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Construction Noise & Vibration Management Plan

Reconstruction of the Station Beach Boat House Palm Beach
1191 Barrenjoey Road, Palm Beach, NSW

REPORT No
6953-3.1R

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Prepared For:
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1.0 EXECUTIVE SUMMARY

Station Beach Boat House Palm Beach (*SBBHPB*) has recently received an *'Environmental Health Referral Response'*, dated 24 June 2021, from Northern Beaches Council relating to Development Application DA2021/0669, for the reconstruction of the existing *SBBHPB* at 1191 Barrenjoey Road, Palm Beach, NSW.

SBBHPB is located on the western side of Governor Phillip Park on Station Beach looking over Pittwater. *SBBHPB* currently operates as a café (The Boat House), boat hire venue and seaplane dock.

The *SBBHPB* is bounded by Governor Phillip Park to the north, east and south and Pittwater to the west. Dunes Palm Beach (café) is located circa 450 meters to the south-south-east and Palm Beach Golf Club is located adjacent to the south of the site. The nearest residential receivers to the site are located circa 600 metres to the north on Barrenjoey Road, circa 600 metres to the south on Beach Road and circa 2.15 kilometres to the west-south-west on Great Mackerel Beach. The site and surrounds are shown on Figure 1.

It is proposed to reconstruct the existing *SBBHPB* to accommodate its use as a function venue on Fridays and Saturdays through the daylight savings months of October to March, only, and construct a new ancillary building which will include amenities, bin room, cool room, freezer room and store rooms. No major works are proposed the general layout or building façade of The Boat House.

The construction will include the demolition of existing structures (where required), excavation of the site and the construction of the new *SBBHPB*. The proposed hours for construction are during the following standard working hours:

- 7.00 am to 6.00 pm Monday to Friday;
- 8.00 am to 1.00 pm Saturday; and
- No work on Sunday or Public Holiday.

As part of the *'Environmental Health Referral Response'* issued by the Northern Beaches Council, attached as Appendix A, the Deferred Commencement Condition requires the preparation and submission (to Northern Beaches Council) of an *Environmental Management Plan* which is to include an assessment of the potential noise and vibration emissions associated with construction activities on the site at nearby receiver locations.

This construction noise and vibration management plan has been prepared in accordance with the Australian Standard AS2436:2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"*. Construction noise and vibration management levels have been derived from the Environment Protection Authority's *Interim Construction Noise Guideline 2009* and *Assessing Vibration: a technical guideline 2006* and are used for a quantitative assessment at the nearest affected residential, commercial and active recreation receiver locations.

The major noise sources associated with the project are mobile plant and machinery to be used during the demolition, excavation and construction, including concrete breaking (where required), and the transport of raw materials to and from site in trucks.

There is potential, at least on some occasions, for noise emission from construction works to exceed the noise management level at some receivers during various stages of the works.

All feasible and reasonable methods to reduce noise emissions and minimise the noise impact on neighbouring properties have been provided in Section 6 of this report. These include, limiting construction activity to within the prescribed hours, selecting quiet equipment, incorporating periods of respite, maintaining community consultation relations, managing noise complaints and conducting ground-borne vibration monitoring (if necessary).

Provided the recommendations in Section 6 of this report are implemented and adhered to, the level of noise and vibration from the construction works will be minimised in accordance with Australian Standard AS2436:2010 and the NSW Environment Protection Authority's *Interim Construction Noise Guideline 2009* and *Assessing Vibration: a technical guideline 2006*.

2.0 CONSULTING BRIEF

Day Design Pty Ltd has been engaged by Blue Pacific Constructions on behalf of Station Beach Boat House Palm Beach to assess the environmental noise impact of the construction of the proposed redevelopment of the Station Beach Boat House Palm Beach at 1191 Barrenjoey Road, Palm Beach, NSW.

This commission involves the following:

Scope of Work:

- Inspect the site and environs
- Review the background noise levels at critical locations and times provided in the previously submitted Environmental Noise Impact Assessment Report
- Establish acceptable noise level criterion
- Quantify noise emissions from the demolition, excavation and construction works
- Calculate the level of noise emission, taking into account distance attenuation
- Prepare a site plan identifying the development and nearby noise sensitive locations
- Provide recommendations for noise control (if necessary)
- Prepare a Construction Noise and Vibration Management Plan.

3.0 PROJECT DESCRIPTION

3.1 Site Description

The existing *SBBHPB* is located at 1191 Barrenjoey Road, Palm Beach, NSW, on land zoned *E2 Environmental Conservation*, under Pittwater Local Environment Plan (LEP) 2014.

The property is bounded by Governor Phillip Park to the north, east and south and Pittwater to the west. Dunes Palm Beach (café) is located circa 450 metres to the south-south-east and Palm Beach Golf Club is located adjacent to the south of the site. The nearest residential receivers to the site are located circa 600 metres to the north on Barrenjoey Road, circa 600 metres to the south on Beach Road and circa 2.15 kilometres to the west-south-west on Great Mackerel Beach.

The location of the proposed development and the surrounding premises, in various directions, are shown in Figure 1 and Figure 2, and summarised below in Table 1.

Table 1 Noise Sensitive Receptors

Receptor and Type	Address	Direction from site
R1 – Commercial	*Dunes Palm Beach*, 1193 Barrenjoey Road	South South East
R2 – Residential	1, 1A & 2 Waratah Road	South
R3 – Active Recreation	*Palm Beach Golf Club*, 2 Beach Road	South
R4 – Residential	1199 Barrenjoey Road *(Ku-ring-gai Chase National Park)*	North
R5 – Residential	1 Ross Smith Parade	West South West

NOTE: We have been advised that due to sea level rise the existing building level (RL) has increased from RL 2.3 to RL 2.8 (+ 500 mm). This will have no effect on potential noise emissions from the construction activities on the SBBHPB site.

