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Appendix M

Acoustic Assessment

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Redfern Waterloo
Authority

Eveleigh Heritage Walk

Acoustic Environmental
Assessment

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Assessment

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1 Introduction

This appendix provides a noise and vibration assessment during construction and operation of the proposed Eveleigh Heritage Walk (EHW).

2 Site Description

The development site is located just south of the Redfern railway station. The EHW will consist of a bridge over the railway and associated ramps, and will connect the Australian Technology Park site (ATP) with North Eveleigh.

Construction compounds are proposed to be located at the North Eveleigh Plaza (see Location 1 circled on Figure 1) in the north and at the Australian Technology Park in the south (see Location 2 circled on Figure 1). Access to the North Eveleigh Plaza construction compound will be via Wilson Street. Access to the Australian Technology Park construction compound will be via Cornwallis Street.

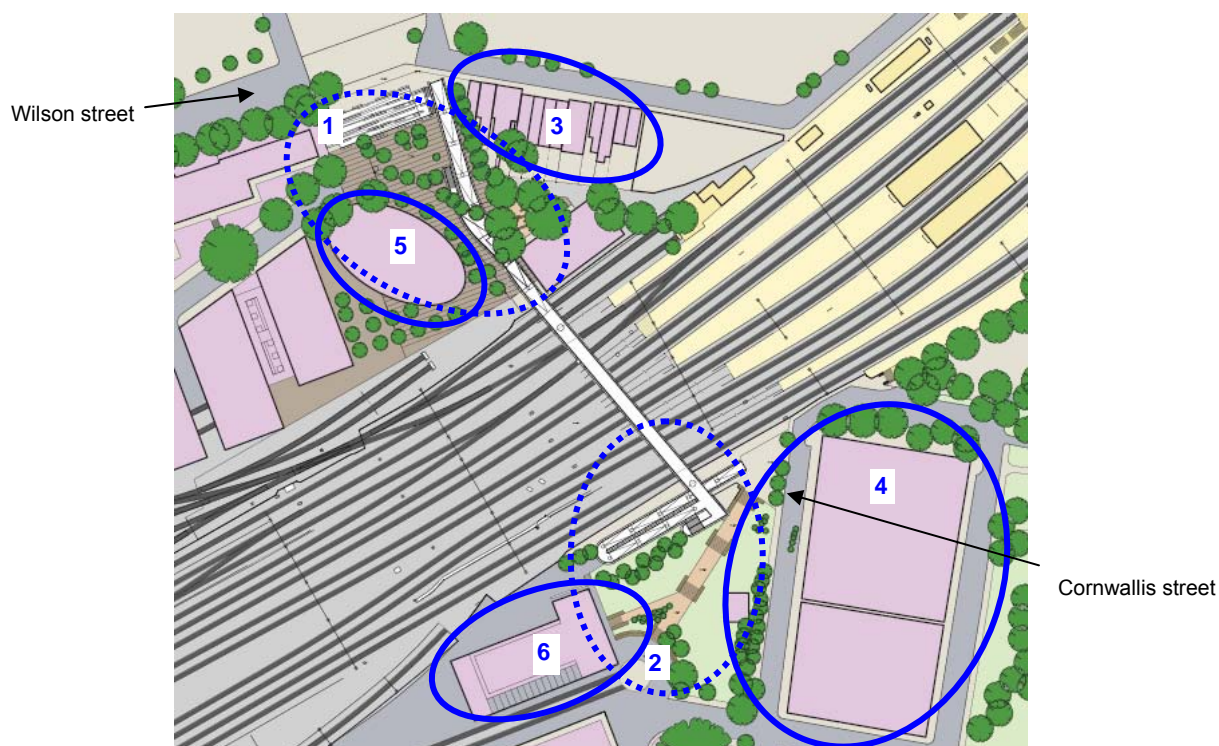


Figure 1 Construction compounds and noise sensitive receivers in close proximity of the bridge.

