The Acoustic Group
CONSULTING ACOUSTICAL & VIBRATION ENGINEERING

45.5164.R5C:MSC

30th June, 2015

Solotel
Level 2, Golden Sheaf Hotel
429 New South Head Road
DOUBLE BAY NSW 2028

Attention: Mr B. Solomon

PROPOSED RESTAURANT & BAR
BUILDING R1
BARANGAROO PROJECT

The purpose of this report is to present the results, findings and recommendations of an acoustic assessment in relation to the proposed Restaurant & Bar to be located in the Building R1 of the southern portion of the Barangaroo Project, Sydney.

There is a proposal to utilise a newly constructed building (currently identified as building R1) in the south western corner of the Barangaroo site as a Restaurant & Bar for Solotel (see Appendices A1 & A2).

The R1 building has three levels (see cross section in Appendix A3). It has been identified that the top floor of the building is to be used as a high-end bar up to 250 patrons, the first floor as a restaurant up to 200 people and the ground floor as a general bar for up to 350 people.

Immediately to the north of building R1 is a newly constructed building designated R9 that is to have commercial/retail use on the ground floor with residential accommodation above. Building R9 represents the nearest residential premises for the purpose of an acoustic assessment, being located approximately 15 metres from the external building envelope of building R1.

To the east of building R1 is another commercial tower (was previously going to be residential) identified in Appendix A2 as building R7.

Of relevance to the acoustic environment of the area (particularly at night) is the existing licensed premises immediately south of building R1 that is identified as Bungalow 8, being approximately 55 metres from building R9.

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We have been advised that the proposed operating hours for building R1 is limited to midnight.

For the acoustic assessment of the proposed development there is a requirement to ascertain representative background levels and acoustic design targets/criteria specified for the Barangaroo Project.

There are a number of acoustic assessments/reports that have been prepared in relation to the Barangaroo project but no reports specifically in relation to the use of building R1.

Acoustic reports prepared in relation to the Barangaroo project identified high ambient noise levels for the area and that the provision of natural ventilation to residential apartments in the R9 building would exceed the satisfactory acoustic amenity criteria identified in the Council's Development Control Plan.

Under the Council's DCP to achieve a satisfactory acoustic amenity requires windows to be closed and the provision of mechanical ventilation. The attenuation of the building façade and the level of noise generated by the mechanical ventilation system are to obtain a repeatable maximum LAeq (1 hour) not to exceed 38 dB(A) for bedrooms (10pm – 7am) and 48 dB(A) for main living areas (24 hours).

As a consequence of the location of the R9 residential building it is obvious that with the doors and windows open there would be an unsatisfactory acoustic amenity in those apartments.

There is no identification within any report submitted to date that with doors and windows open the occupants of the residential apartments will have an unsatisfactory acoustic amenity. This matter become significant for the R1 project in that there is no prescribed policy/criteria in the acoustic reports for Barangaroo that address noise from licensed premises in terms of the requirement to have doors and windows closed to achieve a satisfactory acoustic amenity, thereby requiring the assessment of noise from licensed premises adjacent to or in Barangaroo to be assessed with doors and windows closed as was required for the apartment complex at 1 – 7 Macquarie Street, East Circular Quay.

We are advised that for the Barangaroo development the assessment of noise from licensed premises, including the proposed development in Building R1, will be subject to the council's standard noise conditions imposed by the Council that are related to the background level, but that for the period before midnight the criterion will be applied inside the dwelling with doors and windows closed and mechanical ventilation in operation.

As the Barangaroo Project is still under construction the current acoustic environment is impacted by construction noise and absent the general noise arising from the occupation and use of the new building. This situation requires in the first instance the use of previous noise data and predicted noise emission from the project.

In relation to building R9, the development application on the Department of Planning's website (with respect to a design modification) refers to an Operational and Construction Noise and Vibration Report prepared by Renzo Tonin & Associates dated November 2012.

A monitoring location near King Street Wharf (Tonin's L4) identifies a background level of 60 dB(A) during the evening period reducing to 46 dB(A) during the night time period but increasing to 48 dB(A) on a Saturday night. However these noise levels are only in dB(A) and do not cover the frequency spectrum specified for licensed premises by the Council and OLGR.

The data in Table 2 of the Tonin report indicates a night time Leq level of 60 dB(A) in the week and 62 dB(A) on a Saturday night. It is upon the Leq level that the construction of the building façade is assessed to achieve the internal levels from the DCP.

Section 5.3 of the Tonin report refers to future ambient noise levels applicable to the R8 & R9 buildings with reference to investigations carried out by Wilkinson Murray to determine the estimated ambient noise levels for Barangaroo South, being based on measurements carried out at East Circular Quay, Darling Walk and Harbourside.

Set out in Table 5 "Estimated Future Ambient Noise Levels at Barangaroo South Precinct" but are expressed in terms of an Leq level over the entire period and a maximum level (L1, period) but does not identify the estimated background level.

Attendance to King Street Wharf at night (and in the day) found there is no access to buildings R1 and R9 by way of fencing prohibiting access to the Barangaroo site. In any event measurements adjacent to the Barangaroo site boundary at night are dominated by noise from Bungalow 8 and are no assistance in determining the background level at building R9.

As a result of there being no suitable data to undertake the assessment, arrangements were made for the installation of an unattended noise logger in the SW corner of level 4 of building R9 with monitoring conducted between Wednesday 27th May through to Wednesday 3rd June 2015.

Measurement Techniques

Measurements were taken in accordance with the Australian Standard AS1055 *"Acoustics - Description and Measurement of Environmental Noise"* and the measurement procedures set out in Appendix B of the EPA's *Industrial Noise Policy*.

The attended sound level measurements were recorded using Brüel & Kjær 2260 Sound Level Meter (serial Nos. 1772289) for the attended survey. The reference calibration level of each meter was checked prior to and after measurements using a Brüel & Kjær Sound Level Calibrator Type 4231 and exhibited no system drift. The calibration of the sound level meter to manufacturer's requirements is current.

Unattended sound level measurements were recorded using a BWSA 801 sound level meter (serial No. 14988). The reference calibration level of the meter was checked prior to and after measurements using a Brüel & Kjær sound level calibrator Type 4230 and exhibited a system drift. The calibration of the Sound Level Meter (logger) to manufacturer's requirements is current.

Measurement Results

Appendix B provides the results of sound level measurements conducted on 22nd May 2015. As noted above the acoustic environment of the area was dominated by noise from Bungalow 8 and controlled the background and Leq level at the wharf location.

The time splice graph in Appendix B shows the variation in the A-weighted level for location 1 (in Lime Street) where there was a reduced level of noise from Bungalow 8 such that the environment was a mixture of Bungalow 8, vehicle traffic and pedestrian traffic.

Appendix C sets out the unattended noise logger results (in A-weighted statistical levels) over the entire period between 27th May 2015 and 3rd June 2015.

The ambient background levels in the day are influenced by construction activities where it can be seen for Saturday 30th May (1fter 2pm) and all of Sunday 31st May the background levels are noticeably lower.

The major concern for the acoustic assessment is the ambient background levels to 12 midnight. For Wednesday night, Thursday night, Sunday night and Monday night the background levels are at or slightly above 50 dB(A).

However for Friday night and Saturday night the background levels at midnight are in the order of 62 dB(A) as a result of Bungalow 8. The logger results reveal for building R9 the average ambient Leq levels to be similar to those nominated by Tonin. However for the Council's repeatable maximum LAeq, 1 hour there would appear to be higher levels than the average Leq level over the night period on weekend nights.

The Tuesday night results indicate the influence of an extraneous noise source.

Access to building R9 or the area adjacent building R9 for the purpose of conducting attended measurements at night (to supplement the unattended logger measurements) was denied.

The unattended noise logger data when processed in accordance with Appendix B of the EPA's *Industrial Noise Policy* results in the following Rating Background Levels and ambient Leq levels.

TABLE 1: Unattended Noise Logger Results, dB(A) – All Data

	Day (7am - 6pm)	Evening (6pm - 10pm)	Night (10pm - 7am)
Rating Background Levels	60	54	47
Leq Ambient Noise Levels	73	63	60

If one separates the week day logger data from the weekend (Friday & Saturday for the night period, and Saturday and Sunday for the day and evening periods) and then applies the Rating Background method the following background levels are obtained for the weekend.

TABLE 2: Unattended Noise Logger Results, dB(A) – Weekend

	Day (7am - 6pm)	Evening (6pm - 10pm)	Night (10pm - 7am)
Rating Background Levels	56	55	48
Leq Ambient Noise Levels	67	62	62

The logger used for measurements (being a precision sound level meter) is capable of determining the statistical results of the octave bands for the purpose of such analysis. Appendix D sets out the octave band logger information where the results are presented in terms of the Rating Background Level method adopted by the EPA for the day, evening and night time periods. As the ambient background level throughout the night can change significantly Appendix D also considers the Rating Background Level in 2 hour segments through the night time period the provide identification of the change throughout the night.

Appendix D provides an example of 24 hour octave bands for the entire logging period utilising unweighted (linear) frequency results in view of the attenuation of the A-weighted curve would render some frequency bands not measurable.

Appendix D1 provides the RBL in Linear Octave Bands derived for the entire monitoring period for the EPA assessment periods and 2 hour periods during the night. The RBL for the period of 10pm to midnight is 52 dB(A).

A similar table is provided for the weekend night data to reveal the RBL for 10pm to midnight is 61 dB(A).

Despite building works occurring on the site at night the background levels provided for the critical period of 10pm to midnight (excluding the Tuesday night) are considered as being representative of the current environment.

For the purpose of the acoustic assessment the above existing background levels would be subject to a marginal increase as a result of mechanical plant serving the various building on the Barangaroo site. We have been advised that the sources of plant likely to affect the southern end of building R9 would be rooftop plant from R1 and R7 (including risers for fresh air supply to the basement of those buildings). We understand that the criteria for mechanical plant in the Barangaroo site has been to assign a 45 dB(A) criterion for each “building” when assessed at the nearest residential building.

On this basis it is considered the resultant background level of existing + approved mechanical plant would be an additional 1 dB(A) for the lower levels of building R9 and 2 dB(A) for the upper levels above the base RBL of 52 dB(A) to midnight. For the Friday and Saturday nights the mechanical plant contributions are not considered to add to the measured background level of 61 dB(A) for those two nights.

The potential for an increase in the background level as a result of other licensed premises on the ground floor of building R9 is unknown at this time and therefore cannot be included in this assessment. It may well be that after the ground floor of building R9 is occupied and operational the background levels at night will increase.

Acoustic Criteria

Mechanical plant for ventilation services on Building R1 was included in the overall noise emission consent conditions for Barangaroo and therefore does not form part of this assessment. The critical issue for the proposed operations is compliance with the OLGR criteria, which in the absence of noise conditions for the residential apartments in Building R9 that would apply with doors and windows closed, must apply at the residential boundaries as discussed below.

In relation to noise emission from Licensed Premises the former NSW Liquor Administration Board ("LAB") imposed a more stringent set of noise criteria to that normally imposed by the EPA.

The same noise criteria (as the LAB) have been adopted by the Office of Liquor, Gaming and Racing, being the government department replacing the LAB (now incorporated into the Department of Trade and Investment, Regional Infrastructure and Services).

For consistency with the general description of noise criteria for licensed premises we refer to the LAB/OLGR noise criteria for the licensed premise as the "OLGR" criteria.

For the purposes of conducting an OLGR compliance assessment, measurements are in the form of an average maximum level compared to the background level in octave bands, rather than the Leq approach adopted by the EPA/DECC for industrial noise sources.

In OLGR assessments there is a requirement to break up the analysis into frequency components called octave bands with centre frequencies from 31.5 Hz to 8 kHz. Musically speaking, low frequency is typical of the bass guitar and bass drum whilst high frequency is like a cymbal or a triangle. The octave bands measured encompass most of the audible spectrum and the OLGR analysis requires the music to be assessed in individual octave bands.

