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Noise Impact Assessment

Sydney Heritage Fleet

Pyrmont, NSW 2009

Report Number 610.10676

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Suite 100, Jones Bay Wharf
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PYRMONT NSW 2009

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Noise Impact Assessment

Sydney Heritage Fleet

Pyrmont, NSW 2009

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EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd has been commissioned by Crawford Architects on behalf of Sydney Maritime Museum Ltd to provide environmental assessment reports to support a Development Application for the Sydney Heritage Fleet, Bank Street, Pyrmont.

This report presents the Noise Impact Assessment for the above proposed development.

This report has been completed with reference to the Director-General's Requirements for the development, and with reference to the NSW Governments *'Interim Construction Noise Guideline'* (DECC 2009), *'Industrial Noise Policy'* (EPA 2000)*, Assessing Vibration: A Technical Guideline* (DEC 2006) and associated application notes, as appropriate.

The report examines the existing environmental conditions at the proposed Project Site by reference to validated noise monitoring data. The potential sources of noise emissions associated with the construction and operational phases of the development have been identified, and quantified where possible.

The potential impact of these sources upon the surrounding residential areas has been made through quantitative methods. During construction impacts are anticipated during piling and recommendations include a construction noise management plan. Operational noise impacts are anticipated during the hull riveting operations. To reduce these impacts it is recommended that riveting occurs on the southern side of the vessel, with vessel rotation on the floating pontoon as required. In addition consideration should be given to restricting the hours of riveting to between 8 am to 4 pm with no riveting between midday and 2 pm.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) has been commissioned by Crawford Architects on behalf of Sydney Maritime Museum Ltd (Client) to provide environmental assessment reports to support a Development Application (DA) for the Sydney Heritage Fleet (SHF), Bank Street, Pyrmont.

This report presents the Noise Impact Assessment for the above proposed development.

This report has been undertaken in accordance with SLR's Offer of Services, Sydney Heritage Fleet Bank Street, Pyrmont; Specialist Building/Environmental Technology Services (Ref. 610.10676 SHF P1 20110823, dated 23 August 2011).

From the information provided by the Client, the following briefly describes the development:

- The development will comprise a non-profit making working museum and a home for the SHF.
- The site is located under the eastern pylon of the Anzac Bridge with a water frontage to Blackwattle Bay and a street frontage to Bank Street. Approximately half of the site adjacent to the bridge pylon will be occupied by the SHF and the other half to the east will become a community park. The land understood to be developed as a community park does not form part of this assessment.
- Located to the west of the bridge pylon is a freestanding Exhibition Pavilion with an attached refreshment kiosk and amenities.
- The land based component of the project comprises two storage areas at sea wall/water level.
    - The first to store dragon boats operated by Dragon Boats NSW with direct access to a new boat ramp.
    - The second to store and operate small vessels owned by the SHF, which will also make use of the boat ramp.
- Directly above the boat storage areas are exhibition spaces, meeting rooms, amenities, and entry lobby and reception areas.
- Across from the entry courtyard fronting Bank Street is a single storey building with some mezzanine spaces over which are the SHF's maintenance workshops and storage areas which are required to service the SHF vessels. The roof of the maintenance areas will be "green", to provide sound insulation for the SHF's operations and a visually attractive landscape for the adjacent residential buildings.
- Where reference is made to the site being developed for commercial use, this terminology is used to differentiate from residential or industrial uses, and is not intended to construe a commercial (or business) venture.

1.1 Objectives

The objective of this assessment is to determine the potential noise impacts from the construction and operation of the proposed development in accordance with the Director-General's Requirements (DGRs).

Key issues identified from the DGRs with respect to noise are as follows:

> *Noise*
>
> *The Environmental Assessment should include an assessment of noise and vibration impacts, prepared in consultation with the DECCW. All feasible and reasonable noise impact measures should be implemented. The assessment should be prepared in accordance with the NSW Governments Interim Construction Noise Guideline', Industrial Noise Policy and Application Notes, Environmental Criteria for Road Traffic Noise and Assessing Vibration, A Technical Guide, as appropriate.*

> *A noise management plan for the demolition and construction phase should be submitted. The report should have regard to the City's Code of Practice for Construction Hours/Noise 1992, in particular assessment should be carried out of the noise impact from any highly intrusive equipment (Category A appliances) to be employed as identified in Schedule 1 of the Code of Practice.*

Acoustic terminology used in this report is presented in **Appendix A**.

1.2 Scope of Work

To achieve the above objectives, the following scope of works was implemented:

- Description of environmental values.
- Identification and estimation of noise emissions.
- Assessment of potential impacts.
- Identification of mitigation measures.

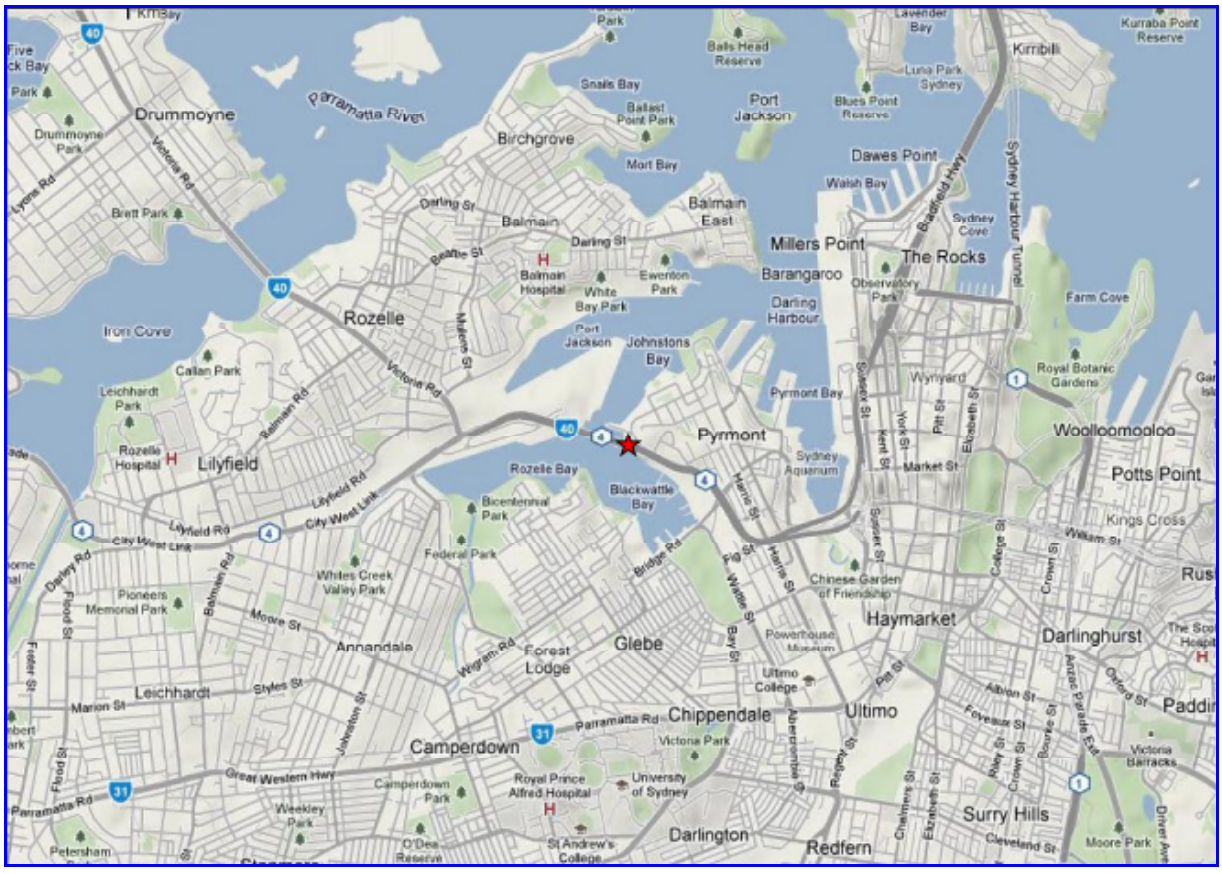
2 SITE DESCRIPTION

2.1 Site Location and Description

The Project Site is located off Bank Street, Pyrmont, NSW 2009, approximately 1.3 kilometres (km) west of Sydney Central Business District (CBD).

A Locality Map is provided below in **Figure 1**.