Figure 1. Location Plan 1 – 1191 Barrenjoey Road, Palm Beach, NSW

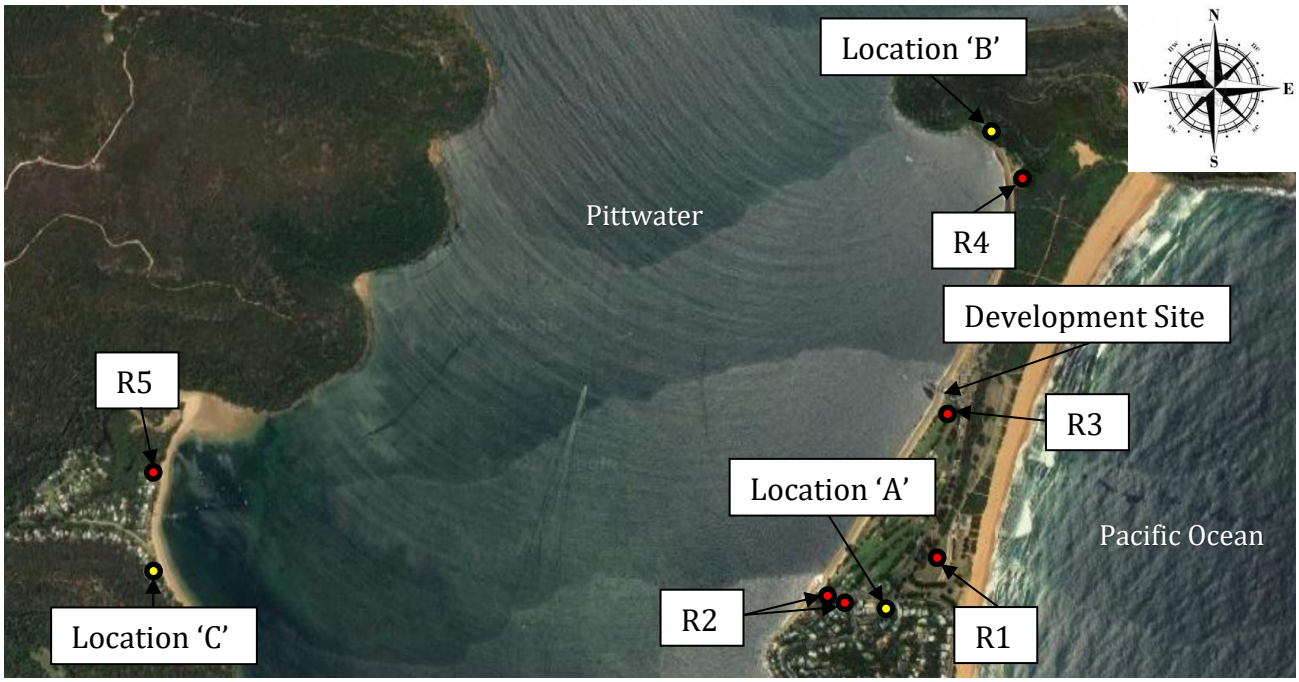

Figure 2. Location Plan 2 – 1191 Barrenjoey Road, Palm Beach, NSW

3.2 Development Description

The development will be constructed in three phases:

- Phase 1 – Demolition of majority of the existing buildings
    - Expected timeframe of 4 weeks
    - Activities include use of an excavator, hand tools, dump trucks and a rock breaker for concrete removal (approximately 4 days), as required.
- Phase 2 – Excavation and earth moving
    - Expected timeframe of 6 weeks
    - Activities include use of excavator and dump trucks, sheet piling (approximately 3 days), pile bore and a rock breaker for concrete removal (approximately 1 day), as required.
- Phase 3 – Construction
    - Expected timeframe 44 weeks
    - Activities include use of cement trucks, cranes, gensets, and hand tools.

The proposed hours of construction works, including delivery of materials to and from the site, are during standard construction hours, as follows:

- 7.00 am to 6.00 pm Monday to Friday;
- 8.00 am to 1.00 pm Saturday; and
- No work on Sunday or Public Holiday.

4.0 NOISE CRITERIA

4.1 Ambient Noise Levels

In order to assess the severity of a possible environmental noise problem in a residential area it is necessary to measure the ambient background noise level at the times and locations of worst possible annoyance. The lower the background noise level, the more perceptible the intrusive noise becomes and the more potentially annoying.

The ambient L_{90} background noise level is a statistical measure of the sound pressure level that is exceeded for 90% of the measuring period (typically 15 minutes).

The Rating Background Level (RBL) is defined by the NSW EPA as the median value of the (lower) tenth percentile of L_{90} ambient background noise levels for the day, evening or night time periods, measured over a number of days during the proposed days and times of operation.

Day Design Pty Ltd prepared an Environmental Noise Impact Assessment (ENIA) report, Report Number 6953-1.1R Rev B, dated 5 February 2021, as part of the Development Application (*DA2021/0669*) documentation for the redevelopment of *SBBHPB*.

The ENIA established the daytime RBLs in Section 4.1 to be used to establish the noise criteria for all nearby residential receivers during the day, as follows:

Based on the measured background noise levels at Location 'A':

- **40 dBA** $L_{eq,\ 15\ minute}$ during the day.

Based on the measured background noise levels at Location 'B':

- **37 dBA** $L_{eq,\ 15\ minute}$ during the day.

Based on the measured background noise levels at Location 'C':

- **46 dBA** $L_{eq,\ 15\ minute}$ during the day.

4.2 Northern Beaches Council

SBBHPB received an *'Environmental Health Referral Response'*, dated 24 June 2021, from Northern Beaches Council relating to Development Application DA2021/0669. The Deferred Commencement Condition within the *'Environmental Health Referral Response'* requires the preparation and submission (to Northern Beaches Council) of an *Environmental Management Plan* which is to include an assessment of the potential noise and vibration emissions associated with construction activities on the site at nearby receiver locations, as follows:

'Environmental Management Plan

An Environmental Management Plan (EMP) shall be prepared for the approved development.

The plan shall be prepared by a suitably qualified person and shall be to the satisfaction of Council and shall address:

Risk assessment of all Environmental Aspects and impacts to site and other potentially impacted properties.

The impacts must at minimum consider the following areas:

- *Hazardous Substances*
- *Water*
- *Air*
- *Noise*
- *Vibration*
- *Waste & Litter*
- *Land*
- *Community*
- *Environmental Protection objectives and control strategies*
- *Environmental conditions using measurable indicators and standards*
- *Emergency Response Plan*
- *Environmental monitoring and reporting plan.*

Reason: To ensure the appropriate operation and management of the approved use.

4.3 Australian Standard AS2436

The Australian Standard AS2436:2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"* provides guidance on noise control in respect to construction, demolition and maintenance sites. The Standard also provides guidance for the preparation of noise and vibration management plans.

Section 1.5 'Regulatory Requirements' of the Standard states:

"Legislation associated with the control of noise and vibration on and from construction, demolition and maintenance sites in Australia is generally the responsibility of the relevant State or Territory government, local council or a designated statutory authority."

Consequently the Standard does not provide specific noise criterion rather sets out practical methods for determining the potential for noise and vibration impact on the community from construction, demolition and maintenance sites.

A qualitative method is described in Section 3.3 of the standard, which is designed to avoid the need for complex noise predictions by following a series of questions relating to, for example, whether the noise is likely to be loud, have annoying characteristics or affect sleep.

In the event that any of these outcomes are likely, a more detailed and quantitative approach should be adopted.

In relation to carrying out detailed noise impact assessments, Section 4 'General' of the standard states:

"Regulatory authorities may have relevant polices and/or guidelines for the control of noise and vibration on construction sites. These should also be referred to when developing noise and vibration management plans for such projects."

In NSW this is the NSW Environment Protection Authority's *Interim Construction Noise Guideline 2009* as outlined in Section 4.4.

