5.5m	Adjacent to main carriageway
	CH12520	CH12600	5m	
Stanton Road	CH12760	CH13000	3m	Adjacent to off ramp
	CH13000	CH13200	4m	
	CH13200	CH13400	3m	Adjacent to main carriageway

Appendix K9 contains the year 2021 predicted road traffic noise levels including the mitigation strategies indicated in Table 15.22. Road traffic noise emission contours for the year 2021 with the mitigation strategies may be seen in Appendices K10 and K11. These contour maps indicate façade noise levels, including a 2.5dBA façade correction, for single storey (2m) and two storey (4.5m) residences.

With the mitigation strategies in place, the predicted noise levels at the residential receivers and Weedon Street Sports Fields, as shown in Appendix K9, comply with the project criteria of 68dBA $L_{A10(18hour)}$.

Appendix K9 documents the predicted 2021 $L_{A10(1hour)}$ internal noise levels at all health and educational facilities (including halls and churches) adjacent to the Motorway corridor with the recommended noise mitigation. With the recommended noise mitigation strategies incorporated there remained several health and education facilities where predicted noise levels in 2021 still exceeded the project noise criteria of 55dBA $L_{A10(1hour)}$ internal, as shown in Appendix K9 and summarised in Table 15.24.

Table 15.24 Predicted 2021 Noise Levels with Mitigation at Health and Educational Facilities Exceeding 55dBA $L_{A10(1hour)}$ internal

Location	Description	Predicted Internal Noise Level $L_{A10(1hour)}$
Between Old Cleveland Road and Cleveland Branch Rail Line		
Wright St - 2 Church Hall	Church and Hall located on Old Cleveland Road in Carindale	59dBA
Wright St – 3 Church		56dBA
Wright St - 4 Vintage Car Club	Vintage Car Club located on Old Cleveland Road in Carindale	57dBA

Location	Description	Predicted Internal Noise Level $L_{A10(1hour)}$
Between Old Cleveland Road and Cleveland Branch Rail Line		
Wright St – 12 Belmont Girl Guide	Girl Guide Club House located on Wright Street, Carindale	57dBA

A review of the facilities in Table 15.24 indicated the following:

- Wright Street -2 Church Hall and 3 Church
  - A survey of the Church Hall revealed that although there are windows facing the Motorway, they are always kept closed by the Church members with ventilation supplied by an air conditioning system.
  - A survey of the Church revealed that there are no windows facing the Motorway and all other windows are closed with ventilation supplied by an air conditioning system.
  - Attenuation through closed windows is often 10 to 15dBA greater than that predicted through an open window and as such it is expected that the predicted internal noise levels for both the Church and Hall will be below the project criteria.

- Wright Street – 4 Vintage Car Club
  - The internal noise level is predicted to exceed the project criteria by 2dBA.
  - Considering the type of facility and that its use will most likely be outside of peak traffic periods, this small exceedance is not considered significant.

- Wright Street – 12 Belmont Girl Guides
  - This building does not have windows located on the façade facing the Motorway resulting in a typical reduction in predicted internal noise levels by (at least) 3dBA and compliance with the project criteria.

Cleveland Branch Rail Line to Pinkenba Rail Line

Prediction and Assessment

Appendix K4 contains plans showing all the noise sensitive locations assessed as part of the EIS. Appendix K5 contains future (2021) predicted $L_{A10(18hour)}$ noise levels for all residences, $L_{A10(12hour)}$ noise levels for all parks and outdoor educational and $L_{A10(1hour)}$ internal noise levels for all health and educational facilities based on the GUP concept design.

Road traffic noise emission contours for the year 2021 with no mitigation may be seen in Appendix K6 and K7. These contour maps indicate façade noise levels, including a 2.5dBA façade correction, for single storey (2m) and two storey (4.5m) residences.

