Report

Acoustics

EUROBODALLA SHIRE COUNCIL - BATEMANS BAY REGIONAL AQUATIC, ARTS AND LEISURE CENTRE (BBRAALC) – NOISE IMPACT ASSESSMENT

NBRS

Report

Norman Disney & Young
A TETRA TECH COMPANY

Contents

1 EXECUTIVE SUMMARY

1.1 Purpose

NDY has undertaken a Noise and Vibration Impact Assessment of the proposed Batemans Bay Recreation Arts and Aquatics and Leisure Centre (BBRAALC) Batemans Bay, NSW.

The purpose of this report is to address the aspects of the proposed development under the relevant provisions of the Protection of the Environment and Operations Act (1997) and provide in-principle recommendations to determine compliance with these requirements.

1.2 Revision History

Rev	Date Issued	Comment
1.0	21 August, 2019	Draft
2.0	5 September, 2019	Final Draft
3.0	27 September, 2019	Final with Comments
4.0	30 September, 2019	Final

1.3 Professional Accreditation

The noise calculation and reporting has been undertaken by acoustic engineer David Luck and Akil Lau of Norman Disney & Young. Akil Lau and David Luck are both certified members of the Australian Acoustical Society (MAAS).

Additionally, NDY Acoustics Sydney is a member firm of the Association of Australasian Acoustical Consultants (AAAC).

2 PROJECT INFORMATION

2.1 Project Description

The proposed redevelopment will consist of an upgrade to the existing Batemans Bay Swimming Centre. The new facility will be renamed the Batemans Bay Regional Aquatic, Arts and Leisure Centre. The BBRAALC facility, shown in Figure 1 will consist of the following:

- An aquatic centre with a 25-metre swimming pool with separate 10x20 m warm therapy pool, freeform indoor leisure pool, with children's splash pools, slide tower and water slides;
- A purpose build art, cultural and community facility consisting of a main auditorium for 350 people, wet and dry arts spaces, kitchen and storage facilities;
- Tourism, Food and Retail facilities shared front entrance and foyer, visitor centre, café/retail space and a gallery theatrette;
- Open air car parking facilities with provision for 202 car parking spaces.

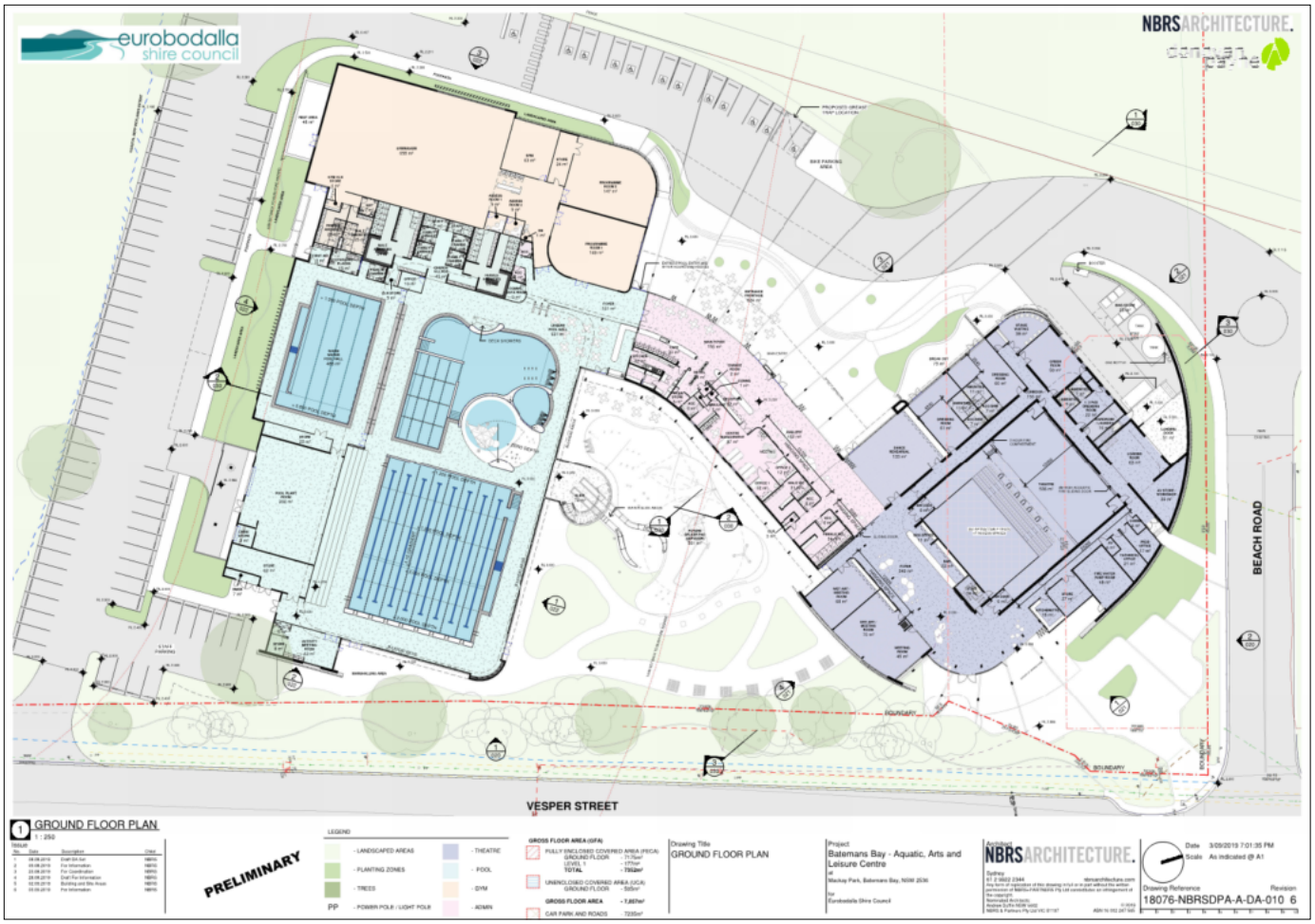


Figure 1: Proposed Batemans Bay Recreation Arts and Aquatics and Leisure Centre (BBRAALC).

