

Major civil construction between The Bays and Sydney CBD

Environmental Impact Statement 2021

Technical Paper 2

Noise and vibration

APPENDIX A

Acoustic Terminology

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_p are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

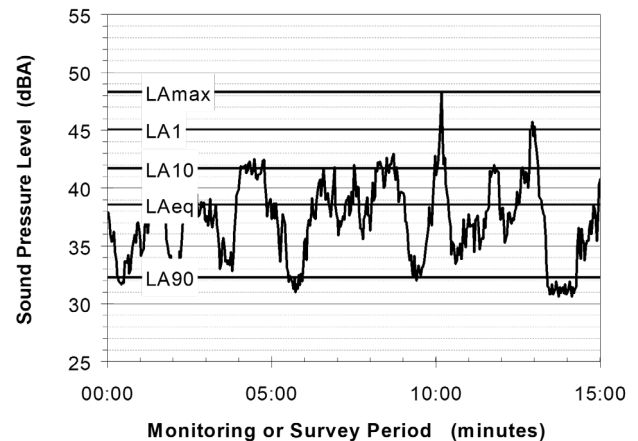
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_w , or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN} , where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise level exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

- L_{A1} The noise level exceeded for 1% of the 15 minute interval.
- L_{A10} The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.
- L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.
- L_{Aeq} The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition, the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq} , L_{A10} , etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

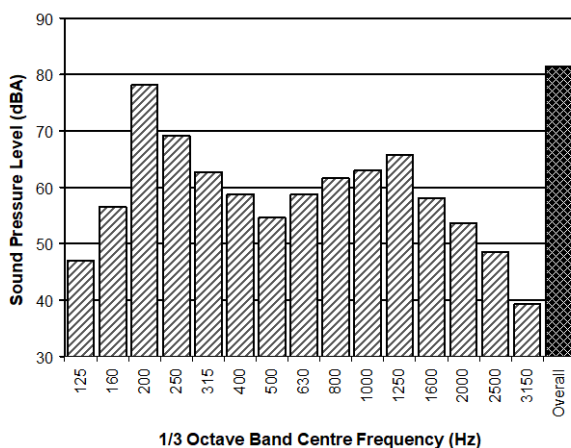
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V , expressed in mm/s can be converted to decibels by the formula $20 \log (V/V_0)$, where V_0 is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organisations.

9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Over-Pressure

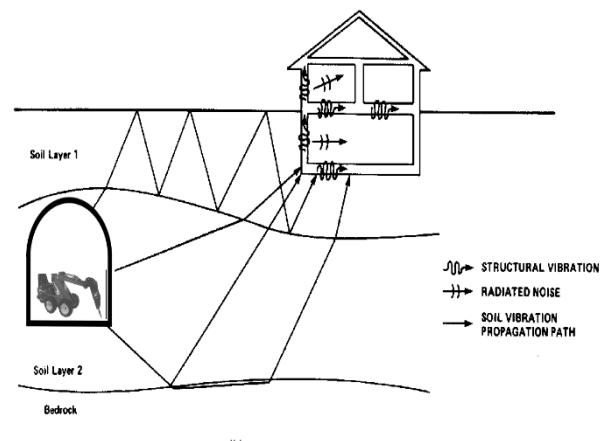
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).


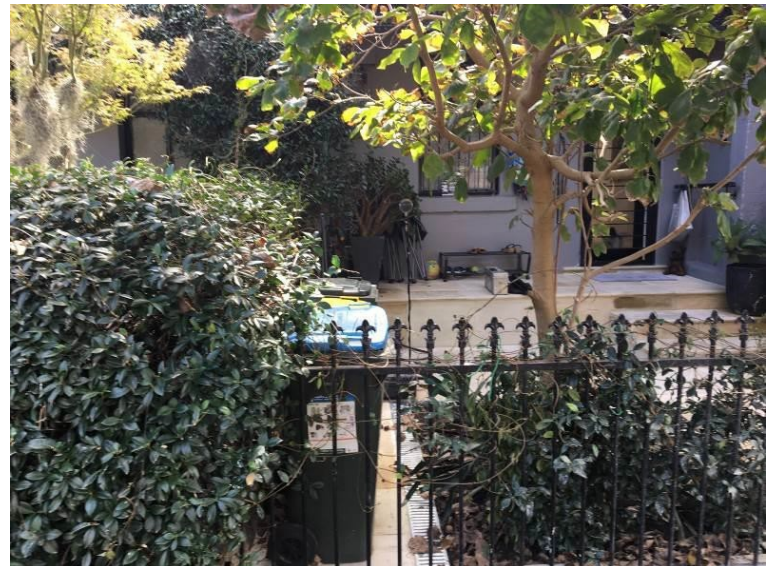
The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



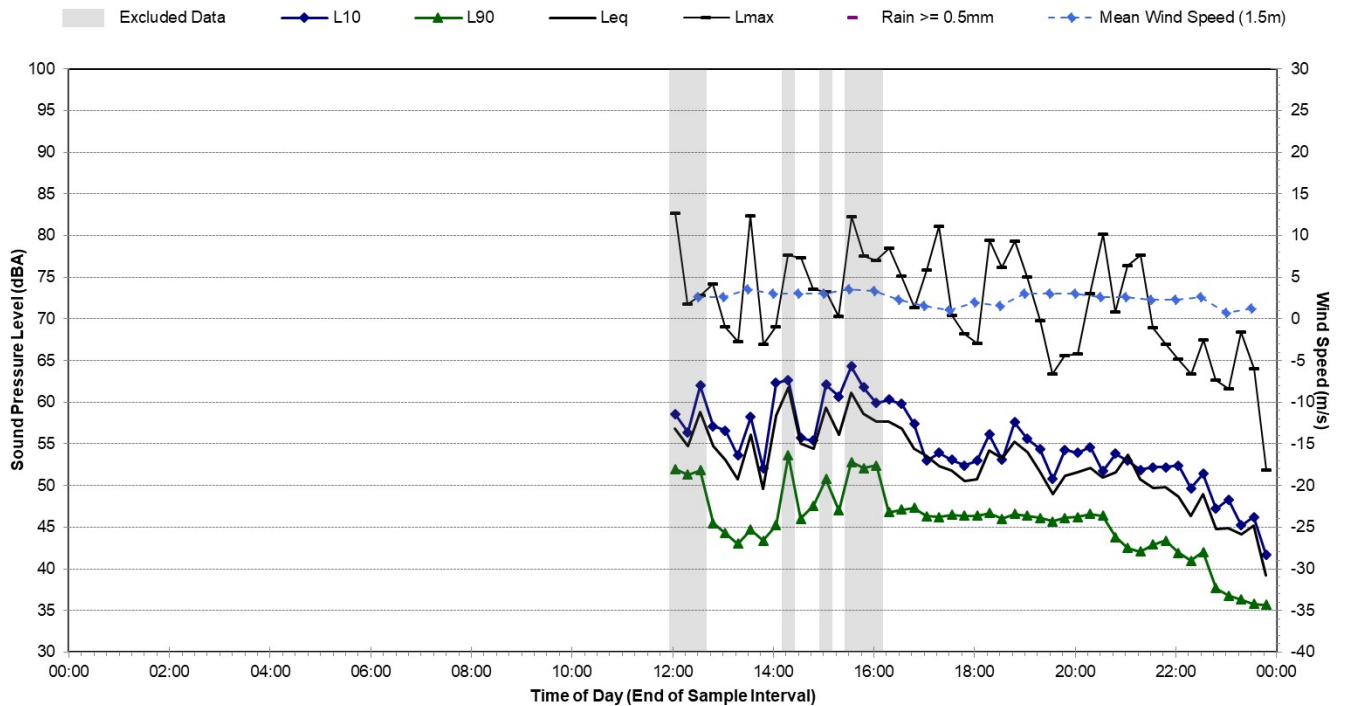
The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

APPENDIX B

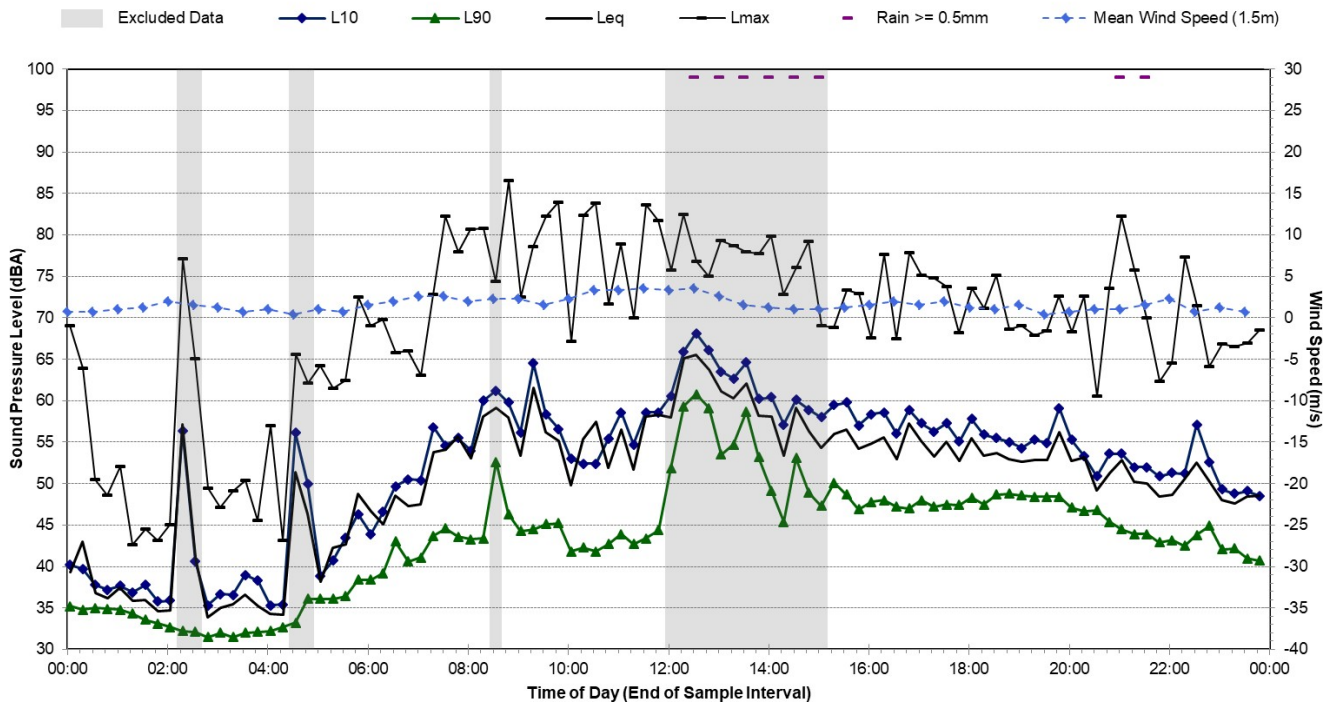
Ambient Noise Monitoring Results

Noise Monitoring Location		B.01				Map of Noise Monitoring Location
Noise Monitoring Address		21 Mansfield Street, Rozelle				
Logger Device Type: SVAN957, Logger Serial No: 20674 Sound Level Meter Device Type: Brüel and Kjær 2260, Sound Level Meter Serial No: 2487418						
Ambient noise logger located at 21 Mansfield Street, Rozelle. Logger located with view of Mansfield Street to the west and the Western Distributor to the north.						
Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Mansfield Street. Industrial/Commercial also contributes to the measured levels.						
Measured noise levels (LAm _{ax}): 20/05/2019: Light-vehicle traffic Mansfield Street: 48-72 dBA, Industrial/Commercial operations: 45-76 dBA, Birds: 45-60 dBA, Aircraft: 48-52 dBA						Photo of Noise Monitoring Location
Ambient Noise Logging Results – ICNG Defined Time Periods						
Monitoring Period (02/05/2019 – 20/05/2019)		Noise Level (dBA)				
		RBL	LA _{eq}	L ₁₀	L ₁	
Daytime		43	56	57	65	
Evening		43	54	54	61	
Night-time		35	47	42	50	
Ambient Noise Logging Results – RNP Defined Time Periods						
Monitoring Period (02/05/2019 – 20/05/2019)		Noise Level (dBA)				
		LA _{eq} (period)		LA _{eq} (1hour)		
Daytime (7am-10pm)		58		61		
Night-time (10pm-7am)		47		50		
Attended Noise Measurement Results						
Date	Start Time	Measured Noise Level (dBA)				
		LA ₉₀	LA _{eq}	LA _{max}		
29/05/2019	13:07	43	52	76		

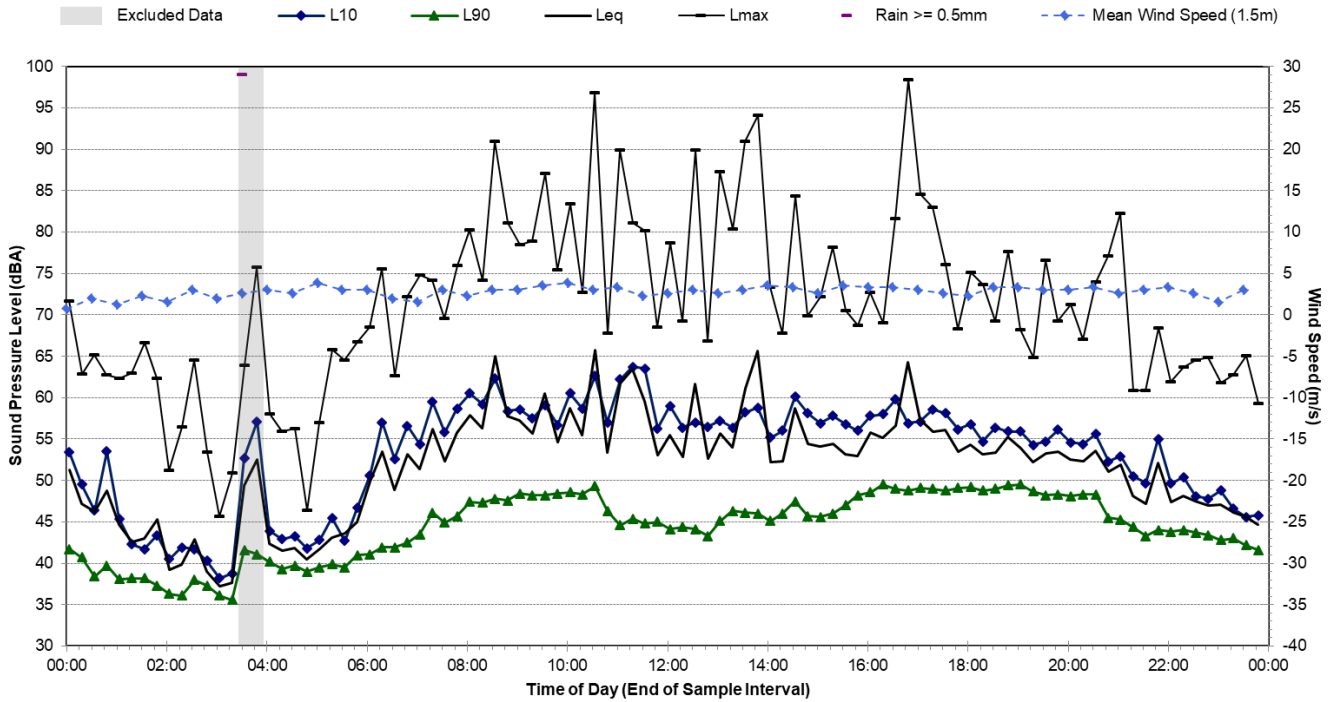
Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Thursday, 2 May 2019



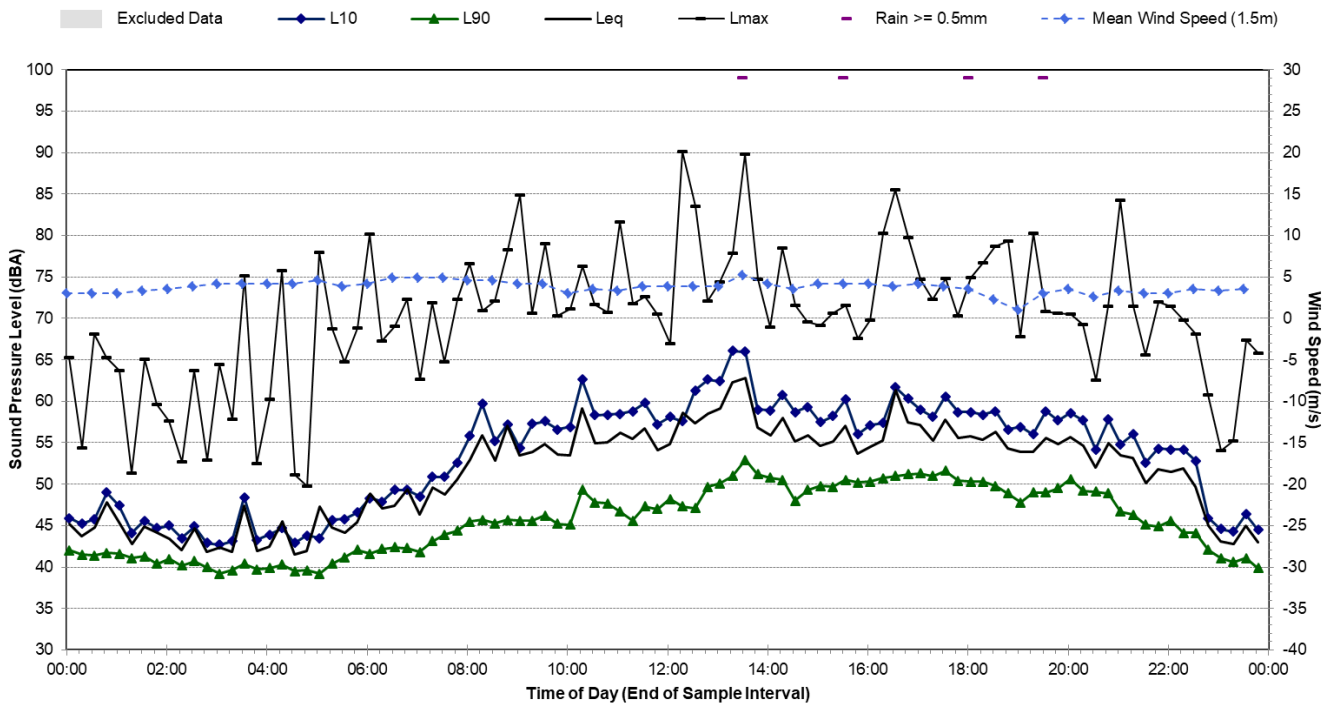
Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Friday, 3 May 2019



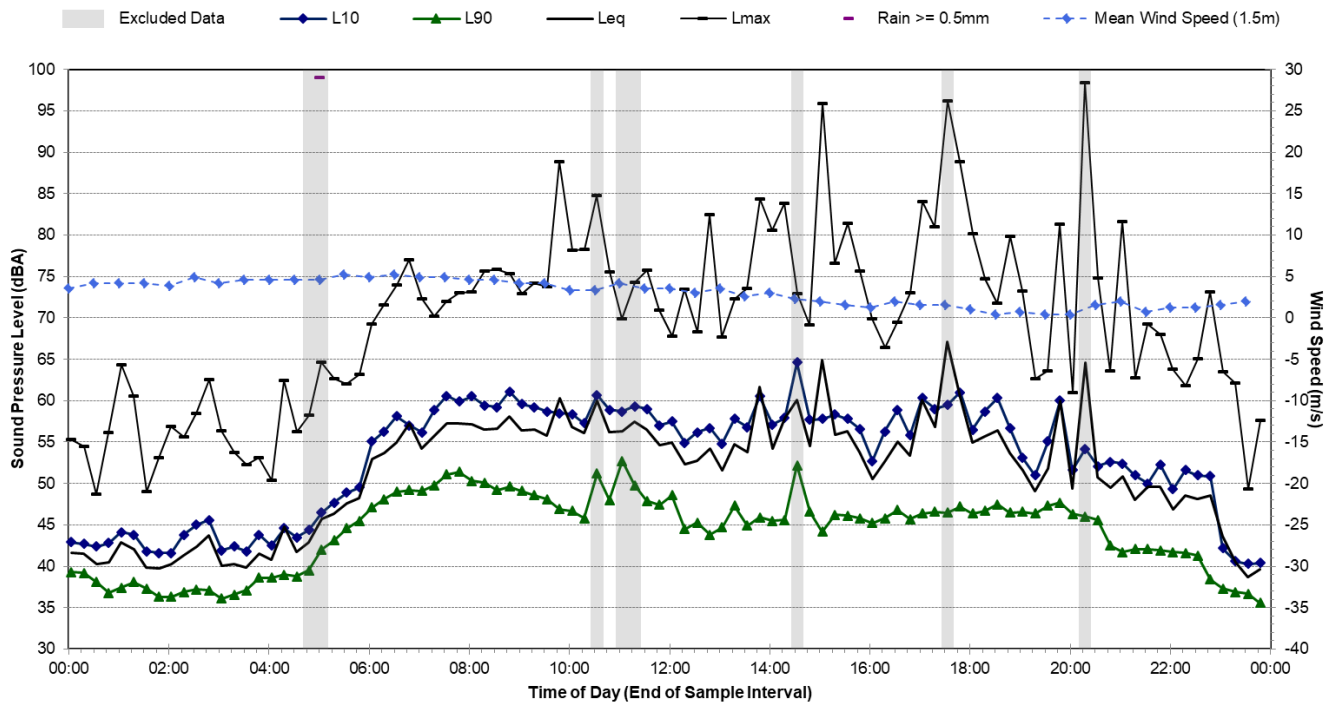
Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Saturday, 4 May 2019



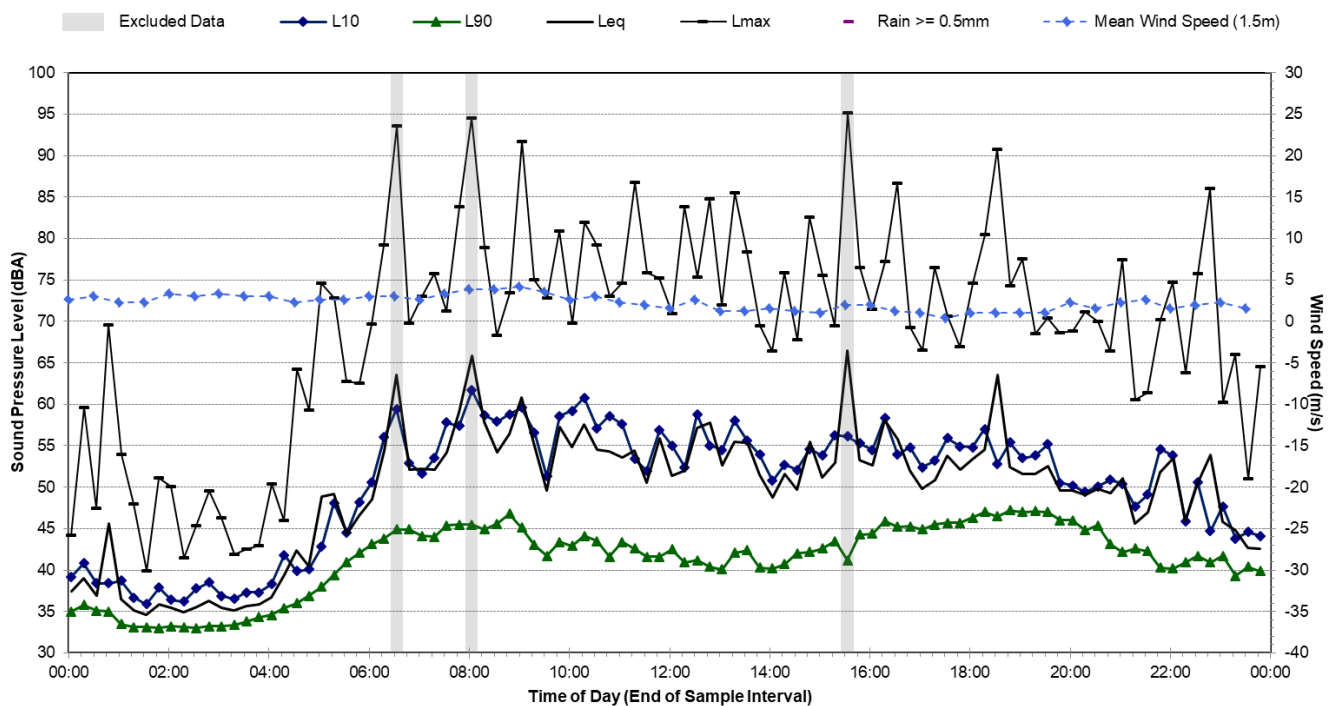
Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Sunday, 5 May 2019



Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Monday, 6 May 2019

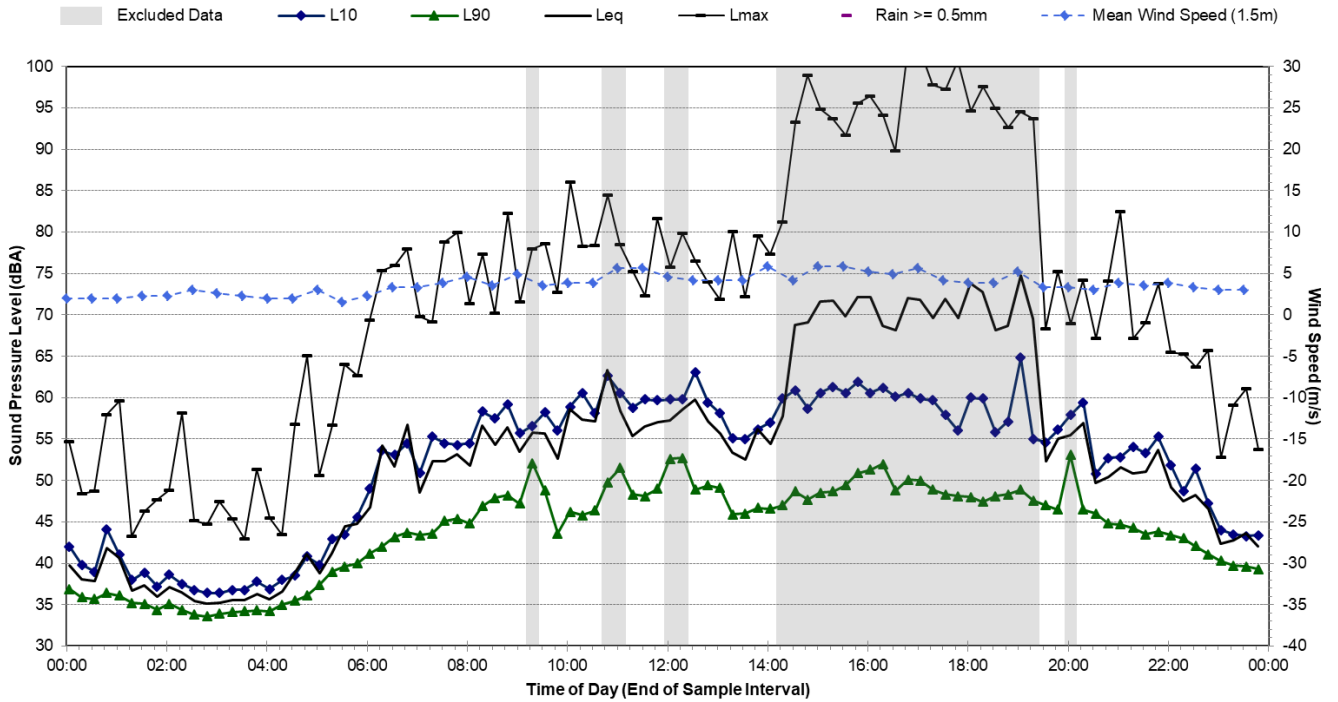


Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Tuesday, 7 May 2019



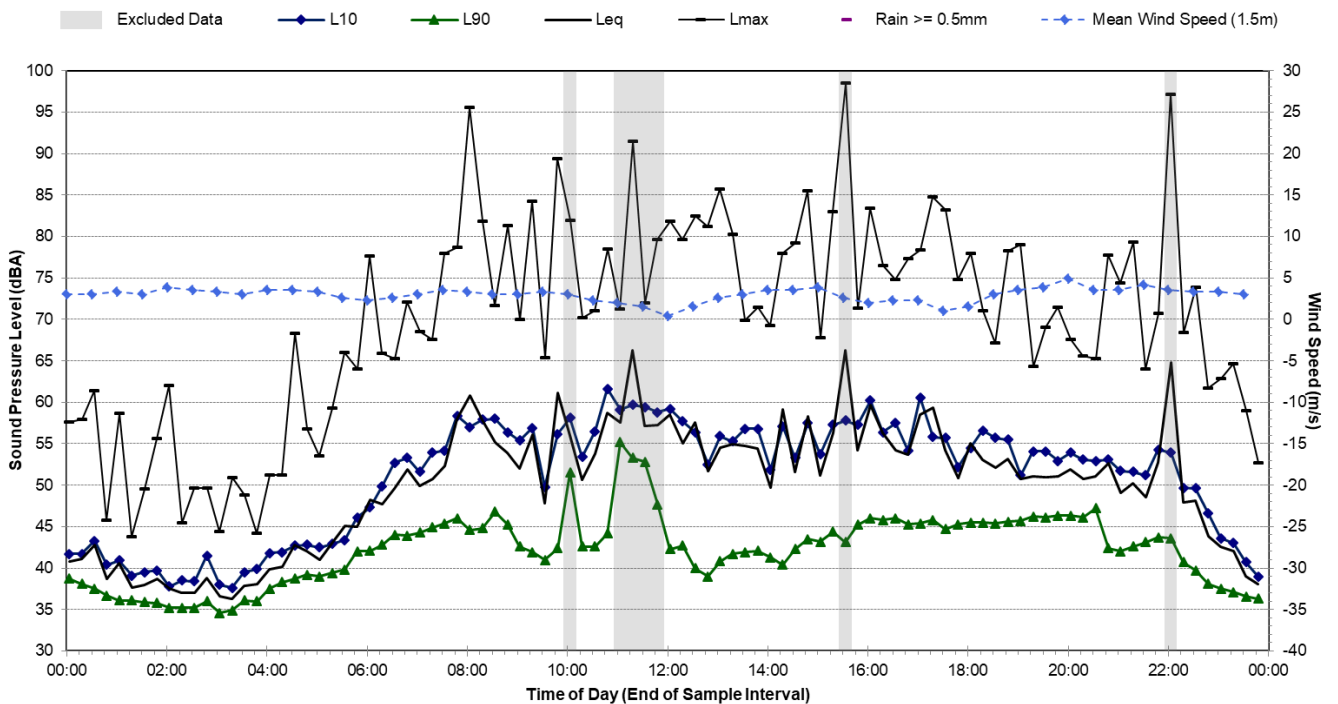
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Wednesday, 8 May 2019

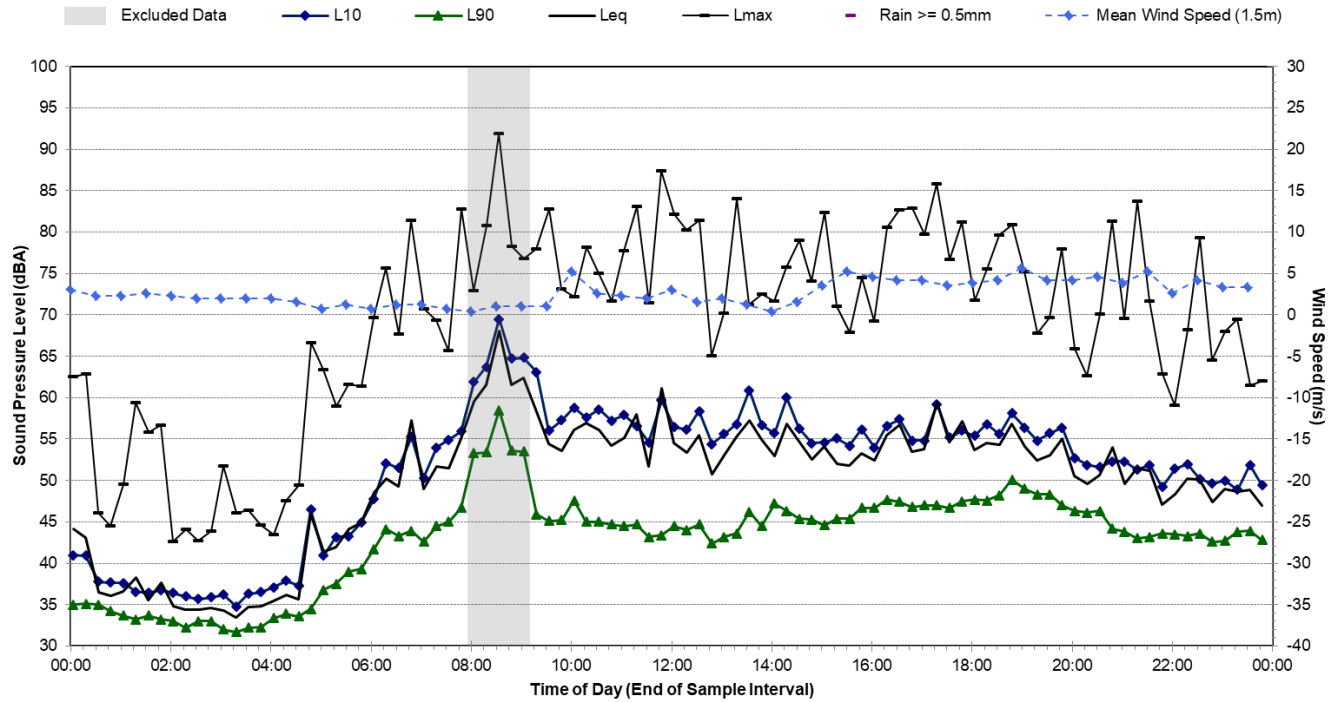


Statistical Ambient Noise Levels

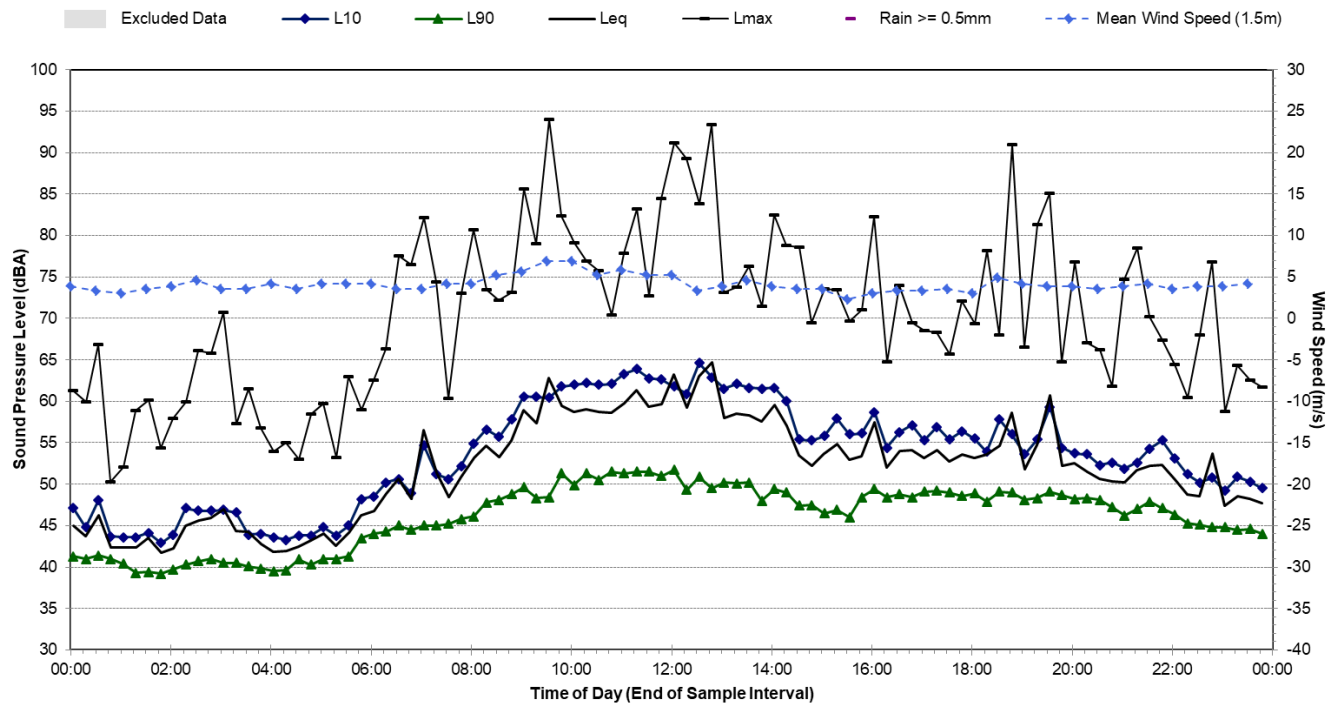
21 Mansfield St, Rozelle - Thursday, 9 May 2019



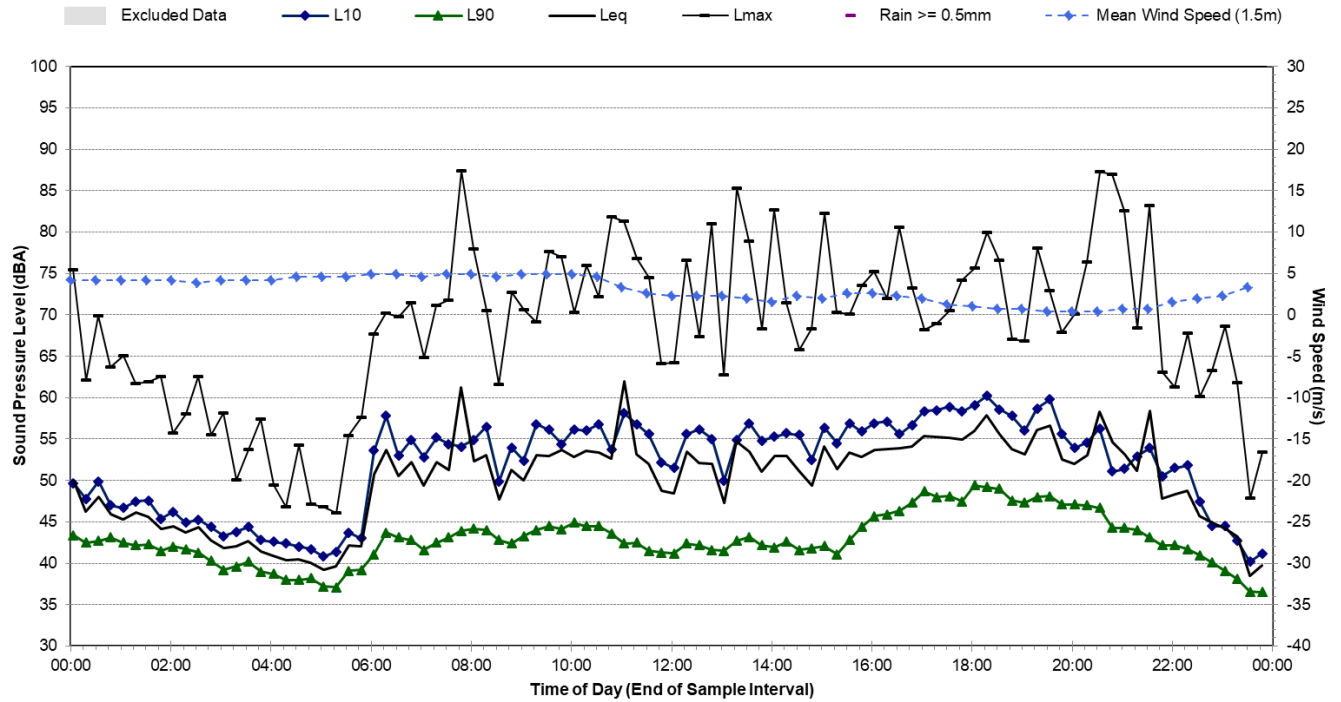
Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Friday, 10 May 2019



