AGNSW

Art Gallery of NSW Expansion - Sydney Modern Project

Environmental Impact Statement – Acoustics Report

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Update with Client comments

Contents

Appendices

Appendix B

Environmental Noise Survey Results

Executive Summary

This report has been produced in response to the Secretary's Environmental Assessment Requirements as amended 8 June 2016 in support of the State Significant Development Application Number SSD 6471 on behalf of The Art Gallery of NSW (AGNSW).

This report addresses Key Issues required for a SSD and specifically responds to the SEARs Key Issue numbers 3 and 11 as these relate to noise and vibration. These Key Issues state:

(3) Address and outline design principles incorporated into the development in terms of sunlight/overshadowing, natural ventilation, wind impacts, visual and acoustic privacy, and safety and security;

(*11) Address potential air quality, noise and odour impacts, in particular during the construction and operation of the development and appropriate mitigation measures.*

Undertake a quantitate assessment of potential construction and operational noise and vibration impacts of the proposals, including potential impacts on nearby sensitive receivers

Detail noise and vibration management and monitoring measures to mitigate impacts on sensitive receivers.

This report sets out the criteria that relate to noise and vibration from the development affecting the environment both during construction and in operation. Also included are recommendations for noise intrusion limits to enable the internal environment to comply with the requirements for various noise policies.

Conclusion

This report has addressed the SEARs Issues 3 and 11 and demonstrates that the issues in SEARs that relate to noise and vibration can be appropriately resolved. In particular:

- Criteria based on site measurements have been developed for noise from plant affecting the environment. These criteria comply with the *NSW Industrial Noise Policy (EPA 2000).*
- The impact of road and rail noise and vibration on the development has been assessed in relation to *NSW Road Noise Policy (DECCW 2011), Development Near Rail Corridors and Busy Roads (DoPI), SEPP (Infrastructure) 2007 (relating to the frontage to a classified road).* The proposed internal noise level criteria are consistent with these criteria and the provisions to control noise intrusion through the envelope of the building will enable these requirements to be met.
- Vibration measurements have shown that the levels of ground vibration is such that appropriate criteria (based on *Assessing Vibration: A Technical*

Guideline 2006 and other requirements relating to the protection of precious artefacts) can be achieved.

- Noise during construction will be assessed based on the requirements set out in the *Interim Construction Noise Guideline 2009 (EPA)*. The control of noise and vibration during construction will be a strict requirement for the future contractor. The requirements to achieve acceptable construction noise and vibration levels in the gallery are likely to be more onerous than those to achieve acceptable conditions at the nearest noise sensitive receiver.

1 Introduction

The Art Gallery of NSW proposes to undertake a major expansion of the existing art gallery in the eastern part of the Royal Botanic Gardens and Domain. The expansion is located north of the existing gallery, partly extending over the Eastern Distributor land bridge and includes a disused Navy fuel bunker located to the north east of this land bridge.

The new expansion, known as the Sydney Modern Building, comprises a new entry plaza, new exhibition spaces, shop, food and beverage facilities, visitor amenities, art research and education spaces, new roof terraces and landscaping and associated site works and infrastructure, including loading and service areas, services infrastructure and an ancillary seawater heat exchange system.

Development consent is sought for:

- Site preparation works, including:
  - Site clearing, including: demolition of former substation, part of road surfaces, kerbs and traffic islands, pedestrian crossings, foot paths, retaining walls, stairs, and part of disused underground former Navy fuel bunkers;
  - Tree removal;
- Excavation and site earthworks;
- Remediation works;
- Construction of the Sydney Modern Building comprising:
  - Covered public plaza;
  - Entry pavilion and five building levels following the site topography down to Lincoln Crescent;
  - Retention of part of existing disused underground former Navy fuel bunker for use as gallery space and support spaces;
  - Art gallery spaces;
  - Outdoor terraces;
  - Shop, café and restaurant;
  - Multipurpose space;
  - Education spaces;
  - Ground level loading dock (accessed via Lincoln Crescent) with associated workshops, service parking, plant, and storage areas.
- New open staff and administration visitor carpark to rear of art gallery building;
- Landscaping and public domain improvements including:

  - Continuation of the east-west pedestrian link between the Domain and Woolloomooloo Bay, including dedicated lift structure for disability access;
  - Hard and soft landscaping to roof terraces;
  - Planter beds and new pathways;
  - Increased landscaped area to forecourt of existing Art Gallery building;
  - Relocation of selected trees to the south-eastern corner of the site;
  - Sound barrier to edge of land bridge;
- Upgrade works to part of Art Gallery Road, Cowper Wharf Road, Mrs Macquaries Road, and Lincoln Crescent, including new pedestrian crossings;
- Provision of vehicle drop off points including a taxi stand, private vehicle drop off and bus/coach drop off, at Art Gallery Road;
- Installation of an ancillary seawater heat exchange system to act as the new building's cooling system, adjacent to and within Woolloomooloo Bay;
- Diversion, extension and augmentation of physical infrastructure and utilities as required.

2 SEARs Issues Addressed

This report addresses the following Key Issues for SEARs (as amended 8 June 2016) issued for the project identified within Application Number SSD 6471.

(3) Address and outline design principles incorporated into the development in terms of sunlight/overshadowing, natural ventilation, wind impacts, visual and acoustic privacy, and safety and security;

The design principles incorporated into the development must also ensure that The Royal Botanic Garden and Domain's (RBGD) high level of environmental amenity is preserved.

(*11) Address potential air quality, noise and odour impacts, in particular during the construction and operation of the development and appropriate mitigation measures.*

Relevant Policies and Guidelines

- *NSW Industrial Noise Policy (EPA)*
- *Interim Construction Noise Guideline 2009 (EPA)*
- *Assessing Vibration: A Technical Guideline 2006*
- *NSW Road Noise Policy (DECCW 2011)*
- *Development Near Rail Corridors and Busy Roads (DoPI)*

In addition to the above, noise has been assessed in relation to

- *SEPP (Infrastructure) 2007 (relating to the frontage to a classified road)*

Note that this report only considers noise and vibration impacts. Issues associated with air quality and odour are dealt with in separate documents.

3 Existing Environment

The NSW Industrial Noise Policy (INP)[1] sets out a methodology to derive appropriate criteria for noise from plant affecting the environment. This is based on the levels of existing noise around the site which in turn are derived from an extensive survey of existing noise levels, details of which are given below. The derivation of the noise criteria from this data is given in Section 4.1 below.

3.1 Description of Site

The Sydney Modern Project is located on the north eastern side of the existing Art Gallery of New South Wales.

The site is situated within the Domain and connected to the Botanic Garden to its north.

There are two major roads and a railway line close to the site. The Eastern Distributor Motorway and Cahill Expressway are going through the site (under land brdige) from south to the north west of the site. The railway is located on the south west of the existing Art Gallery of New South Wales.

There are residential buildings adjacent to the site on Lincoln Crescent.

Noise sensitive receivers close to site are summarised in the Table 1 below.

Noise Sensitive Receiver	Classification
10 Lincoln Crescent	Residential
9-31 Lincoln Crescent	Residential
Botanic Garden	Passive recreation
Domain	Active recreation

Table 1: Summary of Noise Sensitive Receivers

3.2 Measurement of existing noise levels

3.2.1 Methodology

Unattended Long Term Noise Measurements

Unattended noise monitoring equipment was used to gain an understanding of typical noise levels at the subject site. Noise monitoring devices were installed on 10 March to 24 March 2016 at two locations shown in Figure 1.

Long-term noise measurements were made in 15-minute intervals, with a ‘fast’ time weighting. Broadband and octave band L_{Aeq}, L_{A10} and L_{A90} measurements

[1] NSW Industrial Noise Policy. Environment Protection Authority. January 2000

were made. This equipment measured continuous noise data in two sessions (10 March to 17 March and 17 March to 24 March 2016).

Meteorological conditions were monitored during the survey period. Measured data was removed as required to account for the influence of any adverse weather conditions and extraneous noise events.

Attended Short Term Noise Measurements

Attended short term noise measurements were undertaken by Harvey Yang on 10 March 2016 (Location 1, 2 and 3) and by Jonothan Holmes on 24 March 2016 (Location 1 and 2). Broadband and octave band L_{Aeq}, L_{A10} and L_{A90} measurements were made. The locations of the attended short term noise measurements are shown in Figure 1.

The attended measurement at Location 3 was conducted at 5.2 m above the ground, as shown in Figure 2.

Figure 1 Locations of noise loggers and attended measurements

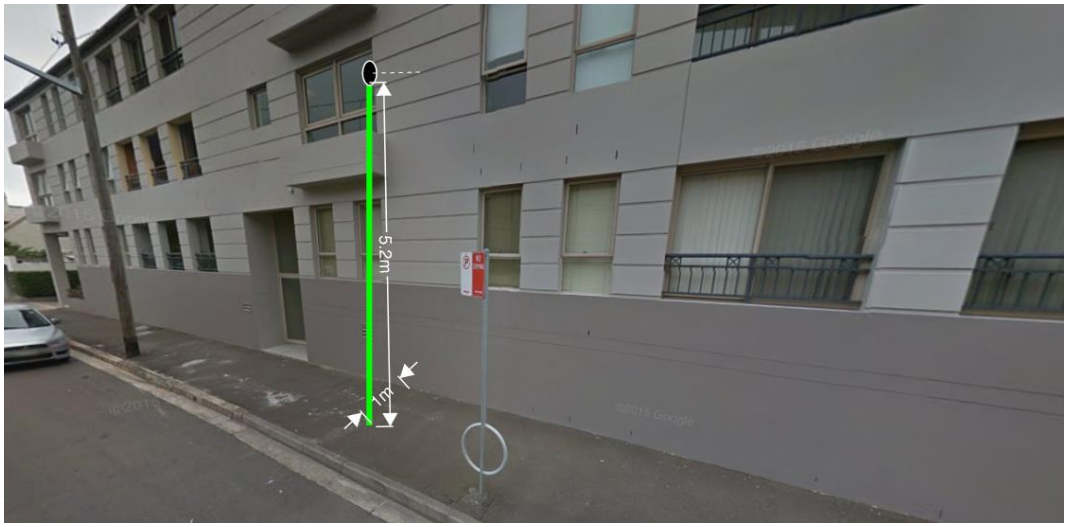


Figure 2 Microphone position at Location 3

3.2.2 Equipment

Equipment used to measure the baseline noise levels is detailed in Table 2. All equipment was checked for calibration before and after measurements with no significant drift in calibration being recorded. All equipment held a current NATA calibration certificate at the time of the survey.

