

Transportation Noise Assessment

The Rivergums Residential Development

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Prepared for:

Cedar Woods

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The map illustrates the Revised Rivergums Structure Plan, detailing various land uses and infrastructure. Key features include:

- Residential Areas:** Residential R20 (yellow), Residential R30 (orange), and Residential R40 (brown) zones.
- Public Open Spaces:** Green areas designated for Public Purposes, including PS/HS - Primary/High School WSD - Water Authority of WA.
- Schools:** High School and Primary School sites.
- Infrastructure:** Dual Use Path Network (blue line), Footpath Network (red line), and Structure Plan Boundary (black outline).
- Other Features:** Sewerage Treatment Plant, Future Sewer Pump Station, and various reserves like Parks and Recreation Reserve and Public Open Space Reserve.

Legend:

- Residential R20
- Residential R30
- Residential R40
- Public Open Space
- Public Purposes
- PS/HS - Primary/High School WSD - Water Authority of WA
- Dual Use Path Network
- Footpath Network
- Structure Plan Boundary

GROSS STRUCTURE PLAN AREA 70.4730ha
PUBLIC OPEN SPACE AREA
Area 1a 0.96ha
Area 1b 3.54ha
Area 2 3.48ha
Area 3 1.84ha
Area 4 0.41ha
Total 10.27ha
SEWER PUMP STATION (P) 0.7000ha
CATV SITE 0.0100ha
PARKS & RECREATION 0.3510ha
SCHOOL SITES 14.1164ha
NET DEVELOPABLE AREA 49.92ha
PROPOSED LOTS 684
DWELLINGS PER NET HECTARE 13.7

Total 14.1164ha

LEGEND

- Residential R20
- Residential R30
- Residential R40
- Public Open Space
- Public Purposes
- PS/HS - Primary/High School WSD - Water Authority of WA
- Dual Use Path Network
- Footpath Network
- Structure Plan Boundary

Section 100(4)

N

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

2 CRITERIA

The criteria relevant to this assessment is the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (hereafter referred to as the Policy) produced by the Western Australian Planning Commission (WAPC). The objectives in the Policy are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; and
- Facilitate the strategic co-location of freight handling facilities.

The Policy's outdoor noise criteria are shown below in *Table 2-1*. These criteria applying at any point 1-metre from a habitable façade of a noise sensitive premises and in one outdoor living area.

Table 2-1 Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB L _{Aeq} (Day)	60 dB L _{Aeq} (Day)
Night (10pm to 6am)	50 dB L _{Aeq} (Night)	55 dB L _{Aeq} (Night)

Note: The 5 dB difference between the target and limit is referred to as the margin.

In the application of these outdoor noise criteria to new noise sensitive developments, the objectives of this Policy is to achieve -

- acceptable indoor noise levels in noise-sensitive areas (e.g. bedrooms and living rooms of houses); and
- a 'reasonable' degree of acoustic amenity in at least one outdoor living area on each residential lot.

If a noise sensitive development takes place in an area where outdoor noise levels will meet the *target*, no further measures are required under this policy.

In areas where the *target* is exceeded, but noise levels are likely to be within the 5 dB margin (i.e. less than the *limit*), customised noise mitigation measures should be implemented with a view to achieving the *target* in at least one outdoor living area on each residential lot, or if this is not practicable, within the *margin*. Where indoor spaces are planned to be facing outdoor areas that are above the *target*, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces.

3 METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of the Policy as described below in *Sections 3.1 and 3.2*.

3.1 Site Measurements

Noise monitoring was undertaken between 20 May and 31 May 2010 in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18\text{hour}}$, $L_{Aeq(\text{Day})}$ and $L_{Aeq(\text{Night})}$); and
- Calibrate the noise model for existing conditions.

The instrument used was an ARL Type 316 noise data logger, located 35 metres from the edge of the road, with the microphone 1.4 metres above ground level. The logger was programmed to record hourly L_{A1} , L_{A10} , L_{A90} , and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within ± 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

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

3.2 Noise Modelling

The computer programme *SoundPLAN 7.2* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered. Note that corrections are applied to the exhaust of -8.0 dB (based on Transportation Noise Reference Book, Paul Nelson, 1987) and to the engine source of -0.8 dB, so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;
- An adjustment of -1.7 dB has been applied to the predicted levels based on the findings of An Evaluation of the U.K. DoE Traffic Noise Prediction; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group 1982.

