6 June 2016

Carolyn McNally
The Secretary
NSW Department of Planning and Environment
23-33 Bridge Street
SYDNEY NSW 2000

Attention: Anthea Sargeant, Executive Director & Alexander Scott, Senior Planner – Key Sites and Industry Assessments

Dear Ms Sargeant,

Development Application SSD 14_6513 – Building R1 Barangaroo South
Updated Operational Acoustic Report

As requested, please find the following documents attached:

- The updated *Barangaroo South Master Plan Noise Assessment* (Master Plan) Version G dated February 2016; and
- A statement from the Operational Acoustic Report Acoustic Group dated 4 May 2016) confirming consistency with the *Barangaroo South Master Plan Noise Assessment* (Master Plan) Version G.

These respond to correspondence from the Department of Planning and Environment dated 8 April 2016 requested further information and provided comments on the application from the City of Sydney Council.

Should you have any queries about this matter or require any further information, please contact me at clare.hall@lendlease.com

Yours Sincerely,

Clare Hall
Planning Manager, Barangaroo South
Lend Lease (Millers Point) Pty Ltd

cc. Ben Lusher, Director - Industry, Key Sites and Social Projects

ACOUSTICS AND AIR

BARANGAROO SOUTH

MASTER PLAN NOISE ASSESSMENT

REPORT NO. 10232-BN-1
VERSION G

FEBRUARY 2016

PREPARED FOR

LENDLEASE
THE BOND, 30 HICKSON ROAD
MILLERS POINT NSW 2000

WILKINSON MURRAY

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Working Draft	7 September 2015	Neil Gross	Barry Murray
B	Working Draft	6 October 2015	Neil Gross	
C	Working Draft	16 October 2015	Neil Gross	
D	Working Draft	19 October 2015	Neil Gross	
E	Draft	20 October 2015	Neil Gross	Barry Murray
F	Final	28 October 2015	Neil Gross	
G	Final	18 February 2016	Neil Gross	

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GLOSSARY OF COMMON ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

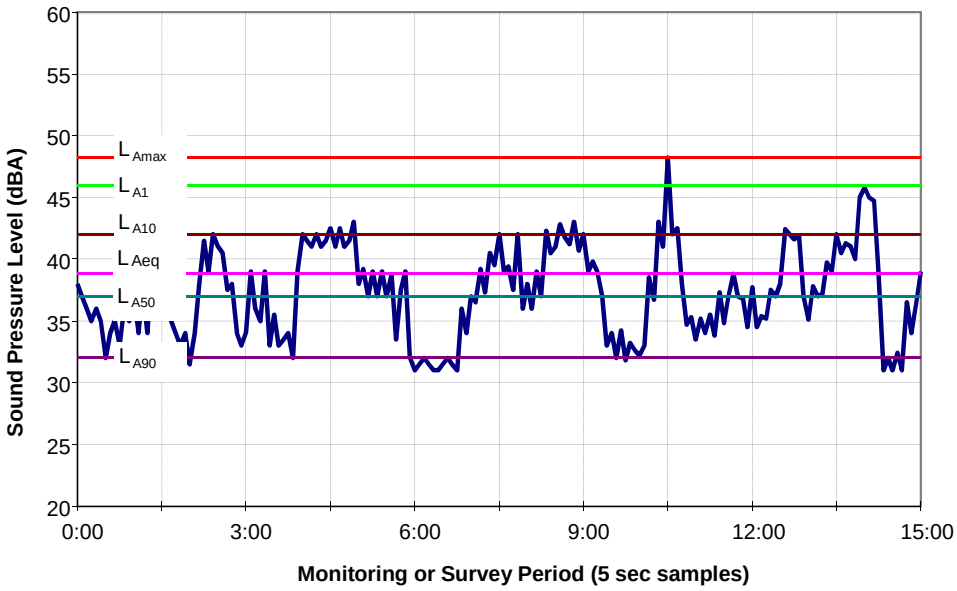
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

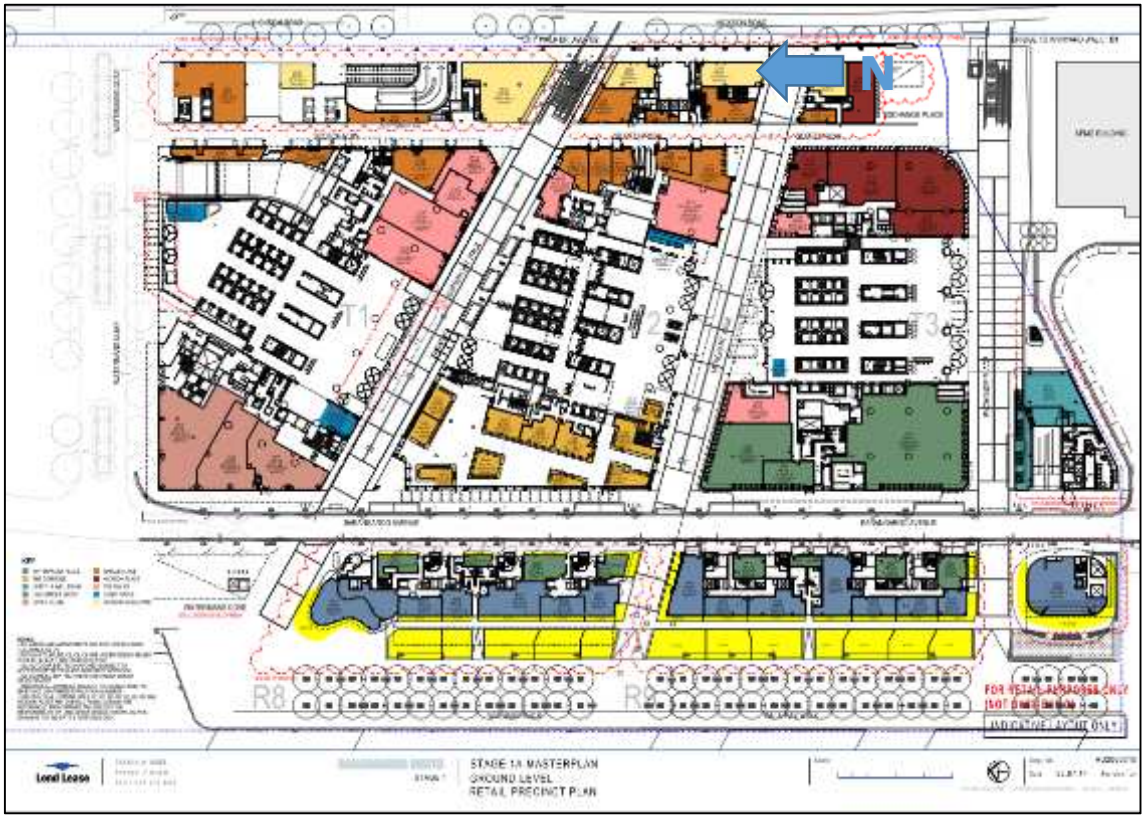
Barangaroo is a mixed use zone as shown in the plan in Figure 1-1. Some buildings are due for completion in late 2015, including R8 and R9 on the western fringes, which will have retail premises on the ground floor with residences above. The remaining buildings in the precinct (R1, R7, T1-T3) will be commercial / retail, including restaurants / bars. These retail tenancies will be progressively completed and occupied up until the end of 2016 (with the exception of building C1).

It is expected that the ambient noise levels in the precinct will continue to change until full occupation and reasonable noise criteria have been recommended based on the expectations of a "vibrant" precinct and the desire for quiet for residents.

This report presents a Master Plan Noise Assessment for the Barangaroo South precinct. Its purpose is to set a framework for noise management enabling the establishment of individual noise limits for the various retail operators, based on their location within the precinct and proposed hours of operation, taking into account the cumulative noise from all retail operators, likely to affect each residence.

To manage this complexity, the approach needs to be simplified and also retain some flexibility, so a number of reasonable assumptions have been made about the likelihood and extent of cumulative noise occurring and how it is reasonably shared between retail tenancies which may change over time.

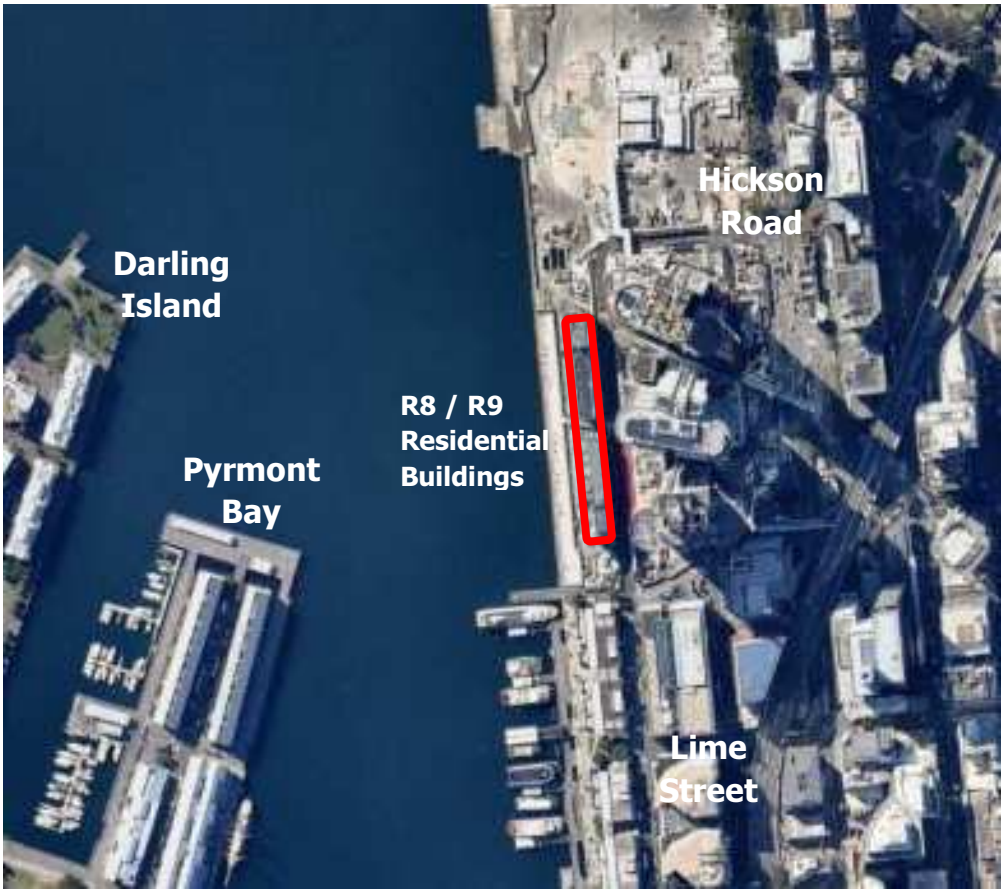
Figure 1-1 Plan of Barangaroo showing Mixed Use



2 APPROACH TO NOISE MANAGEMENT

Mixed used zones in a new urban precinct, which has been marketed as being part of a vibrant city, present issues in establishing appropriate noise criteria to protect residential receivers. A distinction needs to be made between existing residences (such as Pyrmont Bay and Darling Island) and future residences, particularly those within the Barangaroo precinct (initially Buildings R8 and R9). These are addressed in Chapters 3 and 4 respectively.

Figure 2-1 Aerial Photo Showing Surrounding Residential Areas



The R8 and R9 residential components within Barangaroo have been constructed with the ability to control internal acoustic amenity in mind, with upgraded double glazing minimum R_W38. The slab between the retail floor and residences above is also 300mm thick to improve transmission loss over more conventional slab thicknesses ($R_W > 60$ is expected).

It is expected that many of the retail premises within Barangaroo will operate through the evening and into the night time, and in the warmer months will have people seated outside, in relative close proximity to residences above or adjacent.

Some aspects of the retail premises operations such as mechanical plant and equipment and music can be controlled, however the noise of patrons outside is much more difficult to control.

Each tenancy will need to prepare their own DA acoustic assessment, providing patron numbers and an indicative layout and providing noise predictions showing how it complies with the noise management framework established in this report, considering cumulative impacts.

3 RESIDENCES EXTERNAL TO BARANGAROO PRECINCT

The historical approach applied by the City of Sydney for each development application associated with an individual tenancy is to assess noise levels external to residences (located in Pyrmont Bay, Darling Island, Hickson Road/Kent Street and Lime Street) with typical conditions as follows:

Noise caused by the approved use, including music and other activities, must comply with the following criteria (NOISE ENTERTAINMENT):

(a) The L_{10} noise level emitted from the use must not exceed 5dB above the background (L_{90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 7.00am and 12.00 midnight when assessed at the boundary or window of the nearest affected residential property. The background noise level must be measured in the absence of noise emitted from the use.

(b) The L_{10} noise level emitted from the use must not exceed the background (L_{A90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 12.00 midnight and 7.00am when assessed at the boundary or window of the nearest affected residential property. The background noise level must be measured in the absence of noise emitted from the use.

(c) Notwithstanding compliance with (b) and (c) above, the noise from the use must not be audible within any habitable room in any residential property between the hours of 12.00 midnight and 7.00am.

Note: The $L_{10,15min}$ noise level emitted from the use is as per the definition in the Australian Standard AS1055-1997 Acoustics – Description and measurement of environmental noise. The background noise level $L_{90,15min}$ is to be determined in the absence of noise emitted by the use and be representative of the noise sensitive receiver. It is to be determined from the assessment L_{90} / rating L_{90} methodology in complete accordance with the process listed in the NSW EPA *Industrial Noise Policy* and relevant requirements of AS1055.1997.

As a minimum these criteria must still be achieved, however City of Sydney also needs to consider cumulative noise impacts from the proposed operation of a number of tenancies which may affect existing residences, noting each tenancy may not be operating at capacity at the same time as other tenancies. No cumulative entertainment criteria exist.

In this regard a conservative approach is for cumulative patron L_{Aeq} noise levels to achieve background +5dB prior to 12 midnight and background + 0dB after 12midnight, noting there are stringent limits on music noise within the precinct.

Allowing for the number, location and expected mix of premises - the following L_{Aeq} individual limits for day, evening and night time, below the cumulative limits have been established for typical size premises, with commensurate approach to the octave band levels. (These are based on existing background noise levels and octave band spectra refer Appendix B and should be updated/reviewed every 5 years.

Table 3-1 Individual External Noise Limits – Typical Tenancies (L_{Aeq} dBA)

Location	Day	Evening	10pm-12am
Pyrmont Bay	52-10 = 42	48-7 = 41	46-5 = 41
Hickson Road	53-5 = 48	53-5 = 48	51-5 = 46
Lime Street	54-5 = 49	52-5 = 47	50-5 = 45

Note different limits 3dB higher are applied to the R1 premises due to their scale relative to typical premises

4 RESIDENCES WITHIN BARANGAROO

4.1 Background

This section establishes appropriate internal L_{Aeq} noise level criteria which should be achieved internally within residences from the cumulative operation of all premises and measured with windows and doors closed. It does not include any contribution from internal mechanical plant. These criteria consider social expectations about residences choosing to live in this vibrant precinct.

Based on these internal noise criteria, with knowledge of the number of premises likely to be operating, internal noise criteria can then be established for each retail premises based on sharing the noise to achieve overall internal noise levels. It is proposed that separate noise limits are established for patron noise and music noise.

With knowledge of the glazing construction and area of windows and typical finishes within living rooms and bedrooms it is then possible to establish external noise levels to ensure the internal noise levels can be achieved.

These external noise criteria can then be adopted by any future retail operator to ensure the design and management of their premises can achieve these external limits, without needing to be concerned about the façade design and noise generated by their neighbours.

There is limited information available worldwide which specifically considers impacts from patron type noise. Most entertainment precincts contain a significant contribution from music, and particularly low frequency noise which can both escape the venue in which it is being created, as well as break into the nearby residences much more easily than mid and high frequency noises from patrons' voices.

Comparable, "vibrant" global cities where **internal** noise levels within residences are specified in local noise regulation are New York and San Francisco. Our interpretation of their requirements, are shown alongside the proposed limits for Barangaroo.

Table 4-1 Comparable Internal Noise Limits

Period	San Francisco	New York	Proposed Barangaroo South	Comment
Day / Evening	40-55	42 (music)	43 Living / 38 Bedroom	Similar
Night	40-45	42 (music)	40 Living / 35 Bedroom (until 12 midnight only)	Barangaroo quieter

There is also a requirement to meet noise limits in the low frequency octave bands, typically in octaves less than 250Hz, and / or assess music using the dBC weighting.

These levels need to be considered in the context of guidelines which traditionally deal with external noise intrusion from traffic or mechanical plant. Generally, living areas are set 5dBA higher than bedrooms and for bedrooms, daytime periods are set 5dBA higher than night time periods. However in this instance a daytime limit 3dBA higher than night time is considered reasonable, resulting in 43dBA for Living rooms and 38dBA for bedrooms.

4.2 Precinct Specific Noise Criteria

4.2.1 Patron Noise Impacts 7am to Midnight

It is considered that midnight is a reasonable time within a mixed use zone beyond which noise must be carefully controlled. Prior to midnight, there is a need to balance the vibrancy expectations and internal residential amenity.

For the period of 7am to midnight residents may need to keep windows and doors closed in order to provide a satisfactory acoustic amenity. **Internal** noise limits have therefore been established to address the cumulative impact of retail noise intrusion. Based on the acoustic design of the residential buildings R8 and R9, equivalent external noise limits have been established. The external limits are also given to allow retail tenants to more readily assess noise from their development without needing to understand the details of the residential building design.

It is understood that upgraded glazing is provided to habitable rooms of buildings R8 and R9, with a minimum specified performance of R_W38. For a typical patron noise spectrum (from an unshielded source), allowing for room characteristics and glazing area of R8 / R9, these glazing systems are predicted to provide an outside (free field) to inside noise reduction of approximately 32dBA for a typical bedroom and 28dBA for a living room.

Where patron noise external to the façade has already been attenuated due to shielding by awnings then the overall dBA reduction will be lower. We understand the southern half of Building R9 has a marginally higher performance but this has not been allowed for in this assessment.

On this basis, the following table presents the cumulative internal and external $L_{Aeq,15min}$ patron noise limits.

Table 4-2: Project Specific Cumulative $L_{Aeq,15min}$ Noise Limits for Retail Noise Intrusion

Time of Day	Receiver	Residential Internal Limit – Windows Closed -dBA	External Cumulative Limit (free field) – dBA
7.00am to 10.00pm	Living	43	70
	Bedroom	38	
10.00pm to Midnight	Living	40	67
	Bedroom	35	

Barangaroo will comprise of a number of retail premises which will all require an individual DA for their proposed operations. Whilst each residence will experience cumulative noise from several premises, to provide certainty to each retail operator this cumulative noise target needs to be shared, based on the number of contemporaneous operations likely to affect each residence and the proximity of the retail premises.

To meet the cumulative internal noise limits, individual internal limits have been set for each retail tenancy. The management of the cumulative impacts and residential amenity has also required the specification of restricted operating hours for some uses.

For the majority of waterfront restaurants along R8 / R9, it is considered that setting the individual restaurant contributions 5dB below the cumulative total will manage cumulative noise. However at some locations at the north and south end of each buildings, it is possible only 2 restaurants may influence an individual residence. The individual limits would then be 3 to 5 dBA below the cumulative noise level limits

For R1, individual noise level limits from 2 to 6-7dBA below the cumulative criteria are appropriate, subject to time of day. For the retail premises overlooking Barangaroo Avenue (T1-T3 and R7 plus the east façade of R8 and R9, due to potentially more premises with the potential to affect residences an individual noise level limit from 5 to 7dBA below the cumulative criteria is appropriate, although this is considered conservative.

These limits have been included in Table 4-3. A range has been provided, as the individual limit for each tenancy will be determined in the individual DA report based on Lendlease's management of cumulative noise. The City of Sydney can confirm the proposed limits for each tenancy do not exceed the range nominated and can also check cumulative levels if they wish.

