REVERB ACOUSTICS
Noise and Vibration Consultants

Rail Traffic Noise & Vibration Impact Assessment Existing Residence 2 Chapman Street Dungog NSW

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Building Acoustics - Council/EPA Submissions - Modelling - Compliance - Certification

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1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a rail traffic noise and vibration impact assessment for an existing residence located at No.2 Chapman Street, Dungog. The purpose of the assessment is to theoretically determine the noise and vibration impact within habitable spaces of the residence from passing rail traffic on the North Coast Rail Line and to discuss noise control options for the residence.

This rail traffic noise and vibration impact assessment has been conducted with reference to the NSW Department of Planning and Environment's (DP&E's) Guideline, *Development near Rail Corridors and Busy Roads – Interim Guidelines.*

The Assessment was requested by Perception Planning Pty Ltd to form part of a Rezoning Application to Dungog Shire Council (DSC).

2 TECHNICAL REFERENCE / DOCUMENTS

Department of Planning (2008). *"Development near Rail Corridors and Busy Roads - Interim Guidelines".*

ARTC (2007). *Hunter Valley Corridor 2007-2012 Capacity Strategy Consultation Document.*

AS 2107-2000 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors".*

State Rail Authority of NSW (1995) *"Rail related noise and vibration issues to consider in local environmental planning – development applications and building applications".*

NSW Environment Protection Authority. *Environmental Noise Control Manual, Ch's.163 & 174.*

Rail Infrastructure Corporation. (2003). *Interim Guidelines for Councils – Consideration of rail noise and vibration in the planning process.*

Rail Infrastructure Corporation. (2003). *Interim Guidelines for Applicants – Consideration of rail noise and vibration in the planning process.*

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

3 CRITERIA

3.1 Rail Traffic Noise

Previously rail noise assessments for residential situations were conducted in accordance with the requirements of Rail Infrastructure Corporation's (RIC's) *"Interim Guidelines for Councils – Consideration of rail noise and vibration in the planning process"*. However, DP&E's *"Development near Rail Corridors and Busy Roads - Interim Guidelines"* (released in December 2008) is the most recent document and will be used for assessment purposes. Limits specified within the Policy, which will be used for the purpose of this assessment, are shown below:

Type of Occupancy	*Noise Level in dB(A)*	*Applicable Time Period*
Sleeping areas (bedroom)	35	Night 10pm to 7am
Other habitable rooms (excluding garages, kitchens bathrooms & hallways)	40	At any time

If criteria are exceeded by more than 10dB(A) with windows open, mechanical ventilation should be incorporated into the design of affected rooms.

3.2 Rail Traffic Vibration

3.2.1 Personal comfort

Various authorities have set maximum limits on allowable ground and building vibration in different circumstances and situations, all directed at personal comfort rather than building damage. This usually leads in virtually every situation to people who interpret the effects of a vibration to ultimately determine its acceptability. The most recent criteria for assessment of rail traffic vibration impacts upon occupants of a building are those contained in D&PE's *"Development near Rail Corridors and Busy Roads - Interim Guidelines*". The Guideline recommends that the EPA's *Assessing Vibration: A Technical Guideline (2006)* should be used for the assessment of vibration. Limits set out in the Guideline are for vibration in buildings, and are directed at personal comfort for continuous, impulsive and intermittent vibrations. Table 1 shows the Vibration Dose Values for intermittent vibration activities such as train passbys, pile driving and use of vibrating rollers, taken from Table 2.4 of the Guideline, above which various degrees of adverse comment may be expected.

Table 1: Acceptable Vibration Dose Values ($m/s^{1.75}$)
Above which Degrees of Adverse Comment are Possible

Location	Day (7am-10pm)		Night (10pm-7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas #	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Hospital operating theatres, precision laboratories, etc.

3.2.2 Building Safety Criteria

Australian Standard AS2187.2-1993, dealing specifically with blasting vibration, specifies a maximum peak particle velocity of 10mm/sec for houses and a preferred limit of 5mm/sec where site specific studies have not been undertaken. German Standard DIN 4150 - 1986, Part 3 Page 2, specifies a maximum vibration velocity of 5 to 15 mm/sec in the foundations for dwellings and 3 to 8 mm/sec for historical and sensitive buildings, for the range 10 to 50Hz. British Standard BS 7385 Part 2, specifies a maximum vibration velocity of 15mm/sec at 4Hz increasing to 20mm/sec at 15Hz increasing to 50mm/sec at 40Hz and above, measured at the base of the building.