Predictions are made at heights of 1.4 metres above ground floor level and at 1.0 metre from an assumed building façade (resulting in a $+2.5$ dB correction due to reflected noise).

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

3.2.1 Ground Topography, Road Design & Cadastral Data

Noise modelling is 3-dimensional so that landmarks such as hills and buildings are taken into account. The existing ground topography, cadastre and road design are on file due to the involvement of LG Acoustics with the Southern Gateway Alliance.

All buildings are assumed to be single storey, at a height of 3.5 metres.

Finished lot levels were provided by Tabec.

3.2.2 Traffic Data

Traffic data includes:

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

Table 3-1 Noise Relationship Between Different Road Surfaces

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

- The road surface in this section of the Kwinana Freeway is open graded asphalt with intersections and side roads being dense graded asphalt.
- Vehicle Speed – The existing and future posted speeds are 100km/hr.
- Traffic Volumes – Information used in the modelling is provided in *Table 3-2* as was supplied by MRWA

Table 3-2 Traffic Information Used in the Modelling

Description	Scenario			
	Existing - 2005		Future - 2031	
	6am to Midnight	10pm to 6am	6am to Midnight	10pm to 6am
Volumes	28,158	2,348	55,670	2,930
Percentage Heavy Vehicles	13.2	19.8	7	15

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.25 (25%) within the road reserve and 0.9 (90%) outside of the reserve, where 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.2.4 Parameter Conversion

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

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

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised below in *Table 4-1* and shown graphically in *Figures 4-1 & 4-2*.

Table 4-1 Measured Average Noise Levels – Monitoring Locations

Date	Average Weekday Noise Level, dB			
	$L_{A10,18\text{hour}}$	$L_{Aeq,24\text{hour}}$	$L_{Aeq(\text{Day})}$	$L_{Aeq(\text{Night})}$
Tuesday 25 May 2010	63.5	60.6	61.8	56.6
Wednesday 25 May 2010	64.3	61.0	62.1	57.3
Thursday 25 May 2010	64.2	61.7	62.7	58.8
Friday 25 May 2010	64.0	61.1	62.3	56.2
Saturday 25 May 2010	62.3	58.9	60.2	54.1
Sunday 25 May 2010	61.5	58.3	59.7	52.8
Weekday Average	64.0	61.1	62.2	57.2

The average differences between the weekday $L_{A10,18\text{hour}}$ and $L_{Aeq(\text{Day})}$ is 1.8 dB and this conversion has been used in the modelling. The average differences between the weekday $L_{Aeq(\text{Day})}$ and $L_{Aeq(\text{Night})}$ is 5.0 dB. In comparison to the Section 2.0 criteria, this means that neither the day nor night levels are more critical than the other.

Figure 4.1
Weekday Noise Monitoring alongside Kwinana Freeway
3m From Cadastral Boundary