Table 4-3 Recommended Internal & External $L_{Aeq,15min}$ Noise Criteria for Each Premises

Tenancy Location & Notes	Time of Day	Receiver – Living or Bedroom	Internal Limit Cumulative dBA – Windows Closed	Internal Limit Individual dBA – Windows Closed	External individual limit (free field equivalent) on most exposed Balcony or Outside Windows dBA
R8 / R9 waterfront Closes at 11pm	7.00am – 10.00pm	Living	43	38-40	66-68 dBA
		Bedroom	38	33-35	65-67 dBA
	10.00pm – 12midnight	Living	40	35-37	63-65 dBA
		Bedroom	35	30-32	62-64 dBA
	12midnight – 7.00am	Living	35	30-32	CoS Ent (b) "+0"
		Bedroom	Inaudible	Inaudible	CoS Ent (b) "+0"
R1 Not influenced by R9 reduced noise after 11pm	7.00am – 10.00pm	Living	43	36-41	64-69 dBA
		Bedroom	38	31-36	63-67 dBA
	10.00pm – 12midnight	Living	40	34-38	62-66 dBA
		Bedroom	35	29-33	61-65 dBA
	12midnight – 7.00am	Living	35	25-30	CoS Ent (b) "+0"
		Bedroom	Inaudible	Inaudible	CoS Ent (b) "+0"
R7 Needs to share noise with Barangaroo Ave and R1	7.00am – 10.00pm	Living	43	36-38	64-66 dBA
		Bedroom	38	31-33	63-65 dBA
	10.00pm – 12midnight	Living	40	33-35	61-63 dBA
		Bedroom	35	28-30	60-62 dBA
	12midnight – 7.00am	Living	35	28-30	CoS Ent (b) "+0"
		Bedroom	Inaudible	Inaudible	CoS Ent (b) "+0"

Restaurant Location & Notes	Time of Day	Receiver – Living or Bedroom	Internal Limit Cumulative dBA – Windows Closed	Internal Limit Individual dBA Windows Closed	External individual limit (free field equivalent) on most exposed Balcony or Outside Windows dBA
Barangaroo Ave, either side and Upper Globe. More sources from both sides of road, plus lower external patron numbers	7.00am – 10.00pm	Living	43	36-38	64-66 dBA
		Bedroom	38	31-33	63-65 dBA
	10.00pm – 12midnight	Living	40	33-35	61-63 dBA
		Bedroom	35	28-30	60-62 dBA
	12midnight – 7.00am	Living	35	28-30	CoS Ent (b) "+0"
		Bedroom	Inaudible	Inaudible	CoS Ent (b) "+0"
Scotch Row, Shipwright Walk, Mercantile Walk & Exchange Place with no line of sight to R8/R9	7.00am – 10.00pm	Living	43	28	56 dBA
		Bedroom	38	23	55 dBA
	10.00pm – 12midnight	Living	40	25	53 dBA
		Bedroom	35	20	52 dBA
	12midnight – 7.00am	Living	35	20	CoS Ent (b) "+0"
		Bedroom	Inaudible	Inaudible	CoS Ent (b) "+0"

4.2.2 Music 7.00am to 12 Midnight

It is expected that most premises will play background music only. In this instance music noise must be controlled to be 8dBA below the external noise limits at receivers. The dBC level of music should not exceed the dBA music level by more than 10dB or exceed 65dBC.

City of Sydney have indicated they will not approve outdoor speakers without justification for their use and a detailed assessment of system set up and predicted noise levels. As a minimum any outdoor speakers, where practicable, shall be in shielded locations with respect to residences, such as beneath solid awnings and should face down and not directed towards the potentially most affected residences or public domain.

It is noted that high music noise levels can require patrons to raise their voice to communicate. Operators should ensure that music noise levels are restricted to limit this effect. In this regard the $L_{eq,1min}$ noise level from music measured at 3m from any speaker mounted externally or 3m from any opening where music noise may escape must not exceed 80dBC or 75dBA.

Any operator wishing to play anything other than background music in line with the requirements above, will need to prepare a detailed noise assessment outlining the location of all speakers, demonstrating how music will be controlled and confirming with detailed calculations the noise levels expected at the nearest residences, relative to patron noise levels and.

4.2.3 Noise Impacts Midnight to 7.00am (Music and Patron noise)

Whilst most of the premises are not planning to trade after midnight, it is worthwhile at this stage also recommending criteria for this period. The following approach (similar to existing City of Sydney assessment standards) is recommended. This is denoted in the last column of Table 4-3 as CoS Ent (b) "+0":

- The L_{eq} noise level emitted from the use must not exceed the background (L_{90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of midnight and 7.00am when assessed at the boundary or window of the nearest affected residential property. The background noise level must be measured in the absence of noise emitted from the use.
- Notwithstanding compliance with the above, the noise from the use must not be audible within any bedroom in any residential property between the hours of midnight and 7.00am with windows/doors of the residential premise open.

Note: The background noise level $L_{90,15min}$ is to be determined in the absence of noise emitted by the use and be representative of the noise sensitive receiver. It is to be determined from the assessment L_{90} / rating L_{90} methodology in complete accordance with the process listed in the NSW EPA *Industrial Noise Policy* and relevant requirements of AS1055.1997.

4.3 Mechanical Plant

The use of mechanical plant on the premises shall not give rise to any one or more of the following:

(a) A sound pressure level at the worst affected external location on or within the boundary of a residential premise that exceeds the Project Specific Noise Level determined in accordance with the NSW Industrial Noise Policy (amenity or intrusiveness). The source noise level shall be adjusted in accordance with EPA guidelines for tonality, frequency weighting, impulsive characteristics, fluctuations and temporal content.

(b) A $L_{eq,15min}$ noise level emitted from the use must not exceed the background noise level ($L_{90,15min}$) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3dB when assessed indoors at any affected residential premises during normal use of the premises.

(c) Reference should also be made to any Major Project Approval

5 SENSITIVE COMMERCIAL (OFFICES / CHILDCARE)

The historical approach applied by the City of Sydney for each development application which doesn't satisfy the exempt and complying development requirements, (i.e. a tenancy which would fall under their noise - entertainment provisions) is to assess noise levels within commercial premises with typical conditions as follows:

Noise caused by the approved use, must comply with the following criteria

> The $L_{10,15min}$ noise level emitted from the use must not exceed the background noise level ($L_{90,15min}$) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises during normal use of the premises.

Note: The $L_{10,15min}$ noise level emitted from the use is as per the definition in the Australian Standard AS1055-1997 Acoustics – Description and measurement of environmental noise. The background noise level $L_{90,15min}$ is to be determined in the absence of noise emitted by the use and be representative of the noise sensitive receiver. It is to be determined from the assessment L_{90} / rating L_{90} methodology in complete accordance with the process listed in the NSW EPA *Industrial Noise Policy* and relevant requirements of AS1055.1997.

These criteria are normally assessed as an internal to internal noise transmission. As a minimum these criteria must still be achieved, however the City of Sydney also needs to consider cumulative noise impacts from the proposed operation of a number of tenancies which may affect the external façade of both existing offices outside the precinct as well as new offices within the precinct, noting each tenancy may not be operating at capacity at the same time as other tenancies. Cumulative noise is proposed to be addressed as a L_{Aeq} noise level.

Generally it is expected that the busy periods for the noise generating development (evenings and weekends) does not coincide with core business hours.

For an internal office environment a typical occupied background noise spectrum during normal operation will comprise background noise from mechanical services, plus people and activity noise. Adopting a conservative low internal level of 40dBA during normal operations, the resulting internal criteria would apply in the absence of collecting specific background data within the potentially affected tenancy.

Table 5-1 Internal Criteria for Offices

Scenario	A-Weighted	Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1K	2K	4K	8K
Assumed Background Level	40	55	53	45	41	37	34	31	25	20
Internal LAeq Criteria	40	55	53	45	41	37	34	31	25	20

For offices within Barangaroo, allowing for the acoustic performance of the façade (Rw32) a cumulative external noise limit for offices of 70dBA for patron and music noise would apply, and assuming that there are only likely to be 2-3 tenancies with the potential to impact a particular point on an office facade an external limit of L_{Aeq} 65dBA should apply individually for each tenancy for music and patron noise. To control music noise an external limit of L_{Ceq} 70dBC should apply.

For offices external to Barangaroo, it is really only the southern boundary of the precinct where the proposed bar/restaurants are near to existing offices and the potential for cumulative noise

from up to 2 tenancies is possible (for example, R1 & R7 in relation to the eastern side and C2 & T3 for the western side). As a conservative approach, if the external background noise level isn't exceeded in any octave band internal compliance will be achieved. Based on the background data from Tables B-2 and B-3 in Appendix B the L_{Aeq} of 54dBA should apply individually for each tenancy.

Where these external limits can't be achieved, a more detailed review of likelihood of cumulative noise, contemporaneous use of the commercial premises, confirmation of background noise levels, the sound transmission loss of the façade and the measured internal office environment should be undertaken to assess potential impacts to achieve the internal criterion.

6 SUMMARY

This Master Plan Noise Assessment Report has assessed the potential noise impact associated with the cumulative operation of a number of premises within the Barangaroo precinct at existing residences/commercial external to the precinct as well as the new residences/offices within the precinct.

Standard City of Sydney criteria have been adopted at existing residences external to Barangaroo and office premises both inside and outside the Barangaroo precinct. In addition cumulative impacts have also been conservatively addressed to these residential and office receivers.

Cumulative internal noise level criteria have been established for residences within Barangaroo, however these internal criteria have been translated to external criteria and applied to the individual retail tenancies, based on sharing the noise in a pragmatic manner.

Based on assumed patron numbers, their location and reasonable typical noise generation for restaurant and bar scenarios, including music, noise levels have been predicted to residences and offices both external to the Barangaroo precinct and those within. This include Pyrmont Bay, Darling Island, Lime Street, Hickson Road and Kent Street as well as buildings R8 and R9.

These reasonable predictions demonstrate that noise levels will meet standard City of Sydney and OLGR criteria at existing residential premises external to Barangaroo and cumulative noise has been appropriately managed.

For this urban living precinct, fit for purpose noise criteria have been recommended for residences within Barangaroo (buildings R8 and R9) to allow for the acoustic benefits provided by the upgraded double glazing and 300mm slab in these buildings.

The predicted noise levels from typical operations have been shown to comply with these criteria and the City of Sydney can therefore reasonably control noise by establishing strict noise requirements and limits for music and external seating / patron numbers for each premises.

This Master Plan Noise Assessment Report will be referenced in the DA report prepared by the operator of each retail premises. The DA report for each premises will need to confirm patron number limits and controls on music (particularly if outdoor speakers are proposed) to satisfy these conditions.

Examples of an assessment of typical retail operations are shown in the Appendix A. These can be used as a template for a DA, where appropriate.

APPENDIX A

WORKED EXAMPLE ASSESSMENT OF TYPICAL RETAIL OPERATIONS

This appendix assesses the typical operation of two restaurants located on the R8 / R9 waterfront; one located towards the centre of the block and one at the end. It has been prepared to demonstrate that a typical use within the precinct is expected to comply with the proposed criteria based on reasonable assumed operations for a typical restaurant. Where the actual operation of the restaurant is as described, then this assessment can be taken as representative, with minor adjustments to deal with actual patron numbers and location of seating.

Each tenancy will need to submit their own noise assessment based on this Master Plan.

A1 Description of Typical Restaurant Operations

The proposed trading hours are Monday to Saturday from 8.00am to 11.00pm and to 10.00pm on Sundays.

Pre-recorded background music is expected to be played, although final details of speakers are not yet available. They are expected to be wall- or ceiling-mounted internally or fixed to the façade under the main awning. No speakers will be located within the louvered awning area. Noise levels will be set to comply with the 80dBC / 75dBA limit at 3m.

A.1.1 Central Restaurant Location

Figure A-1 shows the extent of seating area beneath the awning and operable structure, indicating the seats are shielded to the residences directly above.

Figure A-1 Typical Seating Plan (131 Total – 110 External)

A.1.2 End Restaurant Location

Figure A-2 shows the northern end of building R9 with residences approximately 10m away from the nearest seat. The lower levels look across into this seating area under the awning. This figure also shows the extent of seating area beyond the awning in yellow, indicating a number of seats are not covered and therefore have direct line of sight to residences above.

Figure A-2 Typical Seating Plan (yellow shading shows uncovered areas)

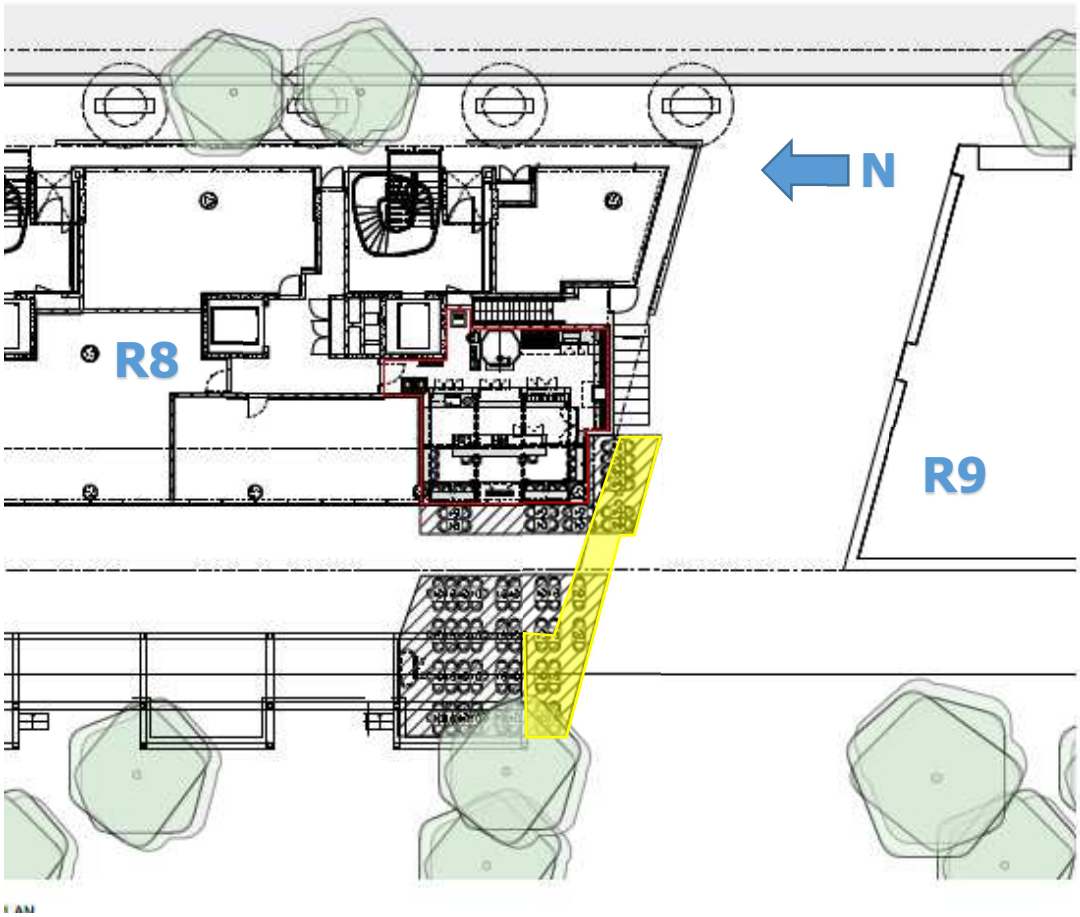


Figure A-3 and Figure A-4 show the proposed internal layouts of the residential apartments in buildings R9 and R8 which are typical of the building. The living areas generally face west to the harbour, with some bedrooms on this façade. Most bedrooms face east to Barangaroo Avenue.

Figure A-3 R9 Northern End – Internal Layout

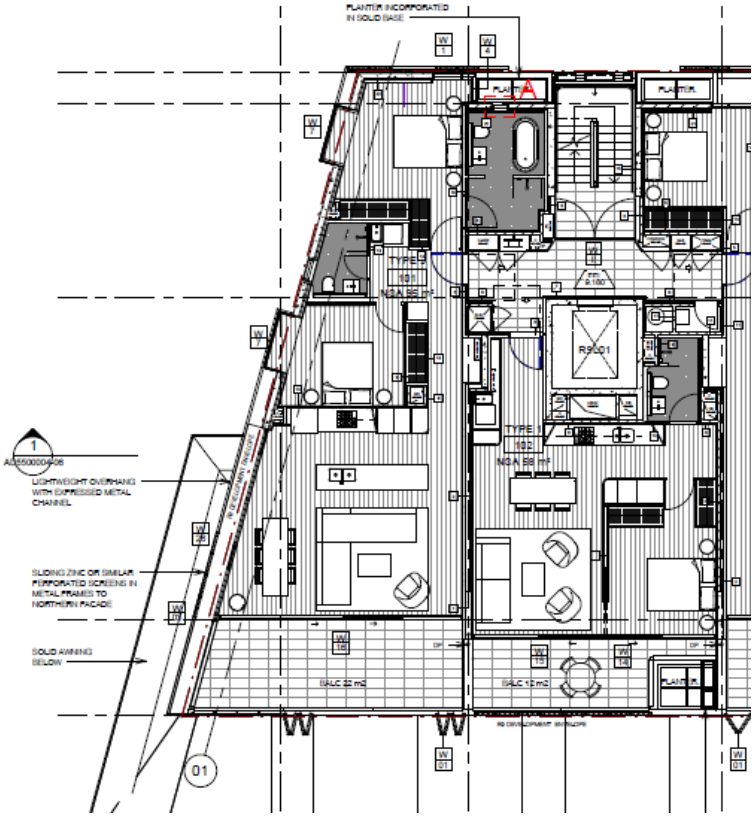
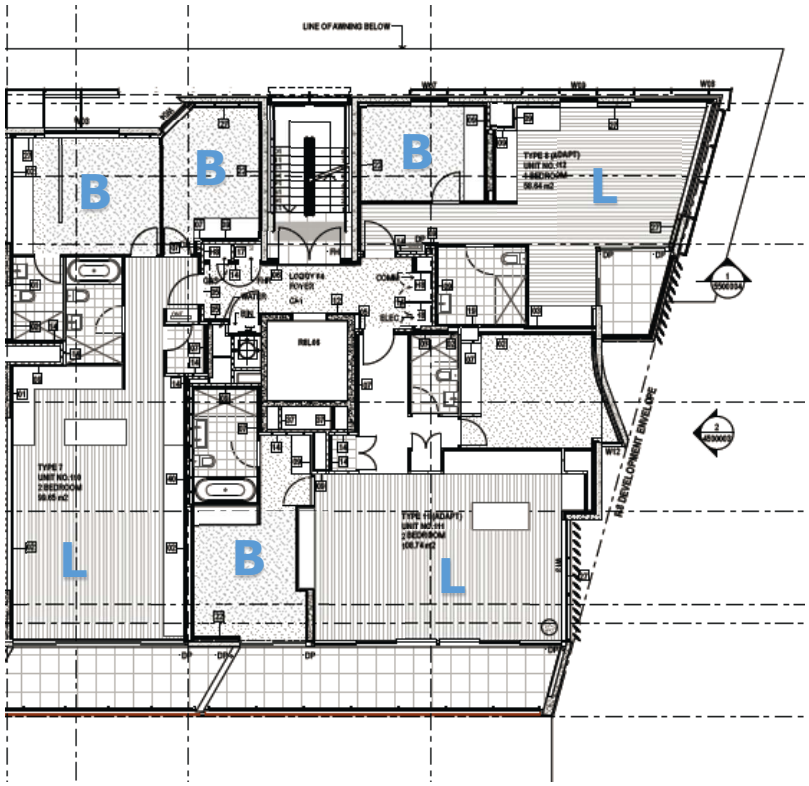


Figure A-4 R8 Southern End – Internal Layout



A.2 Mechanical Plant & Kitchen / Internal Noise

In almost all cases, the retail operators will use the base building power and kitchen exhaust systems, which discharge at roof level and have been designed to meet appropriate criteria. On this basis, there is no mechanical plant noise likely to exceed the nominated criteria for mechanical plant.

Where separate mechanical systems are required, these will need to be controlled to meet the criteria nominated.