Figure 1 Locality Map



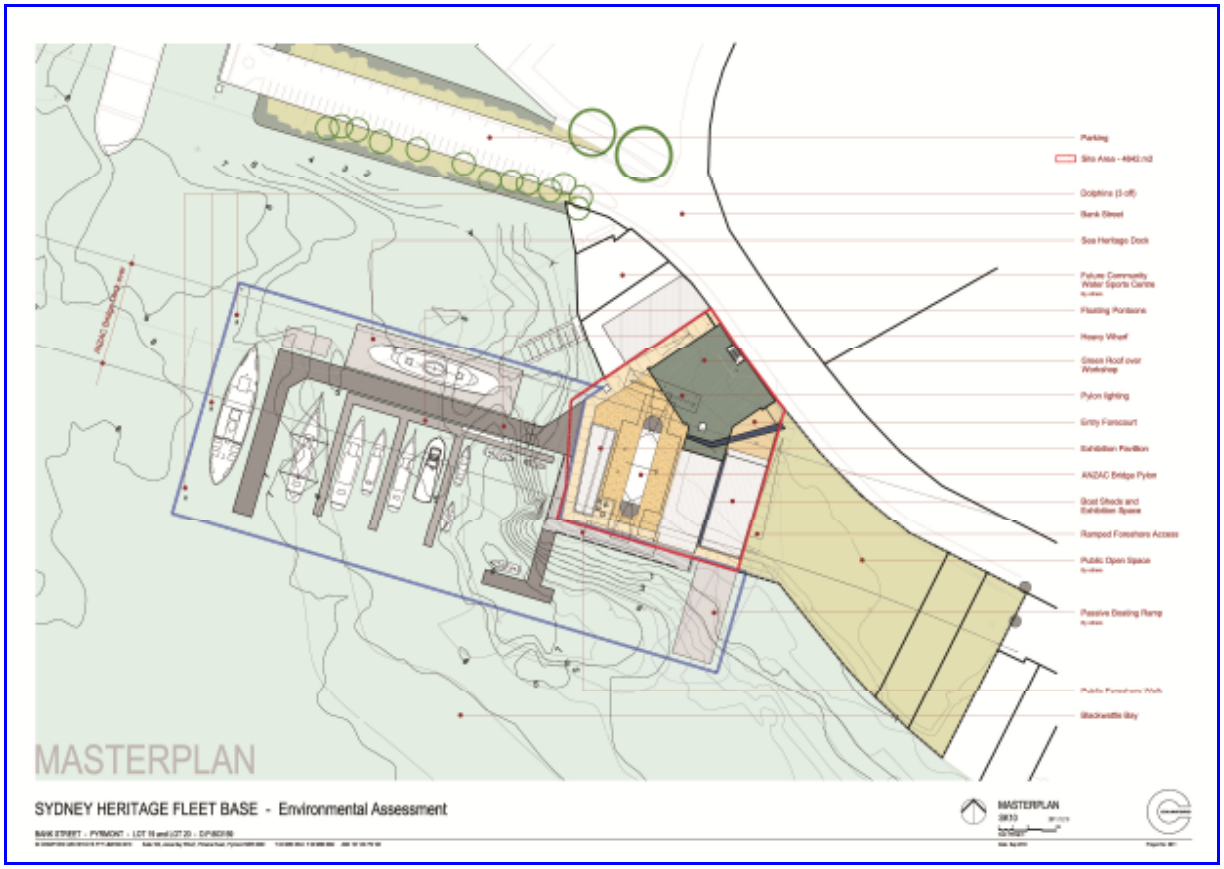
Source: SLR Consulting

The Project Site is a combination of two lots located beneath the eastern pylon of the Anzac Bridge, comprising Lot 19 and Lot 20 of Deposit Plan 803159. The area included within this DA is shown in **Figure 2** and is approximately 4,642 m^2 in area.

For clarity, throughout this report when both lots are being referred to, the term 'Project Site' will be used. If they need to be discussed individually the lots will be referred to by their associated lot and Deposit Plan number.

Two leases exist are proposed for the site, a land lease (identified in **Figure 2** by a red boundary) and a water lease (identified by a blue boundary). The public open space (shaded in green in **Figure 2**) is also shown, although this is not included within this DA, and does not form part of this assessment.

Figure 2 Site Plan



Source: Crawford Architects

The Project Site is bordered to the south and west by Blackwattle Bay, to the north by Bank Street. The surrounding land uses include:

- North and Northwest: On the other side of Bank Street is Jackson's Landing residential and community estate.
- South and West: Blackwattle Bay borders the Project Site.
- Northeast: There is a small cluster of commercial buildings located on the opposing side of Bank Street.
- Southeast: A series of buildings operated by Poulos Bros Seafoods Pty Ltd, Bidvest Australia Pty Ltd, Hymix Australia Pty Ltd and the Sydney Fish Markets.

2.2 Project Description

The proposed development works shall incorporate the following:

- A two storey building with some mezzanine spaces.
- Located west of the bridge pylon is a freestanding Exhibition Pavilion with an attached kiosk and amenities.
- Boat sheds and vessel storage for dragon boating.
- Shipwrights and boat storage area which includes a machine shop, workshop, timber store, lunch room and amenities.
- Directly above the storage areas are exhibition spaces, meeting rooms, amenities, and entry, lobby and reception areas.

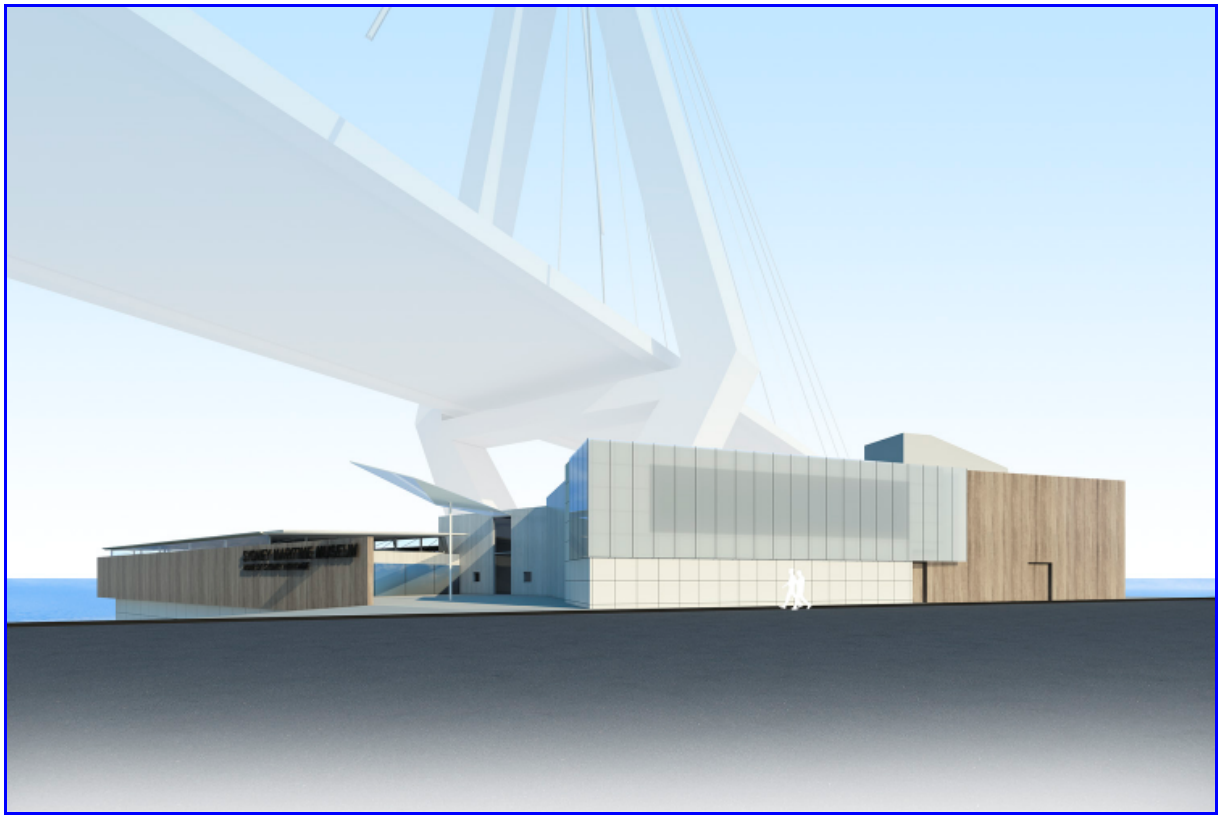
- Restoration and maintenance workshop, including a metal fabrication workshop, coal stores, garbage and recycling stores, paint and flammable goods store.
- Working living museum.
- Lay apart stores and electrical workshop.
- A mezzanine which incorporates storage areas for parts required to service the SHF vessels.
- Fixed wharf.
- Floating pontoons.

Figure 3 and **Figure 4** below show design perspectives for the proposed development from the proposed public open space and from Bank Street, respectively.

Figure 3 View of Proposed Development from Public Open Space

Source: Crawford Architects

Figure 4 View of Proposed Development from Bank Street



Source: Crawford Architects

3 LEGISLATION AND GUIDANCE

3.1 OEH's Interim Construction Noise Guidelines 2009 (ICNG)

The Guideline is specifically aimed at managing noise from construction works regulated by the NSW Office of Environment and Heritage (OEH, previously the DECCW, DEC and EPA) and is used to assist in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by OEH under the Protection of the Environment Operations Act 1997 (POEO Act) are:

- Construction, maintenance or renewal activities carried out by a public authority (Section 6 of the POEO Act).
- Non-scheduled activities for the purpose of regulating water pollution (Section 43(d) of the POEO Act) - in this case the licence may include conditions for managing noise impacts.
- Scheduled development work that will enable scheduled activities to be carried out (Section 47 of the POEO Act).
- Construction, maintenance of renewal related activities described in Schedule 1 of the POEO Act - OEH regulates these activities through an environment protection licence.

3.1.1 Construction Noise Emissions

The ICNG recognises that higher levels of noise are likely to be tolerated by people in view of the relatively short duration of the works and recommends the following approaches to mitigating adverse noise impacts from construction sites.

Hours of Construction

The ICNG recommend confining permissible work times as outlined in **Table 1**.

Table 1 Preferred Hours of Construction

Day	Preferred Construction Hours
Monday to Friday	7.00 am to 6.00 pm
Saturdays	8.00 am to 1.00 pm
Sundays or Public Holidays	No construction

3.1.2 Construction Noise Assessment Method

The ICNG recognises that people are usually annoyed more by noise from longer-term works than by the same type of works occurring for only a few days. For this reason the ICNG identifies two methods of assessing noise from construction:

- The quantitative assessment method which applies to long-term duration work, and
- The qualitative assessment method which applies to short-term duration work.

