Project No: 011619

Noise Impact Assessment
Koolewong Marina
Koolewong, NSW

Prepared for:
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1.0 - INTRODUCTION

This report presents the results, findings and recommendations arising from a noise impact assessment of the proposed development of a 50 berth marina and reconfiguration of the car park at 19 Brisbane Water Road, Koolewong, on the NSW Central Coast.

From an acoustic point of view the most significant aspects of the marina development will involve;

- Upgrade of the existing timber jetty from 1m to 1.5m in width,
- Construction of a 50 berth marina extending 100m into Brisbane Water from the end of the existing jetty,
- The main walkway of the marina will be 2.4m wide with two arms in a reverse F formation, and
- The upgrade and reconfiguration of the existing car park to provide an additional 11 car parking spaces to the 33 existing spaces.

The proposal **does not** involve;

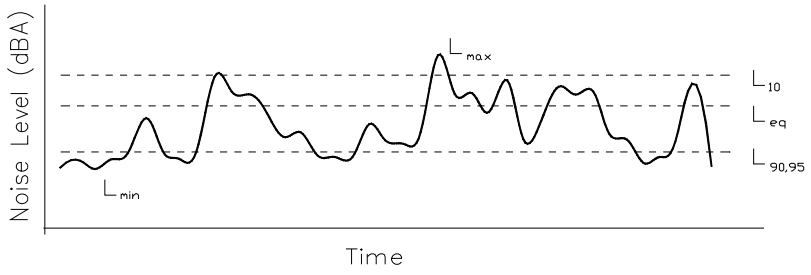
- Construction, repair, maintenance, sale or hire of boats,
- Fuelling of boats,
- Sewage pumping, or
- Launching or landing facilities.

The assessment was requested by ADW Johnson Pty Ltd in response to the requirements of the Director General of the Department of Planning (DGR's for application number MP10_0209).

2.0 - TERMS AND DEFINITIONS

Table 1 contains the definitions of commonly used acoustical terms and is presented as an aid to understanding this report.

TABLE 1 DEFINITION OF ACOUSTICAL TERMS	
Term	Definition
dB(A)	The quantitative measure of sound heard by the human ear, measured by the A-Scale Weighting Network of a sound level meter expressed in decibels (dB).
SPL	Sound Pressure Level. The incremental variation of sound pressure above and below atmospheric pressure and expressed in decibels. The human ear responds to pressure fluctuations, resulting in sound being heard.
STL	Sound Transmission Loss. The ability of a partition to attenuate sound, in dB.
Lw	Sound Power Level radiated by a noise source per unit time re 1pW.
Leq	Equivalent Continuous Noise Level - taking into account the fluctuations of noise over time. The time-varying level is computed to give an equivalent dB(A) level that is equal to the energy content and time period.
L1	Average Peak Noise Level - the level exceeded for 1% of the monitoring period.
Lmax	The Maximum noise level recorded for a measurement period.
L10	Average Maximum Noise Level - the level exceeded for 10% of the monitoring period.
L90	Average Minimum Noise Level - the level exceeded for 90% of the monitoring period and recognised as the Background Noise Level. In this instance, the L90 percentile level is representative of the noise level generated by the surrounds of the residential area.



3.0 - CRITERIA

The Department of Environment, Climate Change and Water (DECCW) and local councils share responsibility for the approval and control of noise emissions from commercial and industrial premises within council boundaries. These approvals are generally based on procedures and criteria detailed in the NSW Industrial Noise Policy (INP).

The INP describes intrusive and amenity criteria applicable to industrial sites. These noise criteria depend on the existing background noise level at potentially affected residential receiver areas.

Ambient noise levels representative of these areas were measured at 15 minute statistical intervals using a Svan 949 sound and vibration analyser used as an environmental noise logger. The measurements were done in accordance with relevant DECCW guidelines and AS 1055-1997 "Acoustics – Description and Measurement of Environmental Noise". The noise logger used complies with the requirements of AS 1259.2-1990 "Acoustics – Sound Level Meters", and has current NATA calibration certification.