The restaurant will use the base building mechanical systems for standard kitchen exhaust and air conditioning so is not part of this DA. Commercial bar fridges will be used internally. The exhaust systems for solid fuels, such as the wood fired pizza oven, need to be separated. This oven will run horizontally via ductwork / filters through the restaurant ceiling space and discharge via the shop front underneath the awning. No details of the mechanical system are available at this DA stage; however, noise limits have been specified for the residences above and with the acoustic shielding provided by the awning no impact from mechanical services noise is therefore expected.

The internal area is predominantly kitchen space rather than dining. Internal noise would be dominated by the commercial kitchen, including the sound of voices and kitchen appliances.

Allowing for the 300mm concrete slab (R_W > 60) $L_{Aeq,15min}$ noise levels are expected to be less than 20dBA, which is well below the internal criterion when assessed in octave bands.

A.3 Patron / Music Source Noise Levels

Wilkinson Murray has collected data from various restaurant and bar uses over time, and apply the following. This relies on the premises having a noise management plan which can curtail unruly behaviour such as patrons shouting.

1. For outdoor restaurants or internal restaurants with good acoustics and no background music, it is reasonable to assume that half the people would be talking in a normal voice.

2. For covered outdoor spaces or restaurants with poor acoustics or bars with no background music, it is reasonable to assume that half the people would be talking, with one quarter at a normal voice and one quarter with a raised voice.

3. For an outdoor restaurants with low level background music, it is reasonable to assume that half the people would be talking at any one time. We have assumed one quarter of the people would be talking with a raised voice and one quarter with a normal voice and background music.

4. For cocktail bars with background music, it is reasonable to assume that half the people are talking with a raised voice. If there is more than background music, then additional low frequency music noise will be present.

5. For other bars, then an individual assessment is required to consider total number of patrons, patron density, layout, acoustic treatments in order to determine appropriate patron voice levels.

In this typical noise assessment, Scenario 3 would apply.

A.4 Predicted Patron & Music Noise Levels

Noise levels have been predicted to the potentially most affected receivers, including external residences at Pyrmont Bay approximately 250-280m from the temporary activation area and then the residences in R8 and R9 directly above. These residences directly above will be shielded by the solid awnings, have the upgraded slab and upgraded double glazing, minimum R_W 38. The predictions allow for geometric spreading and shielding provided by the awnings.

The assessment considers approximately 100 patrons in external seating for varying waterfront restaurant frontages of approximately 10m.

A.4.1 External Residences

Table A-1 summarises the predicted levels external to Barangaroo at the closest residences at Pyrmont Bay.

Table A-1 Predicted L_{10} Noise levels at Pyrmont Bay

Scenario	A-Weighted	Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1K	2K	4K	8K
100 Capacity	40	24	33	35	36	38	37	29	18	-
External Criteria 11pm	49	55	56	54	50	47	44	37	27	15

The predicted levels comply with the external criteria for the proposed capacity operation with the highest expected noise generation.

A.4.2 Internal Residences within Barangaroo

Table A-2 summarises the predicted $L_{eq,15min}$ noise levels for Barangaroo residences. These predictions assume the glazing / façade achieves the R_W 38 rating nominated (within acceptable tolerances) and is based on typical room sizes, finishes and glazing areas. Internal finishes assume carpet in bedrooms and hard floors in living rooms. The awnings include a louvered section which, for prediction purposes, is assumed to be closed later in the evening and subject to need.

Table A-2 Predicted External & Internal L_{eq} Noise levels at R8 / R9

Assessment Location	External dBA	Internal dBA	Octave Band Centre Frequency (Hz)								
			31.5	63	125	250	500	1K	2K	4K	8K
End Restaurant Location											
R8 Living Room	62	34	39	42	42	39	32	24	17	5	-
R8 Bedroom	61	29	35	39	37	34	26	18	11	-	-
R9 Living Room	57	29	37	41	38	34	26	19	11	-	-
R9 Bedroom	58	26	38	40	37	30	22	15	7	-	-
Central Restaurant Location											
R8 Living Room	52	27	39	42	39	32	22	13	4	-	-
R8 Bedroom	52	24	38	40	36	29	18	9	-	-	-

The predicted levels within the centrally located restaurants of R8 and R9, where all patrons are shielded comply with the internal and external criteria for operation until 12.00 midnight. The predictions confirm the need to manage patron noise at all times and to close the louvres, as required, during the evening. External patron numbers of up to approximately 150 can be readily approved.

For end restaurant locations where some patrons may not be shielded to all residences, the criteria are also complied with, but with less headroom.

APPENDIX B

BACKGROUND NOISE LEVELS (INFORMATION PURPOSES ONLY)

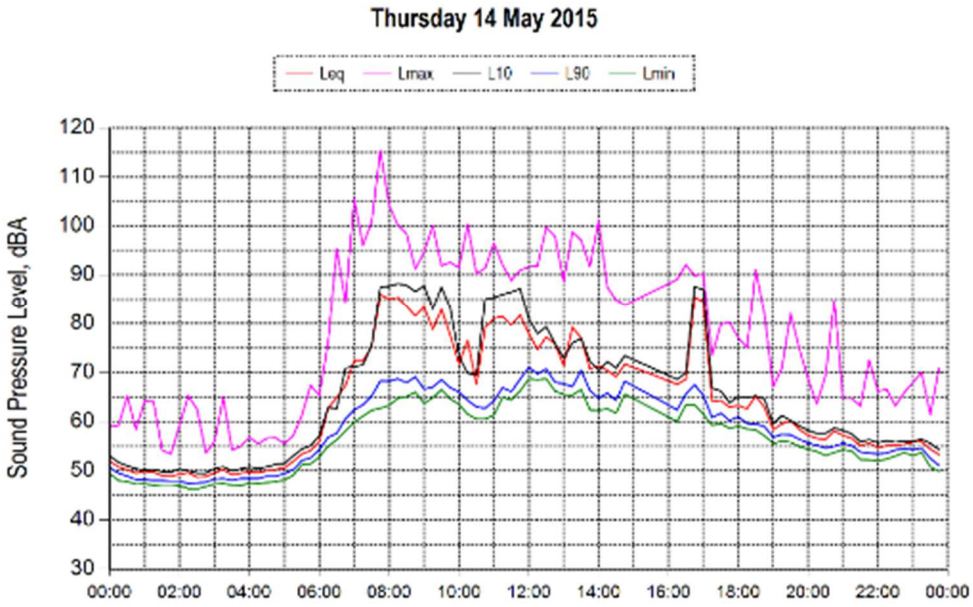
Background noise levels at residential receivers external to the Barangaroo development have been measured at various locations and times over the past few years by Wilkinson Murray, Arup, Renzo Tonin and Associates and SLR and presented in previous reports. For the purpose of this report, additional background noise levels were measured at four locations within the existing site as shown in Figure B-1.

1. Southern end of R9 on a balcony on Level 4
2. Western side of R9 on a balcony on Level 4
3. Northern end of R8 on a balcony on Level 4
4. Eastern side of R8 on a ledge on Level 4

Figure B-1 Measurement Locations Buildings R8 & R9

Measurements at Location 1 were undertaken from 12 to 19 May 2015. Measurements at Locations 2 – 4 were undertaken from 27 May to 2 June 2015. A typical weekday from Location 1 is shown in Figure B-2, although the levels were influenced by construction noise during daytime. This graph shows a steady decline in background noise level during the evening until about 1.00am, where it remains steady until about 5.00am. The full set of graphical data is shown at the end of Appendix B

Figure B-2 Typical Ambient Noise Levels Southern End of R9



All recent measurements at Barangaroo are affected by daytime construction noise, so are not representative. However, as a conservative approach, the 6.00pm to 8.00pm measurements have been reviewed as well as Sunday data to determine a reasonable RBL to apply for the daytime period.

We understand at night time there was no construction in the vicinity likely to influence background noise levels. We visited the site on Thursday, 14 May at 9.00pm and 12.00 midnight to confirm on that night there was no construction activity likely to influence background noise levels. The only sources of noise at that time were from King Street Wharf venues and boats moored at the Wharf in addition to the urban hum from the CBD.

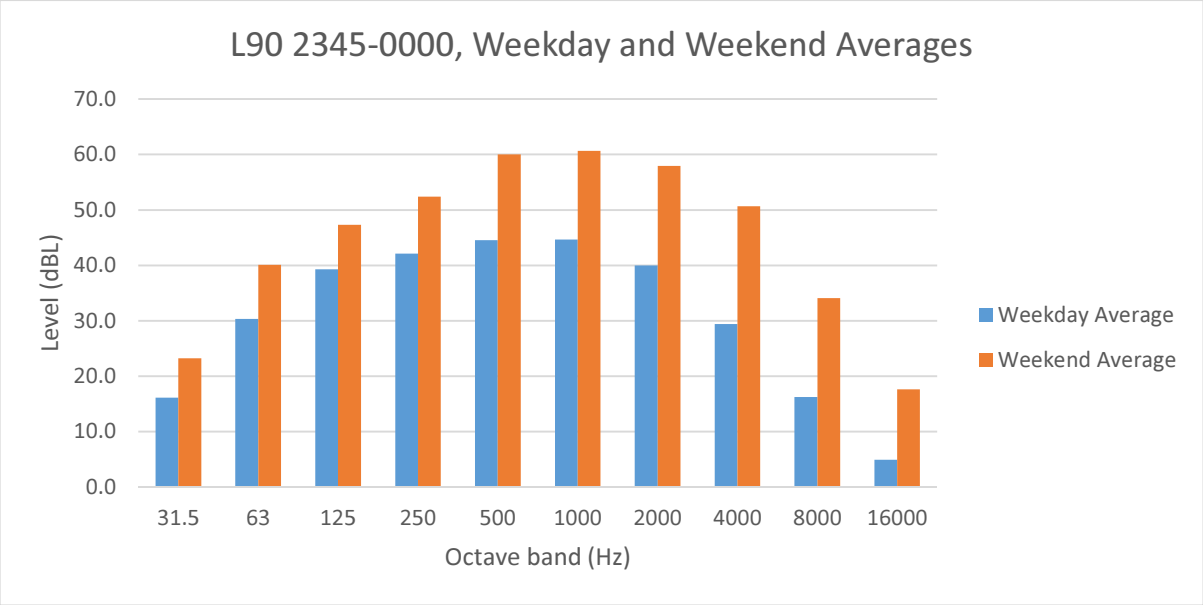
On Friday and Saturday, there is influence from existing activities at King Street Wharf (music and voices) and this is part of the background on these two nights, which is as high as 63-64dBA. This data has been excluded from the analysis. On an "RBL" approach adopted by the NSW EPA (as the median of the 5 quieter values) a summary of the overall background noise levels for each period, including 10.00pm to 12 midnight, are shown in Table B-1.

Table B-1 Existing Background (RBL) Noise Level Summary (dBA)

Location	Day	Evening	Night	10pm-12am
Existing Residences				
Pyrmont Bay	52	48	43	46
Hickson Road	53	53	49	51
Lime Street	54	52	48	50
Future Residences				
1 – R9 South	58	54	48	52
2 – R9 West	54	51	45	49
3 – R8 North	54	51	44	49
4 – R8 East	55	51	44	49

Audio was also recorded between 9.00pm and 2.00am each night at Location 1 (southern end of R9) in order to establish the background noise levels in octave bands. A sample of the 15 minute files commencing at 11.45pm have been post-processed in order to obtain typical octave band background data, as shown in Figure B-3.

Figure B-3 Average of L_{A90} between 11.45pm & 12am for Weekdays & Weekends



Compliance with noise criteria proposed in this document during and beyond the temporary activation requires understanding of the future background noise levels both inside and outside residential receivers likely to be affected by noise from the approved licensed premises.

At Barangaroo, the current background noise levels are expected to increase once the development is completed and fully occupied. This section provides additional information to assist in estimating future background noise levels.

The types of future noise sources and the likelihood they will add to existing background noise levels can be split into mechanical services noise from plant rooms and then noise from other sources, such as the proposed Ferry Hub, local traffic and general activity. These are discussed below, even though many will not apply to the temporary activation phase.

B1 – Mechanical Services Noise

The current approach for buildings within Barangaroo has been to set a criterion of approximately 45dBA for the mechanical plant in each "building" at the nearest residential location. This would separately apply to the common basement of the development, the Towers T1-T3 including the podiums, R1, R7 and also R8 & R9.

Of course not all the plant noise from surrounding buildings would affect the same receiver location. It is expected that the background noise at the southern and eastern facades of R8 and R9 will be affected, but the northern and western facades are unlikely to be affected.

The likely sources of plant affecting the ambient noise at the southern end of R9 prior to 12.00 midnight are the rooftop plant from R1 and R7, which also have risers for car park fresh air supply

to the basement buildings. Their position on the roof are unlikely to influence the lower levels of R9 which would be shielded. Whilst car park fans may need to operate later in the evening, they may not operate at full duty.

The cumulative additional plant noise at 12 midnight is likely to be approximately 45dBA and is unlikely to exceed 50dBA from a combination of sources from the various buildings at the southern and eastern ends of R9.

It is considered this would add no more than possibly 1dBA to the lower levels of R9, and 2dBA to the upper levels of R9 above the base background levels (assumed to be 52dBA). This would result in background levels of 53-54dBA at these locations.

For the eastern side of R8 and R9, it is considered an increase of 1-2dBA is likely, resulting in levels of 51dBA.

For the northern and western sides of R8 and R9, no increase has been allowed for mechanical services noise.

B2 – **Other Sources of Background Noise**

In addition to mechanical plant noise from within the Barangaroo development, there are likely to be other sources of semi-continuous or intermittent noise. The following sources are considered relevant.

- People noise within the outdoor areas of restaurants in the precinct;
- Staff clearing up within the outdoor areas of restaurants;
- People noise walking / talking in the public areas arriving / leaving premises;
- Vehicle noise / taxis from Lime Street (and extension);
- Vehicle noise / roller shutters from car park exits;
- Vehicle noise / roller shutters from loading areas; and
- Proposed Ferry Terminal – Ferries will be moored / cleaned / and minor maintenance etc.

An extract from the Ferry Hub Noise assessment is provided below.

> *The southern side of each wharf would provide a single berth for daytime layover, subject to timetable requirements. Overnight, up to three vessels may be in layover on each wharf. During layover minor vessel maintenance (e.g. cleaning, minor repairs and daily sewerage pump-out) may be undertaken. Ferries would run on shore power during layover.*
>
> *For the purpose of this assessment it is anticipated that maintenance activities would occur in the night-time assessment period; after the last scheduled service (end of shift) between 12:00 am midnight and 1:00 am. Noise sources considered for the operation of Barangaroo Ferry Hub include, but are not limited to, the following:*
> *Operational*
>
> - *Ferry noise (engine, propeller noise, horns/warning devices and impact noise of ferries against pontoons during docking);*
> - *PA systems; and*
> - *Passenger noise.*
>
> *Maintenance (on vessels and on wharves)*
> - *Sewerage pump-out;*
> - *Cleaning;*
> - *High pressure water cleaning of wharf facilities around three times weekly; and*
> - *High pressure water blasting on tidal stairs or ladders would occur once monthly.*

We consider these noise sources are likely to influence different facades of R8 and R9 to different degrees.

In relation to just "people" noise levels from the restaurants, they are unlikely to be sufficiently high on a regular basis after 10.30pm on the quieter nights of the week to reliably measurably add to the background noise at the upper floors of R9, but would have more influence on the lower floors. However, when considering more local traffic / taxis, the ferries and staff cleaning etc, it is not unreasonable to assume that the cumulative impacts of all of these intermittent sources on background noise levels would be to increase them by a further 1-2dBA with the smaller increases at the lower floors.

A review of the data from Location 1 (R9 South logger) shows how high the background level can be raised from the current "people and music" associated with activities at King Street Wharf. On the busy weekend nights, background noise levels were approximately 64dBA between 10.00pm and 12.00 midnight.

B3 – Overall Future Background Levels

For the temporary activation phase, it has been conservatively assumed that no increase will occur above the existing measured levels, even though some mechanical plant and background activity will be occurring. On a review of available data, the future background (RBL) noise levels in Table B-2 are estimated at the various facades. Table B-3 indicates the numerical adjustments that need to be applied to the overall dBA level to get the linear octave band levels.

Table B-2 Estimated Future Background Noise Level Summary

Location	L_{A90} Levels (dBA)		
	Day	Evening	10pm-12am
Pyrmont Bay	52	48	46
Hickson Road	53	53	51
Lime Street	54	52	50
L1 R9 South	60	56	55
L2 R9 West	60	54	53
L3 R8 North	58	53	51
L4 R8 East	59	54	52
R8 West	58	53	51
R9 East	60	54	52

Table B-3 External Octave Band Spectrum relative to dBA

A-Weighted	Octave Band Centre Frequency (Hz)								
	31.5	63	125	250	500	1K	2K	4K	8K
0	+6	+7	+5	+1	-2	-5	-12	-22	-34

B4 – **Internal Background Noise Levels**

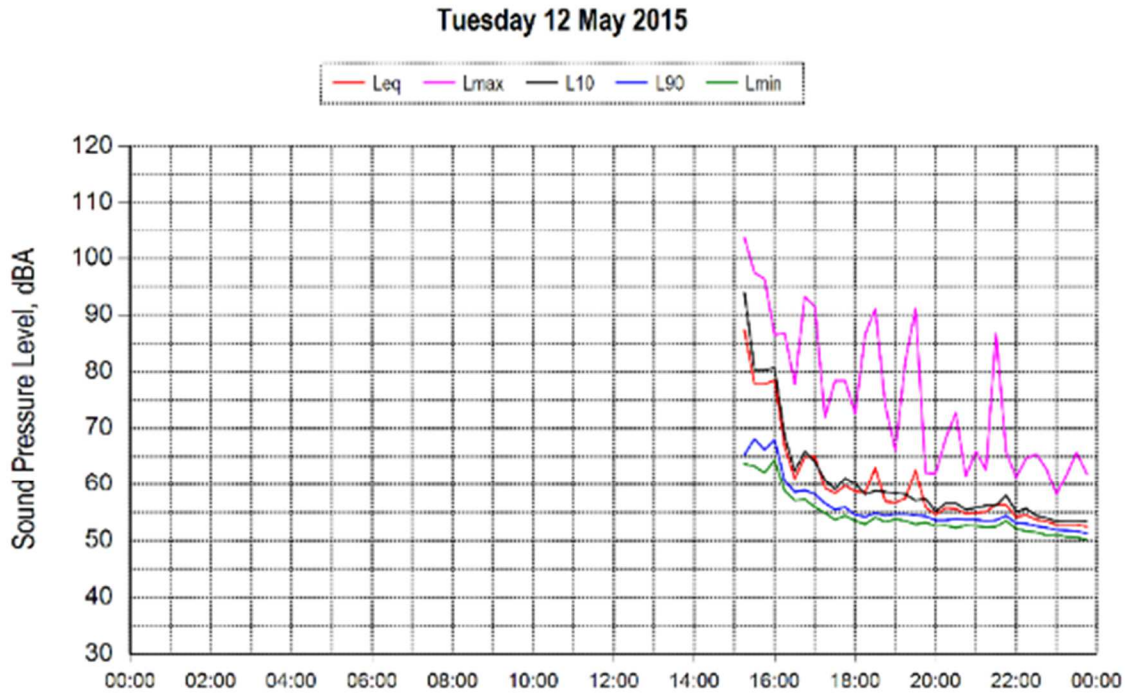
To assess mechanical plant noise internally or internal to internal noise transmission, it is necessary to estimate a future background noise level internally with the air-conditioning operating on medium setting.