The results of the assessment indicated that for the Cleveland Branch Rail Line to Pinkenba Rail Line section, future (2021) predicted $L_{A10(18hour)}$ noise levels for all residences are expected to be below the noise criteria of 68dBA $L_{A10(18hour)}$.

Future (2021) noise levels with the proposed deviation are predicted to be around 1dBA higher than the existing 2004 levels for monitoring locations 2 and 3 north of the Brisbane River. This is only a marginal increase above existing noise levels, and is favourable compared to future noise levels without the proposed deviation. Without the proposed deviation it would be fully expected that greater increases in noise would be experienced by residents (due to increased traffic volumes). Noise levels with the deviation are predicted to be between 1 to 2dBA quieter at monitoring locations 1 and 4 compared to the existing noise levels. Both of the above points are due to the fact that the new northern deviation will reduce the number of vehicles using the existing Gateway Motorway in the short to medium term by vehicles utilising the new deviation.

In summary, the proposed deviation is anticipated to result in a more favourable acoustic environment for residents adjacent the existing Gateway Motorway (north of the river).

Table 15.25 documents the predicted 2021 $L_{A10(1hour)}$ internal noise levels at all health and educational facilities (including halls and churches) adjacent to the Motorway in the Cleveland Branch Rail Line to Pinkenba Rail Line section of the GUP (refer southern section for details of assessment procedure).

Table 15.25 Predicted (2021) Internal Noise Levels at Health and Educational Facilities (Cleveland Branch Rail Line to Pinkenba Rail Line)

Location	Description	Predicted Internal Noise Level $L_{A10(1hour)}$
TAFE 01	Brisbane Institute of TAFE Gateway Campus located on Kingsford Smith Drive	55dBA
TAFE 02		57dBA
TAFE 03		57dBA
TAFE 04		58dBA
TAFE 05		49dBA
TAFE 06		51dBA
TAFE 07		50dBA
TAFE 08		50dBA
TAFE 09		59dBA

As may be seen in Table 15.25, internal noise levels at the TAFE buildings 2, 3, 4 and 9 are predicted to exceed the project noise criteria of 55dBA $L_{A10(1hour)}$ internal. A review of the facilities shown in Table 15.25 indicate the following:

- buildings do not have windows located on the façades facing the Motorway resulting in a reduction in predicted internal noise levels by at least 3dBA and compliance with the project criteria; and
- A survey of building 9 indicated that all windows on the building exterior are typically closed, with ventilation supplied by an air conditioning system. Attenuation through closed windows is often 10 to 15dBA greater than that predicted through an open window and as such it is expected that the predicted internal noise will be below the project criteria.

Recommended Mitigation Measures

No noise mitigation measures specifically to address year 2021 operation road traffic noise emissions for the Cleveland Branch Rail Line to Pinkenba Rail Line section will be required.

Pinkenba Rail Line to Nudgee Road

Prediction and Assessment

Appendix K4 contains plans showing all the noise sensitive locations assessed as part of the EIS. Appendix K5 contains future (2021) predicted $L_{A10(18hour)}$ noise levels for all residences, $L_{A10(12hour)}$ noise levels for all parks and outdoor educational and $L_{A10(1hour)}$ internal noise levels for all health and educational facilities based on the GUP concept design.

Road traffic noise emission contours for the year 2021 with no mitigation may be seen in Appendix K6 and K7. These contour maps indicate façade noise levels, including a 2.5dBA façade correction, for single storey (2m) and two storey (4.5m) residences.

The results of the assessment indicated that for the Pinkenba Rail Line to Nudgee Road section, future (2021) predicted $L_{A10(18hour)}$ noise levels for all residences are expected to be below the noise criteria of 68dBA $L_{A10(18hour)}$.