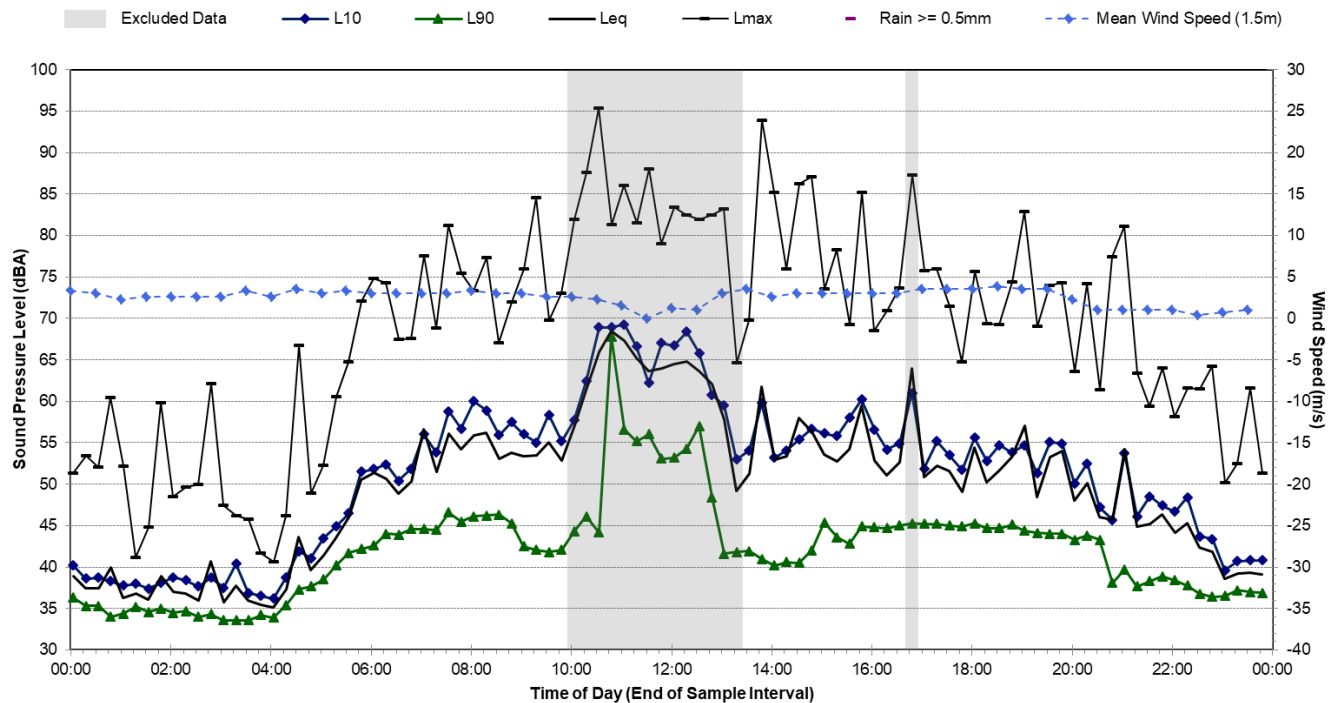
Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Saturday, 11 May 2019



Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Sunday, 12 May 2019

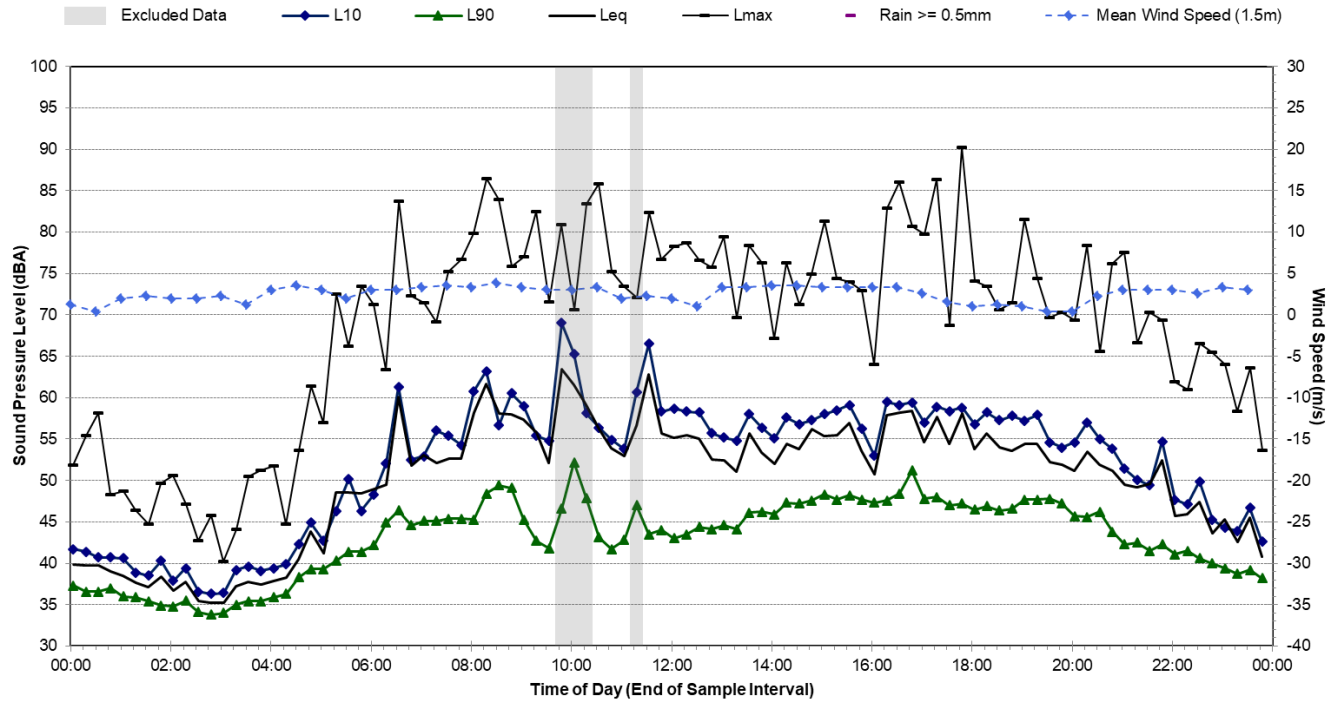


Statistical Ambient Noise Levels 21 Mansfield St, Rozelle - Monday, 13 May 2019



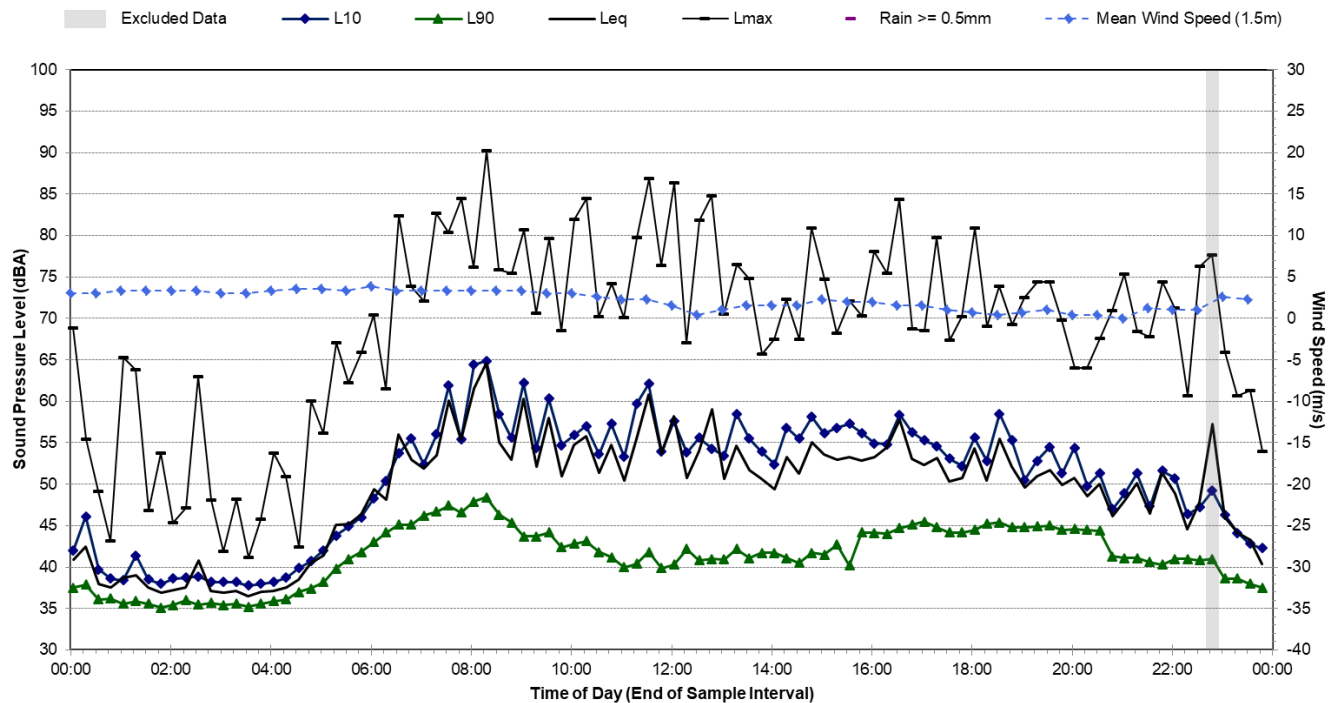
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Tuesday, 14 May 2019



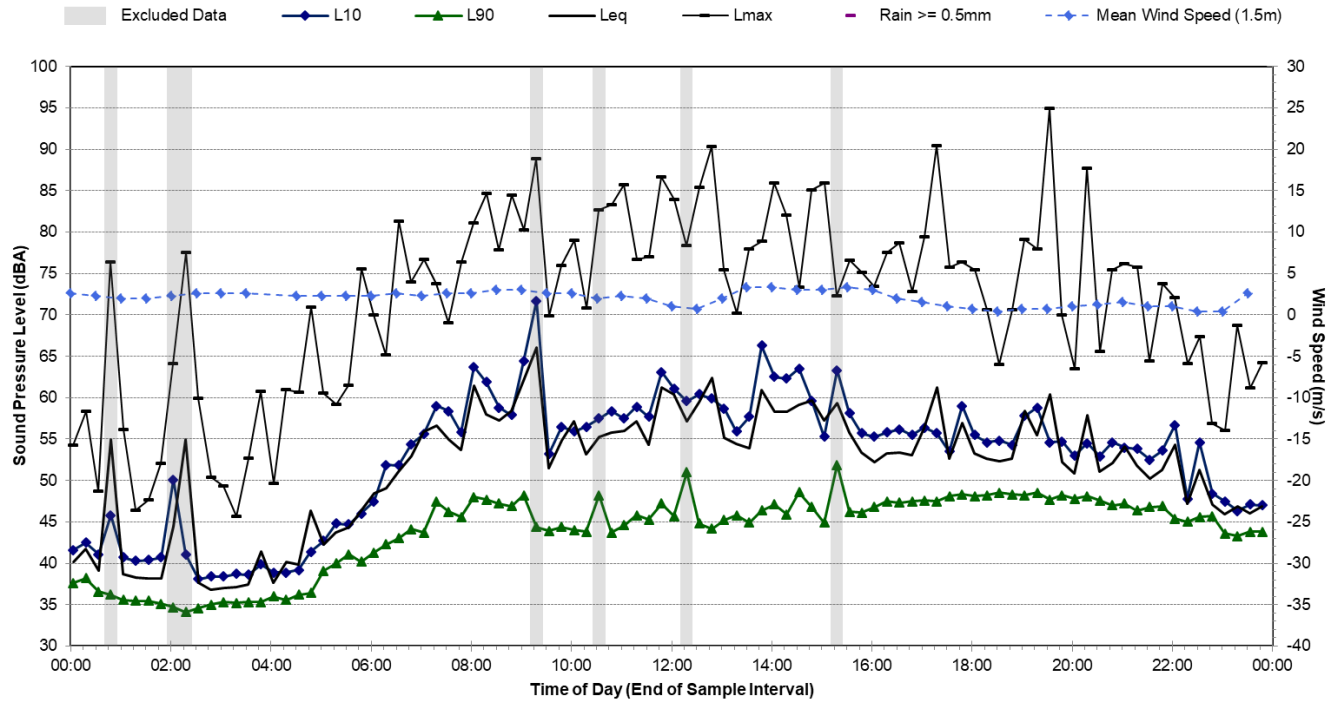
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Wednesday, 15 May 2019



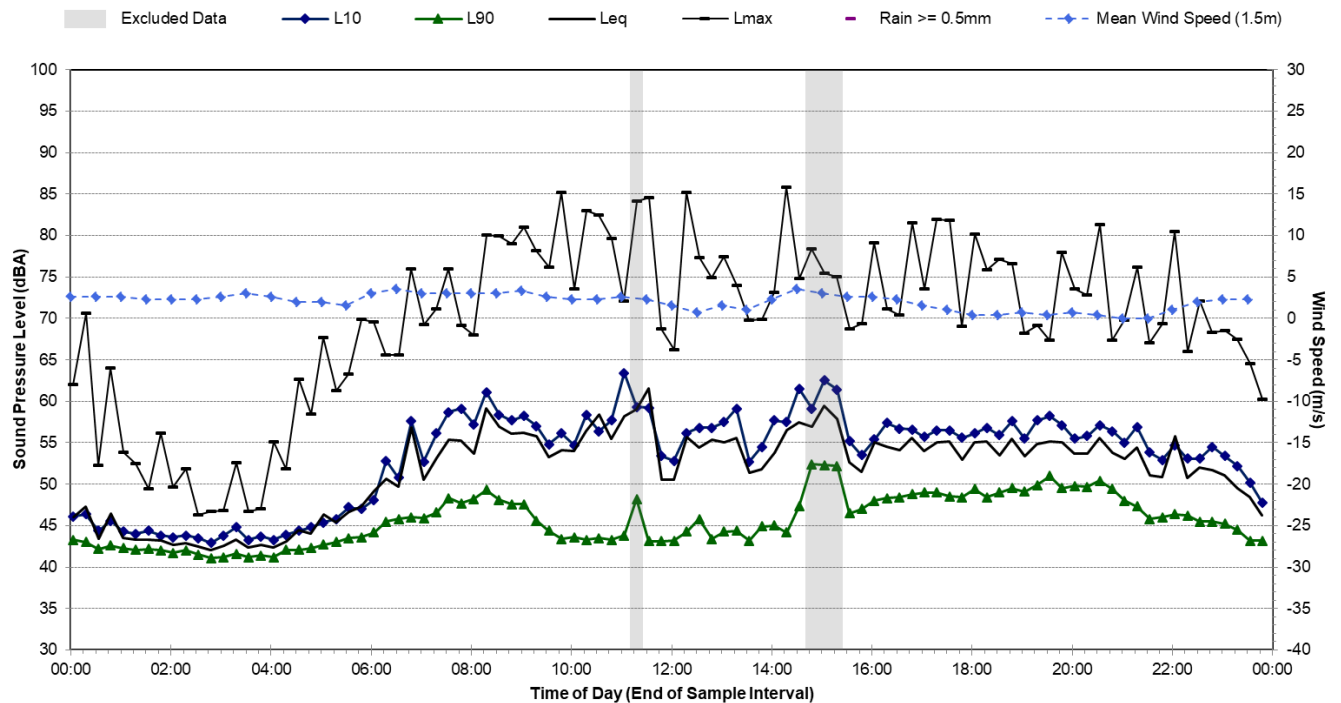
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Thursday, 16 May 2019



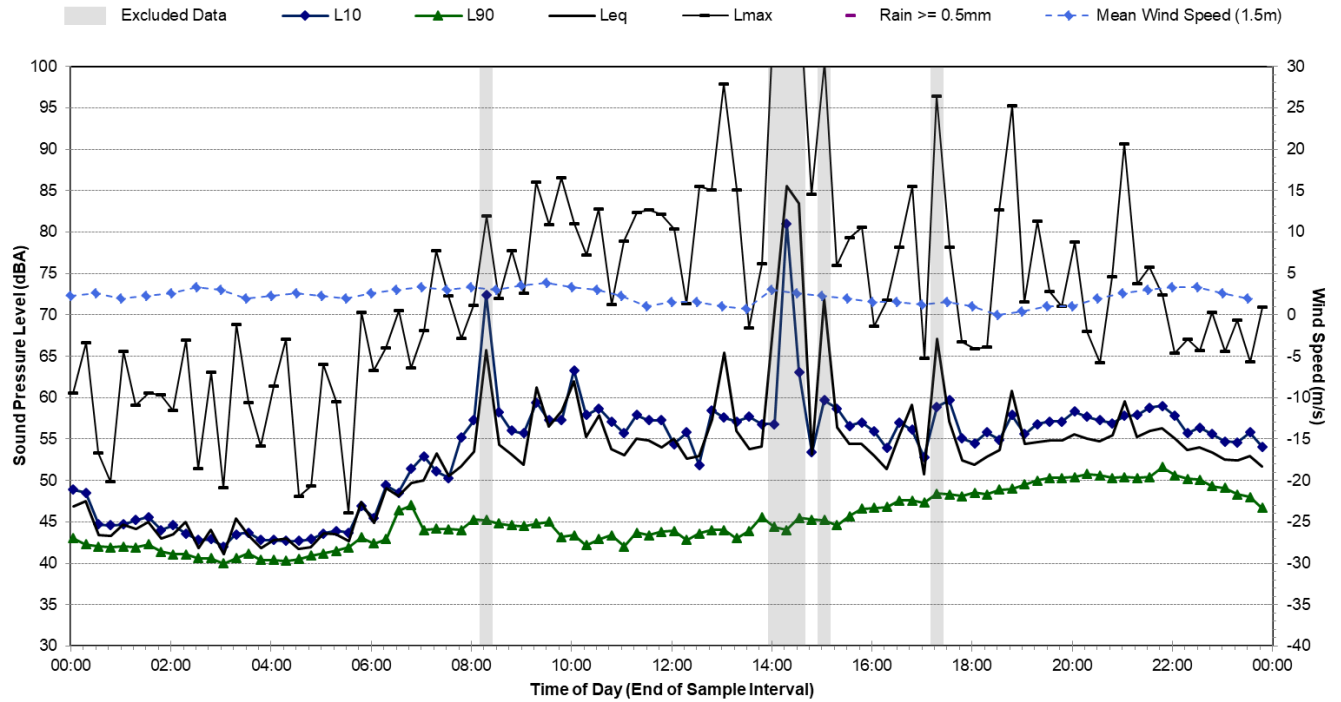
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Friday, 17 May 2019



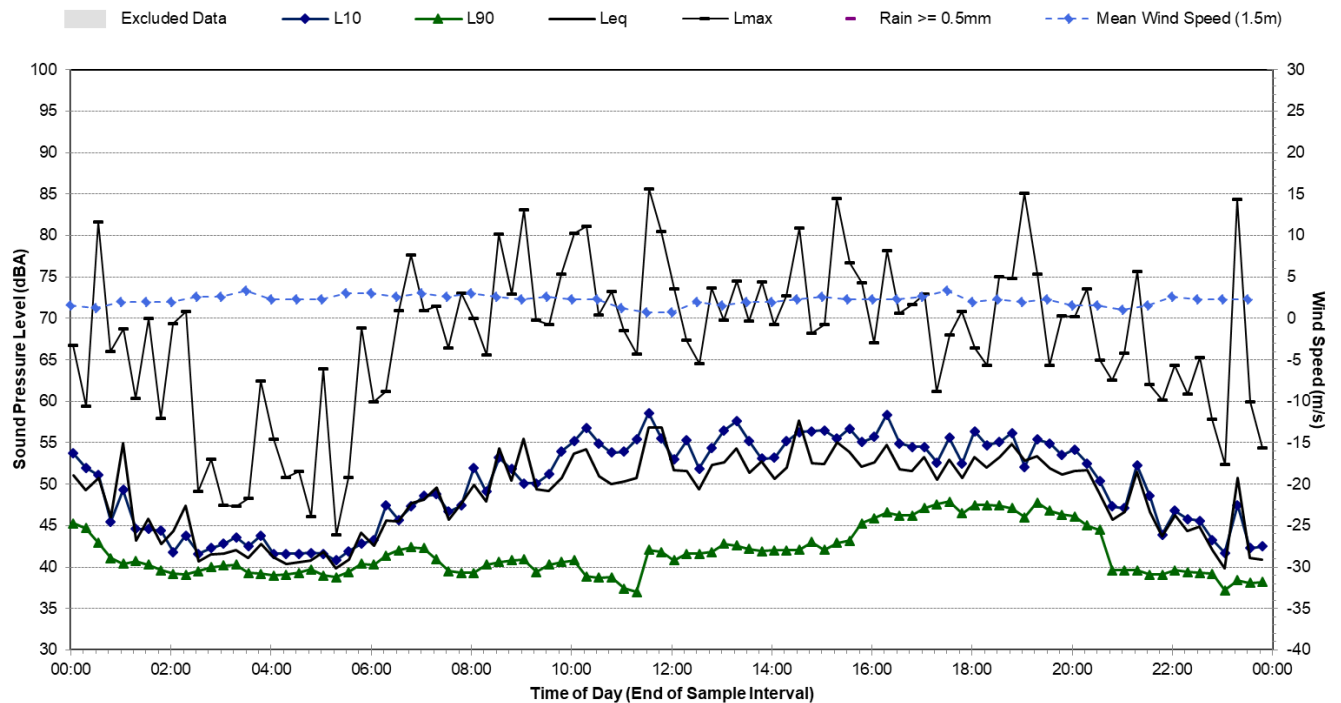
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Saturday, 18 May 2019



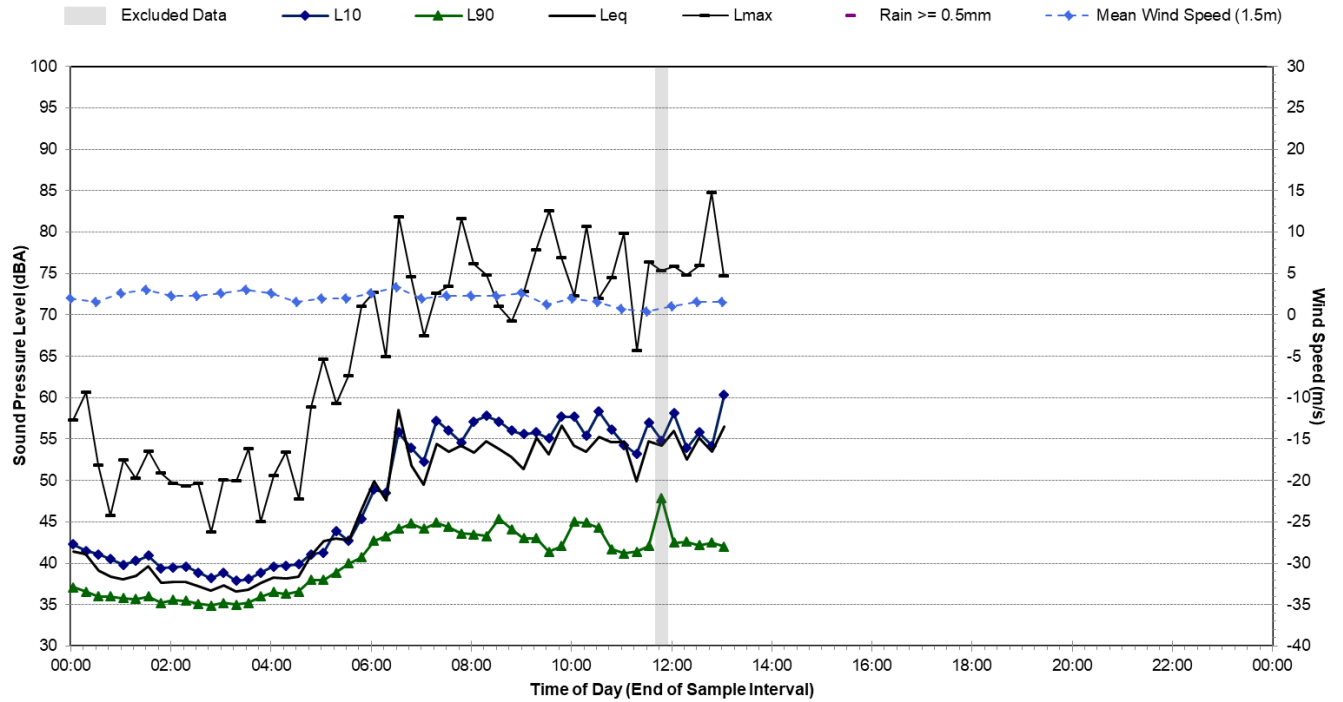
Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Sunday, 19 May 2019

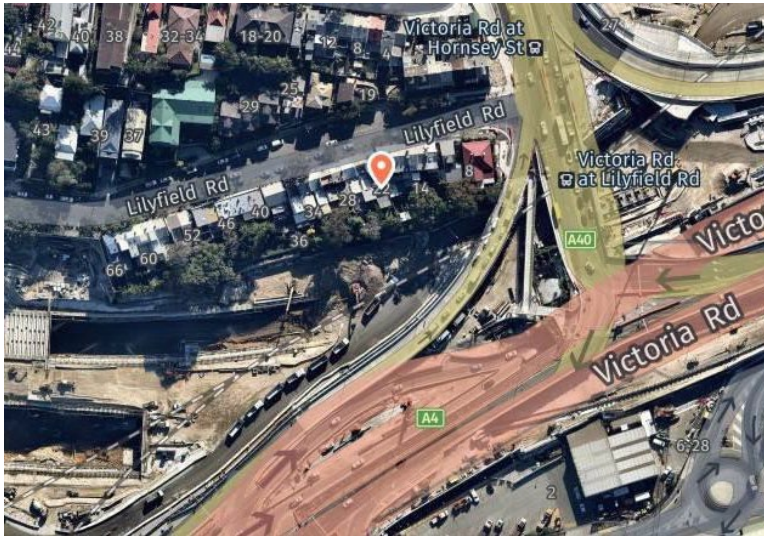



Statistical Ambient Noise Levels

21 Mansfield St, Rozelle - Monday, 20 May 2019



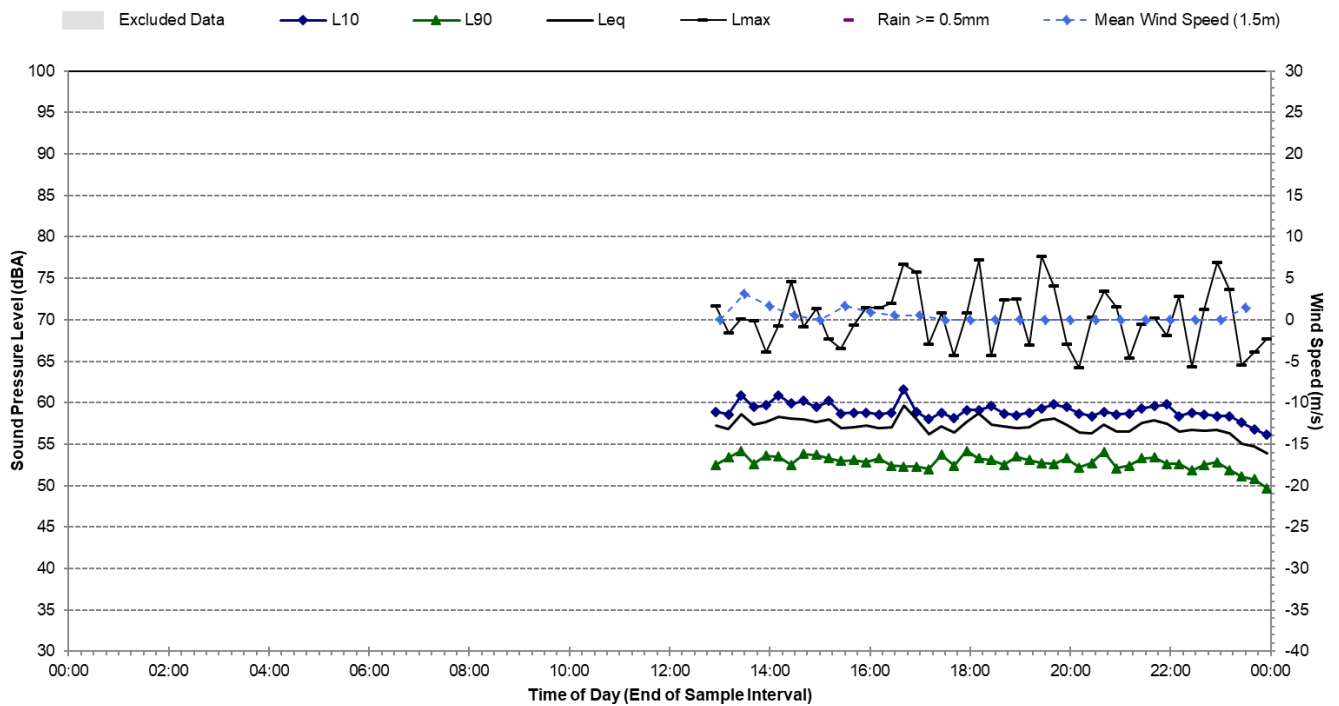
Noise Monitoring Location		B.02			Map of Noise Monitoring Location	
Noise Monitoring Address		22 Lilyfield Rd, Rozelle				
Logger Device Type: Svantek 957, Logger Serial No: 23293 Sound Level Meter Device Type: Brüel and Kjær 2260, Sound Level Meter Serial No: 2414604						
Ambient noise data obtained as part of the WestConnex Project. Ambient noise logger located in the rear yard of 22 Lilyfield Road, Rozelle.						
Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Victoria Road to the east and City West Link to the south. Frequent aircraft noise contributes to the measured noise levels. Noise from heavy vehicles and horns was noted to occur regularly during the measurements.						
Measured noise levels: (L _{Amax}): 21/07/2016: Light-vehicle traffic Victoria Road and City West Link: 55-68 dBA, Heavy-vehicle traffic Victoria Road and City West Link: 60-84 dBA, Aircraft: 61-69 dBA						
Ambient Noise Logging Results – ICNG Defined Time Periods						Photo of Noise Monitoring Location
Monitoring Period (21/07/2016 – 02/08/2016)		Noise Level (dBA)				
		RBL	L _{Aeq}	L ₁₀	L ₁	
Daytime		51	57	59	63	
Evening		51	57	59	62	
Night-time		45	54	55	59	
Ambient Noise Logging Results – RNP Defined Time Periods						
Monitoring Period (21/07/2016 – 02/08/2016)		Noise Level (dBA)				
		L _{Aeq} (period)		L _{Aeq} (1hour)		
Daytime (7am-10pm)		57		58		
Night-time (10pm-7am)		54		59		
Attended Noise Measurement Results						
Date	Start Time	Measured Noise Level (dBA)				
		L _{A90}	L _{Aeq}	L _{Amax}		
21/07/2016	12: 50	54	59	84		





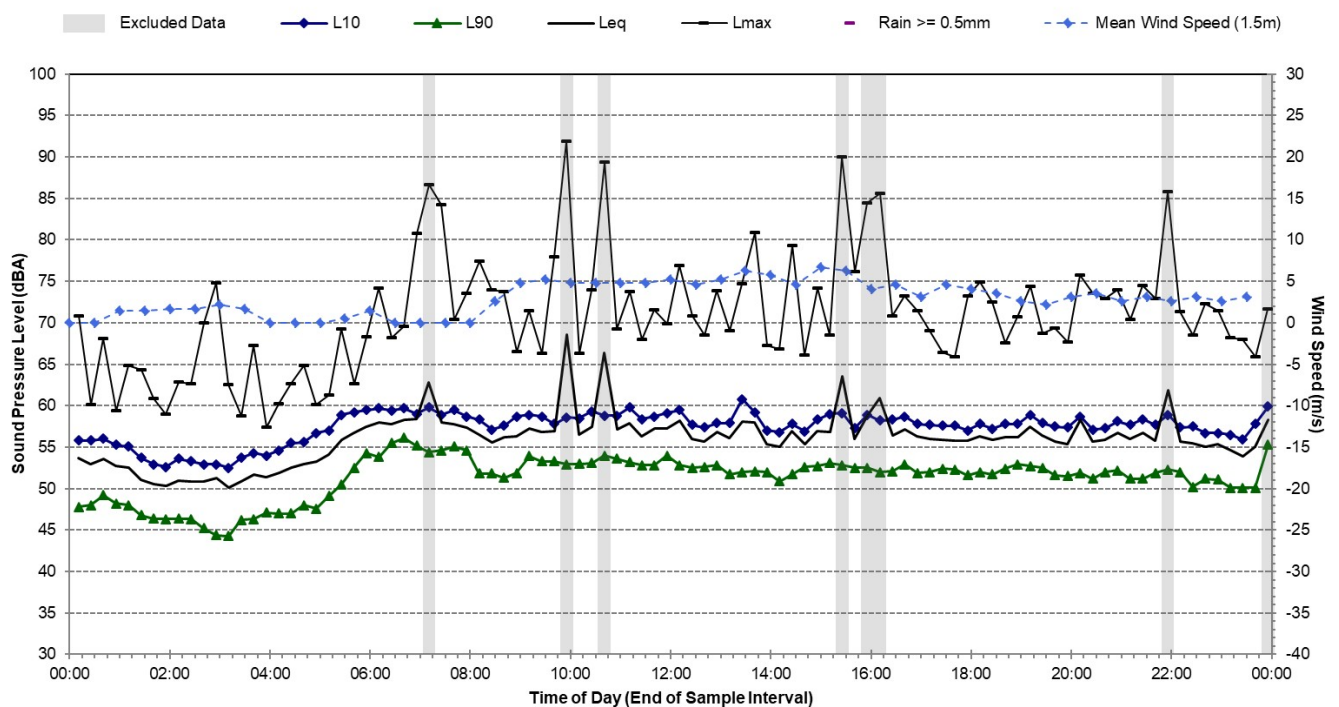
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Thursday, 21 July 2016



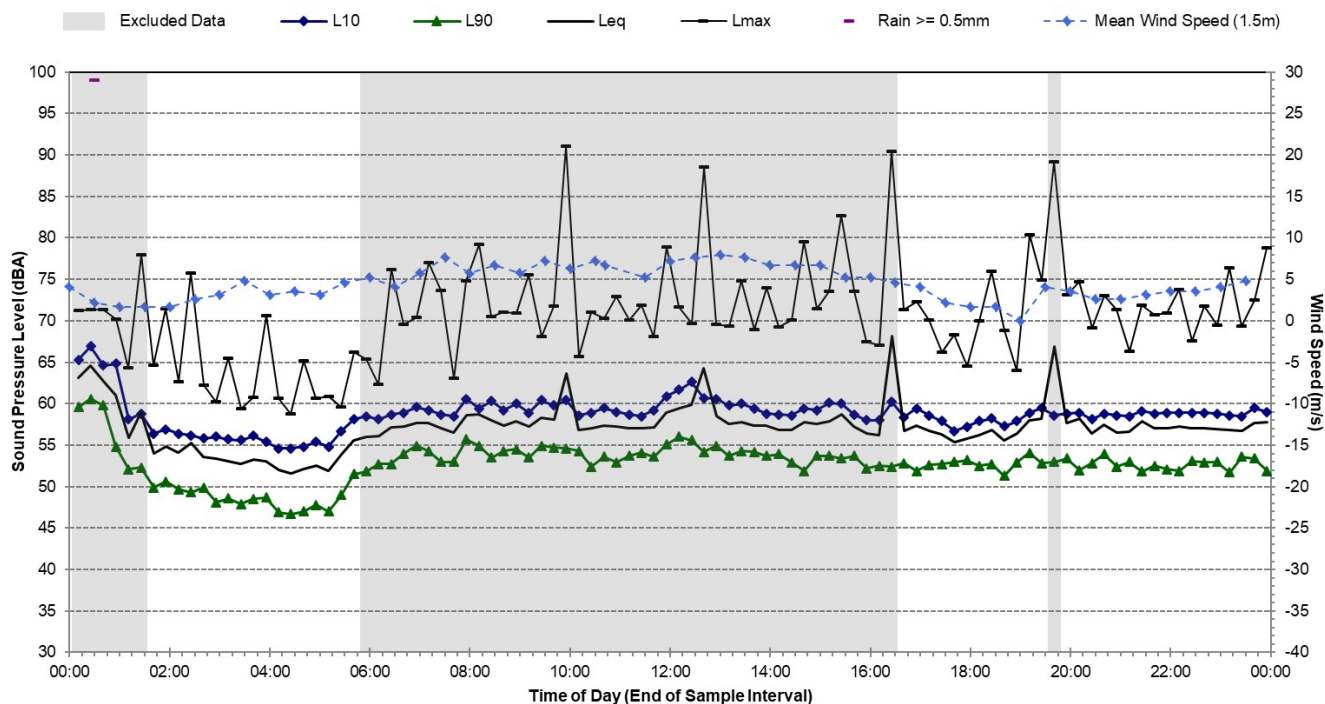
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Friday, 22 July 2016



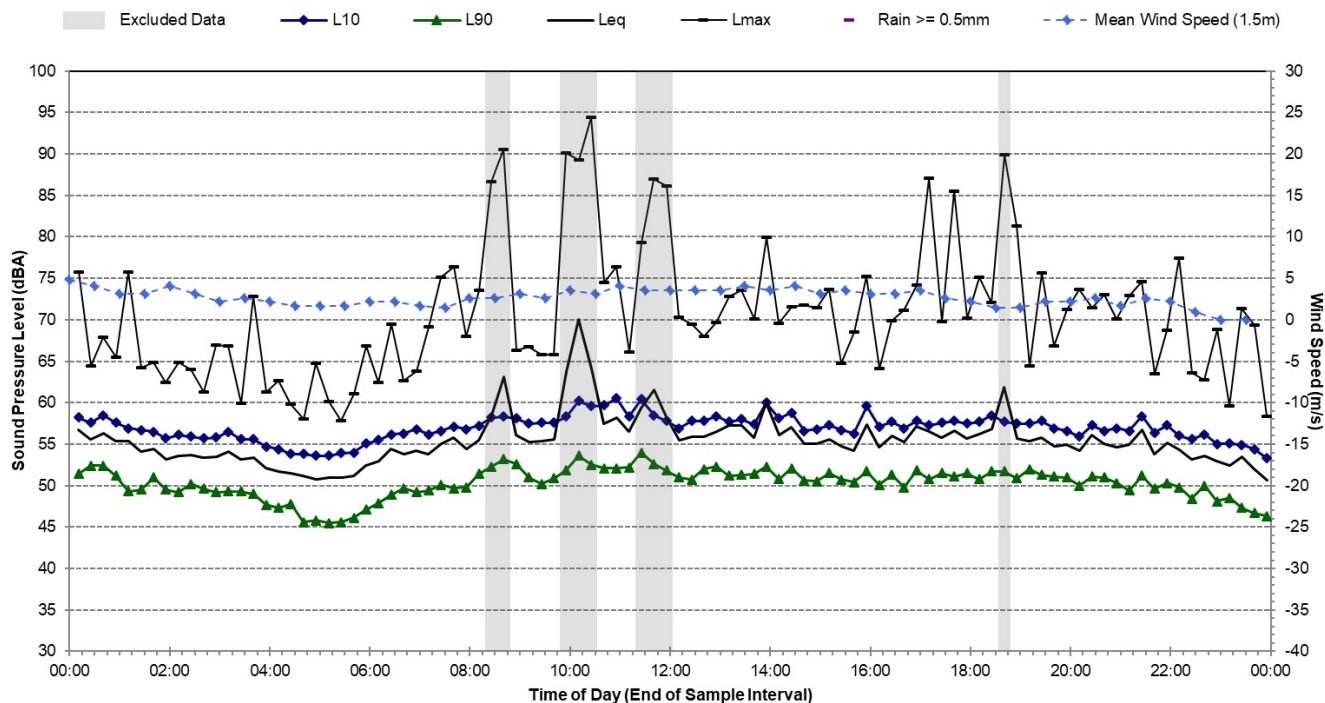
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Saturday, 23 July 2016