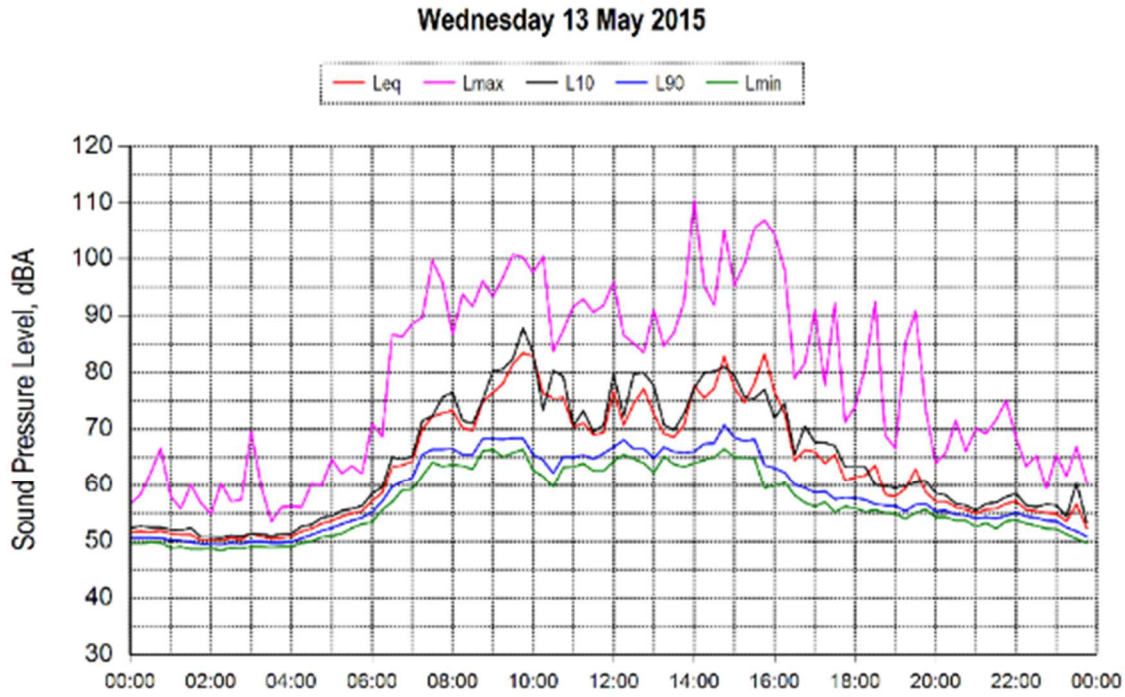
It is assumed for the apartments that an internal level of 35dBA will be achieved for Living Rooms and 30dBA for Bedrooms with the air-conditioning on, with the levels in octave bands shown in Table B-4.

Table B-4 Estimated Future Internal Background Noise Levels

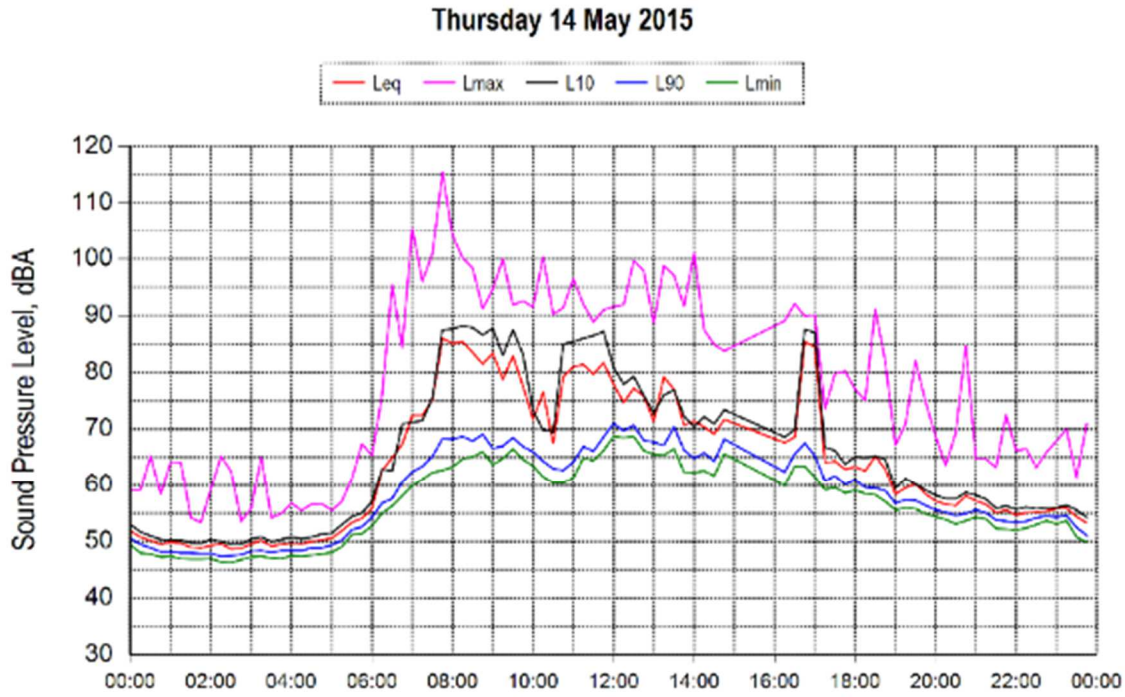
Measurement Location	A-Weighted	Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1K	2K	4K	8K
Living Room	35	51	45	42	37	30	31	26	16	14
Bedroom	30	47	43	40	30	24	25	20	13	12

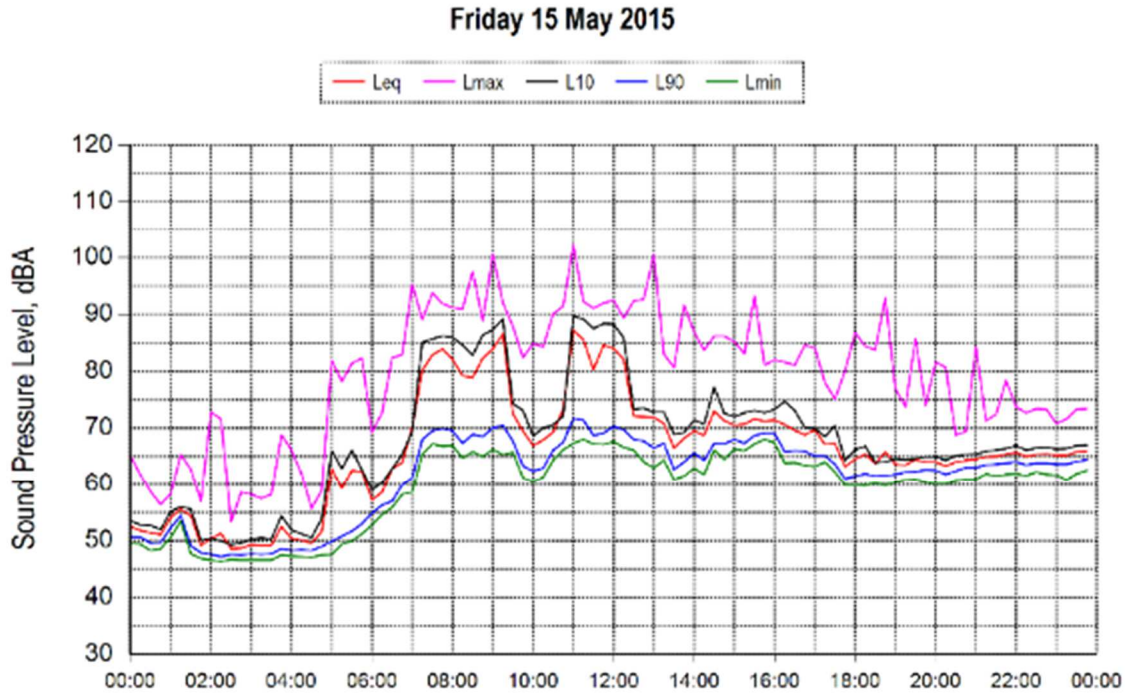
Location 1 – Level 4, Building R9 Southern End



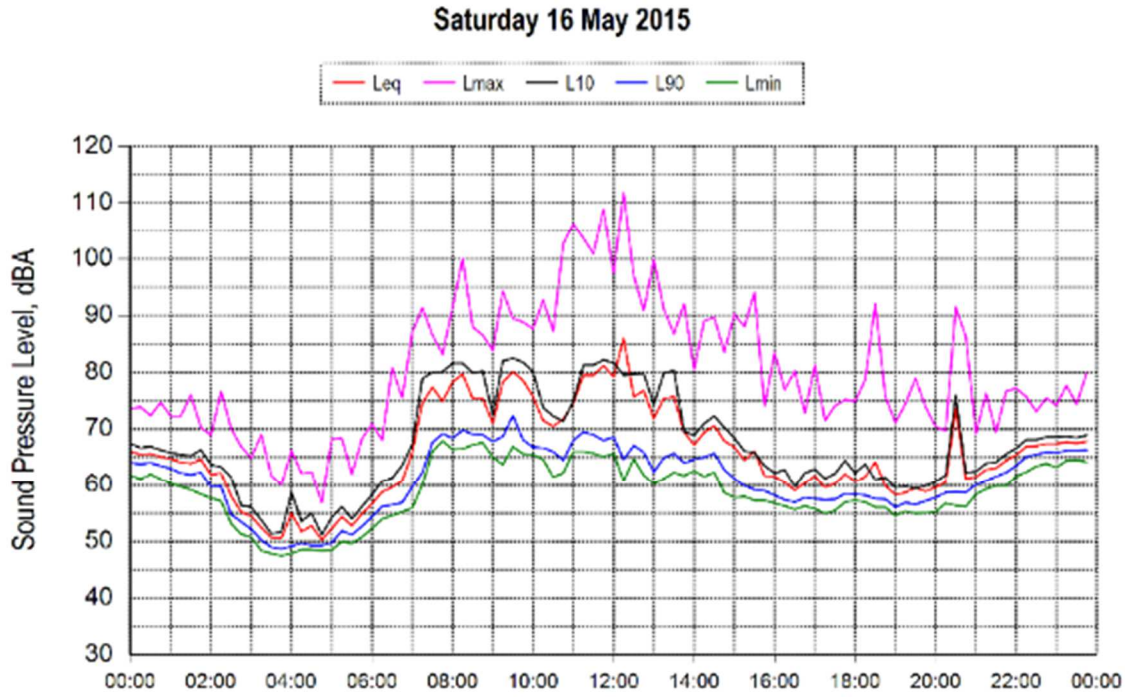


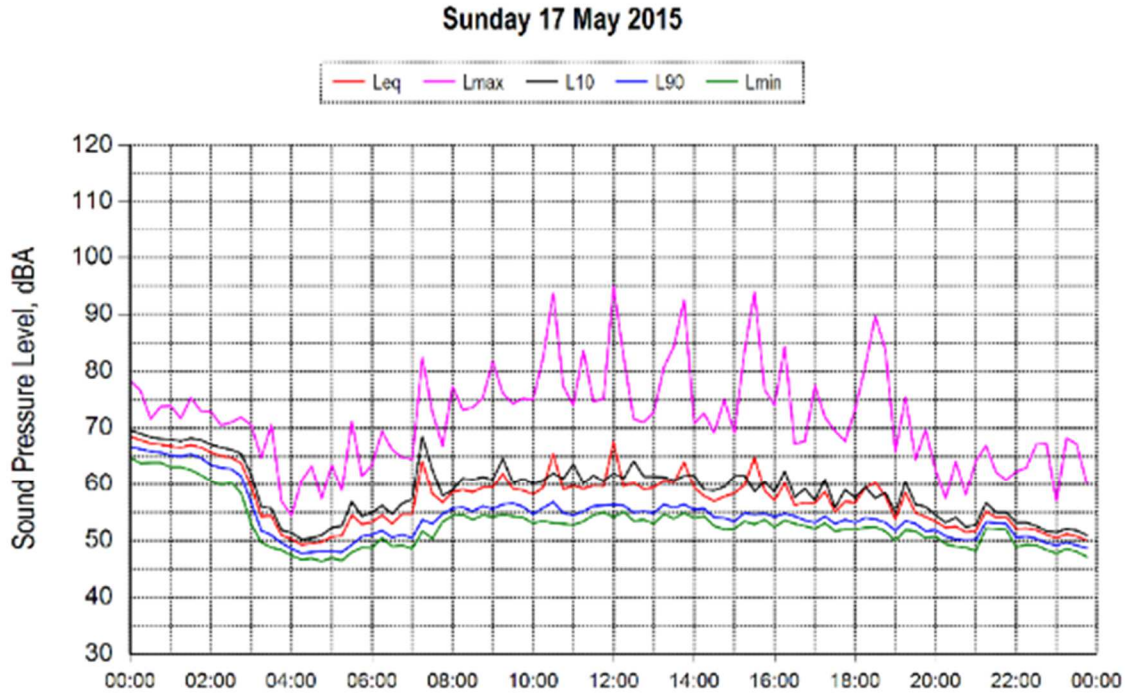
Location 1 – Level 4, Building R9 Southern End



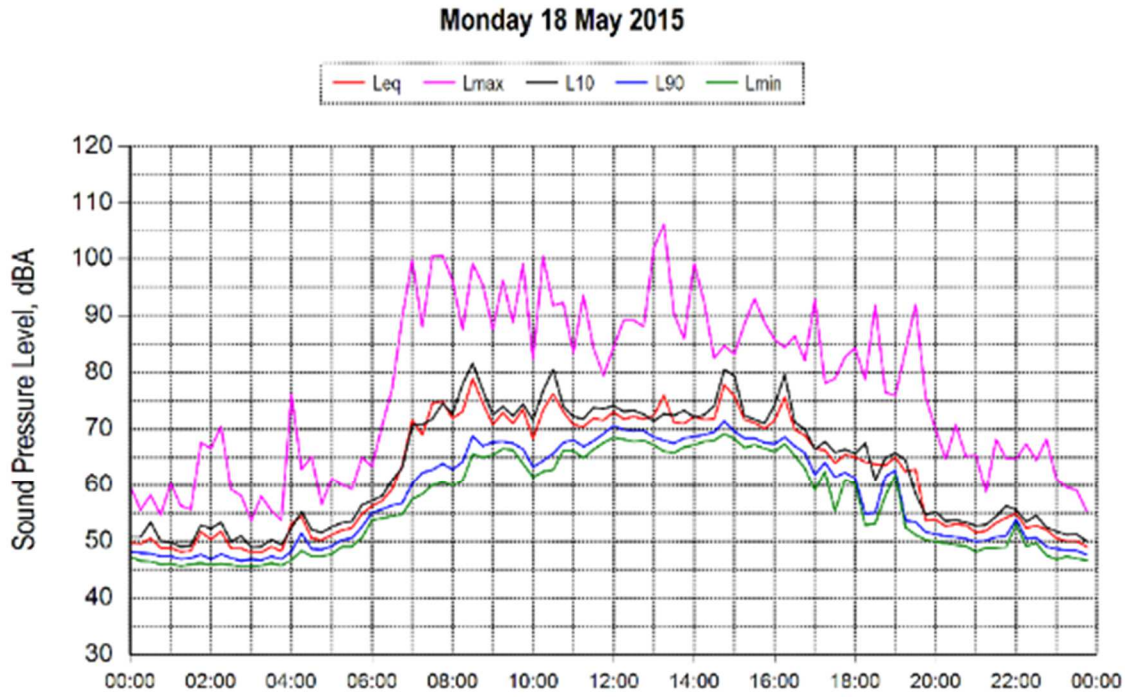


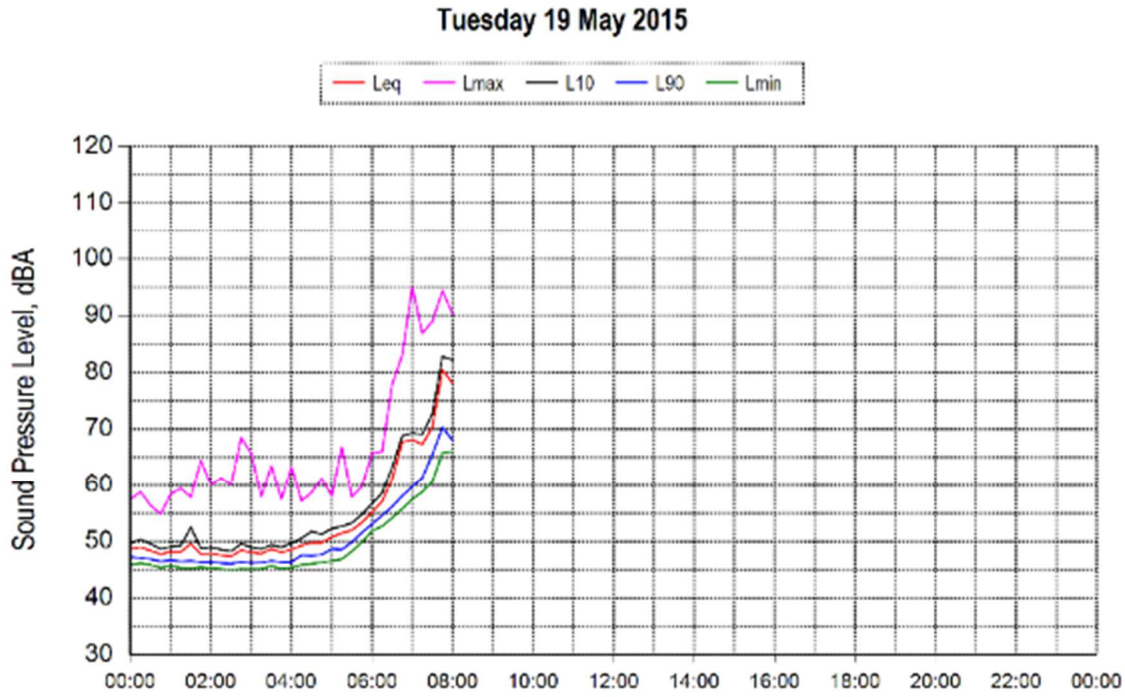
Location 1 – Level 4, Building R9 Southern End



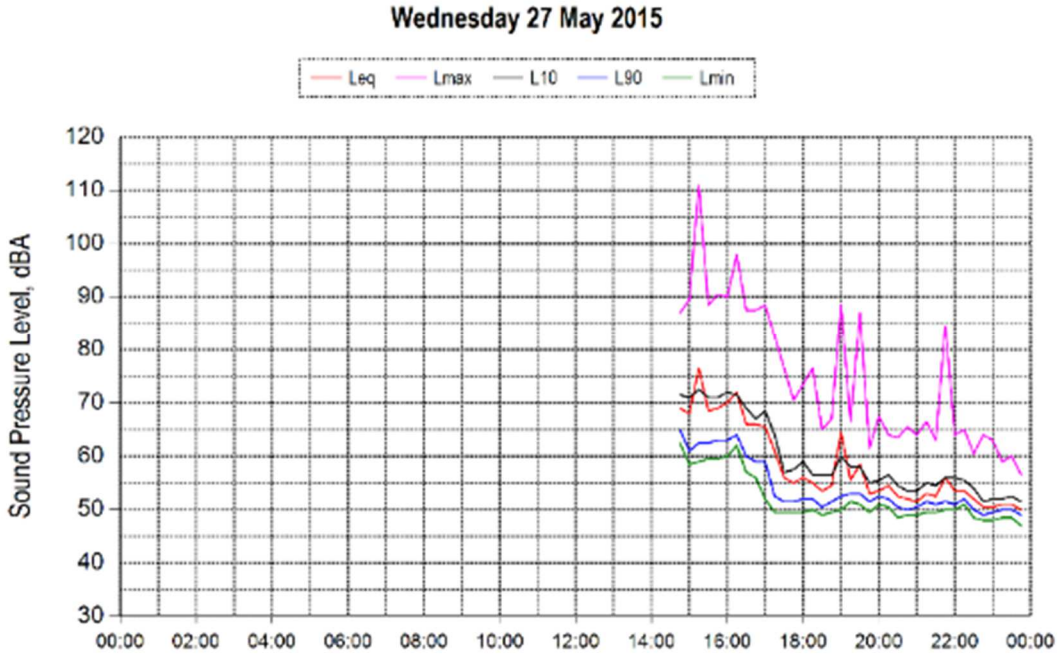


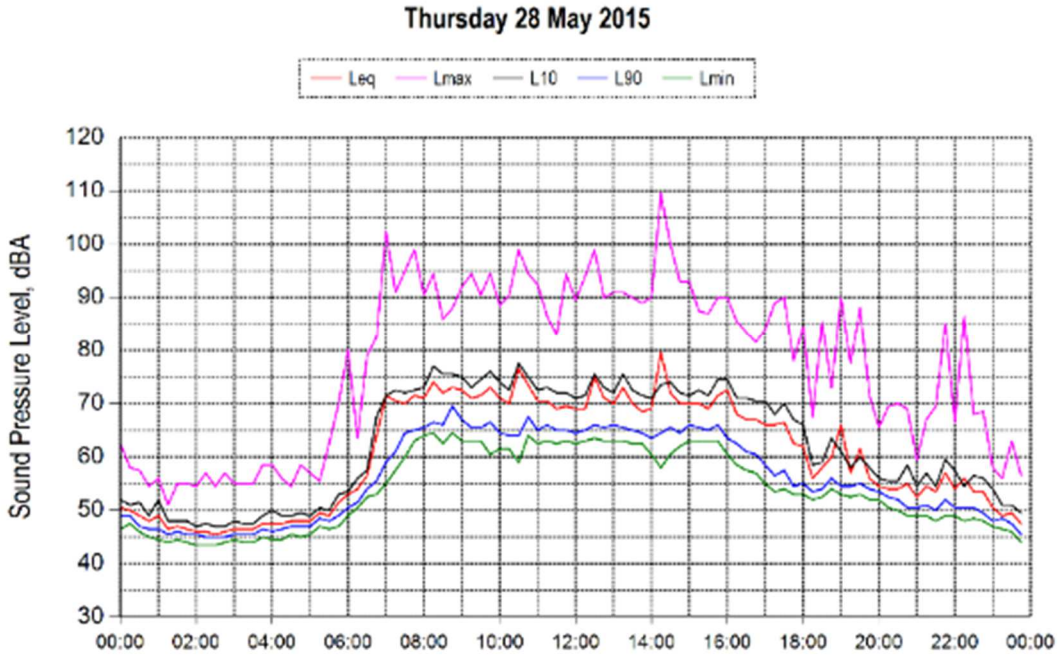
Location 1 – Level 4, Building R9 Southern End