The Standard further states, in Section 4.6.1, that if noisy processes cannot be avoided, then the amount of noise reaching the receiver should be minimised and goes on to provide advice and recommendations to reduce noise and vibration impacts as far as reasonably practicable.

This report has been prepared in accordance with the guidance provided in AS2436:2010.

4.4 EPA Construction Noise Guideline

The NSW Environment Protection Authority published the *Interim Construction Noise Guideline* in July 2009. While some noise from construction sites is inevitable, the aim of the Guideline is to protect the majority of residences and other sensitive land uses from noise pollution most of the time.

The Guideline presents two ways of assessing construction noise impacts; the quantitative method and the qualitative method.

The quantitative method is generally suited to longer term construction projects and involves predicting noise levels from the construction phase and comparing them with noise management levels given in the guideline.

The qualitative method for assessing construction noise is a simplified way to identify the cause of potential noise impacts and may be used for short-term works, such as repair and maintenance projects of short duration.

In this instance, the quantitative method is the most appropriate and has been used in this assessment. Details of the quantitative method are given in Section 4 of the Guideline.

The recommended standard construction hours are defined by the EPA as follows:

- 7.00 am to 6.00 pm Monday to Friday;
- 8.00 am to 1.00 pm Saturday; and
- No work on Sunday or Public Holiday.

Table 2 in Section 4 of the Guideline sets out noise management levels at affected residences and how they are to be applied during normal construction hours. The noise management level is derived from the rating background level (RBL) plus 10 dB in accordance with the Guideline. This level is considered to be the 'noise affected level' which represents the point above which there may be some community reaction to noise.

The 'highly noise affected' level of 75 dBA represents the point above which there may be strong community reaction to noise. This level is provided in the Guideline and is not based on the RBL. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected' noise management level.

Based on the RBLs at the sensitive residential receiver locations, 'R2', 'R4' and 'R5' ,in the daytime, the recommended noise management level during all aspects of the construction program are summarised in Table 2.

Table 2 $L_{Aeq,\ 15\ minute}$ Noise Management Levels from Construction Activities at 'R6'

Time of day	Noise Management Level	How to Apply
Recommended standard hours	***'R2'*** **50 dBA (40 + 10)**	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ noise level is greater than the noise affected level, the proponent should apply all feasible and reasonable* work practices 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.
	'R4' **47 dBA (37 + 10)**	
	'R5' **56 dBA (46 + 10)**	
	'R2', 'R4' & 'R5' **Highly noise affected 75 dBA**	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. 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); 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

*Section 6, 'work practices' of The *Interim Construction Noise Guideline*, states: *"there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts. This approach gives construction site managers and construction workers the greatest flexibility to manage noise"*.

Definitions of the terms feasible and reasonable are given in Section 1.4 of the Guideline.

Section 4.1.2 of the guideline sets out external noise management levels for the nearby affected active recreation areas. It states that *'management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. The proponent should consult with noise sensitive land use occupants likely to be affected by noise from the works to schedule the project's work hours to achieve a reasonable noise outcome.'*

The noise management levels for the nearby active recreation areas are as follows:

- 'R3' *Palm Beach Golf Club*: external $L_{Aeq,\ 15\ minute}$ 65 dBA.

Section 4.1.3 of the guideline sets out external noise management levels for the nearby affected commercial premises. It states *'the external noise levels should be assessed at the most-affected occupied point of the premises'*.

The noise management levels for the nearby commercial premises are as follows:

- 'R1' *Dunes Palm Beach:* external $L_{Aeq,\ 15\ minute}$ 70 dBA.

The proponent should assess construction noise levels for the project, and consult with occupants of commercial premises prior to lodging an application where required.

During construction, the proponent should regularly update the occupants of the commercial and active recreation premises regarding noise levels and hours of work.

4.5 EPA Vibration Guideline

The NSW EPA published the *Assessing Vibration: a technical guideline* in February 2006. This guideline is based on the British Standard BS6472:1992 *"Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)."*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. The guideline considers vibration from construction activities as Intermittent Vibration. Table 2.4 of the guideline sets out limits for Vibration Dose Values to assess intermittent vibration and is replicated below in Table 3 for residential and commercial receptor locations.

Table 3 Vibration Dose Values (VDV) from Construction Activities

Receptor Location	Daytime	
	Preferred value ($m/s^{1.75}$)	Maximum value ($m/s^{1.75}$)
All Residences	0.20	0.40
Office	0.40	0.80

The British Standard BS7385-2:1993 *"Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration"* provides guide values for transient vibration relating to cosmetic damage, replicated below in Table 4 for residential and commercial buildings.

Table 4 Transient Vibration Guide Values for Cosmetic Damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures - residential buildings and light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

In our opinion, an overall peak particle velocity of **15 mm/s** at the boundaries of residential buildings and commercial type buildings will comply with the recommended values in Table 4, and is an acceptable criterion for intermittent vibration to prevent cosmetic damage to the adjacent residential, community and commercial buildings.

Note: preferred and maximum vibration values for use in assessing human responses to vibration in active recreation areas are note provided in the above documents, therefore, no further consideration is given to the level of vibration at 'R3' in this report.

4.6 Project Noise Trigger Levels

In our opinion, the most relevant noise and vibration management levels for this development are those outlined in Sections 4.4 and 4.5 of this report, and summarised as follows:

4.6.1 Noise Management Levels

- Noise management level of **70 dBA** ($L_{eq,\ 15\ minute}$) for commercial receptor 'R1';
- Noise management level of **50 dBA** ($L_{eq,\ 15\ minute}$) for place of residential receptor 'R2';
- Noise management level of **65 dBA** ($L_{eq,\ 15\ minute}$) for active recreation area receptor 'R3';
- Noise management level of **47 dBA** ($L_{eq,\ 15\ minute}$) for residential receptor 'R4';
- Noise management level of **56 dBA** ($L_{eq,\ 15\ minute}$) for residential receptor 'R5'.

Note: all noise management levels above are external.

4.6.2 Vibration Management Levels

- A Vibration Dose Value (VDV) between **0.2 – 0.4 m/s$^{1.75}$** for human annoyance in residential buildings – 'R2', 'R4' and 'R5';
- A Vibration Dose Value (VDV) between **0.4 – 0.8 m/s$^{1.75}$** for human annoyance in commercial receptor 'R1';
- A Peak Particle Velocity no greater than **15 mm/s** for cosmetic damage at the boundaries of residential buildings and commercial type buildings – 'R1', 'R2', 'R4' and 'R5'.

5.0 NOISE EMISSION

The main sources of noise on the site during the three phases of demolition, excavation and construction will be from heavy machinery such as excavators, dump trucks, cranes, cement mixers, rock breakers, etc.

Unless otherwise noted, the predicted noise levels in the following Sections assume that all equipment and plant listed are operating at the same time within the same general area along the nearest or furthest boundaries. This constitutes a worst-case scenario, however, due to the nature of the works, it is more likely that equipment will be dispersed over a wider area of the construction site and will not be continuously operating simultaneously. Typically, therefore, lower average levels can be expected.