The logger was programmed to continuously register environmental noise levels over the 15 minute intervals, with internal software calculating and storing Ln percentile noise levels for each sampling period. Calibration of the logger was performed as part of the instrument's initialisation procedures, with calibration results being within the allowable $\pm$ 0.5 dB(A) range.

The logger was located at 29 Johns Road, Koolewong from March 3 to March 9, 2011. This logger location was chosen to capture the existing noise levels in the vicinity of the nearest potentially affected residential receivers. The location was in the rear yard of the residence with line of sight to the proposed marina location.

Ambient Leq and background noise levels, obtained from the logger, are summarised below in **Table 2** and shown graphically in **Appendix I**.

TABLE 2
MEASURED AMBIENT NOISE LEVELS 3/3/11 to 9/3/11

Location	Day	Evening	Night
29 Johns Road	46 dB(A) L90	47 dB(A) L90	38 dB(A) L90
	63 dB(A) Leq 15 min	64 dB(A) Leq 15 min	61 dB(A) Leq 15 min

In setting noise goals for a particular project the INP considers both Amenity and Intrusiveness criteria. The former is set to limit continuing increase in noise from industry, whilst the latter is set to minimise the intrusive impact of a particular noise source.

Based on definitions in the INP the residential area is best described acoustically as "suburban". Given the site is not subject to any significant existing industrial noise, the intrusiveness criteria are those applicable to setting the project specific noise goals. That is, the Rating Background Level (RBL) for the time period, plus 5 dB(A). The RBL (L90) is defined as the overall single figure background level representing each assessment period.

Table 3 below specifies the applicable project specific noise goals (PSNG) for the site being assessed.

TABLE 3 PSNG's	
Period	Intrusiveness Criterion* L_{eq} (15 min) dB(A)
Day	51
Evening	51**
Night	43

* Rating Background Level (RBL) + 5dB. RBL is the median value of each ABL (Assessment Background Level) over the entire monitoring period. The ABL is a single figure representing the "L_{90} of the $L_{90's}$" for each separate day of the monitoring period.
** Application notes to the INP state that the noise goal for evening cannot be higher than that for day time.

Car Park

The assessment of noise from vehicles associated with a development is covered by the INP if those vehicles are not on a public road. An example of this is vehicles using the car park at the marina. Vehicles may be moving about in the car park at any time.

An assessment of car park noise as a result of this use has been carried out against the DECCW project specific noise level for day/evening (**51 dB(A) Leq (15 min)**) as this is the time period where the car park will have the most use and for night (**43 dB(A) Leq (15 min)**) as this is the time period with the most stringent criterion.

Sleep Disturbance

To help protect against people waking from their sleep, the DECCW (in the Environmental Noise Control Manual - ENCM) recommends that 1-minute L1 noise levels (effectively, the Lmax noise level from impacts, etc) should not exceed the background level by more than 15 dB(A) when measured/computed at the outside of a bedroom window. The "sleep disturbance" criterion is only applicable to night-time operations.

Based on the measured night time background noise level of 38 dB(A) the sleep disturbance criterion at the receivers is set at **53 dB(A) L1 (1 min)**, and applies to all maximum noise emissions at night (i.e. between 10 pm and 7 am).

The ENCM is an old document, however, and more recent findings referenced in the DECCW's Environmental Criteria for Road Traffic Noise (ECRTN, Appendix B3) lead to the following conclusions;

- *Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions.*

- *One or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly.*

Since the main objective of this assessment is to determine potential noise impacts on amenity, rather than on health and wellbeing, it can be assumed from the above conclusions that disturbance to sleep may be minimised by ensuring that internal maximum noise levels do not exceed 50 to 55 dB(A). It is also accepted by DECCW, and generally, that the noise loss through an open window to the centre of a room is at least 10 dB. Under these circumstances the maximum acceptable external noise level would therefore be in the range 60 to 65 dB(A) at the façade of the bedroom of any residence.

4.0 - NOISE ASSESSMENT

Site Operations and Noise Levels

The layout of the proposed marina is shown below in **Figure 1**.