The OLGR criteria are in two parts according to different times of day being the pre midnight criteria (7.00 am to midnight) and the post-midnight criteria (after midnight to 7.00 am). The OLGR pre midnight criteria allows noise emissions from a licensed premises to exceed the background noise level by 5 dB in any octave band with centre frequencies between 31.5 Hz and 8 kHz at any residential boundary.

As the background level is defined as the level that is exceeded 90% of the time and therefore is measured on a statistical basis, the impact of the acoustic environment of the area on a statistical L10 level does not permit one to determine the noise level attributed to the licensed premises.

To identify the difference between the existing ambient L10 and the noise to be assessed from a licensed premises the OLGR before midnight residential boundary criterion be described as:

> *The LA10* noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5 Hz – 8k Hz inclusive) by more than 5 dB between 07:00 am and 12:00 midnight at the boundary of any affected residence.*

For the purpose of the OLGR jurisdiction the LA10* means the average maximum deflection on a sound level meter – not a statistical L10 level.

The OLGR post–midnight criteria are more stringent and require that the noise emission from any licenced premises is not to exceed the background noise level within the same octave bands used in the pre–midnight criteria at any residential boundary. The post-midnight criteria also stipulate that noise emissions from licenced premises are to be inaudible in any habitable room of any residential premises.

As access is not normally available to residential premises for the period after midnight, determination of the inaudibility criterion is based upon contribution of between 7 to 10 dB below the background.

We are instructed the operating hours for the proposed development will not extend past midnight. Therefore the background + 5 dB (in octave bands) limit would apply at residential receivers.

Using the RBL results in Appendix D for the critical period of 10pm to midnight the background levels and the resultant noise limits (all A-weighted) with the uniform incremental increase for mechanical plant have been applied for this assessment.

TABLE 3: Week day nights 10pm - midnight

	dBA	A-weighted Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1k	2k	4k	8k
R9 Level 4 RBL	54	16	32	40	44	50	50	45	37	20
OLGR criterion	59	21	37	45	49	55	55	50	42	25
R9 Level 1 RBL	53	15	31	39	43	49	49	42	34	19
OLGR criterion	58	20	38	44	48	54	54	47	41	24

TABLE 4: Friday and Saturday nights

	dBA	Linear Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1k	2k	4k	8k
R9 RBL	61	17	38	45	48	55	57	54	47	31
OLGR criterion	66	22	43	50	53	60	62	59	52	36

The Council use for licensed premises a condition similar to the OLGR conditions but specifying the L10 level as a statistical level rather than the OLGR average maximum level. The statistical method is more difficult to use where there are extraneous noise sources that are also present during such measurements.

Determining the noise emitted from a licensed premise (i.e. a contribution) is complex on a statistical basis and requires the use of listening to the recorded data to remove extraneous noise from the calculation program and can be very time consuming.

The modification of the standard council noise condition to apply inside the dwellings with doors and windows closed and mechanical ventilation operating simplifies the issue of extraneous noise.

However, in the absence of details concerning the construction of the façade for building R9, or the design level of mechanical plant, one is presented a difficulty in undertaking the assessment. One can only assume from the Tonin report the external noise level with respect to the DCP's internal Leq (1 hour) level not to exceed 38 dB(A) for bedrooms (10pm – 7am) and 48 dB(A) for main living areas (24 hours) is greater than 53 dB(A) to midnight for weekdays and above 60 dB(A) on Friday and Saturday nights.

From the logger graphs in Appendix C that identify the ambient noise at night the ambient L90 is approximately 2 dB lower than the Leq on the weekend nights. To comply with the DCP requirements the external design target would have to be not less than 63 dB(A) thereby giving rise to a noise reduction of not less than 63 – 48 = 15 dB(A) for main living areas and 63 – 38 = 25 dB(A) for bedrooms. Assuming the major element for the transmission of noise is the glazing one can consider Rw ratings not less than 22 for the main living areas and 32 for bedrooms if the entire façade was glass. Any safety factor or a higher Rw could be used for design purpose but such design targets are unknown.

Acoustic Assessment

With respect to the R1 usage the proposal was for the top floor of the building to be used as a high-end cocktail bar up to 250 patrons (100 inside and 150 outside), the first floor as a restaurant up to 200 patrons (150 inside and 50 outside), and the ground floor as a general bar for up to 350 patrons (120 inside and 230 outside).

In dealing with the emission of noise from outdoor areas in licensed premises the procedure is to consider the sound power level 50% of the patrons talking simultaneously at the relevant vocal effort to then apply distance attenuation, sound power to sound pressure level conversion and any additional attenuation due to absorption or shielding.

For restaurant use the vocal effort is classified as "normal voice" whilst for a general outdoor terrace "raised" voice is used until such time as the density increases (or the space is confined) when the level increases to loud.

For the nominated patron numbers on the ground floor the density for the internal area increases the vocal effort to loud.

Examination of the plans set out in Appendix A it can be seen that from an acoustic perspective the layout for building R1 can have patrons approximately 15 metres from building R9 for the outdoor balconies, whilst moving to the south provides additional distance attenuation, acoustic shielding and can involve closed facades. The permutation of different locations for patrons and different residential receiver locations leads to a matrix of possible permutations to be assessed.

The combination of three floors of R1 that can operate simultaneously presents a further complexity in the assessment of noise emitted from the licensed premises. For the purpose of a preliminary analysis to gauge the potential number of patrons under the standard OLGR approach the following table considers a background level of 52 dB(A) at the lower balconies (levels 1 – 3) and 54 dB(A) for level 4 of R9 to determine the maximum number of patrons for three external areas per level giving a contribution of 52/54 dB(A) per location.

TABLE 5: Permissible number of People per area – standard OLGR approach

R9 level	North Balcony	West Balcony	South Balcony
Ground Floor of R1 (RL 3.45)			
1 (RL 9.2)	34	200>	200>
2 (RL 12.3)	40	200>	200>
3 (RL 15.5)	50	200>	200>
4 (RL 18.65)	200>	200>	200>
First Floor of R1 (RL 8.2)			
1 (RL 9.2)	112	200>	200>
2 (RL 12.3)	120	200>	200>
3 (RL 15.5)	138	200>	200>
4 (RL 18.65)	200>	200>	200>
Second Floor of R1 (RL 12.45)			
1 (RL 9.2)	108	.200>	200>
2 (RL 12.3)	30	104	200>
3 (RL 15.5)	30	200>	200>
4 (RL 18.65)	56	200>	200>

The above table indicates the relevance of the various levels of R1 versus the level of R9 that reflect the elevation in Appendix A3, i.e. the ground floor of R1 is the major impact of level 1 on R9 whilst the second floor of R1 is the major impact on level 2 of R9.

Appendix E provides a more detailed analysis of the impact of R1 level 2 on R9 level 2 (including octave band analysis) showing the increase in distance attenuation and shielding effects on the contribution assigned to each area. Compliance with the standard OLGR/Council criteria for licensed premises imposes restrictions on the proposed operation of building R1.

For the Saturday night RBL the permitted higher noise limits would not place any restrictions of the proposed number of patrons.

Undertaking the same exercise on the basis of the OLGR criterion is applied inside the habitable rooms with the doors and windows closed requires one to assume the internal background level if controlled by the external noise and the mechanical plant to be 35/36 for bedrooms and 45/46 dB(A) for living rooms. Using these levels provides the following maximum number of patrons for three external areas per level.

TABLE 6: Permissible number of People per area – modified Council approach

R9 level	North Balcony	West Balcony	South Balcony
Ground Floor of R1 (RL 3.45)			
1 (RL 9.2)	78	200>	200>
2 (RL 12.3)	82	200>	200>
3 (RL 15.5)	100	200>	200>
4 (RL 18.65)	200>	200>	200>
First Floor of R1 (RL 8.2)			
1 (RL 9.2)	200>	200>	200>
2 (RL 12.3)	200>	200>	200>
3 (RL 15.5)	200>	200>	200>
4 (RL 18.65)	200>	200>	200>
Second Floor of R1 (RL 12.45)			
1 (RL 9.2)	200>	.200>	200>
2 (RL 12.3)	58	104	200>
3 (RL 15.5)	62	200>	200>
4 (RL 18.65)	70	200>	200>

The above table indicates for the modified council condition there would need to be a limitation of 78 people on the northern ground floor balcony and 58 people for the northern balcony on the second floor on Sunday to Thursday nights.

In considering noise emissions we have assumed the glass facades are 10.38mm glass by reason of the size of the panels and the underside of the external balconies have acoustic absorption above the slotted timbers. Such absorption shall be suitable for the outdoor space and have a NRC (Noise Reduction Coefficient) not less than 0.85 incorporated into the design.

On the basis of a balanced contribution from each of the external areas and the internal areas as shown on the fit out plans for the R1 building, to satisfy the OLGR criteria of background +5 dB applied inside the residential apartments before midnight, the following operating restrictions will apply:

- the northern balcony (closest to building R9) on level 2 should be restricted to a maximum of 58 people 7 days a week.
- for level 2 operations after 10 PM on any day except Friday or Saturday the northern facade of the internal area is required to be closed.
- the internal occupancy of level 2 requires a ceiling providing acoustic absorption (not set plasterboard)
- the restaurant on level 1 is required to have an acoustic ceiling (not set plasterboard).
- the ground floor northern (external) area should be restricted to a maximum of 78 people 7 days a week.
- the northern façade of the ground floor internal bar area is to be closed from 9 PM on Sunday to Thursday.
- the bar area on the ground floor is required to have an acoustic ceiling (not set plasterboard).
- whilst the intent of building R1 is not that of a night club, the provision of music throughout the internal parts venue for the purpose of background music has considered an internal noise level of 95 dB(A) at 2 metres from any speakers and that no speakers are to be directed towards building R9. The internal level may be modified subject to compliance testing.
- External speakers can be provided for any level of R1.
- Any external speakers should be located in the ceiling and directed downwards.
- The permitted level for such speakers is subject to compliance testing where levels for each section can be determined and the limiter set to control each area.

Additional external seating could be provided for the southern balcony to cater for the restriction in numbers on the northern balcony, or could be used as a designated smoking area.

Conclusions

In an acoustic planning sense the Barangaroo project whilst requiring noise controls to residential apartments to address the existing acoustic environment (or the anticipated acoustic environment) of the area failed to identify that such a situation should apply for the assessment of noise emitted from various licensed premises both in and near the Barangaroo project.

The fact the residential buildings incorporate noise control measures to address the external noise environment (which would include licensed premises as part of the project) is a relevant factor in terms of the acoustic planning of the Barangaroo project.

The consequence of having appropriate noise control measures and mechanical ventilation to satisfy the Council's DCP should have automatically been identified as part of addressing noise from licensed premises that could have been incorporated into the specification of the project such that noise from individual licensed premises and the cumulative impact of noise from multiple licensed premises would have been applied inside the residential apartments with the windows closed and mechanical ventilation in operation.

This is the same situation that applied for the Toaster/Bennelong apartment development on Macquarie Street East Circular Quay where the acoustic planning concepts identified a very high acoustic environment and specifically imposed a condition for any noise intrusion to residential apartments was based upon the windows closed to mechanical ventilation operating. There would not appear to be any such condition on the DA for building R9.

The liquor licence for premises both in and adjacent to the Toaster/Bennelong apartments reflects that situation and gives the occupants of the apartments the ability to have a satisfactory acoustic environment in their apartments. If the residents choose to have the windows open and natural ventilation then the ambient noise in the area, including noise from licensed premises, becomes by choice their internal acoustic environment without placing any undue burden or restriction on the operation of licensed premises.

The City Council has been quite specific that if there are no such restrictions on the development consent for apartments then notwithstanding the provision of conditions to satisfy the Council's DCP for the internal acoustic amenity that position does not permit the assessment of licensed premises to occur with the windows closed and said mechanical ventilation in operation.

Renzo Tonin & Associates, who prepared the Operational Noise Management Plan for Building R9, and referred to the DCP acoustic requirements, whilst being aware of the Council's position in relation to that expressed in the previous paragraph, having advised the Council on that exact point before the Land & Environment Court concerning the Slip Inn (Hemmes Trading Pty Ltd v Council of the City of Sydney [2012] NSWLEC 1048), did not identify the impact from building R1 on building R9, or the acoustic criterion that would be applied to the operation of various licences premises in proximity to building R9.