Future (2021) noise levels with the proposed deviation are predicted to be around 1dBA higher than the existing 2004 levels for monitoring locations 2 and 3 north of the Brisbane River. This is only a marginal increase above existing noise levels, and is favourable compared to future noise levels without the proposed deviation. Without the proposed deviation it would be fully expected that greater increases in noise would be experienced by residents (due to increased traffic volumes). Noise levels with the deviation are predicted to be between 1 to 2dBA quieter at monitoring locations 1 and 4 compared to the existing noise levels. Both of the above points are due to the fact that the new northern deviation will reduce the number of vehicles using the existing Gateway Motorway in the short to medium term by vehicles utilising the new deviation.

In summary, the proposed deviation is anticipated to result in a more favourable acoustic environment for residents adjacent the existing Gateway Motorway (north of the river).

Table 15.26 documents the predicted 2021 $L_{A10(12hour)}$ noise levels at all parks and outdoor educational areas adjacent to the Motorway.

CoRTN does not predict $L_{A10(12hour)}$ noise levels therefore a correction factor was determined from the measurement data to take the output of CoRTN and equate it to the MR $L_{A10(12hour)}$ descriptor for parks and outdoor educational areas.

The process for determining this correction factor was to:

- Calculate the daily weekday difference between the $L_{A10(18hour)}$ and $L_{A10(12hour)}$ noise levels; and
- Average the daily (weekday) differences to determine a single correction factor.

The above process resulted in a +1dBA correction to the $L_{A10(18hour)}$ noise levels for predicting $L_{A10(12hour)}$ noise levels.

Table 15.26 Predicted (2021) Noise Levels at Parks and Outdoor Educational Areas (Pinkenba Rail Line to Nudgee Road)

Location	Description	Predicted Noise Level $L_{A10(12hour)}$
Brisbane Grammar School Sports Field 1	Sporting Fields located on Nudgee Road	70dBA
Brisbane Grammar School Sports Field 2		67dBA
Brisbane Grammar School Sports Field 3		70dBA
Brisbane Grammar School Sports Field 4		70dBA
Brisbane Grammar School Sports Field 5		70dBA
Brisbane Grammar School Sports Field 6		70dBA

Whilst an exceedance of the 63dBA $L_{A10(12hour)}$ criterion is predicted at the Brisbane Grammar School Sports Fields in 2021, the 2021 noise levels will either remain at the current 2004 level or be approximately 1dBA quieter than the existing 2004 noise environment.

Table 15.27 documents the predicted 2021 $L_{A10(1hour)}$ internal noise levels at all health and educational facilities (including halls and churches) adjacent to the Motorway corridor in the Pinkenba Rail Line to Nudgee Road section of the GUP (refer southern section for details of assessment procedure).

Table 15.27 Predicted (2021) Internal Noise Levels at Health and Educational Facilities (Pinkenba Rail Line to Nudgee Road)

Location	Description	Predicted Internal Noise Level $L_{A10(1hour)}$
ACU 1	Australian Catholic University located on Nudgee Road, Nudgee	51dBA
ACU 2		51dBA
ACU 3		51dBA

As may be seen in Table 15.27, the predicted internal noise levels are expected to comply with the project noise criteria of 55dBA $L_{A10(1hour)}$.

Recommended Mitigation Measures

No noise mitigation measures specifically to address year 2021 operation road traffic noise emissions for the Pinkenba Rail Line to Nudgee Road section will be required.

15.2.10 Future Noise Monitoring

Noise monitoring will be undertaken prior to the start of the construction process in 2006 and during the 6 to 12 month period after construction has been completed in 2011 when the Motorway is experiencing normal operation.

Noise monitoring will then be undertaken in 2021.

15.3 Vibration Assessment

15.3.1 Applicable Vibration Criteria

General

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those in which the integrity of the building or the structure itself may be prejudiced, and those where the building contents may be affected.

Humans are far more sensitive to vibration than is commonly realised. They can detect and possibly even be annoyed at vibration levels which are well below those causing any risk of damage to a building or its contents.

The actual perception of motion or vibration may not, in itself, be disturbing or annoying. An individual's response to that perception, and whether the vibration is "normal" or "abnormal", depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2-1975. On this basis, the resulting degrees of perception for humans are suggested by the continuous vibration level categories given in Table 15.28.