2.2 Project Site

The site is located in the main civic area of Batemans Bay, NSW and is located on the Vesper Street (Princes Highway), which is the main access route into the town and to North Batemans Bay. The site is bordered immediately to the north by the Batemans Bay Mini Golf Facility, Mackay Park immediately to the west and residential receivers located 75m-130m east of the site on the opposite side of the Vesper Street (Princes Highway).

Figure 2: Site Layout and Logger Locations

2.3 Sensitive Receivers

Below are the nearest sensitive residential receivers near the site:

- Aged care facility - 125m north-east of the site;
- 3-17 Vesper Street residences at distances between 65m-200m from the site, south and south-east of the site;
- Hill Street and Bent Street residences 120m west of the site, with other residences in Bent St, at distances of 150-210m east and south east of the site;
- There are also commercial receivers, such as McDonalds Restaurant, located immediately west of the site approximately 55m from the site, Coles approximately 100m north of the site.

3 MEASUREMENT LOCATIONS

3.1 Noise Monitoring

Unattended monitoring locations shown in Figure 1 was undertaken at two locations for this assessment, which are described further below:

- Location A - Visitors centre located on the corner of the Princes and Old Princes Highway;
- Location B - Pool Boundary, located on the north-eastern corner of the existing Batemans Bay Pool site.

Figure 3: Logger Location A, facing towards the existing facility.

Figure 4: Logger Location B, located on the north eastern corner of the existing site.

4 ACOUSTIC CRITERIA

4.1 Protection of the Environment and Operations Act (1997)

Under the Protection of the Environment and Operations Act (PEOA) (1997), the Environment Protection Authority (EPA), now incorporated within the Department of Planning, Industry and Environment (DPIE), has the responsibility to issue policy statements to set out criteria and methods of management for noise within NSW. The following operational and construction noise and vibration criteria are relevant policies which are provisions under the PEOA (1997).

4.2 Operational Noise Criteria

4.2.1 NSW Noise Policy for Industry 2017 - Assessment

For the purpose of the assessment, the measured noise data was processed into the following time periods:

- Daytime: 0700 to 1800 hrs;
- Evening: 1800 to 2200 hrs;
- Night-time: 2200 to 0700 hrs.

The measured background (L_{A90}) and equivalent continuous (L_{Aeq}) noise levels during these defined time periods are presented in Table 1.

The L_{A90} noise levels presented are *Rating Background Levels* (RBLs), being the median of the background L_{A90} (i.e. of the lowest 10th percentile of samples) in each daytime, evening and night-time measurement period, for each 24-hour period during the noise survey.

The L_{Aeq} noise levels presented are the logarithmic average of all the L_{Aeq} samples taken in each of the daytime, evening and night-time periods.

Table 1 shows the existing ambient noise levels at the Eastern boundary noise monitoring location.

Table 1: Existing Ambient Noise Levels, dB(A).

Location	Noise Index	Noise Level, dB re 20 µPa		
		Daytime 0700 to 1800	Evening 1800 to 2200	Night-time 2200 to 0700
A	L_{A90} (RBL)	55	41	34
	$L_{Aeq,period}$	68	63	61
B	L_{A90} (RBL)	51	40	36
	$L_{Aeq,period}$	60	55	53

4.2.2 NSW Noise Policy for Industry 2017 - Criteria

Based on the unattended noise survey discussed in Section 3 of this report, the external noise level criteria for the receiver location has been derived in accordance with the NSW Noise Policy for Industry (NSW NPfI).

The NSW NPfI provides assessment methodologies, criteria and detailed information on the assessment of environmental noise emissions in NSW.

The NSW NPfI criteria for noise sources consider two (2) components:

- Controlling **intrusive** noise impacts for residential receivers. Assessing intrusiveness generally requires noise measurements to quantify background (L_{A90}) noise levels at a location considered representative of the most potentially affected residential receiver(s). The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source(s) under consideration should be controlled to not exceed background noise levels by more than 5 dB.
- Maintaining noise **amenity** for various categories of land use (including residential receivers and other sensitive receivers). The amenity criterion is based on the sensitivity of a particular land use to industrial-type noise. The recommended amenity noise levels detailed in Table 2.2 of NSW NPfI represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. This is to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area. The project amenity criteria for each new source of industrial noise is equalled to recommended amenity noise level minus 5dB(A). A +3dB(A) to be added to project amenity noise level for conversion from a period level to a 15-minutes level. Where the resultant project amenity noise level is 10dB or more below the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

The NPfI recommends “Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2, only the amenity levels apply.” The project amenity and intrusive noise levels are listed in Table 2.

Table 2: NPfI Project Intrusiveness and Amenity Noise Criteria, dB(A).

Type of Receiver	Noise Level $L_{eq,15min}$		
	Daytime 0700 to 1800	**Evening 1800 to 2200**	**Night-time 2200 to 0700**
Location A – Visitor Centre	Project Intrusiveness Assessment		
	60	46	39
	Project Amenity Assessment		
	58	53	41
	Project Trigger Noise Level (PTNL)		
	58	**53**	**39**
Location B – Pool Boundary	Project Intrusiveness Assessment		
	56	45	41
	Project Amenity Assessment		
	53	45	43
	Project Trigger Noise Level (PTNL)		
	53	**45**	**41**

4.2.3 'Modifying factor' Adjustments

Penalties may be applied if the noise from the development *"... contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."*

To take into account the potential annoying character of the noise an adjustment of +2dB(A) or +5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), may be added to the measured value to penalise the noise for its potential greater annoyance aspect.

Table C1 of the NSW NPfI provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

4.2.4 Project Trigger Noise Levels

The project trigger noise levels are the most stringent noise levels of the NSW NPfI project intrusiveness and project amenity noise levels for day, evening and night time periods and are project specific. Table 3 below presents the project trigger noise level (PTNL) for the closest receivers.

Table 3: External Project Trigger Noise Levels (PTNL), dB(A).