Equipment manufacturer and type	Description of Equipment	Serial No.
ARL Ngara – Type 1	Sound logging meter	878061
ARL Ngara – Type 1	Sound logging meter	87807F
Brüel and Kjær 2270	Type 1 sound level meter	2754328
Brüel and Kjær 4231	Sound level meter calibrator	2445716

Table 2: Noise Survey Equipment

3.2.3 Noise Logger Results

Results are presented under Day, Evening and Night time periods as defined in the NSW Industrial Noise Policy. Refer to Appendix B for complete noise survey results and details of the derivation of noise criteria.

Long term noise measurements were checked and validated against short-term attended measurements.

Note that the results of Location 3 are developed based on the attended measurement and noise logging results at Location 1, due to the accessibility and safety issues associated with long period logging at Location 3. The attended measurements at Location 3 were synchronized with the noise logging at Location 1, which allows direct comparisons to be made between the two locations. The Rating Background Level (RBL) at Location 3 was then developed by applying the offset to the results at Location 1.

Location	Time Period	Rating Background Level (RBL) – dB(A)	dB $L_{Aeq, period}$
Location 1	Day (7:00 – 18:00)	59	65
	Evening (18:00 – 22:00)	58	63
	Night (22:00 – 7:00)	47	60
Location 2	Day (7:00 – 18:00)	49	60
	Evening (18:00 – 22:00)	49	62
	Night (22:00 – 7:00)	44	54
Location 3	Day (7:00 – 18:00)	54	60
	Evening (18:00 – 22:00)	53	58
	Night (22:00 – 7:00)	42	55

Table 3: Summary of measured noise indices

4 Acoustic Criteria

4.1 NSW Industrial Noise Policy (INP)

This section outlines applicable external noise limiting criteria. Noise criteria are provided to maintain on site acoustic amenity and avoid adverse acoustic impacts to the surrounding environment.

The INP covers noise emissions from the proposed operation of a facility and from other plant and equipment affecting the proposed facility. Noise from traffic movement on a site (i.e. not on public roads) is assessed as being operational noise under the INP.

The objective of the INP is to protect sensitive receivers, such as residences, from noise generated by commercial, industrial or trade premises. In this context, 'industrial' refers to the source of the noise (e.g. plant) rather than the nature of the premises.

Noise limits are set based on land use in the area and existing background noise levels. Compliance is achieved if the adjusted L_{Aeq} noise level at any sensitive receivers affected by noise from the facility is below the noise limit. The adjusted L_{Aeq} is determined by applying corrections for such noise characteristics as duration, intermittency, tonality, and impulsiveness.

The assessment of noise emission under the INP is based on the calculation of a noise limit at a receiver position, taking into account the land-use in the surrounding area and the existing background noise level.

The INP separates the 24 hour day into three different time periods – day, evening and night. These time periods are detailed below in Table 4.

Period	Day of Week	Time period
Day	Monday-Saturday Sunday, Public Holidays	7:00 am-6:00 pm 8:00 am-6:00 pm
Evening	Monday-Sunday	6:00 pm -10:00 pm
Night	Monday-Saturday Sunday, Public Holidays	10:00 pm -7:00 am 10:00 pm -8:00 am

Table 4 Standard INP time periods

The INP states that background noise levels should be determined over the "days and times of operation of the project". When setting criteria, only the measured data from the hours of operation of the project should be included.

The INP provides guidance on acceptable noise levels from the introduction of new industrial noise sources to an area. The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences; and
- Protecting noise level amenity for particular land uses such as residences, recreation areas and commercial offices etc.

Both of these components result in noise criteria that should not be exceeded in order to avoid any adverse noise impacts on the affected areas. Both criteria have been taken into account when assessing the noise impact of building services noise source(s) associated with the project, and where the intrusiveness and the amenity criterion differ, the most stringent of the noise criteria has been adopted as the 'project-specific' noise criterion. In most cases, the project-specific criterion has been determined by the more-stringent amenity criterion.

A summary of the environmental noise criteria is presented in Table 5 below. Refer to Appendix B for complete noise survey results and derivation.

Noise Sensitive Receiver	Classification	Time Period	Project Specific Criterion
10 Lincoln Crescent (Location 2)	Residential	Day	54 dB $L_{Aeq, Day}$
		Evening	52 dB $L_{Aeq, Evening}$
		Night	44 dB $L_{Aeq, Night}$
9-31 Lincoln Crescent (Location 3)	Residential	Day	54 dB $L_{Aeq, Day}$
		Evening	48 dB $L_{Aeq, Evening}$
		Night	45 dB $L_{Aeq, Night}$
Botanic Garden*	Passive recreation	When in use	50 dB $L_{Aeq, peroid}$
Domain*	Active recreation	When in use	50 dB $L_{Aeq, peroid}$

Table 5 Project Specific Noise Levels at Noise Sensitive Receivers

All levels noted for the residential buildings in Table 5 above are applicable at the most-affected point on or within the residential property boundary.

The Botanic Garden to the north of the site is considered to be for passive recreation and is characterised by contemplative activities that generate little noise. The background noise level at Location 2 is considered to be representative for the Botanic Garden, as the location is closer to the Botanic Garden and the amenity is similar.

The Domain and the Domain Pitches are considered to be active recreation areas since sporting activities and public events (e.g. concerts, festivals) often take place within the area. It is also because it serves as a main walking corridor from the city to the Eastern suburbs and is surrounded by major roads and a railway. The background noise level at Location 2 is considered to be representative for the Domain areas because of the similarity of the amenity. Note that the background noise level at Location 1 is not considered to be representative as it is very close to the Eastern Distributor Motorway and Cahill Expressway.

* For both criteria noted for the Botanic Garden and the Domain it is appropriate that the noise criteria in Table 5 above is considered applicable when measured at the most-affected point located at least 15 m from the nearest road barrier, road boundary or AGNSW and new building facades. This deviation from the typical INP parkland assessment distances is recommended because each of them are large land areas adjacent to major roads and they are exposed to high levels of

traffic noise at their boundaries, but the proposed criteria have been derived based on quieter background noise levels more typical of the parkland amenity found when located away from the boundaries.

Assessment of building services noise mitigation requirements to meet these criteria are discussed in Section 5.1 below.

4.2 NSW Road Noise Policy (RNP)

The *NSW Road Noise Policy (DECCW 2011)* provides noise criteria for both residential and other non-residential noise sensitive receivers. The RNP provides both absolute noise level limits, dependent upon road category, and limits to control the relative increase in road traffic noise.

The RNP includes assessment criteria for various types of building but does not specifically include art galleries. Of the types of spaces noted in the RNP, the most relevant is the criterion for School Classrooms. A noise level of 40 dBL_{Aeq} is recommended for traffic noise within classrooms and noise levels from traffic will be designed to meet this criterion for the gallery spaces. Other spaces have more onerous requirements (see Table 11).

4.3 Limits On Noise Local To The Development

As well as controlling noise affecting nearby residences and the nearby recreation spaces, it is appropriate to control noise local to the development in order to protect amenity of the outdoor areas.

Based on the site noise survey, it is proposed that normally operating external plant noise egress is limited to 50 dB(A) when measured at any publically accessible location at least 1m from a grille or the façade of the building.

4.4 Noise from Traffic

Reference in the SEARs has been made to "NSW Road Noise Policy"[2]. It is considered that there are no specific requirements for the proposed development as a result of this policy and that the maintenance of acceptable noise levels as defined in AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors" will ensure that noise intrusion from road noise sources will be kept to acceptable levels.

4.5 Noise and Vibration from Rail

The site is sufficiently far away from the rail corridor (approximately 180 m) that noise and vibration impacts from rail are not significant. Reference has been made to "Development Near Rail Corridors and Busy Roads – Interim Guideline"[3] in this regard.

Noise and vibration measurements on site have shown that rail sources are not significant for the new development, because of the distances involved and the inherent acoustic screening afforded by the existing Gallery.

Comparison with Figures 3.1 and 3.2 in Reference 2 provides further confirmation that rail noise and vibration is unlikely to be problematic.

[2] New South Wales Road Noise Policy. DECCW, March 2011.
[3] Development Near Rail Corridors and Busy Roads – Interim Guideline. NSW Government Department of Planning. December 2008

5 Noise Impacts to the Community

5.1 Noise Sensitive Receivers in the Community

Noise sensitive receivers in the community are summarised in Table 1, including residential buildings on Lincoln Crescent, the Domain and the Botanic Garden.

5.2 Plant Noise

5.2.1 General Plant Noise

Plant noise will be limited to the criteria listed in Section 4.1 above. At this stage in the project, details of the plant selections are not known. During the detailed design process, appropriate noise and vibration control treatments will be specified to ensure that the noise limits are maintained. The plant noise will also be controlled to meet the noise limits in the Royal Botanic Garden and Domain, as well as appropriate noise limits local to the building (see section 4.3 above). This will help to maintain the existing amenity of the areas.