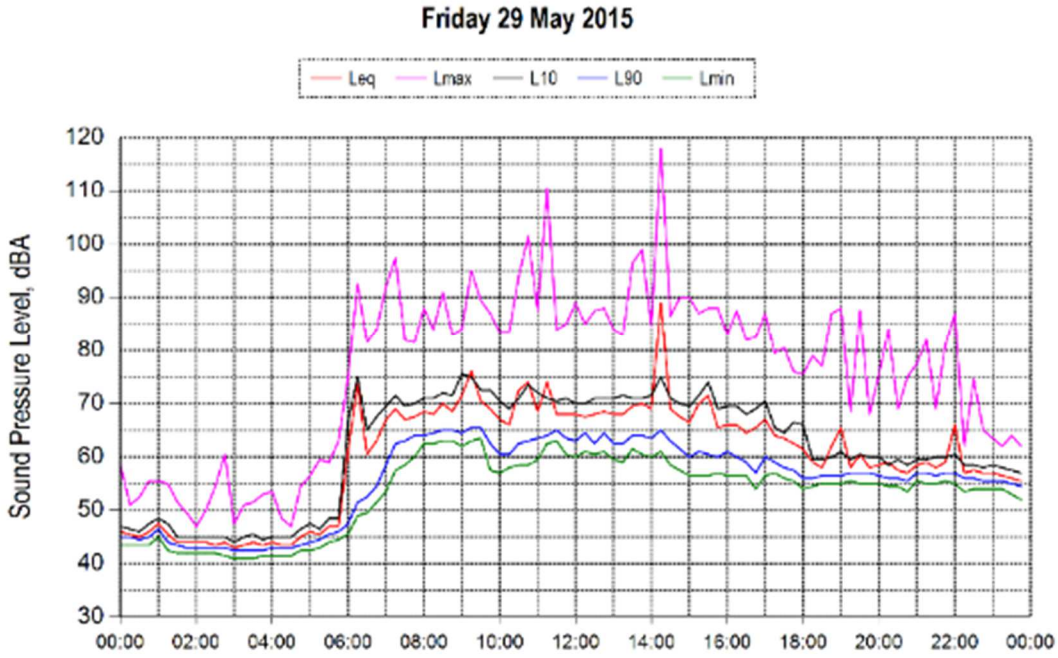


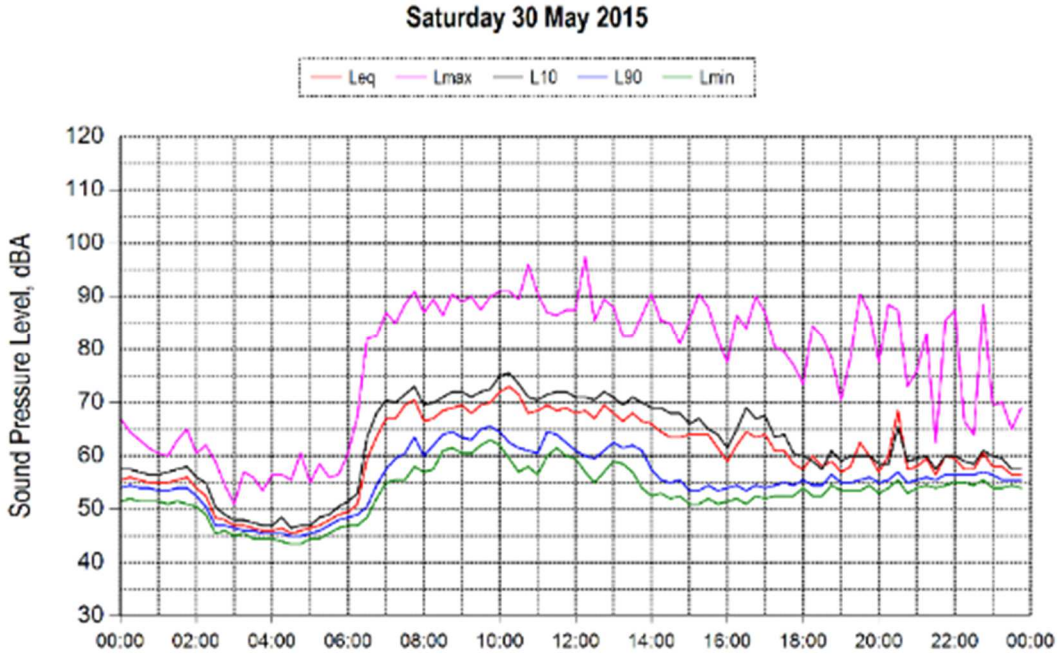
Location 2 – Level 4 Building R9 Western Side



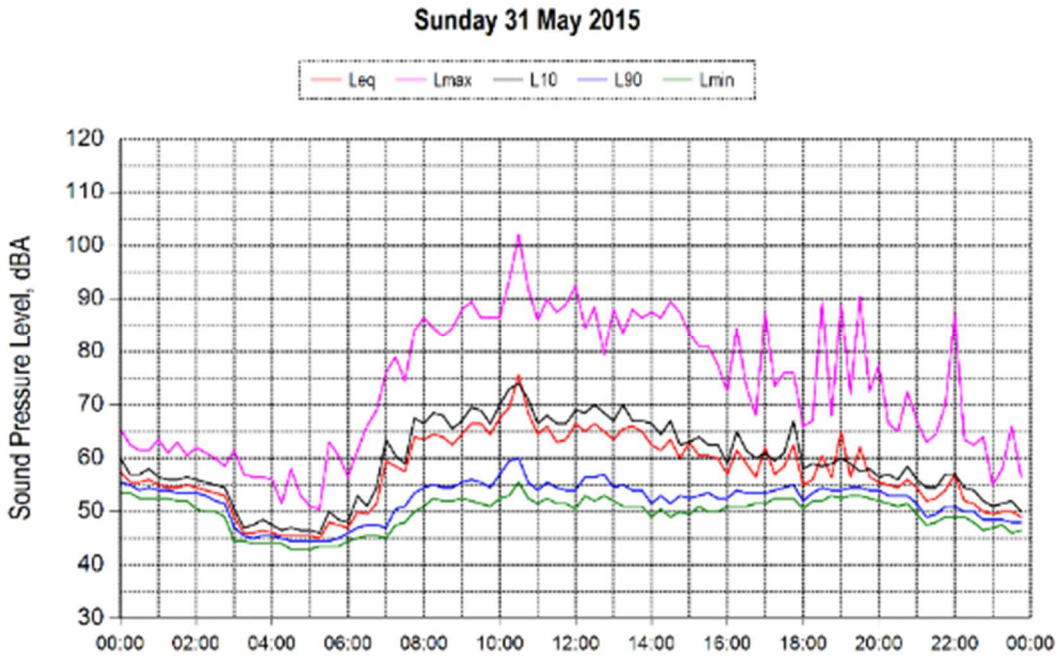


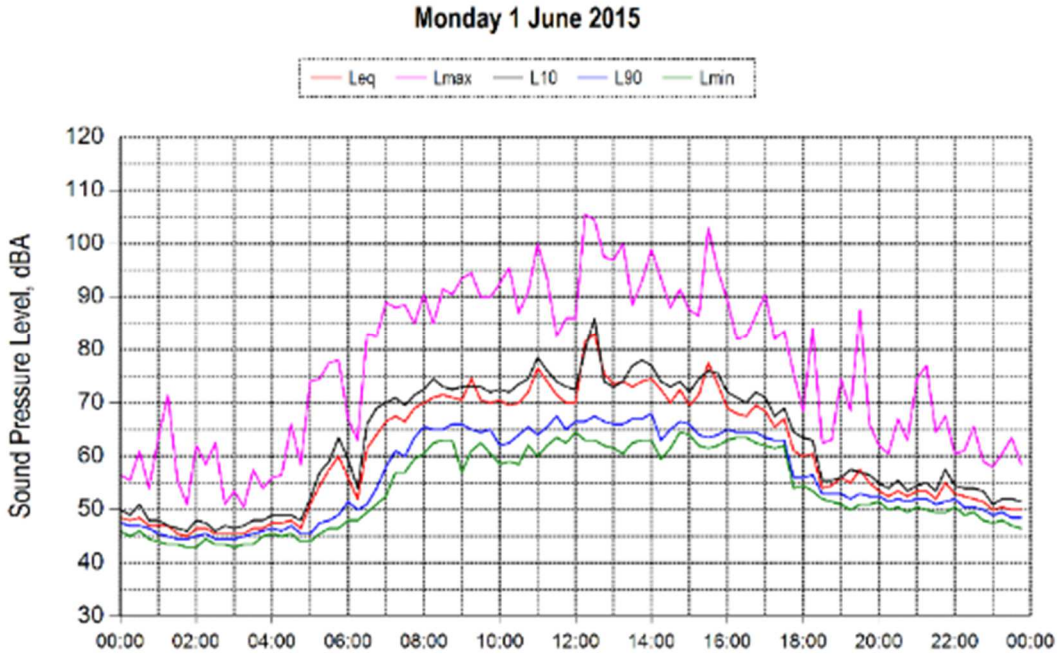
Location 2 – Level 4 Building R9 Western Side



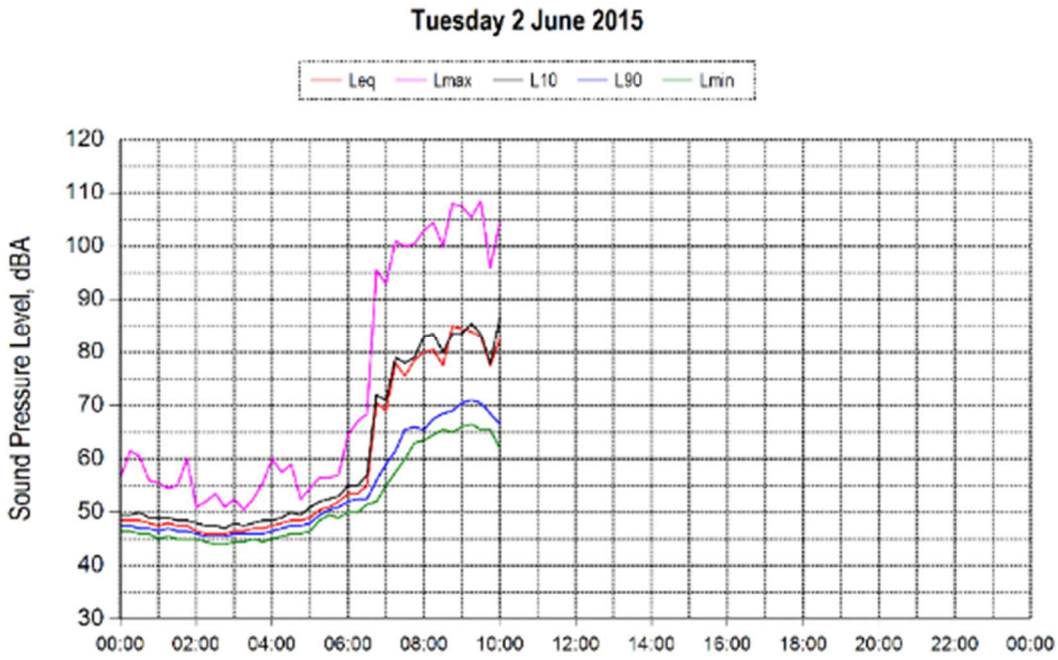


Location 2 – Level 4 Building R9 Western Side

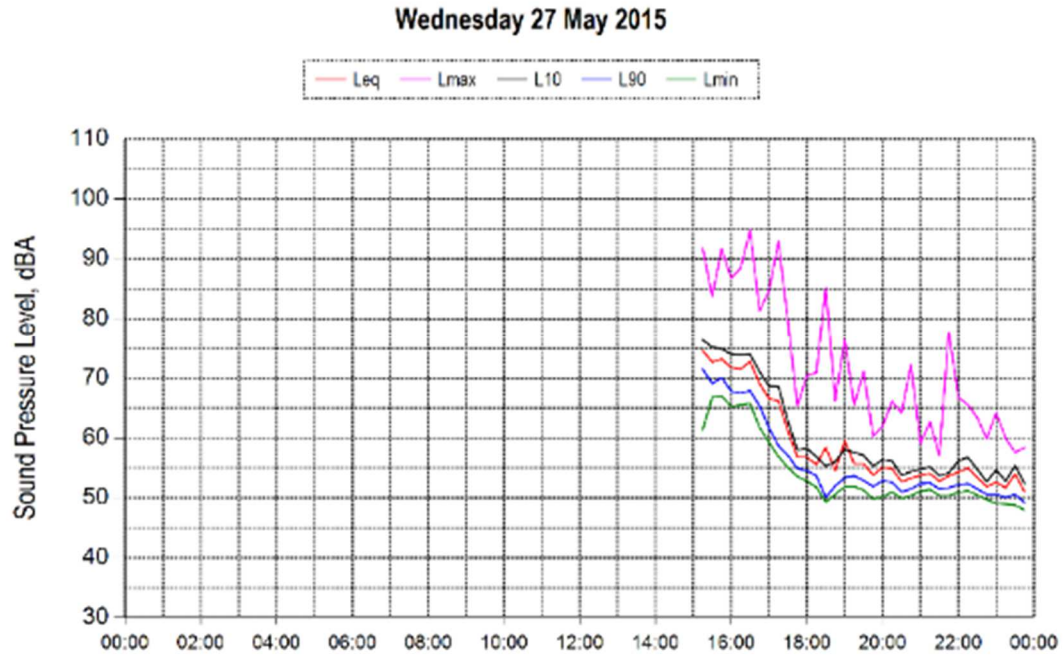


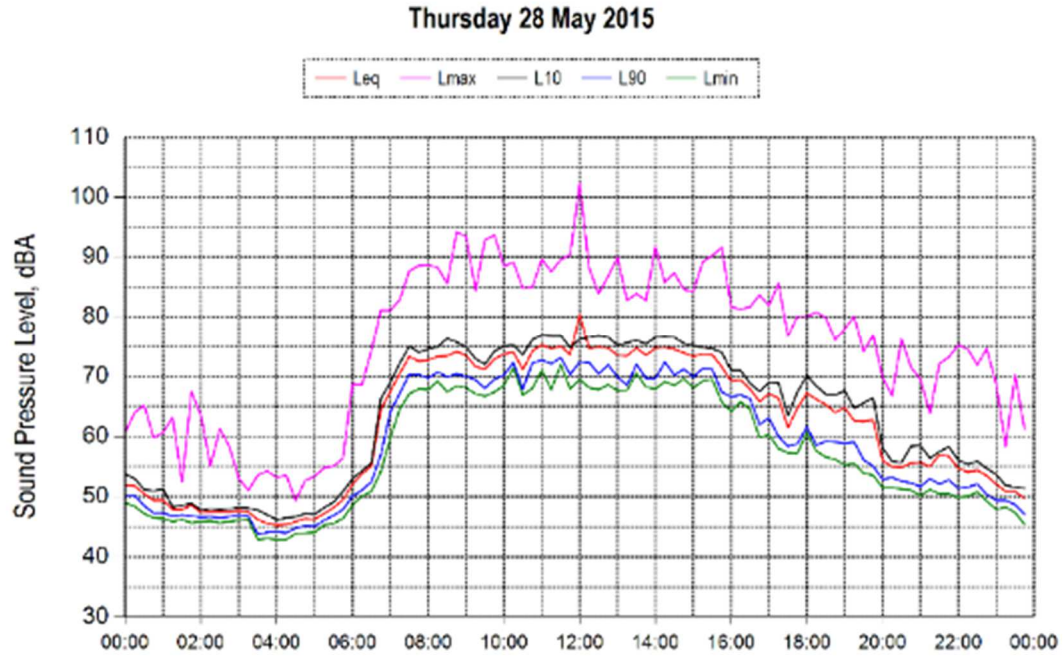


Location 2 – Level 4 Building R9 Western Side

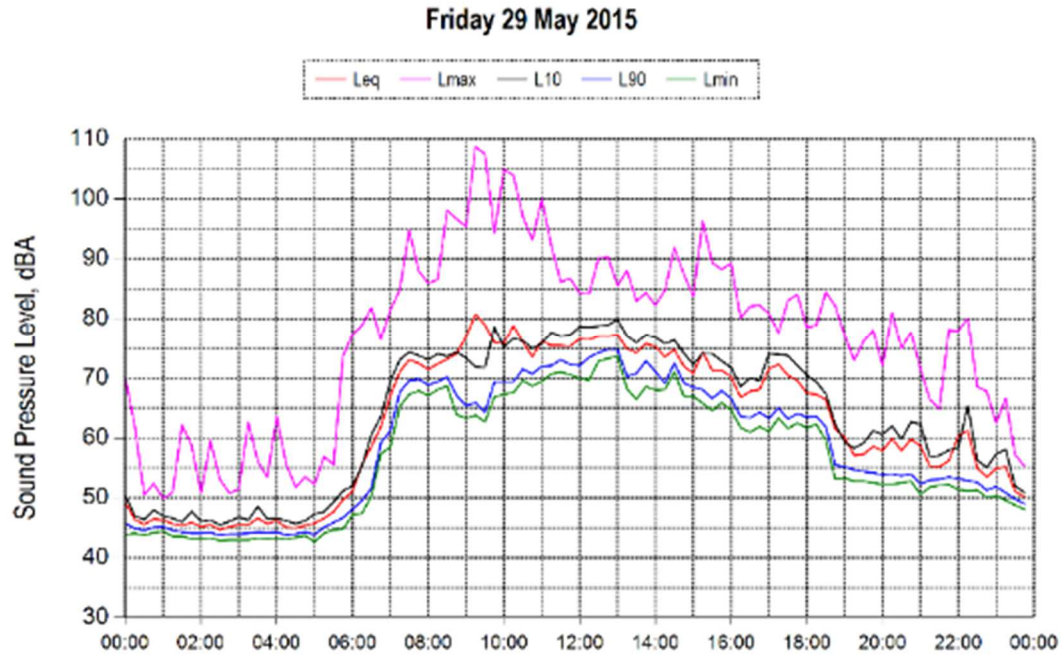


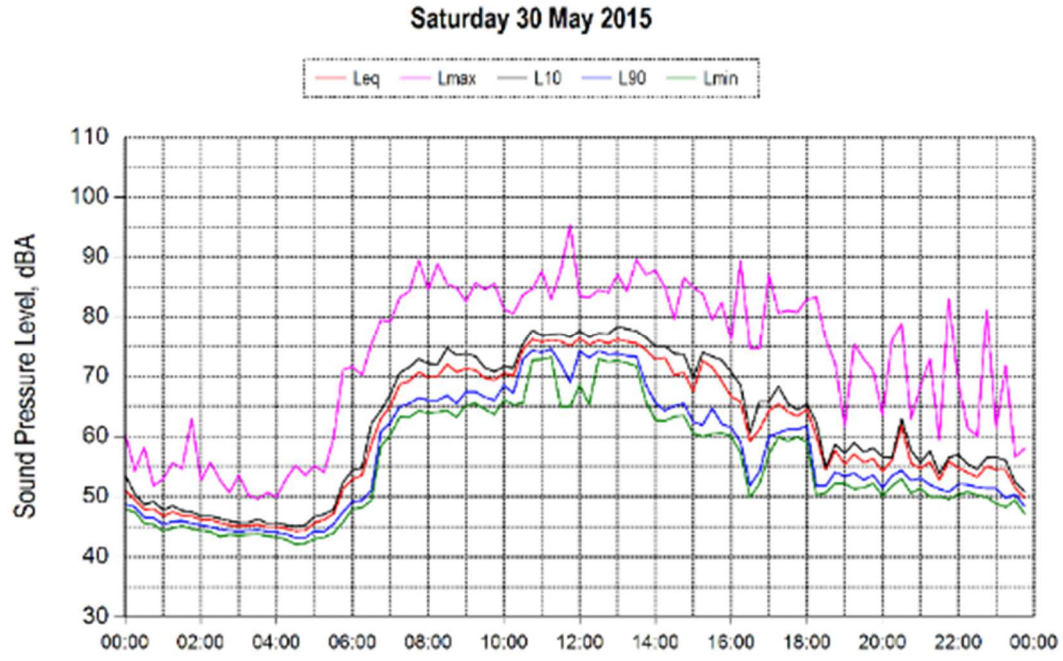
Location 3 – Level 4 Building R8 Northern End



