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SITE 68, SYDNEY OLYMPIC PARK

Acoustic Assessment for Development Application

17 September 2014

Australia Avenue Developments Pty Ltd

TF856-01F02 (r2) DA Acoustic Report.docx

Sydney Melbourne Brisbane Kuwait
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08.09.2014	Prepare draft	0		TW		
12.09.2014	Finalise and issue to Client for review		1			TW
17.09.2014	Issue as final		2	TW		TW

Executive summary

Renzo Tonin & Associates was engaged to undertake an environmental noise assessment of the proposed mixed-use development on Site 68 at corner Australia Avenue and Bennelong Parkway, Sydney Olympic Park to accompany an application for the Development Application.

From our assessment of the proposed development, the following potential noise and vibration issues were identified;

- Traffic noise intrusion from with Australia Avenue and Bennelong Parkway
- Rail noise intrusion from train pass-bys on the adjacent Olympic Park rail corridor
- Ground-borne noise and vibration intrusion from train pass-bys on the adjacent Olympic rail corridor
- Major sporting and entertainment events at Sydney Olympic Park
- Operational noise emission from mechanical plant rooms on dedicated floor levels of the building onto areas of the proposed development and existing adjacent buildings; and
- Noise and vibration generated from construction activities and equipment.

This report presents an assessment of the above acoustic components in terms of Secretary's Environmental Assessment Requirements, Sydney Olympic Park Major Events Impact Assessment guideline, State Environmental Planning Policy (Infrastructure), Australian Standards and NSW Office of Environment and Heritage Industrial Noise Policy.

External Noise Intrusion into the Development

External noise and vibration intrusion into the development has been assessed in accordance with three guidelines and standards:

- State Environmental Planning Policy (Infrastructure) 2007;
- Development Near Rail Corridors and Busy Roads - Interim Guideline 2008; and
- Australian Standard AS2107:2000 'Recommended Design Sound Levels and Reverberation Times for Building Interiors'.
- Sydney Olympic Park Master Plan 2030

The objectives of the noise criteria set out on the above guidelines and standards are to certify the appropriate internal noise amenity for residential dwellings. The major noise intrusion sources were determined to be road traffic and airborne rail noise.

On the basis of the external noise impacting upon the development site, the specified internal noise criteria can be readily addressed through appropriate design and specification of the building envelope.

Our assessment has established laminated glass will be required on worst affected external building facades.

Noise Emission Generated by the Development

Noise emission from mechanical plant such as building exhaust systems, mechanical ventilation and air-conditioning systems associated with the development has the potential to impact on nearby residential properties and is to be controlled at nearby residential properties to meet the noise criteria set out in OEH Industrial Noise Policy. As the specifications of individual mechanical plant are not available at this stage of the development, in-principle noise control advice is present in this report.

Construction Noise

The major construction activities proposed on this site are demolition and excavation works, concrete pours and general building works. Construction and building work is to be managed in accordance with the NSW Interim Construction Noise Guideline so as to minimise disruption to the local community and the environment. As the specifications of construction equipment and operating times are not available at this stage of the project, in-principle noise and vibration measures are provided in this report.

Contents

List of tables

List of figures

1 Introduction

Renzo Tonin & Associates was engaged to conduct an environmental noise assessment of the proposed mixed-use development on Site 68 at corner of Australia Avenue and Bennelong Parkway, Sydney Olympic Park.

From our assessment of the proposed development, the following potential acoustic and vibration issues were identified:

- Rail noise and vibration associated with the Olympic Park railway line
- Traffic noise associated with Australia Avenue and Bennelong Parkway
- Sydney Olympic Park major sporting and entertainment events

Renzo Tonin & Associates attended the site to determine the existing levels of rail noise and vibration affecting the site. In addition a long-term noise monitor was installed on site to establish the existing levels of traffic and ambient noise surrounding the site. Results of the short and long-term noise and vibration surveys were used to calculate noise and vibration levels within the dwellings, and then assessed against the recommended internal noise and vibration criteria for the project.

In addition noise emissions from the operation of the development have been addressed in accordance with the relevant government policies and guidelines in particular the "Sydney Olympic Park Major Event Impact Assessment Guideline".

Noise and vibration levels are assessed according to the criteria recommended for the project and recommendations are made where necessary for noise and vibration mitigation.

The following architectural drawings from Bates Smart Architects were reviewed during the assessment:

Table 1 - Schedule of Architectural Drawings Reviewed

Drawing No.	Issue	Date	Title
DA02.B1[02]	04	29.08.14	Basement Level 001
DA02.B2[02]	04	29.08.14	Basement Level 002
DA02.B3[02]	04	29.08.14	Basement Level 003
DA02.00[02]	03	25.08.14	Ground Level
DA02.01[02]X	05	29.08.14	Level 01-03 General Arrangement Plan
DA02.04[01]X	05	29.08.14	Level 04 General Arrangement Plan
DA02.05[01]X	01	29.08.14	Level 05-09 General Arrangement Plan
DA02.10[01]X	05	29.08.14	Level 10 General Arrangement Plan
DA02.11[01]X	01	29.08.14	Level 11 General Arrangement Plan
DA02.16[01]X	05	29.08.14	Level 16 General Arrangement Plan
DA02.17[01]X	01	29.08.14	Level 17-24 General Arrangement Plan
DA02.25[01]X	04	29.08.14	Level 25-26 General Arrangement Plan

Drawing No.	Issue	Date	Title
DA02.27[X]X	02	29.08.14	Level 27-33 General Arrangement Plan
DA02.34[01]X	01	xx.07.14	Level 34 General Arrangement Plan
DA02.35[01]X	01	xx.07.14	Roof General Arrangement Plan
DA06.01[01]	01	29.08.14	Section A-A North-South
DA06.02[01]	01	01.09.14	Section B-B East-West

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Acoustic Criteria

Renzo Tonin & Associates attended the site on 07/09/2014 from 4pm to 7pm to establish the existing levels of rail noise and vibration from the Olympic Park rail corridor affecting the site. A long-term noise survey was also conducted from 02/09/2014 to 07/09/2014 to determine the existing level of traffic and background noise surrounding the site. The results of the noise and vibration surveys were used to calculate noise and vibration levels within the residential spaces and assessed against the relevant internal noise and vibration criteria describe below.

2.1 Noise and Vibration Criteria

The airborne noise criteria for this development are based on the following documents:

1. Secretary's Environmental Assessment Requirements
2. State Environment Planning Policy (Infrastructure 2007)
3. Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008
4. State Environment Planning Policy (Major Development) 2005
5. State Environment Planning Policy 65 - Design Quality of Residential Flat Development
6. Sydney Olympic Park Master 2030
7. Sydney Olympic Park Major Events Impact Assessment Guideline, and
8. NSW Office of Environment and Heritage Industrial Noise Policy
9. Australian Standard AS/NZS 2107:2000 "Acoustics – Recommended design sound pressure levels and reverberation times for building interior"

The noise criteria outlined in the documents listed were considered, Table 2 and below summaries the relevant acoustic criteria for this development.

Table 2 - Recommended Internal Noise Criteria for Road Traffic and Rail Noise

Occupancy	Period	Maximum Noise Level
Residential		
Living areas (includes kitchen, dining and family rooms)	7am – 10pm	40 dB(A) $L_{Aeq,\ 15hr}$
Sleeping areas	10pm – 7am	35 dB(A) $L_{Aeq,\ 9hr}$
Bathroom, Laundries and En-suites	24 hours	45 dB(A) $L_{Aeq,\ 1hr}$
Resident's common areas [1]	7am – 10pm	50 dB(A) $L_{Aeq,\ 1hr}$
General Retail/Office		
Retail [1]	7am – 10pm	50 dB(A) $L_{Aeq,\ 1hr}$
Office [1]	7am – 10pm	45 dB(A) $L_{Aeq,\ 1hr}$

Occupancy	Period	Maximum Noise Level
Notes: 1. Design sound pressure levels for these spaces (not coved in the ISEPP) were based on Australian Standard AS2107		

The Department of Planning's "Development near Rail Corridors & Busy Roads – Interim Guideline" 2008 provides recommended criteria for ground-borne or regenerated rail noise. Table 3 summaries these noise limits for sleeping and living spaces.

Table 3 - Recommended Internal Noise Criteria for Regenerated Rail Noise

Occupancy	Time Period	L_{Amax} Noise Limit [1]
Residential		
Living areas	7am – 10pm	40 dB(A)
Sleeping areas	10pm – 7am	35 dB(A)

Notes: 1. L_{Amax} – is a-weighted maximum sound pressure level measures using "Slow" response time

2.1.1 Rail Tactile Vibration

In addition to regenerated rail noise, Section 3.6.3 of the Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline", also provides recommended vibration criteria documents to refer to when establishing train vibration criteria for residential buildings.

1. Assessing Vibration: A technical guideline (DECC 2006)
2. German Standard DIN 4150, Part 3 1999
3. British Standard BS 7385 Part 2 1993
4. Australian Standard AS2670.2 1990

The above documents have been reviewed and the criterion for assessment tactile vibration from train pass-bys affecting the proposed development is quantified using:

- Assessing Vibration: A technical guideline (DECC 2006)
- British Standard BS6472:1992 "*Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*"

The criteria curves presented in BS6472:1992 are identical to those in Australian Standard AS2670.2 1990 and the International Standard 2631-2:1989.

Criteria for continuous vibration from the British Standard BS6472:1992 for residential spaces, offices and commercial workshop environments are shown in Figure 1 below.