The above listed criteria vary from 3mm/sec up to 15mm/sec, therefore, the more conservative limit of **3mm/sec** will be adopted for the purposes of this assessment. It should be acknowledged, however, that intermittent ground vibration velocities at 5mm/sec are generally considered the threshold at which architectural (cosmetic) damage to normal dwellings may occur and velocities at 10mm/sec should not cause any significant structural damage, with the exception of the most fragile and brittle of buildings.

4 METHODOLOGY

4.1 Rail Traffic Noise

A Type 1, Svan 949 environmental noise logging monitor was installed at a similar nearby location approximately 20 metres from the near rail line. Noise level measurements were taken over approximately seven days of suitable weather conditions to determine the existing rail traffic noise impact. At the end of the monitoring period the data were analysed to determine applicable noise level metrics and statistical noise levels using dedicated software supplied with the instrument. The instrument was calibrated with a Brüel and Kjaer 4230 sound level calibrator producing 94dB at 1kHz before and after the monitoring period, as part of the instrument's programming and downloading procedure, and showed an error less than 0.5dB.

Data supplied by Rail Infrastructure Corporation and reference to Cityrail timetables indicates that an average of 11 coal/freight trains and 15 diesel passenger trains use the North Coast Rail Line each day. During peak periods perhaps 2 passenger and 2 freight trains are expected to pass the site during the busiest morning or evening hourly period.

The predicted day and night L(A)eq,1hr noise level for trains passing the site was calculated using the US EPA's Intermittent Traffic Noise calculation method. This method was adopted because train movements are not continuous, and have the same passby characteristic pattern as other vehicles. The mathematical formula used to calculate the Leq,T noise level for intermittent rail traffic noise is given in Equation 1 below. The calculated values are merely arbitrary, as noise levels are adjusted to correlate with our measured train noise levels, with the intention to provide a (theoretical) means of determining the degree of noise control required for a particular building component.

$$L_{eq},T = L_b + 10\log\left[1 + \frac{ND}{T}\left(\frac{10^{(L\max - Lb)/10} - 1}{2.3} - \frac{(L_{\max} - L_b)}{10}\right)\right] \text{...... } \textit{Equation 1}$$

Where L_b is background noise level, dB(A)
T is the time (min)
D is duration of noise of each train (min)
L_{MAX} is train noise, dB(A)
N is number of trains

The Lmax train noise levels used in Equation 1 are the maximum predicted noise levels produced at the facade from trains passing the site.

Since rail traffic numbers are expected to increase in the future, site measurements of train passbys do not give a true indication of the rail traffic impact, therefore, for assessment purposes we have assumed a 30% increase in passenger trains passing the site and 100% increase in freight/coal trains, projected to the 2020. This equates to 22 coal/freight trains and 20 diesel passenger trains using the North Coast Rail Line each day, or 3 passenger and 4 freight trains during the busiest morning or evening hourly period.

4.2 Rail Traffic Vibration

Typical vibration levels for train passbys were measured at the nearby site, approximately 20 metres from the rail line. Vibration levels of passenger and coal/freight trains were measured with a Vibroch V801 Seismograph coupled to a triaxial geophone installed on hard packed earth. A sandbag was placed over the geophone during each measurement to ensure elevated readings were not recorded due to bouncing and movement, which may occur at higher vibration amplitudes. The unit is capable of measuring and storing peak Z-axis vibration velocities, as well as vibration in three directions simultaneously and gives peak velocity and acceleration on the x, y and z axes.

5 ANALYSIS AND DISCUSSION

Table 2 shows calculations of the predicted rail traffic noise during the day and night (LAeq,1hr) calculated to the most affected facade of the existing residence, 10 metres from the rail line. Results have been calibrated against measured train noise levels, assuming a -3.0dB(A) correction for day and -3.9dB(A) correction for night.