3.1.3 Quantitative Assessment Method

The ICNG recommends that the $L_{Aeq(15minute)}$ noise levels arising from a construction project, measured within the curtilage of an occupied noise-sensitive premises (i.e. at boundary or within 30 m of the residence, whichever is the lesser), should not exceed the levels indicated in **Table 2**. These noise management levels are generally consistent with community reaction to construction noise. The ICNG also recognises other kinds of noise sensitive receivers and provides recommended construction noise levels for them. Those specific receivers and their recommended noise levels are presented in **Table 3** and **Table 4**.

Table 2 Recommended DECCW General Noise Management Levels for Construction Works

Period of Noise Exposure	$L_{Aeq(15minute)}$ Construction Noise Management Levels (CNMLs)
Recommended Standard Hours	Noise affected[1] RBL + 10 dBA
	Highly Noise affected[2] 75 dBA
Outside Recommended Standard Hours	Noise affected[1] RBL + 5 dBA

Note 1: The noise affected level represents the point above which there may be some community reaction to noise.
Note 2: The highly noise affected level represents the point above which there may be strong community reaction to noise.

Table 3 Noise at Sensitive Land Uses (other than Residences)

Land use	$L_{Aeq(15minute)}$ Construction Noise Management Level
Classrooms at schools and other educational institutions	Internal noise level: 45 dBA
Hospital wards and operating theatres	Internal noise level: 45 dBA
Places of worship	Internal noise level: 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level: 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level: 60 dBA
Community centres	Depends on the intended use of the centre

Table 4 Management Levels at Commercial and Industrial Premises

Land Use	Management Level, $L_{Aeq\ (15\ minute)}$ (applies when properties are being used)
Offices, retail outlets	External noise level: 70 dBA
Industrial premises	External noise level: 75 dBA
Other noise sensitive businesses such as theatres and childcare centres	Assess on a case by case basis. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

The ICNG recommends using the following quantitative assessment when the noise affected level is not met:

3.1.4 Mitigation

Recommended Standard Hours - Noise affected RBL + 10 dBA

- Where the predicted or measured $L_{Aeq(15minutes)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices in order to meet the noise affected level.
- The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Recommended Standard Hours - Highly Noise affected 75 dBA

- Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours during which the very noisy activities can occur, taking into account:
    - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences
    - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

3.1.5 Qualitative Assessment Method

The qualitative method for assessing construction noise is a simplified way to identify the cause of potential noise impacts. It avoids the need to perform complex predictions by using a checklist approach to assessing and managing noise. Short-term means that the works are not likely to affect an individual or sensitive land use for more than three weeks in total.

The following checklist for work practice can be used:

- Community notification
- Operate plant in a quiet and efficient manner
- Involve workers in minimising noise
- Handle complaints

For the purpose of this report, construction noise impacts associated with the construction of the project will be assessed using the Quantitative method.

3.2 OEH Assessing Vibration: A Technical Guideline

This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. It does not address motion sickness, occupational vibration, blasting vibration effects or vibration-induced damage to buildings or structures.

This guideline was considered interim until the revised (2008) BS 6472 was published.

3.3 NSW Industrial Noise Policy 2000 (INP)

The NSW OEH has regulatory responsibility for the control of noise from “schedule premises” under the Protection of the Environment Operations Act 1997. In implementing the NSW “Industrial Noise Policy”, 2000 (INP), the OEH has two broad objectives:

- Controlling intrusive noise impacts in the short-term;
- Maintaining noise level amenity for particular land uses over the medium to long-term.

The specific policy objectives are as follows:

- Establish noise criteria that would protect the community from excessive intrusive noise and preserve the amenity for specific land uses.
- Use the criteria as the basis for deriving “Project Specific Noise Levels” (PSNLs).
- Promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- Outline a range of mitigation measures that could be used to minimise noise impacts.

- Provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of the industrial development.
- Carry out functions relating to the prevention, minimisation and control of noise from the premises scheduled under the Act.

3.3.1 Assessing Intrusiveness

For assessing intrusiveness, the background noise generally needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than 5 dBA above the measured (or default) Rating Background Level (RBL).

3.3.2 Assessing Amenity

The cumulative effect or amenity impacts of noise from industrial sources also need to be considered. The amenity assessment is based on noise criteria specific to the land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. If present, the existing noise level from industry is generally measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion

Extracts from the INP that relate to the amenity criteria are presented in **Table 5**.

Table 5 Amenity Criteria - Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60 dBA	65 dBA
		Evening	50 dBA	55 dBA
		Night	45 dBA	50 dBA

Notes: For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am.
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm ; Night-time 10.00 pm - 8.00 am.

3.3.3 OEH's Application Notes - NSW Industrial Noise Policy

The Application Notes compliment the INP by means of explanation and clarification. One such (important) area explained in the Note is that for "Sleep Disturbance".

3.4 OEH's Environmental Criteria for Road Traffic Road

The ECRTN identifies the strategies that address the issue of road traffic noise from:

- Existing roads
- New road projects
- Road redevelopment projects
- New traffic-generating developments

The ECRTN also defines criteria to be used in assessing the impact of such noise. To achieve this aim, the ECRTN needs to address several critical areas. These are:

- Land use and development planning
- Road and transport planning
- Noise source control
- Transmission path control

4 THE EXISTING ENVIRONMENT

4.1 Noise Monitoring

Environmental noise monitoring was conducted at the potentially most affected (representative) noise-sensitive locations in order to:

- Characterise the existing noise environment in the vicinity of the site.
- Establish the noise levels upon which to base the construction and operation noise emission objectives.

The noise monitoring location was selected after a detailed inspection of the area adjacent to the site, with consideration to other noise sources which may influence the recordings and security issues for the noise monitoring devices.

The noise logger was located at the ground level of the Bayview Towers residential apartment block which overlooks the site, as shown in Figure 5. The location was shielded from traffic on Anzac Bridge (by the elevated roadway), and also shielded and distant from the construction activities at Jacksons Landing. As such the results are considered representative of those residential receivers adjacent to the site and least affected by traffic from Anzac Bridge, with higher noise levels expected at residences at higher elevations less shielded from the roadway.

The noise monitoring was conducted between Thursday 1 December 2011 and Friday 9 December 2011.

Continuous weather data was obtained from the nearby Sydney Airport station in order to identify periods of adverse weather during the unattended noise logging survey. The Sydney Airport site was selected as it is a station providing detailed meteorological data that falls within the guideline offset distance nominated in the INP. Data corresponding to periods of high winds and/or rain were excluded from the noise analysis. The removal of the weather affected noise data did not affect the resulting background noise levels.

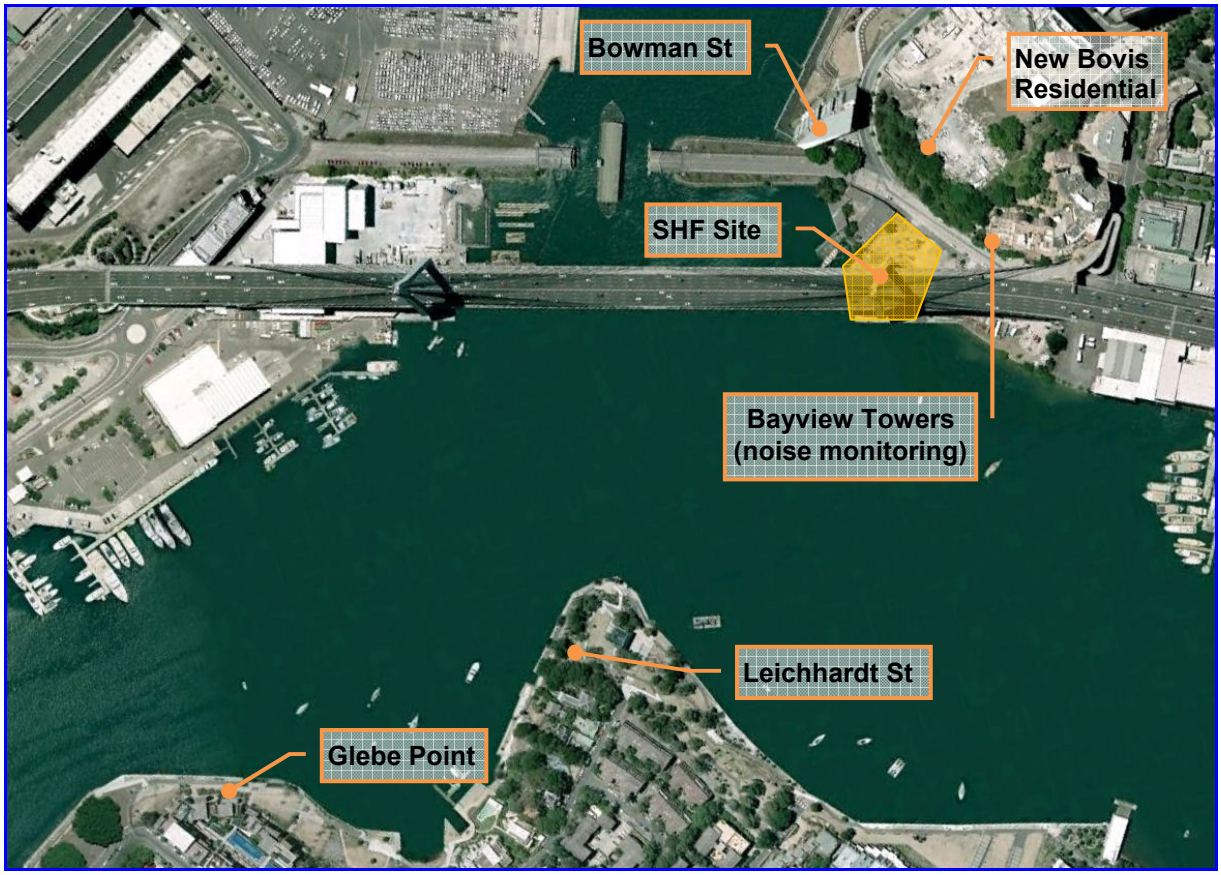
4.2 Noise Monitoring Instrumentation

Equipment for the continuous unattended noise surveys comprised an Acoustic Research Laboratories (ARL) Environmental Noise Logger Type EL 215 (Type 2) fitted with a microphone windshield. Calibration of the logger was checked prior to and following measurements using a Brüel & Kjær Electronic Calibrator Type 4230.