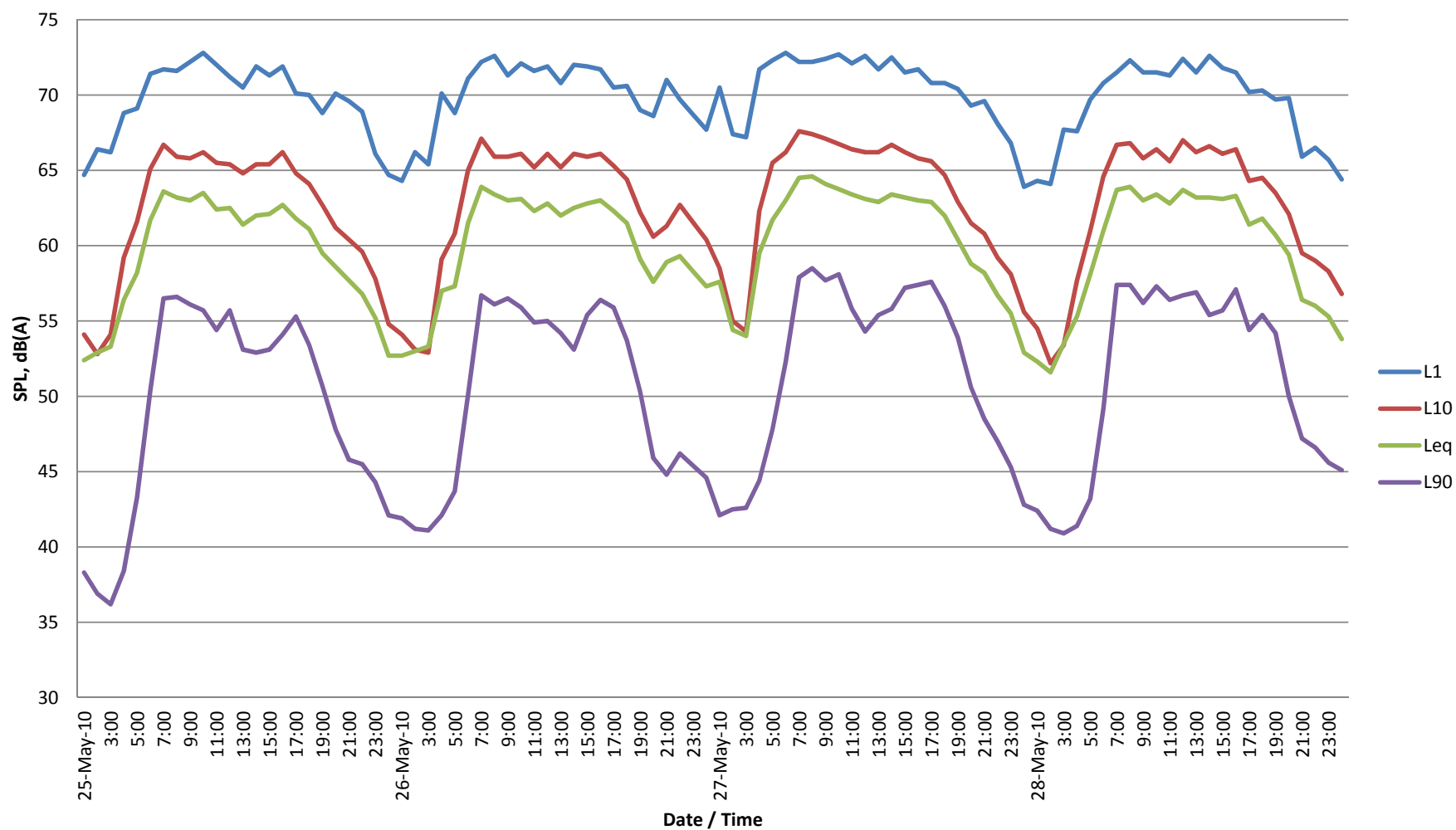