A schedule of the sound power levels for the main demolition, excavation and construction equipment was extracted from the Day Design database of Sound Power Levels and the Australian Standard AS2436:1981 *"Guide to Noise Control on Construction, Maintenance and Demolition Sites".*

Knowing the sound power level of a noise source, the sound pressure level (as measured with a sound level meter) can be calculated at a remote location using suitable formulae to account for distance losses, barrier effects, etc.

Calculations consider distance attenuation only and the range of levels are based on the closest potential distance and furthest potential distance at which each item of plant may operate from each respective receptor location. The calculated noise levels at nearby receptors are presented in Tables 6, 8, 10 and 11.

5.1 Phase 1 – Demolition Works

The demolition of the existing buildings/structures is estimated to take 4 weeks and will involve the use of excavators, rock hammers to break concrete, hand tools and regular truck movements transporting waste materials from the site. The equipment likely to be used and their corresponding sound power levels are presented below in Table 5.

Table 5 Typical Demolition Plant and Equipment - Sound Power Levels

Description	Sound Power Level, dBA
Excavator – Hitachi 330	107
Truck	107
Hydraulic Rock Breaker	118
Hand Tools	102
Bobcat	106

(All sound power levels are based on previous noise measurements at various sites)

Given the intensity of work involved with concrete breaking, it is unlikely that this activity will take place at the same time as any other activity. Therefore we have assessed the noise impact of the concrete breaking individually. The calculated noise levels at nearby receptors are presented in Table 6 as a worst case scenario.

Table 6 Calculated Receptor Sound Pressure Levels from Demolition Works

Receptor Location	Calculated Sound Pressure Levels (dBA)
R1 – 1193 Barrenjoey Rd	51 – 52
R2 – 1, 1A & 2 Waratah Rd	48 – 49
R3 – 2 Beach Rd	69 – 78
R4 – 1199 Barrenjoey Rd	48 – 49
R5 – 1 Ross Smith Pde	37 – 38
Concrete Breaking	
R1 – 1193 Barrenjoey Rd	57 – 58
R2 – 1, 1A & 2 Waratah Rd	54 – 55
R3 – 2 Beach Rd	75 – 84
R4 – 1199 Barrenjoey Rd	54 – 55
R5 – 1 Ross Smith Pde	43 – 44

5.2 Phase 2 – Excavation

The excavation is estimated to take 6 weeks and will involve the use of excavators, rock hammer, sheet pile, pile bores and regular truck movements transporting waste materials from the site. The equipment likely to be used and their corresponding sound power levels are presented below in Table 7.

Table 7 Typical Excavation Works Equipment – Sound Power Levels

Description	Sound Power Level, dBA
Excavator – Hitachi 330	107
Truck	107
Piling (Bored)	111
Piling (Impact Sheet)	127
Hydraulic Rock Breaker	118

Note: (All sound power levels are based on previous noise measurements at various sites)

Given the intensity of work involved with sheet piling, it is unlikely that this activity will take place at the same time as any other activity. Therefore we have assessed the noise impact of sheet piling individually. The calculated noise levels at nearby receptors are presented below in Table 8 as a worst case scenario.

Table 8 Calculated Receptor Sound Pressure Levels from Excavation Works

Receptor Location	Calculated Sound Pressure Levels (dBA)
R1 – 1193 Barrenjoey Rd	49 – 50
R2 – 1, 1A & 2 Waratah Rd	46 – 47
R3 – 2 Beach Rd	67 – 76
R4 – 1199 Barrenjoey Rd	46 – 47
R5 – 1 Ross Smith Pde	35 – 36
Piling (Impact Sheet)	
R1 – 1193 Barrenjoey Rd	66 – 67
R2 – 1, 1A & 2 Waratah Rd	63 – 64
R3 – 2 Beach Rd	84 – 93
R4 – 1199 Barrenjoey Rd	63 – 64
R5 – 1 Ross Smith Pde	52 – 53

5.3 Phase 3 – Construction

The construction of the *SBBHPB* is estimated to take 44 weeks and will involve the use of heavy vehicles and power tools. The equipment likely to be used and their corresponding sound power levels are presented below in Table 9.

Table 9 Typical Construction Equipment - Sound Power Levels

Description	Sound Power Level, dBA
Cement Truck	109
Crane	104
Hand Tools	102
Bobcat	106

Note: (All sound power levels are based on previous noise measurements at various sites)

During the construction phase, work will be more dispersed across the site as the scale of work, compared to the previous phase, is less intensive. The calculated noise levels at nearby receptors are presented below in Table 10 as a worst case scenario.

Table 10 Calculated Receptor Sound Pressure Levels from Construction Works

Receptor Location	Calculated Sound Pressure Levels (dBA)
R1 – 1193 Barrenjoey Rd	52 – 53
R2 – 1, 1A & 2 Waratah Rd	49 – 50
R3 – 2 Beach Rd	70 – 79
R4 – 1199 Barrenjoey Rd	49 – 50
R5 – 1 Ross Smith Pde	38 – 39

5.4 Noise Emission Summary

From the calculated noise levels in Sections 5.1 to 5.3, the levels of exceedance during the recommended standard hours are presented below in Table 11.

Table 11 Calculated $L_{eq\ 15\ minute}$ Noise Levels (Without Noise Controls)

Description	Calculated Noise Levels (dBA)				
	R1	R2	R3	R4	R5
Phase 1 – Demolition Works					
Demolition Works	51 – 52	48 – 49	69 – 78	48 – 49	37 – 38
Concrete Breaking	57 – 58	54 – 55	75 – 84	54 – 55	43 – 44
Noise Management Level	70	50	65	47	56
Exceedance	**Nil**	**Up to 5 dB**	**Up to 19 dB**	**Up to 8 dB**	**Nil**
Phase 2 – Excavation Works					
Excavation Works	49 – 50	46 – 47	67 – 76	46 – 47	35 – 36
Sheet Piling	66 – 67	63 – 64	84 – 93	63 – 64	52 – 53
Noise Management Level	70	50	65	47	56
Exceedance	**Nil**	**Up to 14 dB**	**Up to 28 dB**	**Up to 17 dB**	**Nil**
Phase 3 – Construction					
Construction Works	52 – 53	49 – 50	70 – 79	49 – 50	38 – 39
Noise Management Level	70	50	65	47	56
Exceedance	**Nil**	**Nil**	**Up to 14 dB**	**Up to 3 dB**	**Nil**

It can be seen from Table 11 above, that the predicted levels of noise from construction activities will at times be in excess of the noise management levels at receptor locations, 'R2', 'R3' and 'R4'.

It is noted that the highly noise affected level of 75 dBA is not predicted to be exceeded during any concrete breaking or sheet piling, where required, at the residential receivers 'R2', 'R4' and 'R5'.