The EL 215 noise loggers are designed to comply with the requirements of AS IEC 61672.1-2004: *"Electroacoustics-Sound level meters-Specifications"* and carried appropriate and current NATA (or manufacturer) calibration certificates.

The unattended noise loggers were programmed to continuously monitor the ambient noise levels, recording relevant environmental statistical noise descriptors at the end of each 15 minute period throughout the survey.

Figure 5 Ambient Noise Monitoring and Assessment Locations



Source: SLR Consulting

4.3 Ambient Noise Monitoring Results

The results of the noise surveys are presented in tabular form in **Table 6** and graphically in **Appendix B**. The statistical descriptors shown on the graphs are described below:

L_{A90} The L_{A90} noise level is described as the average minimum background sound level or simply the background level. The L_{A90} is the level of noise exceeded for 90% of the sample time (15 minutes).

L_{A10} The noise level exceeded for 10% of the sample time (15-minute) and is typically described as the average maximum noise level.

L_{A1} The noise level exceeded for 1% of the sample time (15-minute) and is representative of the highest noise level events (e.g. passing heavy vehicles, aircraft etc).

L_{Aeq} The L_{Aeq} is the energy-average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time varying sound.

The noise data were processed in accordance with the procedures documented in the OEH's INP.

Table 6 presents Rating Background Level (RBL) or background (L_{A90}) and L_{Aeq} ambient noise levels for the noise monitoring location adjacent to the site.

Noise monitoring available in the public domain was also conducted at Glebe Point in May 2009, and the results of the survey are also presented in **Table 6**.

Table 6 Summary of Existing $L_{A90(15minute)}$ Rating Background Levels (RBLs) and Existing $L_{Aeq(period)}$ Ambient Noise Levels - dBA re 20 µPa

Location	$L_{A90(15minute)}$ Rating Background Level (RBL)			$L_{Aeq(period)}$ Existing Ambient Noise Level		
	Daytime 0700-1800 Hours	Evening 1800-2200 Hours	Night-time 2200-0700 Hours	Daytime 0700-1800 Hours	Evening 1800-2200 Hours	Night-time 2200-0700 Hours
Bayview Towers, Pyrmont	61	59	55	63	61	59
Glebe Point, Glebe	53	52	46	57	56	53

An operator-attended (15 minute) noise surveys was conducted at the Bayview Towers apartments, on Tuesday 1 December 2011, in order to determine the character of the ambient noise levels. The results of the background noise surveys are presented in **Table 7** together with a description of the noise sources and the prevailing weather conditions at the time of measurement.

Table 7 Operator-attended Background Noise Survey Results

Location Start Time Conditions	Measurement Description	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels (L_{Amax})
		L_{Aeq}	L_{A1}	L_{A10}	L_{A50}	L_{A90}	
Ground Level Bayview Towers 11:45 hours Wind At 6 m : 2-3 m/s SE 6 okta	Ambient	64	69	67	64	62	Traffic 62-63 Truck Exhaust Brakes 68
		Ambient background noise environment influenced by Anzac Bridge Traffic					

4.4 Construction Noise Management Levels (NMLs)

Construction activities on site will be conducted during standard daytime working hours. Therefore based on the RBLs presented in **Table 6** and the OEH's recommended construction noise, the NML is 71 dBA for all residences adjacent to the site in Pyrmont and 63 dBA for those residences across Blackwattle Bay in Glebe, with a highly noise affected $L_{Aeq(15minute)}$ criterion of 75 dBA at both locations. For the commercial premises further to the east, an NML of 70 dBA applies (refer to **Table 6**) however it is noted the Bayview Towers Apartments are significantly closer than the commercial properties, hence the commercial properties will not be considered further.

4.5 Project Specific Operational Noise Criteria

With reference to **Section 3.3** and **Table 1**, **Table 6** and **Table 7**, the project specific operational intrusive and amenity noise emission criteria for residential receivers are given in **Table 8**. Note, as there is negligible existing industrial noise in the area, the amenity criteria is based on the INP's recommended "acceptable" L_{Aeq} noise levels.

Table 8 INP Project Specific Noise Assessment Criteria (dBA re 20 µPa)

	Project Specific Assessment Criteria					
	Intrusive $L_{Aeq(15minute)}$			Amenity $L_{Aeq(Period)}$		
	Day	Evening	Night	Day	Evening	Night
Bayview Towers, Pyrmont	66	64	60	60	50	45
Glebe Point, Glebe	58	57	51	60	50	45

The overall noise criterion for noise emissions from the site is generally the lower of the intrusive and amenity criteria. Note that the Intrusive criterion is applicable over any 15 minute period whereas the amenity level is applicable over the whole daytime, evening or night-time period, as appropriate.

"Modifying Factor" Adjustments

The INP guidelines provide a mechanism in the assessment process that accounts for characteristics of noise that have the potential to result in increased annoyance.

Where a noise contains certain characteristics, such as tonality, impulsiveness (e.g. riveting), intermittency, irregularity or dominant low frequency content, there is evidence to suggest that it can result in greater annoyance than other noise at the same level.

5 IMPACT ASSESSMENT

5.1 Noise Modelling

In order to determine the acoustical impact of the Project, a noise model was developed to incorporate the significant noise sources and the intervening terrain to the residences.

The noise model was prepared using the CONCAWE noise prediction algorithm, suitable for the assessment of construction plant and activities and has been selected for the construction and operational noise assessment.

The noise modelling takes into account source sound level emissions and locations, screening effects, receiver locations, ground topography and noise attenuation due to spherical spreading and atmospheric absorption.

Source and receiver (residence) locations, ground topography, and other cadastral data (e.g. property boundaries) were derived from aerial photographs, site surveys and information supplied by Crawford Architects.

5.2 Construction Phase

Based on the information provided by Crawford Architects and our understanding of the Project, the potential construction noise impacts are expected during the following stages:

- Demolition and site clearance
- Construction of buildings
- On water construction including piling

Equipment scenarios were developed for these scenarios based on the typical maximum Sound Power Levels (SWLs) of construction equipment presented in **Table 9**.

Table 9 Sound Power Levels of Construction Plant Items

Plant Item	L_{Amax}
Grader	110
Excavator	105
Dozer	115
Front end loader	111
Hand tools	100
Dump truck	108
Vibrating roller	114
Grid roller	105
Concrete truck	112
Concrete Pump	109
Small crane	110
Impact pilling rig	134

The sound power levels given in **Table 9** are maximum noise emission levels of plant that will or may be used on this project in typical operation. In order to apply the construction noise goals for the Project, it is necessary to convert these levels to equivalent $L_{Aeq(15minute)}$ noise emissions. From numerous field studies on large construction projects, the measured difference values between the L_{Amax} and $L_{Aeq(15minute)}$ noise levels have been found to be up to 10 dBA depending on the mixture of the plant, intensity of operation and location of the plant relative to the receiver.

In the present study, where the equipment is generally confined to the project area and the receivers are relatively close, adjustments of 2 dBA to 5 dBA have been applied to convert the L_{Amax} noise levels shown in **Table 9** to $L_{Aeq(15minute)}$ noise levels for comparison with the construction noise management levels.

Note, the sound power levels given in **Table 9** do not take into account any noise mitigation strategies or treatment.

The predicted contribution noise levels at the respective receiver locations (**Figure 5**) together with the associated construction noise management levels are presented in **Table 10**.

Table 10 Construction Noise Level Prediction

Receiver Location	Construction Noise Level $L_{Aeq(15minute)}$			Noise Management Level Noise Affected / Highly Noise Affected
	Earthworks	Concreting	Piling	
53 Leichhardt Road, Glebe	52 dBA	44 dBA	70 dBA	63 dBA / 75 dBA
Bayview Towers, Pyrmont (Floors 1 to 7)	61 dBA to 69 dBA	58 dBA to 64 dBA	73 dBA to 75 dBA	71 dBA / 75 dBA
Bowman Street, Pyrmont (Floors 1 to 14)	48 dBA to 62 dBA	46 dBA to 57 dBA	69 dBA to 78 dBA	71 dBA / 75 dBA
Glebe Point, Glebe	43 dBA	35 dBA	60 dBA	63 dBA / 75 dBA
New Bovis Residential, Pyrmont	52 dBA to 65 dBA	48 dBA to 62 dBA	74 dBA to 76 dBA	71 dBA / to 75 dBA

Review of the results presented in **Table 10** indicates that the predicted earthwork noise levels comply with the OEH's recommended "noise affected" criterion, at all the nominated receiver locations, throughout the height of the respective buildings, except during piling operations, conducted in the middle of the pontoon, where there is a potential moderate (3 dBA) exceedance of the highly noise affected criterion on the upper floors (first floor and above) of the Bowen Street, Pyrmont receivers and a potential negligible (<1 dBA) exceedance of the highly noise affected criterion on Floors 3 and 4 only of the New Bovis Residential, Pyrmont receivers.

5.3 Operational Phase

Again, based on the information presented by Crawford Architects and our understanding of the Project, the potential operational impacts were modelled.

Operational "worst case" scenarios were developed in the noise model based on the L_{Aeq} Sound Power Levels (SWLs) of the major noise emitting equipment items/operations presented in **Table 11**, adjusted for the duration of the respective operations where appropriate.