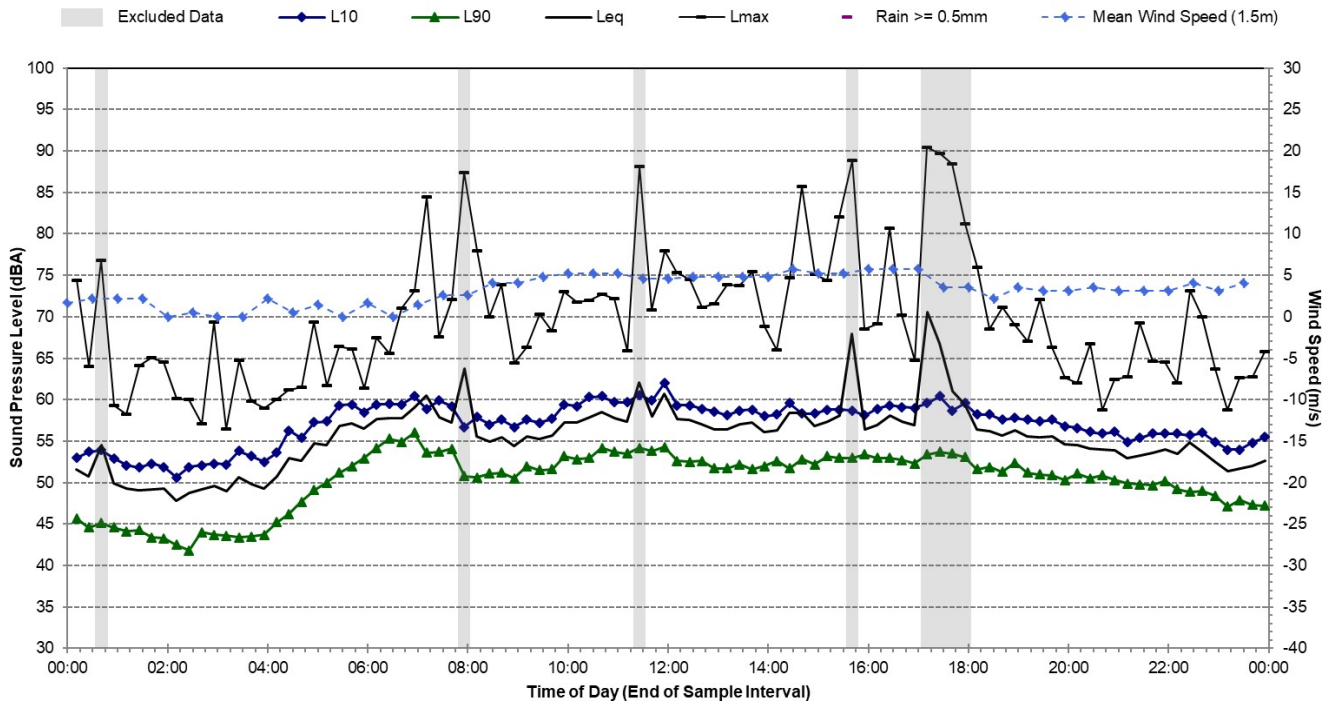
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Sunday, 24 July 2016



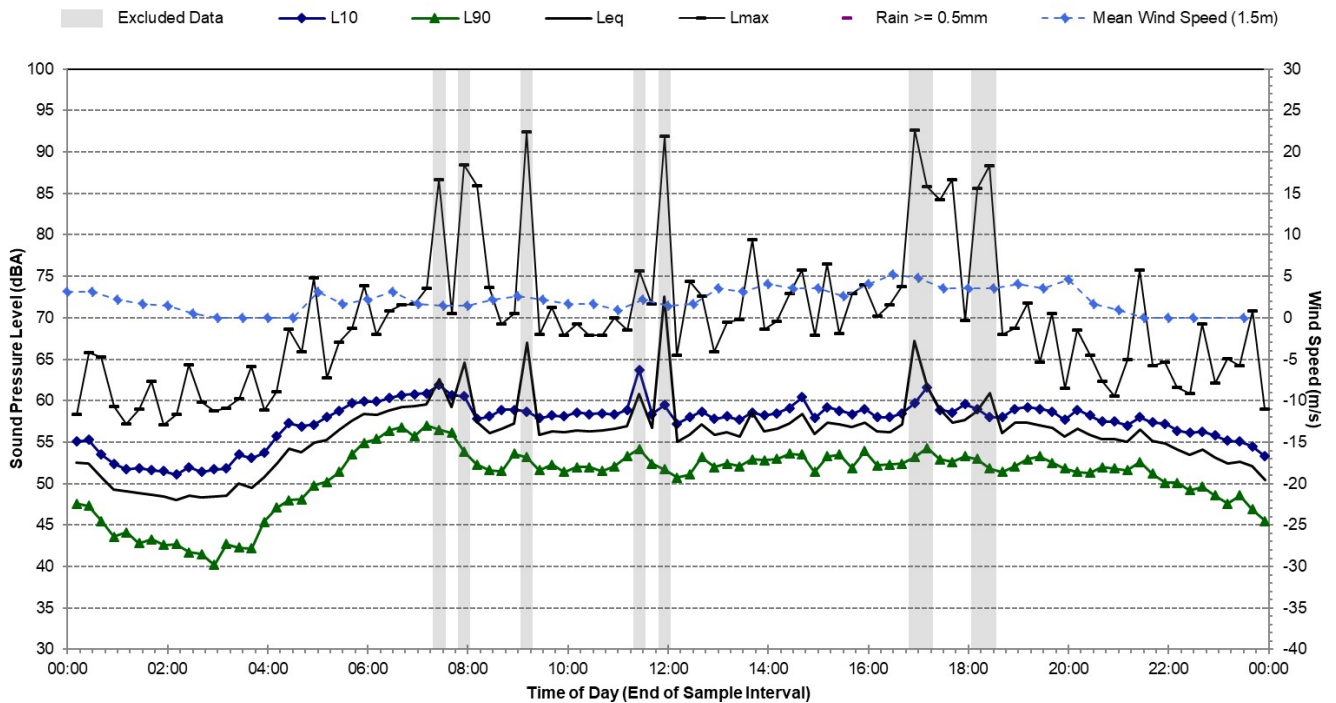
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Monday, 25 July 2016



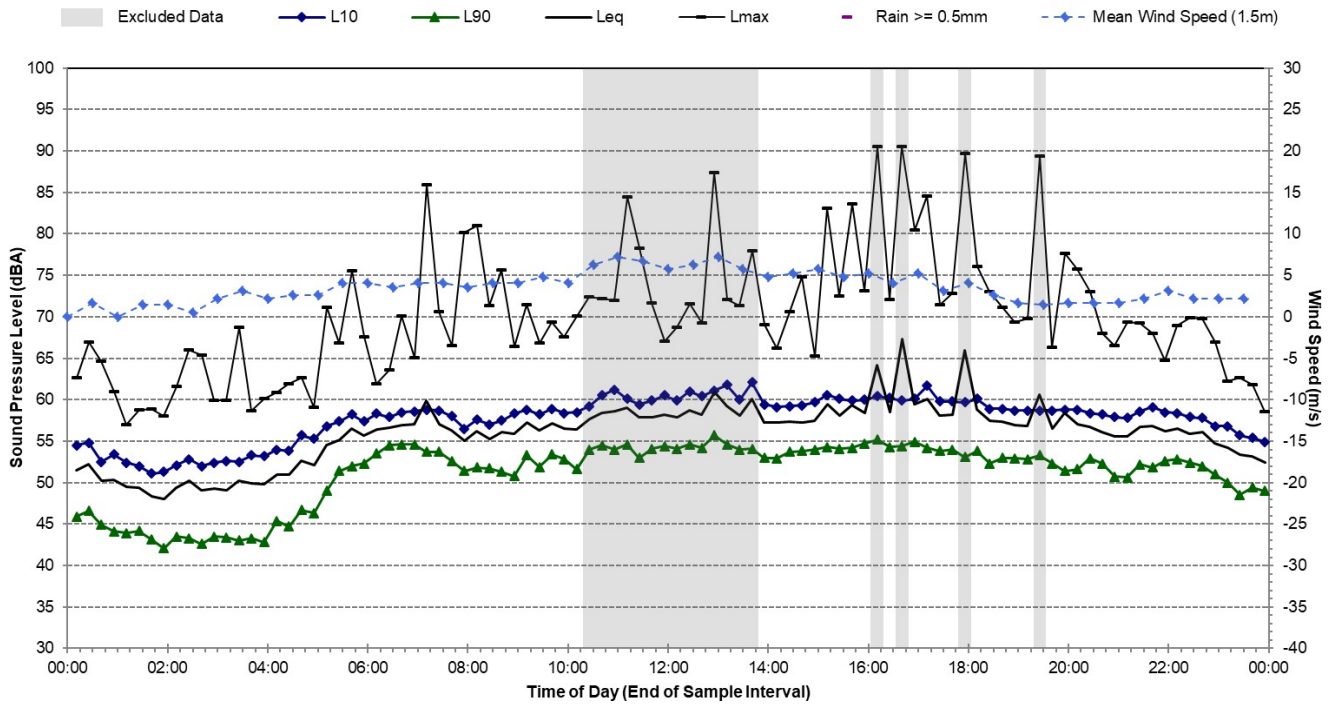
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Tuesday, 26 July 2016



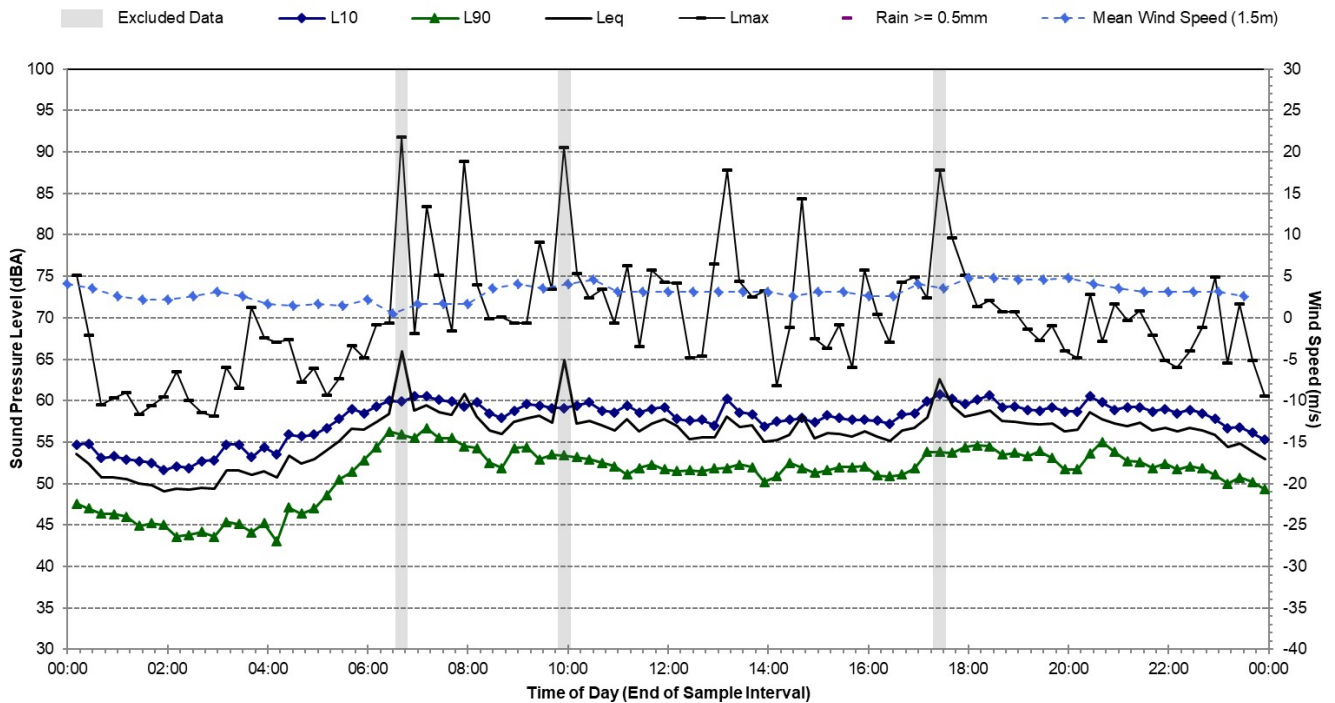
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Wednesday, 27 July 2016



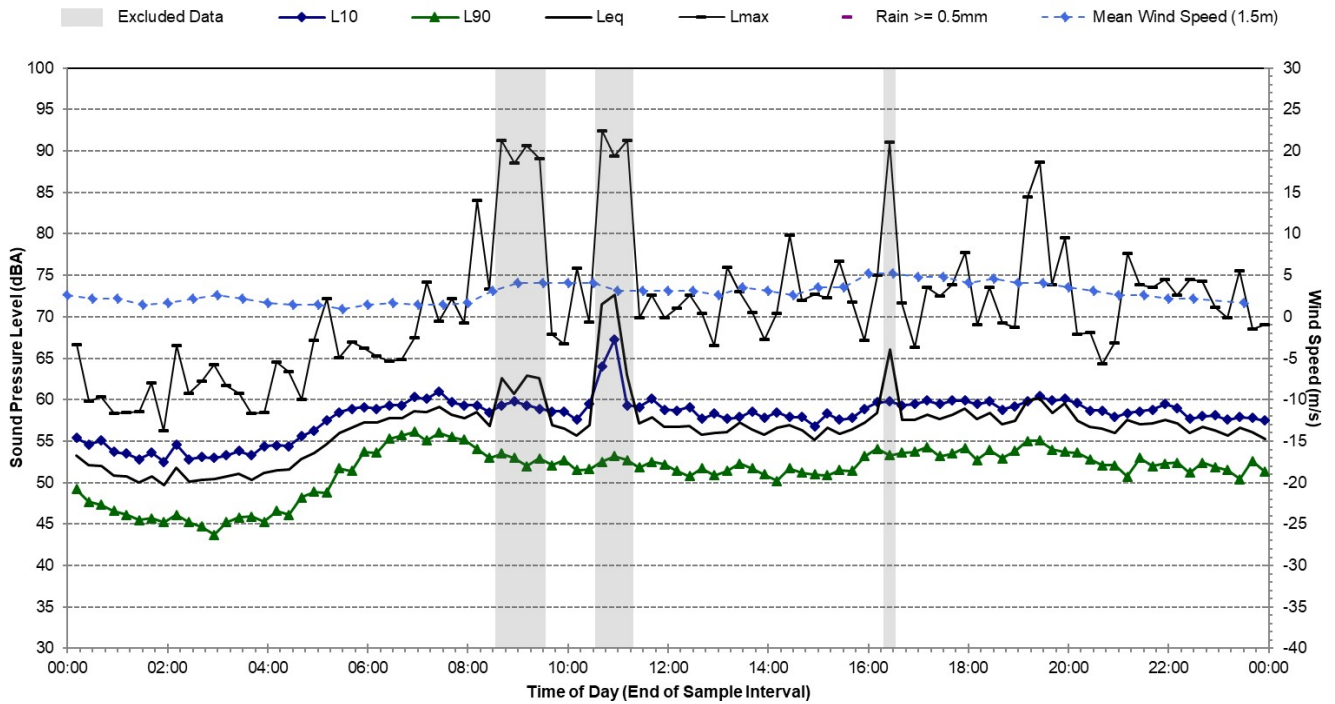
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Thursday, 28 July 2016



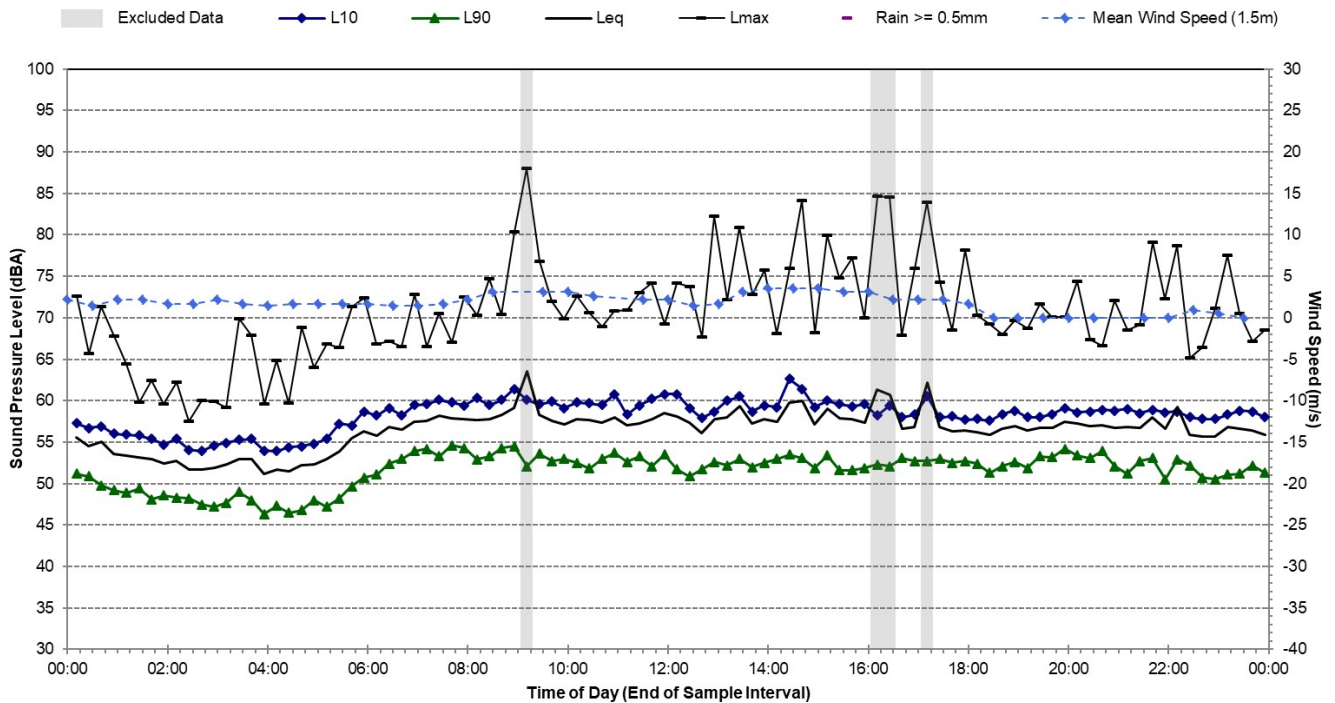
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Friday, 29 July 2016



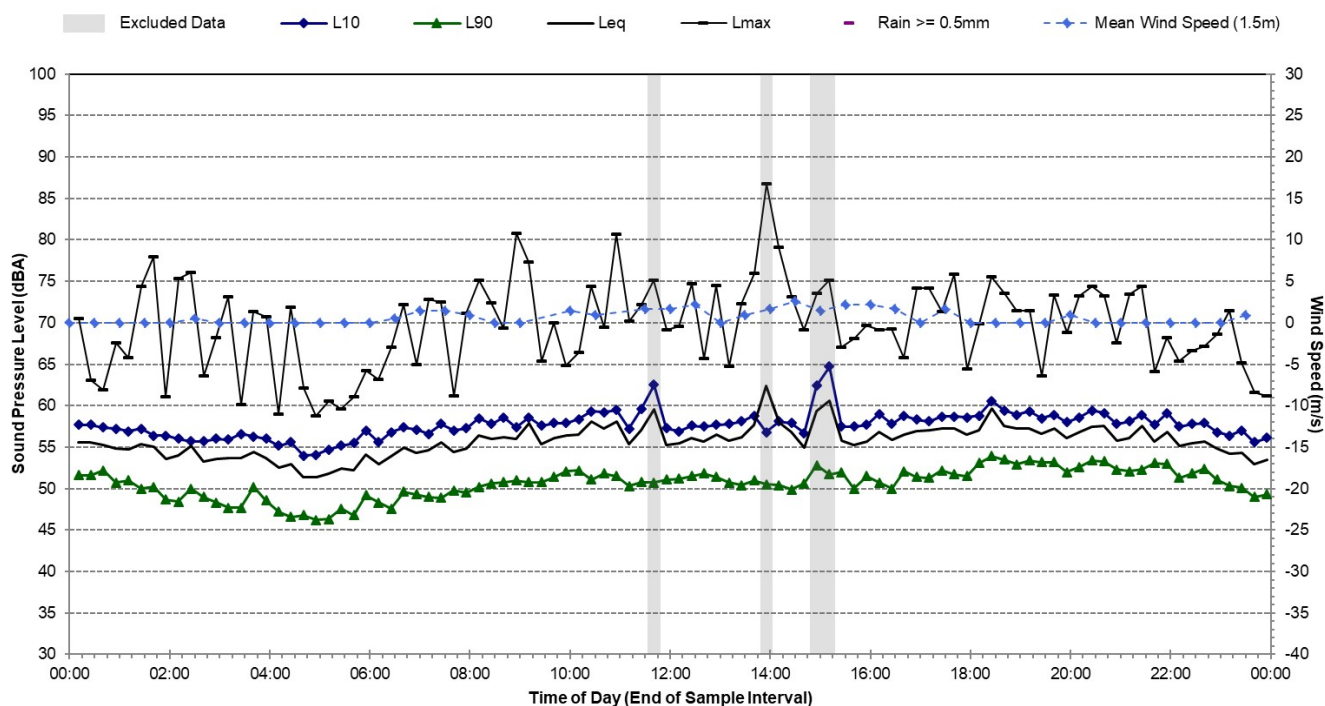
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Saturday, 30 July 2016



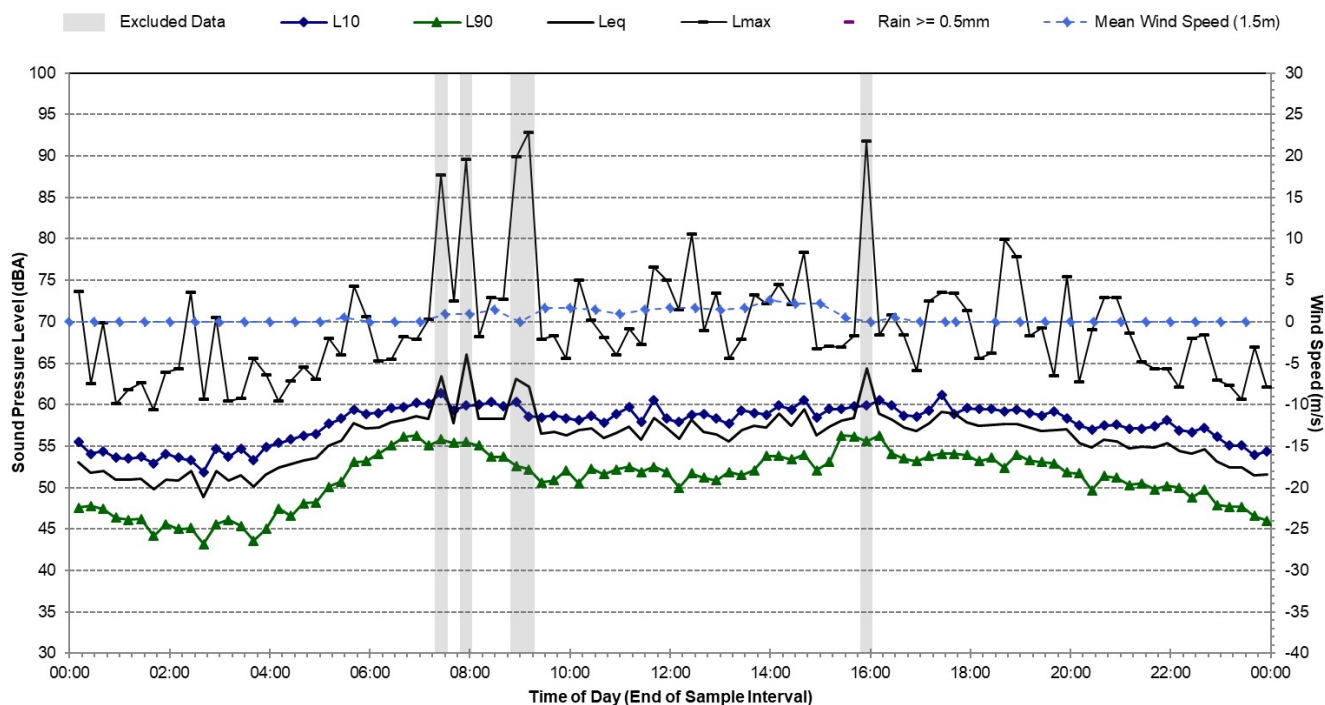
Statistical Ambient Noise Levels

22 Lilyfield Rd, Rozelle - Sunday, 31 July 2016



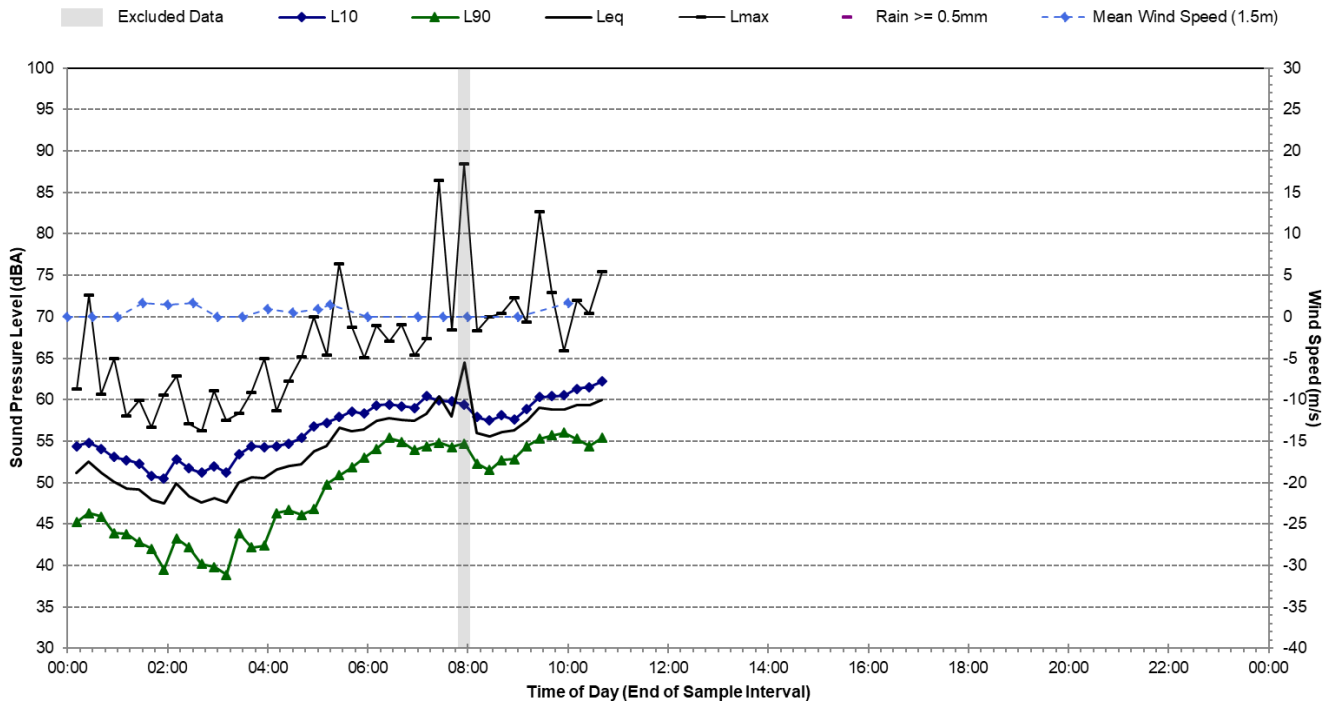
Statistical Ambient Noise Levels



22 Lilyfield Rd, Rozelle - Monday, 1 August 2016



Statistical Ambient Noise Levels

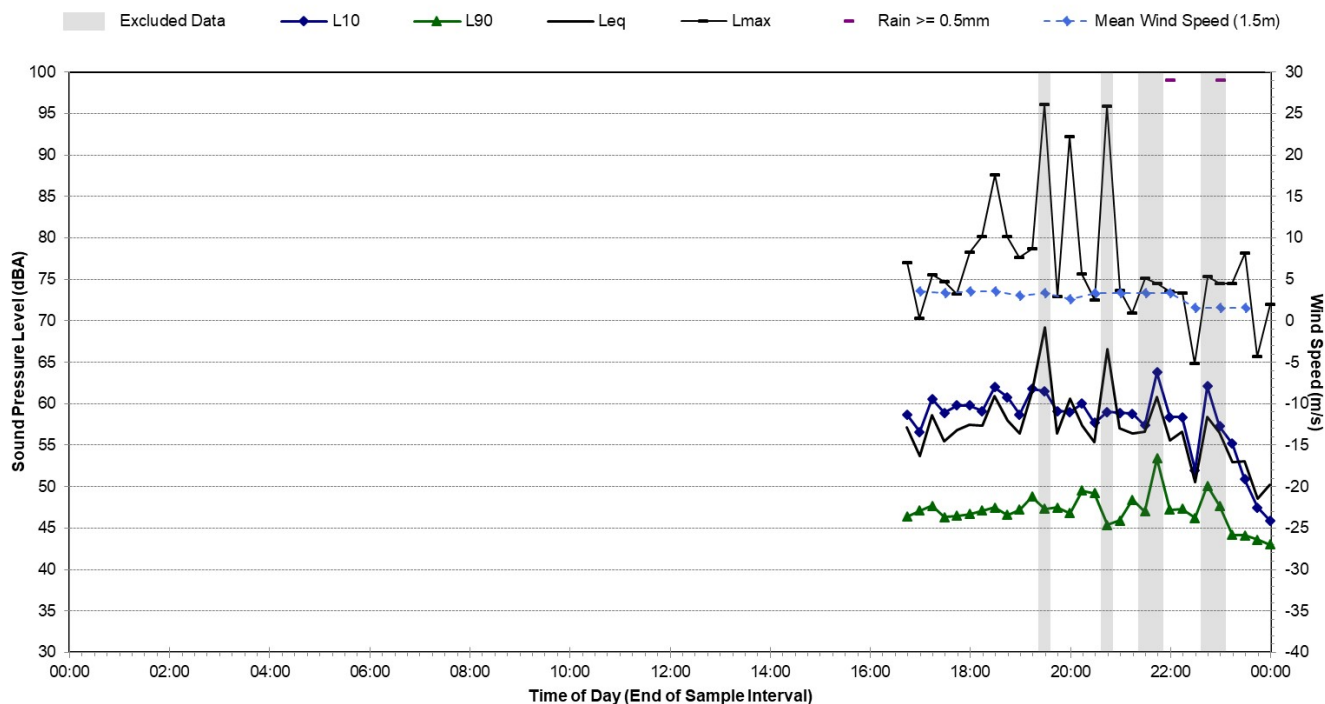
22 Lilyfield Rd, Rozelle - Tuesday, 2 August 2016



Noise Monitoring Location		B.03			Map of Noise Monitoring Location	
Noise Monitoring Address		308 Glebe Point Road, Glebe				
Logger Device Type: SVAN957, Logger Serial No: 20677 Sound Level Meter Device Type: Brüel and Kjær 2260, Sound Level Meter Serial No: 2414604						
Ambient noise logger located at 308 Glebe Point Road, Glebe. Logger located with view of Glebe Point Road to the east and the Western Distributor to the north.						
Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Glebe Point Road. Aircraft noise also contributes to the measured levels.						
Measured noise levels (LAmax): 21/02/2019: Light-vehicle traffic Glebe Point Road: 58-67 dBA, Heavy-vehicle traffic Glebe Point Road: 69-78 dBA, Birds: 50 dBA, Aircraft: 52-68 dBA, Distant traffic Western Distributor:45-50 dBA						
Ambient Noise Logging Results – ICNG Defined Time Periods						
Monitoring Period (21/02/2019 – 08/03/2019)		Noise Level (dBA)				
	RBL	LAeq	L10	L1		
Daytime	48	59	60	69		
Evening	47	58	59	68		
Night-time	39	51	48	60		
Ambient Noise Logging Results – RNP Defined Time Periods						
Monitoring Period (21/02/2019 – 08/03/2019)		Noise Level (dBA)				
	LAeq(period)		LAeq(1hour)			
Daytime (7am-10pm)	58		61			
Night-time (10pm-7am)	52		61			
Attended Noise Measurement Results						
Date	Start Time	Measured Noise Level (dBA)				
		LA90	LAeq	LAmax		
21/02/2019	15:20	47	57	78		

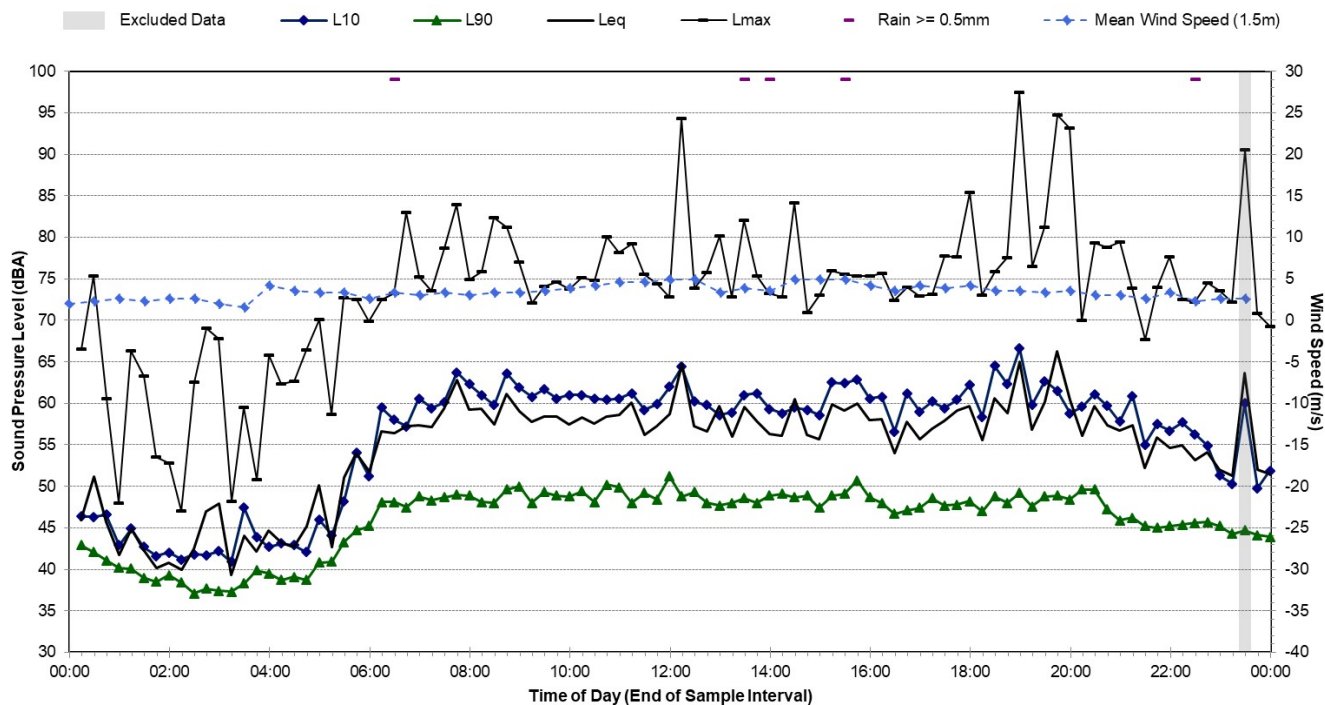
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Thursday, 21 February 2019



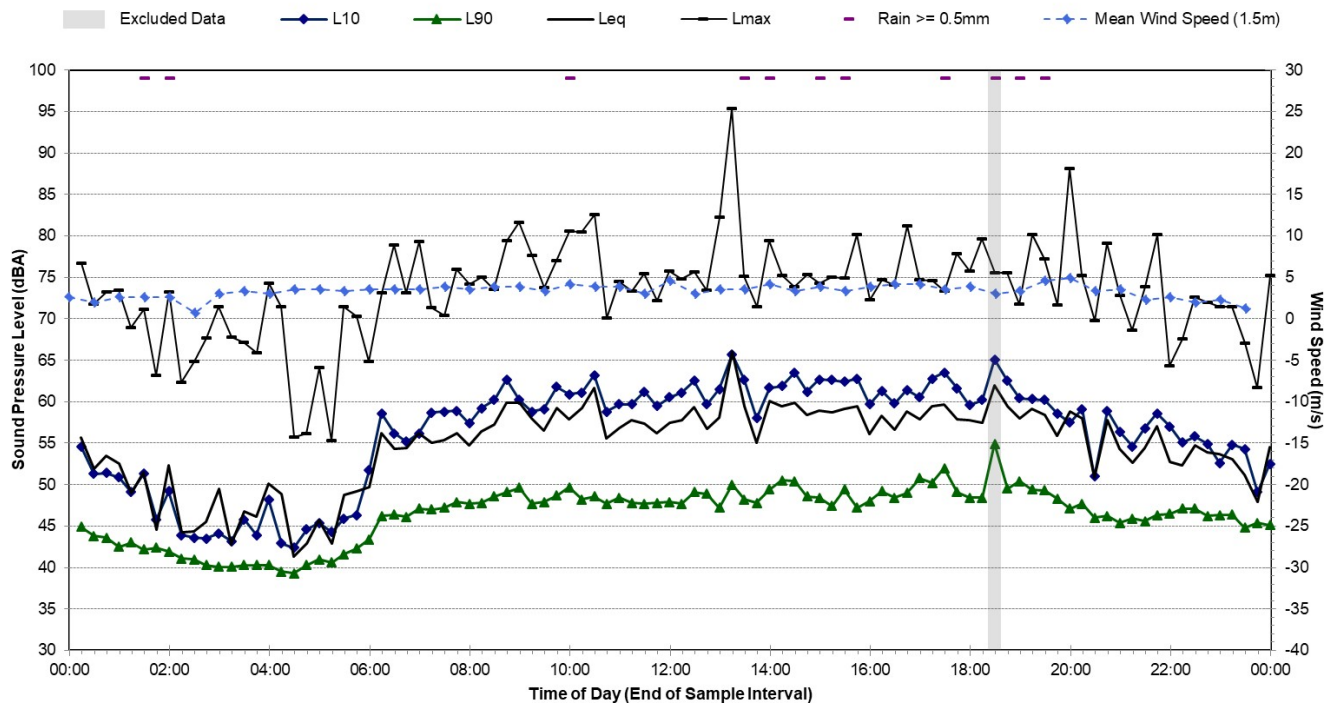
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Friday, 22 February 2019