To minimise the noise impact from the construction activities we recommend that the noise controls and the management sub-plan detailed in Section 6 of this report be implemented.

Concrete breaking and sheet piling (and pile boring) are not considered cumulatively, to include them in the cumulative noise predictions would potentially over-state the predicted impact. However, as a precaution, it is recommended in the noise management controls (Section 6.2) that during concrete breaking and sheet piling (and pile boring), they are conducted in the absence of any other plant operations to avoid a cumulative noise impact.

5.5 Vibration Emission

It is difficult to accurately predict levels of ground borne vibration at remote locations as there are many variables to consider including the surrounding terrain, strata, rock density, etc.

Previous measurements of ground borne vibration from concrete breaking and sheet piling (and pile boring) show that vibration levels can vary significantly at different distances and receptor locations. Given the distances from neighbouring developments to any potential concrete breaking and sheet piling (and pile boring) on site, if warranted (a substantiated complaint is received regarding vibration levels, cosmetic damage to a structure, etc), we recommend that compliance monitoring of ground borne vibration is carried out at the critical receptor, wherever these activities are required.

Recommendations are made in Section 6.4 of this report should complaints arise from nearby premises regarding vibration from the site.

6.0 NOISE CONTROL RECOMMENDATIONS

The predicted level of noise emission from the demolition, excavation and construction activities at the *SBBHPB*, 1191 Barrenjoey Road, Palm Beach, NSW is in excess of the noise management levels established in Section 4.6 of this report.

In order to minimise the noise impact from all demolition, excavation and construction activities, we recommend the following engineering and management noise controls be implemented.

6.1 Engineering and Practical Noise Controls

Australian Standard AS2436:2010, Appendix C, Table C3 provides the relative effectiveness of various forms of noise control that may be applicable and implemented on various construction sites and projects. Table C3 is replicated below in Table 12.

Table 12 Relative Effectiveness of Various Forms of Noise Control

Control by	Nominal Noise Reduction Possible, dB
Distance	Approximately 6 dB for each doubling of distance
Enclosure	Normally 5 dB to 25 dB maximum 50 dB
Silencing	Normally 5 dB to 10 dB maximum 20 dB

Distance

Where applicable, we recommend locating mechanical plant near the centre of the site such that it is as far as practically possible from the residences to the north and south.

Enclosure

Constructing acoustical enclosures around items of mobile plant is recommended where extended use for long periods of time is expected.

Silencing

Consideration should be given to any mobile plant already acoustically treated when assessing tenders. All plant and machinery should be selected with consideration to low noise options where practicable and available.

Care should be taken to ensure that not more than one item of plant is operating simultaneously within close proximity of any given residence as far as reasonably practicable, to minimise cumulative noise impacts.

6.2 Noise Management Controls

The following noise management controls are derived from, or are in accordance with recommendations given in Australian Standard AS2436:2010 and the EPA's *Interim Construction Noise Guideline*.

Periods of Respite

We recommend that noisy construction activities such as concrete breaking and sheet piling (and pile boring) or the like only operate for 2 to 3 hours at a time.

Ensure activities in any one location are staggered, for instance, if concrete breaking or sheet piling (and pile boring) are occurring, all other construction activities will cease in the same location so as to minimise cumulative noise impacts.

Work Practices

We recommend that workers and contractors be trained in work practices to minimise noise emission such as the following:

- Avoid dropping materials from a height.
- Avoid shouting and talking loudly outdoors.
- Avoid the use of radios outdoors that can be heard at the boundary of residences.
- Turn off equipment when not being used.
- Carry out work only within the proposed hours of operation (see Section 3.2).

Heavy Vehicles and Staff Vehicles

- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Locate site vehicle entrances away from residences where practicable.
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Staff parking areas should be located as far from residential receiver locations as practicable.
- No motor vehicles should access the site via, or park within residential areas prior to 7 am on any occasion, in order avoid sleep disturbance.

Community Relations

- A Community Liaison Officer (Project Manager or Site Manager) is to be appointed by the contractor prior to the commencement of any works.
- The Community Liaison Officer will approach all potentially affected residents prior to the commencement of any works as an initial introduction and provide his or her contact details.

- The Community Liaison Officer will explain the project, duration of works, potentially noisy periods as well as determine any particularly sensitive receivers or sensitive time periods and schedule works accordingly, as far as reasonably practical.
- A contact number will be provided for any residents to call with complaints or queries.

Once works commence, communication with the community should be maintained by the Community Liaison Officer. Communication should be maintained via a range of media including, for example, continued individual contact, letter box drops or a clearly visible notice board at the site office or on construction site boundaries.

Consultation and cooperation between the contractor and the neighbours and the removal of uncertainty and rumour can help to reduce adverse reaction to noise.

Managing a Noise Complaint

The Community Liaison Officer should receive and manage noise complaints.

All complaints should be treated promptly and with courtesy.

Should a justified noise complaint not be resolved, noise monitoring may be carried out at the affected receptor location and appropriate measures be taken to reduce the noise emission as far as reasonably practicable.

Where it is not practicable to stop the noise, or reduce the noise, a full explanation of the event taking place, the reason for the noise and times when it will stop should be given to the complainant.

The following guidelines are recommended in Section 6 of the *Interim Construction Noise Guideline* to manage a noise complaint:

- Provide a readily accessible contact point.
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night-time only if requested by the complainant to avoid further disturbance.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

6.3 Noise Monitoring

We recommend that noise emissions from the development be measured during the construction periods in the event that complaints arise from nearby residences, regarding noise.

The noise measurements should be carried out using an attended noise monitor at the location (or as close as practically possible) of the noise complaint. Noise level measurements should be carried out by an appropriately qualified acoustical consultant/engineer, using Type 1 (see AS1259) noise measuring equipment.

The measured noise level are to be compared against the Project Noise Trigger Levels shown in Section 4.6 of this report. The outcomes of the noise monitoring should be submitted to the relevant authority for review.

6.4 Vibration Monitoring

We recommend that the level of vibration be measured during any concrete breaking or sheet piling (and pile boring) in the event complaints arise from any nearby receivers/premises regarding vibration.

The vibration measurements can be carried out using either an attended or an unattended vibration monitor. An unattended vibration monitor should be fitted with an alarm in the form of a strobe light, siren or digital (mobile/computer) alert system to make the plant operator aware immediately when the vibration limit is exceeded. The vibration monitor should be set to trigger the alarm when the overall Peak Particle Velocity (PPV) exceeds **15 mm/s** at the nearest residential building and/or light commercial type buildings.

In the event that levels of ground-borne vibration exceed the recommended acceptable levels for cosmetic damage, vibration causing works should cease immediately and alternative methods, such as rock sawing, be considered.

6.5 Construction Disclaimer

Recommendations made in this report are intended to resolve acoustical problems only. We make no claims of expertise in other areas of building construction and therefore the recommended noise controls should be implements into the building design in consultation with other specialists to ensure they meet the structural, fire, thermal or other aspects of building construction.