2.1 Noise Sensitive Receivers (NSR's)

The closest NSRs are the residences of the terrace houses on Little Eveleigh Street (see Location 3 circled on Figure 1) and the apartment block along Cornwallis Street (see Location 4 circled on Figure 1). A proposed apartment block along the bridge, location 5 on Figure 1, will be built after the construction of the bridge and will be a NSR during the operation stage of the bridge. The tenants of the office building next to the proposed location of the pedestrian bridge, location 6 on the map, are also considered to be potential noise sensitive receivers. However, residences are considered to be more sensitive and the exposure to noise of the office building is expected to be similar to the exposure of the residential building on Cornwallis street (location 4). The closest noise sensitive receiver (with the most stringent criteria) of the Australian Technology Park construction compound is therefore the residential building on Cornwallis Street (location 4).

2.2 Existing noise environment

The existing noise environment for the NSRs discussed in Section 2.1 is influenced by train noise as they are closely situated near a busy railway corridor and train station.

In September 2007 a preliminary assessment was undertaken by Acoustic Dynamics for the development site¹. Ambient noise measurements were undertaken at location BG1 and BG2 (see Figure 1). The results of these measurements are considered as representative for the ambient noise levels for the three NSR's identified.

The ambient noise levels measured at these locations are shown in Table 1. The ambient noise levels on both locations were dominated by train noise. The lowest Rating Background Level (RBL) is comparable with the Background Noise Level (L_{A90}) and is used to set the criterion for both NSR's during the construction stage.

Table 1 Ambient Background Noise Monitoring Results derived from preliminary acoustic report, Acoustic Dynamics, October 2007, dB re 20 μ Pa.

Location	Time of Day	Measured Rating Background Level RBL	Measured L_{Aeq} from all sources
BG1	Day time (7am to 6 pm)	48 dB(A)	62 dB(A)
	Evening (6 pm to 10 pm)	46 dB(A)	64 dB(A)
	Night time (10 pm to 7 am)	42 dB(A)	61 dB(A)
BG2	Day time (7am to 6 pm)	47 dB(A)	58 dB(A)
	Evening (6 pm to 10 pm)	45 dB(A)	58 dB(A)
	Night time (10 pm to 7 am)	39 dB(A)	55 dB(A)

¹ North Eveleigh Redevelopment, preliminary acoustic report, acoustic design considerations, Acoustic Dynamics, 24 October 2007.

3 Operational Noise

3.1 Criteria

The EPA's *Environmental Noise Control Manual*² doesn't set out specific criteria for noise caused by pedestrians or bicycle traffic.

3.2 Assessment and Recommendations

The area around the EHW is dominated by railway and traffic noise, with some existing pedestrian activity. The increase in pedestrian traffic due to the EHW is expected to be small and any noise increase caused by pedestrians and cyclists using the EHW is expected to be insignificant.

It is therefore suggested that no specific noise measures need to be undertaken to control operational noise from the use of the EHW. Should complaints arise, noise mitigation measures, such as shielding of noise sensitive receivers with barriers, can be implemented.

²

Environmental Noise Control Manual, Environmental Protection Authority, June 1994.

4 Construction Noise

4.1 Criteria

4.1.1 Construction Noise Criteria

Chapter 171 of the EPA's *Environmental Noise Control Manual* (ENCM) sets out noise criteria for construction projects. The L_{A10} noise parameter is used as the descriptor to assess construction site noise (i.e. the noise level that is exceeded for 10% of the time, indicative of the *average maximum* level). The relevant criterion depends on the pre-existing L_{A90} noise level (being the noise level that is exceeded for 90% of the time, representative of the *background* noise level) and the duration of the construction activity.

The relevant criteria are as follows;

- For construction periods of four weeks or less, the L_{A10} noise level from construction activity should not exceed the existing L_{A90} background noise level by more than 20 dB.
- For construction periods of between four and 26 weeks, the L_{A10} noise level from construction activity should not exceed the existing L_{A90} background noise level by more than 10 dB.