These treatments are likely to include:

- Specification of maximum sound power levels for all items of plant as part of the project documentation.
- Rectangular and circular attenuators to control fan noise
- Acoustic louvres to control noise from plantroom ventilation openings
- Cooling air and flue gas attenuators on the generator set
- Vibration isolators to reduce vibration input to the building structure
- Acoustic screens around any external plant
- Incorporation of sound absorptive treatments in plantroom spaces where needed.

5.2.2 Seawater Cooling

It is expected that the project will make use of seawater cooling. This is intrinsically quieter than many of the alternatives (i.e. cooling towers or air cooled condensers).

The seawater cooling plant will be located internally within a plantroom and appropriate noise mitigation measures will be employed to ensure that noise from the seawater cooling plant is adequately controlled to minimise the effect on the development and on the local noise receivers.

The final selection of noise mitigation measures will be undertaken by the acoustic consultant but are likely to include:

- Use of attenuators or acoustic louvres on ventilation openings to the plantroom

- Provision of appropriate vibration isolation measures beneath the pumps (eg inertia bases and open spring mounts)
- Sound absorptive treatments within the plantroom to reduce local noise level if required.

5.3 Event Noise

5.3.1 Outdoor café event

Outdoor café is proposed to accommodate 100 people under the normal operation, and up to 500 people during functions.

To assess the noise from the outdoor café, following conservative assumptions are made:

- All 500 people are speaking at the same time on the café terrace
- 500 people are divided in several groups distributed on the café terrace.
- People would interact at normal conversation levels.

Noise levels from crowds can be estimated using empirical methods described in a paper by Hayne and others[4].

With distance loss and acoustic barrier effects provided by the building and terrace, the noise level is estimated to be less than 49 dBL_{Aeq} at the closest noise sensitive receiver, 10 Lincoln Crescent. This resultant noise level from 500 crowds is unlikely to be noticeable during the day and evening time (0700-2200).

Crowd noise of 500 people would be noticeable during the night time (2200-0700) and it is therefore proposed that use of external areas will cease at 2200h.

Noise from light background music and amplified speech is unlikely to be excessive at the noise sensitive receivers. However, loud amplified music/concert would not be acceptable on a regular basis.

5.3.2 Entry Plaza

There will be potentially informal crowds gathering for some exhibitions in the Entry Plaza. Noise from these crowds is not expected to be significant with noise at normal conversation levels.

With the large distances to the receivers, and acoustic barrier effects provided by the gallery buildings, noise levels from crowds are not expected to be excessive. Using Haynes' methodology, the noise level at the nearest residential receiver from a crowd of 1000 people at the Entry Plaza is estimated conservatively to be

[4] Prediction of Noise from Small to Medium Sized Crowds. M.J. Hayne (1), J.C. Taylor (1), R.H. Rumble (1) and D.J. Mee (2), (1) Ron Rumble Renzo Tonin, 96 Petrie Terrace, Petrie Terrace QLD Australia 4000, (2) School of Mechanical and Mining Engineering, The University of Queensland, Brisbane, Australia 4072

less than 40 dBL_{Aeq} at the nearest residential properties in 10 Lincoln Crescent. Noise from the Entry Plaza at this level is unlikely to be noticeable.

5.4 Construction Noise and Vibration Levels

5.4.1 Effect on the Community

The importance of the noise and vibration that will be generated by the project construction is recognised. As noted below, noise and vibration will be critical for the gallery and in some cases, noise control treatments necessary to achieve appropriate noise levels at the existing Gallery will help to reduce noise affecting the nearest residential properties.

The control of noise affecting the community will be given a high priority and form a critical part of the eventual Contractor's scope of work. There will be a specific requirement for the Contractor to prepare a detailed Construction Noise and Vibration Management Plan as part of their appointment.

The project falls *outside* the area where the "Construction Hours / Noise within the Central Business District"[5] document applies and therefore only the requirements given in the "Interim Construction Noise Guideline[6]" will apply (this is also in accordance with the relevant policies as listed in the SEARs). This defines noise limits and work periods based on the Rating Background Level (RBL) as defined in the NSW Industrial Noise Policy.

[5] Construction Hours / Noise within the Central Business District. City of Sydney Code of Practice 1992
[6] Interim Construction Noise Guideline, Department of Environment & Climate Change, NSW, July 2009

Working Hours	Location	Management Level, dB $L_{Aeq,15min}$
Standard hours:		
Monday to Friday 7am to 6pm and Saturday 8am to 1pm No work on Sunday or Public Holiday	10 Lincoln Crescent (Location 2)	59
	9-31 Lincoln Crescent (Location 3)	64
Outside Standard hours:		
Day (Sunday or Public Holiday 7am – 6pm, Saturday 7am - 8am and 1pm – 6pm)	10 Lincoln Crescent (Location 2)	54
	9-31 Lincoln Crescent (Location 3)	59
Evening (6pm – 10pm)	10 Lincoln Crescent (Location 2)	54
	9-31 Lincoln Crescent (Location 3)	58
Night (10pm – 7am)	10 Lincoln Crescent (Location 2)	49
	9-31 Lincoln Crescent (Location 3)	47

Table 6: Management Levels at residences at different working hours

5.4.2 Effect on The Royal Botanic Garden and Domain

Guidance is also given in the Interim Construction Noise Guidelines on the level of construction noise for recreation areas, which should be applied to the central open areas of the Domain and Botanic Garden (i.e. at a distance away from the road boundaries). At these locations, noise management levels of 65 $dBL_{Aeq,15\ min}$ for active recreation (Domain) and 60 $dBL_{Aeq,15\ min}$ (Botanic Gardens – passive recreation) is recommended.

Good practice to limit construction noise and solid hoardings, as well as the natural screening of the domain by the hillside, is expected to limit general construction noise from the site to the noise management levels or below. Construction traffic using Art Gallery Road will be noticeable at particularly busy times.

5.4.3 Effect on the Existing Gallery

The existing gallery is likely to be the most sensitive of the noise receivers. Given the nature of the space and the sensitivity of some of the artefacts, control of construction noise and vibration will be a critical part of the construction process. The project team will be reviewing construction methodologies and the programme from which a detailed construction noise and vibration management plan will be developed along with the contractor.

The eventual contractor will have a key role in managing the noise and vibration levels during the works and this will include:

- Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration.
- Ensuring that the Responsible Person keeps the Gallery (and local community) advised on expected activities.
- Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable.
- Managing and monitoring the noise and vibration logging equipment installed around the site.
- Ensuring that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods as defined in the Interim Construction Noise Guideline for NSW (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays).
- The impact of noise from construction activity on the Gallery may be mitigated by working outside Gallery opening hours, provided there is no adverse impacts on residential receivers nearby.
- Ensuring that noise levels are kept as low as is reasonably practicable and providing appropriate and safe noise mitigation methods following the guidance in *AS2436-1981: Guide to noise control on construction, maintenance and demolition sites*.
- Ensuring that noise levels do not exceed the limits specified in the Interim Construction Noise Guideline for NSW.
- Maintaining appropriate records of complaints.

5.4.4 Construction Noise Levels

The noise levels predicted in this section are indicative based on the preliminary construction plan (i.e. Construction Management Plan Rev11) and assumed noise levels of appliances. The actual noise levels will depend on the appliances finally selected for the works. This will be assessed in detail at a later stage as the construction methodology is fully developed and specific plant is identified.

As noted above, some works may need to be conducted outside of gallery opening hours in order to limit noise affecting the gallery itself. Any such works would comply with the requirements in the Interim Construction Noise Guidelines to avoid disturbing local residents.

Construction Equipment and Staging

The sound power levels of the proposed appliances have been derived with reference to the AS 2436:2010 and DEFRA documents. Where an appliance is shown in both documents, the highest sound power level has been used for the

purpose of this assessment. The sound power levels for the proposed appliances are summarized in Table 7.

Appliances	Sound Power Level, dB(A)
Demolition	
Excavator	115
Loader	105
Truck	117
Construction	
Quick Cut Saw	117
Excavator	115
Air Compressor	101
Generator	99
Concrete Pump	108
Crane	105
Piling	111

Table 7: Source levels of proposed appliances

Mitigation Measures

Noise mitigation measures and indicative noise reductions have been obtained from the guidance of AS2436 and BS5228.1. Mitigation measures relevant to this study are summarised below in Table 8.

Appliance	Mitigation Measures	A-Weighted Sound Reduction (dB)
Excavator with Pneumatic concrete breaker, rock drills and tools	Erection of acoustic screening	Up to 10
	Fit Suitably designed muffler	Up to 10
Compressors and generators	Acoustically dampen metal casing	Up to 10
Piling	Enclose hammer head and top of pile in acoustic screen	5 - 10
Earth-moving plant (crane, dump truck, excavator and loader)	Fit more efficient exhaust sound reduction equipment	5 - 10
Pumps	Use machine inside acoustic enclosure	Up to 20

Table 8: Indicative Noise Reduction Provided by Noise Mitigation Measures

Predicted Noise Levels

The level on noise impact will vary depending on the specific location of each piece of equipment in relation to the nearest noise sensitive receivers. When an item of equipment is closer to the receiver location, the noise impacts will be higher.

Locations and volume of trucks are based on the Construction Management Plan Rev11 Appendix 1 Preliminary Site Management Plan. It is understood that, during the construction phase, the truck route is designed to be Art Gallery Road.

The predictions below are based on the peak volume of trucks and is therefore the worst case.

The predicted noise levels for residential noise sensitive receivers are summarised in Table 9 below.