We encourage clients to check with us before using materials or equipment that are alternative to those specified in our Acoustical Report.

7.0 CONCLUSION

Day Design Pty Ltd has been engaged by Blue Pacific Constructions on behalf of Station Beach Boat House Palm Beach to assess the environmental noise impact of the construction of the proposed redevelopment of the Station Beach Boat House Palm Beach at 1191 Barrenjoey Road, Palm Beach, NSW.

Provided the recommendations in Section 6 of this report are implemented, the level of noise and vibration from the construction works at the Station Beach Boat House Palm Beach at 1191 Barrenjoey Road, Palm Beach, NSW will be minimised as far as reasonably practical in accordance with the Australian Standard AS2436:2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"* and the EPA's *Interim Construction Noise Guideline 2009* and *Assessing Vibration: a technical guideline 2006*, as detailed in Section 4 of this report.

Additionally, the EPA's *'highly noise affected'* level of 75 dBA, as detailed in the *Interim Construction Noise Guideline 2009,* is not predicted to be exceeded at any residential receiver during any stage of the construction works.

Adam Shearer, BCT (Audio), MDesSc (Audio and Acoustics), MAAS
Senior Acoustical Consultant
for and on behalf of Day Design Pty Ltd

AAAC MEMBERSHIP

Day Design Pty Ltd is a member company of the Association of Australasian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

APPENDICES

Appendix A – *'Environmental Health Referral Response'*, DA2021/0669, dated 24 June 2021
Appendix B – Adam Shearer – *Curriculum Vitae*
AC108-1 to 4 – Glossary of Acoustical Terms

northern beaches council

Environmental Health Referral Response - contaminated lands

Application Number:	DA2021/0669

Date:	24/06/2021
Responsible Officer	Jordan Davies
Land to be developed (Address):	Lot 7005 DP 1117451 , 1193 Barrenjoey Road PALM BEACH NSW 2108 Lot 7002 DP 1117592 , 1193 Barrenjoey Road PALM BEACH NSW 2108 Lot 298 DP 721522 , 1191 Barrenjoey Road PALM BEACH NSW 2108

Reasons for referral

This application requires detailed consideration of Phase 1 and 2 contaminated land matters
And as such, Council's Environmental Investigations officers are required to consider the likely impacts.

Officer comments

The proposal is therefore supported.

Note: Should you have any concerns with the referral comments above, please discuss these with the Responsible Officer.

Recommended Environmental Investigations Conditions:

DEFERRED COMMENCEMENT CONDITIONS

Environmental Management Plan
An Environmental Management Plan (EMP) shall be prepared for the approved development.

The plan shall be prepared by a suitably qualified person and shall be to the satisfaction of Council and shall address:

Risk assessment of all Environmental Aspects and impacts to site and other potentially impacted properties

The impacts must at minimum consider the following areas:

- Hazardous Substances
- Water
- Air
- Noise

- Vibration
- Waste & Litter
- Land
- Community
- Environmental Protection objectives and control strategies
- Environmental conditions using measurable indicators and standards
- Emergency Response Plan
- Environmental monitoring and reporting plan

Reason: To ensure the appropriate operation and management of the approved use.

CONDITIONS WHICH MUST BE COMPLIED WITH PRIOR TO THE ISSUE OF THE OCCUPATION CERTIFICATE

Installation of Fuel Tanks
Certification shall be provided from a suitably qualified professional that the fuel tanks have been installed in accordance with Australian Standard 1940. A copy of the Workcover NSW Dangerous Goods License must be submitted.

Details demonstrating compliance are to be submitted to the Certifying Authority prior to the issue of a Interim / Final Occupation Certificate.

Reason: To ensure the proper installation of fuel tanks.

ON-GOING CONDITIONS THAT MUST BE COMPLIED WITH AT ALL TIMES

Fuel-Filling Area
The fuel filling area shall be operated in accordance with all relevant Codes and Manuals including the Australian Institute of Petroleum's Code of Practice for the Design, Installation Operation of Underground Petroleum storage systems (CP22-1994).

Reason: To provide for the correct disposal of liquid wastes.

Environmental Audit
Within 12 months after the submission the Notice of Commencement being forwarded to Council, the person entitled to act upon this development consent shall carry out a comprehensive Environmental Audit of the premises.

This audit shall be carried out in accordance with the appropriate standards at the company's expense by a duly qualified independent person or team. Further, the company shall, at its own expense, comply with any reasonable requests of Council in respect of the implementation of any measures arising from the approval, within such time as Council may agree. Further audits will be required every 12 months from the due date or such longer period as may be agreed by Council.

Reason: Protection of the Environment.

Washing of Vehicles
Washing of vehicles/boats/trucks/buses etc is to be conducted in a car wash bay, which is roofed and bunded to exclude rainwater. All wastewater from car washing is to be discharged to the sewer under a Trade Waste Agreement from Sydney Water. Alternative water management and disposal options may be possible where water is recycled, minimised or re-used on the site. Any such alternative option is to comply with all relevant Standards.

Note: The following Standards applied at the time of determination:

- Environment Protection Authority's Environment Protection Manual for Authorised Officers: Technical Section Small Business (Car Washing Waste)

- Environment Protection Authority's Environment Protection Manual for Authorised Officers - Technical Section Water (Bunding and Spill Management)

Reason: To ensure that wastewater is disposed of in a manner that is not harmful to the environment.

Tanker Delivery
Delivery tankers shall be parked wholly within the site during unloading. Tankers shall enter and exit the site in a forward direction and tankers shall only remain on-site during unloading operations. All tanker deliveries shall only be made during the approved hours of operation outside peak usage periods.

Reason: To protect the amenity of the surrounding neighbourhood.

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Curriculum Vitae

Adam Shearer

Adams Shearer is a Senior Acoustical Consultant at Day Design Pty Ltd. Adam has valuable knowledge and experience in the assessment of earthmoving machinery noise, environmental noise, architectural / building acoustics, mechanical services noise and transportation noise control.

Adam manages a wide variety of projects including the acoustical design of schools, child care centres, places of public worship, pubs and clubs, residential, commercial and industrial developments and mechanical services systems. He is competent in the measurement and assessment of noise, and in the design of noise control for such projects, which often require his reports to be submitted to regulatory authorities for approval. Adam also provides advice and evidence as an expert witness for matters listed in the NSW Land and Environment Court.

Adam regularly operates acoustical instrumentation including noise and vibration meters and analyses the data during the course of his work.