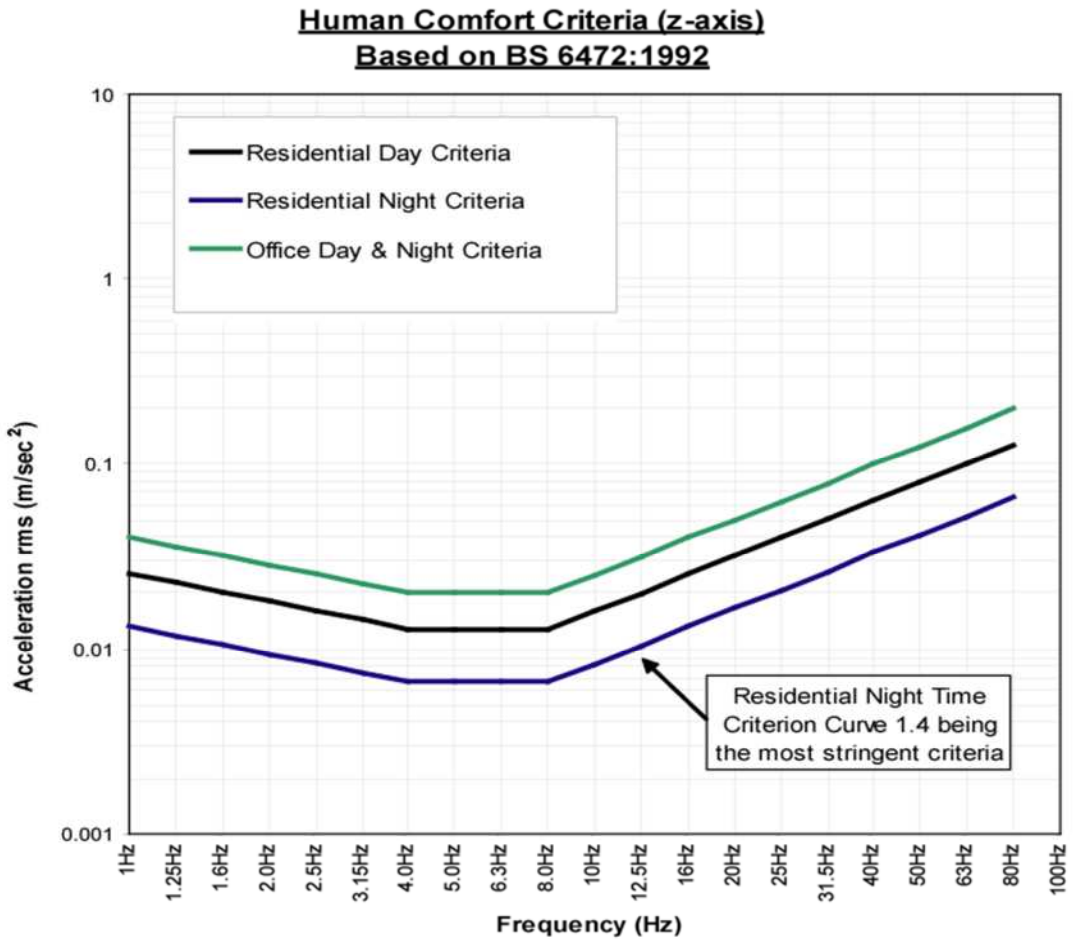


Figure 1 - Tactile Vibration Criteria for Residential Buildings

Table 2.4 of the Department of Environment Climate Change and Water's document "Assessing Vibration: A technical guideline (DECCW 2006)" presents acceptable vibration dose values for intermittent vibration. Table 4 below outlines DECCW's requirements.

Table 4 - Acceptable VDVs for intermittent vibration in residential buildings m/s1.75

Location	Period	Preferred VDV m/s1.75
Residence	Day time (7am – 10pm)	0.20
	Night time (10pm – 7am)	0.13

3 Project Description

The proposed development consists of triangular shaped building over 3 levels of basement car park. The building comprises of 33 levels of residential apartments with ground level used as retail and communal spaces. The site is bounded by the Olympic Park rail corridor (single track) to the west, Australia Avenue to the south and Bennelong Parkway to the east.

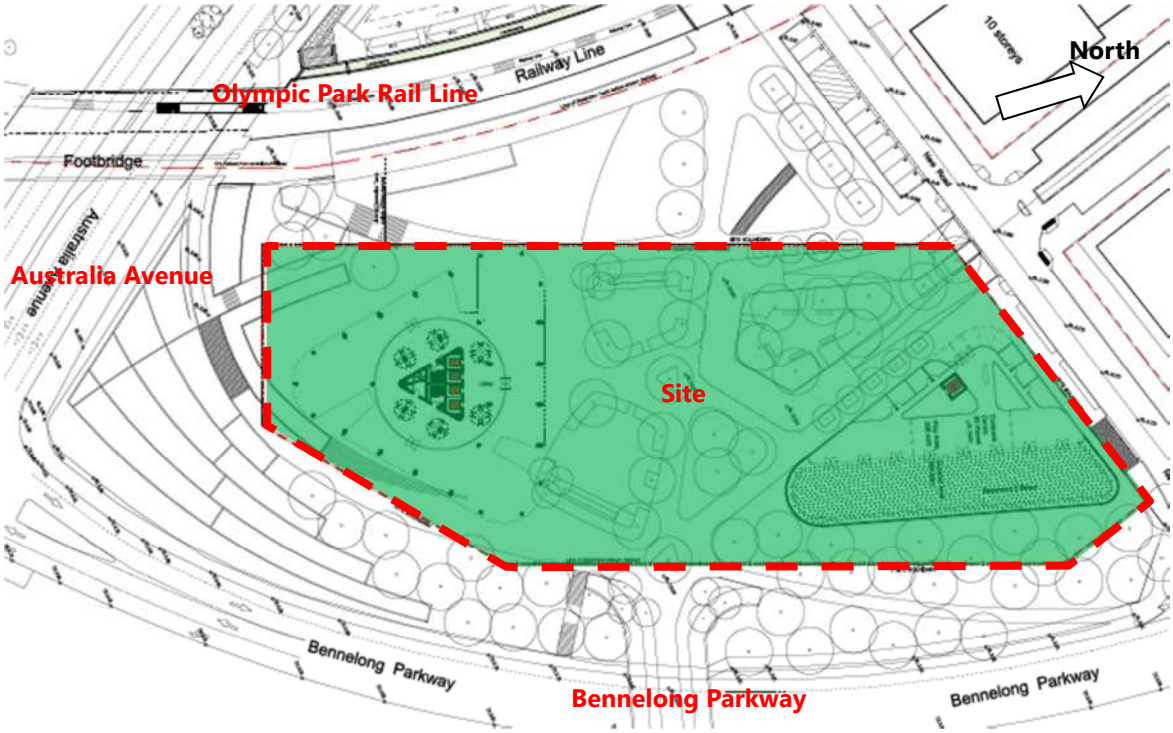


Figure 2- Site Boundary and Surrounding Roads and Rail Corridor

4 Noise & Vibration Survey

4.1 Train Noise and Vibration Monitoring Locations

The Olympic Park rail corridor consists of one operational rail line and is located along the west boundary of site. An operator-attended rail noise and vibration survey was conducted on site at approximately 21m from the rail track as shown Figure 1 below. The measurements were carried out on Sunday 07/09/2014 from 4:30pm to 7:30pm.

All trains on this line were commuter trains and operate in a south-bound direction only. The rail line along the site is curved and gradually slopes up in southern direction. During the survey it was observed the all trains were the "Millennium" trains with 8 carriages. The speed of the trains was estimated to range from 40km to 50km as it passes the development site.

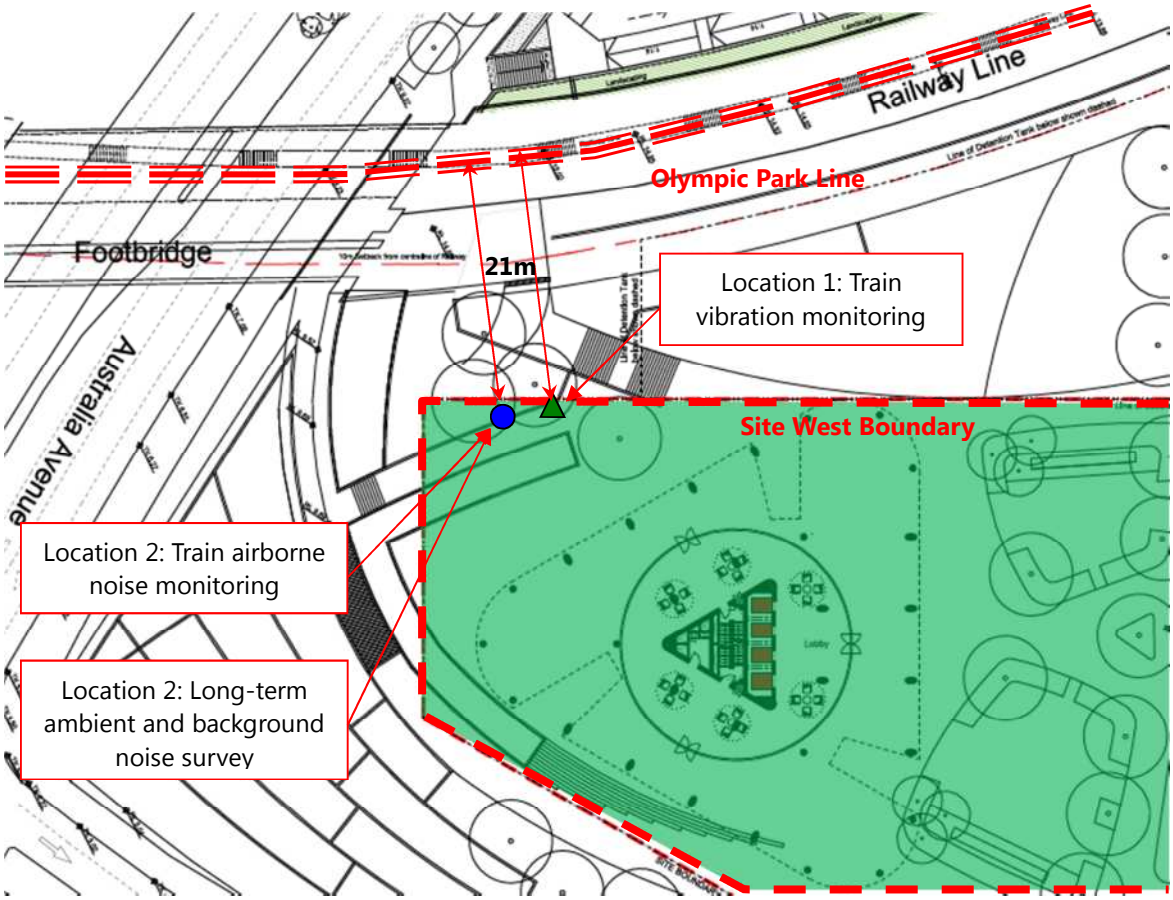


Figure 3 - Noise & Vibration Survey Locations

4.2 Instrumentation

Train vibration levels were measured using the Sinus SoundBook multi-channel analyser and PCB accelerometers as Location 1 shown in Figure 3 above. Three accelerometers were fixed to steel spikes hammered into the ground located approximately 21m from centre line for the track. Airborne rail noise

from the train pass-bys were measured simultaneously using a Bruel & Kjaer Type 4189 microphone connected to the Sinus SoundBook.

Weather conditions were fine during the operator-attended surveys with negligible wind speeds at the monitoring locations. All instruments were calibrated before and after measurement. No significant drift in calibration was observed.

The recorded ground vibration levels of train pass-bys are shown in Section 4.6 together with the vibration criteria from British Standard BS6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80 Hz)" and DECCW intermittent vibration dosage criterion.

4.3 Long-term Ambient and Background Noise Survey

One RTA Technology noise logger was installed on site from 02/09/14 to 07/09/14 to quantify the existing level of ambient and background noise on site. The noise logger was setup on the southern end of site to record road traffic noise from Australia Avenue and Bennelong Parkway.

The noise logger records noise levels on a continuous basis and store data every fifteen minutes. The results of the 6-day monitoring are shown in APPENDIX C.

4.4 Measured Traffic Noise

The representative L_{Aeq} sound pressure levels for the week during day (7am to 10pm) and night time (10pm to 7am) from the long-term noise survey are taken as the design sound pressure levels. The design external traffic noise levels are presented Table 5 below.

Table 5 - Representative Day and Night Traffic Noise Levels

Location	Period	Traffic Noise Level $L_{Aeq, T}$ [1,2]
Southern site boundary at approximately 34m from Australia Avenue and 58m from Bennelong Parkway	Day time (7am to 10pm)	64 dB(A)
	Night time (10pm to 7am)	57 dB(A)

Notes:

1. Noise levels presented are free field values.
2. Representative road traffic noise level in measured L_{Aeq} over 15 hour and 9 hour day and night period respectively.