Location	Time	Descriptor	External PTNL
Location A – Visitor Centre	0700 to 1800	$L_{eq, 15min, day}$	**58**
	1800 to 2200	$L_{eq, 15min, evening}$	**53**
	2200 to 0700	$L_{eq, 15min, night}$	**39**
Location B – Pool Boundary	0700 to 1800	$L_{eq, 15min, day}$	**53**
	1800 to 2200	$L_{eq, 15min, evening}$	**45**
	2200 to 0700	$L_{eq, 15min, night}$	**41**

4.2.5 Sleep Disturbance Noise Limits

In accordance with NSW NPfI (2017), the potential for sleep disturbance from maximum noise level events from premises during the night time period needs to be considered. Sleep disturbance is both awakenings and disturbance to sleep stages.

"Where the subject development/premises night-time noise levels at a residential location exceed:

- *$L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is the greater, and/or*
- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*

a detailed maximum noise level event assessment should be undertaken."

Table details the sleep disturbance noise limits for the nearest residential receivers adjacent to the proposed development. We have adopted a conservative approach and used the base line values given in the NSW NPfI.

Table 4: Sleep Disturbance Noise Limits, dB(A)

Location	Descriptor	Limits based on RBL	Given Noise Limits	PTNL dB(A)
Location A – Visitor Centre	$L_{eq,15mins,\ night}$	39	40	**40**
	$L_{Fmax,\ night}$	49	52	**52**
Location B – Pool Boundary	$L_{eq,15mins,\ night}$	41	40	**40**
	$L_{Fmax,\ night}$	51	52	**52**

4.3 Construction Noise Criteria

4.3.1 Interim Construction Noise Guideline (2011)

The NSW Interim Construction Noise Guideline was developed by the NSW EPA, under the NSW Department of Planning, Industry and Environment. The Guideline contains detailed procedures for the assessment and management of construction noise impacts.

The guideline presents two ways of assessing construction noise impacts – the quantitative method, which is generally suited to longer term construction works and the qualitative method, which is generally suited to short term works (usually not more than 3 weeks) such as infrastructure maintenance.

4.3.2 Construction Noise Criteria

Table and Table set out the management levels for noise at residence and sensitive land uses, respectively. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected management level'.

Table 5: Noise at Residence using Quantitative Assessment, dB(A)

Recommended Hours	Time of Day	External Management Level $L_{eq,15min}$
Recommended Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise Affected RBL + 10
		Highly noise affected 75
Outside recommended standard hours	Any time other than the recommended standard hours	Noise Affected RBL + 5
Note: Noise Levels apply at the boundary that is most exposed to construction noise and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most affected point within 30m of the residence.		

Table 6: Noise at Sensitive Land Use (other than residence), dB(A).

Land Use	External Management Level, $L_{eq,15min}$ (applies when properties are being used)
Industrial premises	75
Commercial premises	65

External Noise Management Levels associated with the construction works are presented in below in Table.

Table 7: Construction Noise Management Levels, dB(A)

Recommended Hours	Time of Day	L_{90}	External Management Level, $L_{eq15min.}$
Location A- Visitor Centre			
Recommended Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	55	*Noise Affected* 65
			*Highly Noise Affected** 75
Outside recommended standard hours	Any time other than the recommended standard hours	34	39
Location B- Pool Boundary			
Recommended Standard Hours	Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	51	*Noise Affected* 65
			*Highly Noise Affected** 75
Outside recommended standard hours	Any time other than the recommended standard hours	36	41
Highly Noise Affected Construction Levels may require respite periods and/or special community consultation to minimize the impacts of noisy works activity.			

For the purposes of this assessment, we have adopted the criteria at **Location A,** which is more closely located to residential receivers to the east and south of the site.

4.3.3 Construction Vibration Criteria

The effects of construction vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration and the possibility of them being disturbed or annoyed;
- Vulnerability of the building structures to vibration induced damaged;
- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

4.3.3.1 Human Response to Vibration

Human are very sensitive to vibration, and they can be disturbed, annoyed and have their work activities interfered with if the levels are too high. The Interim Construction Noise Guideline references "Assessing Vibration: a technical guideline" (Vibration Guideline) issued by the Department of Environment and Conservation NSW for measurement and assessment of vibration. The Vibration Guideline provides vibration criteria for continuous, impulsive and intermittent vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading. Blasting is assessed using ANZECC (1990).	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

These criteria are discussed in more detail in the following sections.

4.3.3.1.1 Continuous and impulsive vibration (1-80 Hz)

According to the Vibration Guideline for continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted root-mean-square acceleration values and results are to be compared against the following preferred and maximum values given for each orthogonal axis. The frequency weightings as per BS6841(1987) (reproduced in Appendix B3 of the guideline) are to be applied to the RMS measurement values (1-80Hz). The criteria in the Vibration Guideline are derived from the limiting values of the assessment curves and multiplying factors from BS 6472(1992) (the curves are no longer referenced in the superseded version of the standard BS 6472(2008). We have assumed hotels will be assessed as per the criteria for residences.

Table 2.2 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1–80 Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am

2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992

The Vibration Guideline notes *"Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum value may be used if they can be justified. For values beyond the maximum value, the operator should negotiate directly with the affected community. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short-term duration. An example is a construction or excavation project."*

4.3.3.2 Structural Response to Vibration - German Standard DIN 4150-3:1999

The German Standard DIN 4150-3 Structural Vibration Part 3: Effects on building and structures is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

The response of a building to vibration is affected by several factors that include its type of foundation, the underlying ground conditions, its construction and the state of the building. Please note the construction vibration limits are designed to ensure the structural integrity of nearby buildings and are not for human comfort; the limits are well above perceptibility.

According to DIN 4150 short term vibration refers to vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated. Long-term vibration refers to all types of vibration not covered by the definition of 'short-term vibration'. The criteria for short-term and long-term vibration are listed in the following.

4.3.3.2.1 Guideline Values for evaluation of short-term vibration - DIN 4150-3:1999

The vibration limits of table 1 in DIN 4150-3 (1999) refer to the evaluation of the effects of short-term vibration on structures.

These criteria are the peak particle velocities (ppv) measured on any foundation or uppermost full storey of any building not related to the site and are listed in the Table below.