Qualifications:

Bachelor of Creative Technology (Audio),
JMC Academy;
Masters of Design Science (Audio & Acoustics),
University of Sydney (2009)

Membership:

Member – Australian Acoustical Society

Professional Experience:

August 2017 - Present
Senior Acoustical Consultant
Day Design Pty Ltd

December 2013 – August 2017
Acoustical Consultant
Day Design Pty Ltd

A short overview of the nature of **Mr Shearer's professional experience** is provided below:

Schools and Child Care Centres:	Schools located at East Leppington, Catherine Fields, Sydney CBD, Harrington Park, Armidale, Balmain, Lake Munmorah, Wahroonga, Ultimo, Castle Hill, Wentworthville, Drummoyne, Canada Bay, Point Claire, Dee Why, Woolwich, Tamworth and Merrylands. Child Care Centres located at Normanhurst, Olympic Park, Wahroonga, Eden, Kogarah, Lindfield, Glendenning, Killara, Middleton Grange, Schofields, Hornsby, Brighton Le Sands, Fairfield, St Leonards, Granville, Mudgee, Willoughby, Gymea, Bexley, Chatswood and Peakhurst.
Hotels/Clubs	Tapavino Restaurant Sydney, Cabra-vale Diggers, Harbord Diggers, St George Hotel, Toukley RSL, Willoughby Hotel, Doonside Hotel, Red Lantern Hotel Eastwood, Tathra Hotel, Woy Woy Bowling Club, Magpies Waitara, Gladesville RSL, Campsie RSL, Club Five Dock and Canterbury Hurlstone Park RSL.
Churches and Places of Worship:	Islamic Prayer Hall at Greenacre, Marsden Park Anglican Church, Eastwood Anglican Church, The Salvation Army at Rouse Hill, Saints in Sydney at Kellyville, St Aidan's Anglican Church at Hurstville Grove, Vine Church at Surry Hills and St Andrews Cathedral in Sydney CBD.
Environmental Noise	Malabar Waste Water Treatment Plant, Kurrajong Zone Substation, Munmorah Substation, Huntingwood Zone Substation, Mount Tomah Communications Facility, Shine Australia The Biggest Loser, Rossi Water Pumping Station, the Smeaton Grange Substation and resource recovery facilities in Kings Park, Somersby and Belmore. Animal facilities located at Kenthurst, North Richmond, Collaroy, Richmond Race Club, Colo Heights, Londonderry, Zetland and Fiddletown.
Mechanical:	New Acland Coal Mine – assessment of earthmoving machinery sound power levels. Residential and commercial mechanical services at Rose Bay, Potts Point, Canada Bay, Willoughby, Bellevue Hill, Bronte, Glebe, Singleton, Chatswood, Surry Hills, Ultimo, Convent Hills and Ryde.

Aircraft Noise:	Assessment of aircraft noise intrusion from Bankstown, Richmond and Sydney Airports. Design and compliance for residential developments in Botany, Mascot, Richmond, Windsor, Annandale, Revesby and Arncliffe.
Traffic Noise:	Design and compliance for residential and commercial developments at Lucas Gardens SSP, Iluka Residential Aged Care Facility, Kiah Residential Development, Fairlight, Pyrmont, West Wollongong, Eastern Creek, Schofields and Box Hill.
Train Noise	Design and compliance for residential and commercial developments at Kiama, Gosford, Revesby, Granville, Belmore, Haywards Bay, Miranda and Thirlmere.
Hearing Loss Assessments:	B&M Quality Meats at Umina, Wyong Rugby League Club at Kanwal, Belmont Golf Club at Marks Point, Hengl Transport at Beresfield, Hancock Sheetmetal at Lambton, Australian Timber Shutters at Berkeley Vale, Punchbowl Bus Co at Riverwood, MET Grono Transport at Ballina, Volvo Group Australia at Beresfield, Flamesafe Fire Protection at Rydalmere, Hunter Valley Buses at Hunter Valley and Integrated Steel Mill Services at Newcastle.
Occupational Noise	ARV Laundry at Glendenning, RBM Plastic Extrusions at Silverwater.
Legal Assignments	ArtMade Architectural Pty Ltd v Willoughby City Council, Child Care Centre. Seventh Street Ventures Pty Ltd v Willoughby City Council, Child Care Centre. Omid Mohebati-Arani v Ku-ring-gai Council, Child Care Centre. Antoniou v Bayside Council, Child Care Centre.

ACOUSTICAL – Pertaining to the science of sound, including the generation, propagation, effects and control of both noise and vibration.

AMBIENT NOISE – The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including road traffic, factories, wind in the trees, birds, insects, animals, etc.

AUDIBLE – means that a sound can be heard. However, there are a wide range of audibility grades, varying from "barely audible" to "just audible", "clearly audible" and "prominent". Chapter 83 of the NSW Environment Protection Authority – Environmental Noise Control Manual (1985) states:
"noise from a particular source might be offensive if it is clearly audible, distinct from the prevailing background noise and of a volume or character that a reasonable person would be conscious of the intrusion and find it annoying or disruptive".

It follows that the word "audible" in an environmental noise context means "clearly audible".

BACKGROUND NOISE LEVEL – Silence does not exist in the natural or the built-environment, only varying degrees of noise. The Background Noise Level is the average minimum dBA level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by cicadas, lawnmowers, etc. It is quantified by the L_{A90} or the dBA noise level that is exceeded for 90 % of the measurement period (usually 15 minutes).

- **Assessment Background Level (ABL)** is the single figure background level representing each assessment period – day, evening and night (ie three assessment background levels are determined for each 24hr period of the monitoring period). Determination of the assessment background level is by calculating the tenth percentile (the lowest tenth percent value) of the background levels (L_{A90}) for each period (refer: NSW Industrial Noise Policy, 2000).
- **Rating Background Level (RBL)** as specified by the Environment Protection Authority is the overall single figure (L_{A90}) background noise level representing an assessment period (day, evening or night) over a monitoring period of (normally) three to seven days.

  The RBL for an assessment period is the median of the daily lowest tenth percentile of L_{90} background noise levels.

  If the measured background noise level is less than 30 dBA, then the Rating Background Level (RBL) is considered to be 30 dBA.

DECIBEL – The human ear has a vast sound-sensitivity range of over a thousand billion to one. The decibel is a logarithmic unit that allows this same range to be compressed into a somewhat more comprehensible range of 0 to 120 dB. The decibel is ten times the logarithm of the ratio of a sound level to a reference sound level. See also Sound Pressure Level and Sound Power Level.

Decibel noise levels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dBA, and another similar machine is placed beside it, the level will increase to 53 dBA, not 100 dBA. Ten similar machines placed side by side increase the sound level by 10 dBA, and one hundred machines increase the sound level by 20 dBA.

dBA – The human ear is less sensitive to low frequency sound than high frequency sound. We are most sensitive to high frequency sounds, such as a child's scream. Sound level meters have an inbuilt weighting network, termed the dBA scale, that approximates the human loudness response at quiet sound levels (roughly approximates the 40 phon equal loudness contour).

However, the dBA sound level provides a poor indication of loudness for sounds that are dominated by low frequency components (below 250 Hz). If the difference between the "C" weighted and the "A" weighted sound level is 15 dB or more, then the NSW Industrial Noise Policy recommends a 5 dBA penalty be applied to the measured dBA level.

dBC – The dBC scale of a sound level meter is similar to the dBA scale defined above, except that at high sound intensity levels, the human ear frequency response is more linear. The dBC scale approximates the 100 phon equal loudness contour.