4.5 Measured Airborne Rail Noise

Airborne noise from train pass-by events were also measured simultaneously during the rail vibration survey at Location 2 shown in Figure 3 above. The results of the survey are summarised in Table 6 below in overall sound pressure level.

Table 6 - Results of Airborne Rail Noise Survey

Train Pass-by Count	Measured SEL Sound Pressure Level in dB(A)
Train 1	87.5

Train Pass-by Count	Measured SEL Sound Pressure Level in dB(A)
Train 2	86.7
Train 3	87.6
Train 4	88.8
Train 5	88.1
Train 6	87.9
Train 7	87.1
Train 8	86.6
Train 9	86.8
Train 10	86.1
Train 11	87.8
Train 12	86.7
Train 13	87.5
Train 14	86.2
Train 15	87.6
Train 16	86.7
Train 17	87.4
Train 18	85.5
Train 19	87.1
Train 20	85.9

Notes:

1. SEL is the Sound Exposure Level of the train pass-by event and is equivalent to $L_{Aeq,T}$ normalised over a 1 second period.
2. All trains were "Millennium" type with 8 carriages travelling at approximately 40-50km/hr

4.6 Measured Tactile Train Vibration & Assessment to BS6472 and DECCW

Results of the train vibration survey were plotted against night and day criterion of British Standard BS6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" as show in Figure 4 to Figure 7 below. In addition the measured train vibration levels were used to calculate the vibration dosage values (VDV) and then compared to the acceptable levels from the Table 2.4 of DECCW guideline.

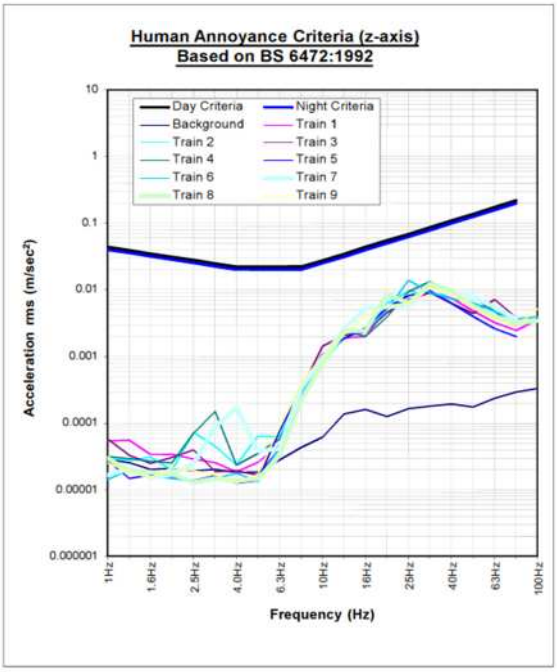
Renzo Tonin & Associates

Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TG856-01
Location:	Corner of Bennelong Parkway & Australia Avenue, Sydney Olympic Park - 18m east rail corridor (21m to centreline of track)
Source:	Commuter Trains - Survey 1

Assessment Location:	Residential	Axis	Z	Total secs of Vib per Day (t):	2.275
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	475



Legend		Background	Train 1	Train 2	Train 3	Train 4	Train 5	Train 6	Train 7	Train 8	Train 9	Preferred DECCW Criterion	Maximum DECCW Criterion
Measurement													
Acceleration rms (m/sec²)	1Hz	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.25Hz	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.5Hz	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000		
	5.0Hz	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	6.3Hz	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001		
	8.0Hz	0.0000	0.0003	0.0003	0.0003	0.0002	0.0003	0.0004	0.0003	0.0002	0.0004		
	10Hz	0.0001	0.0010	0.0008	0.0015	0.0009	0.0011	0.0008	0.0009	0.0008	0.0011		
	12.5Hz	0.0001	0.0019	0.0019	0.0021	0.0024	0.0019	0.0024	0.0026	0.0024	0.0021		
	16Hz	0.0002	0.0020	0.0024	0.0024	0.0020	0.0027	0.0024	0.0052	0.0025	0.0041		
	20Hz	0.0001	0.0053	0.0063	0.0046	0.0040	0.0054	0.0050	0.0056	0.0084	0.0057		
	25Hz	0.0002	0.0068	0.0095	0.0072	0.0095	0.0082	0.0139	0.0059	0.0064	0.0063		
	31.5Hz	0.0002	0.0091	0.0087	0.0092	0.0132	0.0096	0.0091	0.0121	0.0123	0.0108		
	40Hz	0.0002	0.0075	0.0084	0.0063	0.0087	0.0063	0.0073	0.0084	0.0094	0.0087		
	50Hz	0.0002	0.0049	0.0058	0.0044	0.0078	0.0040	0.0064	0.0078	0.0057	0.0053		
	63Hz	0.0002	0.0032	0.0057	0.0072	0.0048	0.0026	0.0048	0.0055	0.0040	0.0036		
	80Hz	0.0003	0.0025	0.0033	0.0039	0.0029	0.0020	0.0037	0.0037	0.0032	0.0029		
	100Hz	0.0003	0.0036	0.0035	0.0035	0.0033	0.0032	0.0039	0.0048	0.0035	0.0052		
Weighted rms	Day												
	Night												
eVDV	Day	0.00	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.20	0.40
	Night	0.00	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.03	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion

QTS-01 (rev 11) Human Annoyance Vibration Assessment BS6472-DEC - z axis

(c) Renzo Tonin Associates Pty Ltd 10/09/2014 Environmental Acoustics Team

Figure 4 - Vibration Assessment (Survey 1) for Human Annoyance in Vertical Plane

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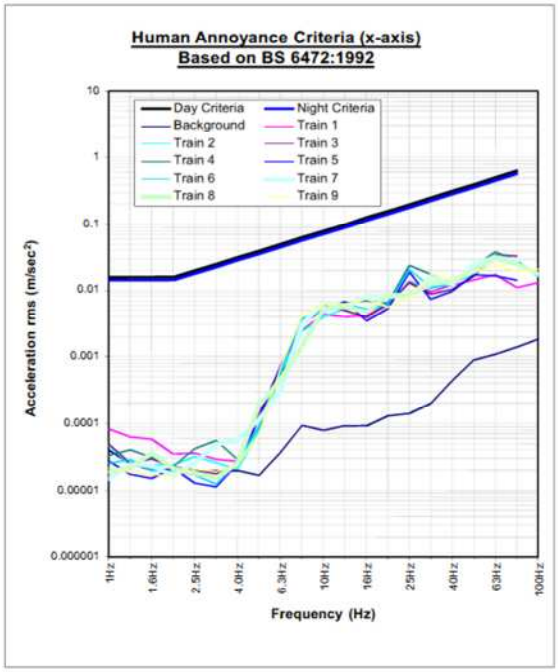
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TG856-01
Location:	Corner of Bennelong Parkway & Australia Avenue, Sydney Olympic Park - 18m east rail corridor (21m to centreline of track)
Source:	Commuter Trains - Survey 1

Assessment Location:	Residential	Axis	X&Y	Total secs of Vib per Day (t):	2,275
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	475



Legend													
Measurement		Background	Train 1	Train 2	Train 3	Train 4	Train 5	Train 6	Train 7	Train 8	Train 9	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.25Hz	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.6Hz	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000		
	5.0Hz	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001		
	6.3Hz	0.0000	0.0007	0.0006	0.0007	0.0006	0.0007	0.0006	0.0003	0.0005	0.0007		
	8.0Hz	0.0001	0.0025	0.0024	0.0031	0.0015	0.0031	0.0037	0.0030	0.0014	0.0041		
	10Hz	0.0001	0.0044	0.0039	0.0062	0.0049	0.0053	0.0048	0.0066	0.0052	0.0062		
	12.5Hz	0.0001	0.0040	0.0053	0.0050	0.0065	0.0068	0.0062	0.0057	0.0057	0.0062		
	16Hz	0.0001	0.0041	0.0048	0.0039	0.0070	0.0035	0.0052	0.0082	0.0047	0.0075		
	20Hz	0.0001	0.0060	0.0061	0.0063	0.0064	0.0053	0.0061	0.0082	0.0085	0.0056		
	25Hz	0.0001	0.0139	0.0134	0.0131	0.0240	0.0192	0.0205	0.0081	0.0086	0.0079		
	31.5Hz	0.0002	0.0096	0.0107	0.0088	0.0176	0.0074	0.0113	0.0159	0.0124	0.0179		
	40Hz	0.0004	0.0120	0.0131	0.0103	0.0118	0.0097	0.0119	0.0125	0.0142	0.0147		
	50Hz	0.0009	0.0144	0.0172	0.0164	0.0230	0.0173	0.0228	0.0243	0.0197	0.0184		
	63Hz	0.0011	0.0174	0.0319	0.0343	0.0381	0.0166	0.0331	0.0316	0.0310	0.0243		
	80Hz	0.0014	0.0111	0.0248	0.0329	0.0282	0.0142	0.0287	0.0282	0.0250	0.0194		
	100Hz	0.0018	0.0132	0.0178	0.0136	0.0144	0.0123	0.0160	0.0164	0.0177	0.0210		
Weighted rms	Day												
	Night												
eVDV	Day	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.20	0.40
	Night	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion

QTS-01 (rev 11) Human Annoyance Vibration Assessment BS6472-DEC - z axis

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Figure 5 - Vibration Assessment (Survey 1) for Human Annoyance in Horizontal Plane

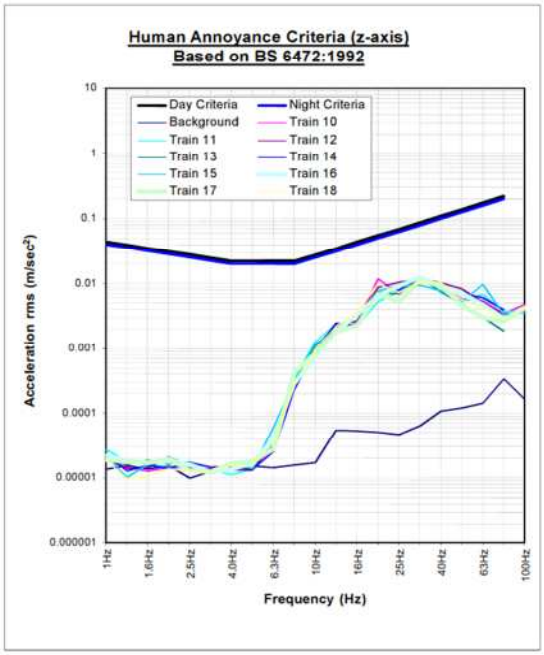
Renzo Tonin & Associates

Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TG856-01
Location:	Corner of Bennelong Parkway & Australia Avenue, Sydney Olympic Park - 18m east rail corridor (21m to centreline of track)
Source:	Commuter Trains - Survey 2

Assessment Location:	Residential	Axis	Z	Total secs of Vib per Day (t):	2,275
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	475