The acoustic environment of the area in proximity to building R1 is significantly influenced by noise emitted from the Bungalow 8 premises that gives rise to a substantial increase in the background levels on Friday and Saturday nights.

Because of the increased background and Leq level on Friday and Saturday nights that have been established previously the acoustic design of buildings R8 & R9 have been designed to satisfy the internal noise targets in the Council's DCP. The details of the façade construction and the internal noise level from the mechanical ventilation have not been supplied.

It is proposed to amend the above situation by modifying the conditions of consent to apply the council's noise limits inside the dwellings of R8 & R9 to require the assessment to occur with the doors and windows closed and the mechanical ventilation operating.

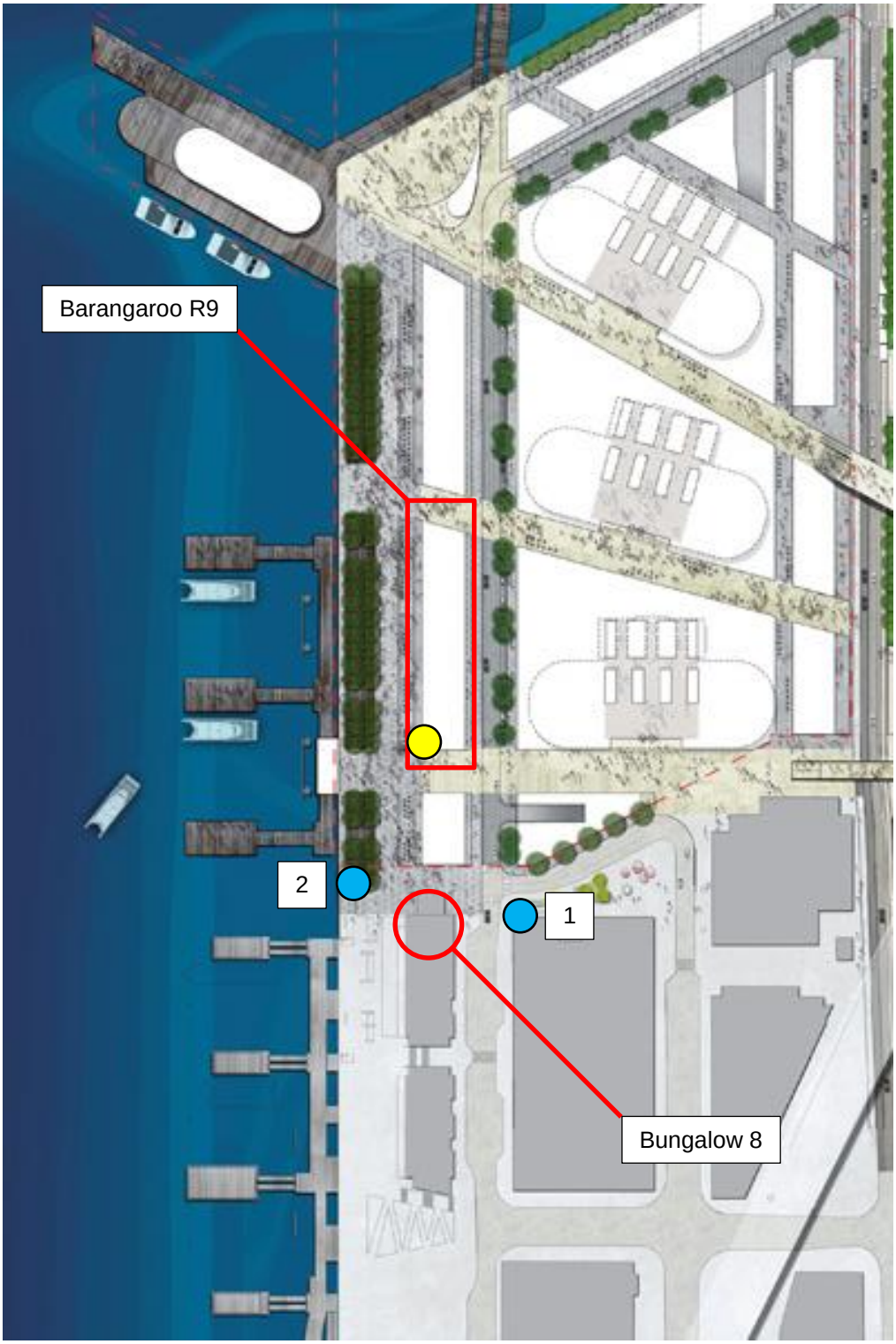
The consequence of having to comply with the OLGR/council criteria inside the dwellings permits the use of R1 to occur with minor restrictions to the northern balconies/outdoor areas on the northern side of the ground level and the second level.

Yours faithfully,

THE ACOUSTIC GROUP PTY LTD

STEVEN E. COOPER

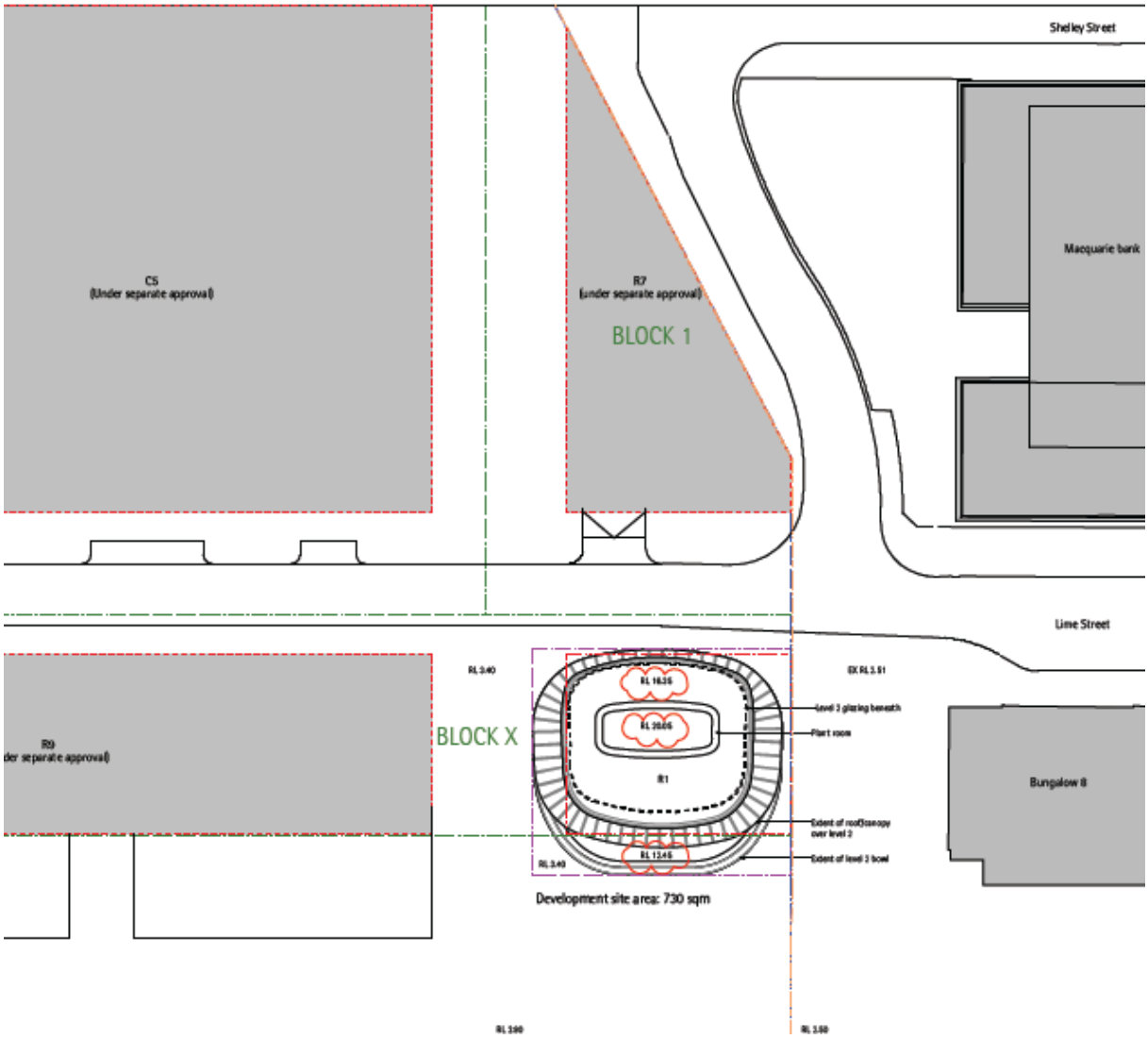
APPENDIX A: Site and Measurement Locations

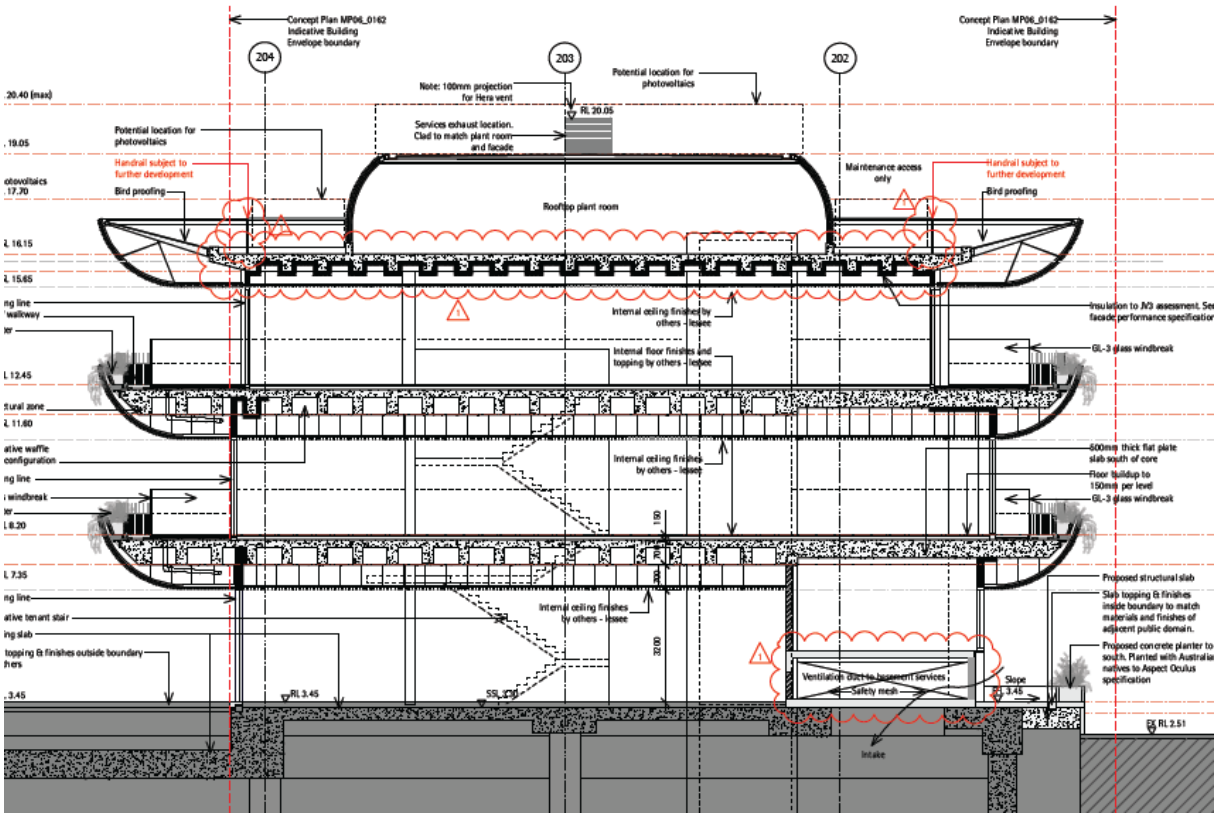


http://www.australiandesignreview.com/features/30412-barangaroo-the-towers-the-fury