EQUIVALENT CONTINUOUS NOISE LEVEL, L_{Aeq} – Many noises, such as road traffic or construction noise, vary continually in level over a period of time. More sophisticated sound level meters have an integrating electronic device inbuilt, which average the A weighted sound pressure levels over a period of time and then display the energy average or L_{Aeq} sound level. Because the decibel scale is a logarithmic ratio the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closely to the L_{Aeq} noise level.

FREE FIELD – This is a sound field not subject to significant reflection of acoustical energy. A free field over a reflecting plane is usually outdoors with the noise source resting on hard flat ground, and not closer than 6 metres to any large flat object such as a fence or wall; or inside an anechoic chamber.

FREQUENCY – The number of oscillations or cycles of a wave motion per unit time, the SI unit being the Hertz, or one cycle per second.

IMPACT ISOLATION CLASS (IIC) – The American Society for Testing and Materials (ASTM) has specified that the IIC of a floor/ceiling system shall be determined by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The IIC is a number found by fitting a reference curve to the measured octave band levels and then deducting the sound pressure level at 500 Hz from 110 decibels. Thus the higher the IIC, the better the impact sound isolation.

IMPACT SOUND INSULATION ($L_{nT,w}$) – Australian Standard AS ISO 717.2 – 2004 has specified that the Impact Sound Insulation of a floor/ceiling system be quantified by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The Weighted Standardised Impact Sound Pressure Level ($L_{nT,w}$) is the sound pressure level at 500 Hz for a reference curve fitted to the measured octave band levels. Thus the lower $L_{nT,w}$ the better the impact sound insulation.

IMPULSE NOISE – An impulse noise is typified by a sudden rise time and a rapid sound decay, such as a hammer blow, rifle shot or balloon burst.

INTRUSIVE NOISE LEVEL, L_{Aeq} – The level of noise from a factory, place of entertainment, etc. in NSW is assessed on the basis of the average maximum noise level, or the $L_{Aeq\ (15\ min)}$. This is the energy average A weighted noise level measured over any 15 minute period.

LOUDNESS – The degree to which a sound is audible to a listener is termed the loudness. The human ear perceives a 10 dBA noise level increase as a doubling of loudness and a 20 dBA noise increase as a quadrupling of the loudness.

MAXIMUM NOISE LEVEL, L_{Amax} – The rms maximum sound pressure level measured on the "A" scale of a sound level meter during a noise survey is the L_{Amax} noise level. It may be measured using either the Fast or Slow response time of the meter. This should be stated.

NOISE RATING NUMBERS – A set of empirically developed equal loudness curves has been adopted as Australian Standard AS1469-1983. These curves allow the loudness of a noise to be described with a single NR number. The Noise Rating number is that curve which touches the highest level on the measured spectrum of the subject noise. For broadband noise such as fans and engines, the NR number often equals the dBA level minus five.

NOISE – Noise is unwanted sound. Sound is wave motion within matter, be it gaseous, liquid or solid. "Noise includes sound and vibration".

NOISE REDUCTION COEFFICIENT – See: "Sound Absorption Coefficient".

OFFENSIVE NOISE - (Reference: Dictionary of the Protection of the Environment Operations Act 1997). *"Offensive Noise means noise:*

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

PINK NOISE – Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

REVERBERATION TIME, T_{60} – The time in seconds, after a sound signal has ceased, for the sound level inside a room to decay by 60 dB. The first 5 dB decay is often ignored, because of fluctuations that occur while reverberant sound conditions are being established in the room. The decay time for the next 30 dB is measured and the result doubled to determine the T_{60}. The Early Decay Time (EDT) is the slope of the decay curve in the first 10 dB normalised to 60 dB.

SOUND ABSORPTION COEFFICIENT, α – α Sound is absorbed in porous materials by the viscous conversion of sound energy to heat energy as the sound waves pass through it. Sound is similarly absorbed by the flexural bending of internally damped panels. The fraction of incident energy that is absorbed is termed the Sound Absorption Coefficient, α. An absorption coefficient of 0.9 indicates that 90 % of the incident sound energy is absorbed. The average α from 250 to 2000 Hz is termed the Noise Reduction Coefficient (NRC).

SOUND ATTENUATION – If an enclosure is placed around a machine, or a silencer is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 30 dBA, reduces the sound energy by one thousand times.

SOUND EXPOSURE LEVEL (SEL) – The total sound energy of a single noise event condensed into a one second duration or in other words it is an L_{eq} (1 sec).

SOUND PRESSURE LEVEL, L_p – The level of sound measured on a sound level meter and expressed in decibels, dB, dBA, dBC, etc. $L_p = 20 \times \log (P/P_o)$ ... dB

where P is the rms sound pressure in Pascal and P_o is a reference sound pressure of 20 µPa. L_p varies with distance from a noise source.

SOUND POWER LEVEL, L_w – The Sound Power Level of a noise source is an absolute that does not vary with distance or with a different acoustic environment.

$L_w = L_p + 10 \log A$ ... dB, re: 1pW,
where A is the measurement noise-emission area in square metres in a free field.

SOUND TRANSMISSION CLASS (STC) – An internationally standardised method of rating the sound transmission loss of partition walls to indicate the decibels of noise reduction of a human voice from one side to the other. (Refer: Australian Standard AS1276 – 1979)

SOUND TRANSMISSION LOSS – The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS1191 - 2002.

STATISTICAL EXCEEDENCE SOUND LEVELS, L_{A90}, L_{A10}, L_{A1}, etc – Noise which varies in level over a specific period of time (usually 15 minutes) may be quantified in terms of various statistical descriptors:

The L_{A90} is the dBA level exceeded for 90 % of the time. In NSW the L_{A90} is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

The L_{A10} is the dBA level that is exceeded for 10 % of the time. In NSW the L_{A10} measured over a period of 10 to 15 minutes. It was until recently used to describe the average maximum noise level, but has largely been replaced by the L_{Aeq} for describing level-varying noise.

The L_{A1} is the dBA level that is exceeded for 1 % of the time. In NSW the L_{A1} may be used for describing short-term noise levels such as could cause sleep arousal during the night.

STEADY NOISE – Noise, which varies in level by 6 dBA or less, over the period of interest with the time-weighting set to "Fast", is considered to be "steady". (Refer AS 1055.1 1997)

WEIGHTED SOUND REDUCTION INDEX, R_w – This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 to 3,150 Hertz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999).

Internal partition wall $R_w + C$ ratings are frequency weighted to simulate insulation from human voice noise. The $R_w + C$ is always similar in value to the STC rating value. External walls, doors and windows may be $R_w + C_{tr}$ rated to simulate insulation from road traffic noise. This is normally a lower number than the STC rating value.

WHITE NOISE – White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.