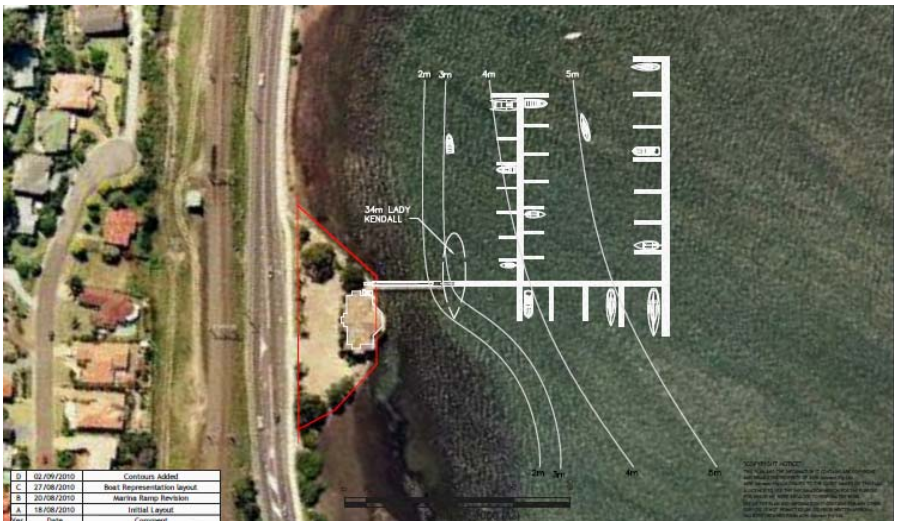


Figure 1 – Site Layout Plan

The marina will act as a mooring for 50 boats. Potential noise sources associated with such an operation will involve that of boats manoeuvring in and out of the marina and people arriving and departing.

It is anticipated that both yachts and cruisers will moor at the marina. Yachts would manoeuvre into the marina under power. Typically yachts are powered by either a small outboard or inboard motor (usually less

than 30 hp). Cruisers are typically powered by inboard diesel motors. In each case the exhaust is below the water line.

All craft manoeuvring in and out of the marina will do so at low speeds with resultant low noise levels. The sound power level of a yacht under power and a diesel powered cruiser, moving at low speed, have been taken from the Spectrum Acoustics technical database and are shown below in **Table 4**.

Noise from people moving to and from boats may also have the potential to create adverse impacts. The sound power level for loud speech is also shown in Table 4.

TABLE 4
NOISE SOURCE SOUND POWER LEVELS
Leq dB(A)

Source	Sound Power Level
Yacht	87
Cruiser	95
Loud Speech	73

The noise levels shown for the in Table 4 are based on the maximum short term measured SPL's for the various noise sources. Boats manoeuvring in and out of the marina will do so over relatively short time periods. The noise source detailed above is for a craft moving and would not be constant for a full 15 minute period. To look at a worst case it was considered that two cruisers left the marina in a 15 minute period at night (i.e. before 7 am) with each boat producing its maximum sound level shown for 2 to 2.5 minutes.

For the calculation of potential impacts the Leq noise level shown has been adjusted by a correction factor of -5 dB(A) to reflect the time taken for the vessel to leave the marina (i.e. a factor of 10xlog 5/15 to represent site noise for 5 minutes out of a 15 minute period).

People moving towards the marina may also have the potential to create noise impacts. For consideration of a worst case up to six people were assessed to be in the car park and moving towards the marina during the night. Each person was considered to have loud speech at the levels shown in Table 4 and facing towards receivers, for 1.5 minutes out of a 15 minute period.

Predicted Noise Levels

To predict potential noise impacts noise levels from the various activities detailed above were theoretically propagated to the nearest residential receivers taking into account the effects of hemispherical spreading (distance loss).

Table 5, below, shows a calculation of noise from six people arriving at the marina car park, and two cruisers leaving the docks, in a 15 minute period, at night. The noise criteria in the INP relate to external noise levels and, therefore, the theoretical noise levels have been predicted to a standard 1.5m high reception point at the boundary of the nearest receiver at 29 Johns Road, Koolewong, approximately 90m from the people in the car park and 160m from the craft leaving the marina (i.e. the closest docks to the shore).