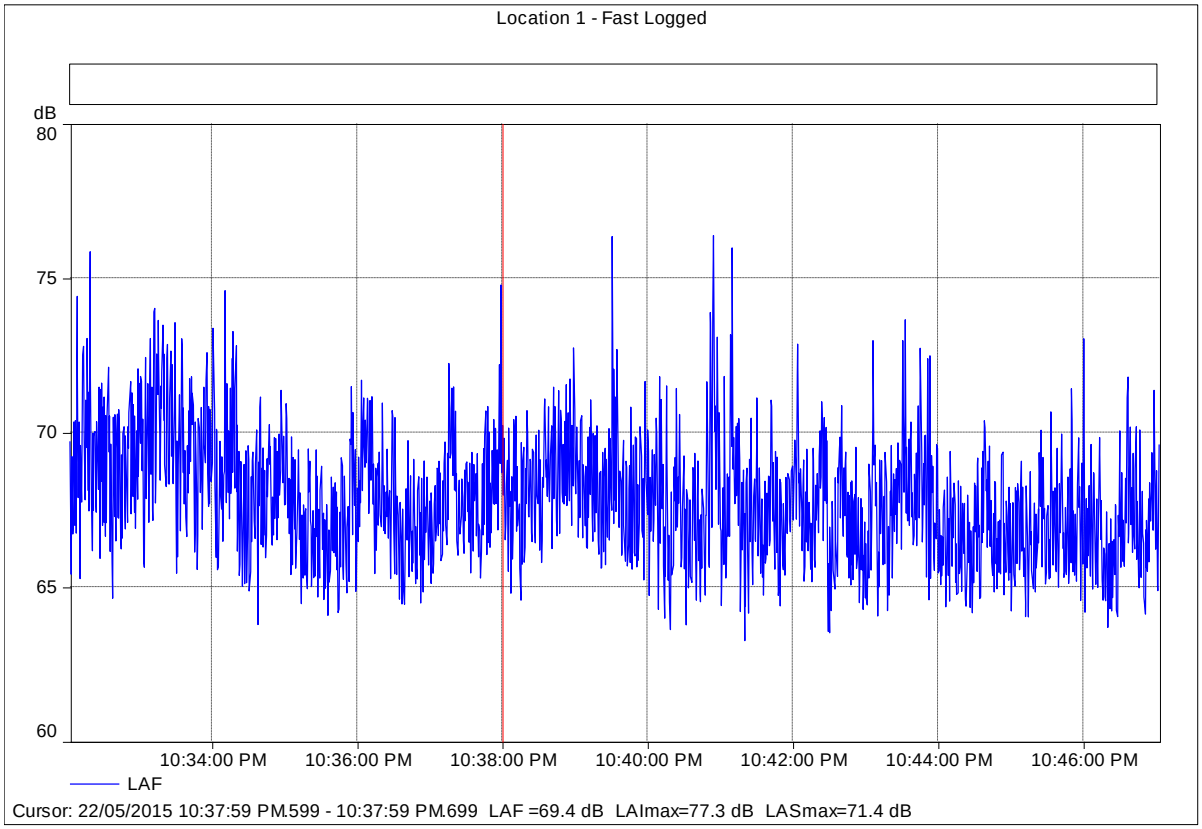
Attended Measurement Location

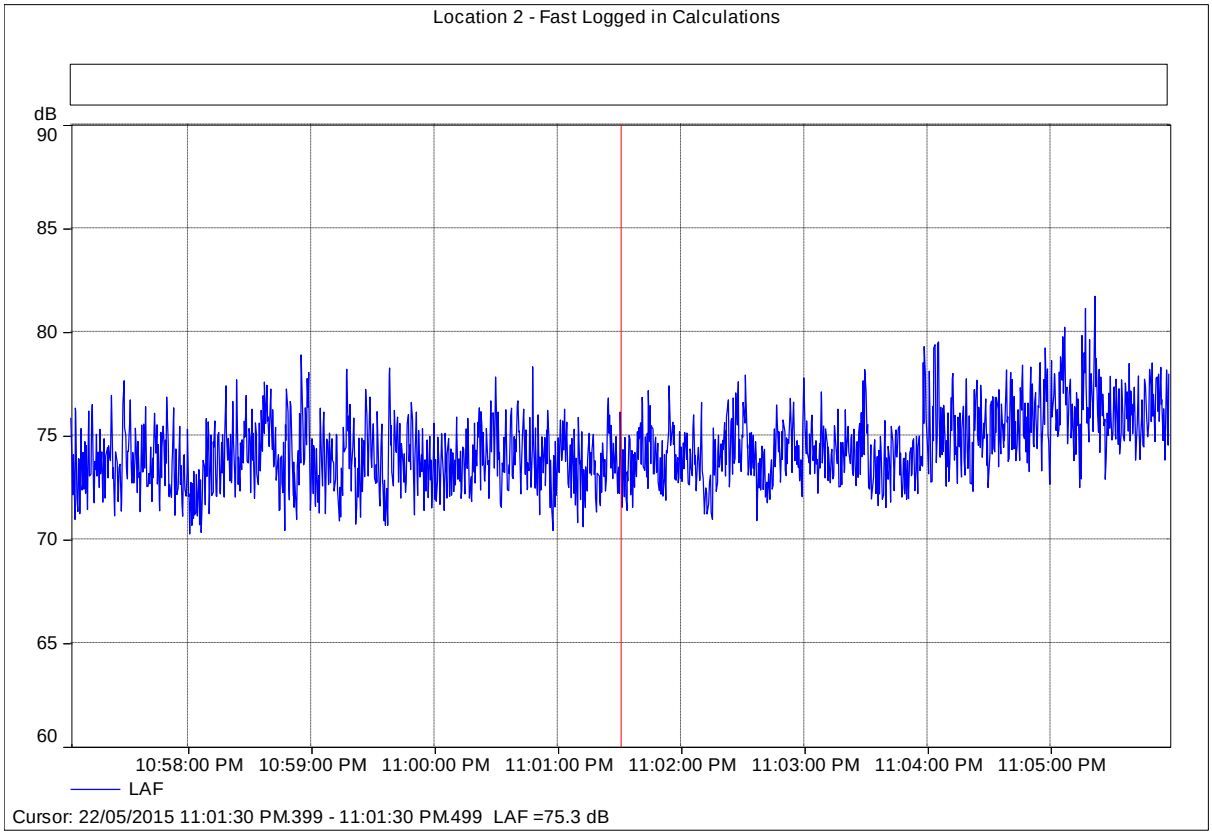
Logger Location


Shelley Street
Macquarie bank
C5
(Under separate approval)
R7
(under separate approval)
BLOCK 1
Lime Street
BLOCK X
R9
Bungalow 8
R1
Development site area: 730 sqm


Concept Plan MP06_0162
Indicative Building
Envelope boundary
204
203
202
Potential location for
photovoltaics
Note: 100mm projection
for Hera vent
RL 20.05
Services exhaust location.
Clad to match plant room
and facade
Maintenance access
only
Handrail subject to
further development
Bird proofing
Rooftop plant room
Internal ceiling finished by
others - lessee
Internal floor finishes and
topping by others - lessee
Insulation to JV3 assessment. See
facade performance specification
GL-3 glass windbreak
600mm thick flat plate
slab south of core
Floor buildup to
150mm per level
Internal ceiling finishes
by others - lessee
Proposed structural slab
Slab topping & finishes
inside boundary to match
materials and finishes of
adjacent public domain.
Proposed concrete planter to
south. Planted with Australia
natives to Aspect Oculus
specification
Ventilation duct to basement services
Safety mesh
Slope
3.45
RL 3.45
RL 2.51
Intake

APPENDIX B: Attended Measurements





Location	Parameter		Octave Band Centre Frequency (Hz), dB(A)								
		dB(A)	31	63	125	250	500	1k	2k	4k	8k
1	Ambient L_{10}	70	37	56	62	59	63	66	63	57	49
	Ambient L_{eq}	68	35	54	59	56	61	64	61	55	46
	Ambient L_{90}	66	31	48	53	52	58	61	58	51	41
2	Ambient L_{10}	76	38	60	65	66	69	73	70	65	57
	Ambient L_{eq}	74	35	57	63	63	67	70	68	62	53
	Ambient L_{90}	72	30	51	56	58	65	67	66	59	47