Noise Sensitive Receiver	Phase	Predicted Unmitigated Noise Levels, dB $L_{Aeq,15min}$	Compliance with the Criteria?	Predicted Mitigated Noise Levels, dB $L_{Aeq,15min}$	Compliance with the Criteria?
10 Lincoln Crescent (assessed for east facing façade. The west facing façade does not have windows/ door to residential units)	Demolition	64	NO	54	YES [2]
	Construction	64	NO	55	YES [2]
9-31 Lincoln Crescent	Demolition	59	YES [1]	49	YES [2]
	Construction	64	YES [3]	56	YES [2]

Notes:

[1] Non-compliance during Evening (6pm – 10pm) and Night (10pm – 7am).

[2] Non-compliance during Night (10pm – 7am).

[3] Non-compliance during Day (Sunday or Public Holiday 7am – 6pm, Saturday 7am - 8am and 1pm – 6pm), Evening (6pm – 10pm) and Night (10pm – 7am).

Table 9: Preliminary Construction Noise Prediction with/without Mitigation Measures

Note that the predictions are preliminary and indicative. It should be checked and updated when the construction plan is finalised.

5.4.5 Construction Vibration

The main vibration sensitive receivers around the site are the existing AGNSW facilities and the nearby residential units in Lincoln Crescent. The other possible vibration sensitive receivers of note are the Sydney Eye Hospital and the Parliament of New South Wales. However, these are some 400m from the

development and unlikely to be significantly affected by vibration from construction of the Sydney Modern development.

The most sensitive location with respect to vibration will be the existing facilities within the AGNSW. Vibration during construction will need to be carefully controlled to protect artefacts and to avoid disturbing visitors and staff working within the building.

The Contractor will be required to enact a detailed vibration monitoring protocol to ensure that vibration levels are kept within acceptable levels. This will form a part of their contractual obligations and will define where vibration levels are to be monitored, how the monitoring is to take place and the reporting and recording process.

The Contractor will also be required to monitor vibration at the residential receivers around in Lincoln Crescent. They will be obliged to install vibration logging devices at a defined location and monitor the outcomes. The precise location in Lincoln Crescent will be determined as part of the contract documentation process as more details of the expected construction methodologies are defined.

The vibration criteria stipulated for artefacts will refer to the recommendations in Reference 7 and will be developed at the latest responsible moment when details of the specific artefacts in the building are known.

Criteria for general comfort will be as shown below in Table 10. These criteria are taken from the recommendations in *Assessing Vibration: A Technical Guideline 2006.*

Audible vibration (eg groundborne noise) will be assessed against airborne noise criteria as part of the noise assessment process.

Location	Z axis vibration	X and Y axis vibration	Z axis vibration	X and Y axis vibration
	Preferred values		Maximum Values	
Continuous vibration				
Residential Daytime	0.010	0.0071	0.020	0.014
Residential Nighttime	0.007	0.005	0.014	0.010
Office Anytime	0.020	0.014	0.040	0.028
Gallery Areas Anytime	To be determined based on items in collection at the time			
Impulsive Vibration				
Residential Daytime	0.3	0.21	0.60	0.42
Residential Nighttime	0.1	0.071	0.2	0.14
Office Anytime	0.64	0.46	1.28	0.92
Gallery Areas Anytime	To be determined based on items in collection at the time			

Table 10: Vibration Limit Values (m/s^2 from 1 to 80Hz)

5.5 Construction Noise and Vibration Management

It will be a specific requirement of the Contractor's scope that he effectively deals with construction noise and vibration by planning, mitigation and consultation and implement all "feasible and reasonable" work practices to minimise noise. They will be required to comply with the requirements of the appropriate codes – particularly Interim Construction Noise Guideline for NSW.

This will include:

- Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration
- Ensuring that the Responsible Person keeps the local community advised on expected activities.
- Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable.
- Ensuring that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods as defined in the Interim Construction Noise Guideline for NSW (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays) unless prior approval from the consent authority is arranged.
- Ensuring that noise levels are kept as low as is reasonably practicable and providing appropriate and safe noise mitigation methods following the guidance in AS2436-1981: Guide to noise control on construction, maintenance and demolition sites.
- Maintaining appropriate records of complaints.

Universal Work Practices

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Ensure site managers periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors
- Avoid the overuse of public address systems.
- Avoid shouting, and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use
- Ensure all doors/hatches are shut

Demolition

- Demolition works are to be conducted during standard construction hours only (i.e. no works on Sunday or Saturday after 1:00 pm)
- Regularly inspect and maintain plant to avoid increased noise levels from rattling hatches, loose fittings etc
- Check hatches/enclosures regularly to ensure that seals are in good working order and doors close properly against seals.
- Use non-“beeper” reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms.
- Avoid dropping materials from height.
- Provide resilient damping material on bin trucks to minimise impact noise from materials loaded on truck
- Avoid metal-to-metal contact on equipment wherever possible
- Conduct work behind temporary hoardings/screens wherever possible. Site hoardings shall be located as close to the noise source as possible, and will be as high as feasible considering the structural support of the hoarding. Site hoardings may not be effective at screening noise to upper floors of residential receivers, but can be an effective noise mitigation measure for receivers located on lower floors.
- Keep blade of saws sharp; use a damped blade wherever possible
- Fit mufflers/silencers to pneumatic tools (e.g. breakers)
- Use residential-grade mufflers on plant
- Use dampened bits on impulsive tools such as jackhammers to avoid “ringing” noise.

If mitigated noise levels from demolition are predicted or measured to exceed 75 dBA $L_{Aeq,15minute}$, provide respite periods (e.g. breaks of 1-2 hours) during the day when demolition does not occur.

Excavation

- Excavation works are to be conducted during standard construction hours only (i.e. no works on Saturday after 1:00 pm)
- Use residential-grade mufflers on major items of plant
- Regularly inspect and maintain plant to avoid increased noise levels from rattling hatches, loose fittings etc
- Check hatches/enclosures regularly to ensure that seals are in good working order and doors close properly against seals.
- Use non-"beeper" reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms.
- Avoid dropping materials from height.
- Provide resilient damping material on bin trucks to minimise impact noise from materials loaded on truck
- Avoid metal-to-metal contact on equipment wherever possible
- Conduct work behind temporary hoardings/screens wherever possible. Site hoardings shall be located as close to the noise source as possible, and will be as high as feasible considering the structural support of the hoarding. Site hoardings may not be effective at screening noise to upper floors of residential receivers, but can be an effective noise mitigation measure for receivers located on lower floors.
- If mitigated noise levels from excavation are predicted or measured to exceed 75 dBA $L_{Aeq,15minute}$, provide respite periods (e.g. breaks of 1-2 hours) during the day when excavation does not occur.

Construction

- Construction is to occur during standard construction hours only (i.e. no works on Saturday after 1:00 pm)
- Use residential-grade mufflers on major items of plant
- Regularly inspect and maintain plant to avoid increased noise levels from rattling hatches, loose fittings etc.
- Check hatches/enclosures regularly to ensure that seals are in good working order and doors close properly against seals.
- Use non-"beeper" reversing/movement alarms such as broadband (non-tonal) alarms or ambient noise-sensing alarms.
- Avoid dropping materials from height.
- Provide resilient damping material on bin trucks to minimise impact noise from materials loaded on truck
- Avoid metal-to-metal contact on equipment wherever possible
- Conduct work behind temporary hoardings/screens wherever possible. Site hoardings shall be located as close to the noise source as possible, and will be as high as feasible considering the structural support of the hoarding. Site hoardings may not be effective at screening noise to upper floors of residential

receivers, but can be an effective noise mitigation measure for receivers located on lower floors.

- If mitigated noise levels from installation are predicted or measured to exceed 75 dBA $L_{Aeq,15minute}$, provide respite periods (e.g. breaks of 1-2 hours) during the day when Installation works do not occur.

Deliveries

- Keep truck drivers informed of designated vehicle routes, parking locations and acceptable delivery hours for the site.
- Avoid deliveries at night/evenings
- No idling of delivery trucks
- Receive/unload all deliveries behind a site hoarding/temporary acoustic screen, wherever possible

Stockpiling

- Stockpile materials behind a site hoarding/temporary acoustic screen
- Use residential-grade mufflers on major items of plant

Landscaping

- Use residential-grade mufflers on major items of plant

Work Outside of Standard Working Hours

Work outside standard hours will only be conducted in the following circumstances:

- Works required to prevent any threat to pedestrian safety or a threat of environmental harm if work was to occur during standard construction hours (e.g. emergency works, incomplete works that need to continue out-of-hours in order to maintain safe passage, works requiring closure of Main Avenue entrance).
  In these situations the person who becomes aware of the situation will notify the Site Foreman (SF) or Project Engineer (PE) who will in turn notify the General Foreman (GF) or Project Manager (PM) who will be responsible for recording the details of the additional working hours. Attended monitoring of noise levels by the Acoustic Consultant (AC) may be required at the discretion of the PM. Clear and concise notification of the community will occur as discussed below.
- The delivery of plant, equipment and materials which is required outside Standard Working Hours as requested by police or other authorities for safety reasons and with clear and concise notification to the community as agreed by the Site Environmental Representative
- All "feasible and reasonable" noise mitigation measures discussed in this chapter must be implemented for out-of-hours' work.

If the resulting mitigated noise levels for the activity exceed the Highly Noise Affected Level (75 dB L_{Aeq}), and works cannot be conducted during standard

construction hours, the works may still occur subject to the consent authority's approval, however affected residents must be informed of the likely time, duration and extent of the noise impacts.

Noise and Vibration Monitoring

Attended environmental noise and vibration monitoring will take place at locations determined prior to the beginning of the construction works. This would include a suitable location in Lincoln Crescent.