TABLE 5
CALCULATED SPL AT NEAREST RESIDENTIAL RECEIVER (NIGHT)
As Leq (15 min)

Source	Noise Level
2 x Cruisers	93
Distance loss to Receiver (160m)	-52
Received Noise from Cruisers	41
6 x People	71
Distance loss to Receiver (90m)	-47
Received Noise from People	24
Combined Noise	41
PSNG - Night	43
Impact	0

The results in Table 5 show that noise levels from the assessed night time operational scenario will not exceed the night time PSNG for the site.

Table 6, below, shows a calculation of noise from 30 people arriving at the marina car park, and 10 cruisers leaving the docks, in a 15 minute period, during the day or evening.

TABLE 6
CALCULATED SPL AT NEAREST RESIDENTIAL RECEIVER (DAY/EVENING)
As Leq (15 min)

Source	Noise Level
10 x Cruisers	100
Distance loss to Receiver (160m)	-52
Received Noise from Cruisers	48
30 x People	78
Distance loss to Receiver (90m)	-47
Received Noise from People	34
Combined Noise	48
PSNG – Day/Evening	51
Impact	0

The results in Table 6 show that noise levels from the assessed day time operational scenario will not exceed the day or evening PSNG for the site.

Car Park

Noise in car parks typically comes from people walking to and from cars, doors opening and closing etc., as well as vehicles moving at slow speeds. Each noise event is characterised by a brief peak which when averaged out over a 15 minute period has a relatively low Leq. The impact of each noise event on any single receiver is also variable depending upon the location of individual cars within a car park and as they move in and out. In addition to this, people arriving or departing a marina would normally be expected to do so in a relatively quiet and orderly fashion.

Typical noise levels from car parks have been sourced from the Spectrum Acoustics technical database. This contains noise measurements from a series of vehicles arriving and departing a car park with people moving to and from vehicles. The measurements were made over a representative period to ascertain a typical noise level from these activities. The measurements were made at varying distances from each car to approximate the situation in relation to an adjacent residence over a 15 minute interval. That is, at any time throughout each 15 minute interval various car parks, at different distances from the nearest residences, will be in use.

The measurements in the database show a noise level of 53 dB(A) Leq measured over a 5 minute period where up to 6 vehicles moved in and out of a car park. The measurements were made at an average distance of 7m. Assuming the noise from the 6 vehicles is consistent for a full 15 minutes at a distance of 7m this equates to a sound power level of 73 dB(A) Leq (15 min) for the car park noise as described. This value has been used to determine impacts over a 15 minute assessment period.

Based on the operational scenarios described above it was considered that a worst case of up to six cars arrived at the car park during the night. 30 cars were considered to arrive during the day.

Table 7 shows the results of the calculation of the assessed car park noise impacting on the rear boundary of 29 Johns Road, Koolewong for each of the night and day/evening time usage.

TABLE 7 CALCULATED SPL AT NEAREST RESIDENTIAL RECEIVER CAR PARK NOISE As Leq (15 min)	
Source	Noise Level
6 x cars	73
Distance loss to Receiver (90m)	-47
Received Noise at Night	26
PSNG – Night	43
Impact	0
30 x cars	80
Distance loss to Receiver (90m)	-47
Received Noise during Day	36
PSNG – Day/Evening	51
Impact	0

The results in Table 7 show there will be no exceedance of any of the PSNG's for the site as a result of the assessed car park noise.

Table 8 shows a calculation of the combined received noise from all of the assessed activities during the day/evening and night.

TABLE 8 COMBINED NOISE LEVELS Leq dB(A)	
Source	Noise Level
Marina - Day	48
Patrons – Day	34
Car Park - Day	36
Total Combined Noise – Day	48
PSNG – Day/Evening	51
Impact	0
Marina – Night	41
Patrons – Night	24
Car Park – Night	26
Total Combined Noise - Night	41
PSNG – Night	43
Impact	0

The results in Table 9 show there will be no adverse noise impacts as a result of the assessed emissions from the operation of the marina.

Sleep Disturbance

The main potential for maximum noise events will come from either impact noises as material is dropped on the marina or from car doors or raised speech etc. in the car park.