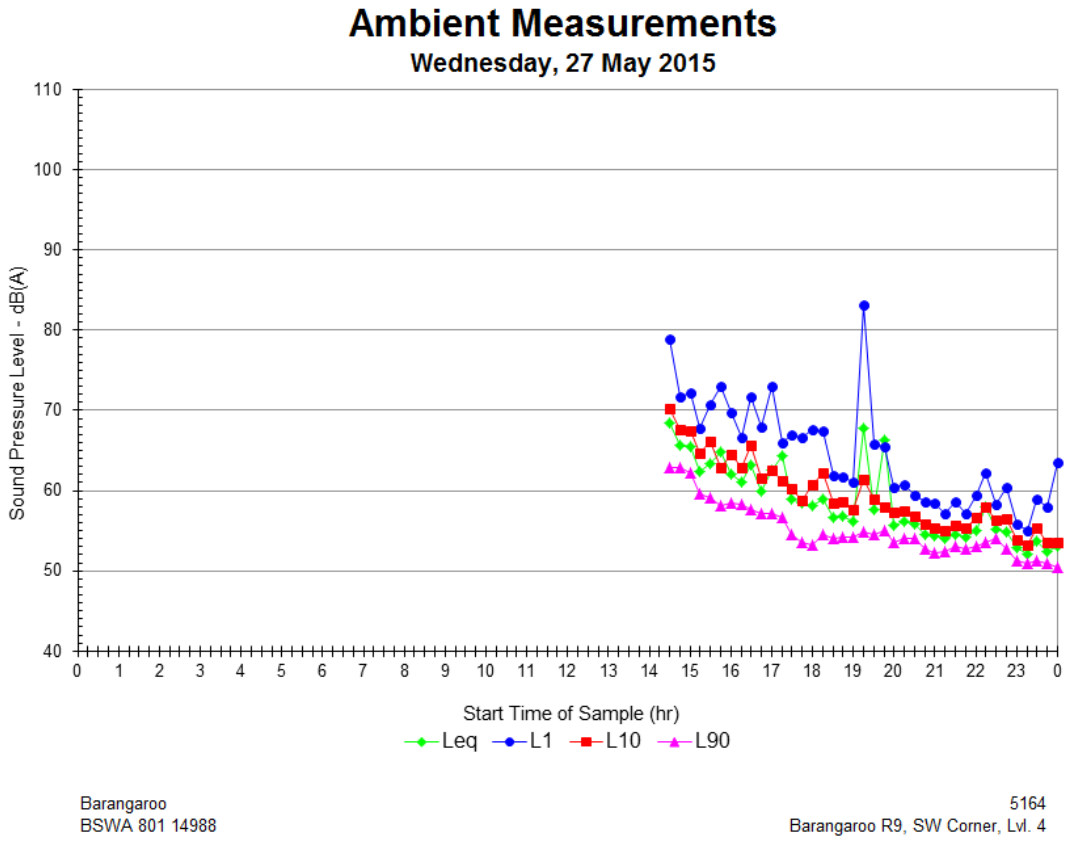
APPENDIX C: Logger Results

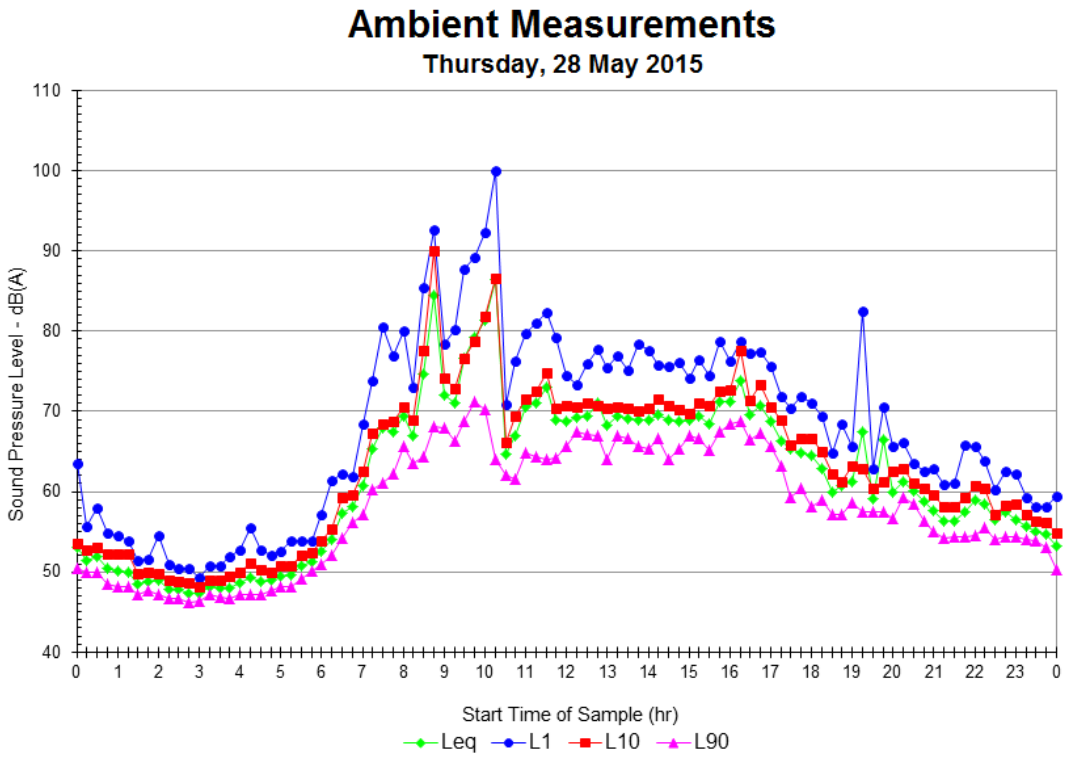
Barangaroo

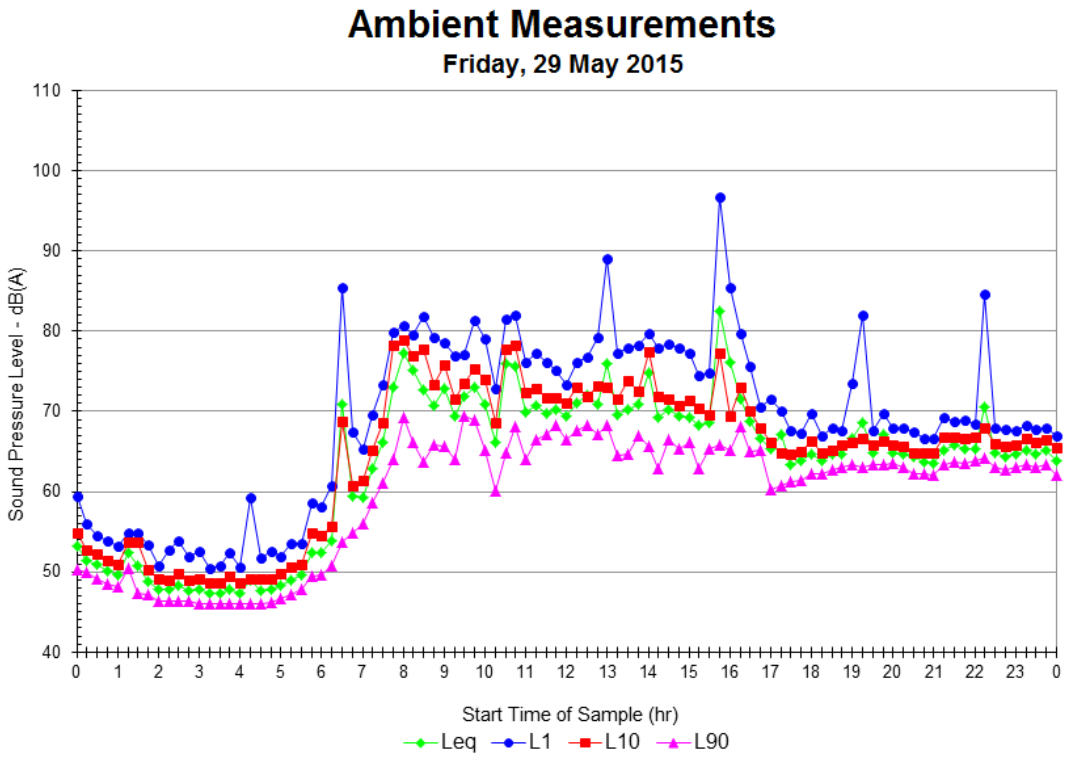
Job Number: 5164
Instrumentation: BSWA 801 14988
Logger Location: Barangaroo R9, SW Corner, Lvl. 4
Free Field: yes
Monitoring Period: Wednesday 27 May 2015 to Wednesday 3 June 2015

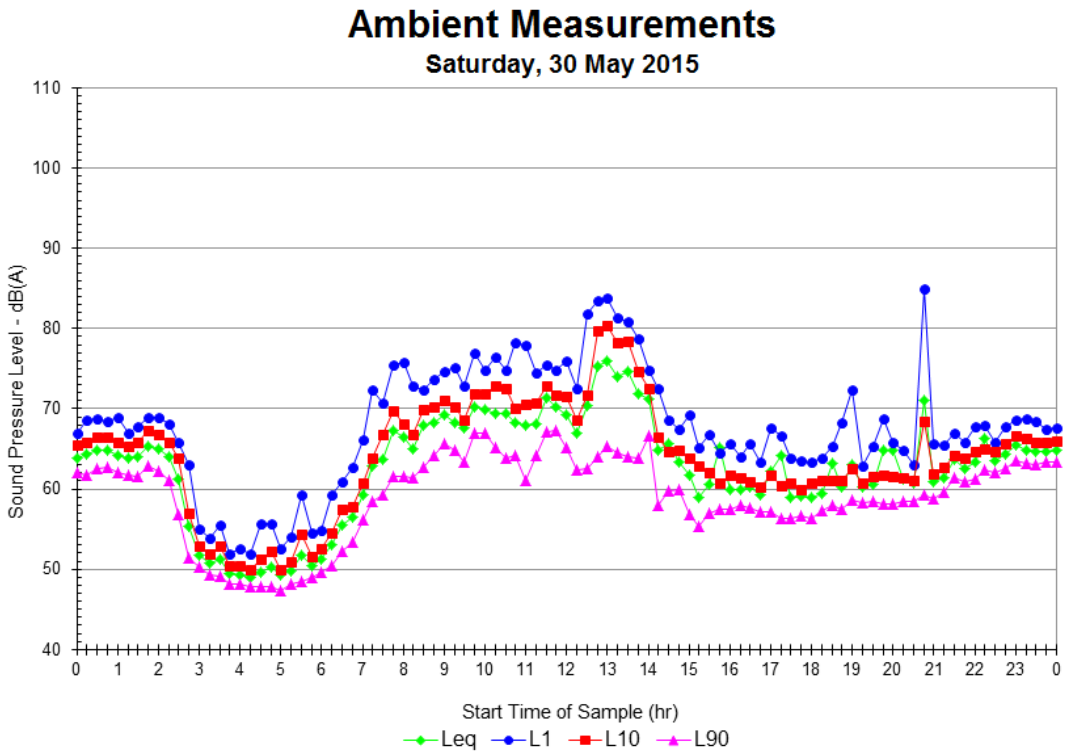
BACKGROUND AND AMBIENT NOISE MONITORING RESULTS
NSW EPA's INDUSTRIAL NOISE POLICY , 2000

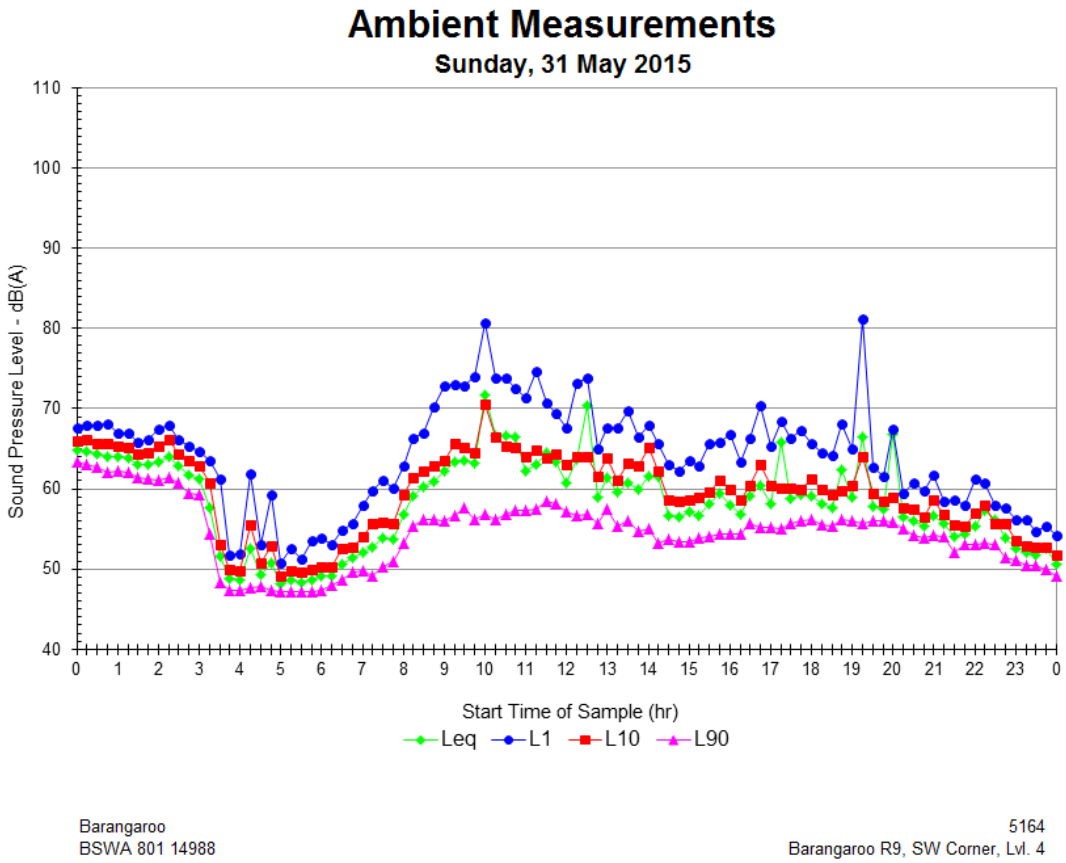
Day	L90 Background Noise Levels			Leq Ambient Noise Levels		
	Day 7am - 6pm	**Evening** 6pm - 10pm	**Night** 10pm - 7am	**Day** 7am - 6pm	**Evening** 6pm - 10pm	**Night** 10pm - 7am
Wednesday 27 May 2015	*	52.4	46.6	*	60.0	52.3
Thursday 28 May 2015	61.0	54.3	46.1	74.9	62.0	57.4
Friday 29 May 2015	60.7	62.2	47.9	72.6	65.4	62.5
Saturday 30 May 2015	56.6	57.3	47.2	68.9	63.6	61.9
Sunday 31 May 2015	53.3	53.0	46.2	62.9	60.4	52.6
Monday 1 June 2015	59.7	53.3	47.4	74.3	62.7	52.5
Tuesday 2 June 2015	61.5	55.3	47.9	75.5	63.2	62.8
RBL Median	**60.2**	**54.3**	**47.2**	-	-	-
Log Average	**-**	**-**	**-**	**73.0**	**62.8**	**59.5**