Table 15.28 Vibration Levels and Human Perception of Motion

Approximate Vibration Level	Degree of Perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Table Note:
These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8Hz to 80Hz.

Table 15.28 suggests that people will just be able to feel continuous floor vibration at levels of about 0.15mm/s and that the motion becomes “noticeable” at a level of approximately 1mm/s.

Structural Damage Criteria

British Standard 7385:Part 2-1993 “*Evaluation and measurement for vibration in buildings Part 2*” provides criteria against which the likelihood of building damage from ground vibration can be assessed.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extractions or construction excavation), demolition, piling, ground treatments (compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of ***cosmetic*** damage to commercial and residential buildings are presented numerically in Table 15.29.

Table 15.29 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4Hz to 15Hz	15Hz and Above
1	Reinforced or framed structures - Industrial and heavy commercial buildings	50 mm/s at 4Hz and above	
2	Unreinforced or light framed structures - Residential or light commercial type buildings	15 mm/s at 4Hz increasing to 20 mm/s at 15Hz	20 mm/s at 15Hz increasing to 50 mm/s at 40Hz and above

The standard states that the guide values in Table 15.29 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 15.29 may need to be reduced by up to 50%.

Since the buildings adjacent to the road are residential (refer Table 15.29) and could potentially experience resonance effects, a conservative continuous cosmetic damage criterion of 7.5mm/s at 4Hz increasing to 10mm/s at 15Hz has been adopted for the purposes of this vibration assessment.

Safe Vibration Levels for Common Services

Vibration due to the construction process has the potential to effect services such as buried pipes, electrical and telecommunication cables.

German Standard DIN 4150-3 1999 *“Structural Vibration – Part 3: Effects of vibration on structures”* provides guidance on safe vibration levels for buried pipe work. The levels assume “current technology” as special considerations must be applied for systems associated with older structures such as might occur in the vicinity of heritage listed buildings. Table 15.30 details the DIN 4150-3 limits for short term vibration. The levels apply at the wall of the pipe. For long term vibration the guideline levels presented in Table 15.30 should be halved.

Table 15.30 DIN 4150 Part 3 – Damage to Buried Pipes – Guidelines for Short-term Vibration

Pipe Material	Peak Wall Vibration Velocity
Steel (including welded pipes)	100mm/s
Clay, concrete, reinforced concrete, prestressed concrete, metal with or without flange (other than steel)	80mm/s
Masonry, plastic	50mm/s

Table Notes:
For gas and water supply pipes within 2 m of buildings, the levels given in Table 15.29 should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

Recommended vibration criteria for electrical cables and telecommunication services such as fibre optic cables range from between 50mm/s and 100mm/s.

It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment be made.

Human Comfort Criteria

Guidance in relation to assessing potential disturbance from ground-borne vibration is set out in British Standard 6472-1992 "*Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*". This standard nominates criteria for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "*low probability of adverse comment*" from occupants. The applicable levels for daytime activities in residential buildings, offices and workshops for this category are shown in Table 15.31.

Table 15.31 Vibration Levels Corresponding to "Low Probability of Adverse Comment" (1Hz to 80Hz)

Building Type	Peak Floor Vibration (X, Y Horizontal)	Peak Floor Vibration (Z Vertical)
Residential	0.8 mm/s to 1.6 mm/s	0.3 mm/s to 0.6 mm/s
Offices	1.6 mm/s	0.6 mm/s
Workshops	3.2 mm/s	1.2 mm/s

The vibration levels given in Table 15.31 for continuous vibration apply to a 16 hour daytime exposure period.