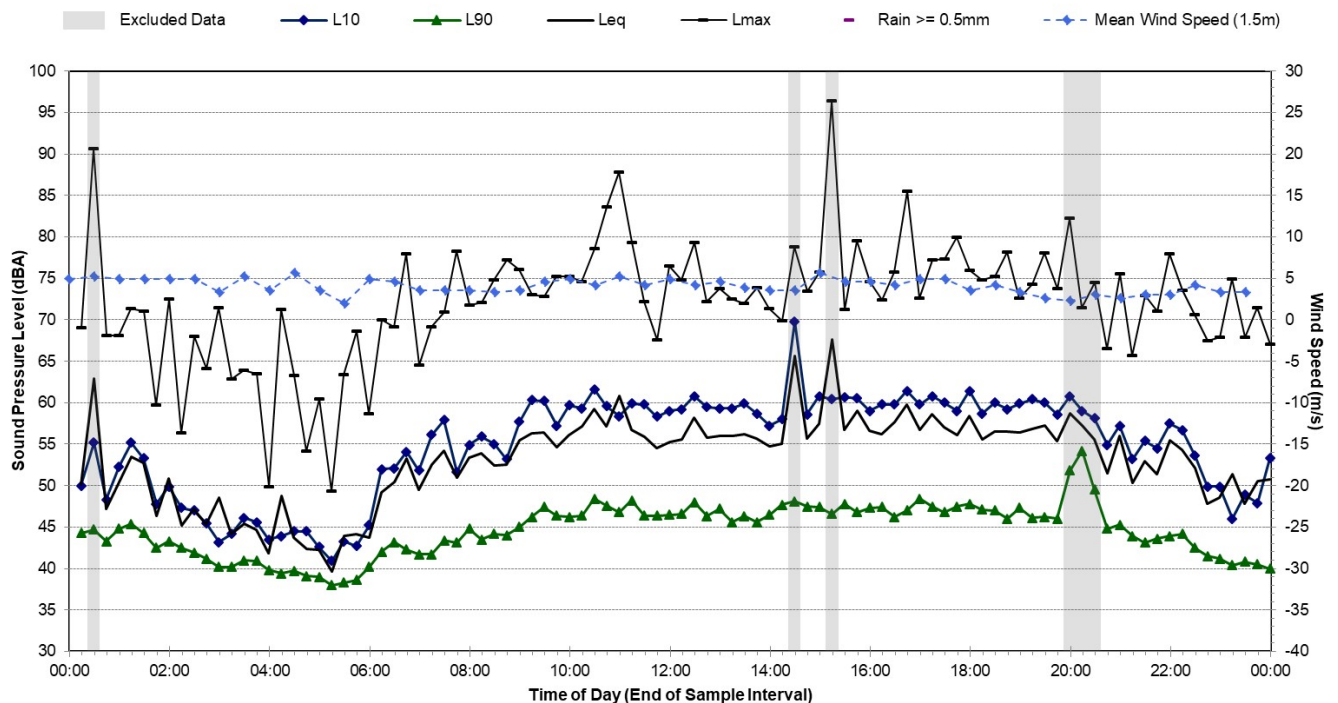
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Saturday, 23 February 2019



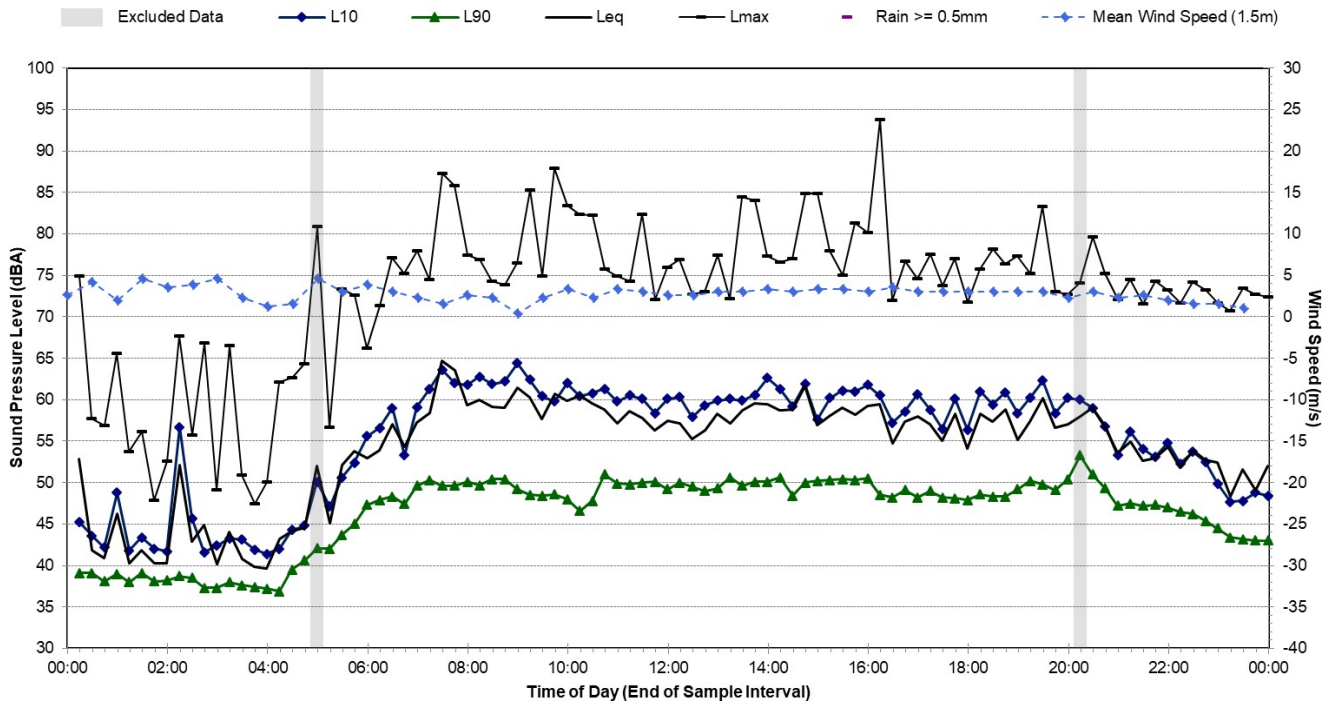
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Sunday, 24 February 2019



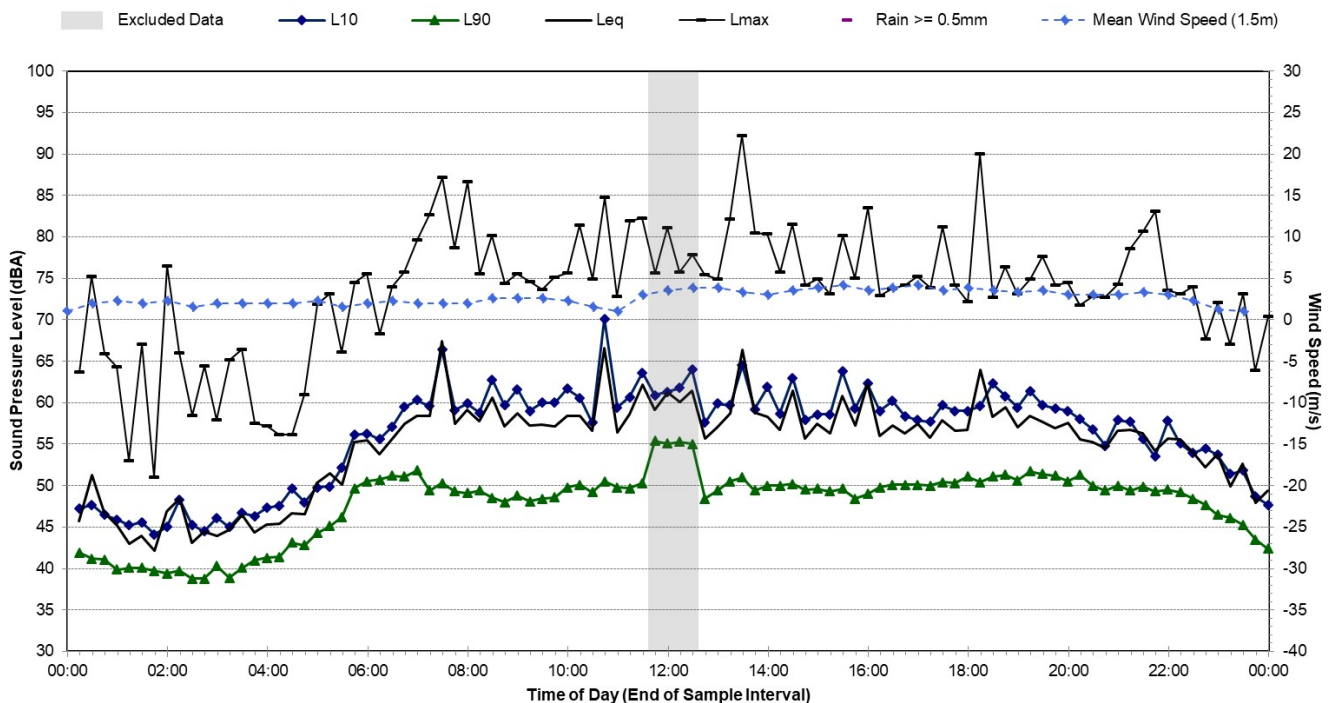
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Monday, 25 February 2019



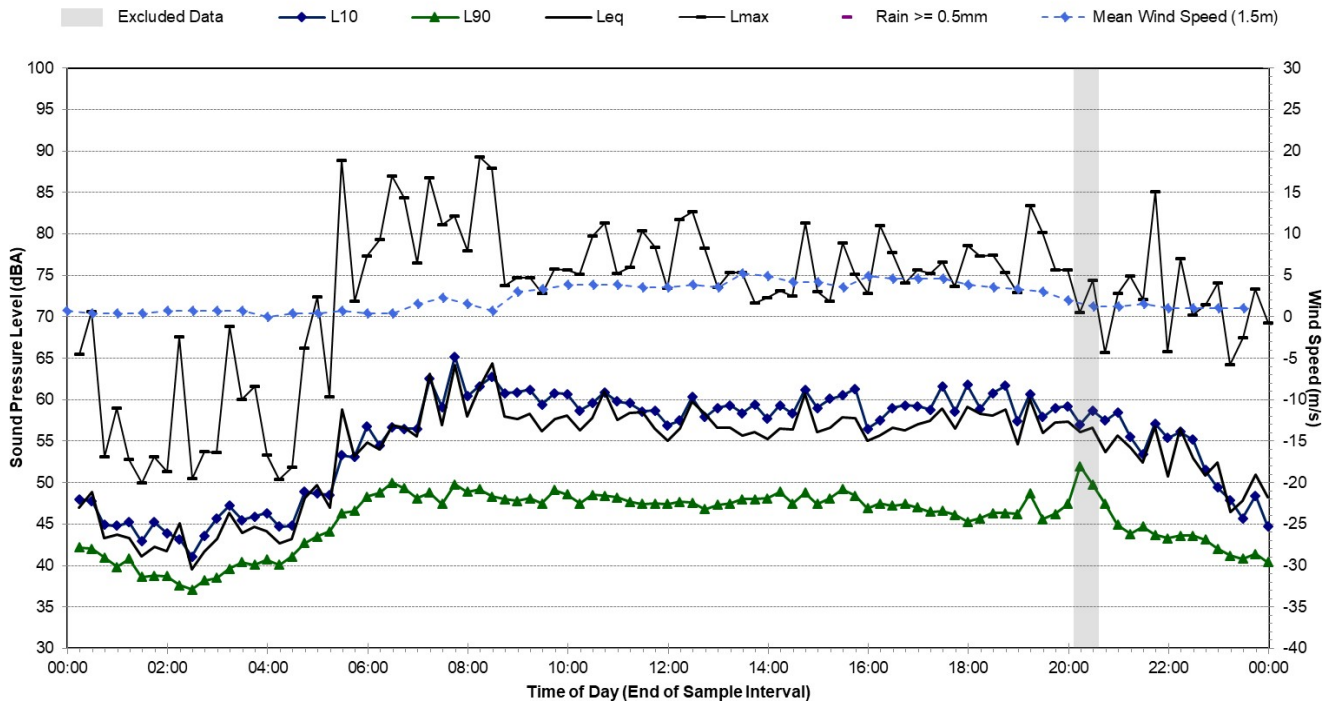
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Tuesday, 26 February 2019



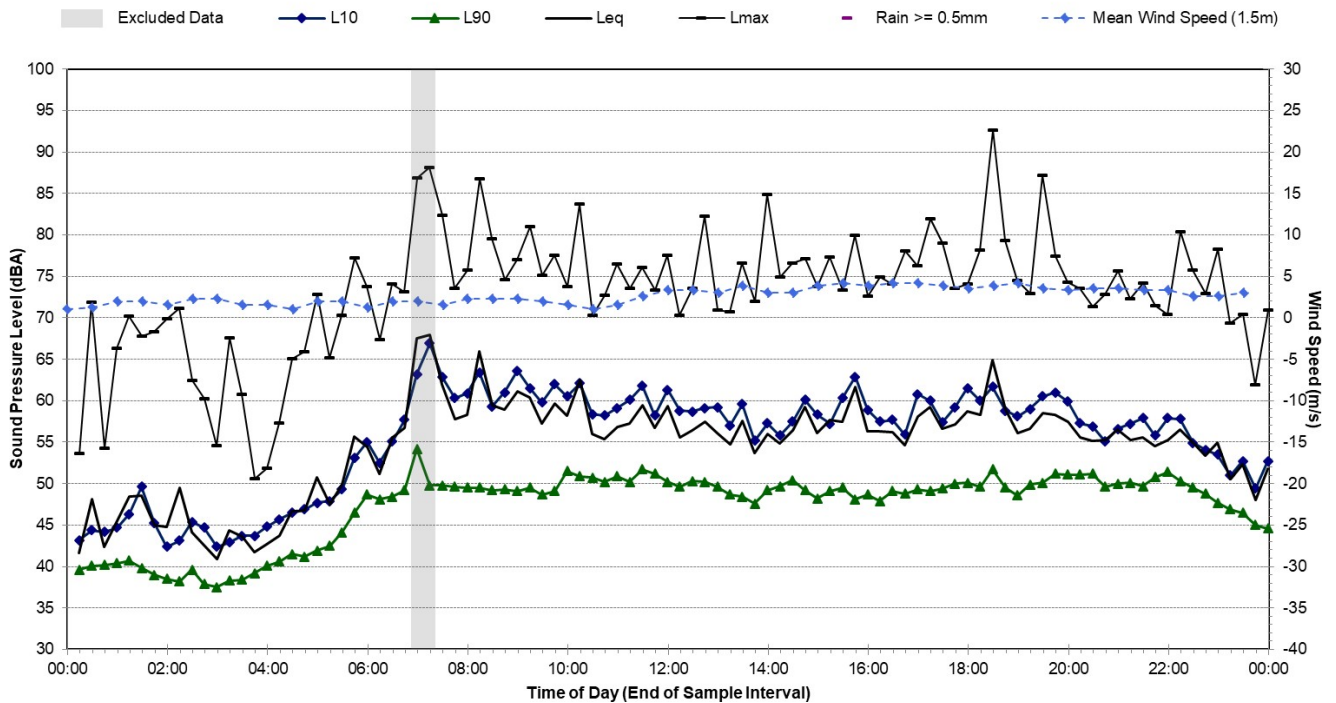
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Wednesday, 27 February 2019



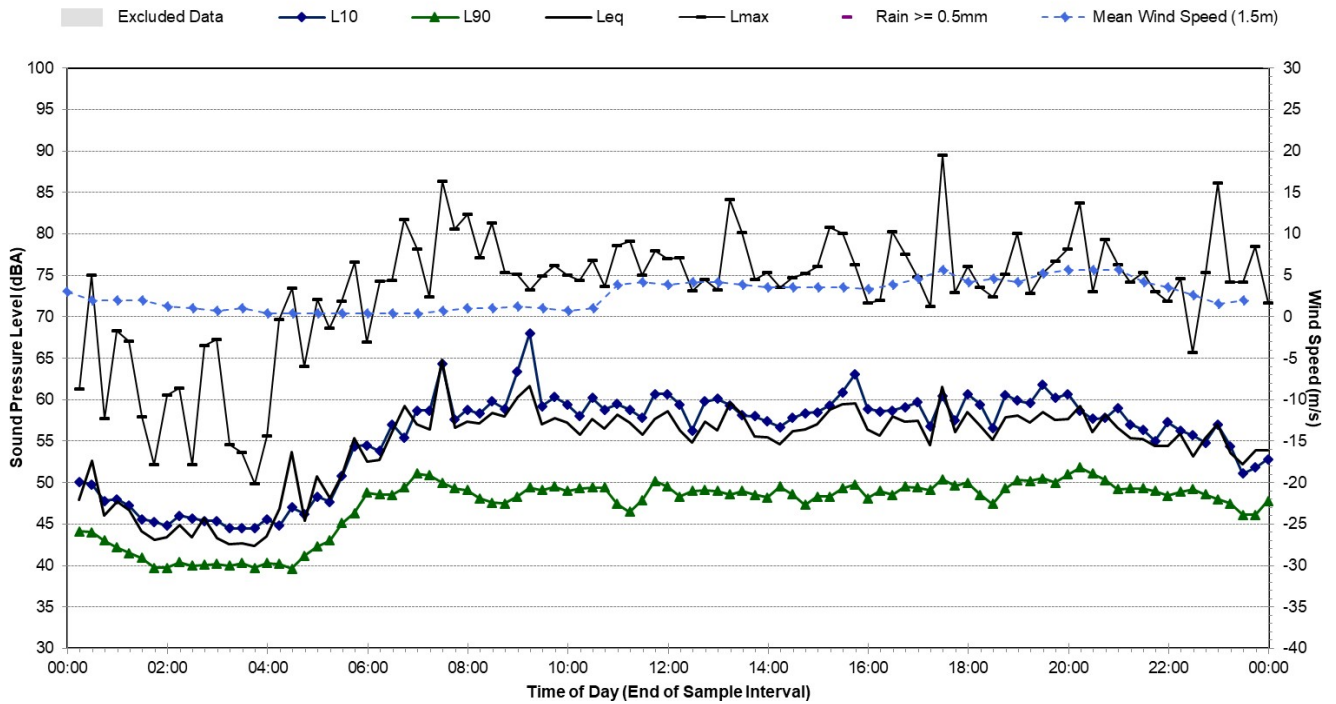
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Thursday, 28 February 2019



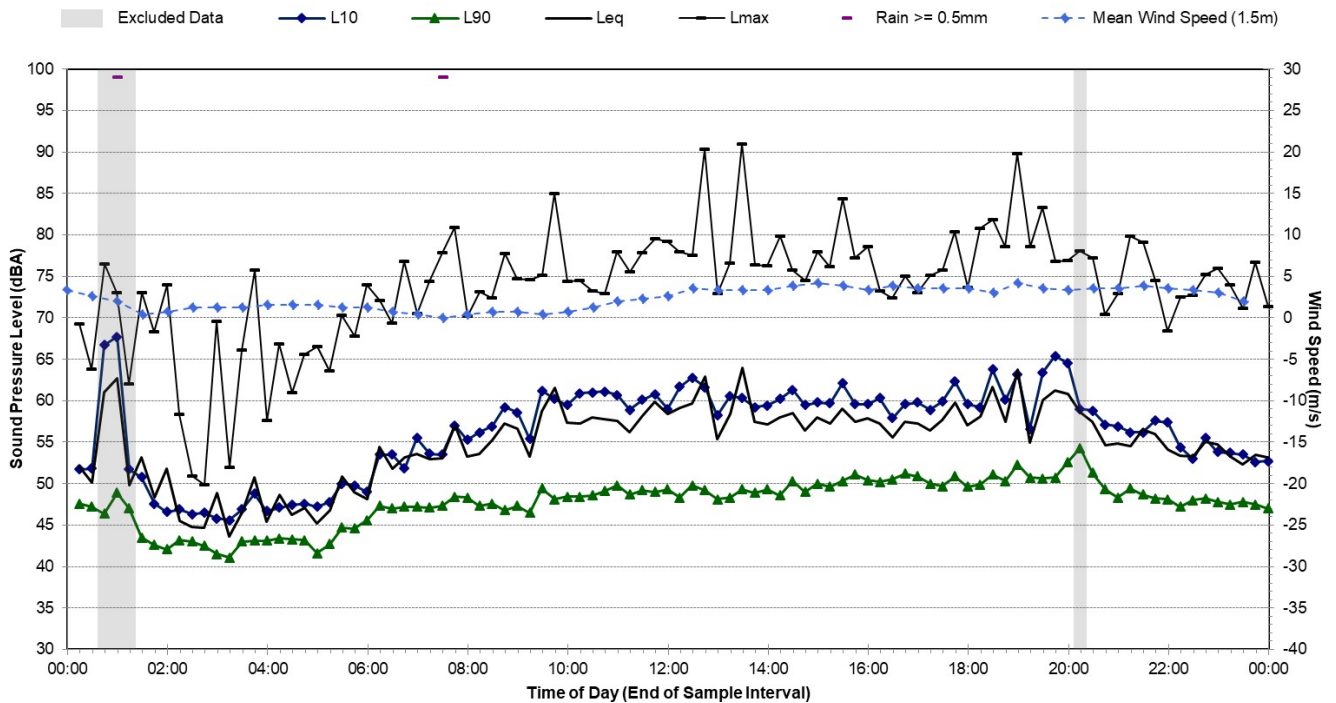
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Friday, 1 March 2019



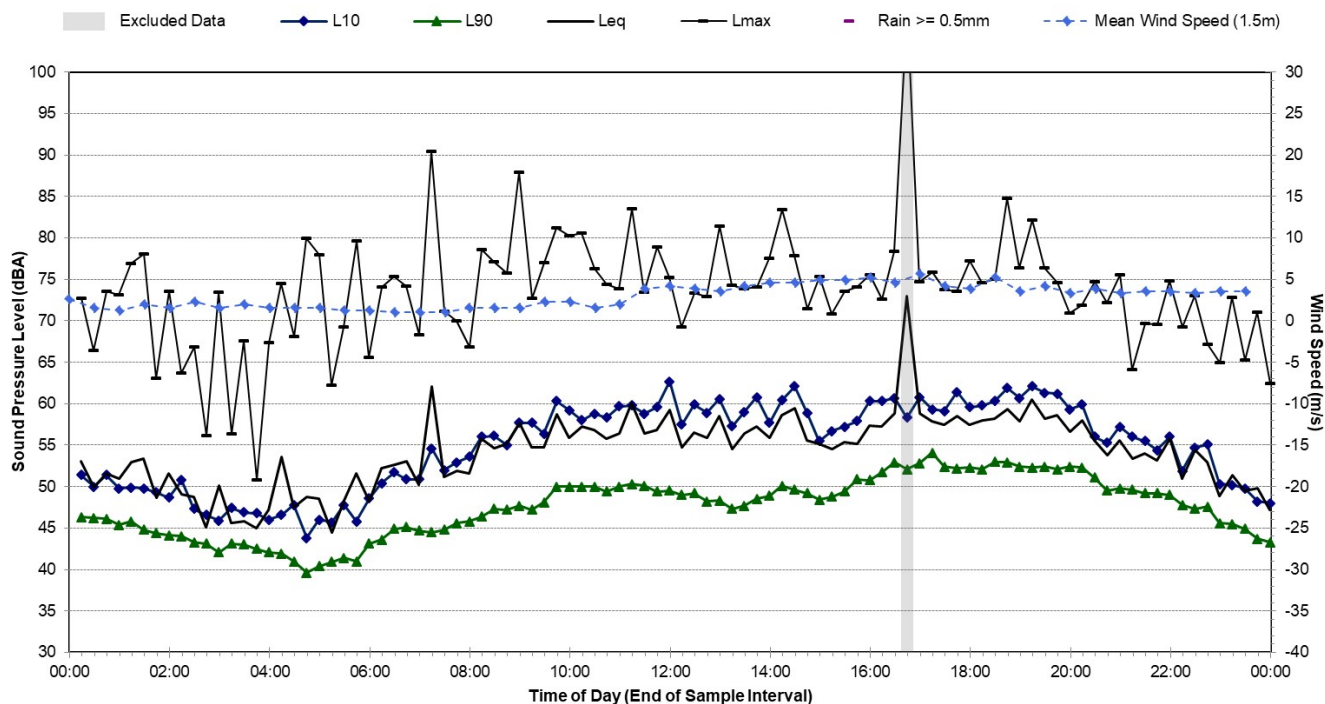
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Saturday, 2 March 2019



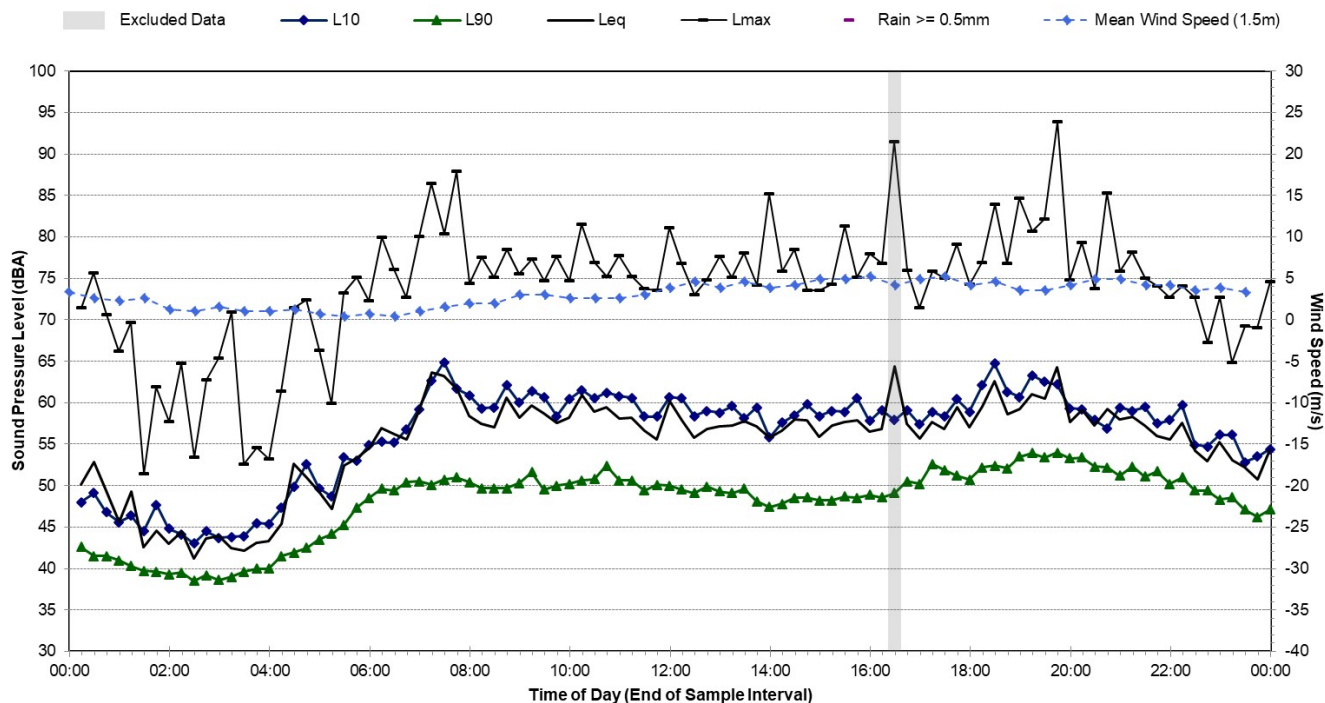
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Sunday, 3 March 2019



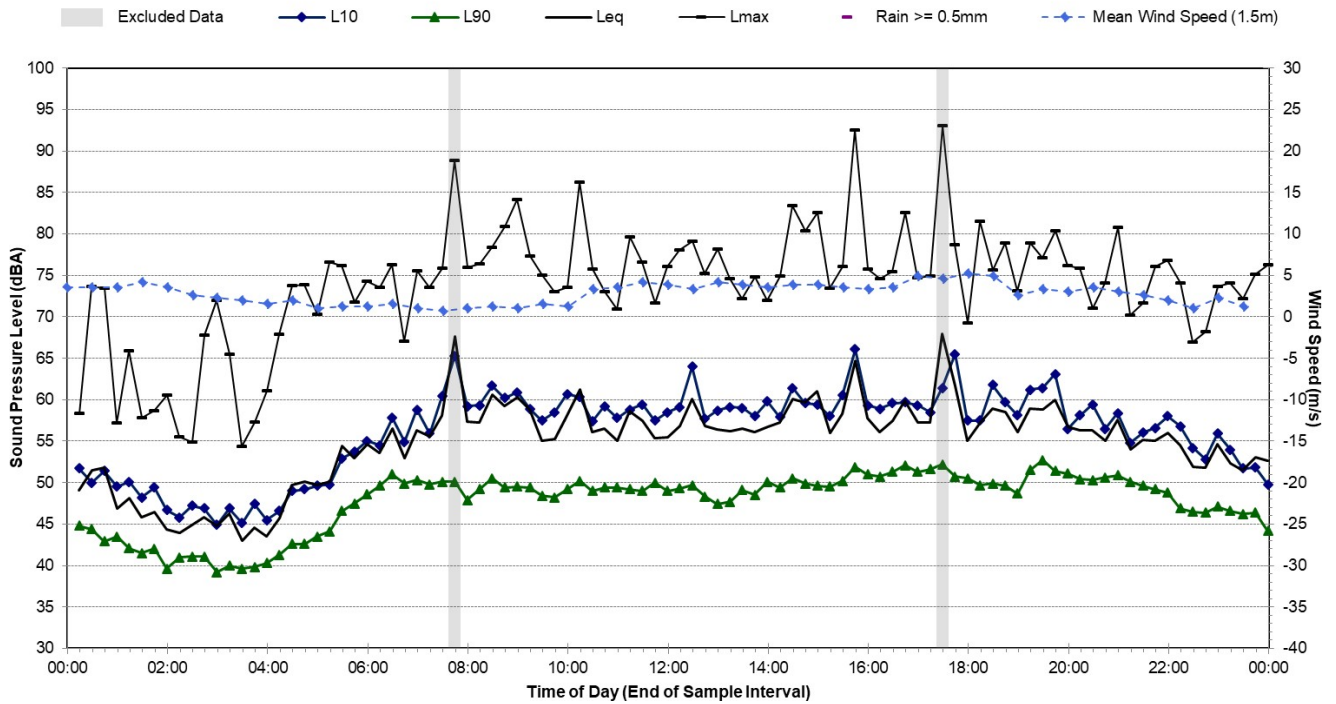
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Monday, 4 March 2019



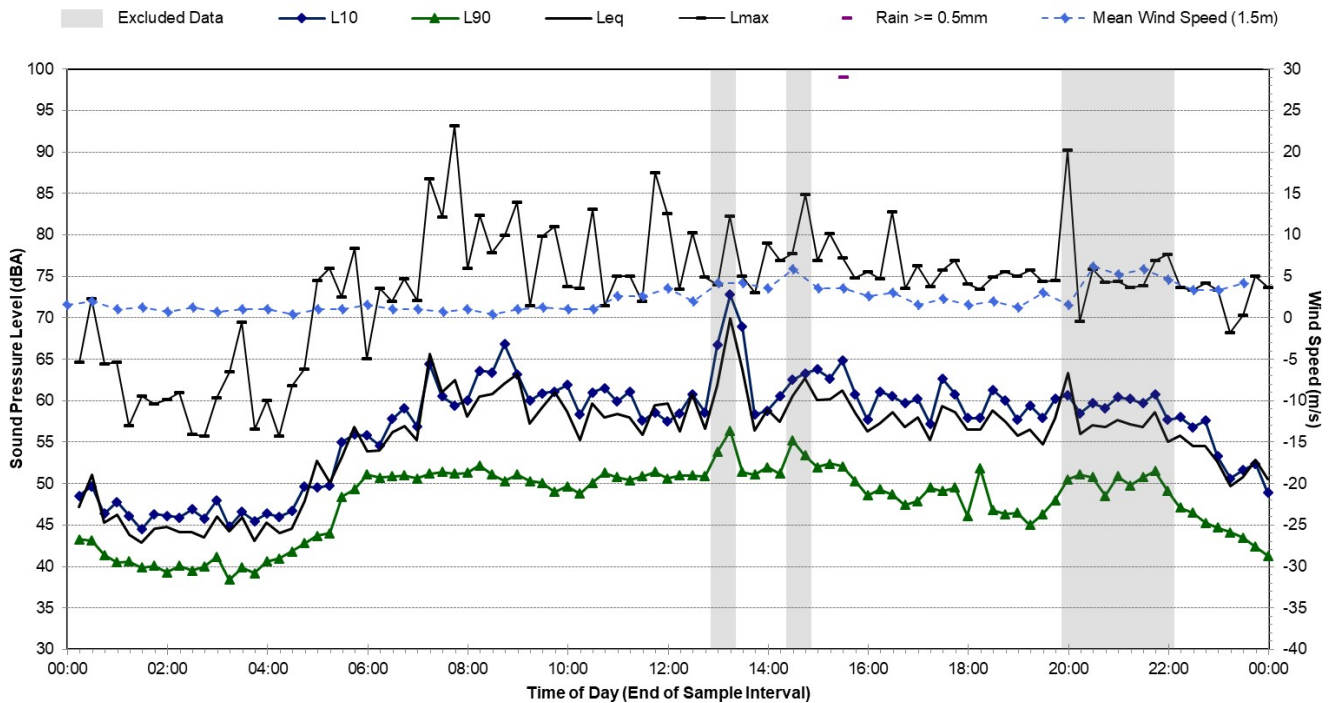
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Tuesday, 5 March 2019



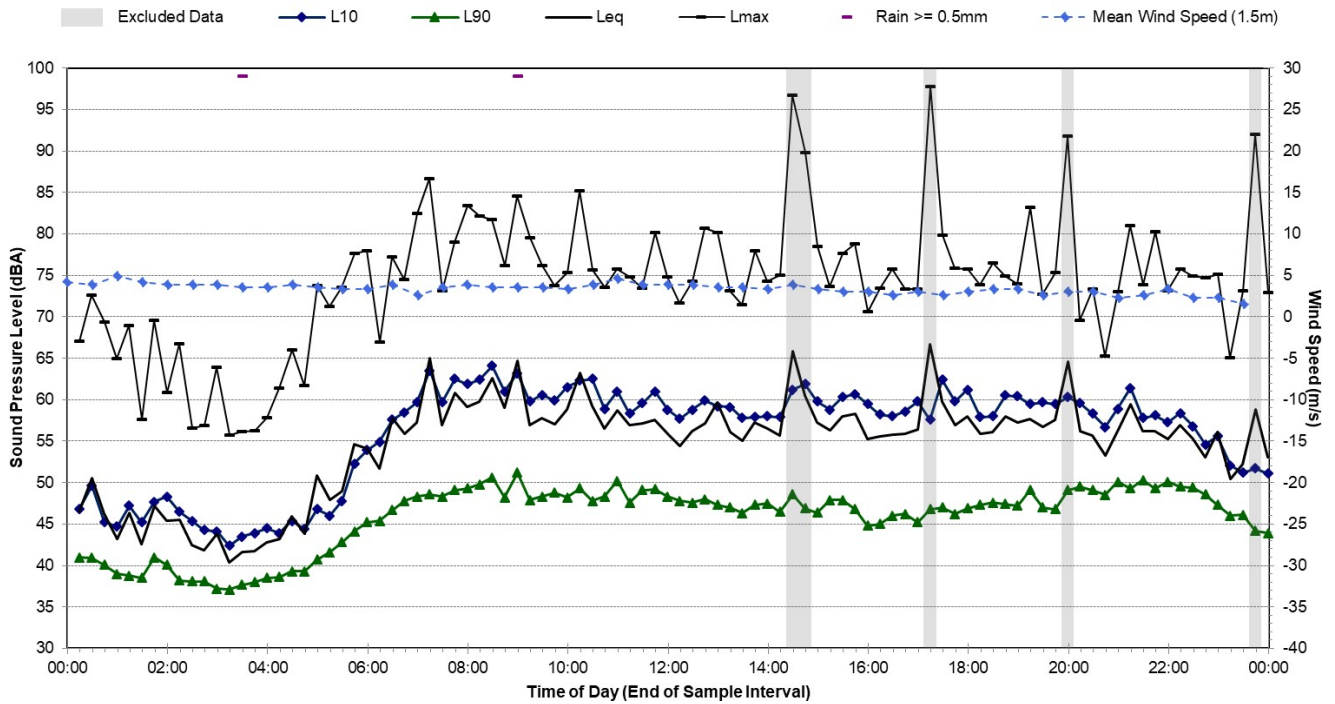
Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Wednesday, 6 March 2019