The locations for noise monitoring shall be representative of the worst affected locations in order to effectively address community concerns in regards to noise and to respond to concerns about vibration affecting the existing AGNSW. Vibration monitoring for the residential premises will be implemented if vibration is expected to be significant.

Additional attended noise monitoring at other locations and plant and equipment monitoring on-site will take place as and when necessary.

The GF will issue a detailed construction programme as required. An acoustic consultant will review the programme and arrange monitoring to coincide with potentially noisy activities.

Reporting

Reports covering the attended monitoring will be prepared after each monitoring session by the Acoustic Consultant. The reports will summarise and interpret the results of each session of noise monitoring. Noise monitoring reports will be prepared within 1 week of completed monitoring and issued in a format suitable for presentation to the consent authority.

Community Notification

Community notification via letter box drops must occur at least five (5) days in advance of any planned out-of-hours work. Notification will occur regardless of whether the planned work is expected to cause adverse noise impacts to residents.

The notification will:

- Provide a clear and concise description of the planned works
- Provide details of the timing and expected duration of the works
- Provide details of the timing and expected duration of "loud" activities
- Inform residents of the noise mitigation measures being implemented for the proposed works, and that all "feasible and reasonable" measures have been implemented to reduce noise impacts.
- Provide a readily accessible contact point (eg mobile phone number and name, 24-hour toll-free information line)

Letter box drops will also be used to manage noise sensitive receiver expectations by notifying residents that increased noise levels may be experienced by upper-floor receivers due to these receivers overlooking the site.

6 Internal Design Criteria

6.1 AS2107

Design levels for steady-state internal noise levels within the building are given in *Australian Standard AS 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors*.

These recommended noise levels apply to all steady-state noise sources within the development. Accordingly, the internal noise levels from the following sources should be controlled to meet the AS 2107 noise levels:

- Noise from the ventilation system (expected to be present in all areas of the development);
- Break-in noise from mechanical plant within the development;
- Traffic noise break-in through the façade; and

AS2107 recommends maximum design noise levels for generic spaces within building interiors, although many of the gallery spaces are not specifically mentioned in the standard. The following criteria for traffic noise intrusion are proposed which are based on the requirements for similar spaces called up in AS 2107 along with specific experience of noise level requirements from other international projects undertaken by Arup. The criteria are outlined in Table 11. These are considered appropriate for the Sydney Modern project and are consistent with, or more onerous than, the generic recommendations in AS 2107.

The criteria for external noise intrusion are expressed in terms of the L_{Aeq} level. This is an overall 'average' of noise levels and as such excludes occasional and sporadic events such as extreme weather or particularly noisy vehicles.

Space	**Maximum External Noise Intrusion Level, dB $L_{Aeq, 15min}$**
Café	45
Gallery Exhibition Spaces	40
Multipurpose	35
Shop	45

Table 11: Design sound levels for Typical Spaces within the Development

6.2 Internal Acoustic Privacy

The nature of the development means that there are only limited requirements to control acoustic privacy.

In practice, acoustic privacy will depend on the sound insulation of the partitions selected and the overall levels of ambient noise within the spaces. The noise control design and specification of partitions will be undertaken by the project acoustic specialist.

Other spaces will need to be provided with high standards of sound insulation in order to protect them from incoming noise that might affect events or noise from events affecting other internal spaces (e.g. multipurpose and cafe).

7 Impact of Environmental Noise and Vibration on the Development

7.1 Noise and Acoustic Privacy

A detailed assessment of noise intrusion is being conducted as part of the acoustic design of the project and will achieve appropriate acoustic privacy between the inside and outside of the building.

This process is ongoing and includes detailed calculations of noise intrusion through the key elements (facades, openings and roofs) and the development of architectural and acoustic designs. These factor in all the acoustical parameters that influence the resulting internal noise levels, recognising that there are many non-acoustic parameters that will also influence the constructions that will eventually be installed.

The preliminary calculations show that controlling internal noise levels to appropriate criteria is unlikely to be problematic. Noise measurements taken on the landbridge at different heights above local ground level show that there is a significant degree of natural acoustic screening by the landbridge parapet, and the low-rise nature of the development will help to maximise the benefits of the screening effects of the parapet.

Further acoustic modelling of the external environment will be undertaken to ensure that the overall internal noise levels resulting from all sources are acceptable.

7.2 Vibration

Measurements have been made of vibration levels on the landbridge and adjoining the highway. This data has formed the basis of an assessment of vibration as it could affect the new development. This assessment has looked at the potential implication of vibration on the building in terms of audible groundborne noise. Calculations show that groundborne noise is unlikely to have any significant impact on noise levels within the development.

The impact of vibration on artefacts has also been reviewed against criteria proposed by the British Museum[7]. Again, the measured levels of vibration are unlikely to be problematic and damage to artefacts from operational vibration is considered very low risk.

Reference has also been made to *Assessing Vibration: A Technical Guideline 2006.* This document primarily refers to human comfort requirements and the criteria in reference 7 are considered more appropriate for assessing vibration affecting art objects.

[7] British Museum, Conservation Research Group. Report No 1999/6 Assessment of Vibration Damage Levels. D. Thickett

Lower levels of vibration can impact items housed on shelving because of the tendency of shelving to amplify vibration where there are long spans. The levels of vibration that will cause items to move on shelving are not well understood - being a complex interaction between the shelf construction and the friction between the shelf and the artefact. This issue is best considered as and when shelving is being procured.

Vibration generating audible noise will be assessed against the internal noise criteria for the development.

The issue of vibration during construction is considered separately in Section 5.4.3.

8 Conclusion

This report has addressed the SEARs Key Issue Nos 3 and 11 regarding the impact of the noise and vibration from development during its construction and operation. In addition to the assessment of the nearby residential premises, the potential noise impacts to the existing Art Gallery, The Royal Botanic Garden and Domain have been assessed. Relevant noise limits and potential noise mitigation measures have been proposed. It also addresses the impact of the existing noise and vibration climate on the development itself.

Reference has been made to relevant NSW and Australian guidance as well as international experience in art gallery design from within Arup. On the basis of the noise and vibration measurements made on site and the information currently available for the development, we see no impediment to approval.

Appendix A

Glossary of Acoustic Terminology

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear, which allows hearing over a large range of sound pressure levels. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

dB(A)

dB(A) is a single number to describe a sound pressure level and includes a frequency weighting to reflect the subjective loudness level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB. Some typical dB(A) levels are shown below.

Sound Level dB(A)	**Example**
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chainsaw at 1 m
100	Inside nightclub
90	Large trucks at 5 m
80	Beside busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Human threshold of hearing

dBL_1

The dBL_1 statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the dBL_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 $dBL_{A1,15min}$ is a sound level of 87 dB(A) or higher for 1% of the 15 minute measurement period.

dBL_{10}

The dBL_{10} statistical level is often used as the "average maximum" level of a sound level that varies with time.

Mathematically, the dBL_{10} level is the sound level exceeded for 10% of the measurement duration. dBL_{10} is often used for road traffic noise assessment. As an example, 63 $dBL_{A10,18hr}$ is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

dBL_{90}

The dBL_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time.

Mathematically, dBL_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 $dBL_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

dBL_{eq}

The 'equivalent continuous sound level', L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

dBL_{eq} is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time. When the dB(A) weighting is applied, the level is denoted $dBL_{Aeq.}$ Often the measurement duration is quoted, thus $dBL_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" and sounds with a higher frequency are perceived as "high pitched".

Vibration

Waves in a solid material are called "vibration", as opposed to similar waves in air, which are called "sound" or "noise". If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (eg a wall) can cause airborne noise to be radiated. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Either metric units (such as mm, mm/s and mm/s2) or using a decibel scale are used to describe vibration.