Table 2: Received Train Noise Levels, 10m from Rail Line

	L(A)eq,1hr DAY		L(A)eq,1hr NIGHT	
	Passenger	**Coal/Freight**	**Passenger**	**Coal/Freight**
Rec Noise Level, Lmax.	92	102	92	102
Train frequency/hr	3	4	2	2
Average Bgd Noise, dB(A)	33			
Calculated train noise, Leq	73.3	60.5	69.4	57.8
Combined impact, dB(A)	**73**		**70**	
Criterion (internal)	**40**		**35**	
Exceedance	**33**		**35**	

Results in the above Table indicate that average rail traffic noise levels impacting on the residence are in the order of 73dB(A) during the day and 70dB(A) at night. To put results into context, an Lmax impact of 73dB(A) implies that the facade must be capable of attenuating 33dB, i.e. 73dB(A),max – 40 = 33. The EPA's Construction Noise Guideline suggests a conservative estimate of the difference between internal and external noise levels is 10dB with windows open to provide adequate ventilation and 15dB(A) with windows shut. Based on this assumption internal noise levels are predicted to be 18dB(A) above the criteria at most exposed locations..

Planning Policies are often much less stringent for existing residences in comparison to requirements for new residences near noise generating sources such as airports and busy roads. A typical example is Port Stephens Council's, *DCP 2013, B15: Aircraft Noise in Buildings*, which only requires acoustic modifications to an extension of a residence that is greater than 40% of the gross floor area. The Policy also only requires modifications to the extension and not the existing residence, i.e. the existing residence is classified as "acceptable" for residential development and the extension is classified as "conditionally acceptable".

Given that the residence at 2 Chapman Street was constructed over 100 years ago, modifications to the residence seem unwarranted, based on the above discussion and similar allowances may be considered by Council.

Attended vibration monitoring conducted at a nearby site reveal that adverse comment is possible, particularly if a person is seated quietly or resting. Under certain circumstances, say if a large vibrating track maintenance machine was to pass the site and the resonant frequency of the ground happened to be an exact multiple of the driving frequency of the source, then higher vibration levels could be expected. However, it is doubtful that levels would reach a magnitude capable of causing any structural damage.

Vibration can be felt at levels well below those considered to cause structural damage. Complaints from occupiers are usually due to the belief that if vibration can be felt then it is likely to cause damage. Slamming of doors or footfall within a building can produce vibration levels above those produced by passing rail traffic. Passing trains will only produce loads, and therefore vibration, when their mass is accelerated, for example when hitting joins or deformities in rails. This emphasises the importance of properly maintained rail lines. Vibration levels caused by trains passing the site are unlikely to cause direct failure, and it is considered the main action is triggering cracks in materials already subjected to stress or natural forces, however, as previously mentioned, this may also arise from internal forces such as slamming of doors. In our experience, vibration will only begin to trigger "natural cracking" at levels above 1mm/sec.

6 CONCLUSION

An acoustical assessment of rail traffic noise and vibration impacting for an existing residence located at No.2 Chapman Street, Dungog, has been completed. Our results show that the noise levels currently exceed relevant criteria for residences however, as previously discussed relaxing of criteria is common for existing residences, which could also be applied to the residence at 2 Chapman Street, Dungog.

It is widely recognised by rail authorities that future increases in rail transport will occur utilising longer and heavier trains, rather than more trains, which means no significant increase in locomotive numbers passing the site. We therefore believe a significant future increase in the daily equivalent continuous noise level (L_{Aeq}) is unlikely.

Similarly, no significant increase in maximum received noise levels are expected in the future, as locomotive and rolling stock manufacturers are continuously developing noise reduction strategies addressing engine, exhaust and wheel noise.

We conclude, with a high degree of confidence that vibration levels at the expected magnitudes will not cause direct structural damage or cause undue annoyance to the occupants. We suspect that one or more natural forces, as discussed in Section 5, will be the cause of any future damage. It should be noted, however, that vibration will be noticed on occasion while a person is standing or seated quietly. Other noticeable indicators may be rattling of window frames and ornaments, and possible visible movement of hanging pictures, etc.

In conclusion, this report has shown that rail traffic noise levels are currently above relevant internal noise goals, however, provision for relaxation of the criteria has been discussed, supporting the Application to Council. We therefore see no acoustic reason why the proposal should be denied.

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Principal Consultant

APPENDIX A
Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
Rw	Weighted Sound Reduction Index. The ability of a partition to attenuate sound, in dB. Given as a single number representation.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
Lmax	The maximum level for the measurement period (usually in dBA)