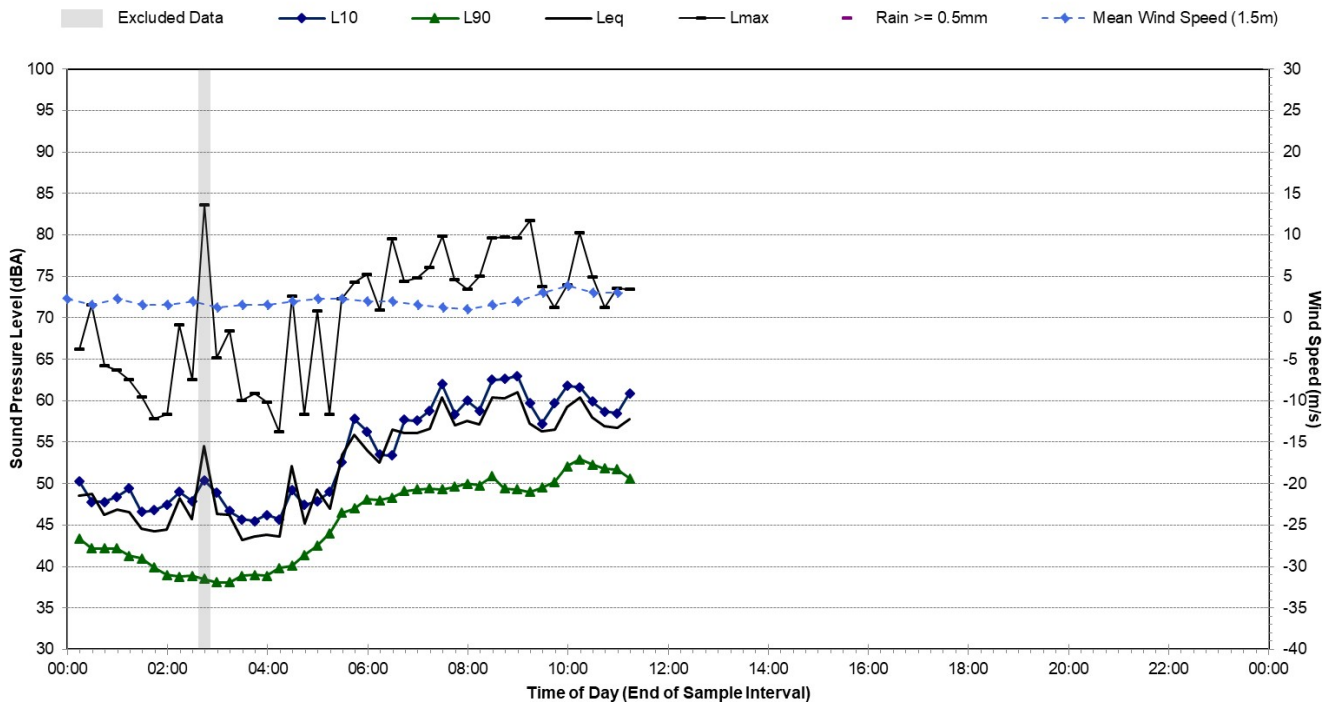
Statistical Ambient Noise Levels



308 Glebe Point Rd, Glebe - Thursday, 7 March 2019



Statistical Ambient Noise Levels

308 Glebe Point Rd, Glebe - Friday, 8 March 2019

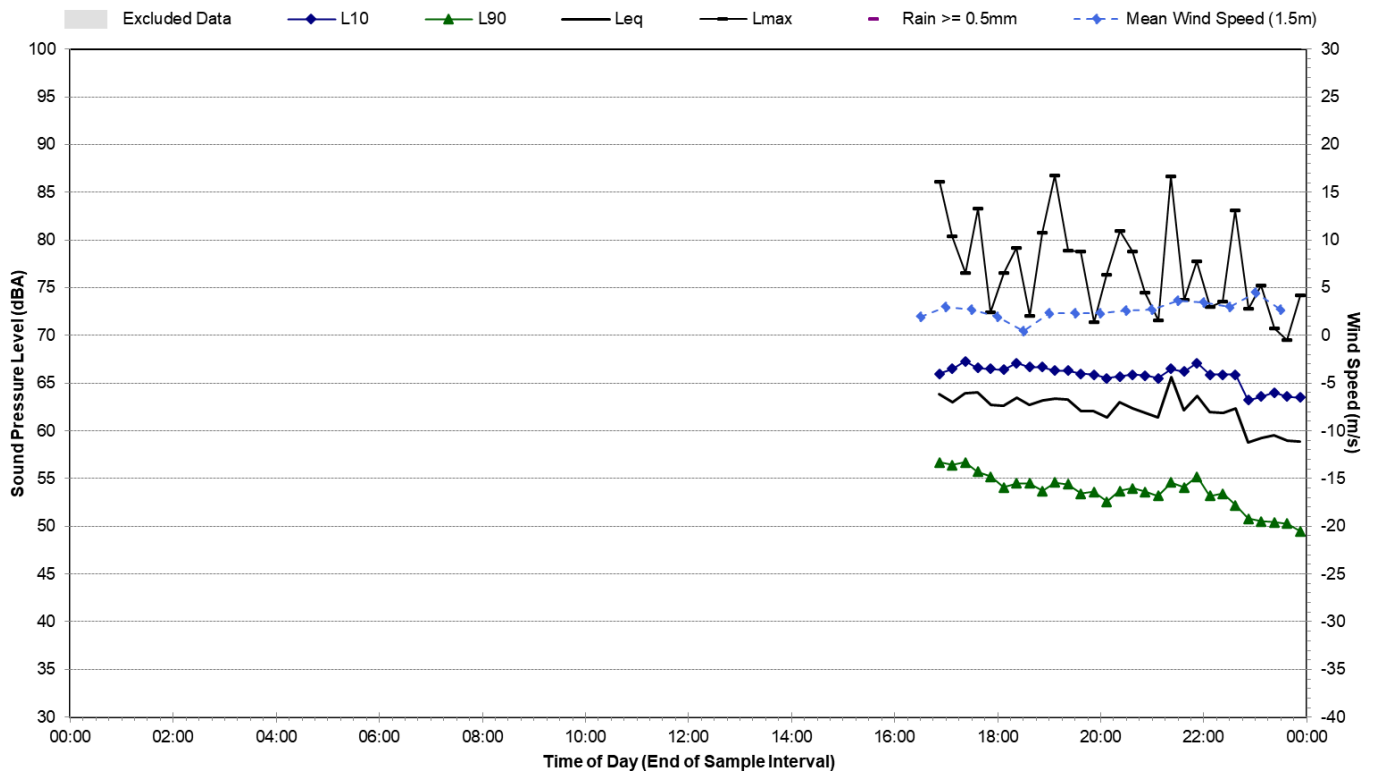


Noise Monitoring Location		B.04				Map of Noise Monitoring Location / Photo of Noise Monitoring Location		
Noise Monitoring Address		200 Paternoster Row, Pyrmont						
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3008204								
Attended noise monitoring conducted at 200 Paternoster Row, Pyrmont. Sound level meter located with view of Pyrmont Bridge Road to the south.								
Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pyrmont Bridge Road.								
Measured noise levels (LAmax): Light-vehicle traffic Pyrmont Bridge Road: 54-64 dBA, Heavy-vehicle traffic Pyrmont Bridge Road: 60-70 dBA, Birds: 55-70 dBA, Aircraft: 52-68 dBA,								
Attended Noise Measurement Results								
Date	ICNG Defined Time Period	Start Time	Measured Noise Level (dBA)					
			LA90	LAeq	LAmax			
02/05/2021	Day	07:00	50	57	74			
02/05/2021	Day	07:16	50	56	76			
02/05/2021	Day	07:31	50	59	82			
02/05/2021	Day	07:48	50	55	72			
05/07/2021	Eve	21:00	47	51	68			
05/07/2021	Eve	21:16	47	51	68			
05/07/2021	Eve	21:31	47	50	62			
05/07/2021	Eve	21:47	47	51	70			
06/07/2021	Night	02:00	45	47	63			
06/07/2021	Night	02:15	45	47	64			
06/07/2021	Night	02:31	45	47	69			
06/07/2021	Night	02:46	45	47	59			
06/07/2021	Day	07:00	50	57	77			
06/07/2021	Day	07:15	50	56	70			
06/07/2021	Day	07:31	50	55	76			
06/07/2021	Day	07:46	50	55	69			
06/07/2021	Eve	21:00	47	52	69			
06/07/2021	Eve	21:16	47	56	82			
06/07/2021	Eve	21:31	47	53	76			
06/07/2021	Eve	21:47	48	59	80			
07/07/2021	Night	02:00	45	46	56			
07/07/2021	Night	02:15	45	47	60			
07/07/2021	Night	02:31	45	63	84			
07/07/2021	Night	02:46	46	48	62			

Noise Monitoring Location		B.05			Map of Noise Monitoring Location	
Noise Monitoring Address		1-5 Harwood Place, Pyrmont				
Logger Device Type: SVAN957, Logger Serial No: 20644						
Sound Level Meter Device Type: Brüel and Kjær 2270, Sound Level Meter Serial No: 3008204						
Ambient noise logger located at 1-5 Harwood Place, Pyrmont. Logger located on balcony with view of Pyrmont Bridge Road to the north.						
Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Pyrmont Bridge Road.						
Measured noise levels (LAm _{ax}):						
25/06/2021: Light-vehicle traffic Pyrmont Bridge Road: 66-70 dBA, Heavy-vehicle traffic Glebe Point Road: 69-73 dBA, Birds: 50-70 dBA, Distant intermittent construction: 50-55 dBA						
Ambient Noise Logging Results – ICNG Defined Time Periods						Photo of Noise Monitoring Location
Monitoring Period (21/02/2019 – 08/03/2019)		Noise Level (dBA)				
		RBL	LA _{eq}	L ₁₀	L ₁	
Daytime		52	61	65	70	
Evening		49	59	62	68	
Night-time		46	56	57	66	
Ambient Noise Logging Results – RNP Defined Time Periods						
Monitoring Period (21/02/2019 – 08/03/2019)		Noise Level (dBA)				
		LA _{eq} (period)		LA _{eq} (1hour)		
Daytime (7am-10pm)		61		52		
Night-time (10pm-7am)		57		69		
Attended Noise Measurement Results						
Date	Start Time	Measured Noise Level (dBA)				
		LA ₉₀	LA _{eq}	LAm _{ax}		
25/06/2021	16:35	55	62	75		

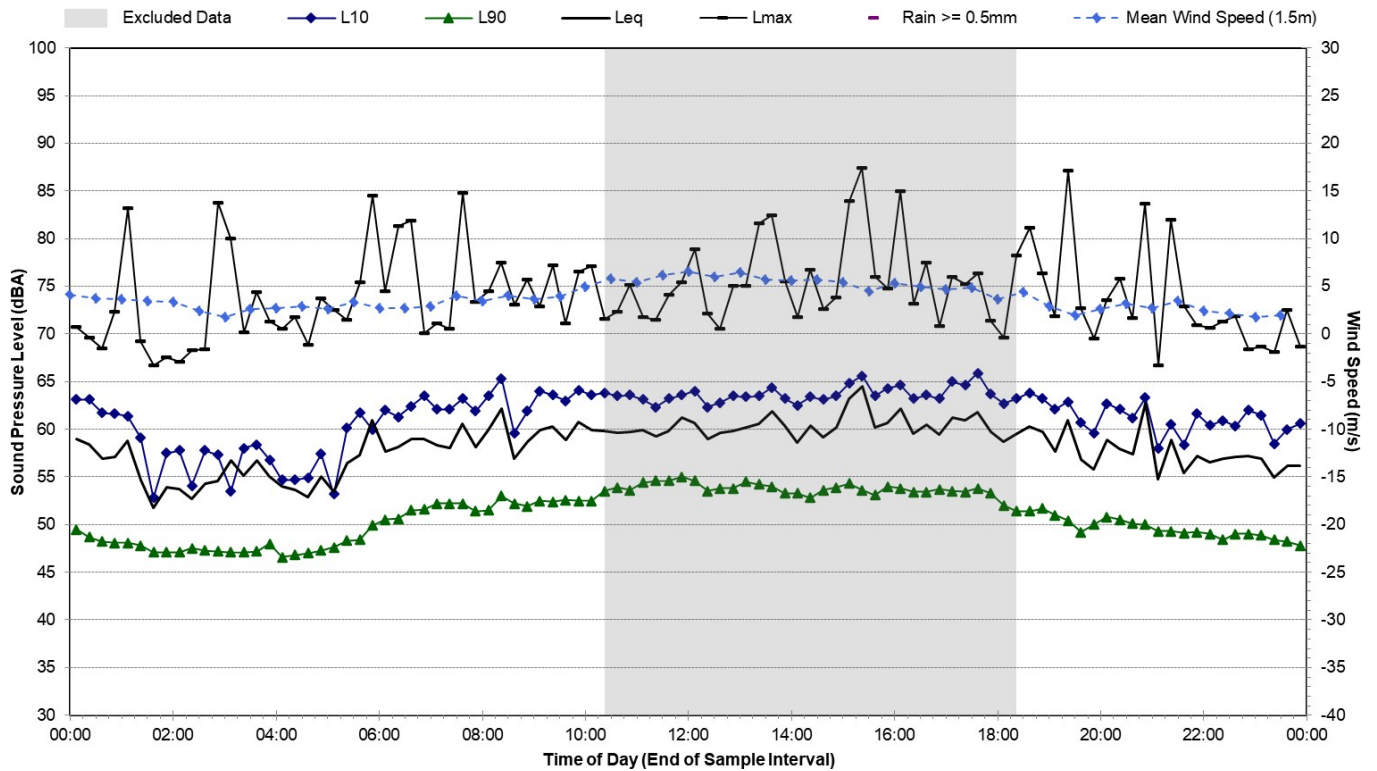
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Friday, 25 June 2021



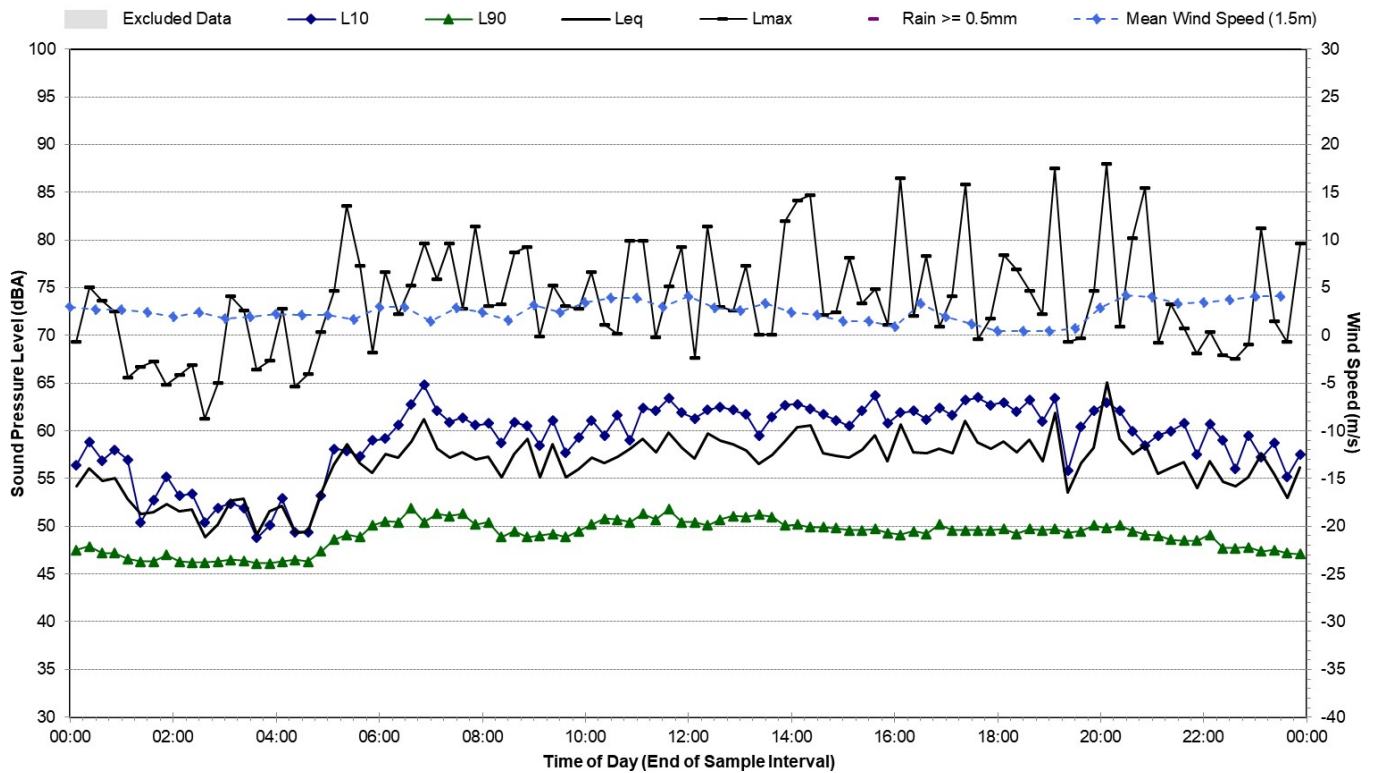
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Saturday, 26 June 2021



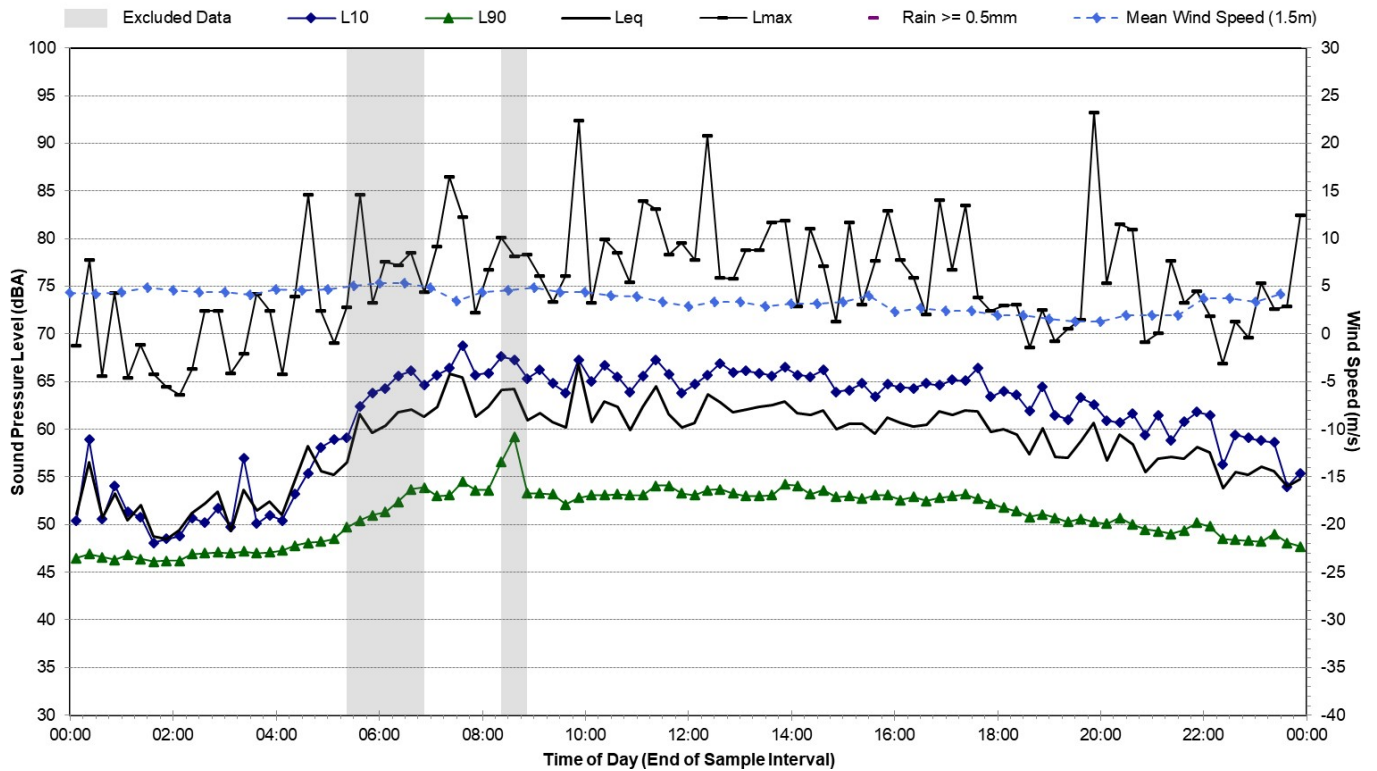
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Sunday, 27 June 2021



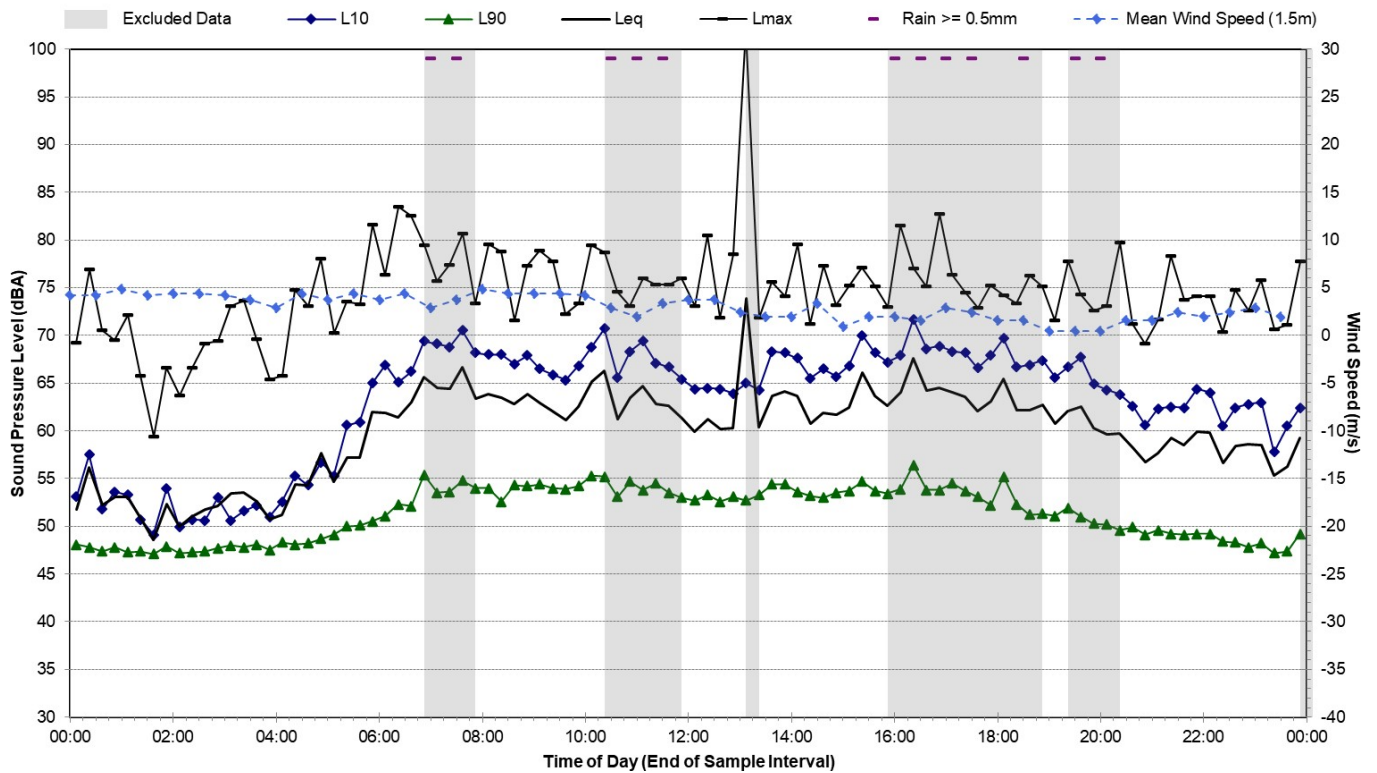
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Monday, 28 June 2021



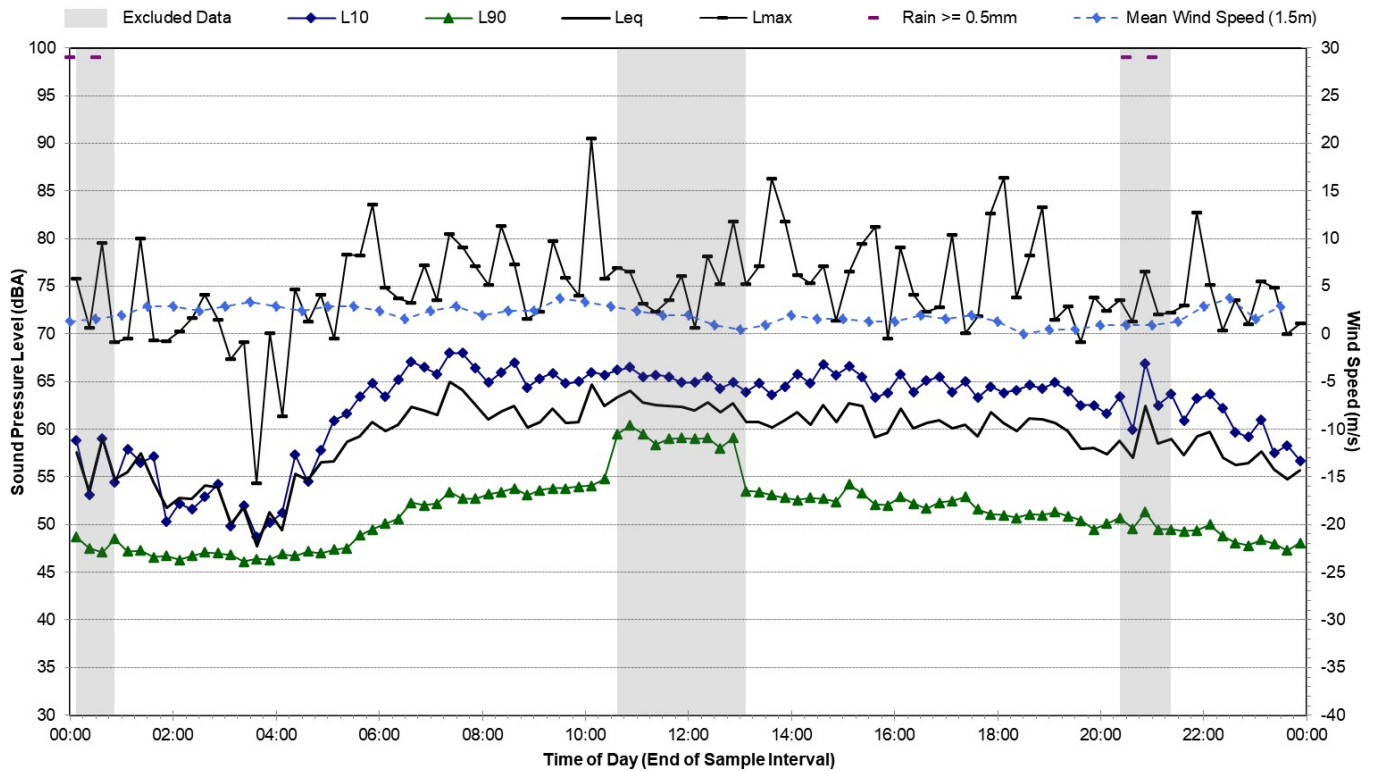
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Tuesday, 29 June 2021



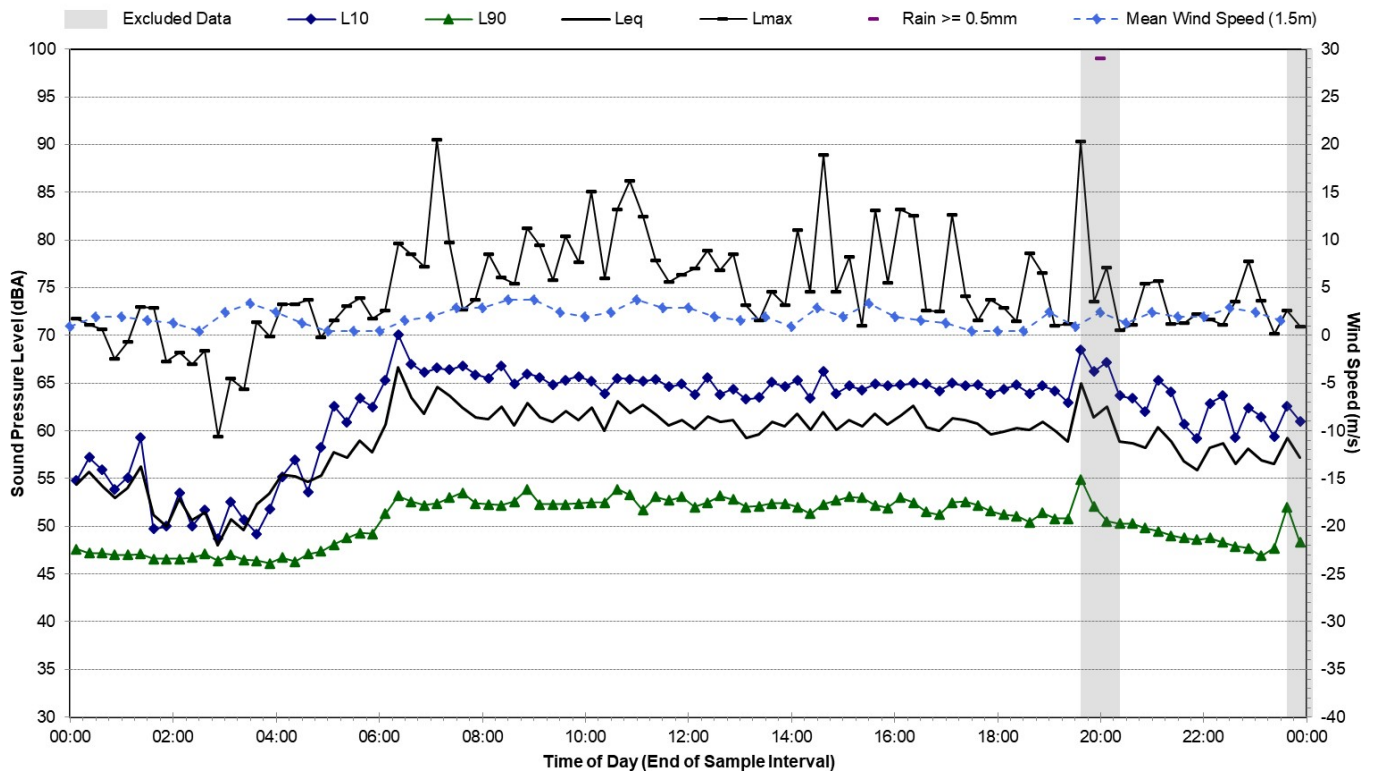
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Wednesday, 30 June 2021



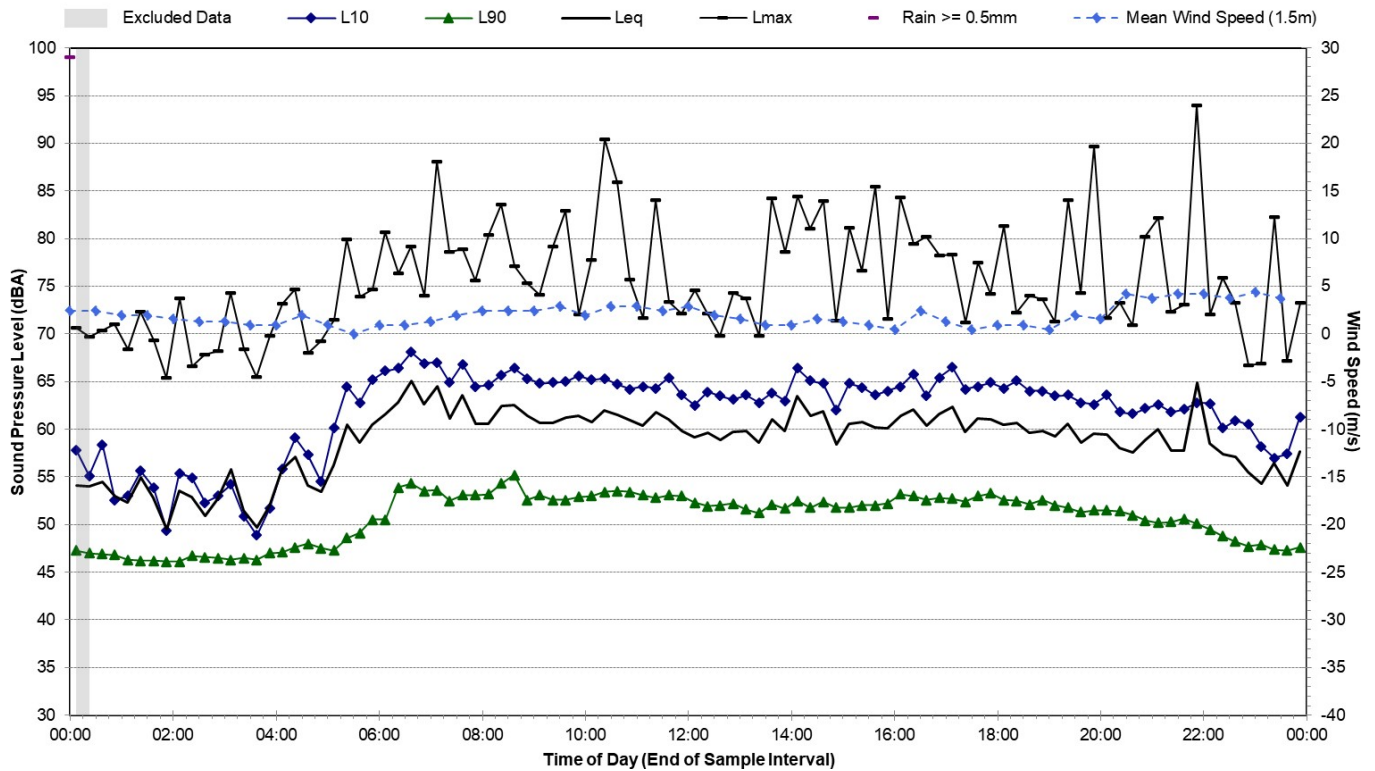
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Thursday, 1 July 2021



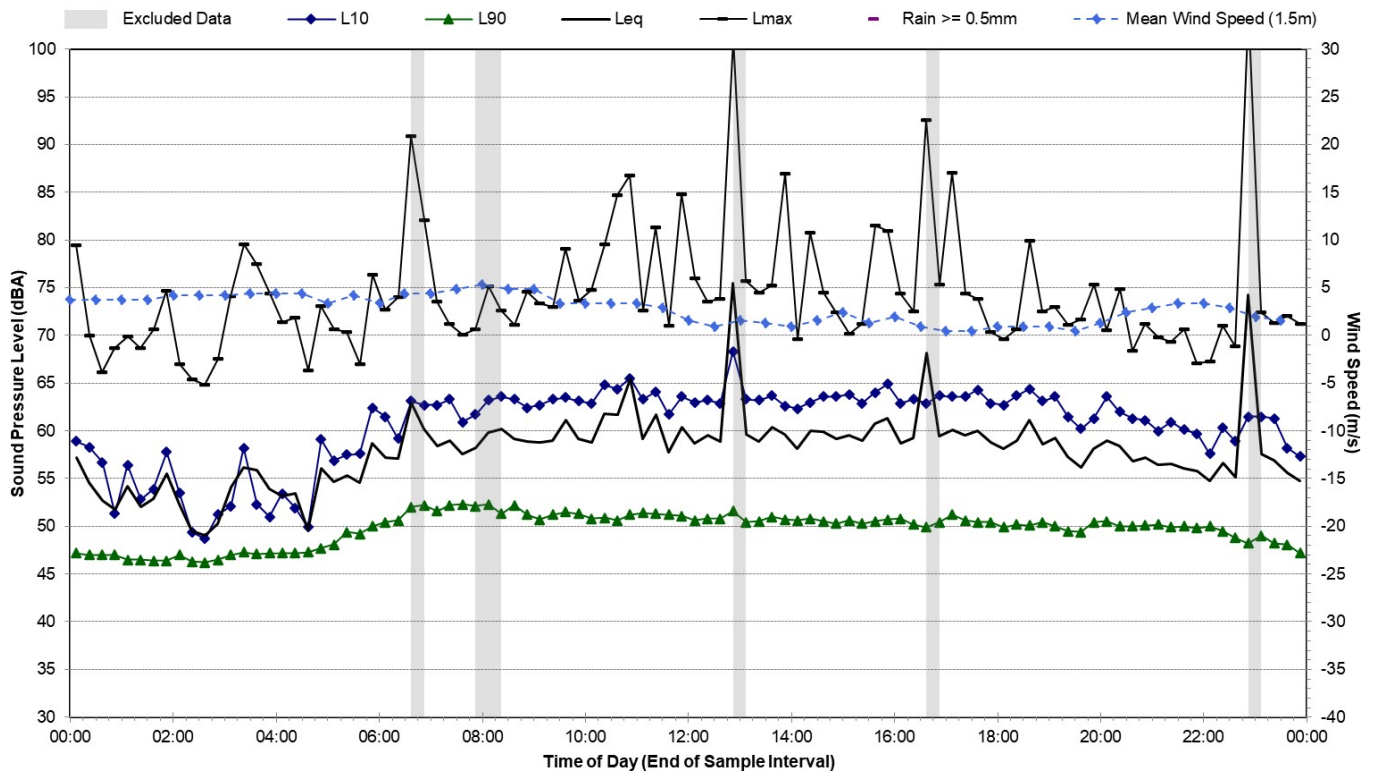
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Friday, 2 July 2021



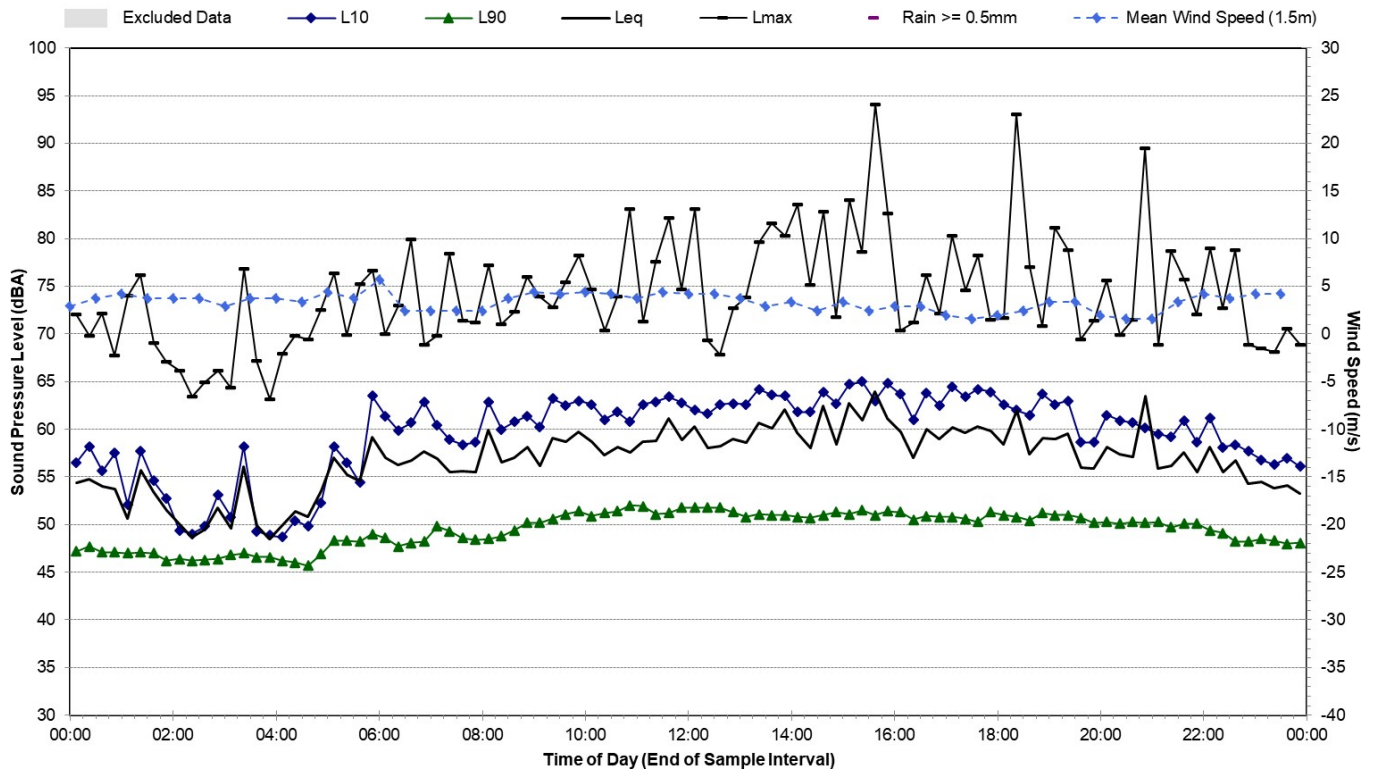
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Saturday, 3 July 2021



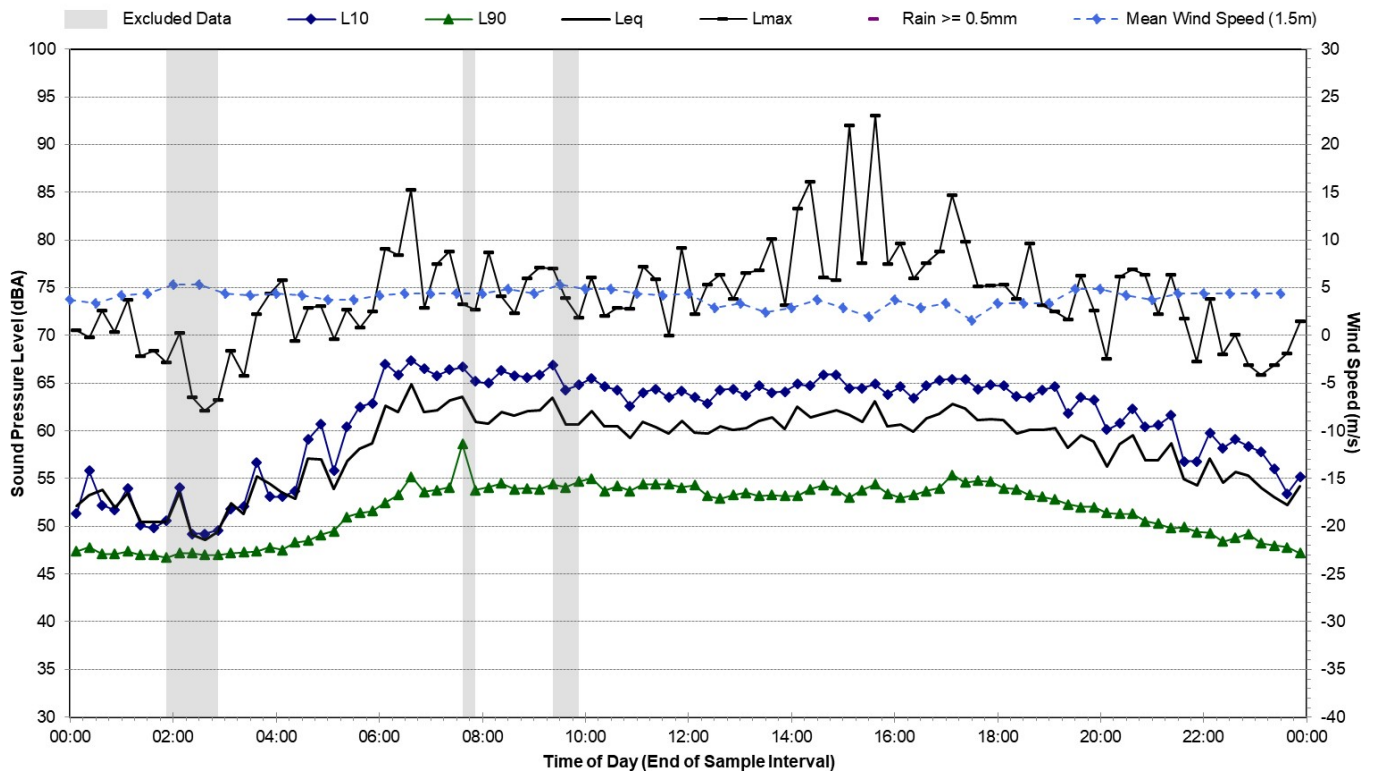
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Sunday, 4 July 2021