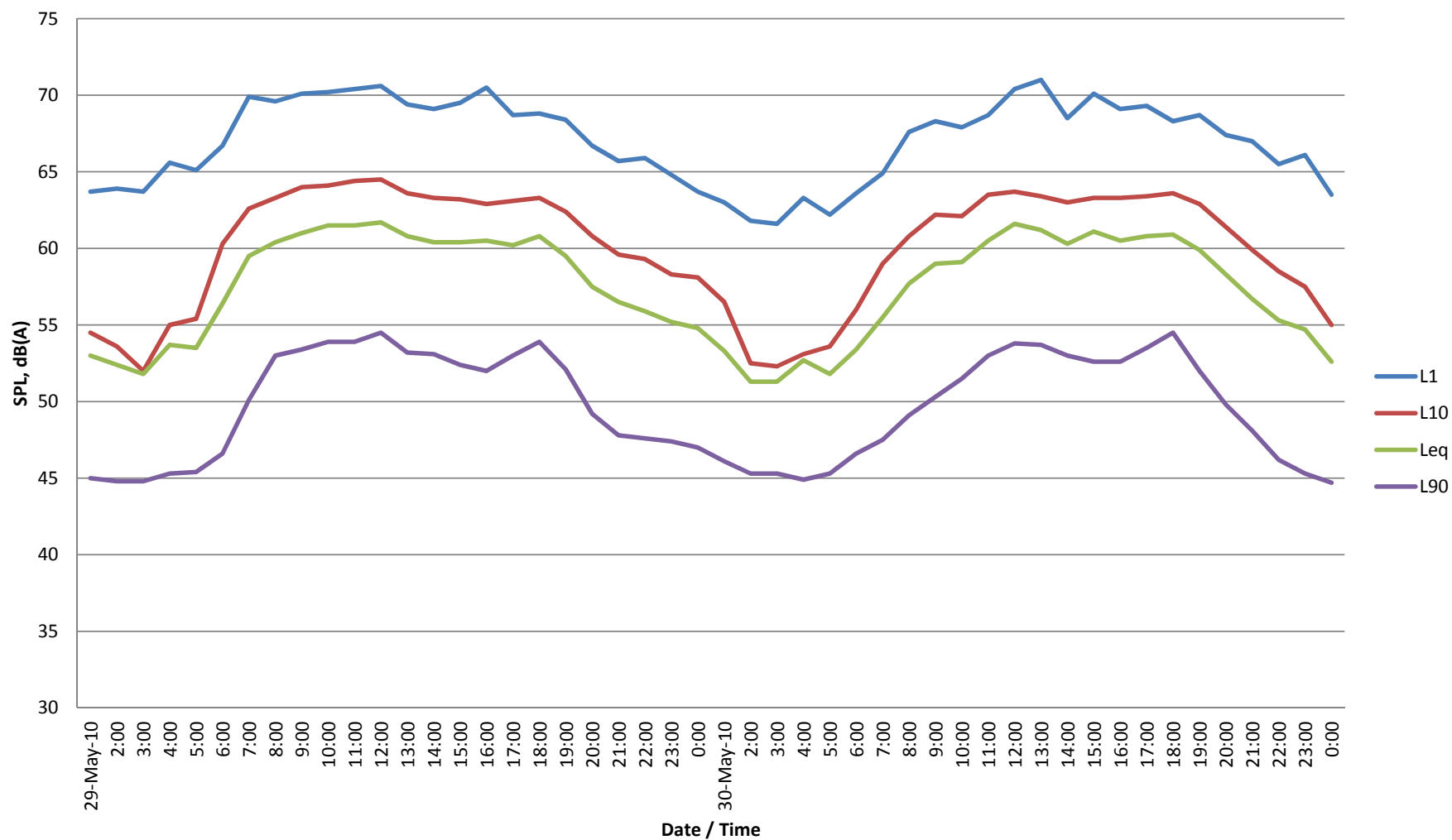