Legend													
Measurement		Background	Train 10	Train 11	Train 12	Train 13	Train 14	Train 15	Train 16	Train 17	Train 18	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.25Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	5.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	6.3Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000		
	8.0Hz	0.0000	0.0003	0.0003	0.0003	0.0003	0.0002	0.0003	0.0003	0.0004	0.0003		
	10Hz	0.0000	0.0008	0.0013	0.0008	0.0011	0.0009	0.0012	0.0007	0.0008	0.0010		
	12.5Hz	0.0001	0.0020	0.0024	0.0023	0.0022	0.0025	0.0017	0.0019	0.0018	0.0022		
	16Hz	0.0001	0.0025	0.0023	0.0027	0.0022	0.0023	0.0031	0.0033	0.0023	0.0036		
	20Hz	0.0001	0.0117	0.0053	0.0088	0.0072	0.0072	0.0077	0.0065	0.0069	0.0100		
	25Hz	0.0000	0.0068	0.0076	0.0105	0.0069	0.0080	0.0093	0.0092	0.0053	0.0072		
	31.5Hz	0.0001	0.0122	0.0110	0.0119	0.0127	0.0129	0.0095	0.0127	0.0112	0.0106		
	40Hz	0.0001	0.0098	0.0084	0.0102	0.0074	0.0091	0.0077	0.0088	0.0093	0.0104		
	50Hz	0.0001	0.0058	0.0053	0.0083	0.0049	0.0071	0.0053	0.0071	0.0047	0.0056		
	63Hz	0.0001	0.0054	0.0068	0.0052	0.0030	0.0060	0.0097	0.0048	0.0030	0.0043		
	80Hz	0.0003	0.0035	0.0037	0.0033	0.0019	0.0039	0.0034	0.0030	0.0026	0.0029		
	100Hz	0.0002	0.0048	0.0039	0.0036	0.0031	0.0038	0.0036	0.0033	0.0043	0.0044		
Weighted rms	Day												
	Night												
eVDV	Day	0.00	0.07	0.05	0.06	0.05	0.06	0.06	0.06	0.05	0.06	0.20	0.40
	Night	0.00	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion

QTS-01 (rev 11) Human Annoyance Vibration Assessment BS6472-DEC - z axis

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Figure 6 - Vibration Assessment (Survey 2) for Human Annoyance in Vertical Plane

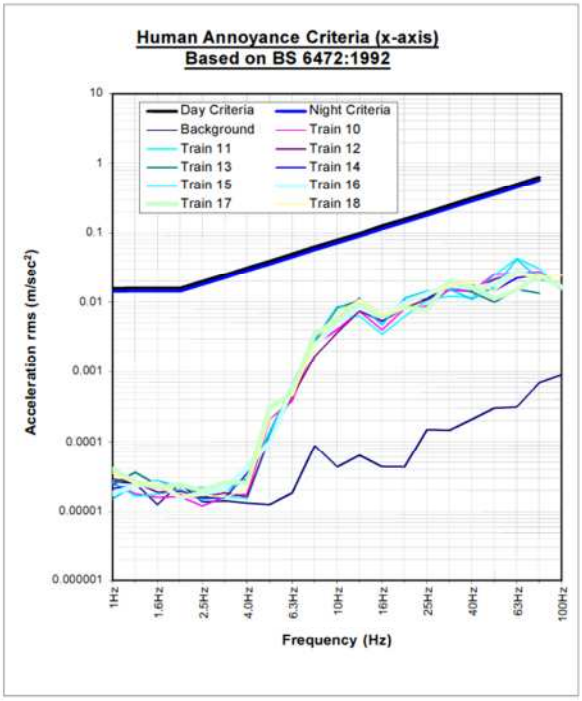
Renzo Tonin & Associates

Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TG856-01
Location:	Corner of Bennelong Parkway & Australia Avenue, Sydney Olympic Park - 18m east rail corridor (21m to centreline of track)
Source:	Commuter Trains - Survey 2

Assessment Location:	Residential	Axis	X&Y	Total secs of Vib per Day (t):	2,275
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	475



Legend												
Measurement		Background	Train 10	Train 11	Train 12	Train 13	Train 14	Train 15	Train 16	Train 17	Train 18	
Acceleration rms (m/sec²)	1Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	1.25Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	5.0Hz	0.0000	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002	
	6.3Hz	0.0000	0.0004	0.0006	0.0004	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	
	8.0Hz	0.0001	0.0025	0.0023	0.0017	0.0029	0.0027	0.0029	0.0024	0.0035	0.0024	
	10Hz	0.0000	0.0040	0.0059	0.0037	0.0083	0.0058	0.0086	0.0051	0.0056	0.0071	
	12.5Hz	0.0001	0.0074	0.0063	0.0075	0.0104	0.0114	0.0090	0.0084	0.0105	0.0105	
	16Hz	0.0000	0.0040	0.0035	0.0053	0.0056	0.0053	0.0047	0.0060	0.0062	0.0065	
	20Hz	0.0000	0.0080	0.0062	0.0082	0.0103	0.0105	0.0114	0.0097	0.0084	0.0089	
	25Hz	0.0002	0.0088	0.0106	0.0110	0.0120	0.0111	0.0145	0.0132	0.0078	0.0121	
	31.5Hz	0.0001	0.0150	0.0121	0.0159	0.0191	0.0181	0.0155	0.0172	0.0202	0.0176	
	40Hz	0.0002	0.0142	0.0116	0.0147	0.0139	0.0179	0.0109	0.0158	0.0166	0.0189	
	50Hz	0.0003	0.0252	0.0245	0.0213	0.0100	0.0147	0.0166	0.0181	0.0112	0.0146	
	63Hz	0.0003	0.0263	0.0428	0.0270	0.0153	0.0223	0.0424	0.0278	0.0148	0.0254	
	80Hz	0.0007	0.0277	0.0308	0.0221	0.0134	0.0248	0.0214	0.0219	0.0243	0.0231	
	100Hz	0.0009	0.0150	0.0149	0.0156	0.0180	0.0305	0.0173	0.0194	0.0164	0.0245	
Weighted rms	Day											
	Night											
eVDV	Day	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.20
	Night	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.13

Preferred DECCW Criterion: 0.20 (Day), 0.13 (Night)
Maximum DECCW Criterion: 0.40 (Day), 0.26 (Night)

NOTE: Red indicates exceedence of Preferred DECCW Criterion

QTS-01 (rev 11) Human Annoyance Vibration Assessment BS6472-DEC - z axis

Figure 7 - Vibration Assessment (Survey 2) for Human Annoyance in Horizontal Plane

The above graphs demonstrate that the floor induced vibration within the proposed building from each of the measured train pass-bys were in compliance with the British Standard BS6472:1997 for human comfort in a residential environment during the day and night. Similarly the calculated vibration dosage values (VDV) from our measurements complied with the preferred day and night VDV criterion defined in the DECCW guideline.

5 Calculated Airborne and Ground-Borne Train Noise

5.1 Calculated Ground-borne Rail Noise inside Proposed Building

Regenerated or ground-borne rail noise is the low rumble heard inside buildings with vicinity of railway tunnels or railway tracks due to ground vibration generated by passing trains which propagate through soil and rock up into building elements such as foundation, wall and floors which re-radiates as audible sound. Ground vibration levels from train pass-bys on the Olympic Park train line have been measured and were used to calculate regenerated noise levels on various floors of the proposed building and assessed to the nominated criteria for this development as shown in Table 7 below.

Table 7 - Calculated Regenerated Noise Levels inside Proposed Building

Floor Level	Proposed Occupancy/Space	Ground-Borne Noise Criteria in dB(A)	Calculated[1] Ground-Borne Noise in dB(A)	Exceedance
Level 2	Residential	35	24	None
Level 1	Residential	35	26	None
Ground	Retail	40	29	None
Basement 1	Car park	N/A	32	N/A
Basement 2	Car park	N/A	35	N/A
Basement 3	Car park	N/A	39	N/A

Notes:

1. Ground-borne noise modelling and predictions were based upon the train pass-bys with highest linear overall L_{Max} as each of the locations.

The above assessment demonstrates ground-borne rail noise levels inside habitable rooms of the development due train pass-bys on the Olympic Park railway line to be in compliant with the $L_{Amax\ (Slow)}$ criteria stipulated in the DOP Guideline 2008.

5.2 Calculated Airborne Rail Noise at Proposed Building Facades

Airborne noise emanating from train pass-bys has been recorded and summarised in Table 6 above. These noise levels were used to predict the sound pressure levels at worst affected facade (eastern and northern) of the proposed development over entire day (15 hours) and night (9 hour) time periods. The calculated facade rail noise levels and sound insulation requirements are presented in Table 8 below.

Table 8 - Calculated Airborne Rail Noise Levels at Proposed Building Facades

Occupancy	Period	Duration	Maximum Number of Train Pass-bys During this Period	Calculated L_{Aeq}[1] Airborne Noise Levels at Proposed Building Facade in dB(A)	Relevant Internal Noise Criteria	Estimated Facade Sound Reduction [4]
Living areas	Day time (7am to 10pm)	15 Hours	91	58 dB(A)	40 dB(A)[2]	18 dB
Sleeping area	Night time (10pm to 7am next day)	9 Hours	19	53 dB(A)	35 dB(A)[2]	18 dB
Living areas	Evening Peak (4pm to 5pm)	1 Hour	6	58 dB(A)	40 dB(A)[3]	18 dB
Sleeping areas	Morning Peak (Before 7am)	1 Hour	6	58 dB(A)	35 dB(A)[3]	23 dB

Notes:

1. Train airborne noise modelling and predictions were based upon the maximum SEL of the measured train pass-bys
2. ISEPP 2007 Target levels for sleeping and living areas over 9-hour night and 15-hour day period.
3. Australian Standard AS2107 for satisfactory interior noise levels in sleeping and living areas over 1-hour periods
4. Overall sound reduction required from external wall and glazing assemblies to achieve relevant internal noise levels

A maximum of 23dB sound reduction is required from glazing assemblies on the worst affected facade by rail noise in order to achieve compliance with ISEPP 2007 airborne noise criteria and Australia Standard AS2107. Glazing and facade design recommendations are provided Section 6 of this report to meet the required facade noise reduction requirements.

5.3 Calculated Internal Traffic and Airborne Rail Noise Levels

Results from the long-term traffic noise monitoring and rail airborne-noise survey were used to determine the overall sound pressure levels at each of the proposed building facades. These sound pressure levels were then used in our noise modelling to predict noise levels inside the proposed development and determine the sound insulation requirements of building façade element such as windows, balcony doors, external walls and roof. Noise calculations and predications were conducted using the Acoustic Glazing software developed in our office which take into account the calculated noise levels at the proposed building facade, facade transmission loss and room sound absorption characteristics.

External facade treatments are recommended in Section 6 below to comply with the relevant acoustic criteria.

6 Recommendations

6.1 Glazing Design Requirements

Table 9 below presents recommended glazing treatment for the building facades to achieve compliance with the maximum noise levels nominated in Table 2 above.