It should however be noted that compliance with the vibration limits to avoid structural damage of buildings, cannot provide certainty. If damage occurs despite compliance with the standard, it is to be assumed that other causes are responsible, however, further investigations are necessary. And on the other hand, exceeding the limits does not necessarily lead to damage.

Table 8: DIN 4150-3 Construction Vibration Limits – Short Term (mm/s).

Type of Structures	Guideline values for vibration velocity			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50 Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, **Industrial building** and building of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

4.3.3.2.2 Guideline Values for evaluation of long-term vibration - DIN 4150-3:1999

The vibration limits of table 3 in DIN 4150-3 (1999) refer to the evaluation of the effects of long-term vibration on structures.

The criteria are the peak particle velocities measured on the uppermost full storey of any building not related to the site and are listed in Table 9 below.

According to the standard, *exceeding the values listed below does not necessarily lead to damage*.

If a building is subject to harmonic vibration, then maximum values can occur in floors other than the top floor, or in the foundation. The values given also apply in these cases.

Table 9: DIN 4150-3 Construction Vibration Limits – Long Term

Type of Structures	Guideline values for velocity, vi, in mm/s of vibration in horizontal plane of highest floor, at all frequencies
Buildings for commercial purposes, Industrial building and building of similar design	10
Dwellings and buildings of similar design and/or occupancy	5
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	2.5

4.4 NSW Road Noise Criteria

The requirements of the NSW Road Noise Policy are applicable to this assessment. Table 10 summarises the assessment criteria for residential zones based on the type of road and the land use for noise from public roads. The functional role for each type of road category is as follows:

- Freeways or motorways/arterial roads:
  - Support major regional and inter- regional traffic movement.
  - Freeways and motorways usually feature strict access controls via grade separated interchanges.
- Sub-arterial roads:
  - Provide connection between arterial roads and local roads.
  - May support arterial roads during peak periods.
  - May have been designed as local streets but can serve major traffic generating developments or support non-local traffic.
- Local roads:
  - Provide vehicular access to abutting property and surrounding streets.
  - Provide a network for the movement of pedestrians and cyclists and enable social interaction in a neighbourhood.
  - Should connect, where practicable, only to sub-arterial roads.

Table 10: Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/land use	Assessment Criteria dB(A)	
		$L_{eq,15hour}$ Day (7am to 10pm) dB(A)	$L_{Aeq,9hour}$ Night (10pm to 7am) dB(A)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	55 (External)	$L_{Aeq,9hour}$ 50 (External)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60 (External)	55 (External)
Local Roads	4. Existing residences affected by noise from new local road corridors 5. Existing residences affected by noise from redevelopment of existing local roads 6. Existing residences affected by additional traffic on existing local roads generated by land use developments	55 (External)	50 (External)

The NSW Road Noise Policy notes the following:

"Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person."

Change in Traffic Noise = 10 x log (Proposed vehicles per hour/Existing vehicles per hour) – where all other environmental factors e.g. speed, gradient, % heavy vehicles are largely constant;

Where a change of >2dB is considered to represent a perceptible change in traffic noise levels.

5 PREDICTED ACOUSTIC IMPACTS

5.1 Operational Noise Impacts

We understand that mechanical plant and equipment is currently in design development, but subject to detailed further detailed considerations, which may impact upon location and subsequent mitigation measures. At this stage we note that the proposed plant will be located at typical minimum distances of 75m from the nearest affected receivers.

For guidance purposes, we recommend that the limiting aggregate sound power level L_w84 dB(A) will be required for mechanical plant to achieve compliance with the NSW NPfI at night. Given the relative set back distance to the nearest affected receivers, we anticipate that the application of best practice measures, highlighted in Section 6 will be suitable to achieve the project criteria, outlined in this report. This recommendation will be further developed further during the detailed design aspects of the project.

5.2 Aquatic Centre Noise Impacts

We note that the main swimming pool will be enclosed, which will provide considerable noise attenuation from the main swimming area. We understand that the main hours of operation for the Aquatic Centre will be closed from 6am-7am and after 9pm.

For the use of the main swimming pool, we have assumed a typical worst-case sporting type event, with a previously measured sound power level (L_w) of 110 dB(A), typical best practice reverberation time of <2.0 seconds and internal reverberant noise level of 87 dB(A). Predicted noise emissions from the facility were determined to be comply with the NPfI criteria with doors open during daytime and evening operation, as shown in Table 11. We understand that the doors to the facility will be closed past 9.00pm. Hence predictions at early morning (6am-7am period) and at night are for guidance purposes only.

Table 11: Predicted noise emissions from the aquatic centre, $L_{eq15min}$, dB(A)

Location	Assessment Period	PTNL dB(A)	Predicted Noise Emission, $L_{eq15min}$ dB(A)	Complies Yes/No
Aquatic Centre Doors Open				
3 Vesper Street, Batemans Bay	Day 0700-1800	58	44	Yes
	Evening 1800-2200	53		Yes
	Night 2200-0700	39		N/A*
Aquatic Centre Doors Closed				
3 Vesper Street, Batemans Bay	Day 0700-1800	58	29	Yes
	Evening 1800-2200	53		Yes
	Night 2200-0700	39		Yes

* It is proposed that doors to the Aquatic Centre will be closed at 6.00am and 9.00pm. This prediction is for guidance purposes only.

5.3 Theatre and Cultural Centre Noise Emissions

For preliminary purposes, we have assessed a typical worst-case crowd activity of 350 persons singing within the main theatre auditorium, assuming typical sound power levels of Lw112 dB(A) and a reverberant internal noise level of 90 dB(A), at approximately 120m from the nearest sensitive receivers in both Hill Street and Vesper Street.

For the main building envelope, we have assumed a predominantly steel frame 92mm stud with double sheeted 12mm compressed fibrous cement walls (Rw62) and lightweight roofing structure (metal deck, insulation, 100mm air cavity, resilient hangers and double plasterboard ceiling Rw50) and theatre doors both closed and open during performances. These assumptions will be further developed further during the detailed design aspects of the project.