Figure 4.2
Weekend Noise Monitoring alongside Kwinana Freeway
3m From Cadastral Boundary



4.2 Noise Modelling

4.2.1 Model Accuracy

The existing traffic volume information provided by MRWA (refer *Table 3.2*) was incorporated into the noise model, with the noise levels then predicted to the logger location. As discussed in *Section 3.2.4*, the noise model calculates the $L_{A10,18\text{hour}}$ value, in this case predicting a level of 65.0 dB $L_{A10,18\text{hour}}$. Hence the noise model is over-predicting the $L_{A10,18\text{hour}}$ parameter by 1.0 dB. The noise modelling has therefore been adjusted by this amount.

4.2.2 Future Noise Levels Across Subject Site

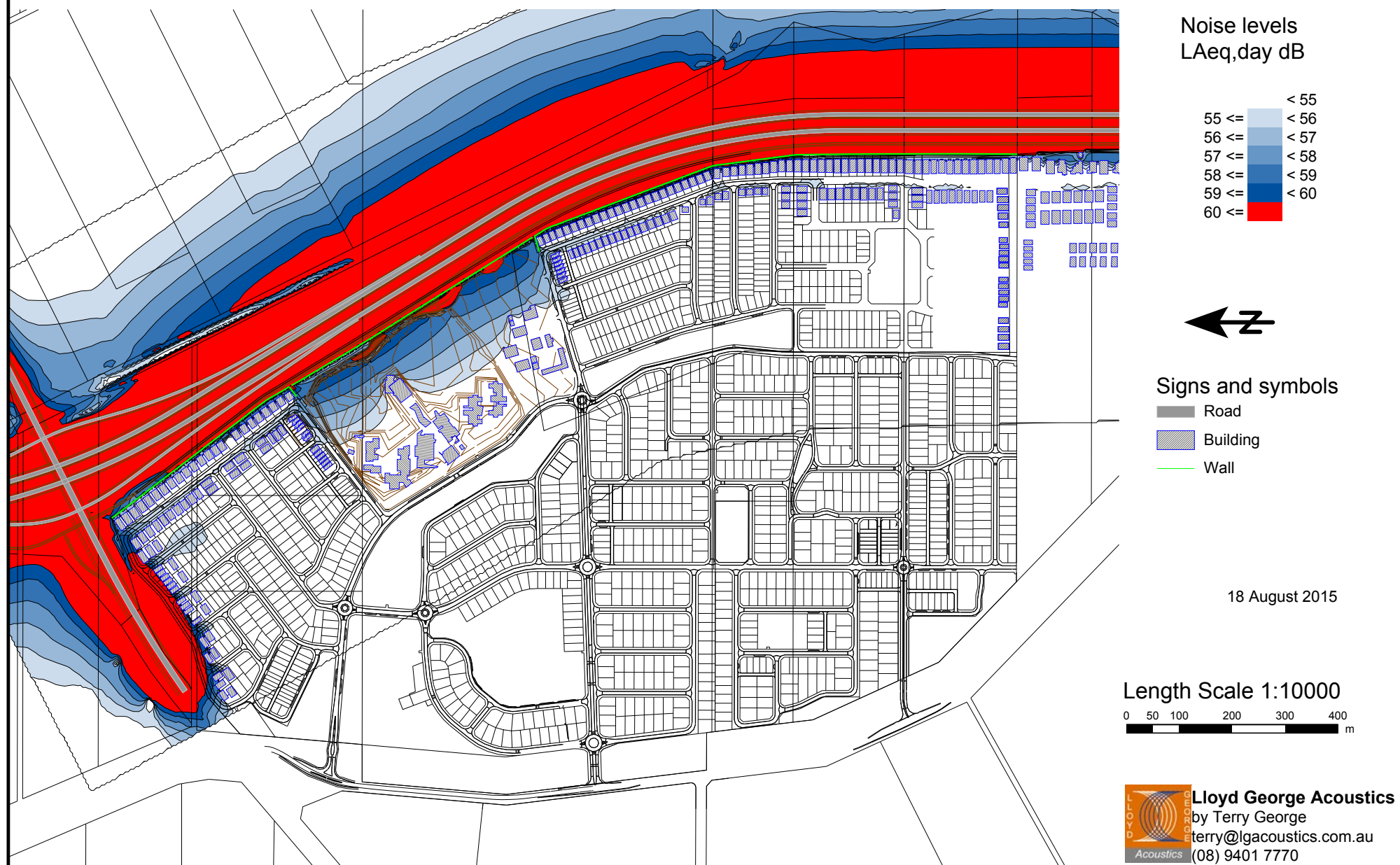
From the earlier noise modelling work, it was evident a noise wall was necessary along the eastern boundary. North of the High School site, the noise wall has been constructed and the height of this wall is included in the model. The height of the wall alongside the schools has been designed although is yet to be constructed. The wall alongside the residences south of the school sites was designed but has since been refined now that finished lot levels are included in the modelling. There is an allowance for a path opening between walls, at the north and south ends of the school. The noise wall heights are provided in *Figure 5-1*.

Including the described noise walls, *Figure 4-3* provides the noise level contours across the site.

The Rivergums Residential Development

L_{Aeq},Day Noise Level Contours - With Wall Alongside Boundary to Kwinana Freeway

Figure 4-3



5 ASSESSMENT

The objectives of the criteria are for noise at all houses to be no more than the *limit* and preferably no more than the *target*. Where the *target* is achieved, no further controls are required. Where the *limit* is achieved or noise levels are within the *margin* (between the *limit* and *target*), further controls are necessary.

The designed wall, shown in *Figure 5-1*, results in noise levels at residences alongside the Kwinana Freeway being no more than the *limit*. This therefore will achieve the requirement for residences to have an outdoor living area with a 'reasonable' acoustic amenity. Some residences along Safety Bay Road will have noise levels above the *limit*, however these dwellings do not back onto Safety Bay Road so the outdoor area can be located either on the side of the house or on the side opposite to Safety Bay Road.

As noise levels at houses will be above the *target*, to ensure a reasonable indoor amenity is achieved, architectural packages are to be incorporated. The packages are provided in Appendix A, with *Figure 5-1* providing the affected lots. Note that alternatives to the Acceptable Treatment Packages can be incorporated, provided these are supported by a report from a suitably qualified acoustical consultant (member firm of the Association of Australian Acoustical Consultants) based on the specific house plans.

Where an affected lot is to be of double storey construction, specialist advice must be sought since the upper level will not receive the same level of attenuation provided by walls or other dwellings.

Figure 5.1

The Rivergums - Cedar Woods Residential Development Minimum Recommended Noise Mitigation



Appendix A

ACCEPTABLE TREATMENT PACKAGES

The packages and information provided on the following pages are taken from *Implementation Guidelines for State Planning Policy 5.4 Road and Rail Transport Noise and freight Considerations in Land Use Planning*; December 2014.