Table 9 - Recommended Glazing Treatment

Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly[16]	Laboratory Test Reference
East facade overlooking Australia Avenue and Rail corridor	Bedrooms	R_w 32	ESTIMATE
	Open plan living/dining/kitchen	R_w 32	ESTIMATE
	Resident's Community Room	R_w 24	ESTIMATE
	Building Manager Office	R_w 27	ESTIMATE
	Foyer	R_w 24	ESTIMATE
Western façade overlooking Bennelong Parkway	Bedrooms	R_w 32	ESTIMATE
	Open plan living/dining/kitchen	R_w 32	ESTIMATE
	Retail	R_w 27	ESTIMATE
	Foyer	R_w 24	ESTIMATE
North facade facing proposed communal open space	Bedrooms	R_w 32	ESTIMATE
	Open plan living/dining/kitchen	R_w 32	ESTIMATE
	Lobby	R_w 24	ESTIMATE

By way of explanation, the Sound Insulation Rating R_w is a measure of the noise reduction property of the partition, a higher rating implying a higher sound reduction performance.

Note that the R_w rating of systems measured as built on site (R'_w Field Test) may be up to 5 points lower than the laboratory result.

LEGEND where no appropriate test certificate exists:

1. ESTIMATE: The client is advised not to commence detailing or otherwise commit to partition construction systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of partition construction systems is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested partition construction systems, estimates or opinions. The advice provided here is in respect of acoustics only.
2. ESTIMATE – APPROVED FOR CONSTRUCTION: Use of the form of construction is approved prior to laboratory certification. To complete the quality control of the design process and confirm the acoustical performance of the construction, we recommend testing in a laboratory to confirm the Rw rating as soon as practicable. In the case of impact rating for floor systems, no particular impact rating is guaranteed to comply with either the Building Code of Australia or Strata Scheme Management Act and hence carpet runners may still be required.
3. ESTIMATE – TEST NOT REQUIRED: Use of the form of construction is approved without laboratory certification. The STC/R_w of the form of construction exceeds the project requirements.
4. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly[16]	Laboratory Test Reference

NOTES FOR GLAZING CONSTRUCTIONS:

5. The information in this table is provided for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.
6. The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.
7. Before committing to any form of construction or committing to any builder, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction where only an "estimate" is available for the sound insulation properties of recommended materials.
8. The glazing supplier shall ensure that installation techniques will not diminish the R_w performance of the glazing when installed on site.
9. All openable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the R_w rating performance of the glazing to not be reduced.
10. The above glazing thicknesses should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

GENERAL

11. The sealing of all gaps in partitions is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
12. Check design of all junction details with acoustic consultant prior to construction.
13. Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
14. The information provided in this table is subject to modification and review without notice.
15. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.
16. Typical glazing comply with sound reduction rating of Rw32 is 6.38mm laminated glass or double glazing consisting of 6mm monolithic/12mm air gap/5mm monolithic. Typical glazing complying with sound reduction ratings of Rw24 and Rw 27 are 4mm monolithic and 6mm monolithic respectively.

6.2 Facade & Roof Sound Insulation

In principle advice is provided below for the acoustic requirements of the roof and external walls for this proposed development.

6.2.1 External Walls

All external walls shall have sound isolation ratings, R_w, of at least 15dB higher acoustic performance than that of the acoustic glazing specified in Table 9 above.

6.2.2 Roof and Ceiling

Roof/ceiling construction shall have a sound isolation rating, R_w, at least 10dB higher than that of the acoustic glazing on its facade walls.

6.2.3 Glazing Assembly Requirements

The following acoustic measures should also be incorporated into the building design:

s1. All operable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the R_w rating performance of the glazing to not be reduced.

s2. The glazing thicknesses outlined in Table 9 should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

s3. The glazing supplier shall ensure that installation techniques will not diminish the R_w performance of the glazing when installed on site. Sliding door meeting stiles should form an airtight seal when closed and locked.

s4. The perimeter of all window and door frames are to be sealed airtight in the external facade using the following methods:

- For gaps less than 10mm - Fill all gaps around the window perimeter with an acoustic mastic sealer (minimum specific gravity 1.6sg) equivalent to Promat Promaseal. The depth of sealer shall be at least equal to the width of the gap.
- If the gap is greater than 10mm, fill the cavity with polyester insulation and a backing rod. Seal the gap airtight an acoustic mastic sealer (min specific gravity 1.6sg) equivalent to Promat Promaseal. The depth of sealer shall be at least equal to the width of the gap. The gaps between frames shall also be sealed using aluminium angle brackets (approximately 25 x 25 x 3mm).

7 Operational Noise Emission from Development

7.1 Existing Noise Environment at Development Site

A noise logger was installed on the southern end of the site to establish existing site background noise levels during day and night time. The noise logger records noise levels on a continuous basis and store data every fifteen minutes. Results of the noise monitoring have been summarised in Table 10 below.

Table 10 – Measured Existing Site Background (L_{A90}) Noise Level

Noise Monitoring		Representative LA90 Background Noise Levels in dB(A)		
Location	**Duration**	**Day** [1]	**Evening** [2]	**Night** [3]
Southern site boundary at approximately 34m from Australia Avenue and 58m from Bennelong Parkway	Tuesday 02/09/2014 to Sunday 07/09/2014	58	54	49

Notes:

Day, Evening & Night assessment periods are defined in accordance NSW OEH Industrial Noise Policy as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays

These noise levels are used in our assessment of external noise emission from the development such as mechanical plant equipment, loading docks etc in accordance to NSW OEH Industrial Noise Policy.

7.2 Operational Noise Emission from Development

Major sources of external noise emissions from the operation of the development have been identified as:

- Mechanical services plant and equipment on roof of proposed building

Noise emission from these sources has the potential to impact on nearby Major Events Venue within the "Event Operation Zone" as defined in Plan 1 (page 20) of the Sydney Olympic Park Major Event Impact Assessment Guideline. Potential impacts have been assessed in the following sections in accordance to Guideline.

7.3 Building Services Noise

Noise from building services will be controlled to comply with the Industrial Noise Policy (INP) outlined in New South Wales Office of Environment and Heritage (OEH). The applicable noise limits, according to the policy, are determined in the Table 11 below.

Table 11 - Design Criterion for Noise Production (OEH INP)

Time of Day	Rating Background Level (RBL) L_{A90}	Intrusiveness Criterion (RBL+5)	Amenity Criterion (Acceptable)	Project Specific Design Criterion L_{Aeq}
Day (7am to 6pm)	58	63	60	60
Evening (6pm to 10pm)	54	59	50	50
Night (10pm to 7am)	49	54	45	45

Explanatory notes:

1. Recommended L_{Aeq} noise level based on 'Residence – Urban' area in Section 2.2, Table 2.1 Amenity Criteria (Recommended L_{Aeq} noise levels from industrial noise sources) of the OEH's INP.
2. Project Specific Design Criterion based on OEH's INP and is the lower of the Intrusiveness or Amenity Criterion

Where necessary, noise amelioration treatment will be incorporated in the design to ensure that noise levels comply with the OEH Industrial Noise Policy. Noise from air-conditioning and building services will be examined in the detail at the design stage.

The Sydney Olympic Park Major Event Impact Assessment Guideline has stipulated any noise emission from developments at Major Events Venues to be no greater its ambient noise levels. Our review of the Guideline (Plan 1) has shown nearest Major Events Venue is at least 500m to the north of the site. Such a distance will provide noise attenuation greater than 5dB, assuming the background noise levels at nearest Major Events Venue is similar to subject site. Therefore compliance with OEH INP policies will ensure compliance with Sydney Olympic Park Major Event Impact Assessment Guideline. Further to this there is likelihood of intervening building structures between the subject development and the Major Events Venues, which will act as noise barriers and provide additional noise shielding.

7.4 Recommended Noise Control Measures for Mechanical Plant

Mechanical plant such as exhaust systems, air-conditioning, mechanical ventilation and refrigeration associated with the development has the potential to impact on nearby residential and commercial properties. As details of mechanical plant are not available at this stage of the development the following in principle noise control advice are provided.

- Acoustic assessment of mechanical services equipment will be require to be undertaken during the detail design phase of the development to ensure that they shall not either singularly or in total emit noise levels which exceed the noise limits in established in Table 9.
- Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following;
    - procurement of 'quiet' plant
    - strategic positioning of roof and balcony plant equipment away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises

- installation of commercially available silencers or acoustic attenuators for air discharge and air intakes of plant
- acoustically lined and lagged ductwork
- provide acoustic screens and/or acoustic louvres between plant and sensitive neighbouring premises
- provide partially enclosed or fully enclosed acoustic enclosure over plant
- Mechanical plant shall have their noise specifications and proposed locations checked prior to installation
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 "Rotating and Reciprocating Machinery - Mechanical Vibration"

8 Major Events Noise Intrusion into Development

The proposed development is potentially affected by noise associated with major sports and entertainment events held within the Sydney Olympic Park events precinct. The Sydney Olympic Park Master Plan 2030 has set internal noise criteria for noise associated with major events intruding into commercial and residential developments within the Sydney Olympic Park events precinct. The criteria for residential spaces are outline in Table 12 below.

Table 12 - Sydney Olympic Park Master Plan 2030 Maximum Internal Noise Criteria for Major Events Noise Intrusion

Internal Space	Noise Criterion	Period	Noise Measure
Living rooms	45dB(A)	Day & Evening	$L_{Aeq, 15min}$
Working areas			
Sleeping rooms	40dB(A)	Night Time	

Renzo Tonin & Associates have previously conducted surveys of noise emission from Major Events at Sydney Olympic Park. Based on results of these surveys, it is estimated noise from Major Events at the facade of subject development to typically be in order of 60 to 70 dB(A). With the installation of acoustic glazing recommended in Table 9 of this report, noise from Major Events activities are expected to comply with noise criteria set in SOP Master Plan 2030 summarised in Table 12 above.

Sydney Olympic Park Master Plan has also mapped out the degree of noise mitigation measures required for different building heights at different locations within the Sydney Olympic Park Events precinct. Our review of Figure 4.8 (Page 95 of the Master Plan) has shown the subject development falls under the “Some Noise Mitigation Required” zone. Section 4.6.15 of the Master plan requires developments in this zone to provide air-conditioning or mechanical ventilation, door and windows which can be opened and closed at various times. It is our understanding the subject development will incorporated these measures.

9 Internal Sound Insulation between Tenancies

9.1 Building Code of Australia 2014

As a minimum requirement, inter-tenancy walls, floors, doors and services shall comply with the Building Code of Australia 2014, Volume One of the National Construction Code Series (BCA).

BCA 2014 sets out the required Weighted Sound Reduction Indexes (R_w) and spectrum adaptation factor (C_{tr}) for partition constructions, of different space/ activity types in adjoining units. The R_w and $R_w + C_{tr}$ are single number descriptors for quantifying the attenuating performance of partitions for typical intrusive noises produced inside residences. The higher the rating, the greater the isolation provided by the partition.

Spectrum adaptation factors are commonly used to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others insulate.

The adaptation factor C_{tr} has now been introduced for most building elements which require an airborne sound insulation rating. The only exception is a wall which separates a dwelling from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification. Therefore, both the C_{tr} factor and the R_w of the building element will need to be considered in most cases.