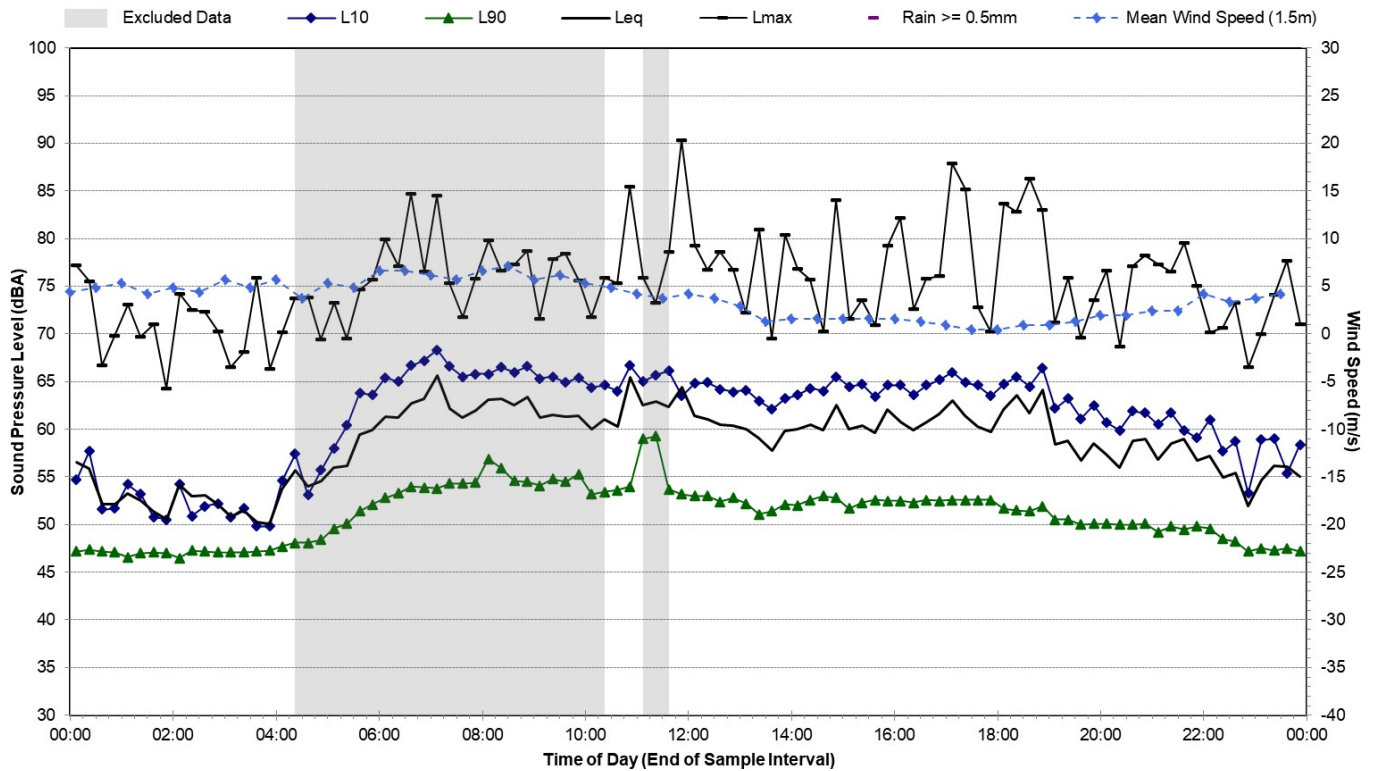
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Monday, 5 July 2021



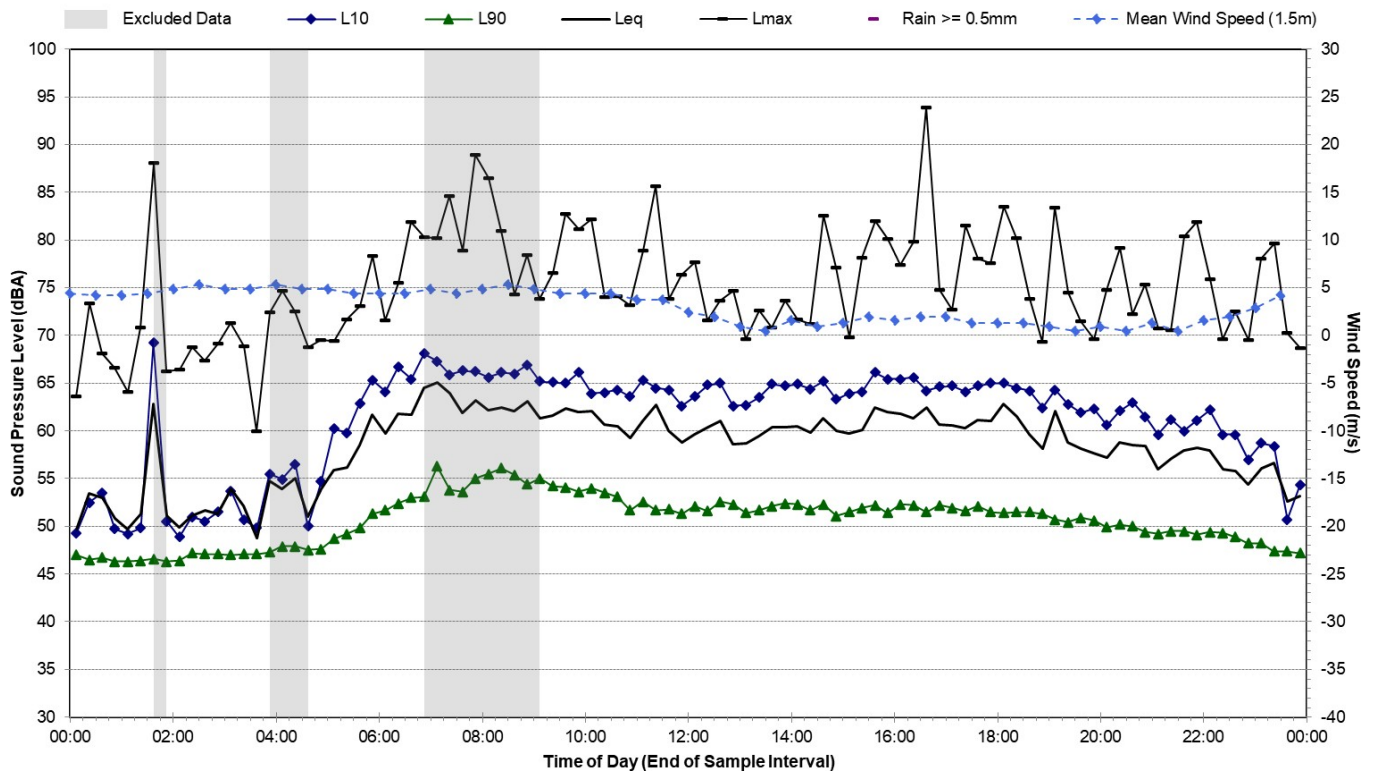
Statistical Ambient Noise Levels

1-5 Harwood Street, Pyrmont - Tuesday, 6 July 2021



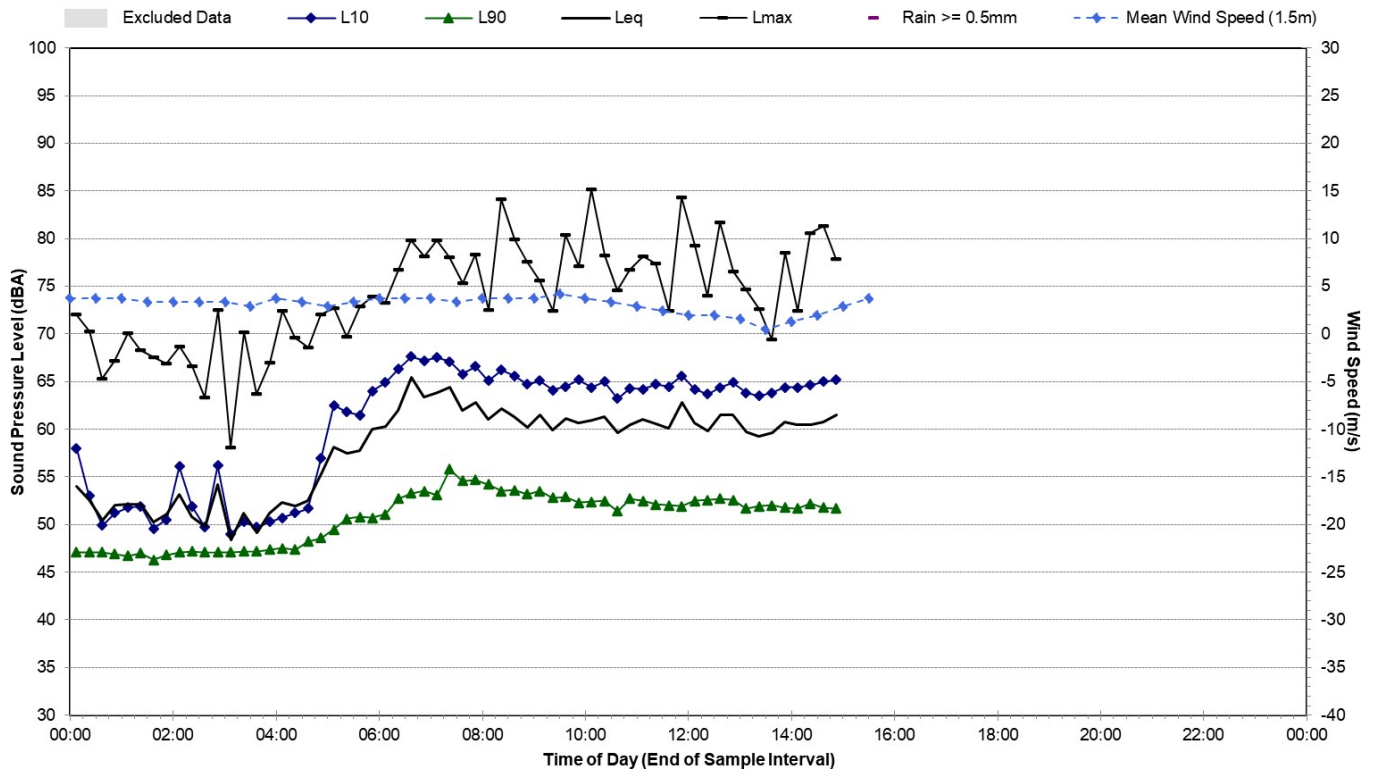
Statistical Ambient Noise Levels

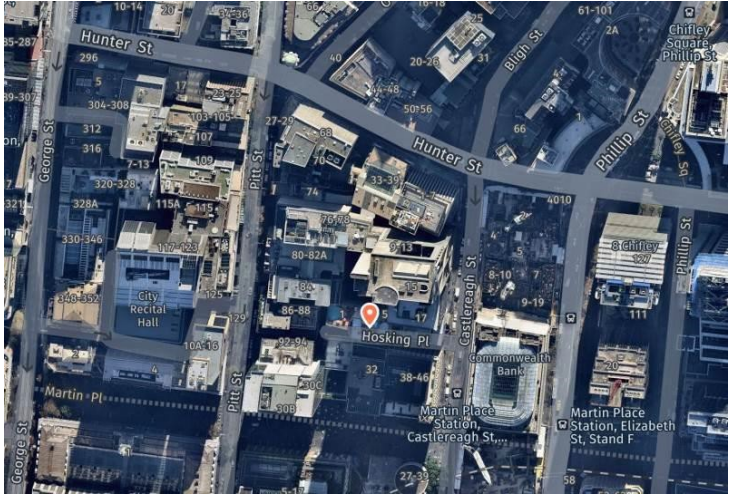

1-5 Harwood Street, Pyrmont - Wednesday, 7 July 2021



Statistical Ambient Noise Levels

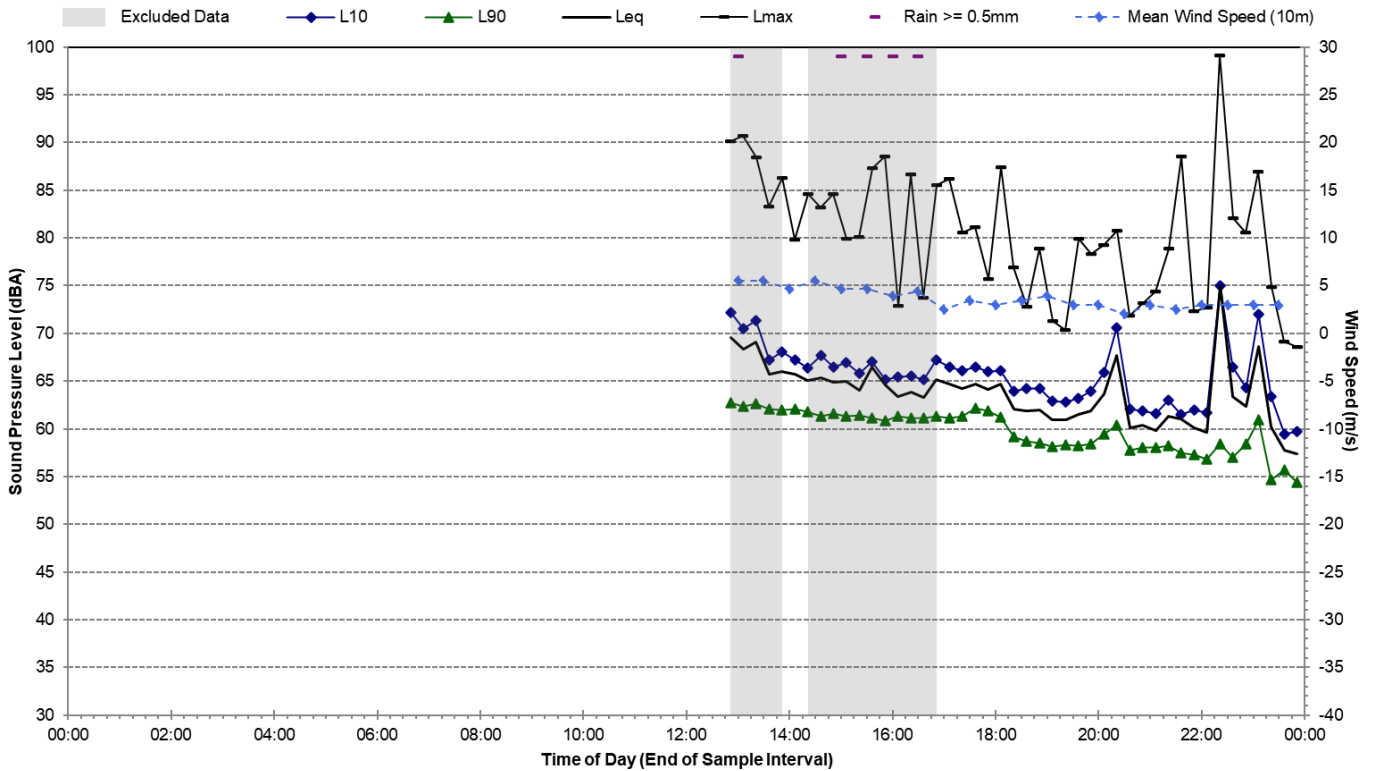
1-5 Harwood Street, Pyrmont - Thursday, 8 July 2021



Noise Monitoring Location	B.06				<div>Map of Noise Monitoring Location</div> 
Noise Monitoring Address	1 Hoskings Place, Sydney				
Logger Device Type: SVAN957, Logger Serial No: 23245 Sound Level Meter Device Type: Brüel and Kjær 2250L, Sound Level Meter Serial No: 3004632					
Ambient noise logger deployed on the balcony of apartment 403 of Medina Serviced Apartments, Martin Place at 1 Hoskings Place, Sydney. Logger located four level up with view over Hoskings Place.					
Attended noise measurements indicate the ambient noise environment at this location is dominated by mechanical plant from neighbouring buildings, building maintenance work and road traffic noise from both Castlereagh Street and Hoskings Place. The background noise level was controlled by surrounding mechanical plant and the ‘city hum’ which is constant in the Sydney CBD.					
Ambient Noise Logging Results – ICNG Defined Time Periods					<div>Photo of Noise Monitoring Location</div> 
Monitoring Period (02/05/2019 – 20/05/2019)	Noise Level (dBA)				
	RBL	LAeq	L10	L1	
Daytime	61	66	66	71	
Evening	56	62	63	68	
Night-time	52	63	59	68	
Ambient Noise Logging Results – RNP Defined Time Periods					
Monitoring Period (02/05/2019 – 20/05/2019)	Noise Level (dBA)				
	LAeq(period)		LAeq(1hour)		
Daytime (7am-10pm)	65		69		
Night-time (10pm-7am)	63		66		
Attended Noise Measurement Results					
Date	Start Time	Measured Noise Level (dBA)			
		LA90	LAeq	LAmx	
19/06/2015	12:44	62	68	85	

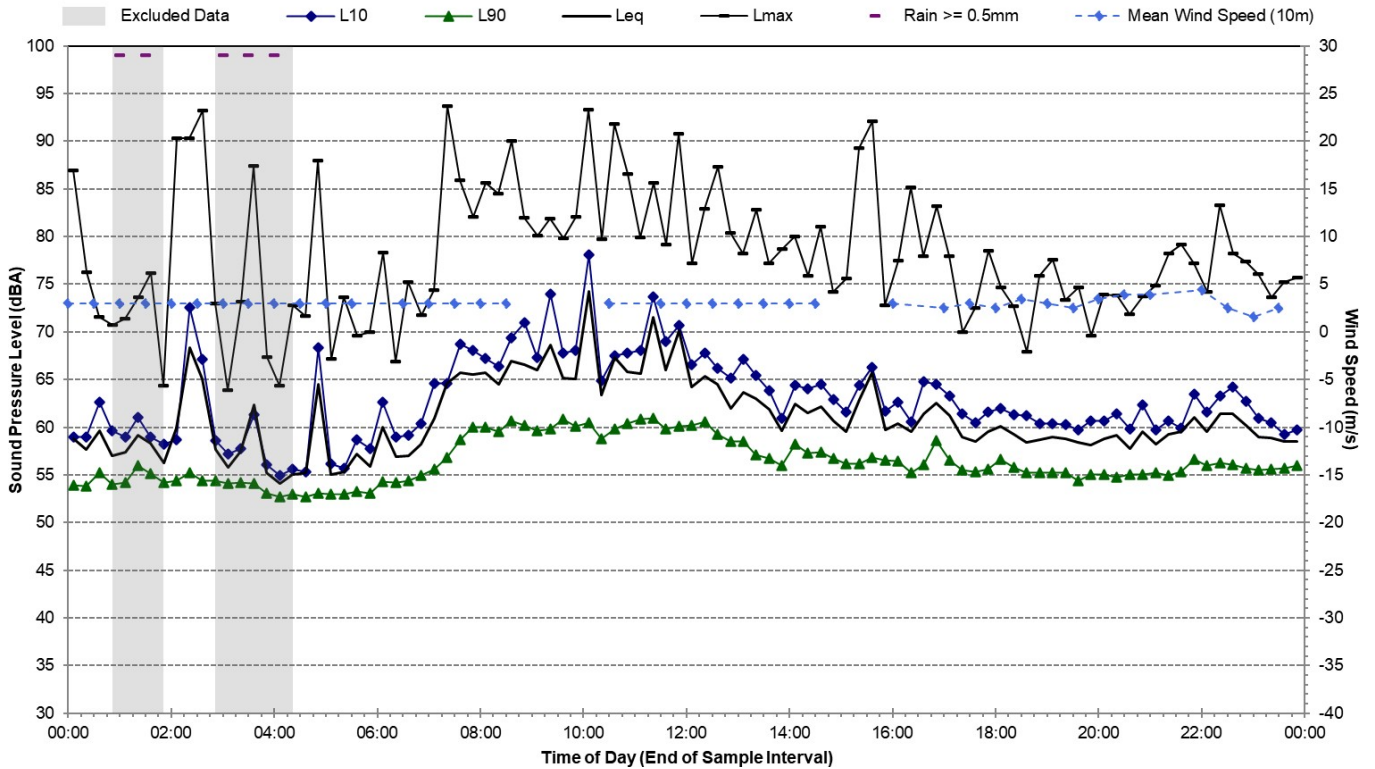
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Friday, 19 June 2015



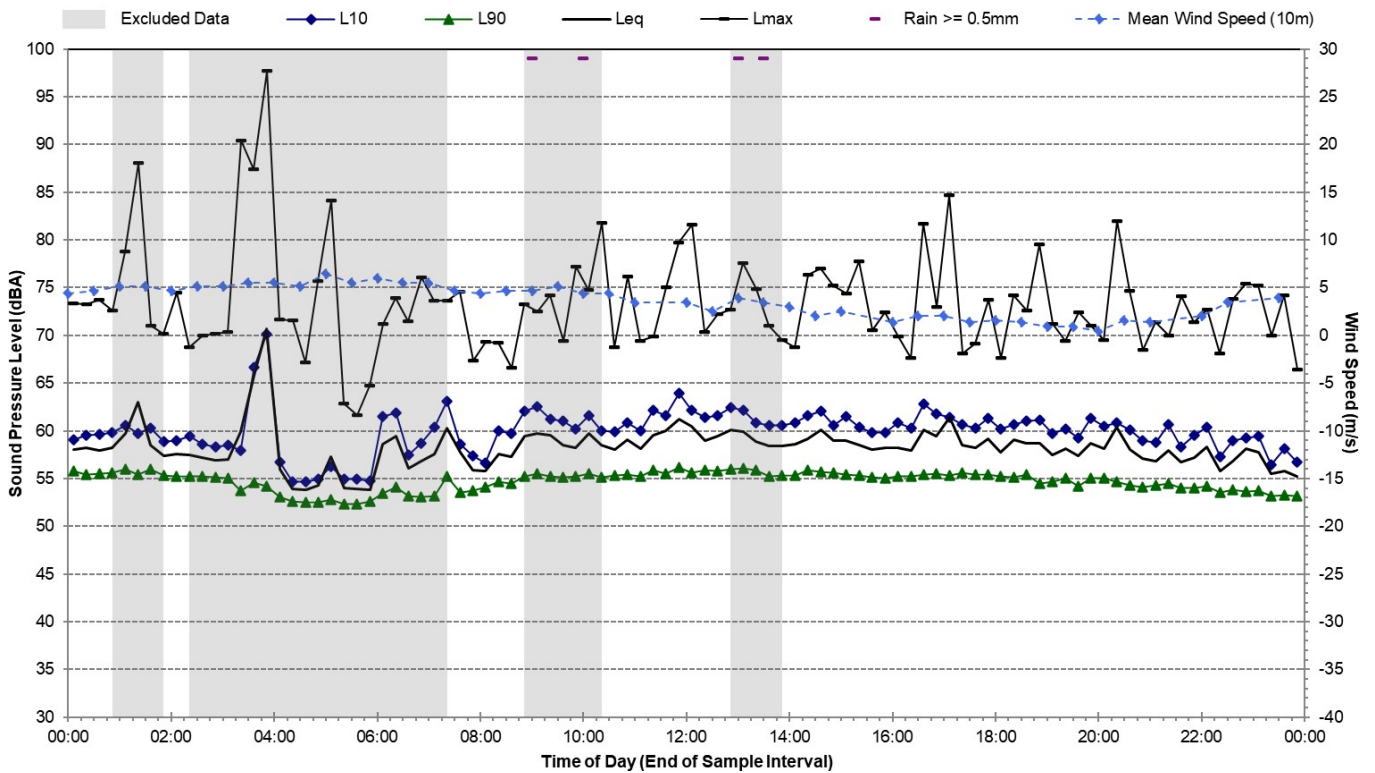
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Saturday, 20 June 2015



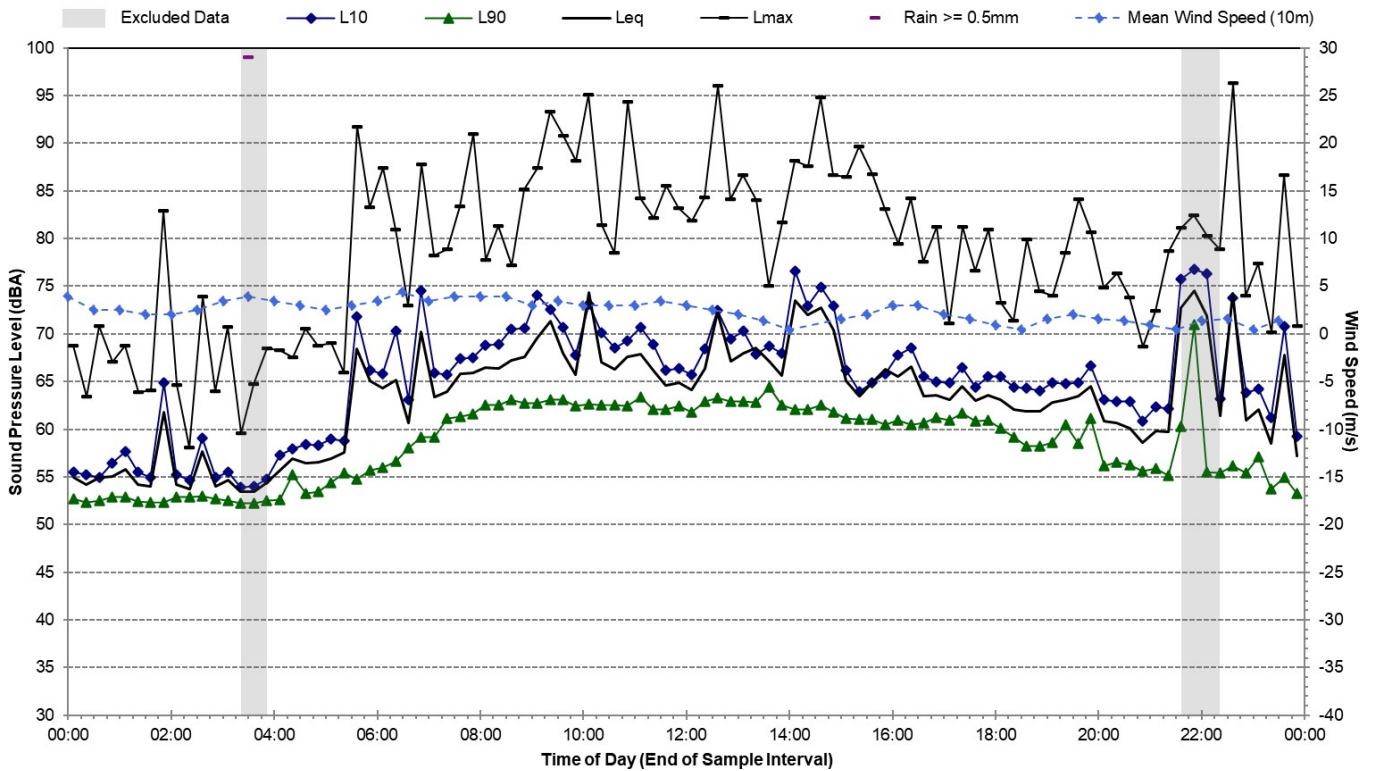
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Sunday, 21 June 2015



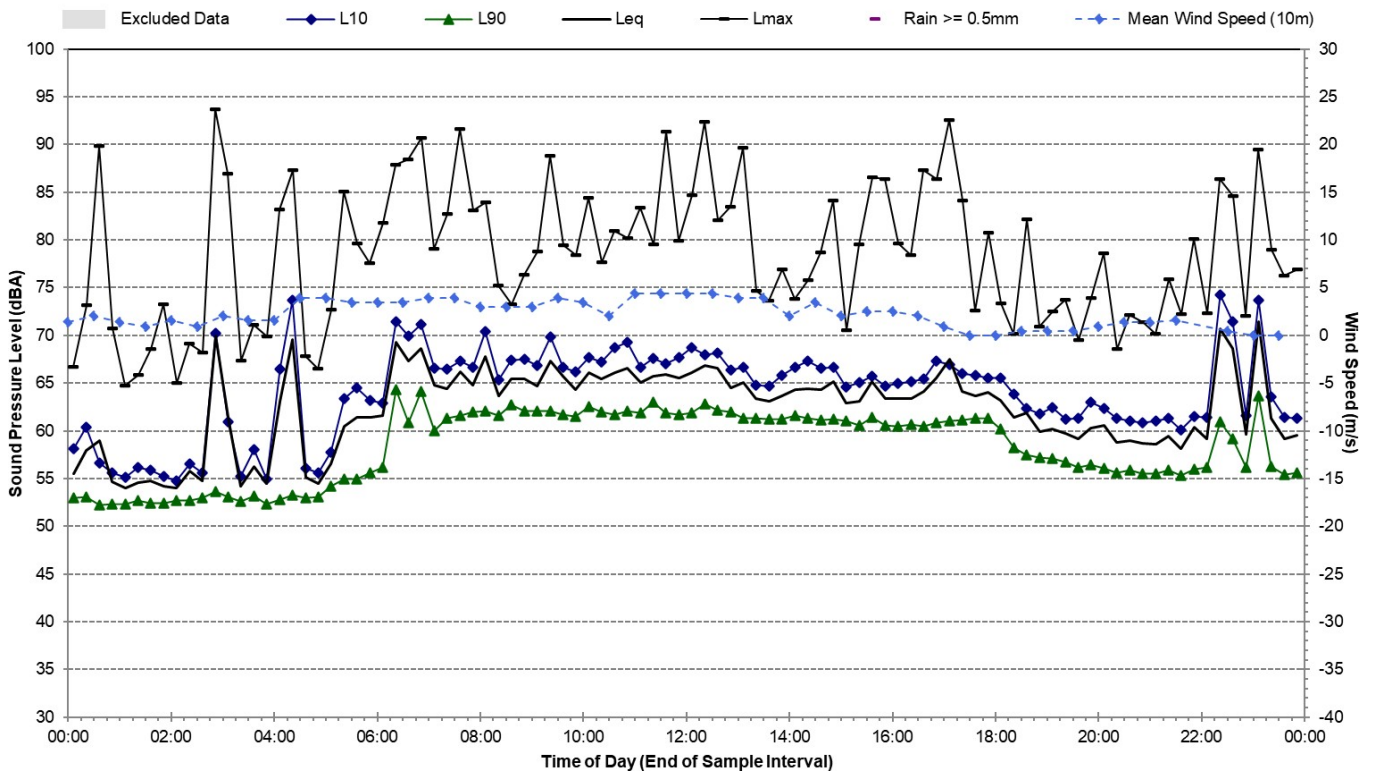
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Monday, 22 June 2015



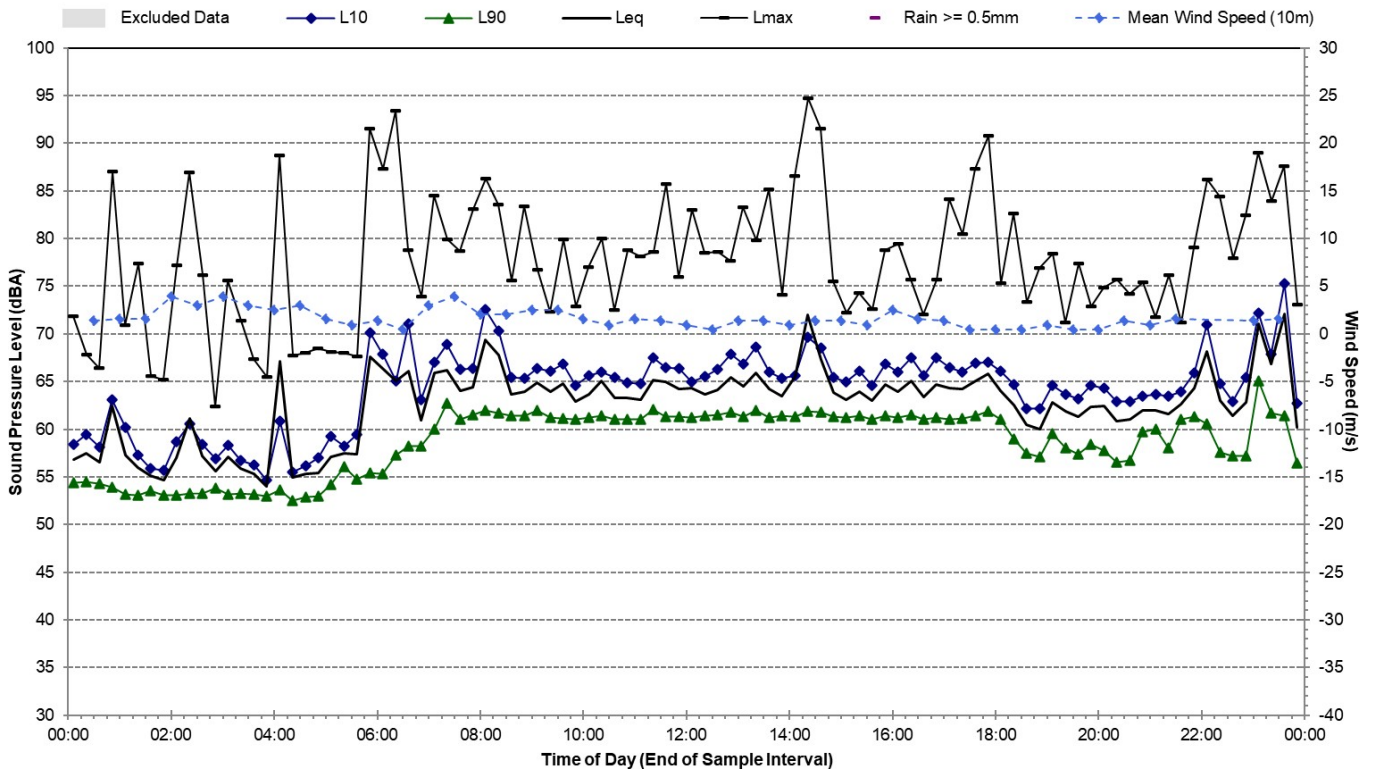
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Tuesday, 23 June 2015



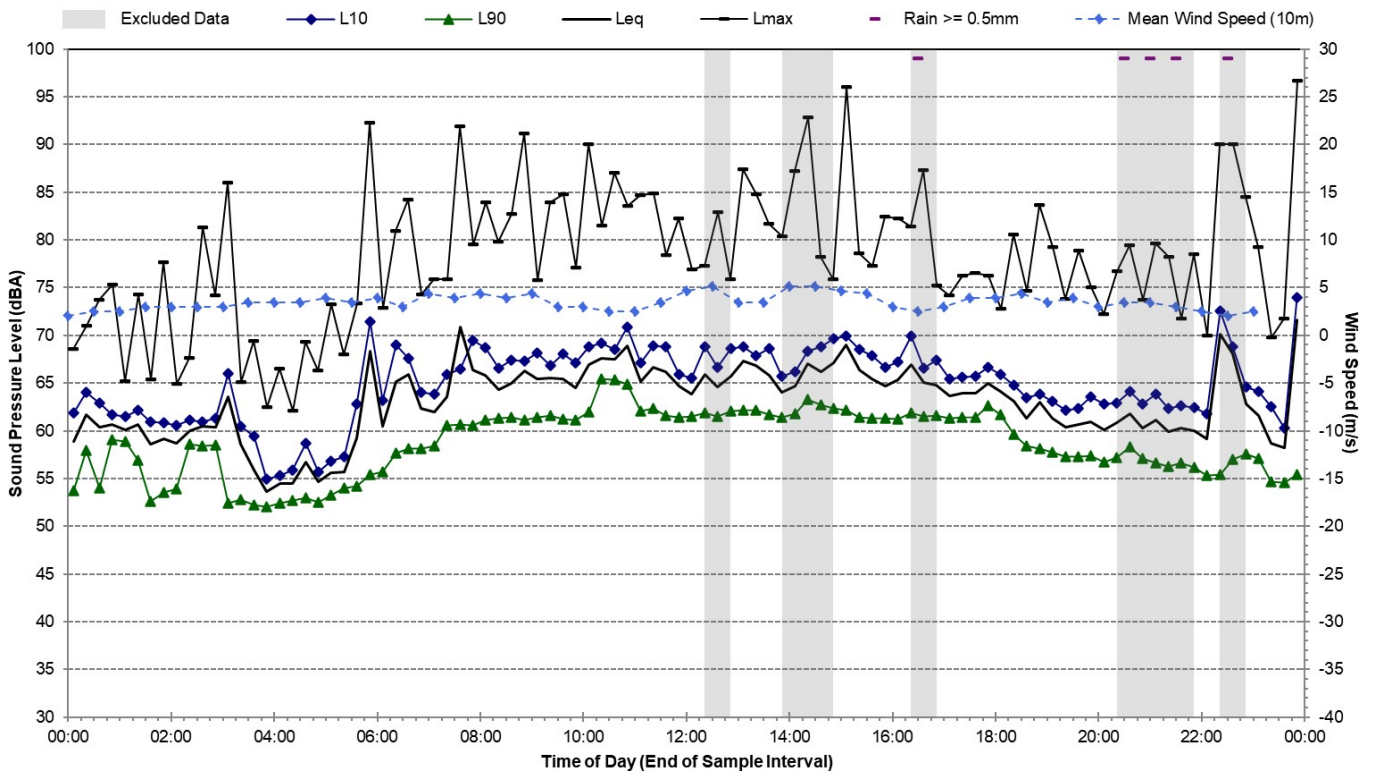
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Wednesday, 24 June 2015



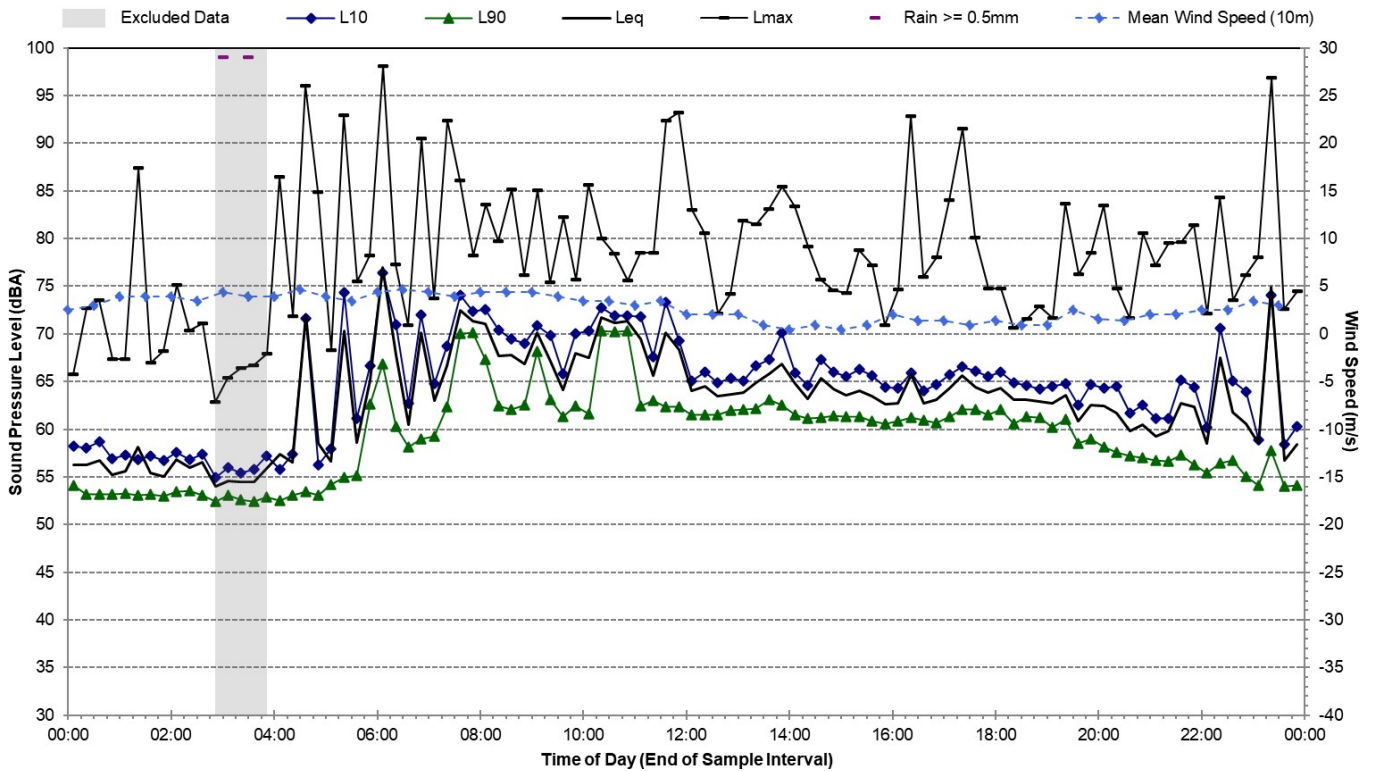
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Thursday, 25 June 2015