The maximum noise levels for such events have been taken from the Spectrum Acoustics technical database as shown below in **Table 9**.

TABLE 9 NOISE SOURCE SOUND POWER LEVELS Lmax dB(A)	
Source	Sound Power Level
Impacts	107
Car Door	98
Raised Speech	90

Table 10 shows the calculation of potential sleep disturbance impacts at the rear facade of 29 Johns Road, Koolewong as a result of the assessed maximum noise events. Note that the sleep disturbance criterion is to be determined at a point 1m from a bedroom window which at the rear of the house.

The noise from a car door being closed was considered to be at the car parks nearest to the jetty entrance as these are the most likely parking spaces to be occupied at night. The impact noise was considered to be at the nearest marina berth to 29 Johns Road, as this represents the worst case.

TABLE 10 CALCULATED SPL AT NEAREST RESIDENTIAL RECEIVER SLEEP DISTURBANCE As Lmax	
Source	Noise Level
Impact Noise on Marina	107
Distance loss to Receiver (170m)	-53
Received Noise	54
Car Door slam	98
Distance loss to Receiver (90m)	-47
Received Noise	51

The results in Table 9 show there will be no adverse sleep disturbance impacts as a result of the assessed noise emissions from car doors being slammed closed.

The results show that received noise levels from the assessed impact noise on the marina may be 1 dB(A) higher than the ENCM sleep

disturbance criterion but significantly lower than the levels adopted in the ECRTN.

It must be noted that the Main Northern Railway Line and Brisbane Water Drive are located between the marina and the nearest residences in the area. A review of the logger data shows that Lmax noise levels significantly higher than the predicted levels were measured regularly at the logger site in the rear yard of 29 Johns Road (see graphic representation of data in Appendix I). It is likely that many of these Lmax events were due to noise from trains and cars. As such, it is considered unlikely that noise levels in the order of less than 55 dB(A) Lmax will cause undue impacts or result in a deterioration of the acoustic environment of the area.

6.0 – CONCLUSION

An assessment has been carried out into the potential for adverse noise impacts arsing from a proposed development of a 50 berth marina and reconfiguration of the car park at 19 Brisbane Water Road, Koolewong, on the NSW Central Coast.

Specifically, the assessment considered noise emissions from vessels entering, leaving and manoeuvring around the marina. It also considered noise from people accessing the marina and using the car park.

Sleep disturbance impacts were calculated based on maximum noise events from car doors and impacts on the marina.

The results of the assessment have shown that there will be no adverse impacts as a result of the operation of the marina under the assessed conditions.

It is, therefore, considered that the marina can operate in the manner described in this report with minimal impact on the community.

7.0 – REFERENCES

Department of Environment, Climate Change and Water (DECCW), 1994. Environmental Noise Control Manual, Sydney.

Department of Environment, Climate Change and Water (DECCW), 2000. NSW Industrial Noise Policy, Sydney.

AS 1055-1997 “Acoustics – Description and Measurement of Environmental Noise”.

AS 1259.2-1990 “Acoustics – Sound Level Meters”

ADDENDUM – CONSTRUCTION NOISE ASSESSMENT

Construction Noise Criteria

The assessment of construction noise impacts has been undertaken in accordance with the OEH's (formerly DECCW) Interim Construction Noise Guideline (ICNG, 2009). The ICNG is a non-mandatory guideline that is usually referred to by local councils and the NSW Department of Planning and Infrastructure (formerly DoP) when construction/demolition works require development approval.

Section 1.5 of the ICNG outlines the steps for management of construction noise impacts as follows:

1. **identify sensitive land uses** that may be affected.
2. **identify hours** for the proposed construction works.
3. **identify impacts** at sensitive land uses.
4. **select and apply the best work practices** to minimise noise impacts.

Each of the above four points is assessed in detail in the following sections.

Land Uses

The subject site lies within a suburban residential area. There are no other sensitive land uses in the area. It is noted that the Main Northern Railway Line lies between the proposed construction and the nearest potentially affected residences.

Operating Hours

The recommended standard hours for construction works are shown in Table 1, section 2.2 of the ICNG as reproduced below.