Where outdoor noise levels are above the *target* level, excluding the effect of any boundary fences, the Guidelines propose acceptable treatment packages that may be implemented without requiring detailed review. The packages are also intended for residential development only. At higher noise levels or for other building usages, specialist acoustic advice will be needed.

The acceptable treatment packages are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development in lieu of a detailed assessment.

Transition between each package should be made on the basis of the highest incident $L_{Aeq(Day)}$ or $L_{Aeq(Night)}$ value to the nearest whole number determined for the building development under assessment.

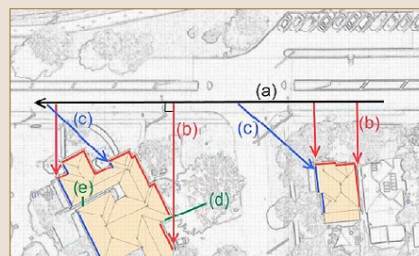
Any departures from the acceptable treatment specifications need to be supported by professional advice from a competent person that the proposal will achieve the requirements of the Policy.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor: Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor: Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor: Neither 'side on' nor 'facing', as defined above.

Determining building face orientation

The following sketch shows two residences in proximity to a road.



'Facing' façades are identified by drawing straight lines (b) perpendicular (at a 90 degree angle) to the road (a). Where these lines intersect a façade – without obstruction – the façades are shown in red as 'facing' the road.

Façades shown in blue are not 'facing' but have clear lines (c) that intersect the road at any angle, and are therefore classed as 'side on' to the road.

The remaining façades are 'opposite' to the road.

Package A

Area	Orientation to Road or Rail Corridor	Package A (up to 60 dB $L_{Aeq}(\text{Day})$ and 55 dB $L_{Aeq}(\text{Night})$)
Bedrooms	Facing	<ul style="list-style-type: none"> Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	<ul style="list-style-type: none"> Windows systems: As above.
	Opposite	No requirements
Other Habitable Rooms Including Kitchens	Facing	<ul style="list-style-type: none"> Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to be same performance including brush seals.
	Side	<ul style="list-style-type: none"> Windows and external door systems: As above.
	Opposite	No requirements
General	Any	<ul style="list-style-type: none"> Walls (minimum $R_w + C_{tr}$ 45) – Two leaves of 90mm thick brick with minimum 50mm cavity Roof and ceiling (minimum $R_w + C_{tr}$ 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. Eaves to be closed using 4mm compressed fibre cement sheet. Mechanical ventilation – Refer following pages.
Outdoor Living Area		<ul style="list-style-type: none"> Where practicable, locate on the side of the building that is opposite to the corridor; or Where practicable, locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package B

Area	Orientation to Road or Rail Corridor	Package B (up to 63 dB $L_{Aeq(Day)}$ and 58 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	<ul style="list-style-type: none"> Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	<ul style="list-style-type: none"> Windows systems: As above.
	Opposite	<ul style="list-style-type: none"> Windows systems: Glazing up to 40% of floor area (minimum $R_w + C_{tr}$ 25) – 4mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Alternatively, 6mm thick glass (monolithic, toughened or laminated) in sliding frame.
Other Habitable Rooms Including Kitchens	Facing	<ul style="list-style-type: none"> Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming $R_w + C_{tr}$ 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	<ul style="list-style-type: none"> Windows and external door systems: Glazing up to 60% of floor area (minimum $R_w + C_{tr}$ 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Glass doors to be same performance ($R_w + C_{tr}$ 28) including brush seals.
	Opposite	No requirements
General	Any	<ul style="list-style-type: none"> Walls (minimum $R_w + C_{tr}$ 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 25mm thick, 24kg/m³ insulation and where wall ties are required, these are to be anti-vibration/resilient type. Roof and ceiling (minimum $R_w + C_{tr}$ 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. Eaves to be closed using 4mm thick compressed fibre cement sheet. Mechanical ventilation – Refer following pages.
Outdoor Living Area		<ul style="list-style-type: none"> Locate on the side of the building that is opposite to the corridor; or Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Mechanical Ventilation requirements

It is noted that natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the National Construction Code. Where the noise *limit* is likely to be exceeded, a mechanical ventilation system is usually required. Mechanical ventilation systems will need to comply with AS 1668.2 – *The use of mechanical ventilation and air-conditioning in buildings*.