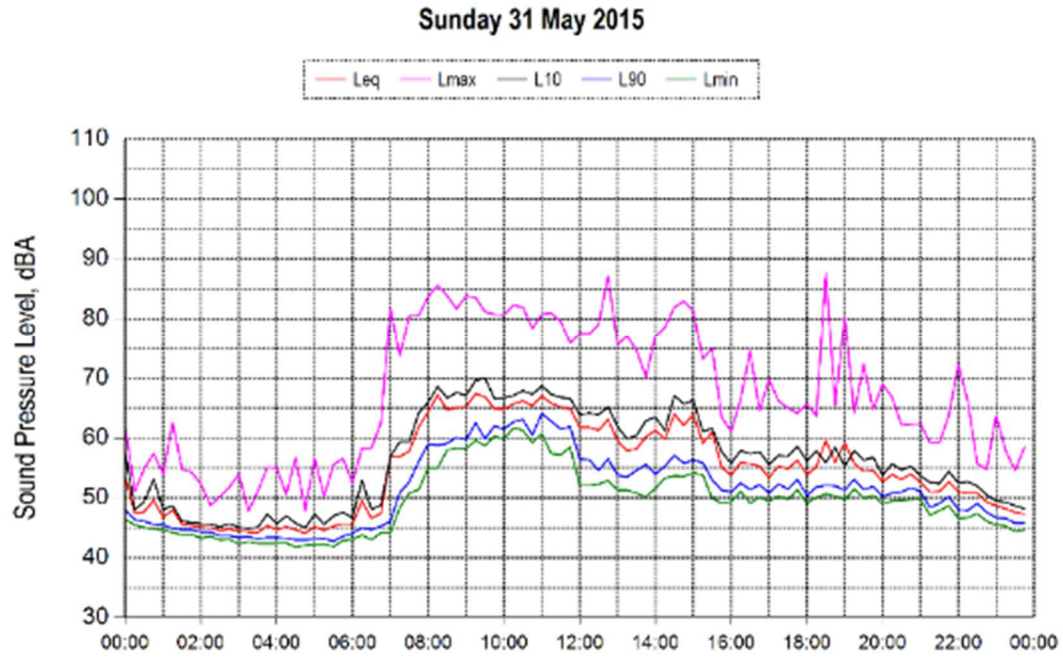


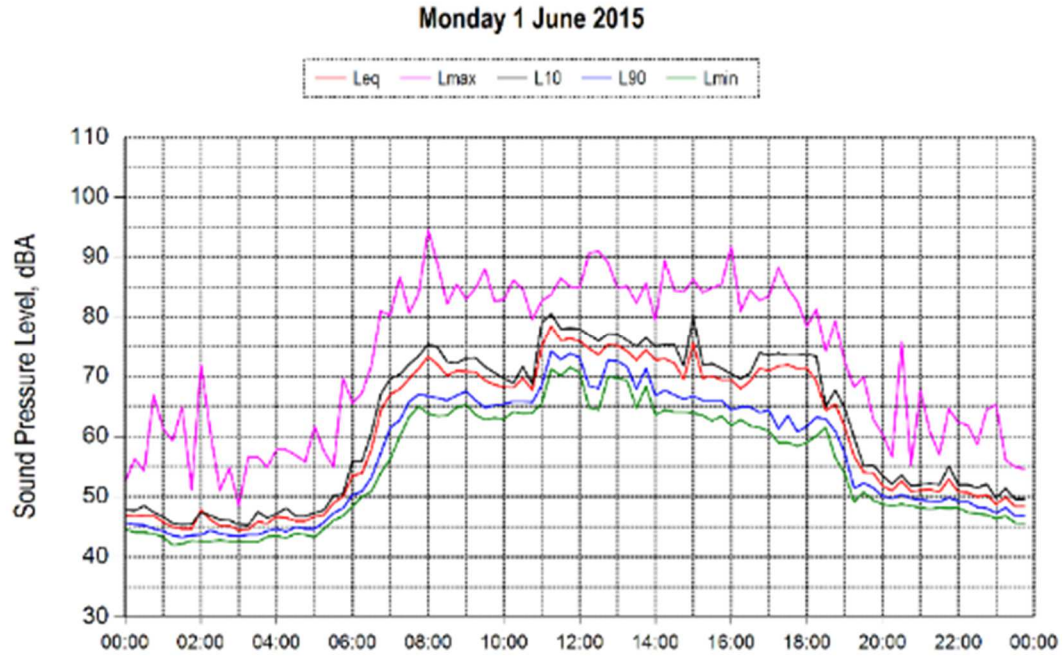
Location 3 – Level 4 Building R8 Northern End



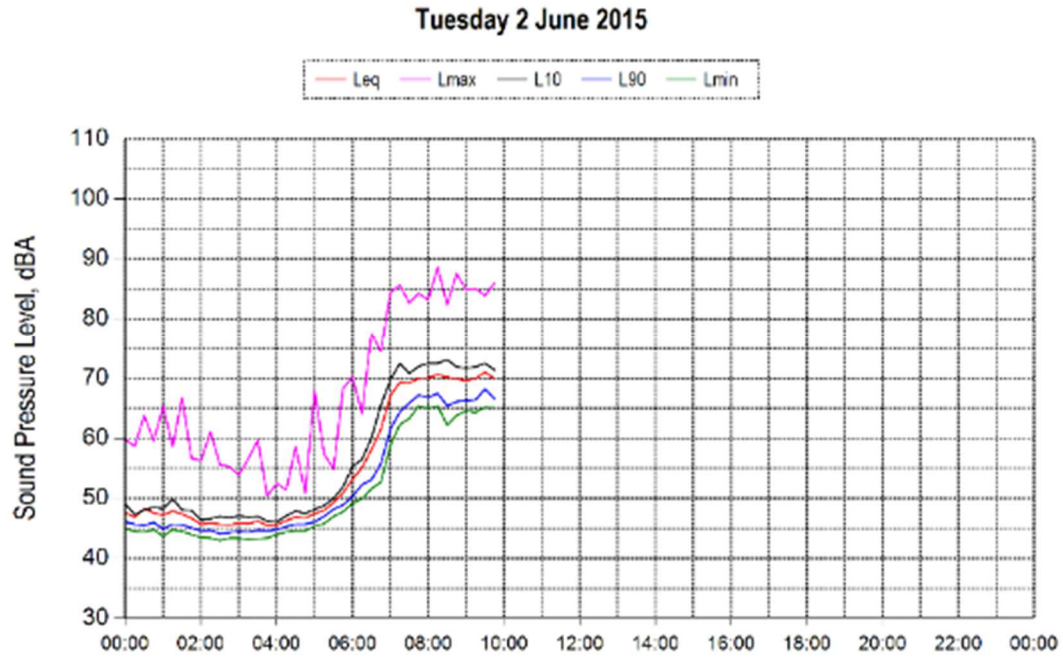


Location 3 – Level 4 Building R8 Northern End

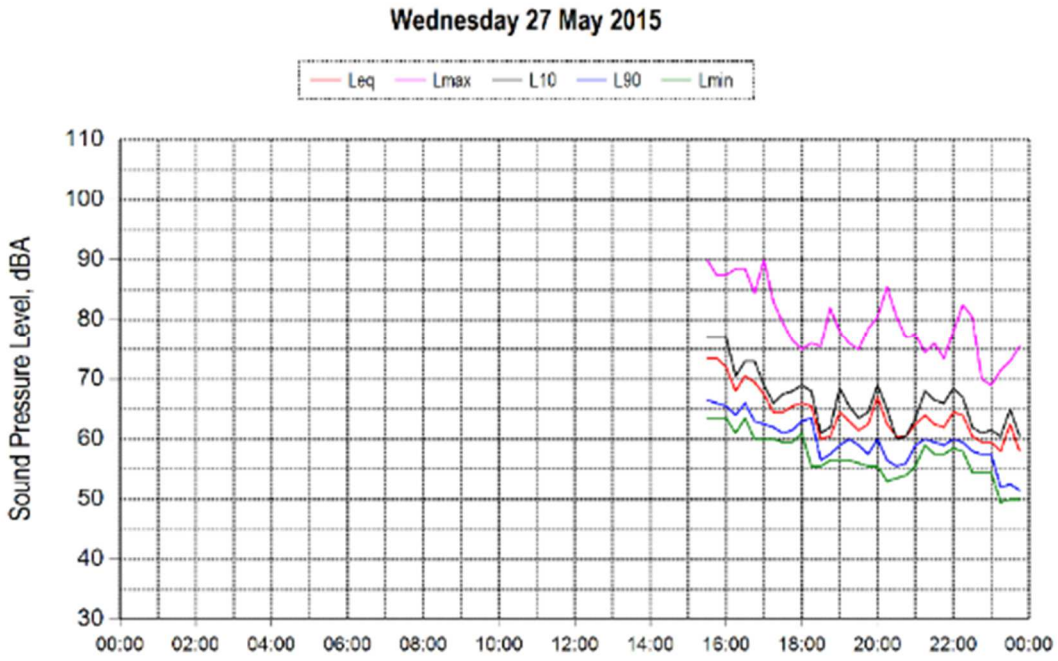


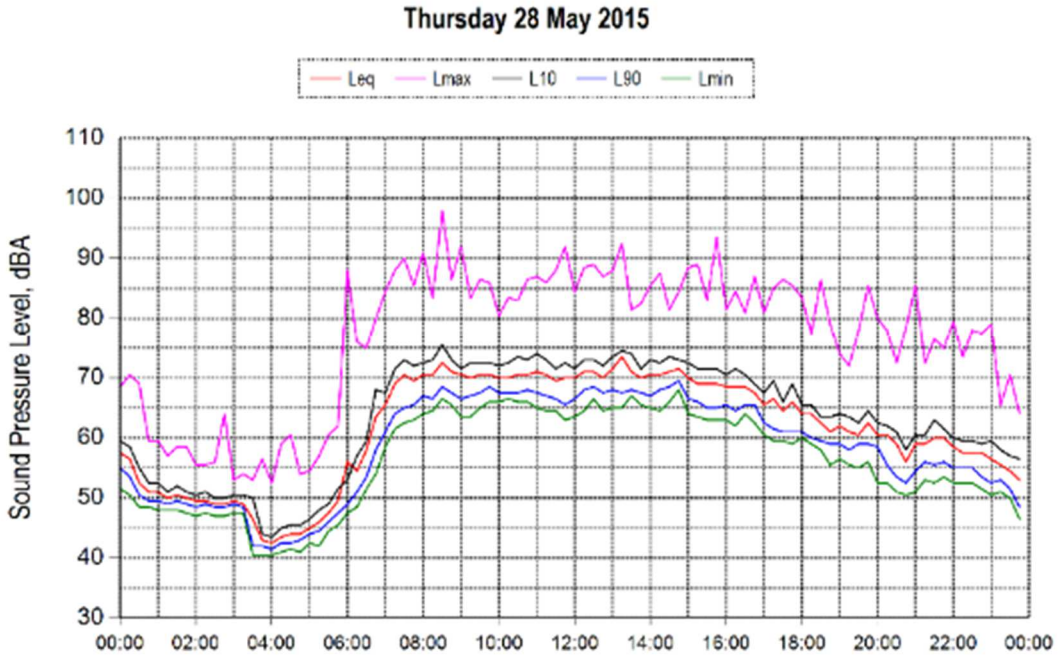


Location 3 – Level 4 Building R8 Northern End

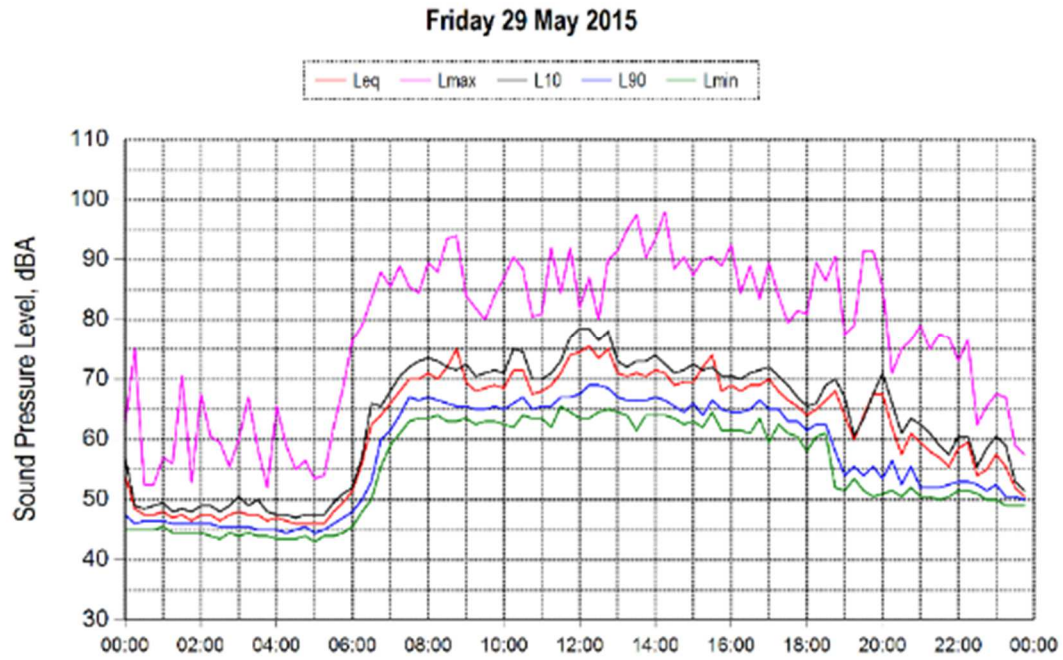


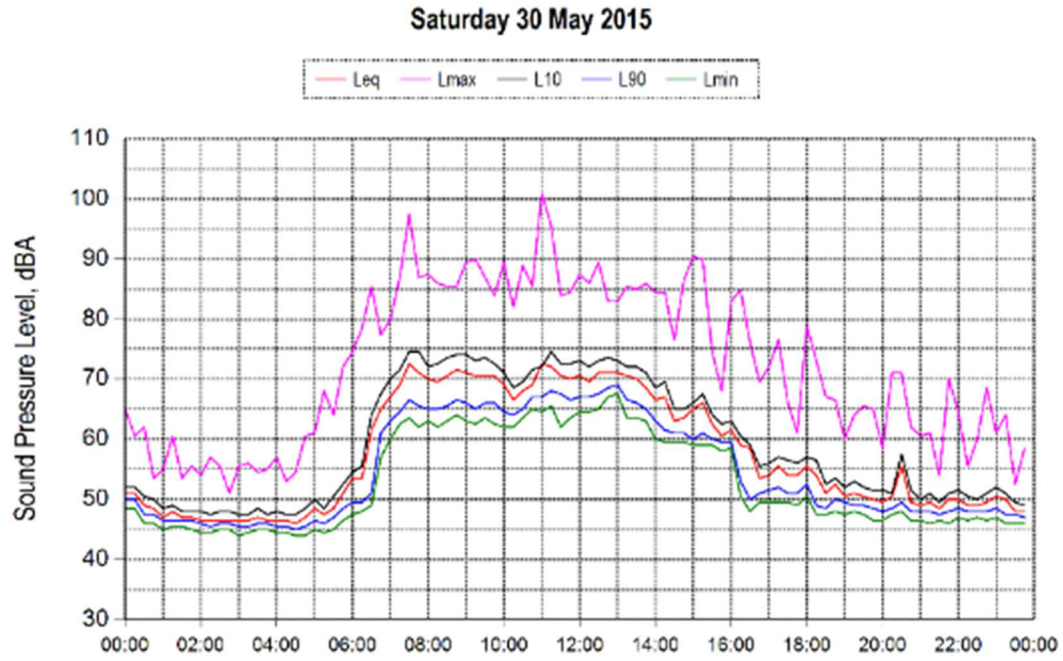
Location 4 – Level 4 Building R8 Eastern Side