Appendix B

Environmental Noise Survey Results

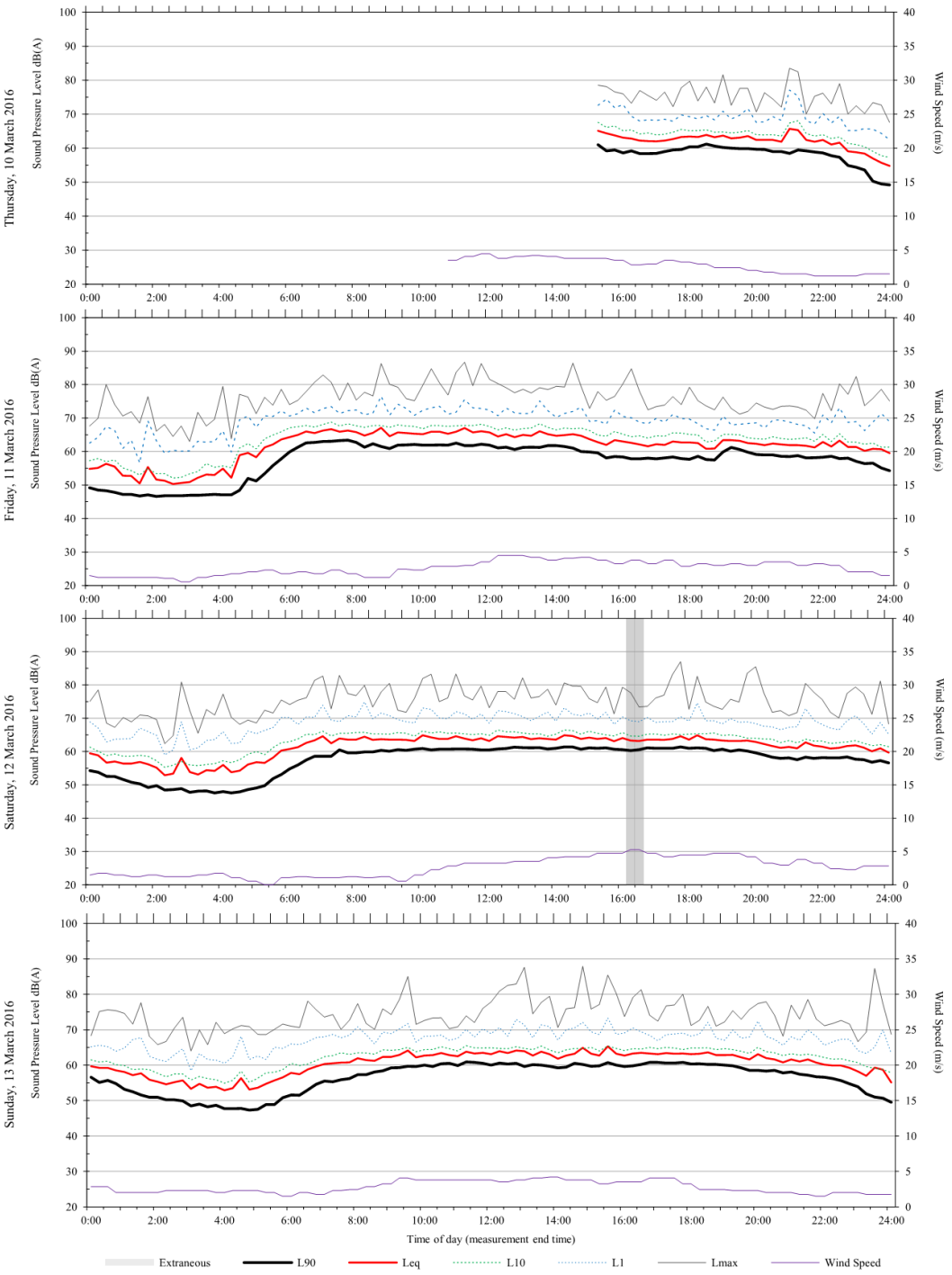
B1 Long Term Unattended Noise Logging Results

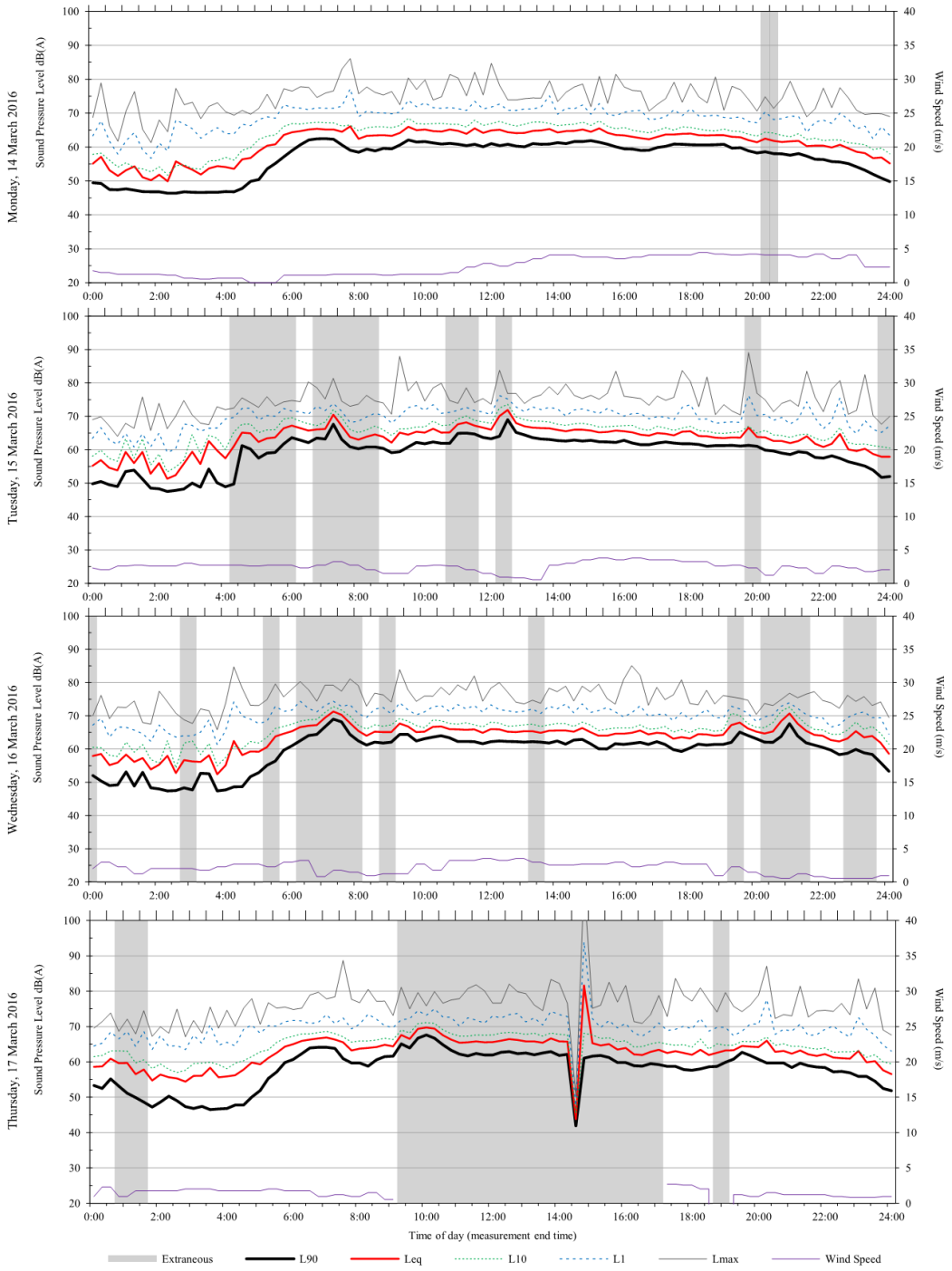
Results are presented under Day, Evening and Night time periods as defined in the NSW Industrial Noise Policy.

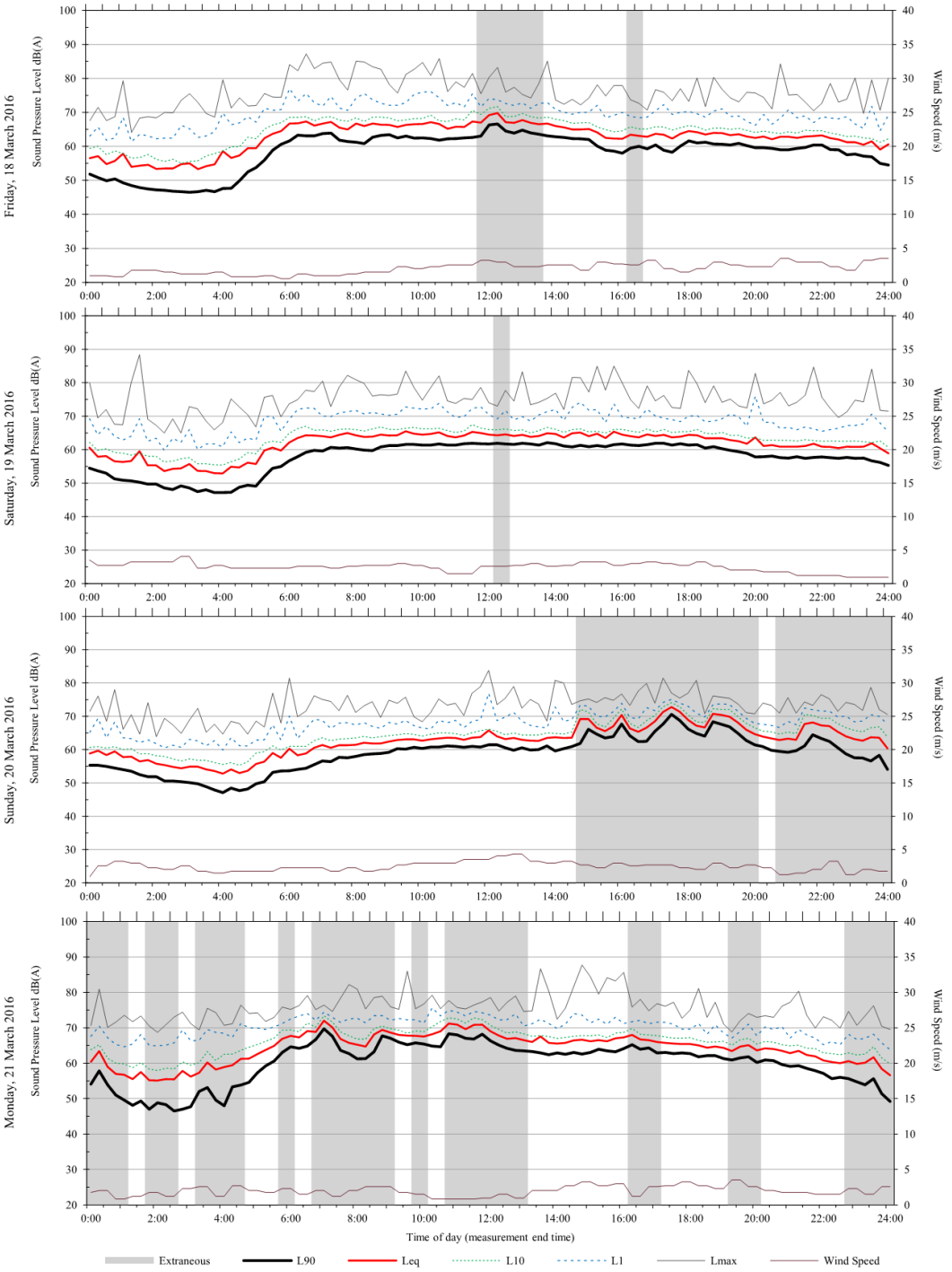
Long term noise measurements were checked and validated against short-term attended measurements. Section B1.1 and Section B1.2 summarised the results in Graphs.