In implementing the acceptable treatment packages, the following must be observed:

- Evaporative air conditioning systems will meet the requirements for Packages A and B provided attenuated air vents are provided in the ceiling space and designed so that windows do not need to be opened.
- Refrigerant based air conditioning systems need to be designed to achieve fresh air ventilation requirements.
- External openings (e.g. air inlets, vents) need to be positioned facing away from the transport corridor where practicable.
- Ductwork needs to be provided with adequate silencing to prevent noise intrusion.

Notification

Notifications on certificates of title and advice to prospective purchasers warning of the potential for noise impacts from major transport corridors help with managing expectations.

The area of land for which notification is required should be identified in the noise management plan and contain a description of major noise sources nearby (e.g. 24-hour freight rail).

Notification should be provided to prospective purchasers, and required as a condition of subdivision (including strata subdivision) for the purposes of noise sensitive development or planning approval involving noise sensitive development, where external noise levels are forecast or estimated to exceed the 'target' criteria as defined by the Policy.

In the case of subdivision and development, conditions of approval should include a requirement for registration of a notice on title, which is provided for under Section 165 of the Planning and Development Act 2005 and Section 70A of the Transfer of Land Act 1893. An example of a suitable notice is:

Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise. Transportation noise controls and Quiet House design strategies at potential cost to the owner may be required to achieve an acceptable level of noise reduction. Further information is available on request from the relevant local government offices.

Appendix B

Terminology

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

Decibel (dB)

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

A-Weighting

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

L_1

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

L_{10}

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

L_{90}

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

L_{eq}

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

$L_{A10,18hour}$

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

$L_{Aeq,24hour}$

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

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

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

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

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

R_w

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

C_{tr}

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

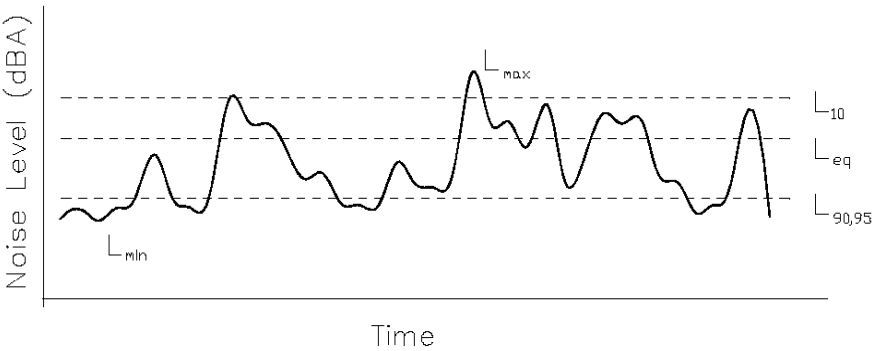
Satisfactory Design Sound Level

The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.



























Maximum Design Sound Level

The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austrorads Vehicle Class

AUSTROADS Vehicle Classification System						
Level 1 Length (m)	Level 2 Axles and Axle Groups	Level 3 Vehicle Type	AUSTROADS Classification			
Type	Axles	Groups	Typical Description	Class	Parameters	Typical Configuration
Short up to 5.5m	1 or 2 3, 4 or 5		Short Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc.	1	d(1) < 3.2m and axles = 2	   
			Short - Towing Trailer, Caravan, Boat, etc.	2	groups = 3 d(1) > 2.1m, d(1) < 3.2m, d(2) > 2.1m and axles = 3, 4 or 5	  
Medium 5.5m to 14.5m	2		Two Axle Truck or Bus	3	d(1) > 3.2m and axles = 2	 
	3		Three Axle Truck or Bus	4	axles = 3 and groups = 2	 
	> 3	2	Four Axle Truck	5	axles > 3 and groups = 2	
	3		Three Axle Articulated Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	 
	4	> 2	Four Axle Articulated Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) > 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups = 2	 
Long 14.5m to 30.5m	5	> 2	Five Axle Articulated Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) > 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups = 2	 
	> 5	> 2	Six Axle Articulated Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups = 2 or axles = 6 and groups = 3	 
	> 6		8 Double 8 Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	 
Medium Combination 17.5m to 30.5m	> 6	> 4	Double Road Train Double road train, or Medium articulated vehicle and one long trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	 
Large Combination Over 33.5m	> 6	> 6	Triple Road Train Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	 
Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart Groups: Number of axle groups Axles: Number of axles (maximum axle spacing of 10.0m) d(1): Distance between first and second axle d(2): Distance between second and third axle						

Typical Noise Levels