Table 1: Recommended standard hours for construction work

Work type	Recommended standard hours of work*
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

* The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours.

Construction works outside the hours in Table 1 is normally only permissible for delivery of oversized structures, emergency works, public infrastructure works that are supported by the affected community or where the proponent demonstrates and justifies a need (other than simply convenience) to work outside the recommended standard hours (ICNG, p9).

For the current project, the proponent has indicated that construction works would occur within the recommended standard hours.

Impacts at Sensitive Land Uses

The ICNG provides two assessment methodologies for construction noise impacts: a 'qualitative' assessment where works occur for less than three weeks and a 'quantitative' assessment for works of longer duration. As the construction works will take longer than three weeks, the quantitative methodology is applicable.

Table 2 of the ICNG sets out noise management levels for construction works as reproduced below.

Table 2: Noise at residences using quantitative assessment

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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.
	Highly noise affected 75 dB(A)	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.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Based on the measured noise levels from the unattended logger the daytime background (RBL) was established in the residential receiver area. The daytime construction noise management level (CNML) has been established as RBL + 10 dB(A) in accordance with Table 2 from the ICNG, as detailed below;

CNML - 56 dB(A) Leq (15 min)

Construction Noise Assessment

Construction noise levels will vary throughout individual days and also throughout the length of the overall works. The noise level at individual receivers will also be dependent upon the location of the various works, relative to those receivers, at any time.

The most significant noise emissions from construction activities will occur during the earthworks associated with the reconfiguration of the car park and the piling works associated with the marina construction.

Typical noise levels of construction plant items are shown in **Table A1** (as adapted from the RTA's Environmental Noise Management Manual, ENMM).

TABLE A1
TYPICAL SOUND POWER LEVELS – CONSTRUCTION PLANT

Plant Item	dB(A) Leq (15 min)
Bulldozer	110
Backhoe	104
Grader	107
Excavator	105
Pile Driving	119

The most significant noise emissions from construction or reconfiguration of the car park are likely to be during works involving the use of a bulldozer, grader and possibly a backhoe.

To assess potential noise impacts in relation to the car park construction, the combined noise from a bulldozer, grader and backhoe all working in close proximity was determined to approximately 112 dB(A).

Using this combined noise for all plant working at the same time, **Table A2** shows a calculation of the worst case impacts at the closest receivers as a result of the described car park construction noise.

TABLE A2 CALCULATED SPL AT NEAREST RESIDENTIAL RECEIVER CONSTRUCTION IN CAR PARK As Leq (15 min)	
Source	Noise Level
Construction Noise (as described above)	112
Distance loss to Receiver (90m)	-47
Received Noise	65
CNML	56
Impact	9

The results in Table A2 show that the received noise from the assessed car park construction will result in received noise in the "noise affected" category but below the "highly affected" category of the ICNG.

It must be noted that the exceedance shown is for the noise associated with the initial phase of construction involving heavy machinery undertaking excavation work and site preparation only. This phase of the construction will be only very short term in nature.

In addition to this the hammering of piles will be necessary for the installation of the marina piers. **Table A3** shows a calculation of the worst case impacts at the closest receivers as a result of the piling noise.

TABLE A3 CALCULATED SPL AT NEAREST RESIDENTIAL RECEIVER HAMMERING OF PILES at MARINA As Leq (15 min)	
Source	Noise Level
Hammering Piles	119
Distance loss to Receiver (160m)	-52
Received Noise	67
CNML	56
Impact	12

The results in Table A3 show that the received noise from the assessed hammering of piles will result in received noise in the "noise affected" category but below the "highly affected" category of the ICNG.

In keeping with the requirements of the ICNG the following general recommendations are made to minimise potential impacts, and maintain the amenity of, the surrounding areas.

The closest neighbouring residents should be notified of the proposed works. Particular emphasis should be placed on the time frame of the works. A contact name and phone number of a responsible person should be given out so that complaints can be dealt with effectively and efficiently. All complaints or communication should be answered.

During the liaison process note should be made of any particularly noise sensitive times of day and care taken to avoid scheduling noisy works, particularly piling of the closest holes) at these times.