Location	Time Period	Rating Background Level (RBL) – dB(A)	$L_{Aeq\ (period)}$, dB
Location 1	Day (7:00 – 18:00)	59	65
	Evening (18:00 – 22:00)	58	63
	Night (22:00 – 7:00)	47	60
Location 2	Day (7:00 – 18:00)	49	60
	Evening (18:00 – 22:00)	49	62
	Night (22:00 – 7:00)	44	54

B1.1 Location 1




Monday, 14 March 2016
Tuesday, 15 March 2016
Wednesday, 16 March 2016
Thursday, 17 March 2016
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of day (measurement end time)
Extraneous
L90
Leq
L10
L1
Lmax
Wind Speed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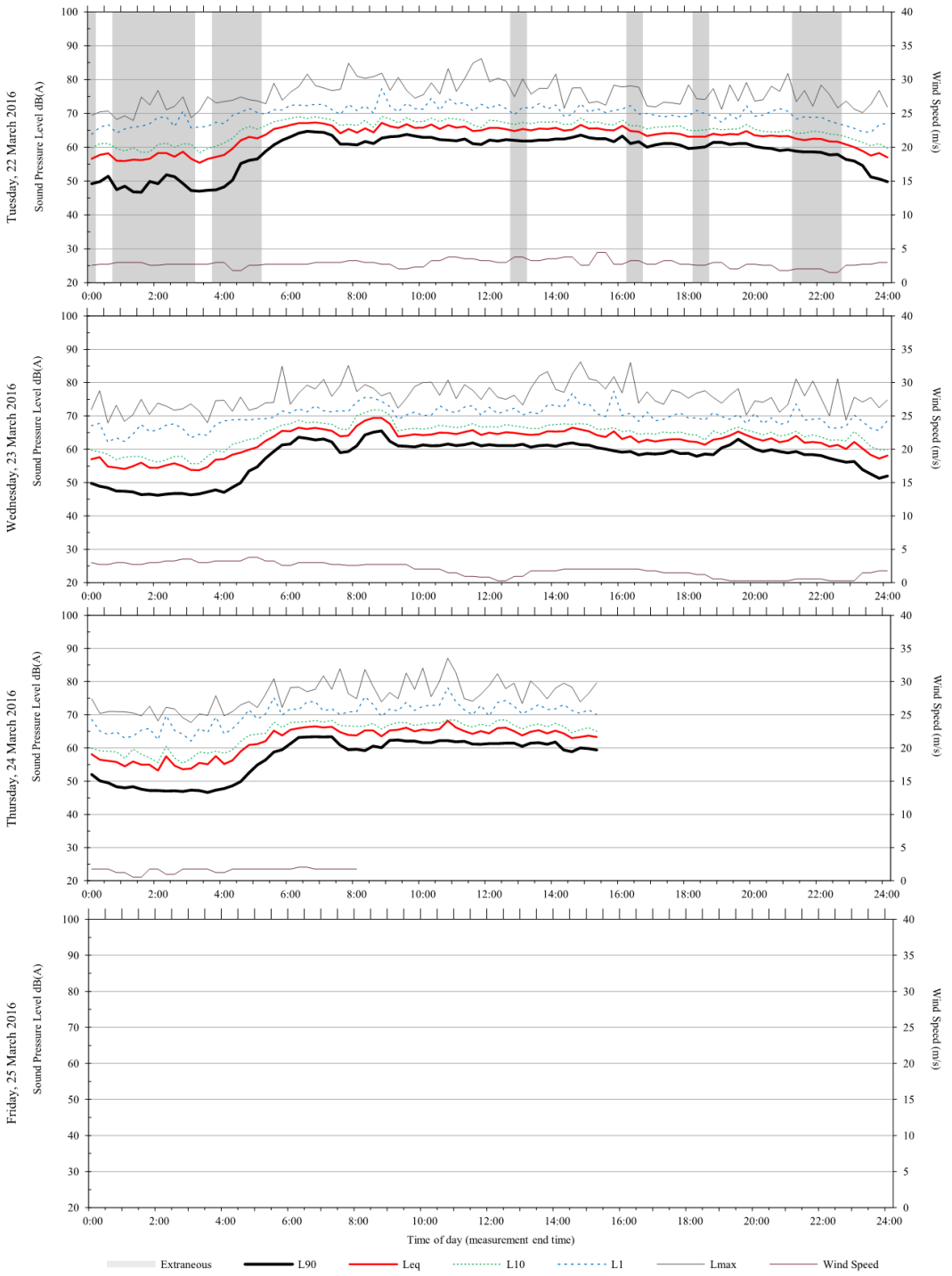
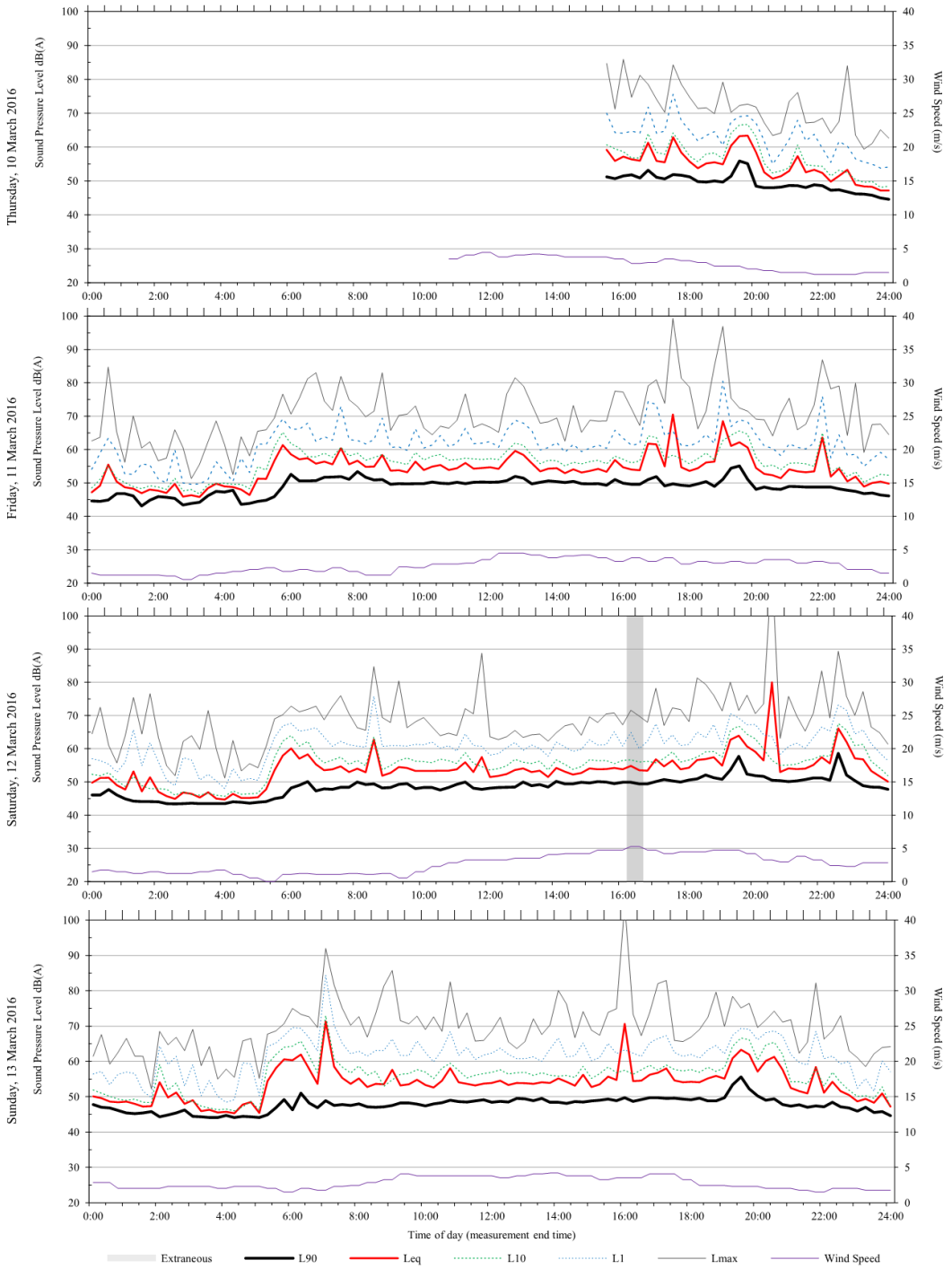
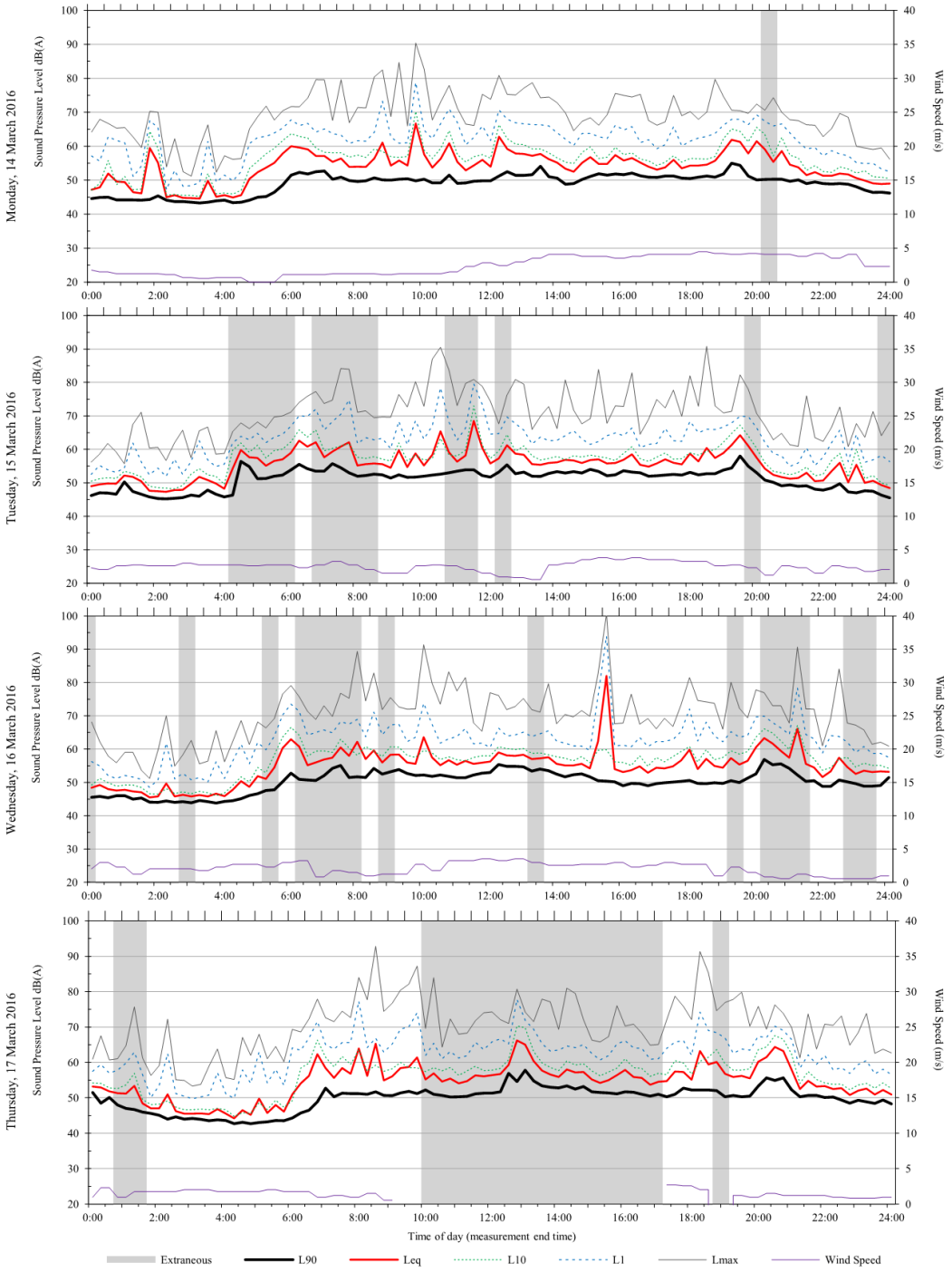
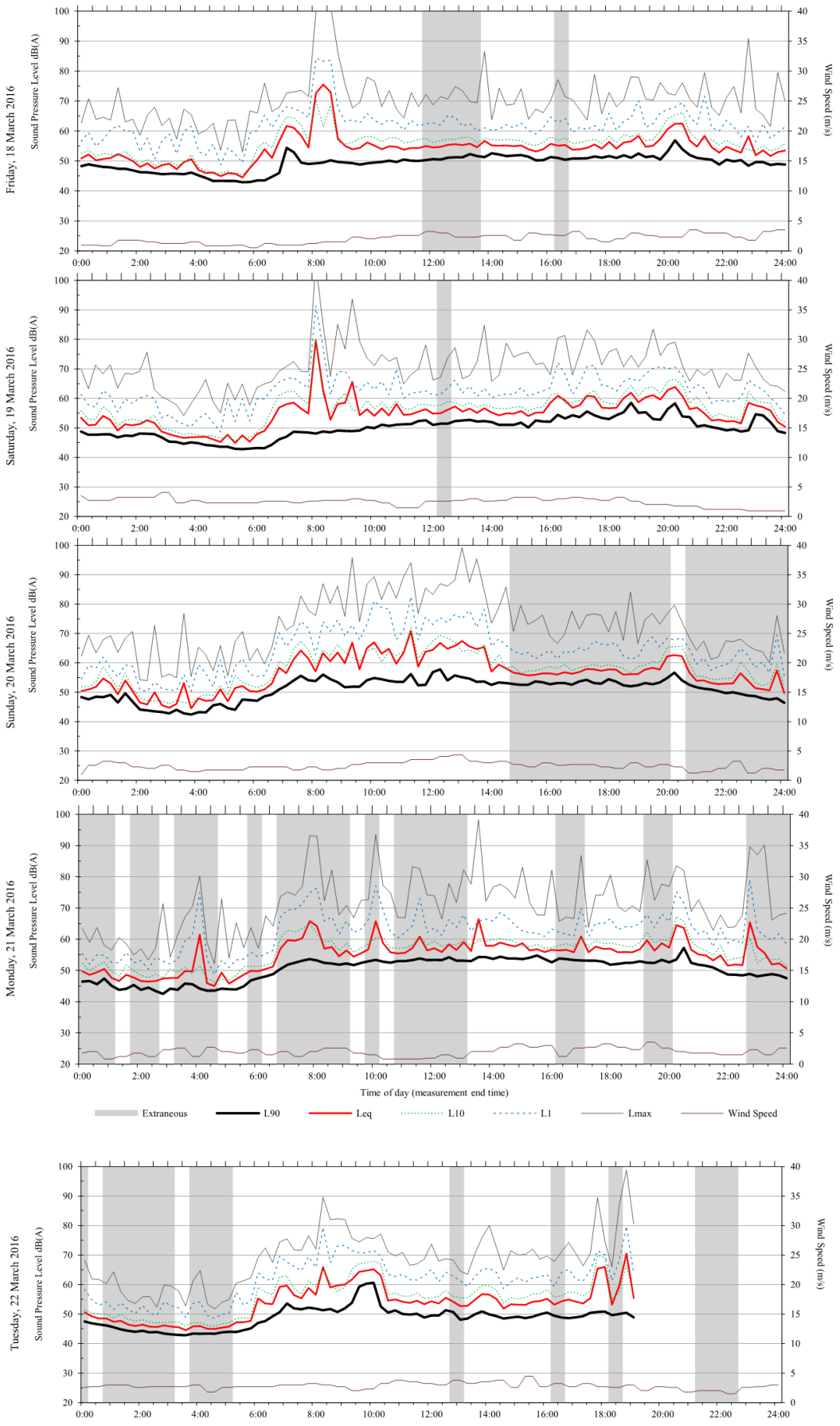
Saturday, 19 March 2016
Sunday, 20 March 2016
Monday, 21 March 2016
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of day (measurement end time)
Extraneous
L90
Leq
L10
L1
Lmax
Wind Speed