Location 4 – Level 4 Building R8 Eastern Side





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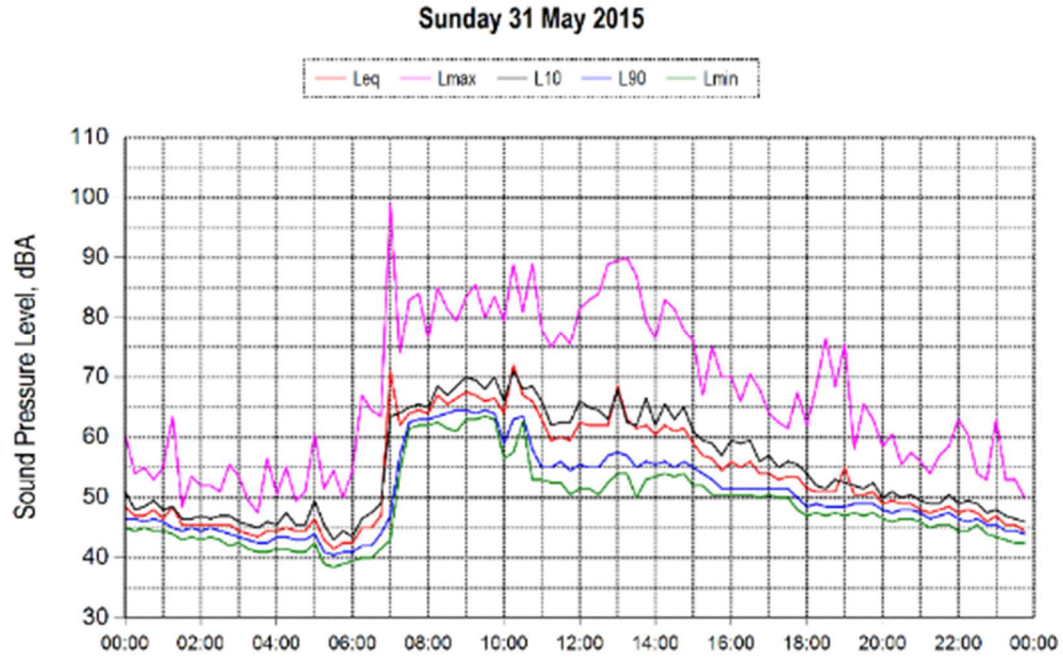
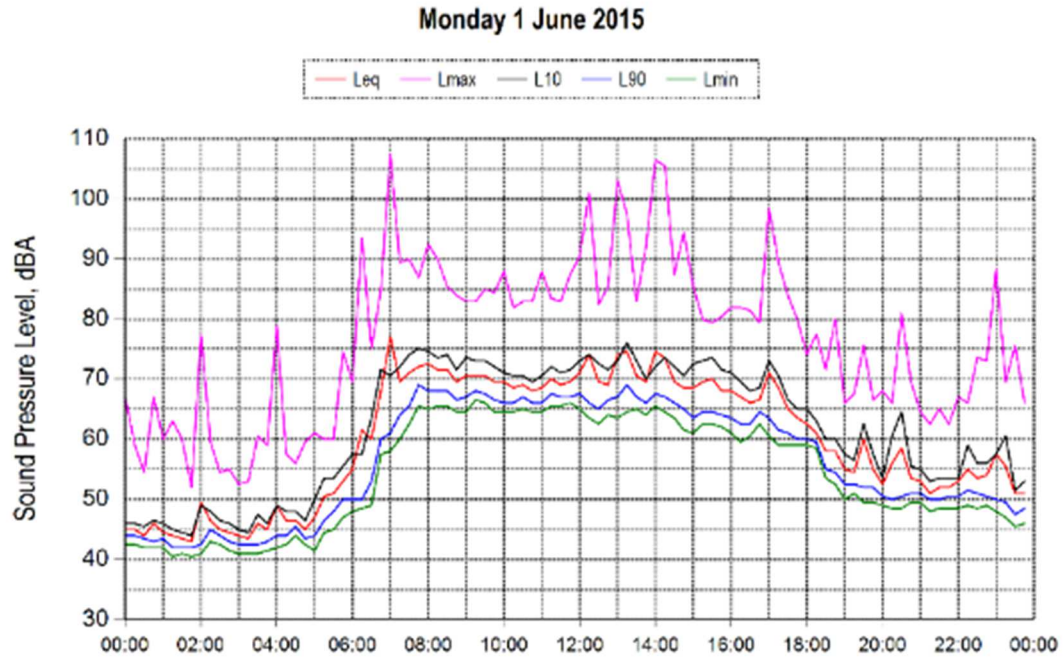
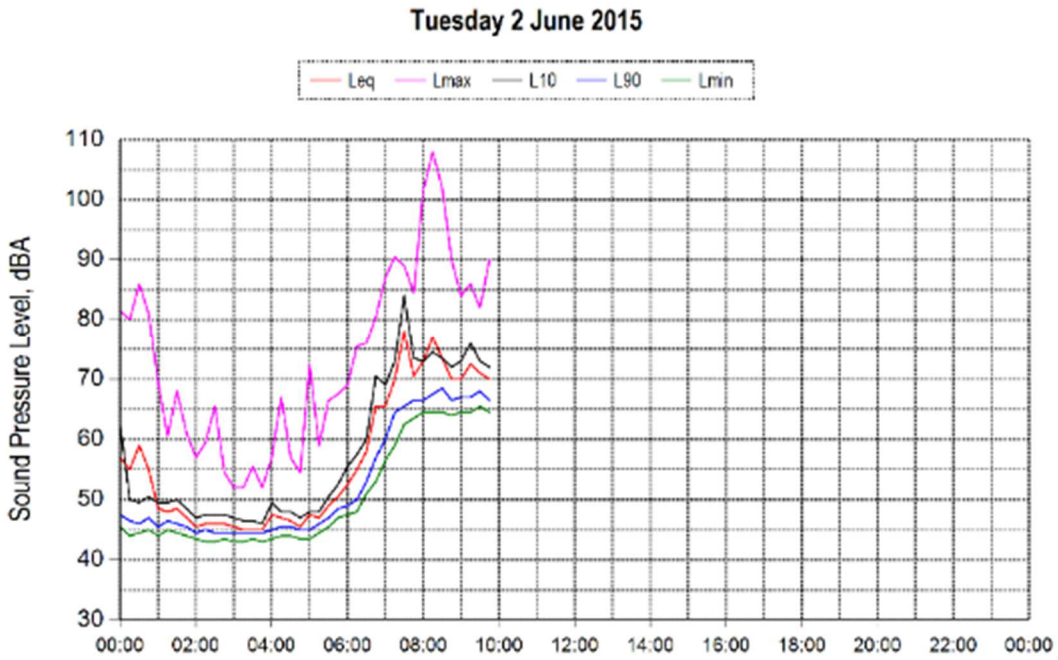




Location 4 – Level 4 Building R8 Eastern Side



The Acoustic Group
CONSULTING ACOUSTICAL & VIBRATION ENGINEERING

46.5164.R9B:MSC

4th May, 2016

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 future acoustic environment of the area (particularly at night) is the development of new licensed premises in Barangaroo South and existing licensed premises south of building R1 that will determine the vibrancy of the area.

20-22 FRED STREET, LILYFIELD, 2040, NSW, AUSTRALIA A.B.N. 73 082 704 701
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We have been advised that the proposed operating hours for building R1 is limited to midnight.

ACOUSTIC CRITERIA

Solotel has received advice from Lend Lease that the application of standard Council noise conditions for licensed premises do not apply for the Barangaroo project.

Lend Lease have advised Solotel that in relation to Building R1 the Executive of the Council of the City of Sydney has signed off on the application of criteria set out in the *Barangaroo South Master Plan Noise Assessment* issued by Wilkinson Murray (report 10232-BN-1 Version G dated February 2016) and becomes the criteria to be used in this assessment.

The *Master Plan Noise Assessment* provides a range of noise criteria that are dependent upon the type of occupancy of the receiver location and whether receiver location is inside or outside the Barangaroo Precinct.

Residences Within Barangaroo

The closest residential receivers to building R1 are in Building R9 and become the critical receivers with respect to the magnitude of noise emitted from the use of building R1.

By reason of the proximity of building R9 to building R1, compliance with the nominated limits for R1 for residences within Barangaroo will automatically achieve compliance with criteria nominate for receivers outside Barangaroo.

The acoustic criteria to be applied to Barangaroo South relates to an internal noise level with doors and windows closed and mechanical ventilation in operation. The *Barangaroo South Master Plan Noise Assessment* transfers the internal noise targets to external noise targets to simplify the assessment of individual licensed premises.

In view of the multitude of licensed premises that will exist in Barangaroo South and the implementation of noise controls to the residential apartments in Buildings R8 & R9, Section 4.2.1 of the Master Plan Noise Assessment discusses patron noise impacts and nominates in Table 4-3 the following noise criteria will apply for building R1.

Table 4-3 Recommended Internal & External $L_{Aeq,15min}$ Noise Criteria for Each Premises

Restaurant Location & Notes	Time of Day	Receiver – Living or Bedroom	Internal Limit Cumulative dBA – Windows Closed	Internal Limit Individual dBA – Windows Closed	External individual limit (free field equivalent) on most exposed Balcony or Outside Windows dBA
R1 Not influenced by R9 reduced noise after 11pm	7.00am – 10.00pm	Living	43	36-41	64-69 dBA
		Bedroom	38	31-36	63-67 dBA
	10.00pm – 12midnight	Living	40	34-38	62-66 dBA
		Bedroom	35	29-33	61-65 dBA
	12midnight – 7.00am	Living	35	25-30	CoS Ent (b) "+0"
		Bedroom	Inaudible	Inaudible	CoS Ent (b) "+0"

The *Master Plan Noise Assessment* identifies the glazing performance in buildings R8 and R9 provides an outside (free field) to inside noise reduction of approximately 32 dBA for a typical bedroom and 28 dBA for a living room.

In the absence of details of the glazing then on the above Wilkinson Murray advice compliance with the external individual limits nominated for Building R1 would achieve compliance with internal individual limit.

Separately to patron noise, to address the cumulative noise impact of all licensed premises in Barangaroo South, Section 4.2.2 of the *Master Plan Noise Assessment* discusses music with an assumption of there being background music. Music noise must be controlled to be 8 dBA below the external noise limits at receivers.

From Table 4-3 for the period of 10pm to midnight the music limit for building R1 as an external limit becomes 53 – 57 dBA external to a bedroom in building R9.

Section 4.2.2 of the *Master Plan Noise Assessment* nominates the dBC level of music should not exceed the dBA music level by more than 10 dB or exceed 65 dBC. From Table 4-3 for the period of 10pm to midnight the music limit for building R1 as an external limit becomes 63 – 65 dBC external to a bedroom in building R9.

Section 4.2.2 of the *Master Plan Noise Assessment* identifies that a level of 80 dBC or 75 dBA is to apply 3m from any speaker mounted externally or 3m from any opening where music may escape.

In dealing with individual licensed premises Lend Lease have provided advice from Wilkinson Murray that identifies the acoustic criteria for R1 will apply for residences on all floors at the southern end of building R9, particularly on Levels 1-4. The advice identifies the measured levels that have been accepted by the Council are cumulative noise levels recorded inside the apartments with doors and windows closed. From the cumulative noise level that is permitted Wilkinson Murray have determined a permitted noise contribution for R1 that applies to a position external to the apartments and have directed this DA acoustic assessment to utilise that specific criteria.

The above criteria prepared by Wilkinson Murray has not addressed the OLGR noise criteria.

Normally, the critical issue for licensed premises is compliance with the OLGR criteria, which for operations before midnight is applied at the residential boundaries.

We have been advised by Solotel that Lend Lease have stated that as a result of consultation between OLGR and Lend Lease, that OLGR will adopt the Wilkinson Murray internal acoustic targets (doors and windows closed) for R1 as Contained within the Master Acoustic Report for Barangaroo South. Accordingly, this acoustic assessment in relation to residential dwellings within Barangaroo is based on these instructions.

Residences external to Barangaroo Precinct

Section 3 of the *Master Plan Noise Assessment* identifies the NOISE ENTERTAINMENT criteria issued by Council that follows the octave band concept provided in the OLGR conditions but is less stringent by use of an L10 (undefined) level that from AS 1055 must be a statistical parameter and not the average maximum deflection method used by the OLGR.

To account for the cumulative impact of Barangaroo the *Master Plan Noise Assessment* nominates use of an Leq descriptor for the assessment of patron noise to be set below the background level, noting that R1 has an allowance of 3 dB higher than the general limits for other premises.

However, we have an issue with the nominated limits in Table 3-1 for Pyrmont based on multiple night time measurements conducted on the Sydney Wharf site.

Compliance testing in relation to Bungalow 8 and Doltone House (Workplace 6 – last test in October 2015) has found night time ambient background levels (10 pm – midnight) on the western side of Sydney Wharf to be 48 – 50 dB(A) and 49 - 53 dB(A) on the eastern side of Sydney Wharf that looks directly onto Barangaroo south. As such the Leq level of 46 dBA suggested in Table 3-1 of the *Master Plan Noise Assessment* for Pyrmont is not accepted as factual material, in that no data has been provided for such a position that represents the ambient levels experienced on the eastern facades of Sydney Wharf.

Due to the additional distance attenuation to residences external to Barangaroo precinct (when compared to residences within the Barangaroo precinct) it is expected compliance with the R1 external limits in Table 4-3 of the *Master Plan Noise Assessment* will automatically satisfy the Council NOISE ENTERTAINMENT presented in Section 3 Section of the *Master Plan Noise Assessment*.

Commercial Premises

Section 5 of the *Master Plan Noise Assessment* presents criteria to be applied to internal office spaces.

Table 5-1 assumes an internal background level of 40 dB(A) with mechanical plant operating and normal operations. In our experience this level seems too low unless one is dealing with executive offices or boardrooms. Hence the application of such criteria as "Sensitive Commercial Offices". For general offices the ambient internal background levels (when in use) would be higher.

Wilkinson Murray identify for office within Barangaroo an acoustic performance of Rw 32 that would result in an external limit of 70 dB(A) with respect to a level of noise intrusion into the sensitive office space.

However, notwithstanding the conservative nature of the internal limit for sensitive offices the external limit has been further downgraded to 65 dB(A) Leq as an external limit when applied specifically for each tenancy for music and patron noise.

Due to the additional distance attenuation to commercial premises (when compared to residences within the Barangaroo precinct) it is expected compliance with the R1 external limits in Table 4-3 of the *Master Plan Noise Assessment* will satisfy the nominated Commercial Premises limit for sensitive offices. However, the noise limit that has been derived for sensitive commercial offices would appear to have been applied to all offices, which is not correct.

ACOUSTIC ASSESSMENT

Version G of the *Barangaroo South Master Plan Noise Assessment* identifies acoustic criteria for different receptor areas. Notwithstanding the areas outside of Barangaroo are subject to a significantly greater degree of distance attenuation than for Building R9 we have been instructed to assess such areas.

Residences within Barangaroo

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.

Whilst the WM criteria is expressed in dB(A) levels the analysis of patron noise is assessed in octave bands (to accord with our source data from other licensed premises).

Examination of the site plans set out in Appendices A1 & A2, 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.

We have been provided a floor plan layout for each level of building R1 from which patron numbers have been assigned for the internal and external areas on each level.

The combination of three floors of R1 that can operate simultaneously requires the assessment of each level. For the assessment of the patron noise criterion (separately to music), on the basis of an equal distribution of the outdoor areas, the following table presents the calculated contribution from each area on the basis of 50% of people talking simultaneous for each area. For the internal areas the people have been distributed across the space and the western façade has been considered open.

From the individual area contributions, the cumulative noise contribution from building R1 has been derived, as shown in Table A.

TABLE A: Noise Contribution from Patrons at R1 – dB(A)

R9 level	North Balcony	West Balcony	South Balcony	Internal (doors open)	Cumulative R1
Ground Floor of R1 (RL 3.45)					
1 (RL 9.2)	55.6	39.8	34.0	58.5	60.3
2 (RL 12.3)	54.9	33.9	28.7	57.8	59.6
3 (RL 15.5)	54.1	30.2	25.3	56.8	58.7
4 (RL 18.65)	48.0	27.6	22.9	50.7	52.6
First Floor of R1 (RL 8.2)					
1 (RL 9.2)	45.5	40.2	37.0	50.1	51.9
2 (RL 12.3)	45.2	31.7	26.4	48.4	50.2
3 (RL 15.5)	44.6	25.2	20.1	47.7	49.5
4 (RL 18.65)	43.8	21.0	16.2	46.8	48.3
Second Floor of R1 (RL 12.45)					
1 (RL 9.2)	48.7	38.0	33.6	48.2	51.7
2 (RL 12.3)	51.2	48.8	45.6	54.7	57.3
3 (RL 15.5)	54.0	43.5	38.7	53.9	57.2
4 (RL 18.65)	53.5	36.0	30.5	52.6	56.1

Table A indicates the relevance of the various levels of R1 versus the levels 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.

The following table provides the cumulative impact of the entire R1 development for the first floor level of R9 and reveals full compliance with the external patron noise design target nominated by Wilkinson Murray for R1 operations up to midnight.

TABLE B: Cumulative Patron Noise Contributions to R9 – dB(A)

	Building R9 Southern Façade			
	Level 1 (RL 9.2)	Level 2 (RL 12.3)	Level 3 (RL 15.5)	Level 4 (RL 18.65)
Cumulative Level of R1	61.4	61.9	61.3	58.2

The results in Table B above reveal the cumulative patron noise from R1 at full capacity satisfies the WM patron design target with the doors (of R1) open.

Appendix B provides an example of the detailed analysis of the impact of R1 level 2 on R9 level 2 (conducted using octave band analysis) to derive the figures in Table A. The table shows the increase in distance attenuation and shielding effects to affect the contribution assigned to each area.

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.

With respect to music occurring in R1, 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 speaker and that no speakers are to be directed towards building R9.

It is noted that the Council normally impose a conditions related to the provision of rms limiters (rather than peak limiters that will not control the average music level) to control all sound systems on a licensed premise. Recently the Council have imposed an overly stringent calibration requirement for such limits that involves testing of the sound system (prior to the issue of an Occupational Certificate) to establish compliance with the music noise limits.

Such limiters are a standard feature on Solotel sound system installations and in terms of the nominated testing protocol and sound system designs the provision of controls for individual areas is easy to establish and thereby set different levels to maintain acoustic compliance.

In our experience sound system graphical speaker plots provide an indication of the sound filed that is generated on the audience area but are inaccurate outside of the audience area. Therefore, providing a detailed assessment of noise radiation from a generic sound system is of no assistance at the DA stage and in any event becomes irrelevant with respect to the onerous rms limiter condition imposed by the Council.

Whereas there are no restrictions or limits imposed on the development in terms of noise that may be generated by individual patrons, as a consequence of the music limits imposed by Wilkinson Murray/Lend Lease in the *Master Plan Acoustic Assessment* (that are 8 dB lower than the patron criteria) the following restrictions would at this stage (subject to adjustment at the OC stage) apply to music:

- the balconies closest to Building R9 (being the northern balconies on building R1) cannot have any external speakers, without the provision of additional controls
- when music is provided inside R1 that is greater than 75 dB(A) at 3 metres from any internal speaker the glass facades on the northern side of R1 are to be closed.
- external speakers can be provided for the western and southern balconies of R1 but will be subject to the provision of limiters.
- 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.
- the provision of external drop blinds or shield walls that provide additional acoustic shielding to building R1 could be implemented to permit the use of internal music in R1 and the balcony doors open but would be subject to on-site testing on the balconies of R9 to determine compliance with the R9 residential balcony limits

Mechanical plant noise has already been addressed in building design brief of the background + 5 dB(A) limit that has been developed for the construction of the relevant buildings in the Barangaroo precinct.

Residences External to Barangaroo Precinct

The nearest residential premises external to the Barangaroo precinct that would have an unobstructed view of the R1 building are located on the opposite side of the bay being apartments identified as Sydney Wharf, Pyrmont.

As discussed earlier measurements that we have conducted on both the eastern side on the western side of Sydney Wharf as part of compliance testing of licensed premises on King Street Wharf, and in Pyrmont, have found an ambient background levels up to midnight to be higher than the LAeq levels nominated in the Master Plan.

As identified on page 5 of this report we are unable to accept an Leq ambient noise level for Sydney Wharf at 46 dB(A) set out in Table 3 – 1 I the Master Plan acoustic assessment. On the basis of minimum background level of 49 dB(A) that we have recorded on the eastern side of Sydney Wharf then the Council L10 criterion for the operation of R1 after 11 PM and before midnight would be 49 + 5 = 54 dB(A).

The Master Plan acoustic assessment nominates an Leq of 44 dB(A) for building R1 that would be taken to be equivalent to an L10 of 47 dB(A). In the absence of any specific details in the Master Plan acoustic assessment it is assumed the time period for the nominated Leq limit is 15 minutes, so as to accord with the Council criterion identified as (NOISE ENTERTAINMENT).

Appendix B2 considers the operation of level 2 of R1 with respect to the upper floor (level 3) of apartment on the eastern side of Sydney Wharf. The assessment has considered a reduction in the attenuation of distance due to the sound travelling over water where the sample calculation has identified an increase of 6 dB to the predicted levels to take account of that situation.

The contribution from level 2 of building R1, including in the situation of the western doors being open, results in a sound level contribution of 42 dB(A).

On the basis of the distribution of patrons throughout the R1 building as identified on page 6 of this report it can be seen that contribution from external patrons associated with the restaurant will be 5 dB lower for the first floor, and 2 dB higher for the ground floor on the basis of a simple 10 log (the number of patrons).

On an A-weighted basis the cumulative impact therefore of all external patrons for R1 at maximum capacity would be 47 dB(A) as an L10 contribution. This level would then be equivalent to an Leq level of 44 dB(A), that achieves the nominated limit and on our experience at (and inside) Sydney Wharf would be lower than the measured ambient background level.