No specific criteria are proposed for construction periods longer than 26 weeks. It is suggested that the intrusiveness criterion described in the *NSW Industrial Noise Policy*³ is used in this situation;

- The $L_{Aeq, 15 \text{ min}}$ noise level must not exceed the Rating Background Level (RBL) + 5 dBA

A summary of all criteria is given in Table 2.

Table 2 Summary of construction noise criteria.

Construction Period	Criteria
4 weeks or less	$L_{A10} \leq L_{A90} + 20 \text{ dB}$
4 weeks to 26 weeks	$L_{A10} \leq L_{A90} + 10 \text{ dB}$
26 weeks or longer	$L_{Aeq} \leq \text{RBL} + 5 \text{ dB}$
tonal or impulsive noise	+5 dB penalty

Where construction noise is audible at residential premises, the EPA guideline recommends that construction should be limited to the following times;

- Monday to Friday, 7:00am to 6:00pm, with a maximum of nine hours per day.
- Saturday 7:00am to 1:00pm if inaudible on premises, otherwise 8:00am to 1:00pm
- No construction work to occur on Sundays or public holidays.

Experience also shows that certain noisy processes are likely to exceed the EPA guidelines at nearby locations even if carried out during the preferred hours. Practical alternatives are not always available and, in these cases, it will be necessary to ensure that the quietest suitable equipment is selected, that temporary noise screening is implemented where practical, and that the timing of the works is subject to prior discussion with the community.

4.1.2 Vibration Noise Criteria

Vibration levels at the nearest residences resulting from the construction works are highly unlikely to exceed either building damage or human comfort vibration criteria and have therefore not been assessed in this environmental assessment.

³

NSW Industrial Noise Policy, Environmental Protection Authority, January 2000.

However, the following vibration criteria are recommended to be applied to the works.

Human Comfort

'Assessing Vibration: A technical Guideline'⁴ describes procedures how to assess vibration on human comfort. The criteria used in this document are derived from the British Standard BS 6472⁵

The recommended preferred and maximum weighted root mean squared (rms) values for continuous and impulsive vibration velocities (mm/s) 1-80 Hz is given in the Table below.

Table 3 RMS human comfort vibration criteria for construction works.

Location	Assessment Period	Preferred Values (mm/s) 1-80 Hz		Maximum Values (mm/s) 1-80 Hz	
		Z-axis	X and Y-axis	Z-axis	X and Y-axis
Residences	Day time 07:00 – 22:00	0.020	0.014	0.040	0.028
	Night time 22:00 – 07:00	0.014	0.010	0.028	0.020

Building Damage

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage.⁶ This lack of data is one of the reasons that there is variation between international standards, why the British Standards Institution (BSI) did not provide guidance before 1992 and why there is still no International Organisation for Standardisation (ISO) guidance limits.

There are however several standards that can be referred to.

Table 4 gives a summary of recommended vibration limits for buildings to prevent damage.

⁴ *Assessing Vibration: A technical Guideline*, DEC, February 2006.

⁵ British Standard BS 6472: 1992 – *Evaluation of human exposure to vibration in buildings 1-80 Hz*.

⁶ *Damage to Structures from Ground-borne Vibration*, BRE Digest, Building Research Establishment (1995).

Table 4 Summary of Current Australian and International Standards.

Standard	Type of building	Recommended vibration limit	Comments
Australian Standard, AS 2187 ⁷	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5mm/s*	For buildings particularly susceptible to vibration. Limit is for peak <i>resultant</i> particle velocity, measured on the ground adjacent to the structure
British Standard, BS 7385 ⁸	Un-reinforced or light framed	15mm/s @ 4Hz rising to 20mm/s @ 15Hz then rising to 50mm/s @ 40Hz and above ¹	Limit is for peak particle velocity in x, y, and z directions
German Standard, DIN 4150 ⁹	Structures of particular sensitivity or worthy of protection	3mm/s to 20mm/s @ <10Hz 3-40mm/s @ 10-50Hz 8-50mm/s @ 50Hz+ Also measurement at the top floor with limit of 8mm/s to 40mm/s across frequency range	Limit is for Peak Particle Velocity in x, y, and z directions Measurement on the top floor in x and y directions only
Swiss Standard, SN 640 312 ¹⁰	Structures of particular sensitivity	3mm/s to 12mm/s @ 10-30Hz 3mm/s to 18mm/s @ 30-60Hz	Limit is for peak particle velocity in x, y, and z directions

* This standard recommends a case-by-case assessment.