Where vibration comprises a number of events, a Vibration Dose (Dv) may be calculated for each event by the following formula using vibration measured in weighted rms acceleration:

Dv = $1.4 \times a_{rms} \times t^{0.25}$ m/s$^{1.75}$

Where, a_{rms} = rms acceleration (m/s^2)

t = Total cumulative time (seconds) of the vibration event or period of vibration

Over the frequency range 8Hz to 80Hz, the formula may also be expressed in terms of unweighted rms vibration velocity (assuming approximately sinusoidal motion):

Dv = 0.07 x Vrms x t0.25 m/s1 .75

Where, Vrms = rms particle velocity (mm/s)

t = Total cumulative time (seconds) of the vibration event or period of vibration

The total vibration dose is then calculated using the following formula:

$$Dv = \left(\sum_{n=1}^{n=N} Dv_n^4 \right)^{0.25}$$

Where, Dv = Total vibration dose value for the day
Dvn = Vibration dose value for each vibration dose event
N = Total number of vibration dose events

Vibration Dose Limits

The permissible rms particle velocity levels corresponding to the vibration dose value varies according to the duration of exposure. Table 15.32 shows the range of satisfactory vibration dose values for which various degrees of adverse comment may be expected in residential buildings.

Table 15.32 Vibration Dose Values (m/s1.75) above which Various Degrees of Adverse Comment may be Expected in Residential Buildings

Location	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential buildings 16 hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night	0.13	0.26	0.51

Based on the relationship between the vibration levels for residences, offices and workshops, the corresponding daytime vibration dose values are given in Table 15.33 - *"Vibration dose Values above which Various Degree of Adverse Comment Expected in Offices and Workshops"*.

Table 15.33 Vibration Dose Values (m/s) above which Various Degree of Adverse Comment Expected in Offices and Workshops

Location	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Offices 16 hour day	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2
Workshops 16 hour day	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Situations exist where motion magnitudes above the dose levels given in BS 6472 can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation project.

In certain circumstances, the use of higher magnitudes of acceptability may be considered, for example for projects having social worth or broader community benefits, or in view of the economic or practical feasibility of reducing vibration to the recommended levels. In such cases, best management practices should be employed to reduce levels as far as practical.

15.3.2 Construction Vibration

Vibration Emission Levels for Typical Construction Equipment

The following information in relation to potential sources of ground vibration has been used as the basis for the vibration assessment.

Pile Driving

The typical levels of ground vibration from pile driving range from 1mm/s to 3mm/s at distances of 25m to 50m, depending on ground conditions and the energy of the driving hammer.

Bulldozers

Typical ground vibration levels from bulldozers range from 1mm/s to 2mm/s at distances of approximately 5m. At distances greater than 20m, vibration levels are usually below 0.2mm/s.

Truck Traffic

Heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels, typically ranging from 0.01mm/s to 0.2mm/s at the footings of buildings located 10m to 20m from a roadway. Very large surface irregularities can cause levels up to 5 to 10 times higher.

Vibratory Rollers

Levels of ground vibration caused by vibratory rollers can range up to 1.5mm/s at distances of around 25m. The highest levels of vibration usually occur as the roller is brought to rest and the frequency of the centrifugal forces passes through resonance with the natural frequency of the roller/ground/structure.

The above data in combination with the vibration criteria outlined in Section 15.3.1 was used to develop “Safe Working Distances” for the construction equipment proposed for GUP.

Predictions and Assessment

Safe working distances for typical items of vibration intensive plant are listed in Table 15.34. Safe working distances are quoted for both "cosmetic" damage and human comfort. The human comfort safe working distances correspond to a *"Low Probability of Adverse Comment"* response.

The safe working distances given in Table 15.34 are indicative and will vary depending on the particular item of plant and local geotechnical conditions, presence of elevated water table, etc. Furthermore, it is noted that the safe working distances for "cosmetic" damage apply to damage of typical buildings and do not address heritage structures or heavy industrial buildings.

Vibration monitoring is recommended for site specific activities and in any situations where there is some doubt regarding the suitability of the plant or where there is believed to be a risk of exceeding the applicable vibration criteria.