All personnel working on the job including contractors and their employees should be made aware of their obligations and responsibilities with regard to minimising noise emissions.

Contractors should familiarise themselves with methods of controlling noisy machines and alternative construction procedures. These are explained in AS2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.

Activities that are known or have the potential to create excessive noise should, where possible, be scheduled to occur at times to cause least annoyance to the community. Carrying out such work during early morning should be avoided. This includes start up and idling etc. of heavy machinery prior to commencement of work.

Mechanical plant should be silenced using best available control technology. Noise suppression devices should be maintained to manufacturer’s specifications. Engines should be fitted with appropriate, well maintained, high efficiency mufflers. Particular emphasis should be placed on the use of exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from site.

Machines which are used intermittently should either be shut down in the intervening periods between work or throttled down to a minimum.

Vibration Assessment

The use of pile drivers may also result in ground vibrations. The attenuation of vibration through the ground is dependent upon site specific factors relating to the strata between the vibration source and receivers.

The ENMM details peak particle velocities (PPV) for pile driving of between 12 and 30 mm/sec at 10m. The Spectrum Acoustics technical database contains measurements of pile driving that range between 13 and 15 mm/sec at 5m.

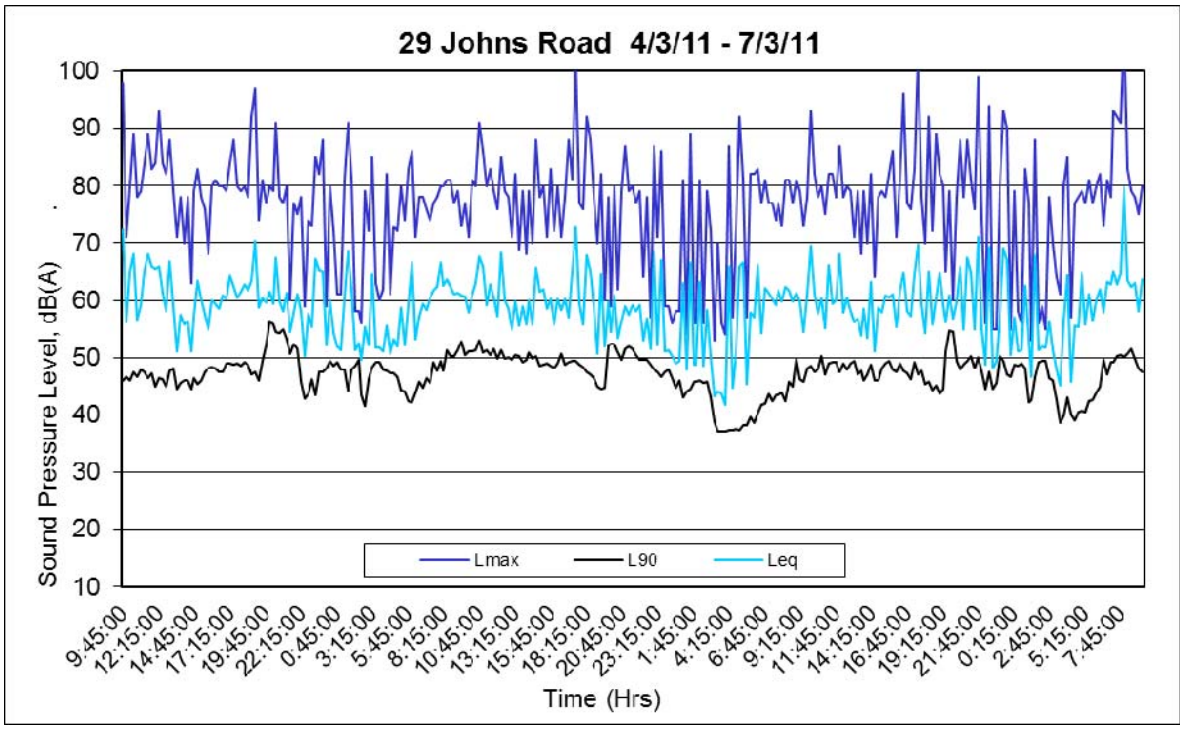
To gain an indication of the likely vibration levels resulting from any pile driving activities on the site it can be assumed that vibration level as a result of pile driving is inversely proportional to distance. That is, at double the distance from the source the vibration level will be halved.