For preliminary purposes, have assumed a typical theatre reverberation time of 1.2 seconds at mid-frequency, based upon AS2107-2016 Appendix A, 'Spaces for Speech'. Predicted noise levels are presented below in Table 12.

Table 12: Predicted typical worst-case theatre noise emissions to the nearest affected receivers, $L_{eq15min}$, dB(A).

Location	Assessment Period	PTNL dB(A)	Predicted Noise Emission (350 persons singing)	Complies Yes/No
Theatre Doors Open				
3 Vesper Street, and 1 Hill Street, Batemans Bay	Day 0700-1800	58	40	Yes
	Evening 1800-2200	53		Yes
	Night 2200-0700	39		N/A*
Theatre Doors Closed				
3 Vesper Street, and 1 Hill Street, Batemans Bay	Day 0700-1800	58	25	Yes
	Evening 1800-2200	53		Yes
	Night 2200-0700	39		Yes
* It is proposed that doors to the Theatre will be closed past 10.00pm. This prediction is for guidance purposes only.				

As shown, provided that very loud performances in the main theatre are undertaken inside the main theatre, with the doors closed will comply in all cases. It is not proposed to have the theatre doors open past 10.00pm, hence it is anticipated that the noise emissions from the theatre will comply with the noise criteria at night.

5.4 Carpark Noise

Based upon our review of the TTPP Traffic report for the BBRAALC project we understand that the primary vehicle access will be at the intersection of Vesper Street and Beach Road. This access point will be signalised and provide turning movements in each direction. It is proposed that a secondary access point will be on the southern side of the site on Vesper Street.

Based upon current information provided, we understand there is currently provision for 202 car spaces at the proposed facility. We have assumed that one quarter of the carpark will leave the site in a 15-minute noise assessment period i.e. 50 vehicle movements.

The entrance to the southern carpark is restricted to emergency vehicles only. The southern egress is for large service vehicles, fire trucks and ambulance movements. General traffic is permissible but will be encouraged to leave the Centre via the Beach Rd intersection after 10pm. The alternate access at the south of the site provides operational benefits for service vehicles, coaches and buses and emergency vehicles allowing these vehicles to efficiently access and manoeuvre around the site.

- Scenario A Southern vehicle access from Vesper road for emergency/service vehicles only.
- Scenario B Southern egress is available for large service vehicles and emergency vehicles circulating through the site. General traffic is permissible but will be encouraged to leave the Centre via the Beach Road intersection after 10pm.

To assess and provide quantification of noise levels from the BBRAALC carpark, Scenarios A and B were investigated for compliance with project noise criteria at the nearest affected residences in Vesper Street.

Scenario A: Emergency/Service Vehicles Only

- Two emergency/service vehicle entering the southern carpark in a 15-minute period, at 75m distance to the receivers;
- The remaining 48 cars exiting the Beach Rd northern ingress/egress in a 15-minute period, at 150m distance to the receivers.

Scenario B: General Traffic and Emergency/Service Vehicles

- Five cars/services vehicles (general traffic) in 15 minutes leaving via the southern side and;
- The remaining 45 cars exiting the Beach Rd northern ingress/egress in a 15-minute period, at 150m distance to the receivers.

Modelling Assumptions

- Typical car movement traverse of 30 seconds inside the carpark, at 20-30km/h;
- Using a typical vehicle L_{Amax} of 65 dB(A) measured at 8m traversing a carpark.

where: $SEL = L_{Amax} + 10 \log ((0.5 \times (t2-t1)) / t_{ref})$ and:

- t_{ref} = 1 second;
- SEL = sound exposure level normalised to 1 second;
- N = no. events and in period T;
- T = total time period under consideration in seconds which is 15 minutes, or 900 seconds;
- (t_2-t_1) = duration of single event in seconds.

Predicted free field noise emissions from the carpark are presented below in Table 13.

Table 13: Predicted noise emissions from the proposed carpark for 50 vehicles exiting the carpark, $L_{eq15min,}$ dB(A).

Location	Period	PTNL dB(A)	Predicted Noise Emission dB(A)	Complies Yes/No
Scenario A: Emergency/Services Vehicle In Scenario (2 emergency or service vehicles IN, 48 cars via OUT via northern egress).				
3 Vesper Street, Batemans Bay	Day (0700-1800)	58	39	Yes
	Evening (1800-2200)	53		Yes
	Night (2200-0700)	39		Yes
Scenario B: Public Use Scenario (5 emergency or public vehicles OUT, via southern egress, 45 cars OUT via northern egress)				
3 Vesper Street, Batemans Bay	Day (0700-1800)	58	39	Yes
	Evening (1800-2200)	53		Yes
	Night (2200-0700)	39		Yes

Based upon the above findings, it is recommended that the use of the Beach Rd exit in encouraged in the management of noise from the carpark. As shown the use of the southern ingress/egress for public use, should be discouraged by venue management as much as possible. However, as shown in Scenario B, up to 5 vehicles exiting the southern end of the carpark in 15 minutes cars will comply with the night time project noise criteria.

5.5 Sleep Disturbance

With regards to sleep disturbance impacts, we have assumed a typical door slam L_{max} sound power level of 103 dB(A) and a typical distance of 75m near the Vesper Street entrance and rear carpark areas, at approximately 150m distance. As shown, predicted door slams are shown to marginally exceed the sleep disturbance criteria, past 10pm at closer distances to the receivers. Noise mitigation measures will be discussed further in Section 6.

Table 14: Predicted sleep disturbance impacts from car door slams at the proposed carpark, $L_{1\ 15min}$ dB(A).

Location/Period	Distance	PTNL dB(A)	Predicted Noise Emission car door slams, L_1 dB(A)	Complies Yes/No
3 Vesper Street, Batemans Bay - Night (2200-0700)	75m	52	55	No
	150m	52	49	Yes

5.6 Traffic Noise Impacts

Based upon NDY's assessment of the TTPP Traffic report, existing traffic conditions were surveyed at the intersection of Beach Road and Vesper Street, in April 2019 for the following periods: Thursday 5-6pm; Saturday 11.15am-12.15pm and Monday 2pm-3pm. It is anticipated that the combined facilities will generate a typical increase of 178 vehicle movements per hour. The following increases in traffic noise have been predicted below in Table 15.