The C_{tr} factor takes into account lower frequency level sounds, and has been chosen in large part, in recognition of the problem of the high bass frequency outputs of modern home theatre systems and music reproduction equipment.

The Deemed-to-Satisfy Provisions also have impact sound insulation requirements for floors. The terms to describe the impact sound insulation of the floor is the weighted normalised impact sound pressure level ($L_{n,w}$) plus the spectrum adaptation term (C_I). The lower the $L_{n,w} + C_I$ of the floor, the better the performance of the floor in terms of impact sound insulation.

The following section represents a summary of acoustic provisions outlined in the Part F5 of the BCA 2014.

9.1.1 Airborne Noise Control between Units

Inter-tenancy Walls

- A wall separating sole-occupancy units must have an $R_w + C_{tr}$ not less than 50.
- A wall separating a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like must have an R_w not less than 50.

- A door incorporated in a wall that separates a sole-occupancy unit from a stairway, public corridor, public lobby or the like (apartment entrance doors) must have an R_w not less than 30.
- Where a wall is required to have sound insulation has a floor or roof above, the wall must continue to the underside of the floor above or to a ceiling that provides the sound insulation required for the wall.

Inter-tenancy Floors

- A floor separating sole-occupancy units must have an $R_w + C_{tr}$ not less than 50.
- A floor separating a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like must have an $R_w + C_{tr}$ not less than 50.

9.1.2 Impact Noise Control between Units

Inter-tenancy Walls

A wall must be of discontinuous construction if it separates:

- A bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit.
- A sole-occupancy unit from a plant room or lift shaft.

Discontinuous construction here means a wall having a minimum 20mm cavity between 2 separate leaves, and

- For masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and
- For other than masonry, there is no mechanical linkage between leaves except at the periphery.

Inter-tenancy Floors

- A floor separating sole-occupancy units must have an $L_{n,w} + C_I$ not more than 62.
- A floor separating a sole-occupancy unit from a plantroom, lift shaft, stairway, public corridor, public lobby or the like must have an $L_{n,w} + C_I$ not more than 62.

9.1.3 Separation of Services

A duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction –

- With an $R_w + C_{tr}$ not less than 40 if the adjacent room is a habitable room (other than a kitchen); or
- With an $R_w + C_{tr}$ not less than 40 if the adjacent room is a kitchen and a living room which form a single space; or
- With an $R_w + C_{tr}$ not less than 25 if the adjacent room is a kitchen or non-habitable room.

Storm water pipe passes through a sole-occupancy unit must be separated by construction –

- With an $R_w + C_{tr}$ not less than 40 if the adjacent room is a habitable room (other than a kitchen); or
- With an $R_w + C_{tr}$ not less than 40 if the adjacent room is a kitchen and a living room which form a single space; or
- With an $R_w + C_{tr}$ not less than 25 if the adjacent room is a kitchen or non-habitable room.

Where access doors or panels are incorporated, they must be firmly fixed, shall overlap the frame or rebate of the frame by no less than 10mm and fitted with an acoustic sealing gasket along all edges.

A door or panel providing access to the pipe must not open into any habitable room (other than a kitchen).

9.1.4 Entrance Doors to Units

A door assembly located in a wall that separates a sole-occupancy unit from public corridor or the like requires an R_w of not less than 30.

10 Construction Noise

The nature of the construction processes proposed for the development does not present difficulties in ensuring that the associated noise limits at surrounding properties are achieved. The major construction activities proposed on this site are demolition works, excavation works, concrete pours and general building works.

Construction and building work will be adequately managed so as to minimise disruption to the local community and the environment.

The NSW Interim Construction Noise Guideline sets out management noise levels and time restrictions for construction activities. The aims of the guideline are to control and manage noise on all building sites within the local area.

Since detail of the construction equipment such as exact type, size, number and operating time are not know at this stage, in-principle noise control measures are provided in Section 10.1 below which may be implemented to minimise any noise exceedances to the noise sensitive receptors where that may occur.

10.1 General Engineering Noise Control

Implementation of noise control measures, such as those suggested in Australian Standard 2436-1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-1981, Appendix E, Table E1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table E2 in Appendix E presents typical examples of noise reductions achievable after treatment of various noise sources. Table E3 in Appendix E presents the relative effectiveness of various forms of noise control treatment.

Table 13 below present noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 13 – Relative Effectiveness Of Various Forms of Noise Control, dBA

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	7 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 30	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Substitution by alternative process	Use electric motors in preference to diesel or petrol	15 to 25	15 to 25	60	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436, for this assessment.

Table 14 below identifies possible noise control measures which are applicable on the construction plant likely to be used on site.

Table 14 – Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Concrete Saw	✔	✔	x	x
Jack hammers	✔	x	✔	x
Mobile Crane	✔	✔	✔	x
Front End Loader	✔	x	✔	x
Pneumatic Hand Tools (general)	✔	✔	✔	✔
Bulldozer	✔	x	✔	x
Tracked Excavator	✔	x	✔	x
Concrete Trucks	✔	x	✔	x
Delivery Trucks	✔	x	✔	x
Dump Trucks	✔	x	✔	x
Truck (> 20 tonne)	✔	x	✔	x
Welders	✔	✔	x	x
Cherry Picker	✔	x	✔	x
Concrete Pump	✔	✔	✔	✔
Power Generator	✔	✔	✔	x
Light commercial vehicles	✔	x	✔	x
Silenced Air Compressor	✔	✔	✔	✔

To ensure efficient noise attenuation performance is achieved using any of the methods listed above, it is recommended acoustic engineers work closely with the construction contractors and carry out preliminary testing prior to commencement of works.

In addition to physical noise controls, the following general noise management measures should be followed:

- Plant and equipment should be properly maintained

- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel
- Avoid unnecessary noise when carrying out manual operations and when operating plant
- Any equipment not in use for extended periods during construction work should be switched off
- Noise compliance monitoring for all major equipment and activities on site should be undertaken prior to their commencement of work on site.
- In addition to the noise mitigation measures outlined above, a management procedure would need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint would need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community should be adequately trained and experienced in such matters.

Where noise level exceedances cannot be avoided, then consideration should be given to implementing time restrictions and/or providing periods of repose for neighbouring receptors.

11 Conclusion

Renzo Tonin & Associates have completed an acoustic assessment of road traffic noise, rail noise and vibration impacts onto the proposed mixed-use development on Site 68 at corner of Australia Avenue and Bennelong Parkway, Sydney Olympic Park in accordance with the Secretary's Environmental Assessment Requirements.

Our assessment of airborne road and rail noise intrusion into the subject development has found that appropriate noise control measures can be incorporated into the building design such as acoustic glazing to achieve compliance with the acoustic requirements stipulated in State Environment Planning Policy ISEPP 2007 and Australian Standard AS/NZS 2107.

In principle acoustic advice and noise management measures have been provided to appropriately address noise emission during the construction and operational phases of the development.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.

L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Assessment and Design Methodology

B.1 SEPP (Infrastructure) 2007

Clause 87 of ISEPP 2007 requires as follows:

87 Impact of rail noise or vibration on non-rail development

- *This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:*
  - *a. a building for residential use,*
  - *b. a place of public worship,*
  - *c. a hospital,*
  - *d. an educational establishment or child care centre.*
- *Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
- *If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*

in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,

anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.

Clause 102 of ISEPP 2007 requires as follows:

102 Impact of road noise or vibration on non-road development

- *This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:*
- *a building for residential use,*
- *a place of public worship,*
- *a hospital,*
- *an educational establishment or child care centre.*

- *Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
- *If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
- *in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,*
- *anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.*
- *In this clause, "freeway", "tollway" and "transitway" have the same meanings as they have in the Roads Act 1993*

B.2 Department of Planning "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008

Table 3.1 of the Guideline presents airborne noise criteria for rail and traffic noise.

Table 3.1: Noise Criteria		
Residential Buildings		
Type of occupancy	Noise Level dBA	Applicable time period
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40	At any time
Non–Residential Buildings		
Type of occupancy		Recommended Max Level dBA
Educational Institutions including child care centres		40
Places of Worship		40
Hospitals	- Wards	35
	- Other noise sensitive areas	45

Note: airborne noise is calculated as Leq (9h) (night) and Leq (15h)(day). Ground-borne noise is calculated as Lmax (slow) for 95% of rail pass-by events.

B.3 Australian/New Zealand Standard AS/NZS 2107:2000

As traffic noise levels are not constant, an L_{eq} noise level descriptor is used when assessing this type of noise source. The L_{eq} is the mean energy level of the noise being measured, and has been found to accurately describe the level of annoyance caused by traffic noise.

This standard provides recommended noise levels for steady state such as noise from building services and quasi-steady state sounds, such as traffic and industrial noise. The noise levels recommended in

AS/NZS 2107:2000 take into account the function of the area and apply to the sound level measured within the space unoccupied although ready for occupancy.

This standard recommends the following noise levels for residential buildings.

Table 15 – Australian/New Zealand Standard AS/NZS 2107:2000 "Acoustic – Recommended design sound levels and reverberation times for building exteriors"

Extract of Table 1 of AS/NZS 2107:2000		
Type of Occupancy/ Activity	**Recommended Design Sound Level, LAeq, dB(A)**	
	Satisfactory	**Maximum**
Residential Buildings		
Houses and apartments near major roads–		
Living areas	35	45
Sleeping areas	30	40
Work areas	35	45
Apartment common areas (e.g. foyer, lift lobby)	45	55
Shop Buildings		
Small retail stores (general)	45	50

Clause 5.2 of the Standard states the following:

> *The design sound levels given in Table 15 are not necessarily appropriate in all circumstances. In particular, lower noise levels may be appropriate where expectations of quality are high. For example, lower design sound levels than those given as satisfactory in Table 15 may be preferred for luxury apartments.*