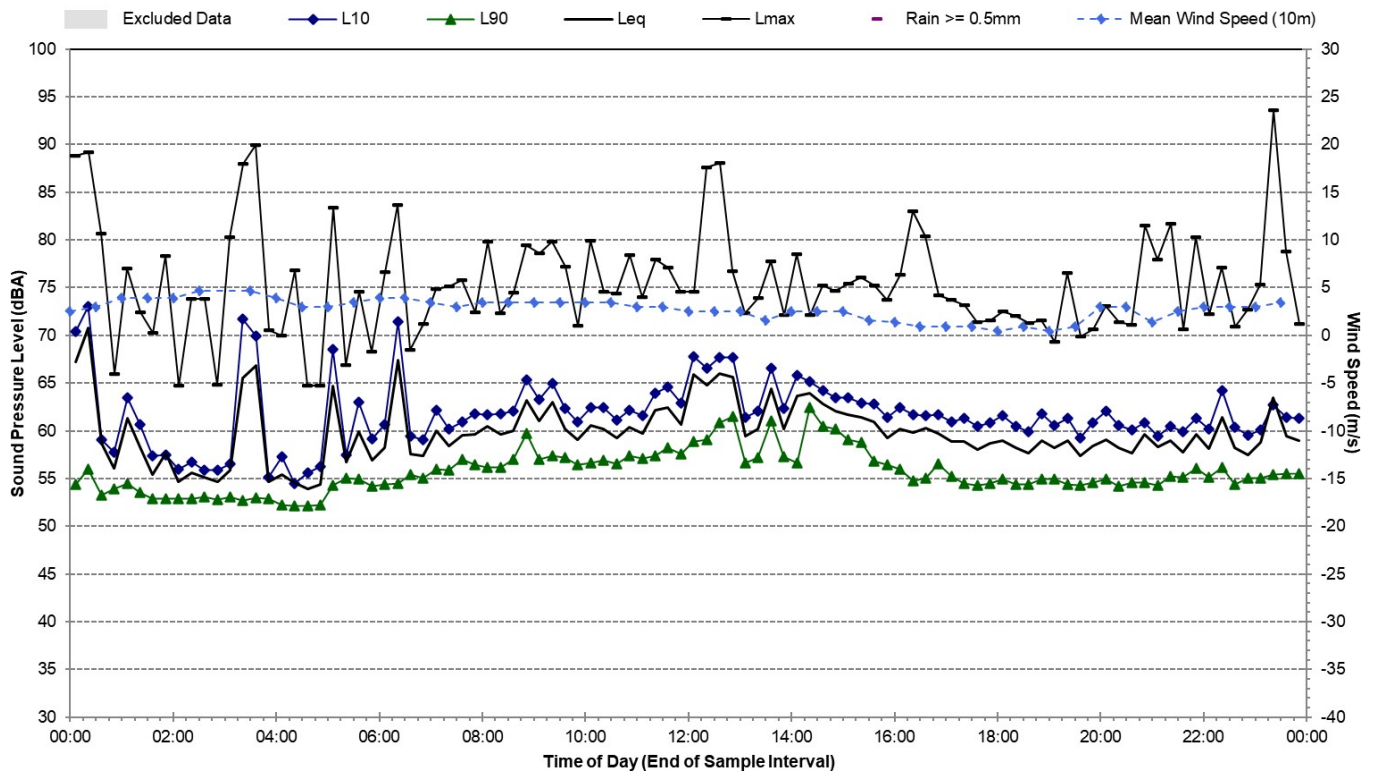
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Friday, 26 June 2015



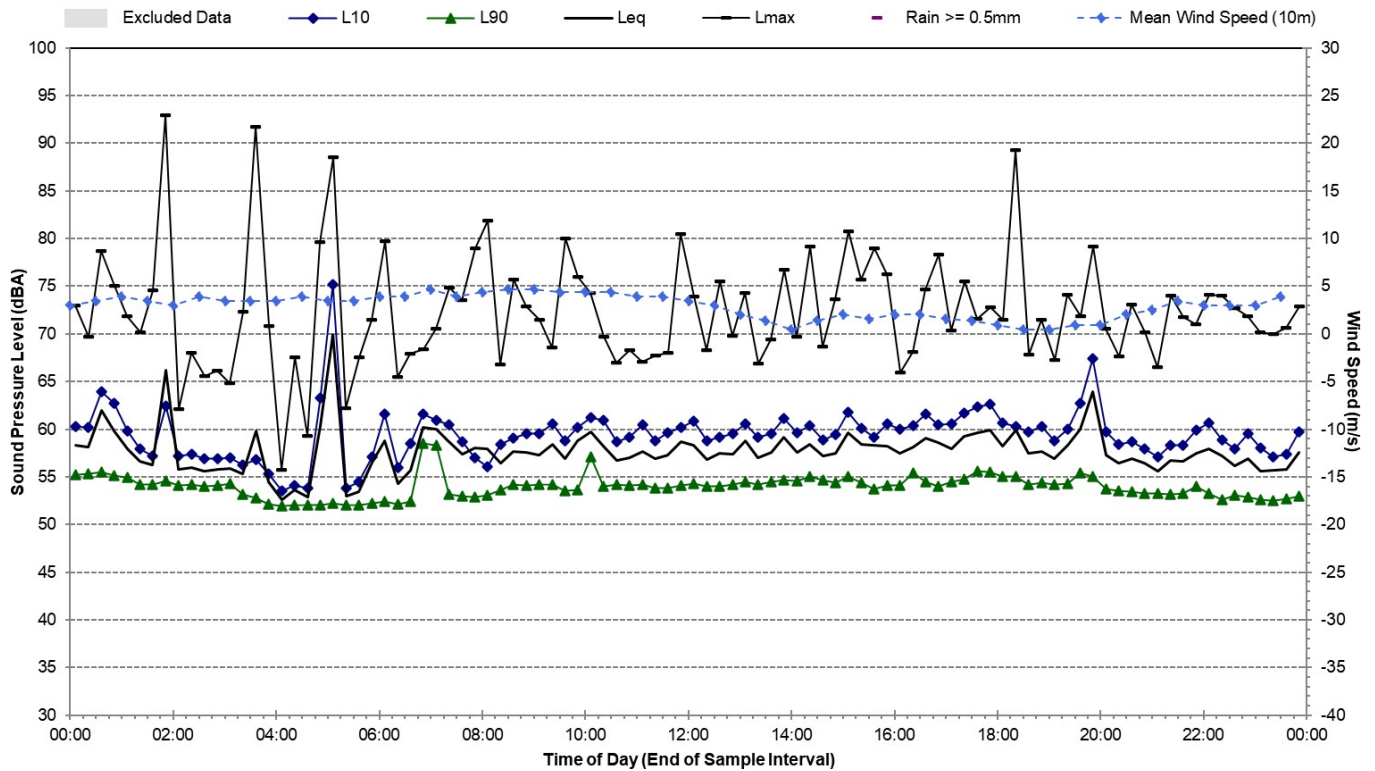
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Saturday, 27 June 2015



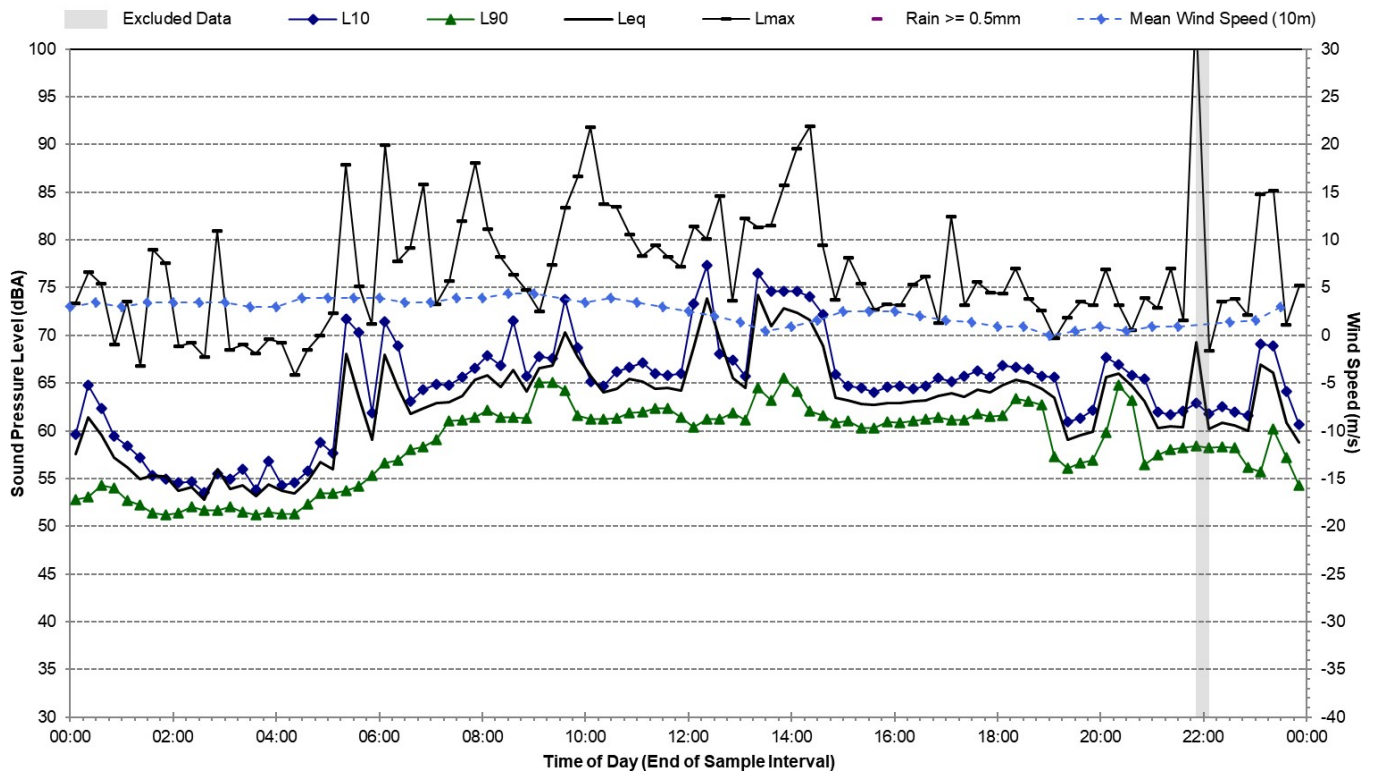
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Sunday, 28 June 2015



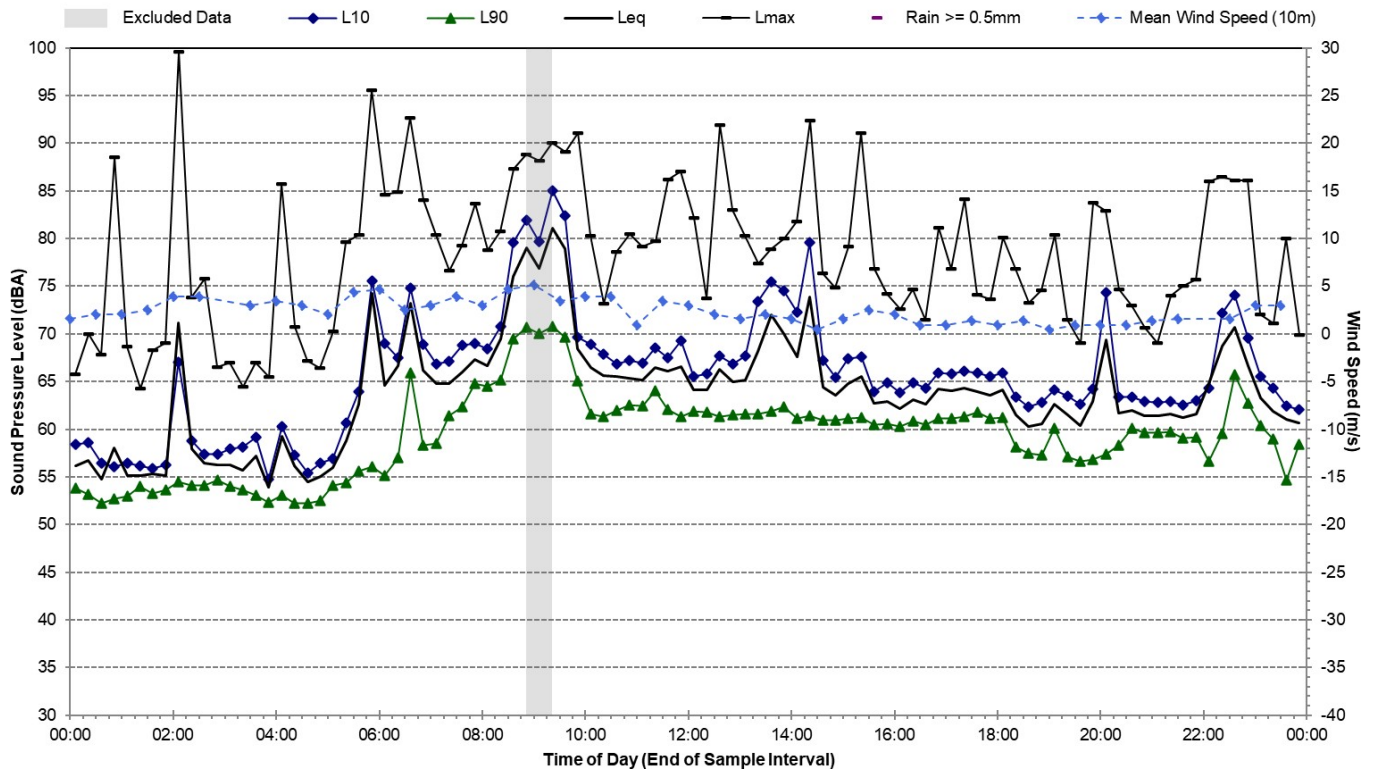
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Monday, 29 June 2015



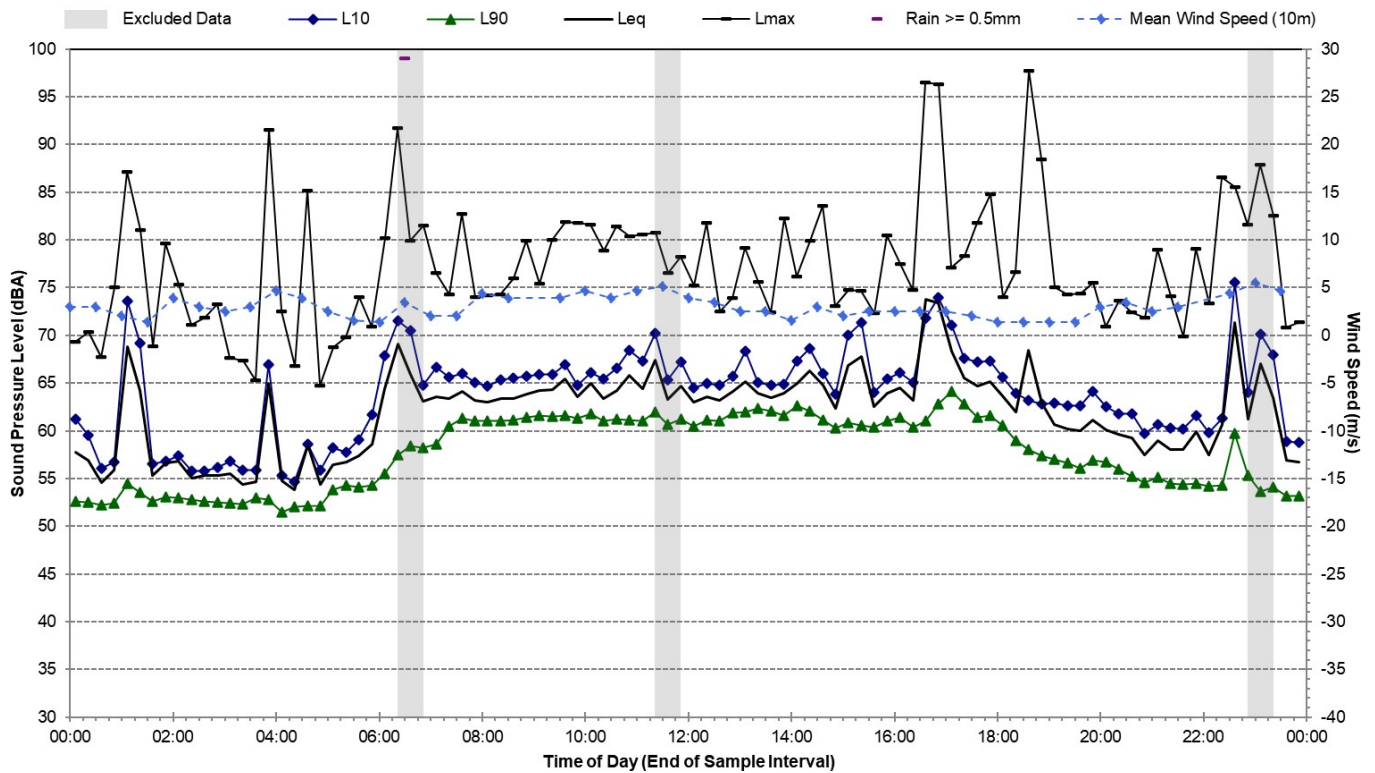
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Tuesday, 30 June 2015



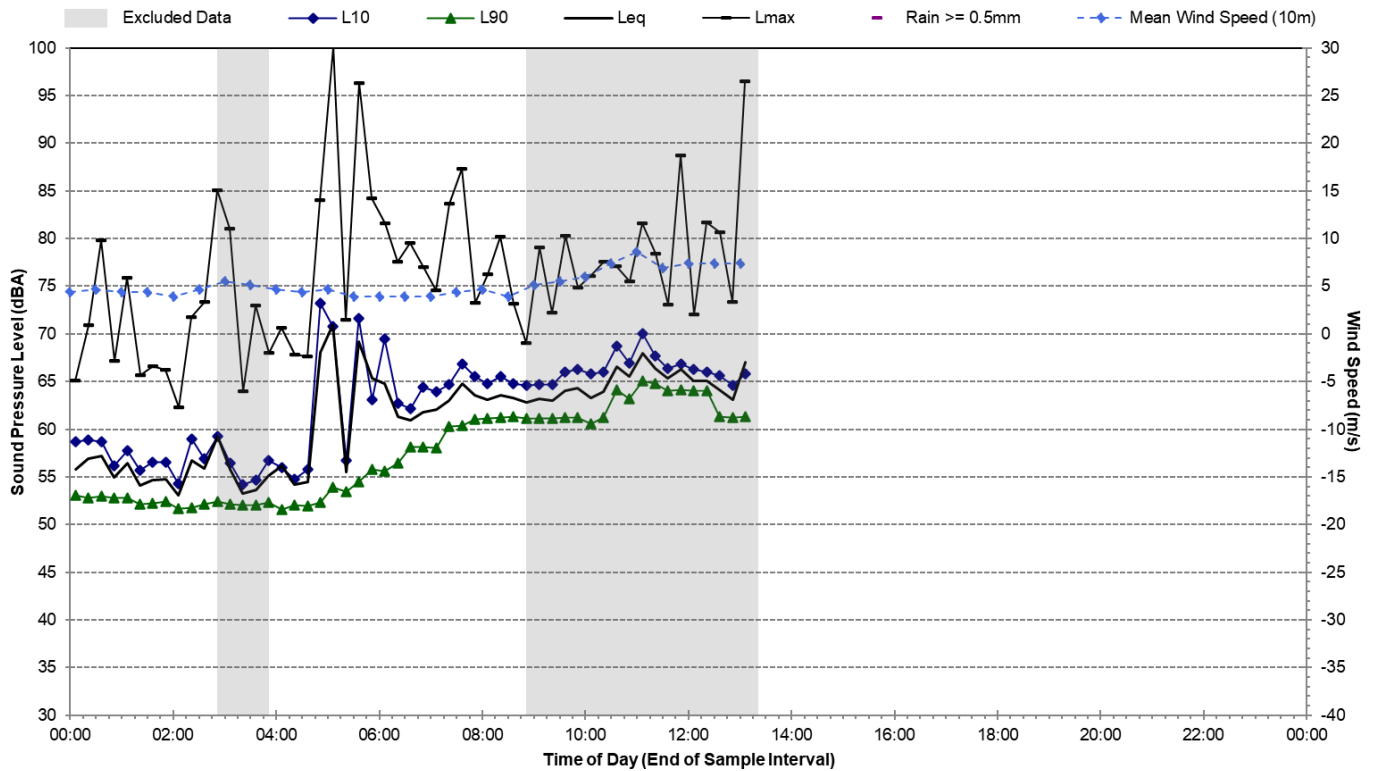
Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Wednesday, 1 July 2015



Statistical Ambient Noise Levels

1 Harwood Place, Sydney - Thursday, 2 July 2015



APPENDIX C

Construction Scenarios and Equipment

Table 1 Equipment Lists and Sound Power Levels

Equipment			TOTAL SWL	Compressor	Compressor for Air Scrubber	Concrete Mixer Truck	Concrete Pump	Dump Truck (approx. 15 tonne)	Elevated Working Platform	Excavator - Breaker ¹	Excavator (14 tonne)	Excavator (22 tonne)	Excavator – Rock Saw ¹	Flatbed Truck	Front End Loader	Generator	Grinder ¹	Hand Tools	Mobile Crane (35 tonne)	Mobile Crane (400 tonne)	Piling - Bored	Rattle Gun	Road Header	Rock Anchor Drill ¹	Shotcrete Rig	Skidsteer Loaders	Telehandler	Tower Crane	Truck (30% acceleration)	Ventilation Scrubber	Water Pump	Welding Equipment				
Sound Power Level ²				95	100	103	106	107	97	126	100	105	111	100	110	102	110	94	98	106	111	99	113	113	106	97	92	100	108	98	83	97				
Estimated on-time in any 15 minutes				15	15	15	15	3	3	10	8	8	5	3	8	15	5	15	8	8	8	8	15	8	15	15	8	8	3	15	8	5				
Scenario	Activity																																			
Enabling Work	Typical	Supporting and loading	107	X								X				X		X	X										X		X					
	Peak	Demolition using a rockbreaker	124	X					X	X		X				X		X	X							X			X		X					
Piling	Typical	Supporting works	106	X		X					X							X	X										X		X					
	Peak	Bored piling with support plant	112	X		X	X				X	X						X	X		X								X		X					
Surface Construction	Typical	General work	104	X												X		X				X									X	X				
	Peak	Noise intensive work	109	X												X	X	X	X			X							X		X	X				
Excavation	Typical	Mucking out	106		X				X		X							X	X										X	X	X					
	Peak	Through rock using rockbreaker	125		X				X	X	X		X					X	X						X	X			X	X	X					
Mined Cavern	Typical	Spoil removal	110		X			X	X		X				X			X							X	X			X	X	X					
	Peak	Mining with support	117		X			X	X		X		X		X			X					X	X	X				X	X	X					
TBM launch and support	Typical	TBM support and spoil removal	106		X				X					X		X		X									X			X	X					
	Peak	TBM assembly and launch / retrieval	111		X				X					X	X	X		X		X							X	X		X	X					

Note 1: Equipment classed as ‘annoying’ in the ICNG and requires a 5 dB correction.

Note 2: Sound power level data is taken from the DEFRA Noise Database, RMS Construction and Vibration Guideline and TfNSW Construction Noise and Vibration Strategy. Construction and Vibration Guideline and TfNSW Construction Noise and Vibration Strategy.

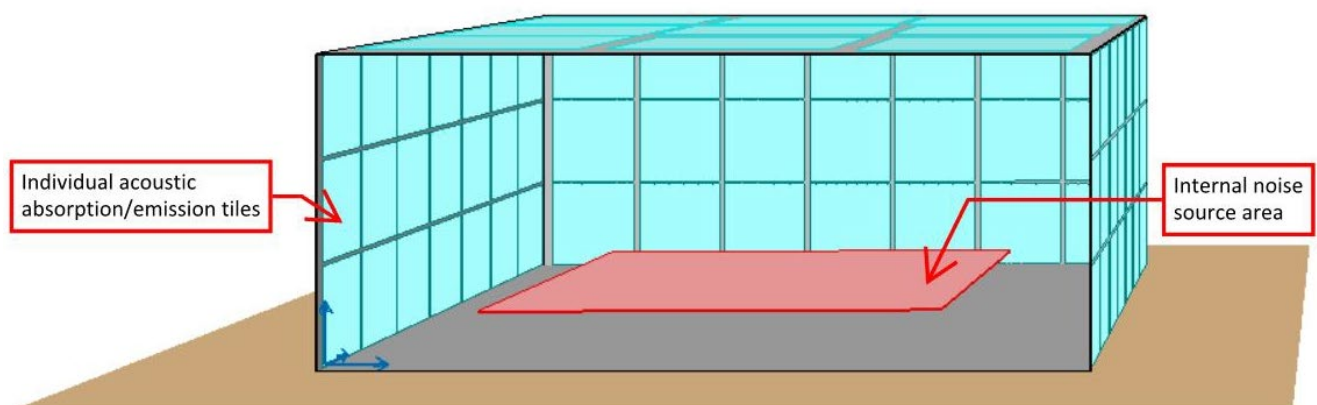
APPENDIX D

Acoustic Shed Acoustic Properties

The acoustic sheds have been modelled with a height of between 15 metres and 25 metres. The footprint of each shed was determined from indicative design information and the sheds were positioned to cover the excavation and internal spoil handling areas.

The sheds were modelled with sound absorption and transmission loss properties applied to each wall, floor and ceiling surface using a five metre grid as shown in **Figure 1**. The various internal construction noise sources were represented in the model using area sources.

Figure 1 Example Acoustic Shed Arrangement



The sheds were modelled with internal acoustic absorption applied to surfaces five metres above ground level and the shed floors were conservatively modelled as reflective as they would mostly be concrete or other equivalent hard ground.

An additional 'doors open' scenario was modelled for locations where trucks are required to drive in and out of the sheds to collect spoil. No specific mitigation measures were included regarding noise transmitted through open doors.

Acoustic absorption and transmission loss values were based on data for products used to construct acoustic sheds on previous stages of Sydney Metro.

A summary of the modelled sound absorption coefficients is shown in **Table 1** and the transmission loss values for each shed element are summarised in **Table 2**.

Table 1 Acoustic Shed Absorption Coefficient Values

Internal Shed Element	Assumed Construction	Absorption Coefficient, α							
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	Total α_{ω}
Roof	0.48 mm steel cladding with 55 mm Permastop building blanket (12 kg/m ³)	0.15	0.45	0.70	0.70	0.70	0.70	0.70	0.70
Wall above 5 m	78.0 mm SpeedWall panel (400kg/m ³) with 55 mm Permastop building blanket (12 kg/m ³)	0.15	0.45	0.70	0.70	0.70	0.70	0.70	0.70
Wall below 5 m	78.0 mm SpeedWall panel (400kg/m ³)	0.30	0.40	0.30	0.15	0.10	0.04	0.12	0.10
Open Door1	Opening	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Floor	Concrete	0.02	0.02	0.02	0.02	0.03	0.04	0.05	0.05

Note 1: Open doors are modelled as fully absorptive inside the shed to stop reflections from this element contributing to internal noise levels.

Table 2 Acoustic Shed Transmission Loss Values

Internal Shed Element	Assumed Construction	Sound Reduction, R (dB)							
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	Total R_w
Roof	0.48 mm steel cladding with 55 mm Permastop building blanket (12 kg/m ³)	6	17	28	38	48	59	69	39
Walls1	78.0 mm SpeedWall panel (400kg/m ³)1	26	24	32	47	59	70	79	45
Open Door	Opening	0	0	0	0	0	0	0	0

Note 1: 55 mm Permastop building blanket (12 kg/m³) does not significantly affect transmission loss

Sound power level data for the noisiest equipment used in the sheds was based on data from the Department for Environment Food & Rural Affairs (DEFRA) *Noise Database For Prediction Of Noise On Construction And Open Sites* and is shown in **Table 3**.

The below octave band data was adjusted based on the quantity of equipment and number of construction faces in each scenario.

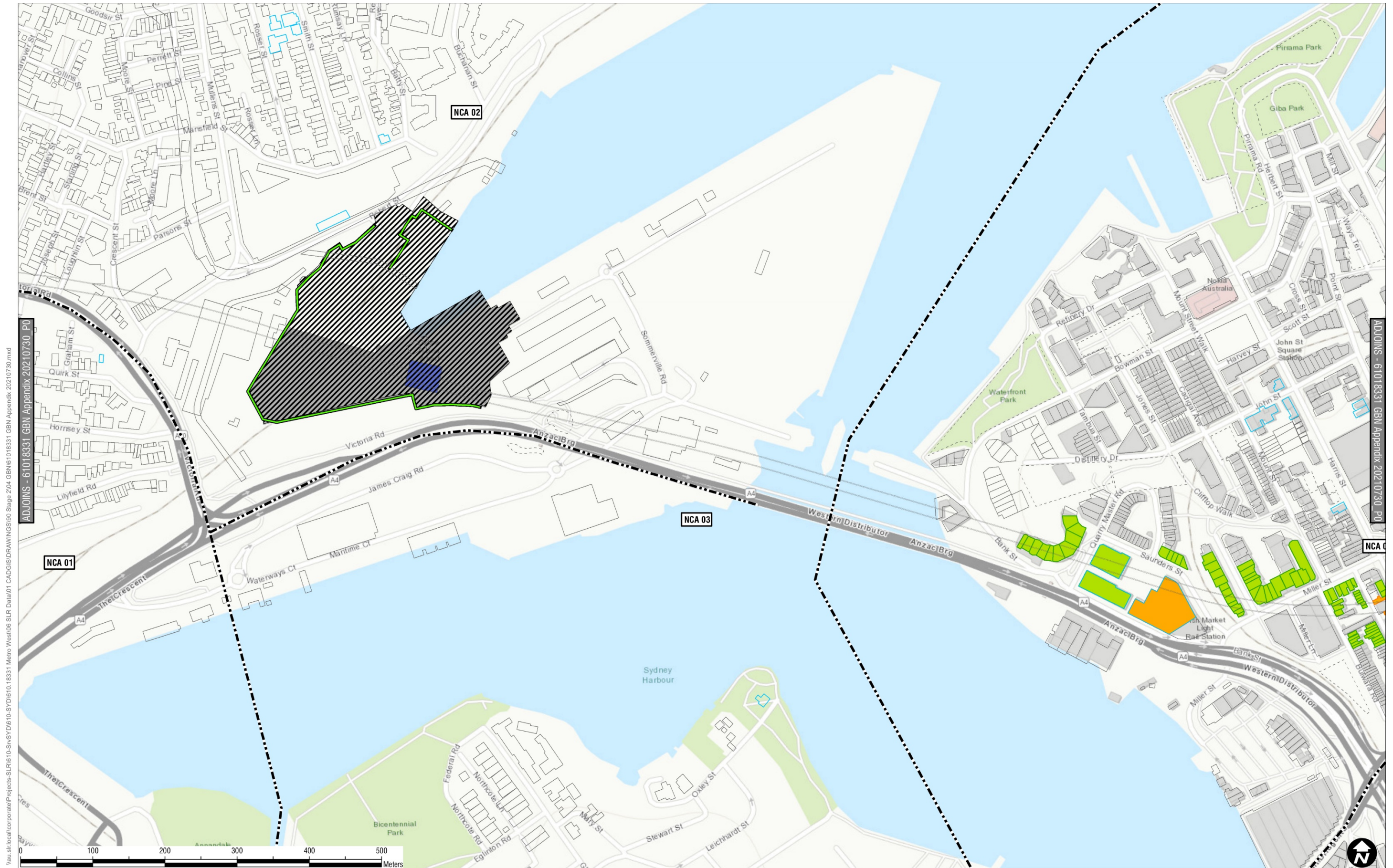
Table 3 Noise Source Sound Power Level Spectra

Noise Source ¹	Sound Power Level (dB)						
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Breaker Mounted on Excavator	116	116	114	117	111	111	108
Excavator – 15t	106	104	99	98	96	94	89
Dozer	108	109	106	102	102	99	94

Note 1: Octave band sound power level data based on DEFRA Noise Database.

APPENDIX E

Ground-borne Noise Impacts from Tunnelling



\\au.slr.local\corporate\Projects\SLR\610-Sydney\610-Sydney\610-18331 Metro West\06 SLR Data\01 CAD\GIS\DRAWINGS\90 Stage 204 GBN\61018331 GBN Appendix 20210730.mxd

ADJOINS - 61018331 GBN Appendix 20210730_P0

ADJOINS - 61018331 GBN Appendix 20210730_P0



2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 6100
F: 61 2 9427 8200
www.slrconsulting.com

Project No.: 610.18331

Date: 27-Aug-2021

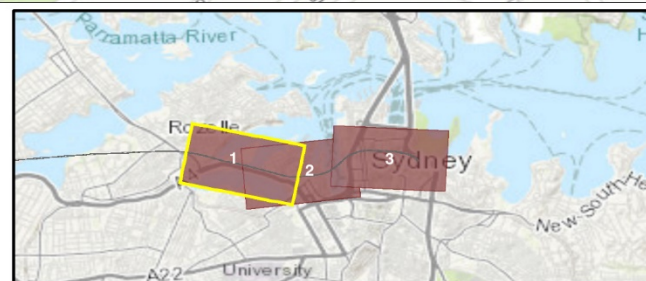
Drawn by: ML

Scale: 1:5,000

Sheet Size: A4

Projection: GDA2020 MGA Zone 56

The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.