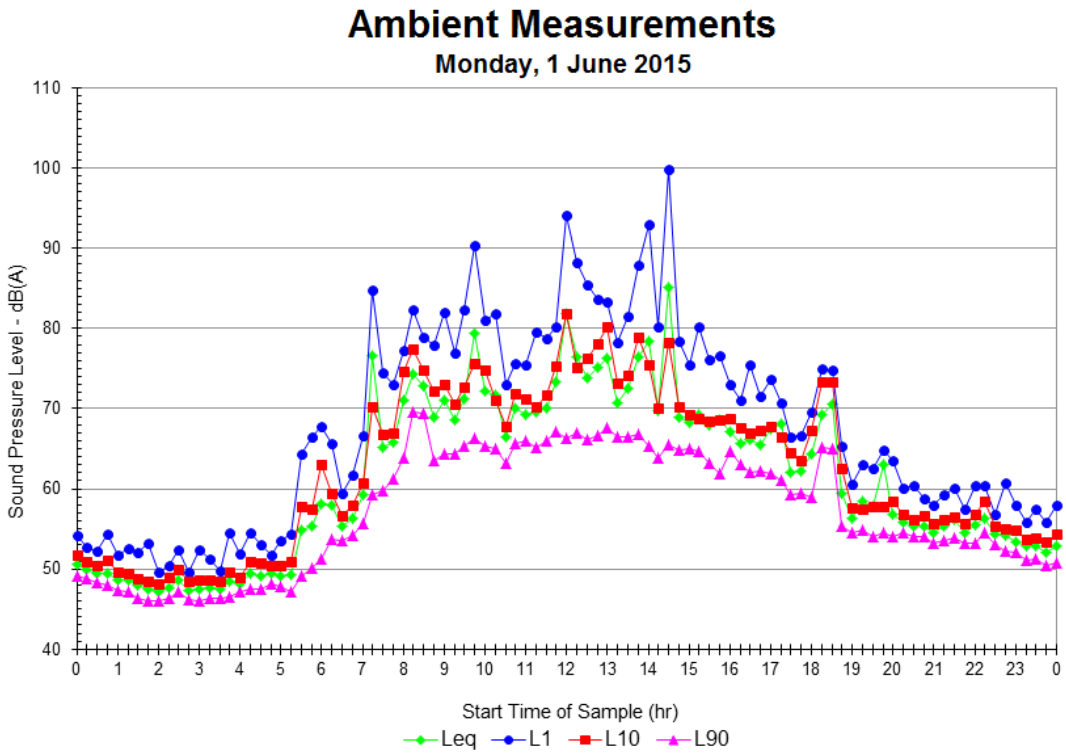


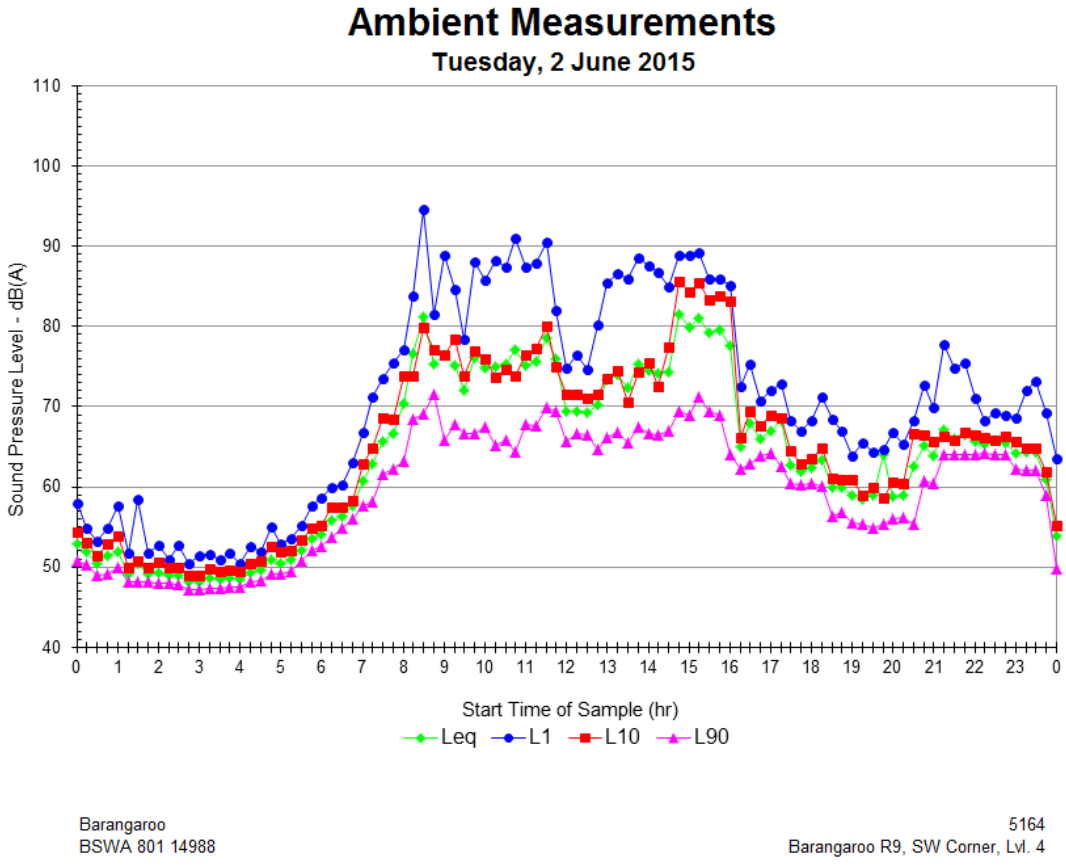

Ambient Measurements
Thursday, 28 May 2015
Sound Pressure Level - dB(A)
110
100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Start Time of Sample (hr)
Leq L1 L10 L90
Barangaroo
BSWA 801 14988
5164
Barangaroo R9, SW Corner, Lvl. 4

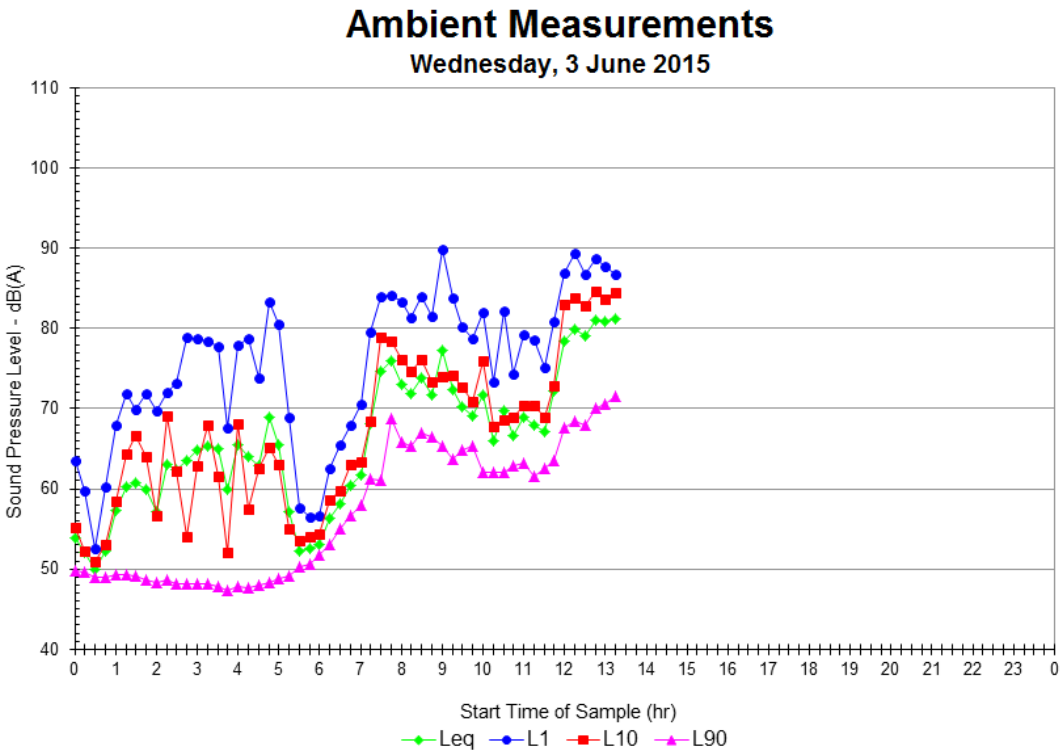

Ambient Measurements
Friday, 29 May 2015
Sound Pressure Level - dB(A)
110
100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Start Time of Sample (hr)
Leq L1 L10 L90
Barangaroo
BSWA 801 14988
5164
Barangaroo R9, SW Corner, Lvl. 4


Ambient Measurements
Saturday, 30 May 2015
Sound Pressure Level - dB(A)
110
100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Start Time of Sample (hr)
Leq L1 L10 L90
Barangaroo
BSWA 801 14988
5164
Barangaroo R9, SW Corner, Lvl. 4


Ambient Measurements
Sunday, 31 May 2015
Sound Pressure Level - dB(A)
110
100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Start Time of Sample (hr)
Leq L1 L10 L90
Barangaroo
BSWA 801 14988
5164
Barangaroo R9, SW Corner, Lvl. 4


Ambient Measurements
Monday, 1 June 2015
Sound Pressure Level - dB(A)
110
100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Start Time of Sample (hr)
Leq L1 L10 L90
Barangaroo
BSWA 801 14988
5164
Barangaroo R9, SW Corner, Lvl. 4


Ambient Measurements
Tuesday, 2 June 2015
Sound Pressure Level - dB(A)
110
100
90
80
70
60
50
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Start Time of Sample (hr)
Leq L1 L10 L90
Barangaroo
BSWA 801 14988
5164
Barangaroo R9, SW Corner, Lvl. 4



Barangaroo
BSWA 801 14988

5164
Barangaroo R9, SW Corner, Lvl. 4

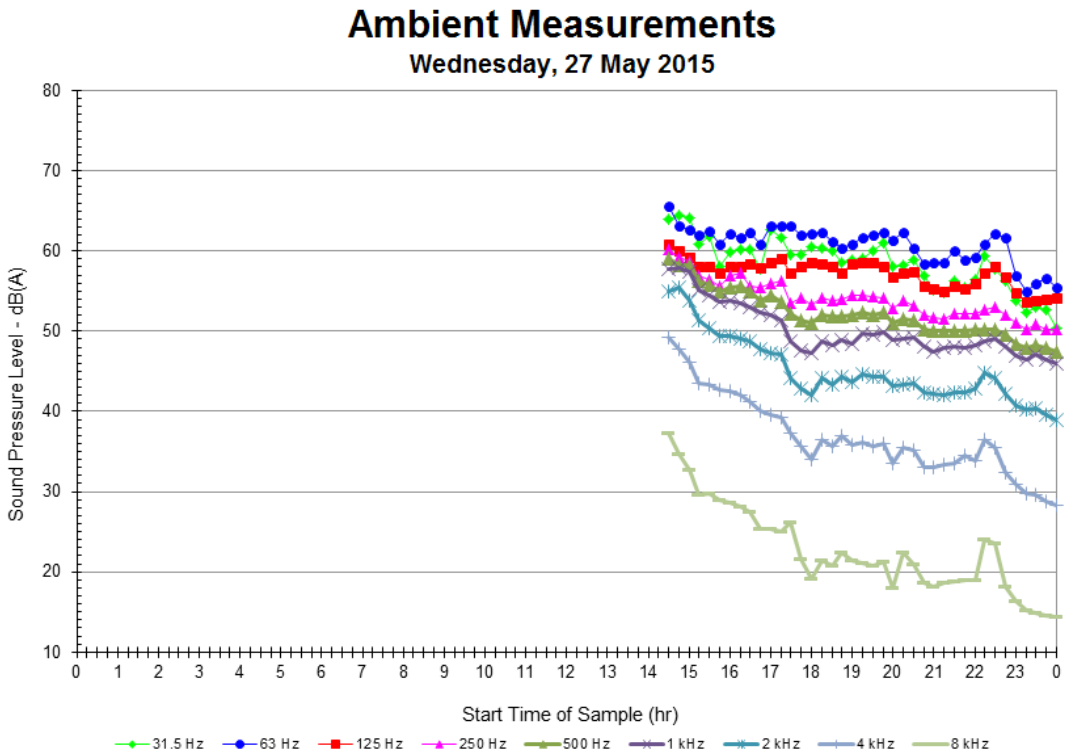
APPENDIX D: Octave Band Logger - L90 Background Results