APPENDIX C Detailed Results of Noise Survey

C.1.1 Ambient and Background Noise Survey

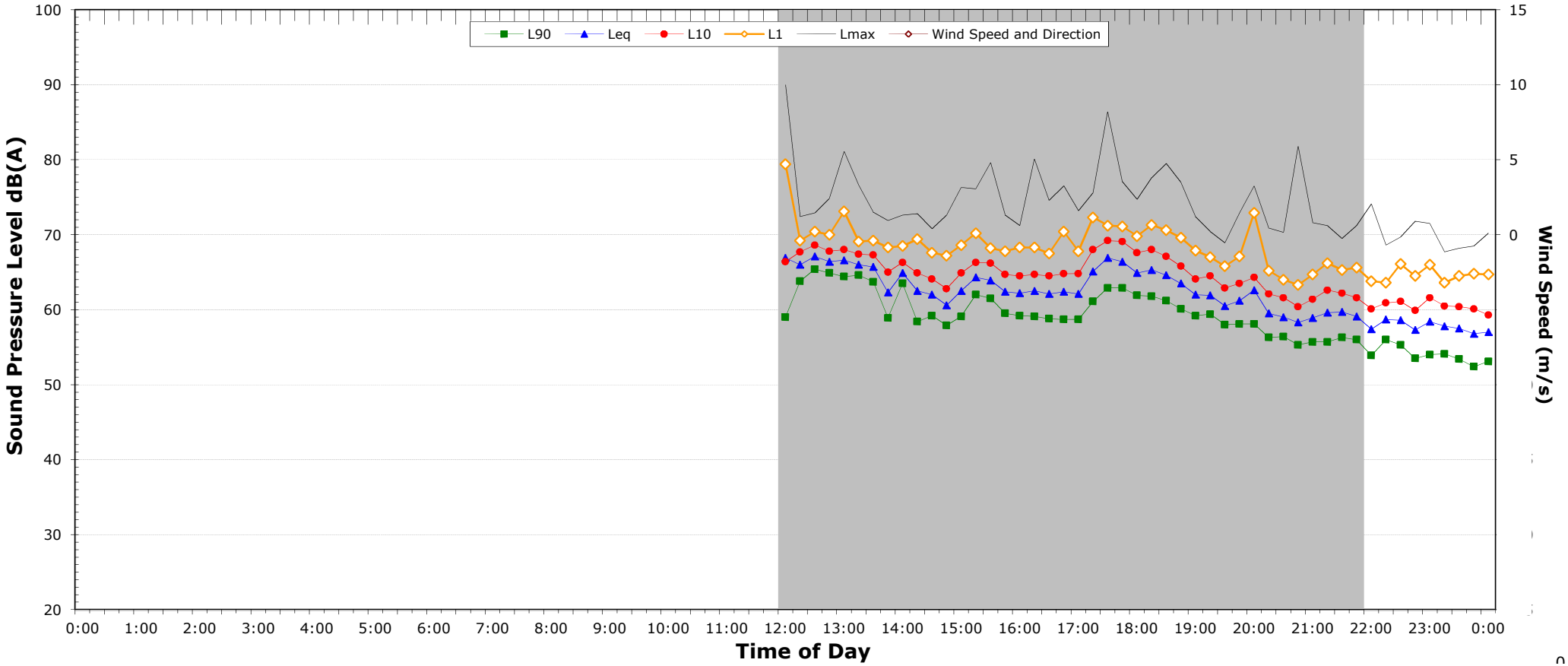
Unattended noise monitoring location: Southern site boundary at approximately 34m from Australia Avenue and 58m from Bennelong Parkway.

Survey Period: 12pm Tuesday 02/09/2014 to 11am Sunday 07/09/2014

EXISTING AMBIENT NOISE LEVELS

Cnr Bennelong Parkway & Australia Av, Sydney Olympic Park

Tuesday, 2 September 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	49.3
Leq	-	-	57.3

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.9	59.8
$L_{eq\ 1hr}$ upper 10 percentile	59.9	64.1
$L_{eq\ 1hr}$ lower 10 percentile	59.9	56.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	71.2	to	82.4
Lmax - Leq (Range)	15.5	to	20.8

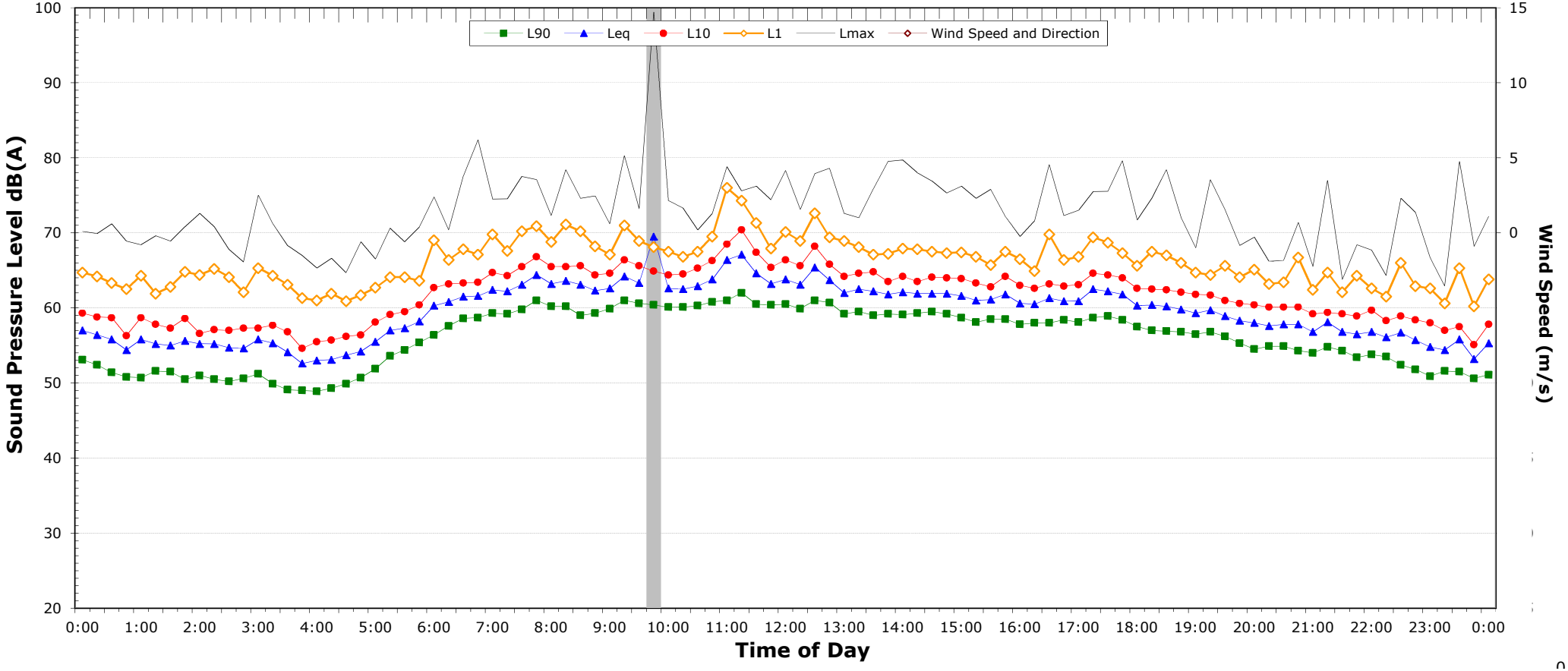
Data File: Logger 61.xlsx

Template QTE-05B (rev 79) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

Cnr Bennelong Parkway & Australia Av, Sydney Olympic Park

Wednesday, 3 September 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	58.1	53.8	48.0
Leq	62.9	58.5	55.8

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	64.6	58.3
$L_{eq\ 1hr}$ upper 10 percentile	67.1	63.7
$L_{eq\ 1hr}$ lower 10 percentile	59.8	54.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.0	to	79.5
Lmax - Leq (Range)	15.0	to	24.7

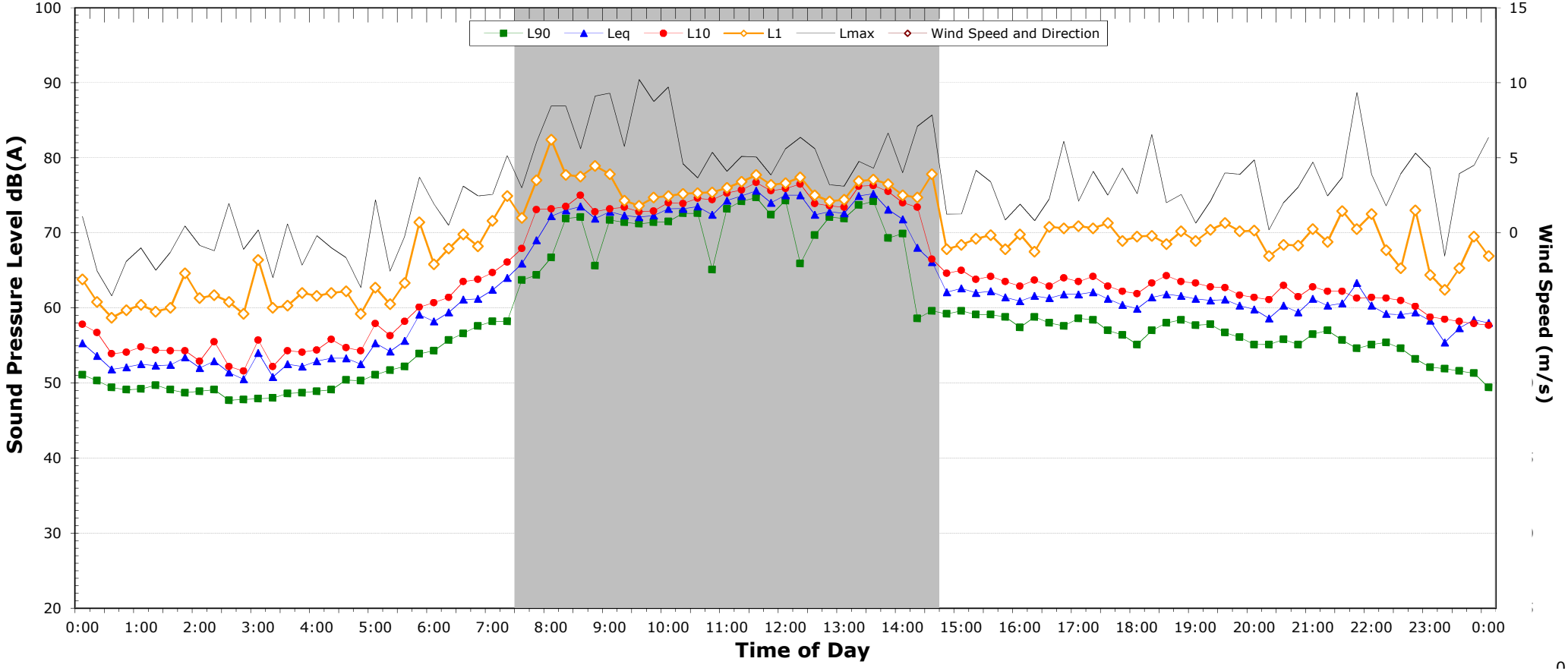
Data File: Logger 61.xlsx

Template QTE-05B (rev 79) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

Cnr Bennelong Parkway & Australia Av, Sydney Olympic Park

Thursday, 4 September 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	55.1	48.9
Leq	-	60.9	57.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	63.8	60.1
$L_{eq\ 1hr}$ upper 10 percentile	66.5	65.1
$L_{eq\ 1hr}$ lower 10 percentile	62.5	55.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	71.4	to	82.7
Lmax - Leq (Range)	16.3	to	26.0