Tuesday, 22 March 2016
Wednesday, 23 March 2016
Thursday, 24 March 2016
Friday, 25 March 2016
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of day (measurement end time)
Extraneous
L90
Leq
L10
L1
Lmax
Wind Speed

B1.2 Location 2




Monday, 14 March 2016
Tuesday, 15 March 2016
Wednesday, 16 March 2016
Thursday, 17 March 2016
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of day (measurement end time)
Extraneous
L90
Leq
L10
L1
Lmax
Wind Speed


Friday, 18 March 2016
Saturday, 19 March 2016
Sunday, 20 March 2016
Monday, 21 March 2016
Tuesday, 22 March 2016
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of day (measurement end time)
Extraneous
L90
Leq
L10
L1
Lmax
Wind Speed

B2 Attended Short Term Noise Measurements

B2.1 Location 1

Date	Time	$L_{eq,15min}$, dB(A)	$L_{1,15min}$, dB(A)	$L_{10,15min}$, dB(A)	$L_{90,15min}$, dB(A)
10 March 2016	16:00 – 16:15	63	73	66	59
24 March 2016	15:15 – 15:30	65	73	68	60

B2.2 Location 2

Date	Time	$L_{eq,15min}$, dB(A)	$L_{1,15min}$, dB(A)	$L_{10,15min}$, dB(A)	$L_{90,15min}$, dB(A)
10 March 2016	15:30 – 15:45	59	70	61	51
24 March 2016	15:15 – 15:30	65	73	68	60

B2.3 Location 3

Date	Time	$L_{eq,15min}$, dB(A)	$L_{1,15min}$, dB(A)	$L_{10,15min}$, dB(A)	$L_{90,15min}$, dB(A)
10 March 2016	17:00 – 17:15	58	65	60	55

B2.4 Derivation of the NSW INP Project Specific Criterion

Noise Sensitive Receiver	Classification	Time Period	Intrusiveness Criterion $dBL_{Aeq,15min}$	Amenity Criterion $dBL_{Aeq,period}$	Project Specific Criterion
10 Lincoln Crescent (Location 2)	Residential	Day	54	**54**	54 dB $L_{Aeq, Day}$
		Evening	54	**52**	52 dB $L_{Aeq, Evening}$
		Night	49	**44**	44 dB $L_{Aeq, Night}$
9-31 Lincoln Crescent (Location 3)	Residential	Day	59	**54**	54 dB $L_{Aeq, Day}$
		Evening	58	**48**	48 dB $L_{Aeq, Evening}$
		Night	47	**45**	45 dB $L_{Aeq, Night}$
Botanic Garden	Passive recreation	When in use	-	**50**	52 dB $L_{Aeq, period}$
Domain	Active recreation	When in use	-	**50**	52 dB $L_{Aeq, period}$