Table 11 Sound Power Levels of Major Noise Emitting Operational Items

Plant Item	LAeq	Operational Duration	Adjusted LAeq(15minute)
Angle grinder	113 dBA	5 mins per 15 minute period	106 dBA
Riveting	135 dBA	10 seconds per 15 minute period	115 dBA
Forklift	88 dBA	N/A	88 dBA
Workshop (reverberant level)	80 dBA	N/A	80 dBA

Note: The above SWLs were measured at the existing SMF operations at Rozelle Bay.

The SWLs given in **Table 11** are the basis of typically "worst case" scenarios in relation to the operations of the subject Project.

Based on the typical worst case operational scenarios, **Table 12** presents the predicted operational noise levels at the respective receiver locations together with the "controlling" operational intrusive noise criteria (refer to **Section 3.3** and **Table 6** to **Table 8**).

Included in the predicted operational noise levels for riveting is an additional 5 dBA penalty for "intermittent" noise (refer to **Section 4.5**).

Table 12 Operational Noise Level Predictions

Receiver Location	Operational Noise Levels (LAeq(15minute))		Operational Noise Criteria (LAeq(15minute))
	Riveting/Workshop	Forklift/Angle/Grinder/Workshop	
53 Leichhardt Road, Glebe	61 dBA	50 dBA	58 dBA
Bayview Towers, Pyrmont (Floors 1 to 7)	67 dBA to 68 dBA	51 dBA to 55 dBA	66 dBA
Bowman Street, Pyrmont (Floors 1 to 14)	64 dBA to 72 dBA	50 dBA to 60 dBA	66 dBA
Glebe Point Road, Glebe	51 dBA	40 dBA	58 dBA
New Bovis Residential, Pyrmont	66 dBA to 69 dBA	52 dBA to 57 dBA	66 dBA

Review of the results presented in **Table 12** indicates that the predicted operational noise levels comply with the OEH's recommended intrusive noise criteria at all the nominated receiver locations, throughout the height of the respective buildings, during the workshop operations, including the use of the forklift and angle grinder.

The operational intrusive noise criteria are also met during the combined riveting and workshop operations at the nominated receiver locations at 53 Leichhardt Road, Glebe as well as at the Glebe Point Road, Glebe receiver location and the ground floors of the Bowman Street and New Bovis Residential locations in Pyrmont. However, marginal exceedances of the intrusive noise criteria of 1 dBA to 2 dBA are predicted at the Bayview Towers, Pyrmont location as well as at floors 2 and above at the New Bovis Residential locations in Pyrmont.

Moderate (5 dBA to 6 dBA) exceedances are predicted at floors 2 and above at the Bowman Street, Pyrmont location.

5.4 Mitigation and Monitoring

5.4.1 Construction Phase

Noise and vibration mitigation and monitoring requirements during the construction works will be detailed in the Construction Noise Management Plan.

Construction Noise Management Plan

Upon the granting of approval for the subject project a Construction Noise Management Plan (CNMP) will be prepared in relation to the demolition and construction phases of the works, as required by the Director-General.

This CNMP will include, but not be limited to the following, with regard to the City of Sydney's Code of Practice for Construction Hours/Noise, 1992 (Code of Practice) and including an assessment of the noise impact from any highly intrusive equipment (Category A appliances) to be employed as identified in Schedule 1 of the Code of Practice:

- Noise and Vibration Guidelines and Criteria
  - Construction Noise Guideline
  - Vibration Damage Criteria - Surface Structures
- Existing Background Noise Environment, Airborne Noise Goals and Recommended Noise and Vibration Criteria
  - Introduction
  - Ambient Noise Surveys
  - Airborne Noise Goals for Residential Receivers
  - Summary of Recommended Noise and Vibration Criteria
- Noise and Vibration Intensive Works
  - Airborne Construction Noise
  - Vibration Compliance
  - Vibration Damage
  - Typical Sound Pressure Levels
  - Safe Working Distances for Vibration Intensive Activities
- Noise and Vibration Monitoring
  - Noise Monitoring
  - Vibration Monitoring
  - Site Validation Vibration versus Safe Distance Criteria
  - Supplementary Noise and Vibration Monitoring
- Noise Mitigation Measures
  - Noise Control
- Vibration Mitigation Measures
- Summary of Mitigation Measures
- Identifying and Managing Future Noise and Vibration Issues
- Reporting
- Non Compliance and Corrective Action
- Complaint Handling
- Community Consultation and Liaison

5.4.2 Operational Phase

Exceedances of up to 6 dBA at the Bowman Street Apartments have been identified during the riveting of steel plates to the hull of the vessel.

Two options for the mitigation of riveting are considered as follows:

- Enclosure
  During the on site measurements of the existing operations on Rozelle Bay measurements were conducted with the riveting operation contained in a purpose build enclosure that was located adjacent to the hull. A reduction of 3 dBA in the radiated noise was achieved, the reduction being limited by the radiation of noise from the hull, rather than at the point of impact. An exceedance of 3 dBA remains following this measure.
- Vessel Orientation
  The vessel is located on a floating barge, and the vessel hull can be utilised to the shield potentially affected receivers from the riveting operation. In this instance riveting can be conducted on the southern (or floating pontoon) side of the vessel, thus shielding the most affected residences on Bowman Street from the operation. When riveting is required on the other (northern) side of the vessel, the vessel floating pontoon can be rotated to enable the continuation of riveting on the southern side. The estimated reduction in noise as a result of the shielding by the hull is estimated to be 6 dBA to 8 dBA, thus enabling compliance with the criterion at the Bowman Street Apartments.

In addition to the above measures it is recommended the hours during which riveting be conducted be restricted to 8 am to 4 pm with no riveting between midday and 2 pm.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

SLR Consulting has been commissioned by Crawford Architects, on behalf of Sydney Maritime Museum Ltd, to provide environmental assessment reports to support a Development Application for the Sydney Heritage Fleet, Bank Street, Pyrmont.

The Noise Impact Assessment examines the existing environmental conditions at the proposed Project Site by reference to ambient noise monitoring data. The potential sources of noise emissions associated with the construction and operational phases of the development have been identified, and assessed against the relevant guidelines and standards.

In accordance with the NSW OEH's INP requirements, the intrusive and the amenity noise criteria were established (based on the ambient measurements conducted by SLR Consulting as well as other consultants).

Noise emissions modelling was undertaken using computer noise prediction software, based on the CONCAWE industrial noise algorithm. The results of the study are summarised as follows:

- Construction noise levels as a result of the proposal have been assessed against the NSW OEH's Interim Construction Noise Guideline. Compliance is expected at all residences, except during piling activities.
- Operational activities associated with the facility include workshop noise and ship repair and restoration works. Compliance is expected during all activities except riveting when an exceedance of up to 6 dBA is predicted in the absence of additional noise mitigation measures. Implementation of the additional noise mitigation measures identified in **Section 5.4.2** would result in noise compliance at all surrounding residential receivers.

No vibration impacts are expected as a result of the project. Furthermore no significant traffic noise impacts are expected as a result of the project.

6.2 Recommendations

Construction Noise

A construction noise management plan is to be prepared in relation to the demolition and construction works.

Operational Noise

To enable compliance with the operational noise criteria mitigation measures are recommended to reduce noise emissions during the hull riveting operations. These include ensuring riveting occurs on the southern side of the vessel, with vessel rotation on the floating pontoon as required. In addition consideration should be given to restricting the hours of riveting to between 8 am to 4 pm with no riveting between midday and 2 pm.

7 LIMITATIONS

The following information will assist in understanding the uncertainties relating to the interpretation of the data obtained during this investigation and the recommendations presented in the report, and help with assessment and interpretation of the report.

The services undertaken consist of a quantitative assessment of identified potential sources of noise emissions associated with the construction and operational phases of the development.

SLR Consulting assumes no responsibility for the quality or accuracy of data obtained from external sources, or for occurrences outside the scope of works defined in this report.

All work conducted and reports produced by SLR Consulting are prepared for a particular Client's objective and are based on a specific scope, conditions and limitations, as agreed upon between SLR Consulting Australia and the Client. Information and/or report(s) prepared by SLR Consulting may therefore not be suitable for any use other than the intended objective.

Before passing on to a third party any information and/or report(s) prepared by SLR Consulting, the Client is to inform fully the third party of the objective and scope, and all limitations and conditions, including any other relevant information which applies to the information and/or report(s) prepared by SLR Consulting.

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Investigations are conducted in a conscientious and professional manner. The nature of the task, however, and the likely disproportion between any damage or loss which might arise from the work and any report prepared as a result and the cost of our services is such that SLR Consulting cannot guarantee that all issues of concern have been identified.

Thus while SLR Consulting carries out the work to the best of our ability, SLR Consulting totally excludes any loss or damages which may arise from services provided to the client or any other parties.

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8 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Sydney Maritime Museum Ltd. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR Consulting.

SLR Consulting disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

9 REFERENCES

- AS 1055.1 1997, *Acoustics - Description and Measurement of Environmental Noise - General Procedures*. Standards Australia.
- AS 2107, 2000, *Acoustics – Recommended design sound levels and reverberation times for building interiors*. Standards Australia.
- AS 2187, Part 2, 2006, *Explosives - Storage and Use - Part 2: Use of Explosives*. Standards Australia.
- AS 2436, 2010, *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*. Standards Australia.
- AS/NZS 1269, *Occupational Noise Management Series - Parts 0 to 4*. Standards Australia.
- BS 5228 Part 2, *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 2*. The British Standards Institution.
- BS 7385 Part 2, 1993, *Evaluation and Measurement for Vibration in Buildings Part 2*. The British Standards Institution.
- Commonwealth of Australia, 2004, *National Standard for Occupational Noise* [NOHSC:1007(2000)].
- DEC, 2006, *Assessing Vibration - a technical guideline*. Department of Environment and Conservation NSW.
- DECCW, 2011, *NSW Road Noise Policy*. Department of Environment, Climate Change and Water NSW.
- DECC, 2009, *Interim Construction Noise Guideline*. Department of Environment and Climate Change NSW.
- City of Sydney, 1992, *Construction Hours/Noise within the Central Business District*. City of Sydney Code of Practice.
- EPA, 2000, *NSW Industrial Noise Policy*. Environment Protection Authority.
- OEH, 2011, *Application notes - NSW Industrial Noise Policy* (*http://www.environment.nsw.gov.au/noise/applicnotesindustnoise.htm*). Office of Environment and Heritage.