As can be seen there is a large variation in vibration levels given in various standards for a variety of building that may cause building damage.

The terrace houses on Little Eveleigh Street are part of a conservation area and therefore heritage listed. Therefore, it is recommended that a building damage vibration criterion of 3 mm/s peak particle velocity (ppv) should be set in the first instance. A vibration criterion of 5 mm/s should be set for other occupied buildings in the area.

4.2 Assessment of Construction Noise Impacts

The construction process consists of the following stages;

Stage 1

In stage 1 the construction of the footing for the bridge structure and ramps, bridge columns, temporary structures and prefabrication of the bridge and precast elements for the ramps will take place. This stage is expected to be completed over a period of six to seven months.

The work will be carried out during normal working hours, from 7 am to 5 pm on week days and from 7 am to 2 pm on Saturdays.

The noisiest activities that will take place in this stage are;

- Piling and construction of pile caps, the drill piling and concrete pouring of the piles will take approximately 4 days on the North Eveleigh Plaza site.

⁷ Australian Standard AS 2187.2 - 1993 *Explosives - Storage, transport and use. Part 2: Use of explosives.*

⁸ British Standard BS 7385: Part 2: 1993 *Evaluation and Measurement for vibration in Buildings Guide to damage levels from ground-borne vibration.*

⁹ German standard DIN 4150: Part 3: 1986.

¹⁰ Swiss Standard SN 640 312.

- Small cranes and trucks, as well as concrete mixers will be operating on site throughout the period on both construction compounds.
- Approximately 150 trucks will be delivering the steel structure over the 6-7 month period via Wilson street to the North Eveleigh Plaza site.
- A small excavator will be operating on site for 2-3 days on both construction compounds.
- Soil compaction equipment such as plate and vibration roller compactors will prepare a hardstand area for the access crane on the Australian Technology Park site. This will take a few days

Stage 2

In stage 2 the prefabricated bridge will be launched. This operation will be done in one weekend. The actual launching of the bridge will take approximately 15 hours and will take place at night time as the railway track will need to be shut down.

The noisiest activities that will take place at this stage are;

- Launching of the bridge. A hydraulic pump will be used and a 400-tonne crane will be in operation, several smaller trucks are expected to be operating on site.
- Generators will be operating in the night time period to provide power and lighting of the site.

Stage 3

In stage 3 the construction of the access ramps and bridge finishes will be comprised. This will take approximately four months.

The noisiest activities that will take place at this stage are;

- Possibly, the installation of the formwork for the in situ concrete pouring of the southern access ramp at the Australian Technology Park will take approximately one week.
- The installation of the handrails, which will involve concrete drilling, will take approximately 4 days.
- Small cranes and trucks, as well as concrete mixers will be operating on site throughout the period on both construction compounds.

Over the total construction period approximately 30 mixer trucks are expected to deliver the required concrete for the project.

The resulting noise levels at the NSRs for the noisiest activities in the three stages have been predicted by assuming a worst case scenario when equipment is operating simultaneously on locations relatively close to the NSRs

Typical sound power levels for the different machineries used are derived from the British Standard BS 5228¹¹ and the Australian Standard, AS 2436¹². See also Table 5.

Distance losses are taken into account.

- Possible reductions through shielding are not taken into account.
- Spherical losses are neglected as distances are relatively short.

The noise levels predicted at the NSRs for the noisiest activities are shown in Table 5.