Table 15: Predicted change in traffic noise, dB(A).

Change in traffic noise levels, based upon increased vph.			
Vesper St (North-South)			
Existing Traffic vph	**Thurs 5-6pm**	**Sat 11.15am-12.15pm**	**Mon 2pm-3pm**
	1086	1512	1150
Proposed Additional (60% of 178 vph)	107	107	107
Total	1193	1619	1257
Change dB(A)	***+0.4***	***+0.3***	***+0.4***
Complies with NSW RNP <2dB	Yes	Yes	Yes
Beach Rd (East-west)			
Existing Traffic vph	**Thurs 5-6pm**	**Sat 11.15am-12.15pm**	**Mon 2pm-3pm**
	375	670	704
Proposed Additional (40% of 178 vph)	71	71	71
Total	446	741	775
Change dB(A)	***+0.8***	***+0.4***	***+0.4***
Complies with NSW RNP <2dB	Yes	Yes	Yes

As shown predicted traffic noise increases during peak periods are in the order of +0.3 to +0.8 dB(A), i.e. < 2dB(A) increase, which complies with the requirements of the NSW RNP. Based upon these

findings, there are no additional road traffic noise mitigation measures to the existing road network required.

5.7 Construction Noise and Vibration

5.7.1 Construction Noise Impacts

At the time of writing, the precise nature of construction activity for the BBRAALC development had not yet been finalised. The purposes of this assessment we have selected a range of typical plant and activity, which will be conducted during a facility of this type. In addition, we anticipate the types of activity and plant used will vary during the various phase of the project (DEFRA 2005). The following typical plant sound power levels have been used to determine noise impacts at the nearest affected receivers, as shown in Table 16.

Table 16: Typical construction plant and equipment sound power levels, L_w

Typical Plant Items	Octave Band Centre Frequency, Hz								
	63	125	250	500	1k	2k	4k	8k	dB(A)
A: Site Establishment Phase									
Bobcat, 5t	99	99	94	87	87	86	82	76	**93**
Truck Delivery/Spoil Collection	114	110	105	102	98	94	90	83	**104**
Screw Piler	104	101	90	94	90	86	82	77	**95**
Angle Grinder	85	79	80	88	98	105	101	101	**109**
Hammer	94	94	96	96	91	85	83	79	**97**
B: Structural Works									
Bobcat, 5t	99	99	94	87	87	86	82	76	**93**
Truck Delivery	114	110	105	102	98	94	90	83	**104**
Concrete Pump, 25kW	99	99	94	87	87	86	82	76	**93**
Concrete Saws, 3kW	110	110	100	99	97	96	90	92	**103**
Wheeled Mobile Crane	113	101	95	99	100	97	91	84	**104**
Angle Grinder	85	79	80	88	98	105	101	101	**109**
Hammer	94	94	96	96	91	85	83	79	**97**
C: Fit out Works (with assumed enclosure loss 20dB)									
Angle Grinder	85	79	80	88	98	105	101	101	**109**
Hammer	94	94	96	96	91	85	83	79	**97**

DEFRA (2005) 'Update of noise database for prediction of noise on construction sites.

Predicted construction noise levels at typical working distances of 60m and 100m are shown in Table 17. At working distances of 60m exceedances of up to 4dB(A) were predicted. This may require some consideration some minor noise management measures, which have been outlined in Section 6 of this report.

Table 17: Predicted construction noise levels, $L_{eq15min}$, dB(A).

Construction Phase	ICNG Criteria – Noise Affected dB(A)	Predicted Construction Noise Levels dB(A)	Complies Yes/No
Working Distances of 60m to the nearest affected residence – Recommended Standard Hours			
Site Establishment Phase	65	52-69	**No**
Main Construction Phase	65	52-69	**No**
Fit out Works	65	35-47*	**Yes**
Working Distances of 100m to the nearest affected residence – Recommended Standard Hours			
Site Establishment Phase	65	48-65	**Yes**
Main Construction Phase	65	48-65	**Yes**
Fit out Works	65	31-43*	**Yes**
*Assumed building enclosure attenuation of 20dB(A).			

It should be noted that predicted construction noise levels exceed the Noise Affected Criteria. However, construction noise levels do not exceed Highly Noise Affected Criteria 75 dB(A). Hence it is anticipated that construction works can be undertaken without respite periods or special community consultation measures. Recommended noise mitigation measures are presented in Section 6.

At this stage, based upon predicted noise levels above, it is not recommended that construction works are undertaken outside recommended standard hours.

5.7.2 Construction Vibration Impacts

The NSW RMS provides suitable working distances for the operation of plant and equipment near sensitive receivers, as shown in Table 18. At this stage, subject to confirmation, it is not anticipated that the use of rock hammers or other vibration plant will be used on the project. However, as shown as residential receivers are at a considerable distance, safe working distances are effectively complied with. However, should vibratory rollers be proposed during construction, then some consideration of their operation, relative to residential receivers should be considered during these works.

Table 18: RMS guideline for safe working distances for construction vibration, metres(m).

Plant Item	Rating/Description	Cosmetic Damage (BS 7385)	Human Response (OH&E Vibration Guideline - AVaTG)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	2 m
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m

6 RECOMMENDATIONS

The proposed BBRAALC facility was assessed for key activities and assessed against the provisions under the Protection of the Environmental and Operations Act (1997). The results of the noise monitoring have determined that background noise levels at night are substantially lower than the day and evening periods. This has resulted in the facility presenting more adverse noise impacts during this period.

Mechanical plant and equipment selections for the project is subject to further detailed design development, which may impact on final location and noise mitigation measures. Based upon typical worst-case distances to the nearest affected receivers, a limiting aggregate sound power level of Lw84 dB(A) has been set, subject to final design and confirmed plant locations. However, as this stage, is anticipated that typical best practice noise mitigation measures will be required to achieve compliance. These include, the use of enclosures, distance attenuation, attenuators and barriers. This will be developed during the detailed design phase of the project to meet the statutory noise limits for the project.