Sensitive Commercial Offices

The nature of sensitive commercial offices as discussed earlier has identified a noise target of less than 65 dB(A) external to the commercial building.

In a general sense it has been established that the R1 building will satisfy an L10 noise level less than 65 dB(A) for the nearest residential premises (being R9) that for sensitive commercial premises that are in different buildings and further removed from R1 it would logically follow that compliance with the nominated commercial target will be satisfied.

The nearest commercial premises to the south is external to Barangaroo is Bungalow 8 and by reason of the activity of the hotel the noise generated from that premises would not be considered in the context of the Master Plan noise assessment report to be a sensitive commercial office.

Reference to site plan for the southern end of Barangaroo identifies that the nearest building (Block 1) would be to the east of building R1. We are instructed that whilst Appendix A2 shows Block 1 being labelled R7 that building is to used as a commercial premises.

By reason of the greater distance to Block 1 (when compared to R9) there will be a greater distance attenuation of noise from R1 to Block 1.

Furthermore, depending upon the assessment location used for Block 1 there will be different degrees of acoustic shielding provided by the envelope of building R1.

We have been advised that the upper level (level 4) of Block 1 will actually be a licensed premises. Therefore, for the purpose of considering the requirements of the Masterplan for commercial use have evaluated noise from building R1 to level 3 of Block 1.

Due to acoustic shielding that will be provided by R1, dependent upon the assessment location on the western facade of Block 1, for the purpose of the calculations in Appendix B3 we have utilised a position at the northern end of the western facade of Block 1 at Level 3.

The sample calculation set out in Appendix B3 has utilised the upper level of building R1 that with respect to Block 1 would have the most number of external patrons and a minimum degree of acoustic shielding.

The cumulative noise contribution as a result of Building R1 level 2 outdoor and indoor areas is shown to be 47 dB(A) which is significantly below the 65 dB(A) target.

Noting that the outdoor areas on the first level and ground floor level would be subject to a greater degree of acoustic shielding with respect to the level 3 of Block 1 then the contribution from the operation of building R1 is well below the nominated target.

Other commercial buildings within Barangaroo, or for that matter external to Barangaroo, would be subject to a greater degree of distance attenuation and therefore (as envisaged from the outset) there would be no issues with compliance with the commercial criteria when compliance with the noise targets for building R9 are satisfied.

Conclusions

In an acoustic planning sense, the Barangaroo project required noise controls to residential apartments to address the existing acoustic environment (or the anticipated acoustic environment) of the area and achieve a satisfactory internal acoustic amenity identified by the Council in their DCP.

The fact the residential buildings incorporate noise control measures to address the external noise environment has led to the development of site specific acoustic planning for occupancies within the Barangaroo project.

This acoustic report has been prepared in response to the *Barangaroo South Master Plan Noise Assessment* (version G) that uses an internal noise target (with doors and windows closed) to determine the external noise target for individual licensed premises.

An analysis of the proposed R1 development has shown that patron noise will satisfy the acoustic criteria specified by Wilkinson Murray for building R1.

The more stringent limits for music will impose restrictions on the internal levels of music relative to what facades are open. For other licensed premises the Council have imposed an onerous testing method for sound systems to verify acoustic compliance that would be expected to apply to building R1.

The only outstanding issue in relation to an assessment of noise emitted from building R1 relates to the liquor licence that at present could impose a different noise condition to that set out in the Wilkinson Murray Masterplan.

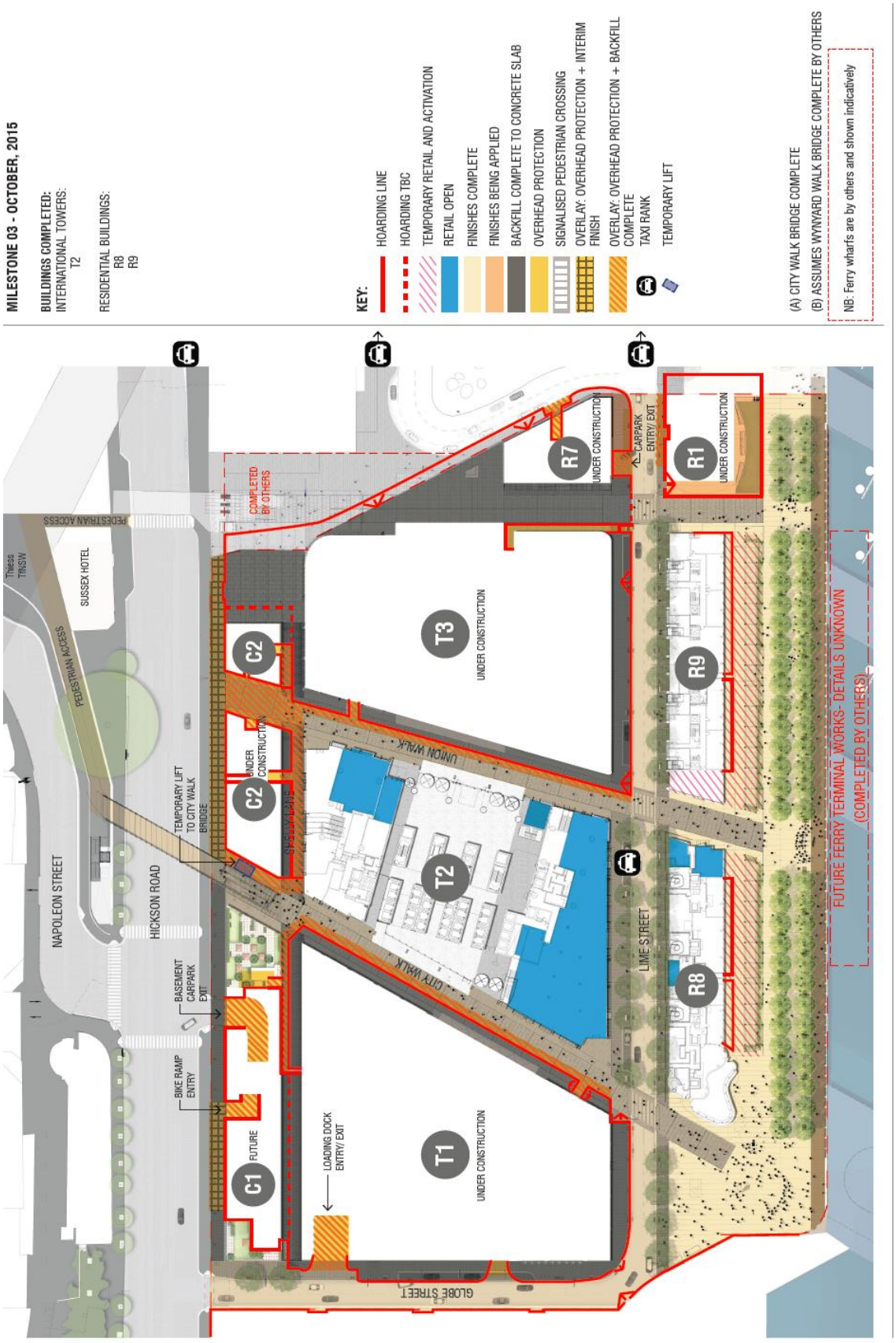
We have been advised by Solotel that Lend Lease have stated that as a result of consultation between OLGR and Lend Lease, that OLGR will adopt the Wilkinson Murray acoustic targets for R1 as Contained within the Master Acoustic Report for Barangaroo South. Accordingly, this acoustic assessment is based on these instructions.

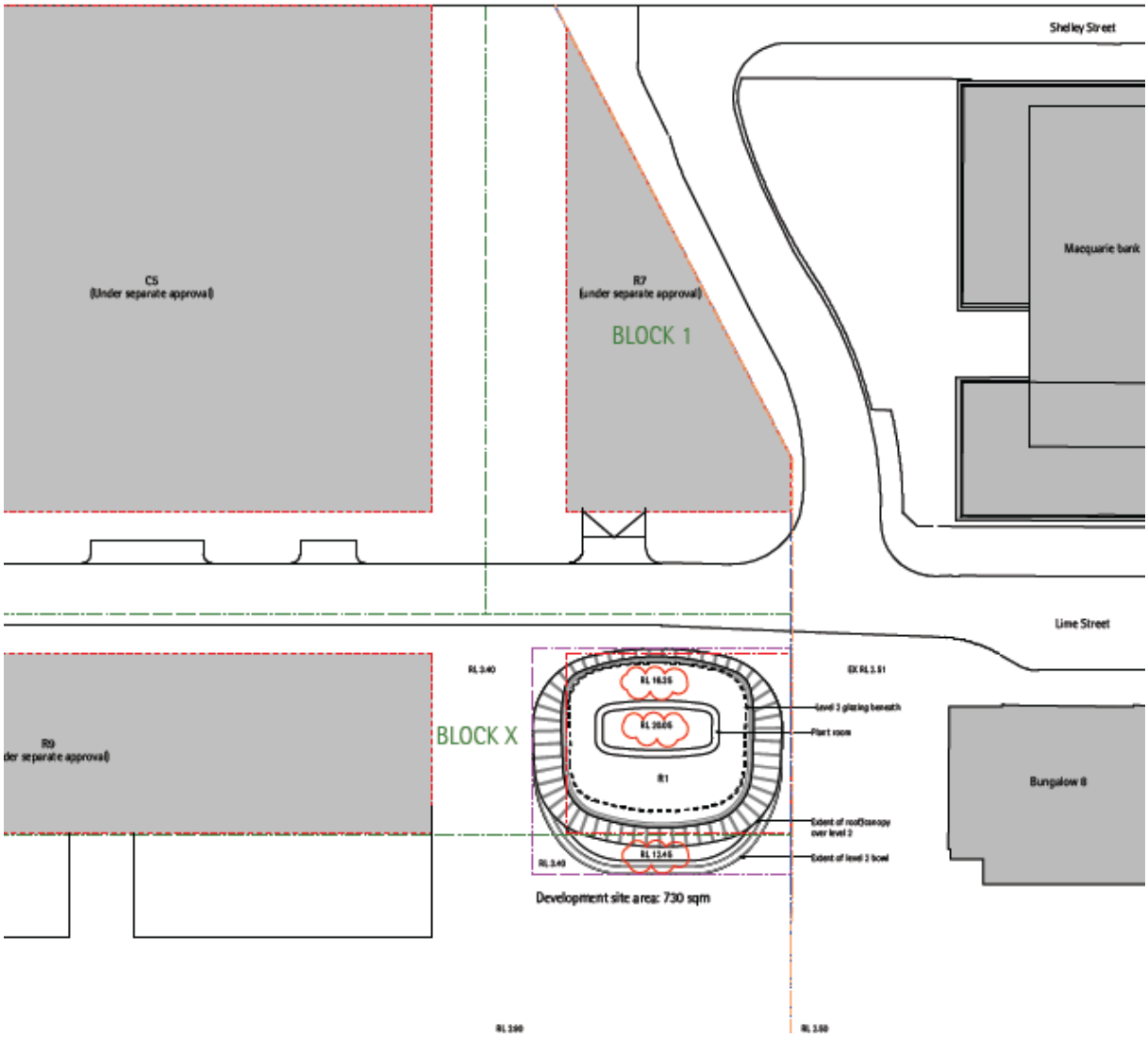
Yours faithfully,

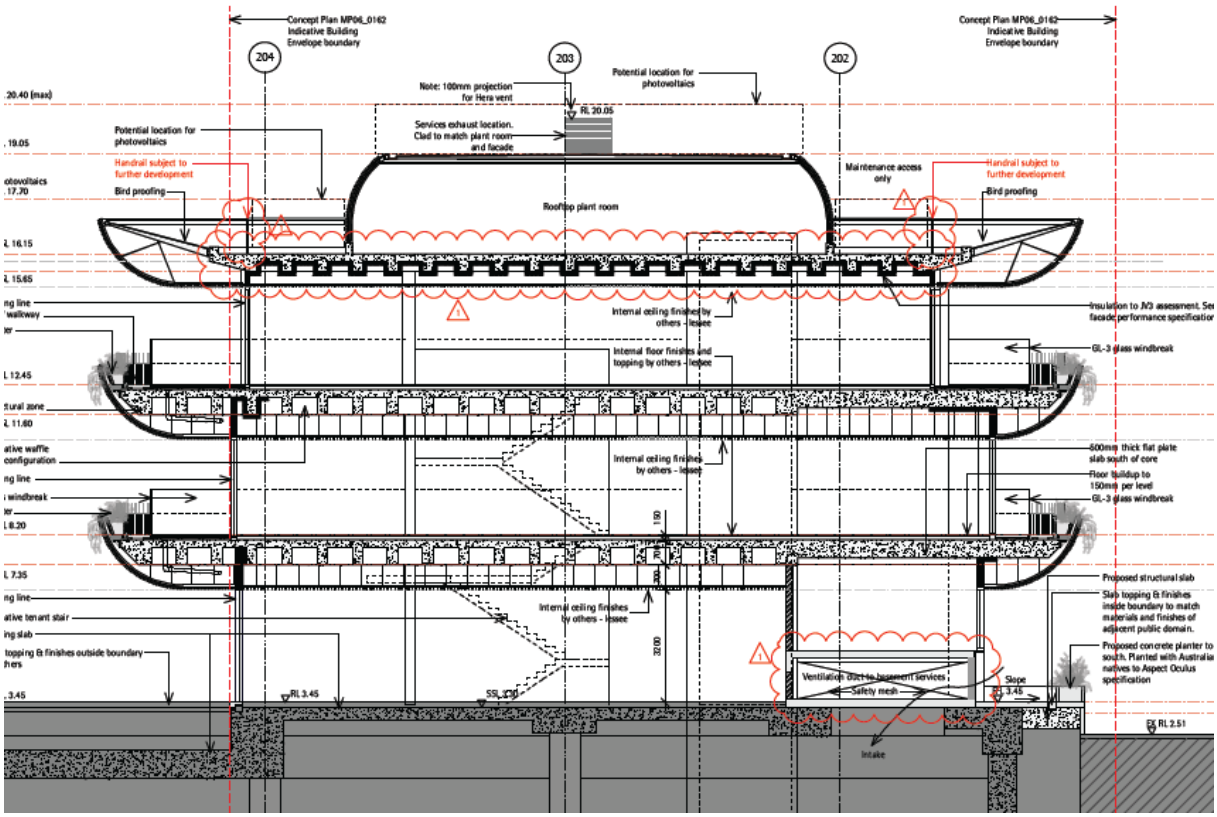
THE ACOUSTIC GROUP PTY LTD

STEVEN E. COOPER

APPENDIX A: Plan of Barangaroo showing Mixed Use




Shelley Street
Macquarie bank
C5
(Under separate approval)
R7
(under separate approval)
BLOCK 1
Lime Street
BLOCK X
R1
Bungalow 8
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
Handrail subject to
further development
Bird proofing
Maintenance access
only
Roofttop plant room
Internal ceiling finished by
others - lessee
Internal floor finishes and
topping by others - lessee
GL-3 glass windbreak
Internal ceiling finishes
by others - lessee
600mm thick flat plate
slab south of core
Floor buildup to
150mm per level
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: Sample 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.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
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	54	-6	8	28	41	50	49	45	40	32
Centre of Terrace – 50% talking in raised voice											
e.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
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	49	-11	3	23	36	45	44	40	35	27
Southern side of Terrace – 50% talking in raised voice											
j.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
k.	Building Shielding		0	0	0	0	0	0	0	0	0
l.	Distance attenuation + Lw to SPL		-40	-40	-40	-40	-40	-40	-40	-40	-40
n.	Contribution	46	-14	0	20	33	42	41	37	32	24
Inside with doors open – 50% talking in raised voice											
o.	100 patrons (50% raised voices)	89	29	43	63	76	85	84	80	75	67
p.	Reverberant effect		+3	+3	+3	+3	+3	+3	+3	+3	+3
q.	Loss through door		-6	-6	-6	-6	-6	-6	-6	-6	-6
r.	Distance attenuation + Lw to SPL		-32	-32	-32	-32	-32	-32	-32	-32	-32
s.	Contribution	54	-6	8	28	41	50	49	45	40	32
t.	Total contribution	58	-2	12	32	45	54	53	49	44	36

R1 Level 2 to level 3 East side of Sydney Wharf (Pyrmont)

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											
u.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
v.	Barrier shielding		0	0	0	0	0	0	0	0	0
w.	Distance attenuation + Lw to SPL		-56	-56	-56	-56	-56	-56	-56	-56	-56
x.	Enhancement of Water		+6	+6	+6	+6	+6	+6	+6	+6	+6
y.	Contribution	36	-24	-10	10	23	32	31	27	22	14
Centre of Terrace – 50% talking in raised voice											
z.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
aa.	Barrier Shielding		0	0	0	0	0	0	0	0	0
ab.	Distance attenuation + Lw to SPL		-56	-56	-56	-56	-56	-56	-56	-56	-56
ac.	Enhancement of Water		+6	+6	+6	+6	+6	+6	+6	+6	+6
ad.	Contribution	36	-24	-10	10	23	32	31	27	22	14
Southern side of Terrace – 50% talking in raised voice											
ae.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
af.	Building Shielding		0	0	0	0	0	0	0	0	0
ag.	Distance attenuation + Lw to SPL		-56	-56	-56	-56	-56	-56	-56	-56	-56
ah.	Enhancement of Water		+6	+6	+6	+6	+6	+6	+6	+6	+6
ai.	Contribution	36	-24	-10	10	23	32	31	27	22	14
Inside with doors open – 50% talking in raised voice											
aj.	100 patrons (50% raised voices)	89	29	43	63	76	85	84	80	75	67
ak.	Reverberant effect		+3	+3	+3	+3	+3	+3	+3	+3	+3
al.	Loss through door		-6	-6	-6	-6	-6	-6	-6	-6	-6
am.	Distance attenuation + Lw to SPL		-56	-56	-56	-56	-56	-56	-56	-56	-56
an.	Enhancement of Water		+6	+6	+6	+6	+6	+6	+6	+6	+6
ao.	Contribution	36	-24	-10	10	23	32	31	27	22	14
ap.	Total contribution L10	42	-18	-4	16	29	38	37	33	28	20

R1 Level 2 to Block 1 Level 3 (northern end of western facade)

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											
aq.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
ar.	Barrier shielding		0	0	0	0	0	0	0	0	0
as.	Distance attenuation + Lw to SPL		-38	-38	-38	-38	-38	-38	-38	-38	-38
at.	Contribution	47	-12	2	22	35	44	43	39	34	26
Centre of Terrace – 50% talking in raised voice											
au.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
av.	Barrier Shielding		-7	-9	-11	-14	-16	-19	-23	-26	-29
aw.	Distance attenuation + Lw to SPL		-41	-41	-41	-41	-41	-41	-41	-41	-41
ax.	Contribution	27	-22	-9	8	19	25	21	14	6	-5
Southern side of Terrace – 50% talking in raised voice											
ay.	50 patrons (50% raised voices)	86	26	40	60	73	82	81	77	72	64
az.	Building Shielding		-7	-9	-11	-14	-16	-19	-22	-26	-29
ba.	Distance attenuation + Lw to SPL		-41	-41	-41	-41	-41	-41	-41	-41	-41
bc.	Contribution	27	-22	-10	8	18	24	20	12	5	-6
Inside with doors open – 50% talking in raised voice											
bd.	100 patrons (50% raised voices)	89	29	43	63	76	85	84	80	75	67
be.	Reverberant effect		+3	+3	+3	+3	+3	+3	+3	+3	+3
bf.	Loss through door		-6	-6	-6	-6	-6	-6	-6	-6	-6
bh.	Barrier Shielding		-10	-12	-15	-18	-21	-24	-27	-30	-33
bi.	Distance attenuation + Lw to SPL		-40	-40	-40	-40	-40	-40	-40	-40	-40
bj.	Contribution	24	-24	-12	5	15	21	17	10	2	-3
bk.	Total contribution	47	-11	3	22	35	44	43	39	34	26