Typical Noise Indices

This Report makes repeated reference to certain noise level descriptors, in particular the L_{A10}, L_{A90} and L_{Aeq} and L_{Amax} noise levels.

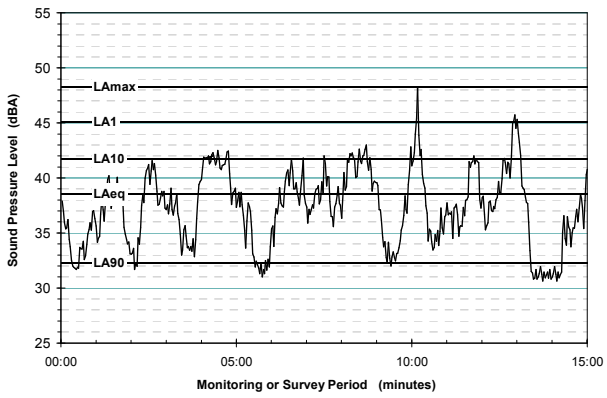
The L_{A10} is the A-weighted sound pressure level exceeded 10% of a given measurement period and is utilised normally to characterise typical maximum noise levels.

The L_{Aeq} is essentially the average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound over the same measurement period. The $L_{Aeq(15hour)}$ is the measurement parameter used to describe the road traffic noise level over the entire daytime (7.00 am to 10.00 pm) period. The $L_{Aeq(9hour)}$ is the measurement parameter used to describe the road traffic noise level over the entire night-time (10.00 pm to 7.00 am) period. Similarly, the $L_{Aeq(1hour)}$ is the measurement parameter used to describe the road traffic noise level during the loudest 1-hour period during the daytime or night-time periods.

The L_{A90} noise level is the A-weighted sound pressure level exceeded 90% of a given measurement period and is representative of the average minimum background sound level (in the absence of the source under consideration), or simply the "background" level.

The L_{Amax} noise level is the maximum A-weighted noise level associated with road traffic movements.

Graphical Display of Typical Noise Indices



Typical Noise Levels

The following table presents examples of typical noise levels.

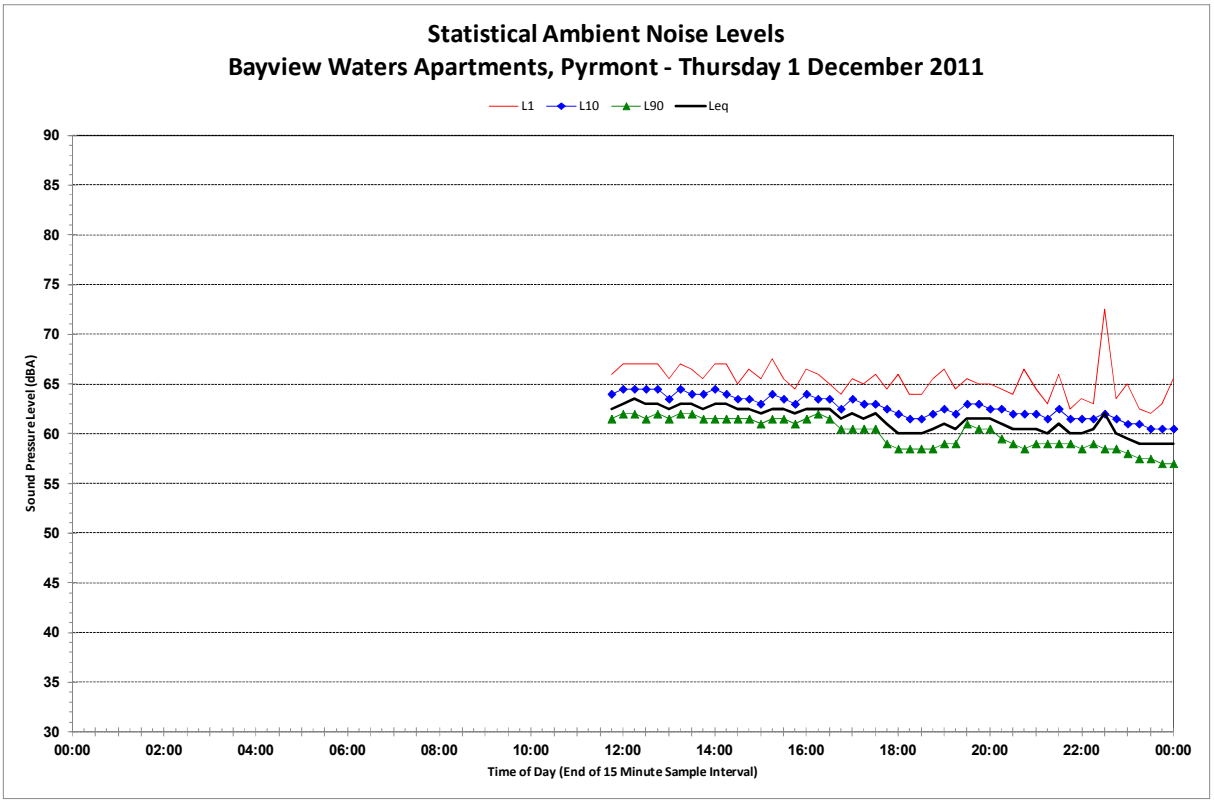
Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerb side of busy street	Loud
70	Loud radio or television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