Noise emissions from the main theatre/function centre will comply with the noise criteria at night with doors/openings to the facility fully closed. Similarly, noise emissions from the aquatic centre will be compliant with the criteria, except for night time, if the doors to the facility are open during peak events. Similarly, it is recommended that during peak activities, all doors/openings to the facility are fully closed. We understand that these facilities will not have doors open past 10pm in any case.

With regards to the operational car park, two carpark scenarios were investigated, based upon the proposed use of the northern (Beach Rd Intersection) entry/exit and southern (Vesper Street) exit to the site. Predicted noise levels just complied with the night time noise criteria in both cases. Hence, it is strongly recommended that any public use of the southern carpark is limited as much as possible. The northern Beach Rd intersection should be strongly encouraged for public use and movements from the southern exit should be limited.

There is some potential for sleep disturbance past 10pm, from activities such as car doors slamming, however best practice measures such as ‘keep quiet’ car park signage, during performance, and carpark attendants/ushers could form part of an integrated facility management plan for the site at night, to minimise sleep disturbance impacts.

Predicted construction noise impacts were predicted to comply with the Recommended Standard Hours criteria at distances of >100m from the nearest affected receivers. However, at closer distances it was predicted that exceedances of up to 4 dB(A) will occur. It is anticipated that management measures outlined in the NSW Interim Construction Noise Guideline, e.g. selection of quieter plant, used of quiet plant, barrier screens, and enclosures could be used to mitigate these impacts. Australian Standards 2436-2010 “Table C3”, shown below also provides feasible and reasonable noise mitigation measures which can effectively manage these exceedances. Screening and distance attenuation measures are highlighted as being relatively effective measures in managing construction noise from the site, as shown in Table 19.

Table 19: AS2346 typical best practice construction noise mitigation measures.

Control by	Nominal noise reduction, in total A-weighted sound pressure level, dB(A)
Distance	Approximately 6 per doubling of distance
Screening	Normally 5 to 10 maximum 15
Enclosure	Normally 15 to 25 maximum 50
Silencing	Normally 5 to 10 maximum 20.

Safe working distances, as per the RMS Construction Noise and Vibration Guideline will need to be maintained to limit the impacts of construction vibration and it is anticipated that there will be suitable distance attenuation between the proposed facility and residential receivers. The use of vibrating plant and equipment will need be confirmed at a later stage of the project.

7 CONCLUSION

A noise and vibration impact assessment were undertaken for the proposed Batemans Regional Aquatic and Arts Centre (BBRAALC). Noise impacts from the facility were determined to generally comply with noise and vibration criteria during the day and evening periods, due higher levels of traffic noise and civic activity which occur during these periods.

While noise management measures are not fully quantifiable, it is anticipated that facility management, including the development of major event management plans would form the basis of an effective means of controlling noise emissions from the site, particularly in relation to night time sleep disturbance associated with cars departing the site.

In summary, the BBRAALC facility has been assessed against potential noise impacts, with night time being the most critical impact. The range of measures outlined in this report have largely been shown to result in the development complying with relevant criteria. It is predicted that some potential for sleep disturbance could occur, although this can be easily managed through event management measures, designed to minimise the departure of patrons into the evening period.