LEGEND

- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site

- Other Sensitive Receivers
- No Exceedance
- Low (1 to 10 dBA)
- Moderate (11 to 20 dBA)
- High (>20 dBA)

Sydney Metro Authority

**Sydney Metro West
Stage 2**

**Worst-case Ground-borne Noise
Impacts from TBM Tunnelling
All Periods**

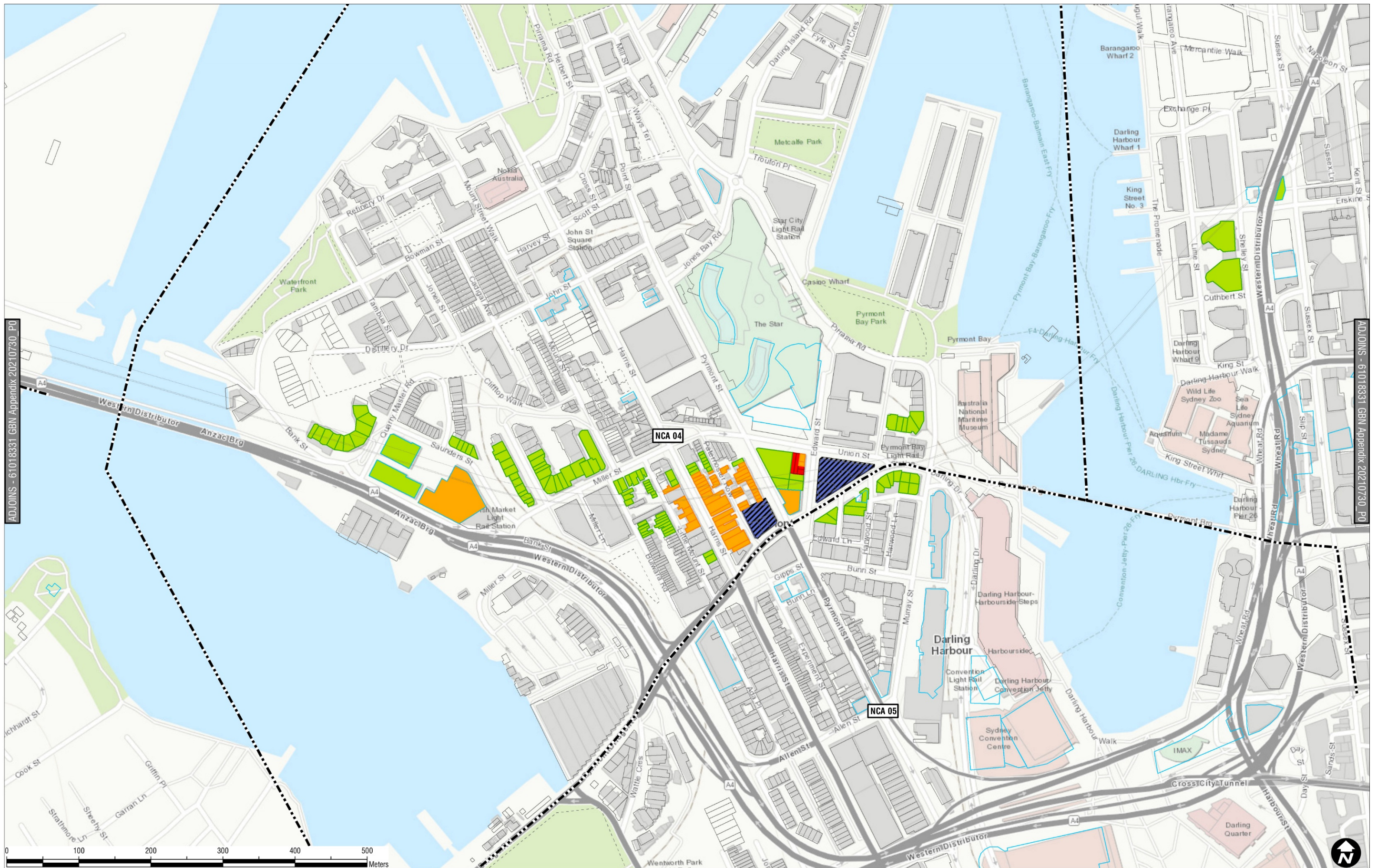
61018331 GBN Appendix 20210730_P01

Page 1 of 3

\\au.slr.local\corporate\Projects\SLR\610-Sydney\610-Sydney\610-18331 Metro West\06 SLR Data\01 CAD\GIS\DRAWINGS\90 Stage 2\04 GBN\61018331 GBN Appendix 20210730.mxd

ADJOINS - 61018331 GBN Appendix 20210730_P0

ADJOINS - 61018331 GBN Appendix 20210730_P0



2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 6100
F: 61 2 9427 8200
www.slrconsulting.com

The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.: 610.18331

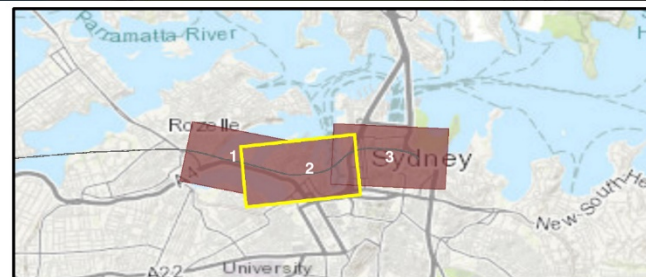
Date: 27-Aug-2021

Drawn by: ML

Scale: 1:5,000

Sheet Size: A4

Projection: GDA2020 MGA Zone 56



LEGEND

- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site
- Other Sensitive Receivers
- No Exceedance
- Low (1 to 10 dBA)
- Moderate (11 to 20 dBA)
- High (>20 dBA)

Sydney Metro Authority

Sydney Metro West
Stage 2

**Worst-case Ground-borne Noise
Impacts from TBM Tunnelling
All Periods**

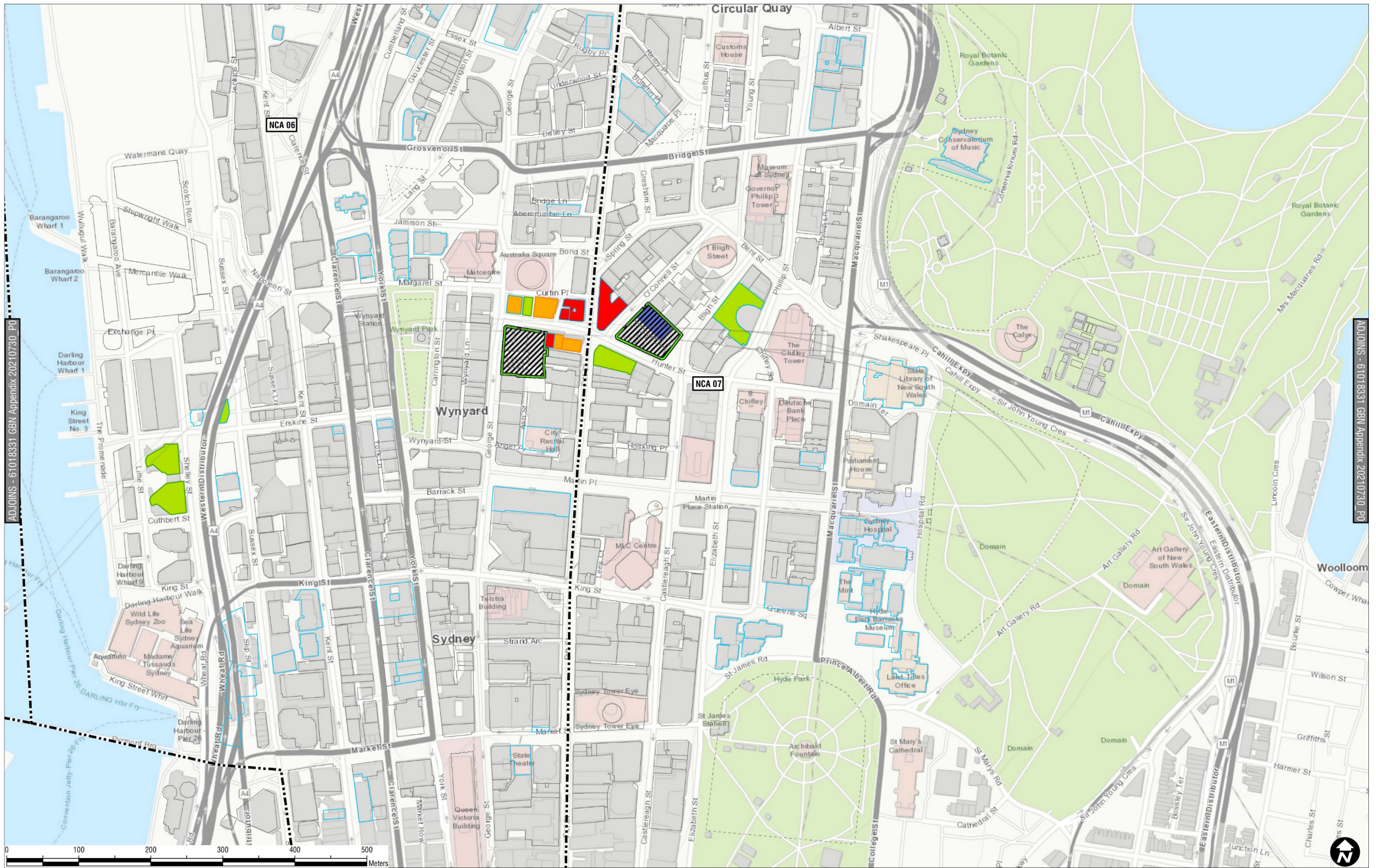
61018331 GBN Appendix 20210730_P02

Page 2 of 3

\\au.slr.local\corporate\Projects\SLR\610-18331\610-18331 Metro West\06 SLR Data\01 CAD\GIS\DRAWINGS\90 Stage 2\04 GBN\61018331 GBN Appendix 20210730.mxd

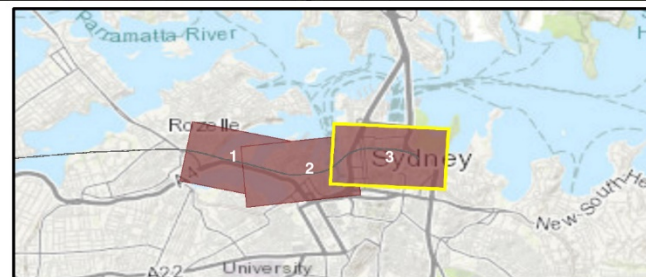
ADJOINS - 61018331 GBN Appendix 20210730_P0

ADJOINS - 61018331 GBN Appendix 20210730_P0



The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.: 610.18331
Date: 27-Aug-2021
Drawn by: ML
Scale: 1:5,000
Sheet Size: A4
Projection: GDA2020 MGA Zone 56



LEGEND

- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site
- Other Sensitive Receivers
- No Exceedance
- Low (1 to 10 dBA)
- Moderate (11 to 20 dBA)
- High (>20 dBA)

Sydney Metro Authority

Sydney Metro West
Stage 2

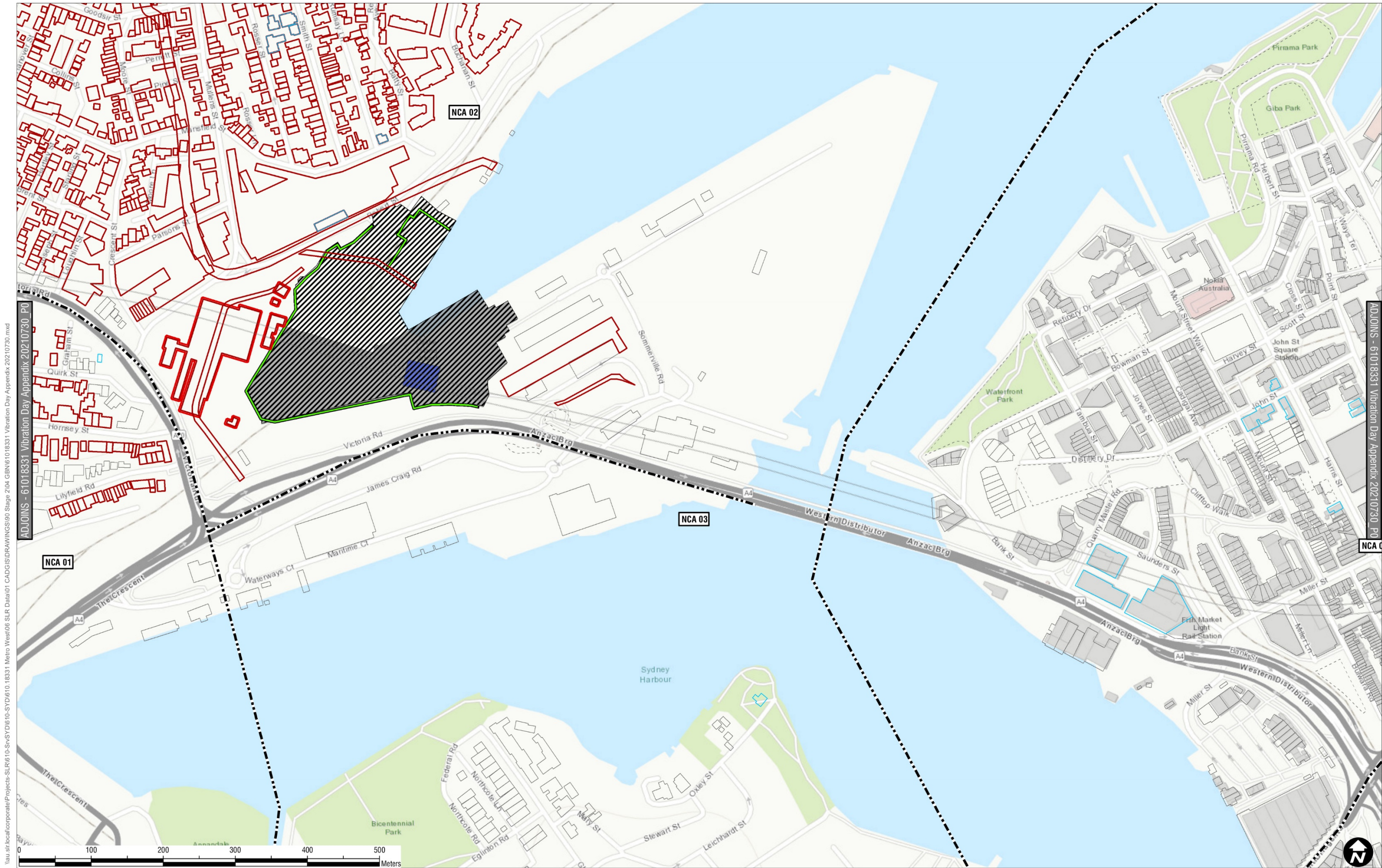
**Worst-case Ground-borne Noise
Impacts from TBM Tunnelling
All Periods**

61018331 GBN Appendix 20210730_P03

Page 3 of 3

APPENDIX F

Vibration Impacts from Tunnelling



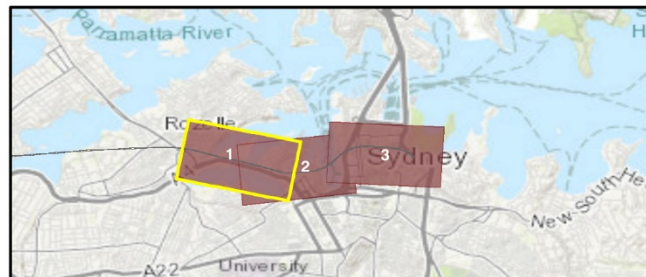
\\au.slr.local\corporate\Projects-SLR\610-SyVSYD\610-SYD\610-18331 Metro West\06 SLR Data\01 CADGIS\DRAWINGS\90 Stage 2\04 GBN\61018331 Vibration Day Appendix 20210730.mxd



2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.: 610.18331
Date: 27-Aug-2021
Drawn by: ML
Scale: 1:5,000
Sheet Size: A4
Projection: GDA2020 MGA Zone 56



- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site
- Heritage/Conservation Listed
- Vibration Sensitive Heritage
- Vibration Sensitive Equipment
- Human Comfort Criteria Exceedance
- Cosmetic Damage Screening Criteria Exceedance
- Sensitive Equipment Screening Criteria Exceedance

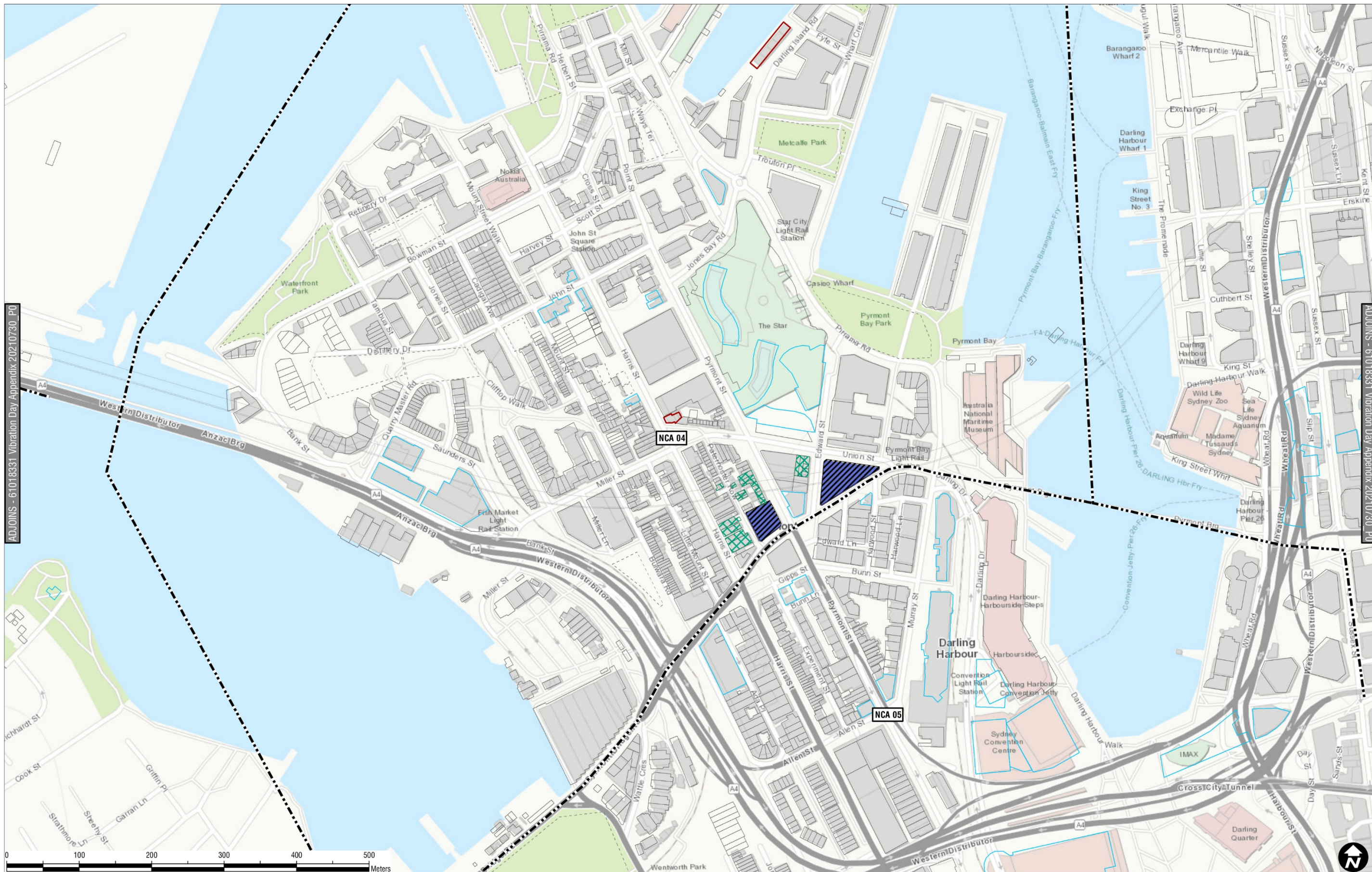
Sydney Metro Authority

Sydney Metro West
Stage 2

**Worst-case Vibration Impacts
from TBM Tunnelling
Day Time**

61018331 Vibration Day Appendix 20210730_P01

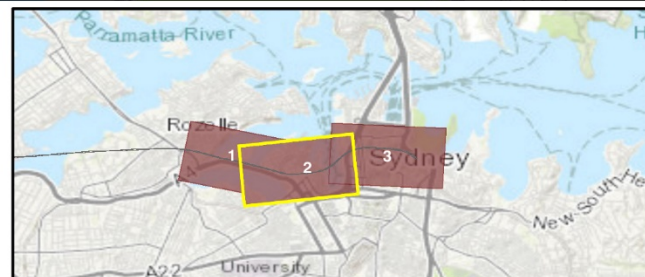
Page 1 of 3



SLR 2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

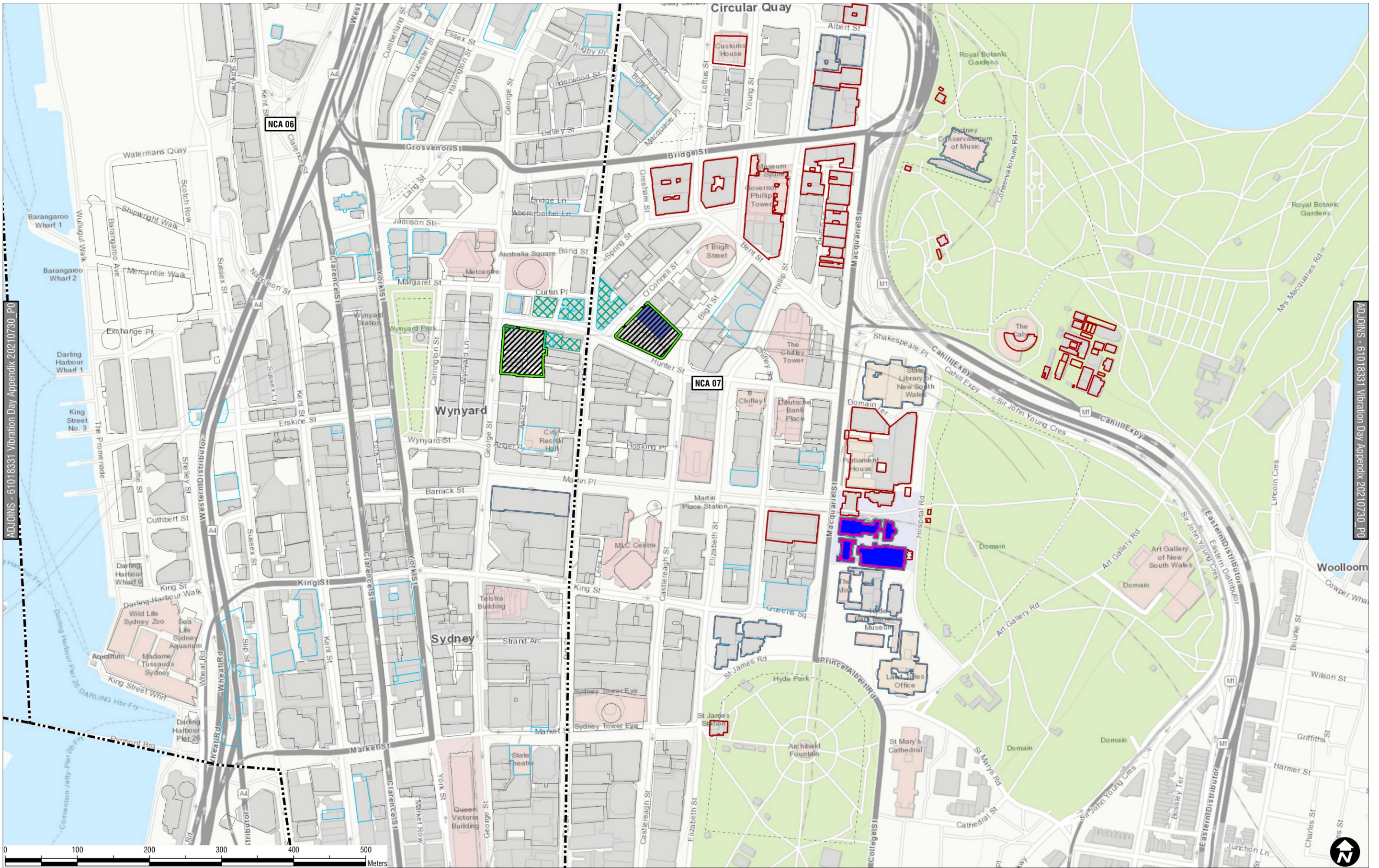
The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.: 610.18331
Date: 27-Aug-2021
Drawn by: ML
Scale: 1:5,000
Sheet Size: A4
Projection: GDA2020 MGA Zone 56



- NCA Boundary
- Project Alignment
- Construction Sites
- Acoustic Sheds
- Acoustic Hoarding
- Tunnel Launch and Support Site
- Heritage/Conservation Listed
- Vibration Sensitive Heritage
- Vibration Sensitive Equipment
- Human Comfort Criteria Exceedance
- Cosmetic Damage Screening Criteria Exceedance
- Sensitive Equipment Screening Criteria Exceedance

Sydney Metro Authority
Sydney Metro West Stage 2
Worst-case Vibration Impacts from TBM Tunnelling Day Time
61018331 Vibration Day Appendix 20210730_P02
Page 2 of 3

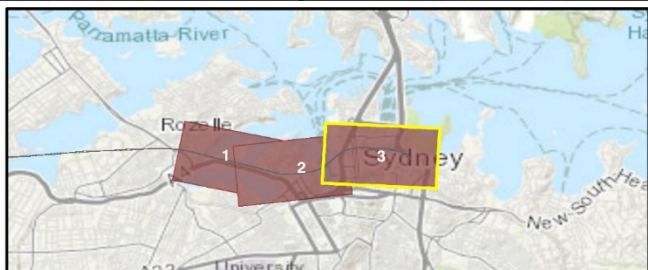




2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.:	610.18331
Date:	27-Aug-2021
Drawn by:	ML
Scale:	1:5,000
Sheet Size:	A4
Projection:	GDA2020 MGA Zone 56



- | | | |
|-----------------------|----------------------------------|---|
| --- NCA Boundary | ■ Tunnel Launch and Support Site | ■ Human Comfort Criteria Exceedance |
| --- Project Alignment | ■ Heritage/Conservation Listed | ■ Cosmetic Damage Screening Criteria Exceedance |
| ■ Construction Sites | ■ Vibration Sensitive Heritage | ■ Sensitive Equipment Screening Criteria Exceedance |
| ■ Acoustic Sheds | ■ Vibration Sensitive Equipment | |
| ■ Acoustic Hoarding | | |

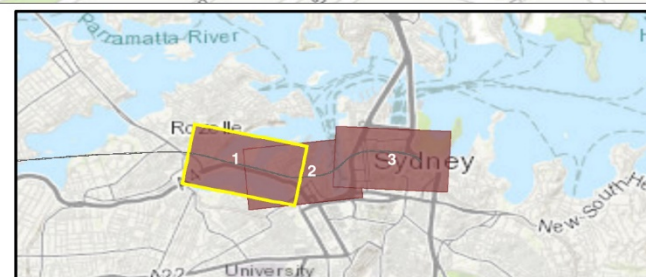
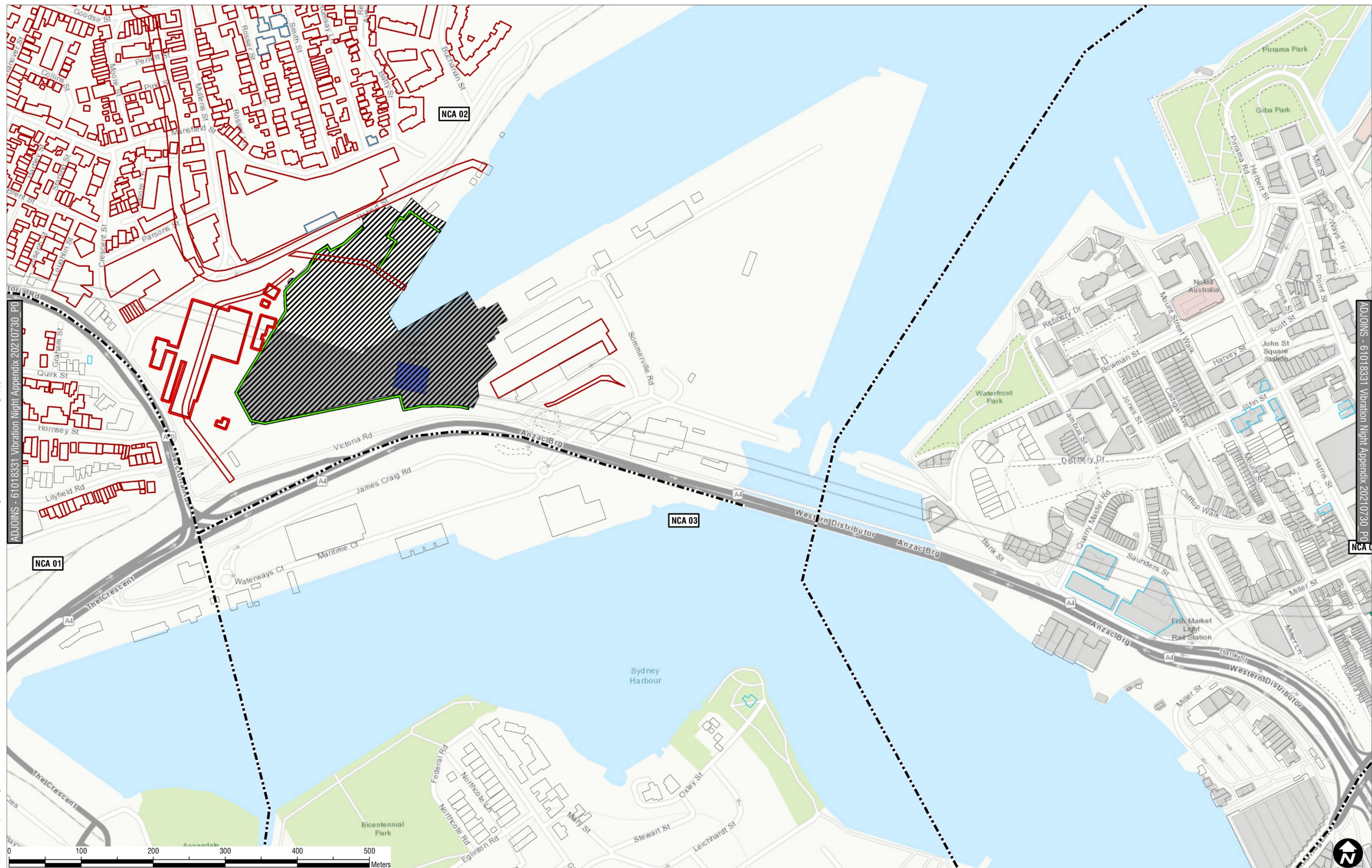
Sydney Metro Authority

Sydney Metro West Stage 2

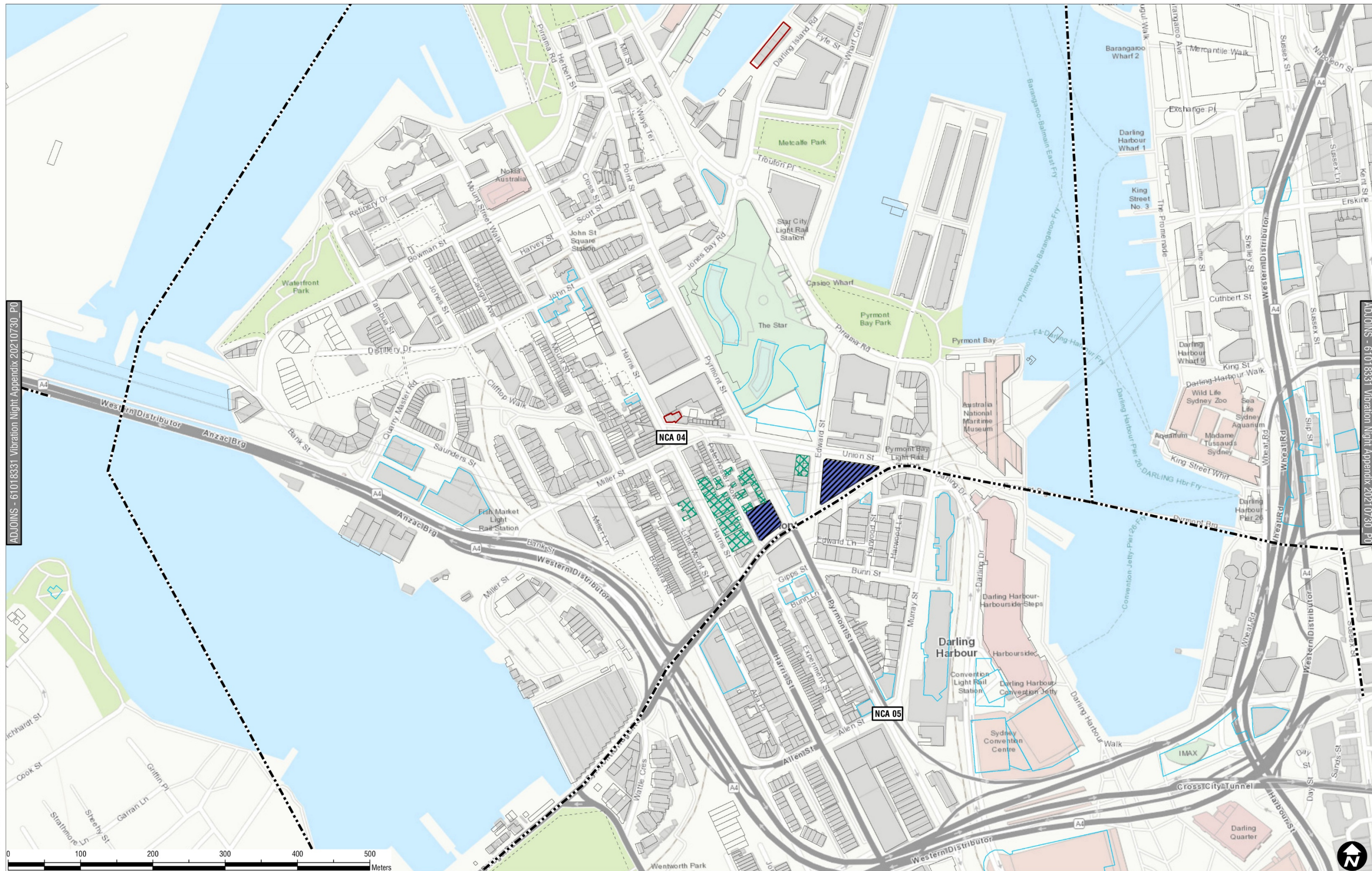
Worst-case Vibration Impacts from TBM Tunnelling Day Time

61018331 Vibration Day Appendix 20210730_P03

Page 3 of 3



\\au.slr.local\corporate\Projects\SLR\610-Sydney\610-Sydney\610.18331 Metro West\06 SLR Data\01 CAD\GIS\DRAWINGS\00 Stage 2\04 GBN\61018331 Vibration Night Appendix 20210730.mxd

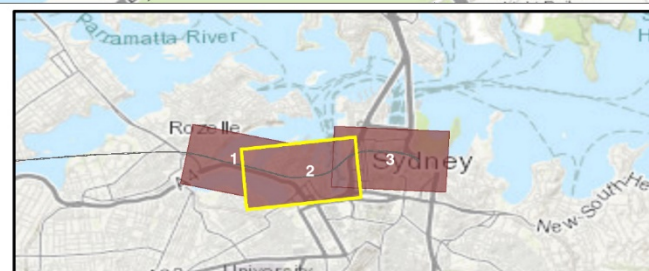


SLR

2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.:	610.18331
Date:	27-Aug-2021
Drawn by:	ML
Scale:	1:5,000
Sheet Size:	A4
Projection:	GDA2020 MGA Zone 56



LEGEND		
--- NCA Boundary	■ Tunnel Launch and Support Site	■ Human Comfort Criteria Exceedance
— Project Alignment	■ Heritage/Conservation Listed	■ Cosmetic Damage Screening Criteria Exceedance
■ Construction Sites	■ Vibration Sensitive Heritage	■ Sensitive Equipment Screening Criteria Exceedance
■ Acoustic Sheds	■ Vibration Sensitive Equipment	
■ Acoustic Hoarding		

Sydney Metro Authority

Sydney Metro West Stage 2

Worst-case Vibration Impacts from TBM Tunnelling Night Time

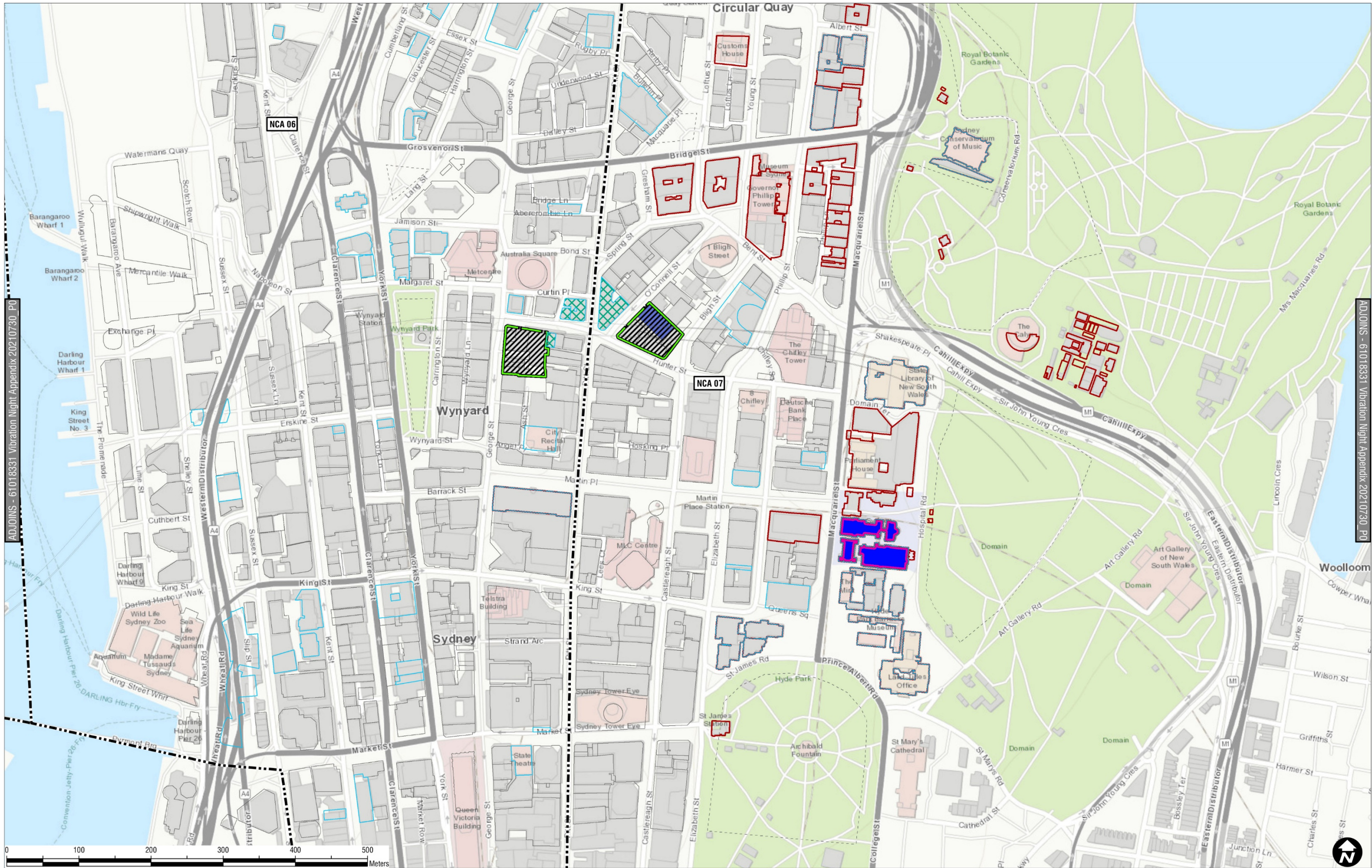
61018331 Vibration Night Appendix 20210730_P02

Page 2 of 3

\\au.slr.local\corporate\Projects\SLR\610-Sydney\610-Sydney\610-18331 Metro West\06 SLR Data\01 CAD\GIS\DRAWINGS\00 Stage 2\04 GBN\61018331 Vibration Night Appendix 20210730.mxd

ADJOINS - 61018331 Vibration Night Appendix 20210730_P0

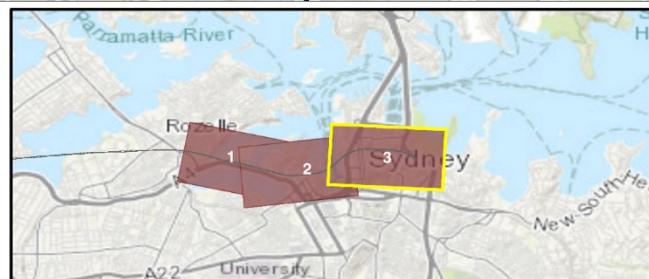
ADJOINS - 61018331 Vibration Night Appendix 20210730_P0



SLR
2 LINCOLN STREET
LANE COVE
NEW SOUTH WALES 2066
AUSTRALIA
T: 61 2 9427 8100
F: 61 2 9427 8200
www.slrconsulting.com

The content contained within this document may be based on third party data.
SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.

Project No.: 610.18331
Date: 27-Aug-2021
Drawn by: ML
Scale: 1:5,000
Sheet Size: A4
Projection: GDA2020 MGA Zone 56



LEGEND

- | | | |
|----------------------|----------------------------------|---|
| --- NCA Boundary | ■ Tunnel Launch and Support Site | ■ Human Comfort Criteria Exceedance |
| — Project Alignment | ■ Heritage/Conservation Listed | ■ Cosmetic Damage Screening Criteria Exceedance |
| ■ Construction Sites | ■ Vibration Sensitive Heritage | ■ Sensitive Equipment Screening Criteria Exceedance |
| ■ Acoustic Sheds | ■ Vibration Sensitive Equipment | |
| ■ Acoustic Hoarding | | |

Sydney Metro Authority

**Sydney Metro West
Stage 2**

**Worst-case Vibration Impacts
from TBM Tunnelling
Night Time**

61018331 Vibration Night Appendix 20210730_P03

APPENDIX G

CNVS Standard Mitigation and Management Measures

The actions set out in the summary of the standard mitigation measures below must be implemented on all Sydney Metro construction projects.

Table 1 CNVS Summary of the Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management measures		
Implementation of any project specific mitigation measures required	Airborne noise Ground-borne noise and vibration	In addition to the measures set out in this table, any project specific mitigation measures identified in the environmental assessment documentation (e.g. EA, REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement community consultation measures	Airborne noise Ground-borne noise and vibration	Periodic Notification (monthly letterbox drop) ¹ Website Project information and construction response telephone line Email distribution list Place Managers
Register of Noise Sensitive Receivers	Airborne noise Ground-borne noise and vibration	A register of all noise and vibration sensitive receivers (NSRs) would be kept on site. The register would include the following details for <ul style="list-style-type: none"> • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number
Site inductions	Airborne noise Ground-borne noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: <ul style="list-style-type: none"> • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on high noise generating activities • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios; on site. No dropping of materials from height; throwing of metal items; and slamming of doors. No excessive revving of plant and vehicle engines Controlled release of compressed air.
Monitoring	Airborne noise Ground-borne noise and vibration	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.

¹ Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works

Action Required	Applies To	Details
Attended vibration measurements	Ground-borne vibration	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise and vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.
Construction respite period	Ground-borne noise and vibration Airborne noise	High noise and vibration generating activities ² may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block ³ .
Equipment selection	Airborne noise Ground-borne noise and vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power Levels compliant with the criteria in Table 11 of the CNVS.
Rental plant and equipment	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 11 of the CNVS.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from NSRs Select site access points and roads as far as possible away from NSRs Dedicated loading/unloading areas to be shielded if close to NSRs Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible and reasonable

² Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

³ "Continuous" includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

ASIA PACIFIC OFFICES

BRISBANE

Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

MACKAY

21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

SYDNEY

2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

AUCKLAND

68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

CANBERRA

GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

MELBOURNE

Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

TOWNSVILLE

Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

NELSON

6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

DARWIN

5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

NEWCASTLE

10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

TOWNSVILLE SOUTH

12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

GOLD COAST

Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

PERTH

Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

WOLLONGONG

Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922