RBL for all days

	dBA	Linear Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1k	2k	4k	8k
RBL day	60	61	63	60	58	57	55	52	45	31
RBL evening	53	57	60	56	53	51	49	44	33	18
RBL night	47	49	51	51	48	45	42	35	25	13
RBL 10pm – midnight	52	53	56	54	51	51	48	42	34	19
RBL midnight – 2am	48	50	52	51	49	46	43	36	26	14
RBL 2am – 4am	46	49	51	51	48	45	41	34	25	13
RBL 4am – 6am	47	49	51	51	48	45	42	35	25	13

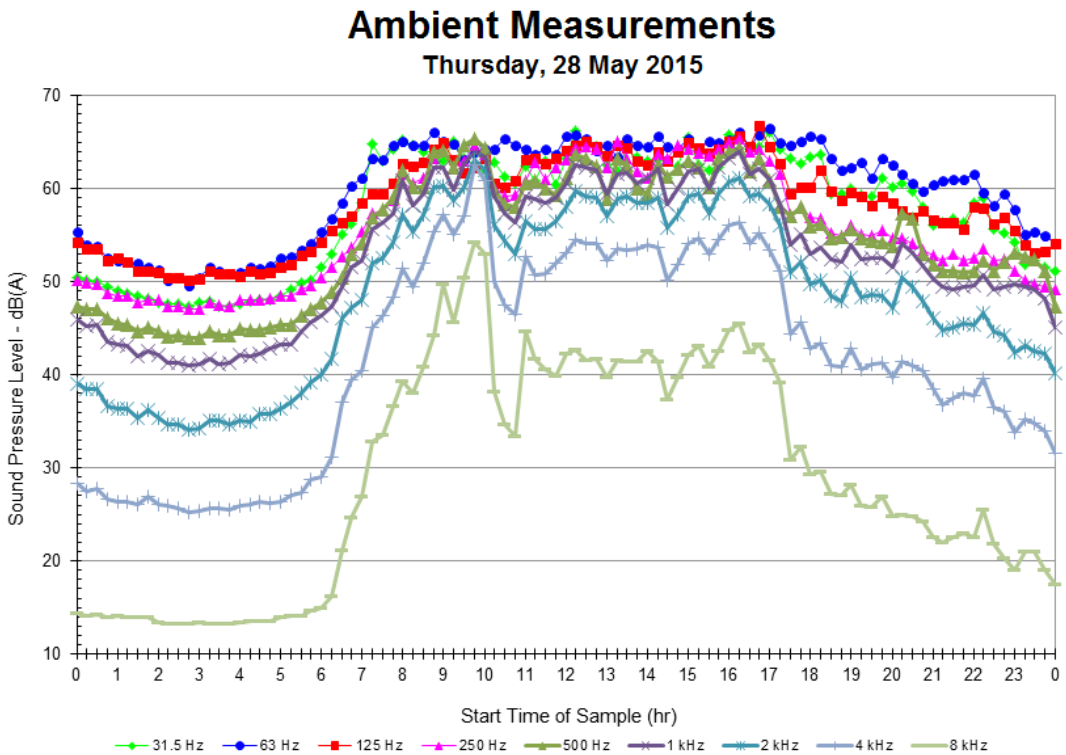
RBL for Friday and Saturday nights

	dBA	Linear Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1k	2k	4k	8k
RBL night	47	49	52	51	48	45	43	36	25	13
RBL 10pm – midnight	61	56	64	61	57	58	57	54	47	31
RBL midnight – 2am	60	52	60	59	56	58	56	53	45	29
RBL 2am – 4am	47	49	52	51	48	45	43	36	25	13
RBL 4am – 6am	46	49	51	51	48	44	42	36	25	13



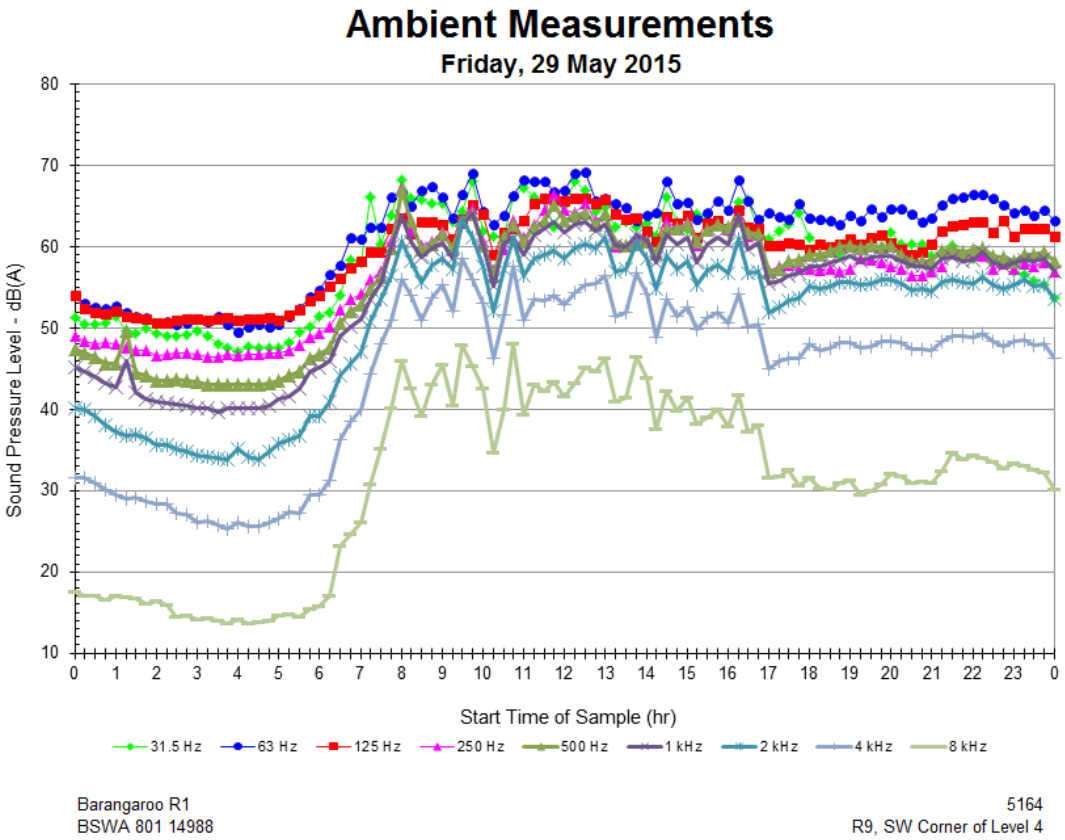
Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4



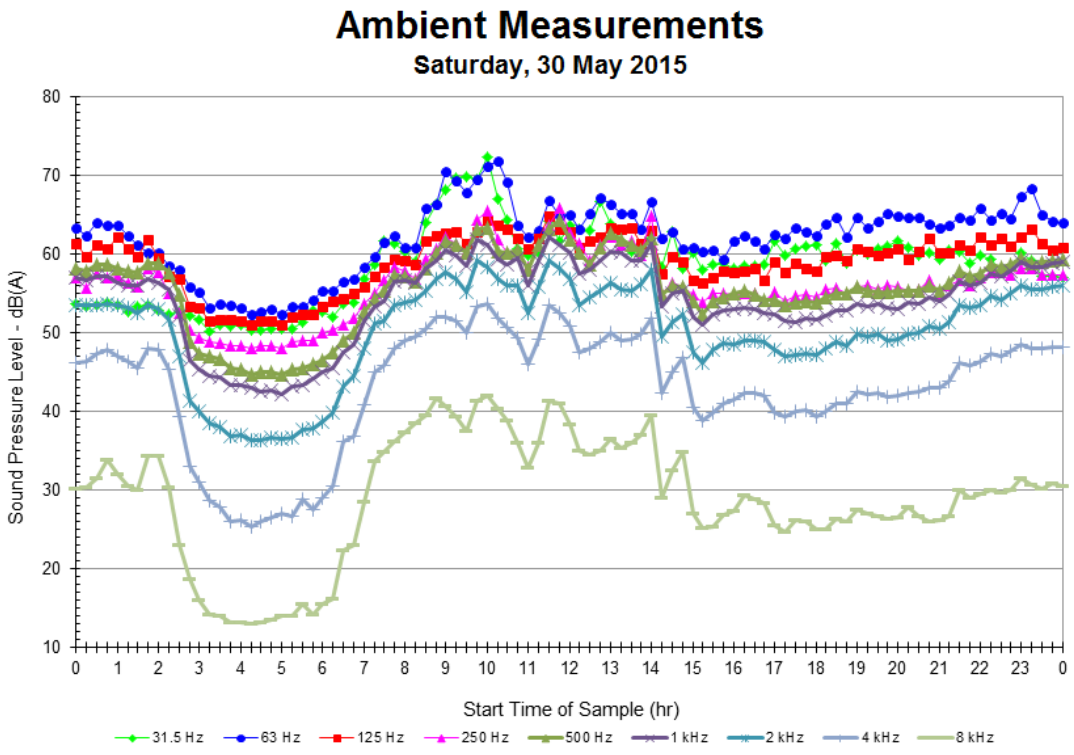
Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4



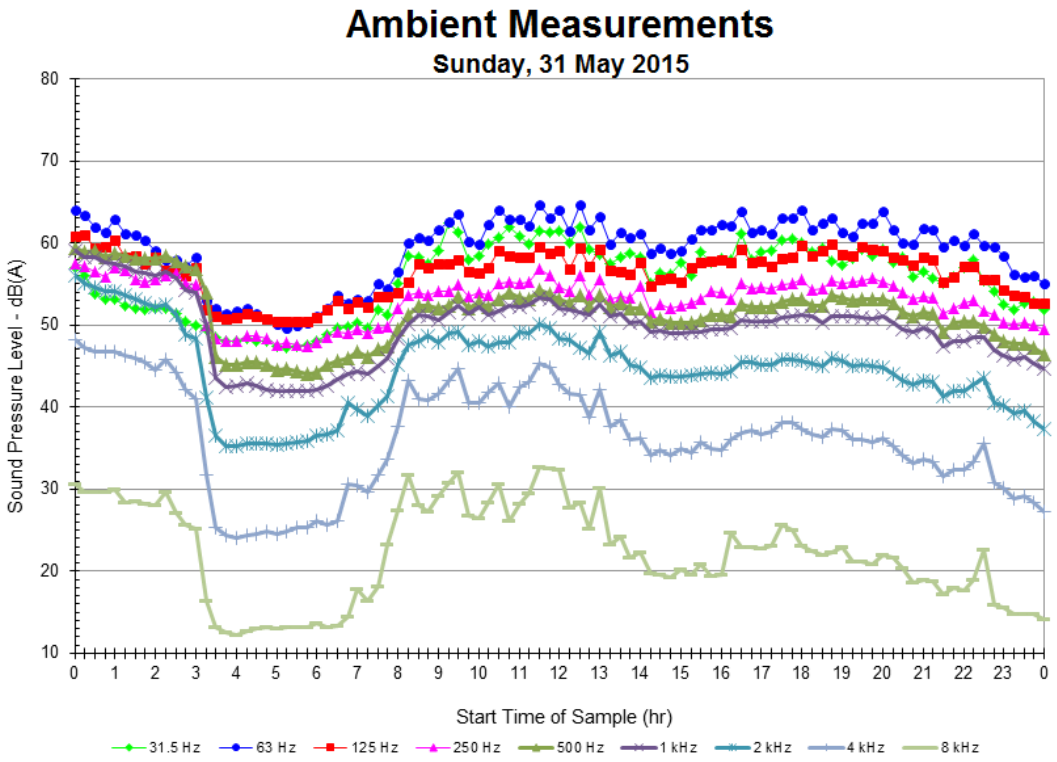
Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4