Based on the worst case vibration level for pile driving of 30mm/sec at 10m, the PPV will be less than 5mm/sec at distances of greater than approximately 70m. Vibration at levels lower than 5mm/sec PPV will not cause damage to any buildings or be a source of annoyance to people.

As the nearest residences to the proposed piling activities are approximately 160m away there is no likelihood of building damage or annoyance.

APPENDIX I

NOISE LOGGER CHARTS


29 Johns Road 4/3/11 - 7/3/11
Sound Pressure Level, dB(A)
100
90
80
70
60
50
40
30
20
10
Lmax
L90
Leq
9:45:00
12:15:00
14:45:00
17:15:00
19:45:00
22:15:00
0:45:00
3:15:00
5:45:00
8:15:00
10:45:00
13:15:00
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18:15:00
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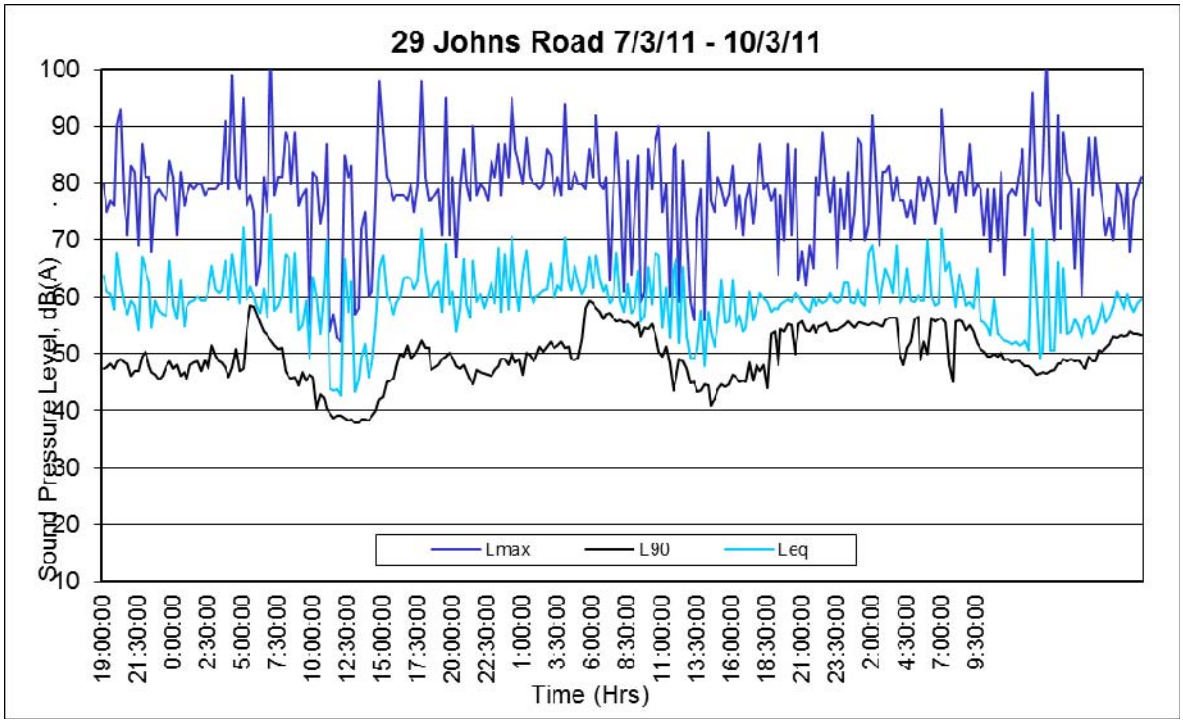
29 Johns Road 7/3/11 - 10/3/11
Sound Pressure Level, dB(A)
100
90
80
70
60
50
40
30
20
10
Lmax
L90
Leq
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21:30:00
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5:00:00
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16:00:00
18:30:00
21:00:00
23:30:00
2:00:00
4:30:00
7:00:00
9:30:00
Time (Hrs)