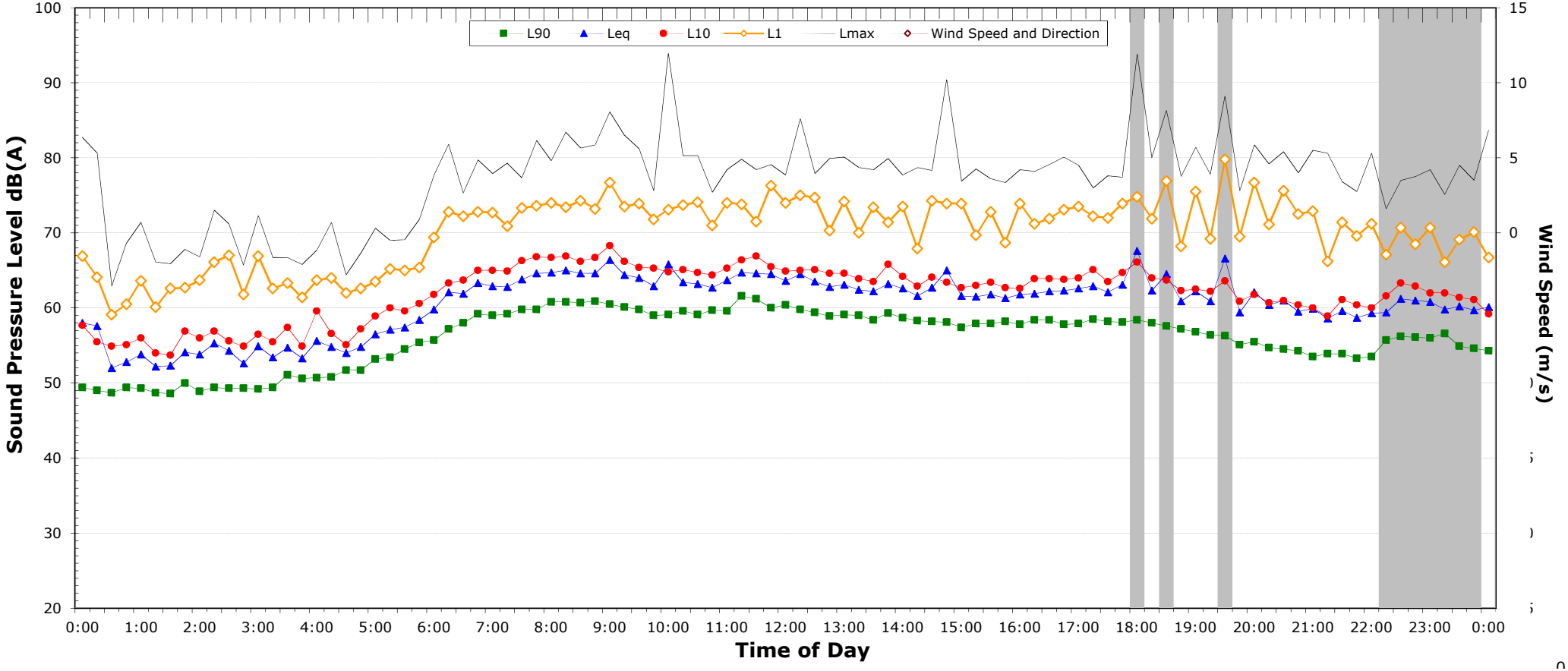
Data File: Logger 61.xlsx

Template QTE-05B (rev 79) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

Cnr Bennelong Parkway & Australia Av, Sydney Olympic Park

Friday, 5 September 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	57.9	53.5	-
Leq	63.5	60.5	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.4	60.5
$L_{eq\ 1hr}$ upper 10 percentile	67.3	64.7
$L_{eq\ 1hr}$ lower 10 percentile	62.2	57.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	74.1	to	83.7
Lmax - Leq (Range)	15.2	to	23.6

Data File: Logger 61.xlsx

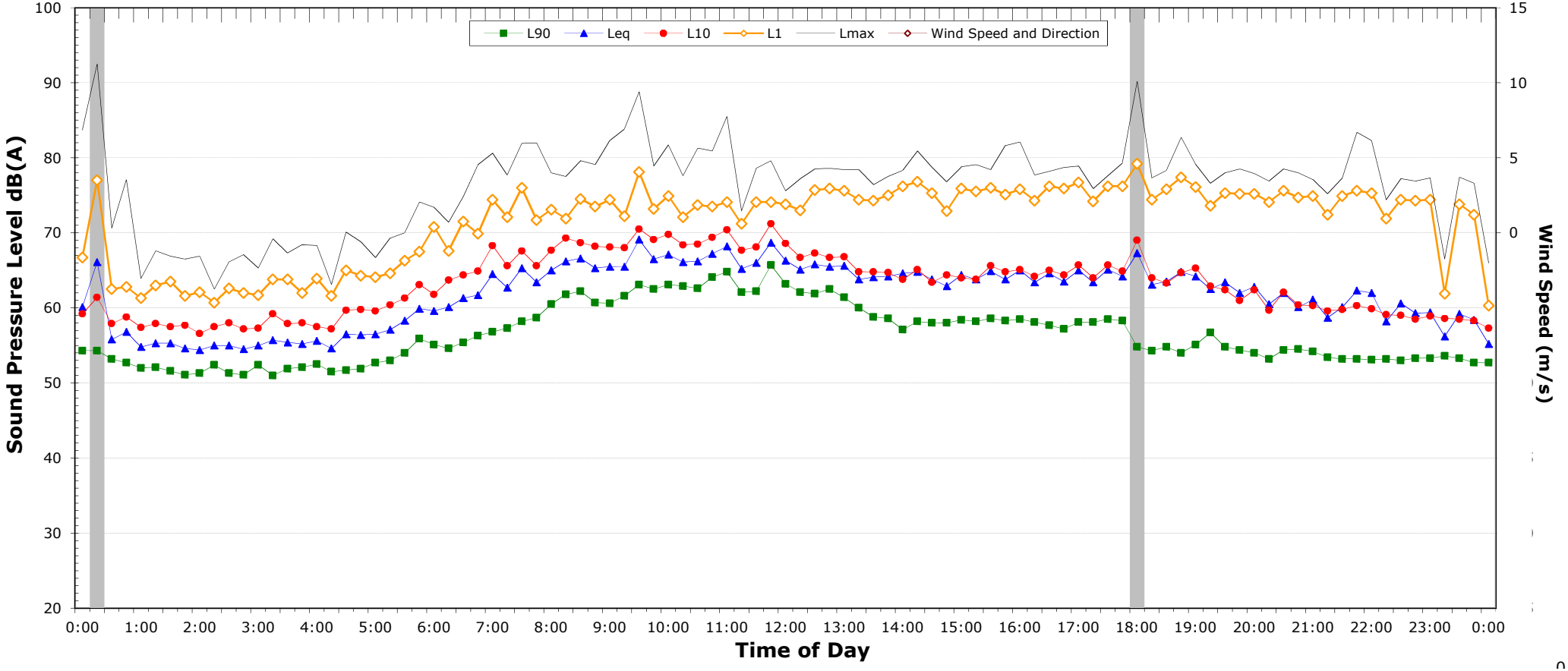
TG856-01L01 (r0) Cnr Bennelong Pkwy & Australia Av Olympic Park.xls

Template QTE-05B (rev 79) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

Cnr Bennelong Parkway & Australia Av, Sydney Olympic Park

Saturday, 6 September 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	58.0	53.2	48.4
Leq	65.5	62.3	57.2

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	67.3	59.7
$L_{eq\ 1hr}$ upper 10 percentile	69.6	62.4
$L_{eq\ 1hr}$ lower 10 percentile	63.5	55.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.3	to	80.6
Lmax - Leq (Range)	17.8	to	23.8

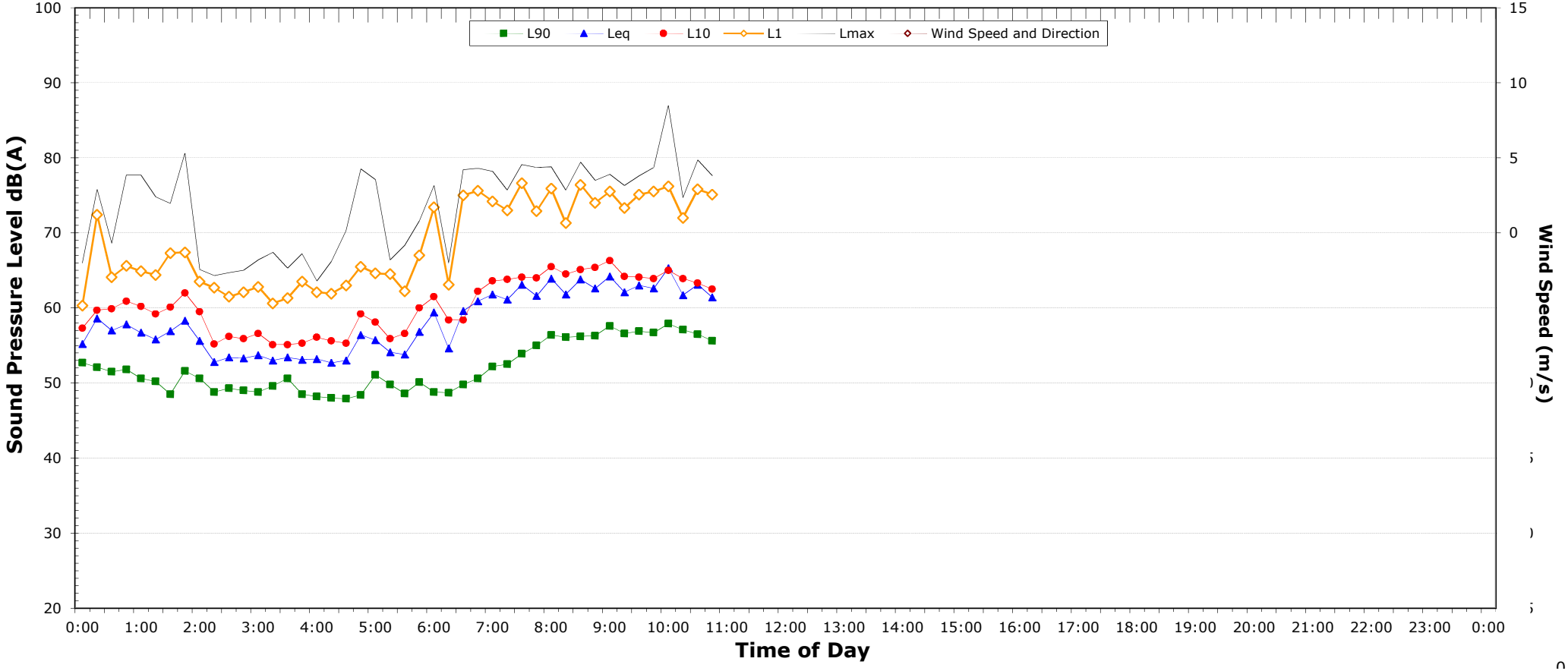
Data File: Logger 61.xlsx

Template QTE-05B (rev 79) Sydney Logger Graphs

EXISTING AMBIENT NOISE LEVELS

Cnr Bennelong Parkway & Australia Av, Sydney Olympic Park

Sunday, 7 September 2014



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW Road Noise Policy (1m from facade)		(see note 3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.4	-
$L_{eq\ 1hr}$ upper 10 percentile	65.9	-
$L_{eq\ 1hr}$ lower 10 percentile	64.6	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Data File: Logger 61.xlsx

TG856-01L01 (r0) Cnr Bennelong Pkwy & Australia Av Olympic Park.xls

Template QTE-05B (rev 79) Sydney Logger Graphs