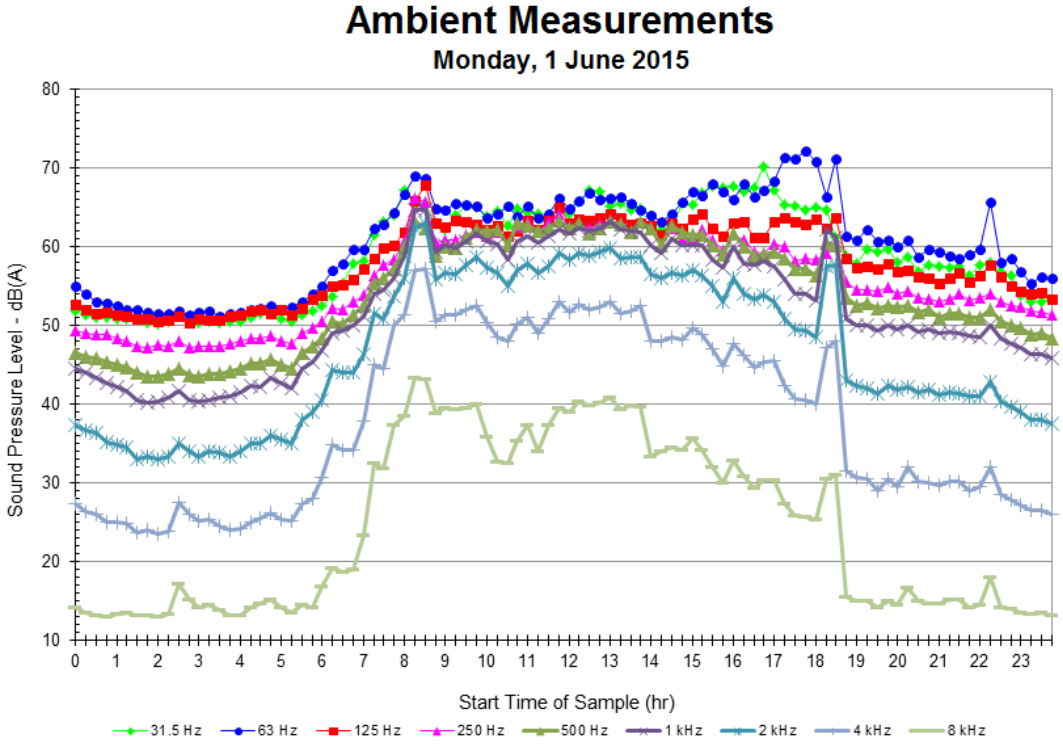
Barangaroo R1

5164
R9, SW Corner of Level 4



Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4

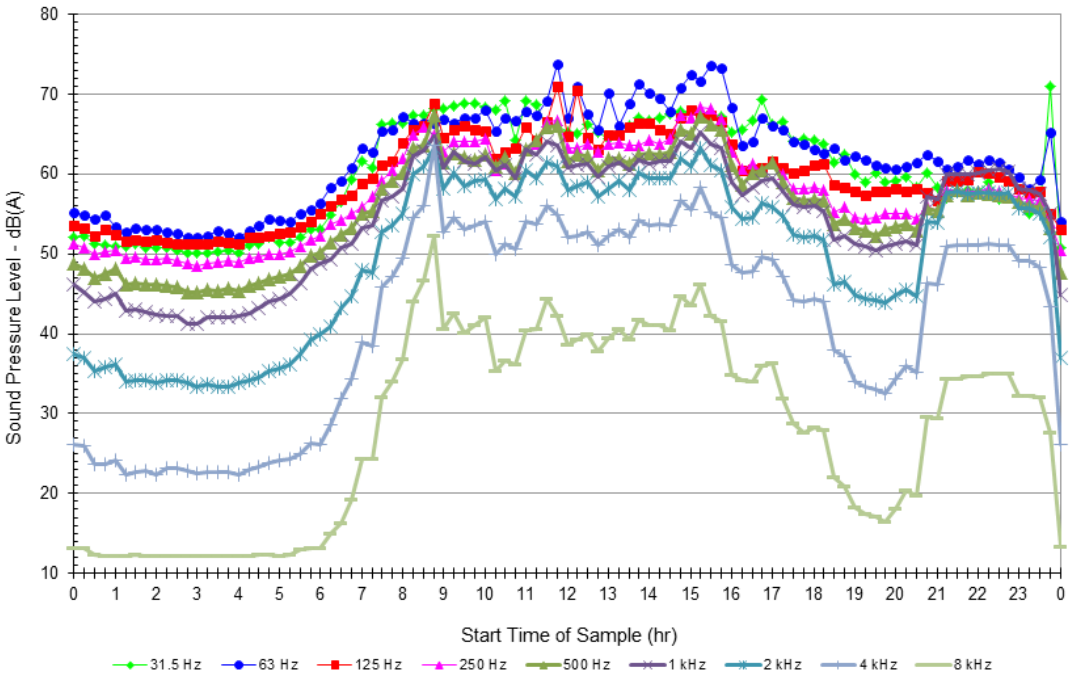


Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4

Ambient Measurements

Tuesday, 2 June 2015

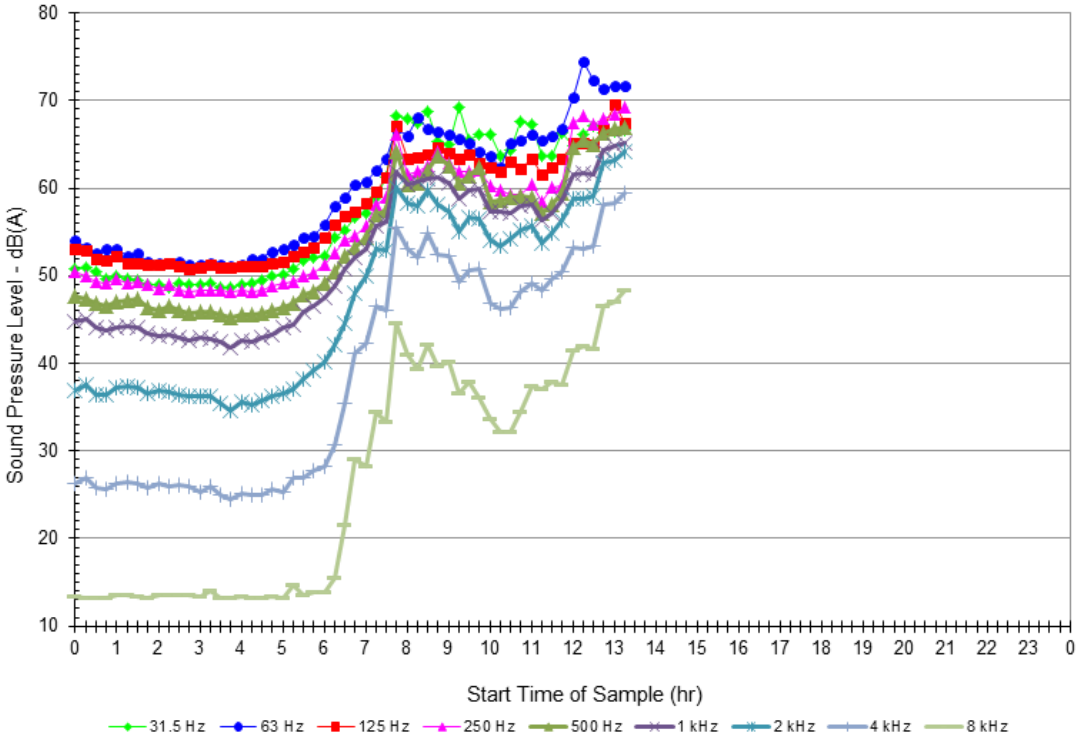


Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4

Ambient Measurements

Wednesday, 3 June 2015



Barangaroo R1
BSWA 801 14988

5164
R9, SW Corner of Level 4

APPENDIX E: Noise Calculations

R1 Level 2 to R9 Level 2

Line			A-Weighted Octave Band Centre Frequency (Hz)								
		dB(A)	31	63	125	250	500	1k	2k	4k	8k
Northern side of Terrace – 50% talking in raised voice											
a.	30 patrons (50% raised voices)	84	24	38	58	71	80	79	75	70	62
b.	Barrier shielding		0	0	0	0	0	0	0	0	0
c.	Distance attenuation + Lw to SPL		32	32	32	32	32	32	32	32	32
d.	Contribution	52	-8	6	26	39	48	47	43	38	30
Centre of Terrace – 50% talking in raised voice											
e.	104 patrons (50% raised voices)	89	29	43	63	76	85	84	80	75	67
f.	Barrier Shielding		0	0	0	0	0	0	0	0	0
g.	Distance attenuation + Lw to SPL		37	37	37	37	37	37	37	37	37
i.	Contribution	52	-8	6	26	39	48	47	43	38	30
Southern side of Terrace – 50% talking in raised voice											
j.	30 patrons (50% raised voices)	84	24	38	58	71	80	79	75	70	62
k.	Building Shielding		8	10	12	15	18	21	24	27	30
l.	Distance attenuation + Lw to SPL		40	40	40	40	40	40	40	40	40
n.	Contribution	24	-24	-12	6	16	22	18	11	3	-8
Inside with doors and windows closed – 50% talking in raised voice											
o.	100 patrons (50% raised voices)	92	32	46	66	79	88	87	83	78	70
p.	Glazing TL		15	19	23	28	30	30	31	36	37
q.	Distance attenuation + Lw to SPL		37	37	37	37	37	37	37	37	37
r.	Contribution	25	-20	-10	6	14	21	20	15	5	-4
s.	Total contribution	55	-5	9	29	42	51	50	46	41	33
t.	Weekday RBL	52	53	56	54	51	51	48	42	34	19
u.	Weekend RBL	60	52	60	59	56	58	56	53	45	29

APPENDIX F: Instrumentation

Sound level measurements conducted in relation to the subject investigation utilised precision sound level meters that under International Standard IEC 61672 – 1 are identified as Class 1 meters. The Standard sets out frequency weighting and tolerance limits for sound level meters.

The Bruel and Kjaer 2250 sound level meter utilises Enhanced Sound Analysis Software to permit the recording of statistical parameters in the overall A-weighted level and in octave bands over the sampling period. The time constant used for measurements is FAST response to accord with the relevant standard utilising sampling based upon 100 ms samples for both statistical analysis and logging of the LAF (Inst) to provide a time splice graph of the variation of the instantaneous A-weighted level over time.

In dealing with licensed premises the criteria is relative to A-weighted results and therefore the instrument is set up to record A-weighted octave band, whereas in general environmental assessments the octave band information is recorded in linear mode (i.e. no A-weighting filter).

In accordance with the manufacturer's specification and relevant standards the reference calibration of the sound level meter is checked prior to and after measurements using a reference calibrator that generates a constant signal of 1 kHz (normally a Bruel and Kjaer Type 4230/4231 calibrator).

Logging measurements utilise a BWSA 801 Class 1 sound level meter set to continuously log the noise level in 15 minute increments utilising fast response exponential averaging to determine the statistical results in each sample period.

The logger is set to operate as a free field situation with no compensation filters and with 1/1 octave results utilising the Z-weighted profile FAST response detector that is identified in the manufacturer's specification as having a flat (linear) response over the frequency range of 20 Hz to 16 kHz.

The A-weighted logger results are processed in accordance with Appendix B of the EPA's *Industrial Noise Policy* to determine the lowest 10 percentile of the individual L90 results for the day, evening and night periods for each of individual day (identified as the ABL) from which the Rating Background Level (RBL) is determined as the median of the individual daily results.

The Leq level for each of the individual day, evening and night periods per day are the energy average of the measured levels from which the individual daily results are energy averaged to provide the Leq for those periods.

The analysis of the logger results also assessed in terms of standard EPA time periods and classifications for traffic noise that requires a correction to obtain a facade corrected level being the index used for assessment of road traffic noise.

By utilising the full logger capabilities of the sound level meter a similar exercise can be carried out to determine the Rating Background Level of the octave band material that correlates with the same A-weighted logger results.

For the purpose of licensed premises that may not operate throughout the entire night-time period of 10 PM to 7 AM, the octave band data is divided into 2-hour subsets to determine the RBL of the individual octave bands for those time periods and as such represents the lowest 15 minute individual octave band level in each 2 hour period. The octave band logger charts are presented in a linear (unweighted) format due to the response of the A-weighting filter showing background levels close to or below 0 dB.