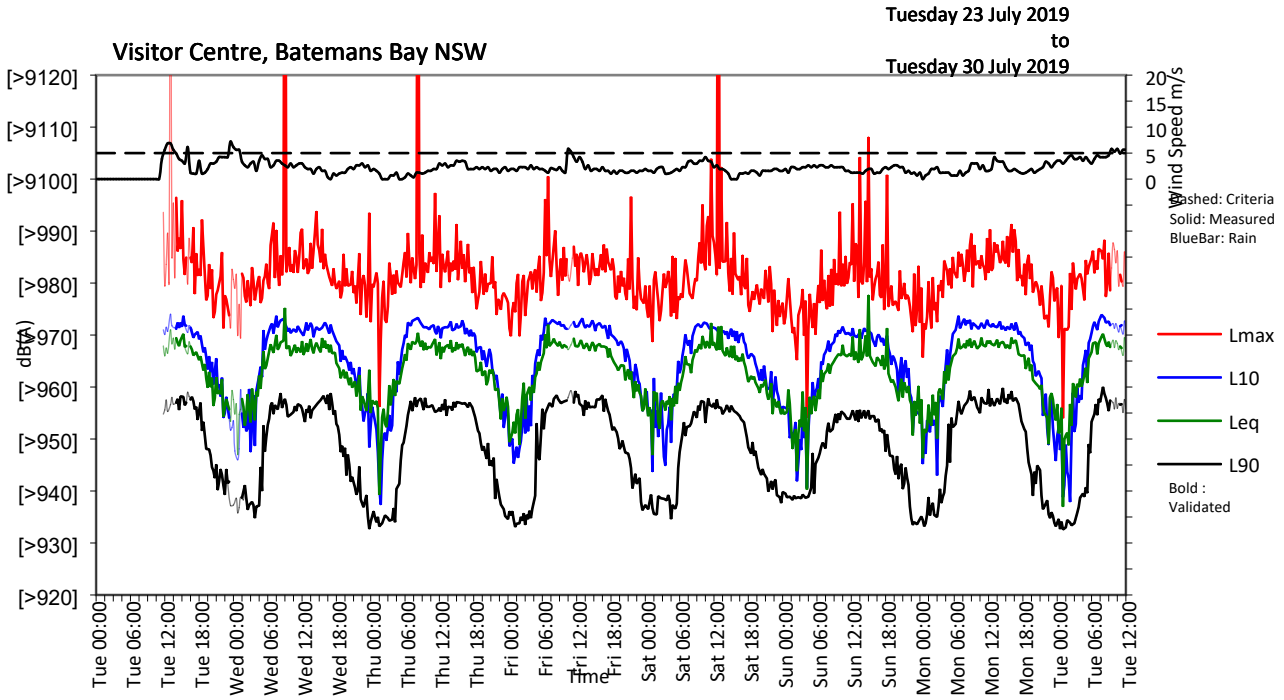
APPENDIX A - ACOUSTIC TERMINOLOGY

'A' Weighted	Frequency filter applied to a noise spectrum that adjusts ('weights') each frequency differently. The 'A' weighting very roughly corresponds with subjective assessments of noise levels.
Ambient Sound	The overall noise level associated with an environment or space. It is usually a composite of sounds from many sources, both near and far. Usually taken to mean the L_{Aeq} value.
Background Noise Level	The average of the lowest measured noise levels in an affected area, in the absence of noise from occupants and/or unwanted external noise sources. Usually taken to mean the L_{A90} value.
dB(A)	The overall 'A' Weighted sound pressure level.
Decibel, dB	Unit of acoustic measurement. Measurements of power, pressure and intensity may be expressed in dB relative to standard reference levels.
L_{90}, L_{10}, etc	A statistical measurement giving the sound pressure level which is exceeded for the given percentile over a measurement period, ie L_{90} is the level which is exceeded for 90% of the measurement period. Likewise, the L_{10} level is the noise level exceeded for 10% of the measurement time. The L_{A90}, L_{A10} (etc) levels are the A-weighted noise levels exceeded for the respective percentile.
$L_{Aeq, T}$	Equivalent continuous A-weighted sound pressure level. The equivalent continuous A-weighted sound that, within a measurement time interval T, has the same A-weighted sound energy as a time-varying sound.
Noise Reduction	The difference in sound pressure level between any two areas. The term 'noise reduction' does not specify any grade or performance quality unless accompanied by a specification of the units and conditions under which the units apply.
NR, Noise Rating	Single number evaluation of a background or ambient noise level. The noise spectrum is plotted against a series of NR curves and the NR is determined by the lowest NR curve not crossed by the noise spectrum. The NR is categorized by the level at 1 kHz i.e. the NR 50 curve has a value of 50 dB at 1 kHz. The NR level is normally around 5 to 6 dB below the 'A' weighted sound pressure level.
R_W	Weighted Sound Reduction Index. A single number value of the acoustic performance of a partition or building element. Calculation procedures for R_W are defined in ISO 140-2:1991 "*Measurement of Sound Insulation in Buildings and of Building Elements Part 2*". The R_W is function of the level difference between two spaces separated by the building partition or element, surface area of the building partition or element, room volume and area of absorption in the receiver room (generally measured by the reverberation time).
Sound Isolation	A reference to the degree of acoustical separation between any two areas. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The

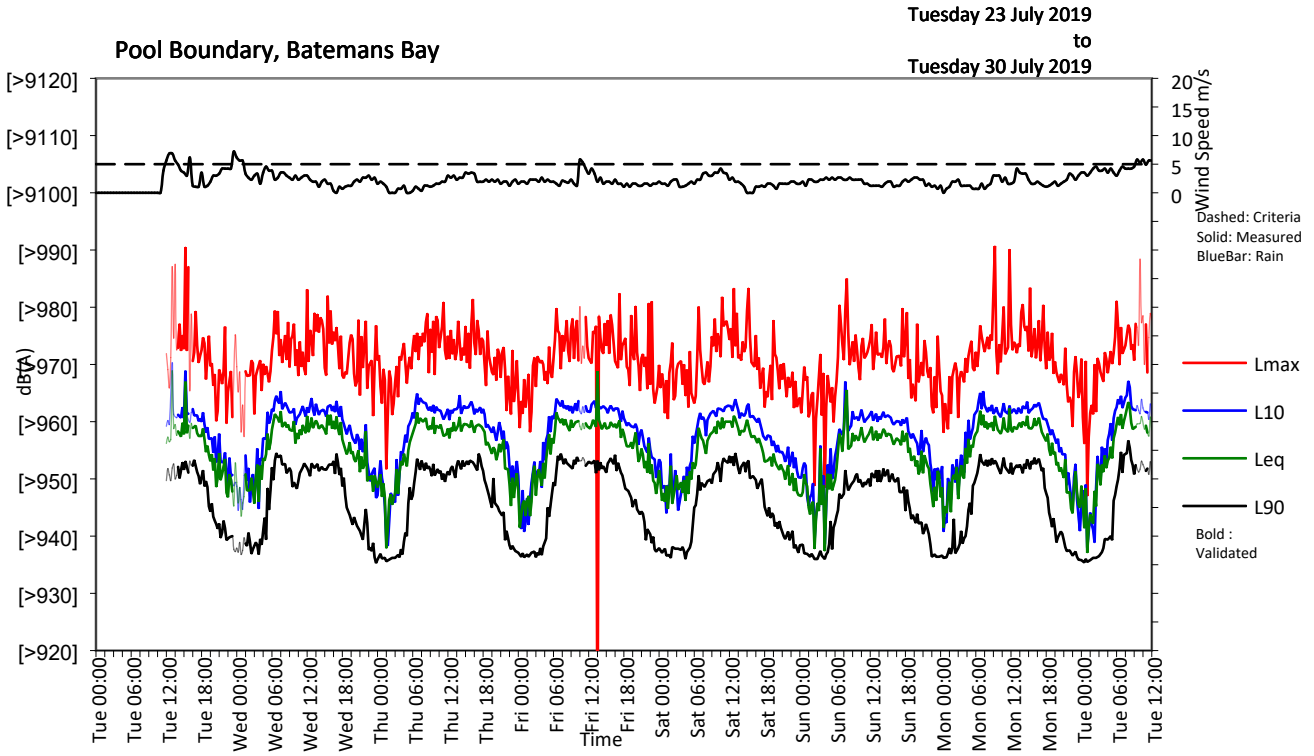
	term 'sound isolation' does not specify any grade or performance quality and requires the units and measurement conditions to be specified.
Sound Pressure Level L_p, dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level depends on the distance from a source and on the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms. sound pressure to the reference sound pressure of 20 microPascals - $20\log_{10}$(measured rms pressure/2 x 10^{-6})

APPENDIX B – UNATTENDED MONITORING RESULTS

7.1 Location A



7.2 Location B



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