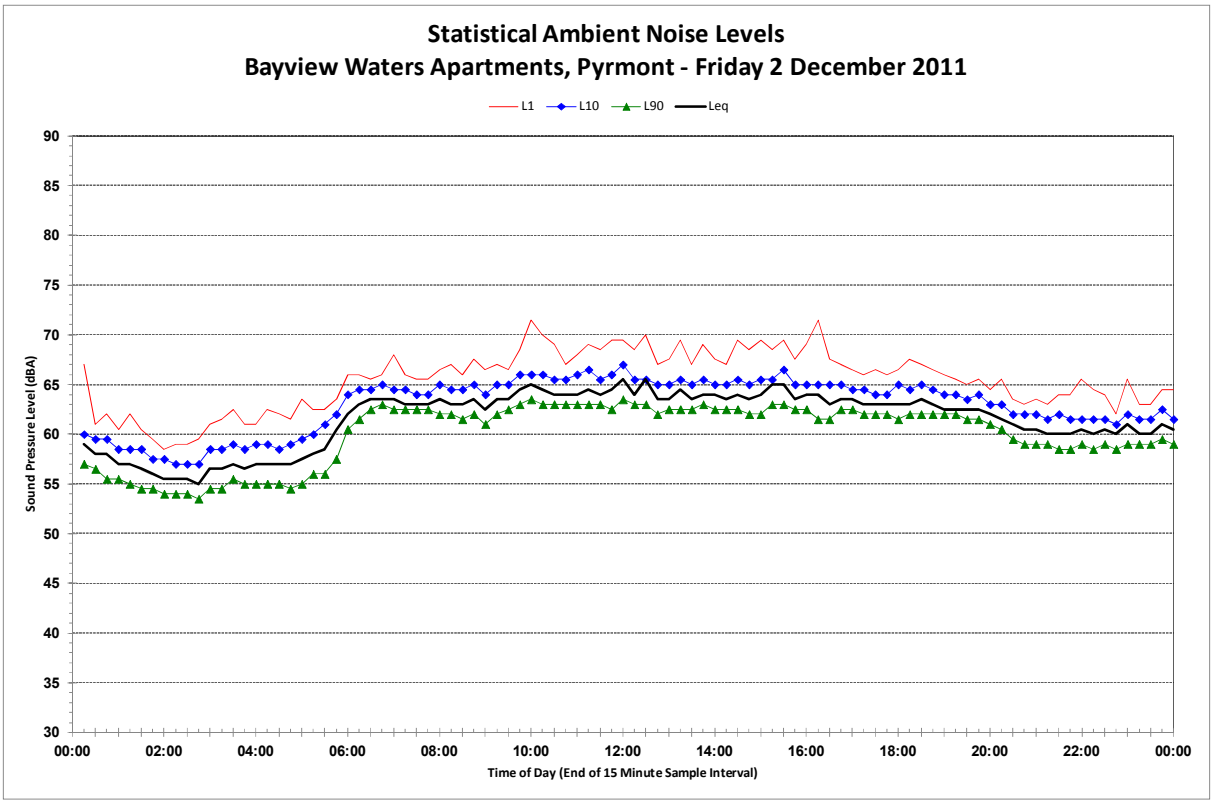
A-Weighting or dBA Noise Levels

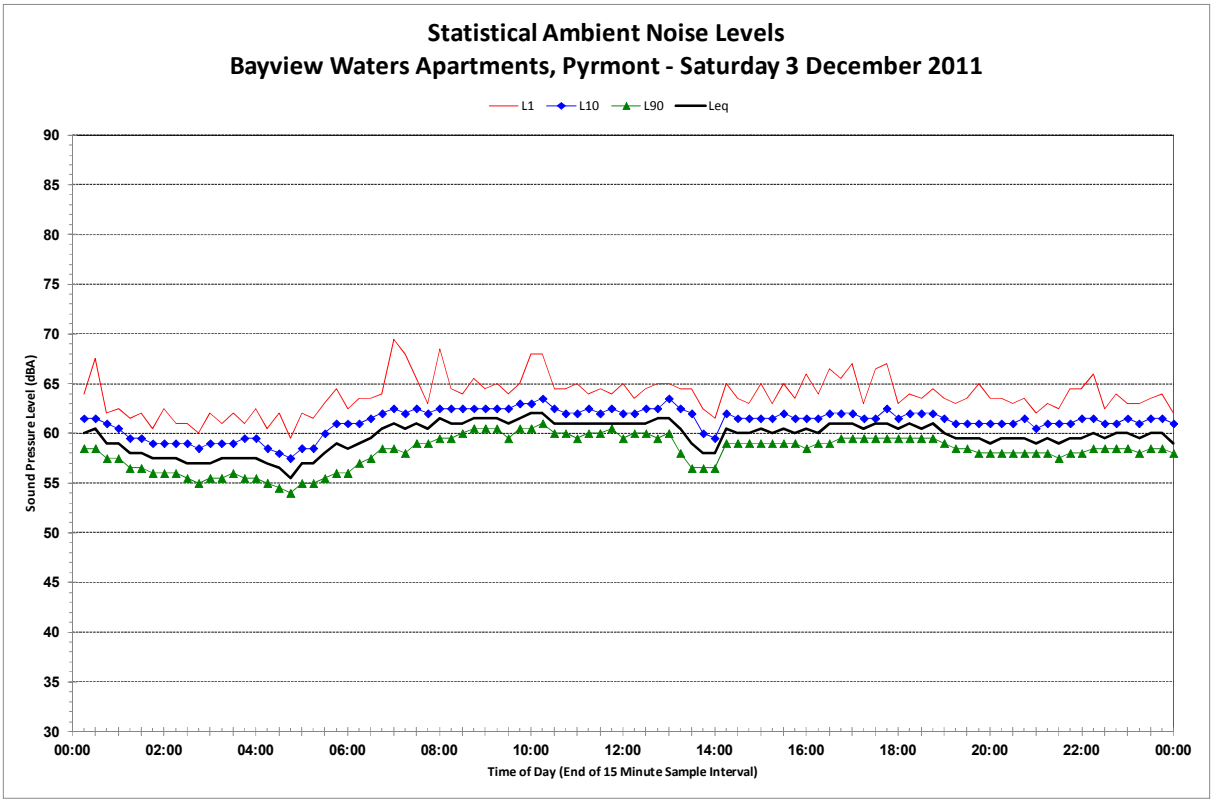
The overall level of a sound is usually expressed in terms of dBA, which is measured using the "A-weighting" filter incorporated in sound level meters. These filters have a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the "loudness" of that sound. Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (e.g. the loudness of human speech and a distant motorbike may be perceived differently, although they are of the same dBA level).

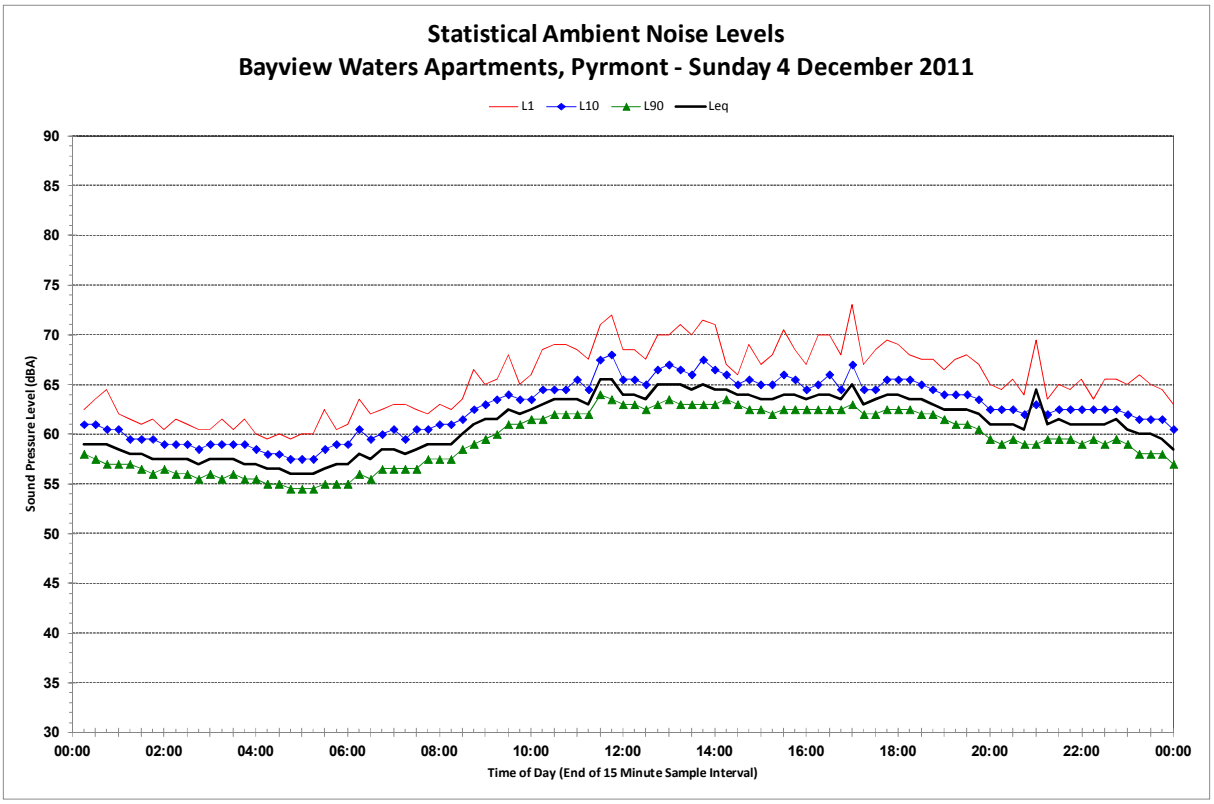
Sensitivity of People to Noise Level Changes

A change of up to 3 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness.