¹¹ British Standard BS 5228: Part 1: 1997, *Noise and Vibration Control on construction and open sites*.

¹² Australian Standard AS 2436-1981 : *Guide to noise control on construction, maintenance and demolition sites*

Table 5 Results of vibration assessment during the construction period.

Activity	Duration	Assumed Plant	BS 5228 Ref.	Lw dBA	Predicted SPL at Terrace Houses Little Eveleigh St	Predicted SPL at Terrace Houses Little Eveleigh St
Auger piling	7 days in each compound	Crane mounted auger	C4:34	116	94	80
		Concrete pump	C5:16	109		
		Truck mixer (2x)	C5:15	109		
		Crane 70 tonne	C7:117	110		
Stage 1 Excavation of forming	21 days	Excavator	C3:93	110	89	83
		Crane 70 tonne	C7:117	110		
		Trucks (2x)	C9:31	113		
		vibratory roller	C3:116	114		
Erect formworks and columns	28 days	Handheld pneumatic rock drill	C7:64	118	84	77
		Crane 70 tonne	C7:117	110		
		Concrete pump	C5:15	109		
		Truck mixer (2x)	C5:15	109		
Stage 2 Bridge launch	15 hrs	Vibrators (2x)	C6:40	101	80	80
		Trucks (2x)	C9:31	113		
		Hydraulic pump	C3:86	100		
		Diesel generators (2x)	C7:56	113		
Stage 3 Construction of ramps and internal works	14 days	Crane 400 tonne	C7:117	110	79	78
		Crane 70 tonne (2x)	C7:117	113		
		Trucks (2x)	C9:31	113		
		Crane 70 tonne	C7:117	110		
		Handheld grinder	AS 2436 D2	104		
		Handheld drill	AS 2436 D2	94		

The increase in road traffic noise at the NSRs due to deliveries to the site is expected to be minimal.

The total construction period is expected to take over 10 months. During this period there will be approximately 11 weeks of noisy activities. Therefore the criterion of $L_{A10} \leq L_{A90} + 10$ dB for construction periods between 4 and 26 weeks seems appropriate for the construction activities.

In **Table 6** the predicted noise levels are compared with the criteria set.

Table 6 Expected noise levels caused by the various construction activities and compliance with criterion.

Activity	Duration	RBL representative for L _{A90}	Criterion	Predicted noise levels		Compliance with criterion	
				Little Eveleigh Street	Wilson street	Little Eveleigh Street	Wilson street
Auger piling	7 days	47	57	94	80	* 37 dB over	* 23 dB over
Excavation of forming	21 days	47	57	89	83	* 32 dB over	* 26 dB over
Erect formworks and columns	28 days	47	57	84	77	* 27 dB over	* 20 dB over
Bridge launch	15 hrs (nighttime)	39	49	80	80	* 31 dB over	* 31 dB over
Construction of ramps and internal works	14 days	47	57	79	78	* 22 dB over	* 21 dB over

4.2.1 Vibration Assessment

Most activities on site are highly unlikely to cause vibration levels that exceed either building damage or human comfort vibration criteria

The vibration level caused by auger piling occurring further than 2 m is highly unlikely to cause any building damage. However, human discomfort may occur. A detailed assessment should be undertaken for auger piling closer than 2 m to any residence.

Vibration levels caused by auger piling occurring further than 15 m from the nearest residences are highly unlikely to exceed either the building damage or human comfort vibration criteria.

Construction activities are predicted to exceed the criteria set in the ENCM. It will therefore be necessary to implement controls to limit construction noise impacts.

4.3 Recommended Construction Noise and Vibration Management Measures

Where possible, construction operations should be conducted during the daytime period (Monday to Friday, 7:00 am to 6:00 pm and Saturday 8:00 am to 1:00 pm).