Table 15.34 Safe Working Distances for Vibration Intensive Plant Items

Item	Rating	"Safe" Working Distance to avoid	
		Cosmetic Damage (refer BS 7385)	Human Response (refer BS 6472)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5m	15 to 20m
	< 100 kN (Typically 2-4 tonnes)	6m	20m
	< 200 kN (Typically 4-6 tonnes)	12m	40m
	< 300 kN (Typically 7-11 tonnes)	25m	100m
	> 300 kN (> 12 tonnes)	25m	100m
Impact Pile Driver		20m to 40m	80m to 120m
Vibratory Pile Driver		5m to 15m	20m to 50m
Pile Boring	(< 800 mm)	2m (nominal)	na
Jack hammer	-	1m (nominal)	Avoid contact with structure

On the basis of the data provided in Table 15.33, vibration buffer zones have been developed for the GUP construction works. These zones are dictated primarily by two activities:

- Bulk earthwork compaction (vibratory roller); and
- Impact pile driving.

The vibration buffer zones are shown in Appendix K8. These diagrams indicate that:

- There is potential risk of cosmetic damage for residences and light commercial buildings located within 25m or so of the compaction works.
- There is potential risk of generating some degree of adverse comment for residents located with 100m or so of compaction works.
- There is potential risk of cosmetic damage for residences and light commercial buildings located within 40m or so of the impact pile driving works.

- There is potential risk of generating some degree of adverse comment for residents located with 120m or so of impact pile driving works.

Recommended Mitigation Measures

Based on this assessment, vibration mitigation to be implemented during construction include:

- That building condition surveys be conducted for all buildings shown in red in Appendix K10. The identified buildings fall within the "safe working distances" for cosmetic damage. It is also recommended that building condition surveys be conducted for a representative number of buildings shown in black which are the closest buildings (to construction activities) within a conservative zone of two (2) times the "safe working distances for cosmetic damage".

Further investigations are recommended for identified (shown red and black in Appendix K9) commercial and industrial buildings to determine if the "light weight" cosmetic damage criterion is applicable as utilised for this assessment, or whether a higher value (as per Table 15.33) is more appropriate.

15.3.3 Operational Vibration

Vibration Emission Levels for Operational Road Traffic Conditions

File data on vibration levels generated by traffic on smooth road pavements indicate relatively low vibration levels, typically ranging from 0.01mm/s to 0.2mm/s at the footings of buildings located 10m to 20m from the roadway.

This data was used to extrapolate operational vibration levels at the nearest sensitive locations adjacent to the GUP.

Predictions and Assessment

Based on the data above vibration levels from traffic utilising the completed GUP will be well below both "building damage" and "human annoyance" criteria. In fact, as most homes are around 25m or further away from the Motorway, it is expected that any vibration from traffic would be imperceptible, less than 0.15mm/s, to neighbouring occupants.

Similarly, vibration levels from traffic utilising the completed Motorway will be below both the "building damage" and "human annoyance" criteria at all commercial and industrial buildings.

15.4 Conclusions

Measurements of the existing ambient noise environment have been made and operational noise levels have been predicted using SoundPLAN computer noise modelling software.

The results of the operational noise assessment predicted areas where road traffic noise levels are expected to exceed the defined criteria. Noise mitigation strategies in the form of noise barriers have been recommended in order to provide sufficient attenuation to achieve the criteria.

Construction noise levels have been predicted based upon proposed construction equipment and expected activities. Mitigation and management strategies have been recommended in situations where the construction noise criteria are expected to be exceeded.

Vibration levels due to construction and operation of the motorway have been predicted and recommendations made, where required, to manage the potential impacts.

Based on the data provided and the investigations undertaken, it is anticipated that all noise and vibration issues associated with both the construction and operational phases of the GUP can be adequately controlled, in relation to the various sensitive locations adjacent to the road corridors, through appropriate mitigation (physical or management) measures.