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Thursday 1 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Friday 2 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Saturday 3 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Sunday 4 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
00:00
02:00
04:00
06:00
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14:00
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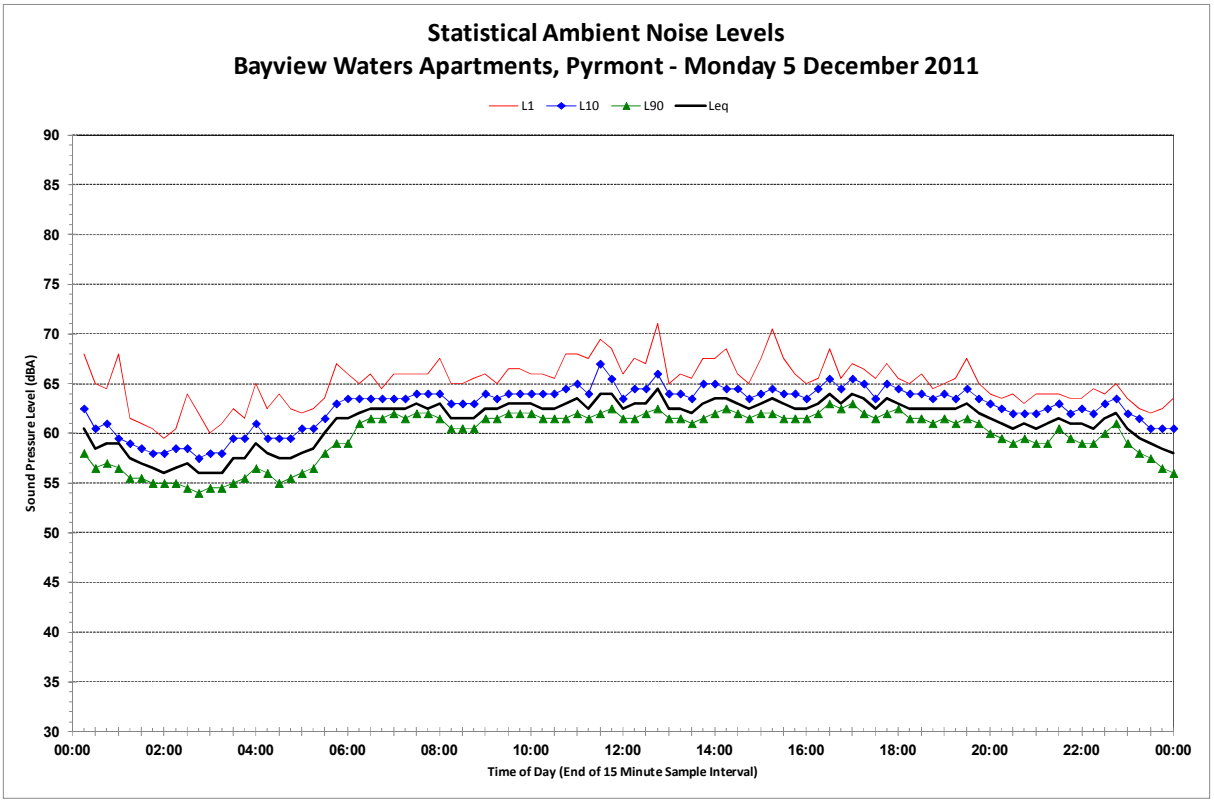
18:00
20:00
22:00
00:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Monday 5 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
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04:00
06:00
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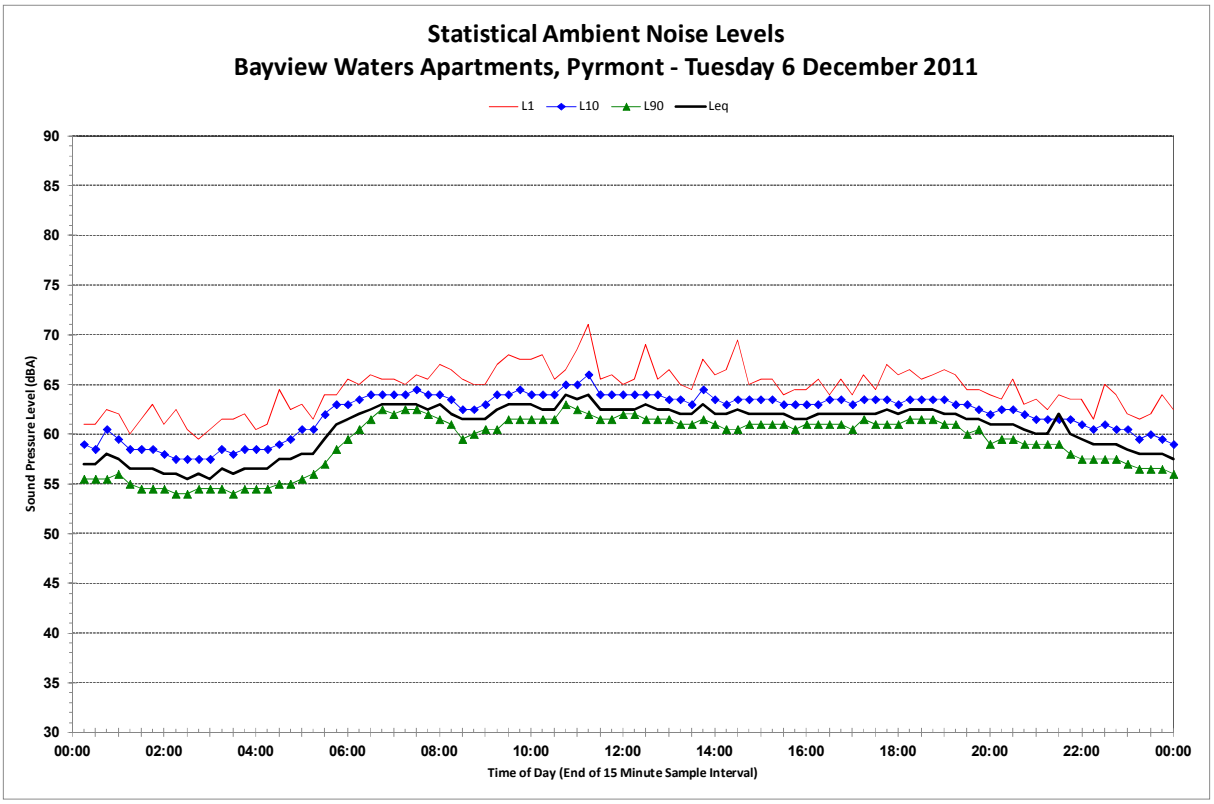
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Tuesday 6 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
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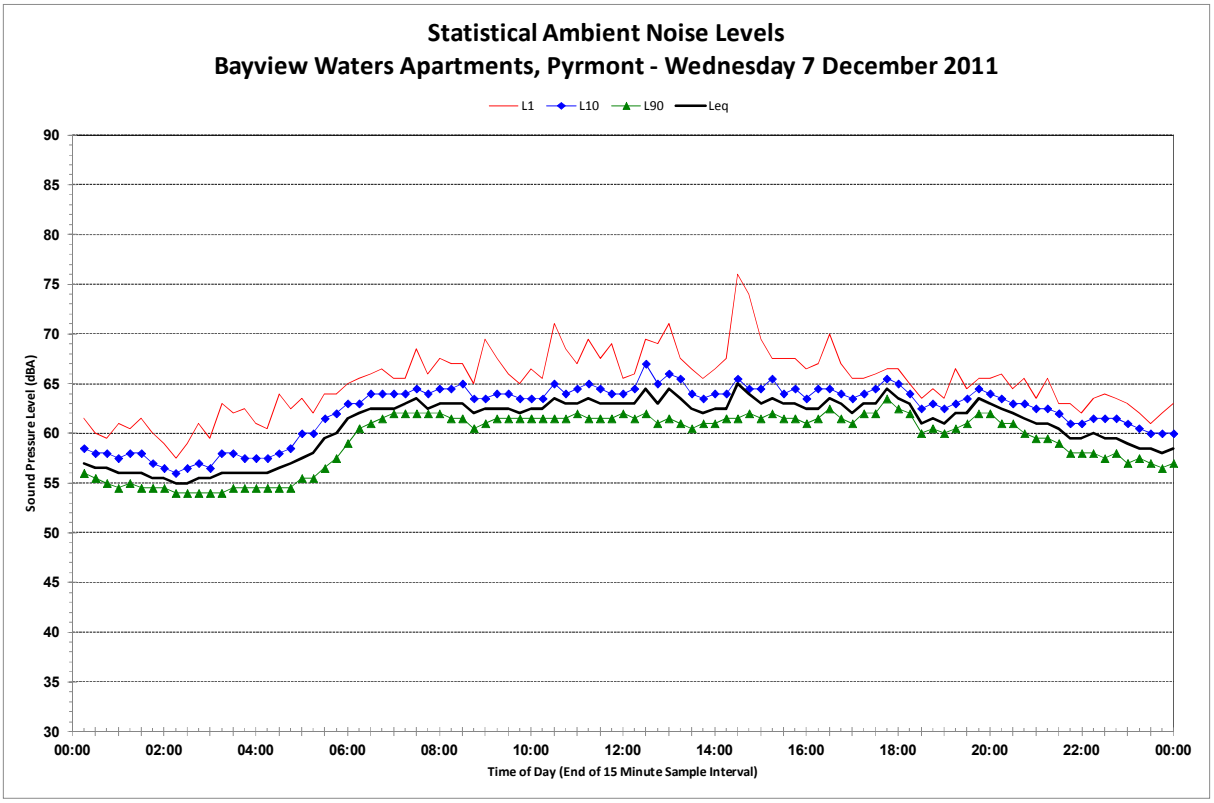
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Wednesday 7 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
00:00
02:00
04:00
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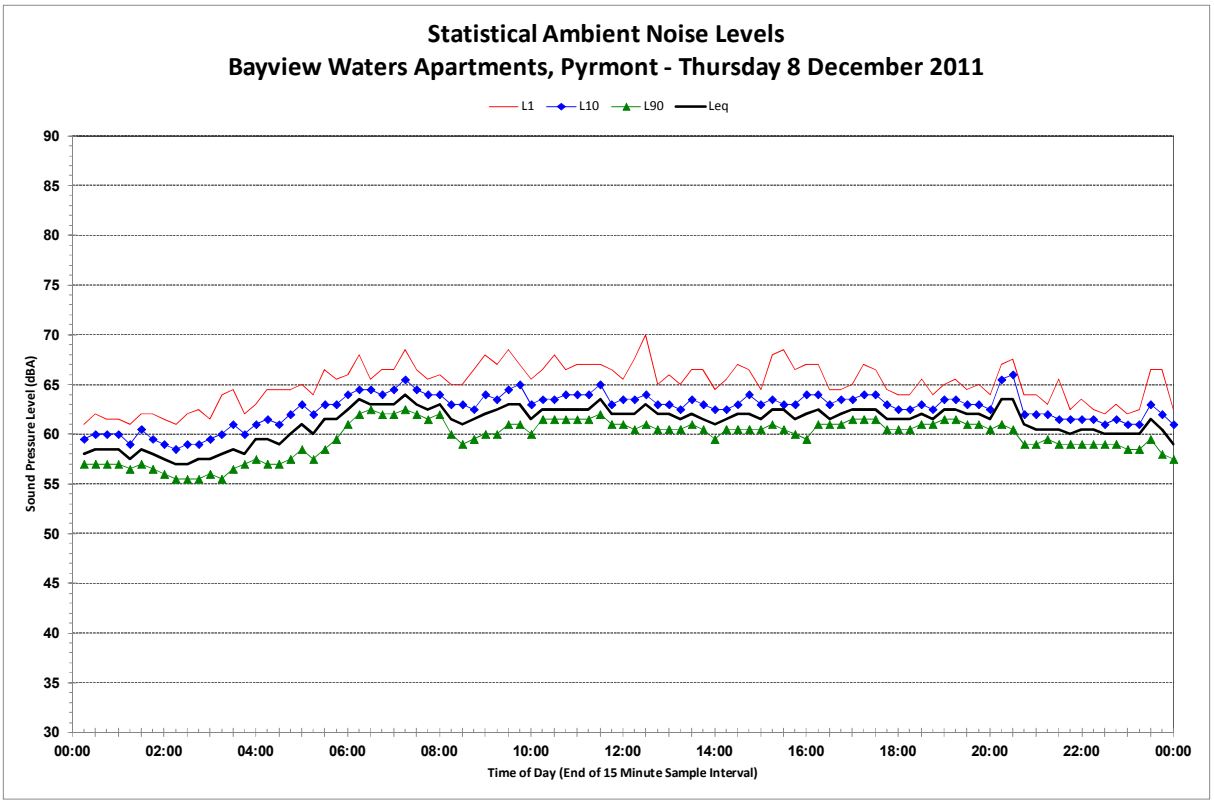
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Bayview Waters Apartments, Pyrmont - Thursday 8 December 2011
L1
L10
L90
Leq
Sound Pressure Level (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
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04:00
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08:00
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12:00
14:00
16:00
18:00
20:00
22:00
00:00
Time of Day (End of 15 Minute Sample Interval)

STATISTICAL AMBIENT NOISE LEVELS