In addition to this the following mitigation measures to reduce the noise will be considered:

- Selection of quieter and less vibrating equipment or alternative work methods,
- Fitting silencers to plant including residential grade mufflers to the exhausts of noisy items of plant,
- Regular maintenance of plant to prevent plant from becoming noisy due to poor maintenance, such as blowing exhausts and loose and rattling components etc.,
- Ensuring machinery is turned off when not in use, e.g. no idling trucks,
- Ensuring machine enclosures, doors and access hatches etc are kept closed,
- The principles of 'Best Management Practice' (BMP) and 'Best Technology Economically Achievable' (BATEA) should be adhered to at all times,

- Site inductions of employees and contractors about noise and vibration management,
- Where appropriate, obtaining acoustic test certificates for machinery noisy plant and machinery brought on to the site,
- A construction noise and vibration management plan should be written and implemented with a significant focus on community liaison,
- Maximise offset distance between noisy equipment, such as generators, and NSR's,
- Non-tonal reversing beepers fitted and used on all construction vehicles which are regularly on site,
- Erect noise shielding (hoardings) around NSR's or noisy equipment,
- Loading and unloading of materials should occur as far as possible from NSR's,
- Avoid simultaneous operation of noisy equipment,
- Construction respite periods (high noise and vibration activities may be only be carried out in periods for 3 hours or less, with one respite hour between each period),
- Community consultation measures such as periodic notification, website and a Project Infoline,
- Acoustic monitoring.

The mitigation measures above will significantly reduce the noise and vibration impacts on the NSR's nearby.

Nevertheless, due to the close proximity of the NSR's and the highly variable nature of the construction works undertaken, exceedances of the construction noise and vibration criteria are likely to occur. For these instances it is suggested to adopt strategies used by the Transport Infrastructure Development Corporation for Rail Projects¹³ described in the Construction Noise Strategy issued November 2007.

The following table is derived from this document and suggests additional measures that should be implemented when exceedances of the criteria still occur after implementation of the standard mitigation measures mentioned above.

The abbreviations in the table refer to the following additional noise mitigation measures¹⁴:

AA	Alternative Accommodation
M	Monitoring
IB	Individual Briefings
LB	Letter Box Drops
RO	Project Specific Respite Officer
PC	Phone Calls
SN	Specification Notification

¹³ *Construction Noise Strategy (Rail Projects)*, Transport Infrastructure Development Corporation, November 2007.

¹⁴ For a full description of each measure refer to the TIDC *Construction Noise Strategy (Rail Projects)*.

Table 7 Table 5.of Additional Mitigation Measures Matrix (AMMM) - Airborne construction noise from Construction Noise Strategy, Transport Infrastructure Development Corporation, November 2007.

Time period	Mitigation measures				
	LA10(15 minute) noise level above background (RBL)				
	Qualitative assessment of noise levels				
	0 to 10 dBA Noticeable	10 to 20 dBA Clearly audible	20 to 30 dBA Moderately intrusive	> 30 dBA Highly intrusive	
Standard	Mon-Fri (7am - 6pm)				
	Sat (8am - 1pm)	-	-	LB, M	LB, M
	Sun/Pub Hol (Nil)				
OOHW	Mon-Fri (6pm - 10pm)				
	Sat (1am - 10pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN,
	Sun/Pub Hol (8am - 6pm)				
OOHW	Mon-Fri (10pm - 6am)				
	Sat (10pm - 8am)	LB	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN
	Sun/Pub Hol (6pm - 7am)				

It is likely that additional measures such as noise monitoring, individual briefing, letter box drops, phone calls and specification notification will be necessary for certain activities such as the bridge launch.

Detailed mitigation measures will be developed by the construction contractor, and will be required to be documented in their Construction Noise and Vibration Management Plan (CN&VMP) as a part of their Construction Management Plan (CMP).

The information provided in this report represents a preliminary analysis. Once construction equipment has been selected and locations for use determined then more accurate source noise levels can be determined either from manufacturers or from direct measurement and more accurate predictions made. In addition to this, specific mitigation measures can be designed and the actual noise reductions determined. Predictions including all equipment operating at a time will be conducted to determine the overall impact.

