Appendix H

Updated Noise and Vibration Impact Assessment

Transport for NSW

Kamay Ferry Wharves Project

Updated Surface Noise and Vibration Impact Assessment Report

KFW01-ARUP-BPW-NV-RPT-000054

Final | 29 September 2021

Job number 273023-00

Arup Australia Pty Ltd, ABN 76 625 912 665

Arup
Level 5
151 Clarence Street
Sydney NSW 2000
Australia
www.arup.com

ARUP

Executive summary

This report assesses noise and vibration impacts associated with the construction and operation of the Kamay Ferry Wharves conducted in accordance with Secretary's Environmental Assessment Requirements (SEARS) and relevant noise and vibration policies and guidance documents.

This report has been updated to respond to the Environment Protection Authority (EPA) comments on the following items:

- Validity of the noise monitoring results in La Perouse
- Addition of two residential receivers in La Perouse
- Clarity on the operating hours of the wharf operations
- Correction of errors with the Noise Policy for Industry (NPfI) operational criteria
- Sound power levels used in the assessment of the wharves operations
- Exclusion of an assessment of a public announcement (PA) system in the wharf
- Assumptions on the sound power levels of construction equipment
- Assumptions used in the assessment of the operational road traffic.

The assessment has been based on information within the concept design reports, and where necessary supplemented by appropriate assumptions based on comparable projects to enable a robust assessment.

Background noise monitoring has been undertaken at the project site to establish the baseline noise environment for the derivation of construction and operational noise criteria. The noise monitoring was carried out from Thursday 26 March to Monday 2 April 2020 just after the start of Covid-19 restrictions lockdown. The results of the noise monitoring may have been affected by the reduced activity however for both locations, the measured Rating Background Levels (RBLs) are consistent with the referenced data from noise monitoring conducted by Wilkinson Murray as part of the Botany Bay Cable Project EIS between Friday 21 July and Friday 28 July in 2006 (Wilkinson Murray, 2006). For the La Perouse location, the noise monitoring was also affected by the operation of mechanical plant between the hours of 11:00 to 20:00. While this results in data that does not strictly accord with the NPfI, provisions in Section B1.3 of the NPfI relating to the analysis procedure of monitoring data allows use of data where it can be demonstrated that the affected period would not materially alter the established RBLs.

The results from the construction noise assessment indicate that noise generated from the various stages of demolition and construction are predicted to exceed the noise management levels (NMLs) and for some receivers, in excess of the highly affected targets. Majority of the works will take place during standard hours, except for piling works which will be out of hours and assessed accordingly. It should be noted that in general, construction works are temporary in nature

therefore any potential noise impact on the community and the surrounding environment will not be permanent. Notwithstanding, preliminary recommendations have been provided for the management of potential impacts, including development of a detailed management plan.

Regarding potential vibration impact from construction works, based on the identified nearest receiver locations, and proposed construction works, the likelihood of adverse vibration impacts is low due to the distances from vibration intensive equipment to the nearest sensitive receivers.

The results from the road traffic assessment from both construction works and ferry wharves operations indicate that any increase in the road traffic will have an insignificant effect on the ambient noise environment.

There is currently no existing framework available to assess the operational noise for marine vessels. Therefore, the NPfI has been used as the criteria within the policy is considered to be conservative. Operating hours of the wharves are to be confirmed once an operator is selected. The noise assessment has assessed the operation of the wharves between 7am and 6pm. Any extension of the proposed operating hours would need to be assessed further. This assessment does not include the effects of underwater noise during operation as this has been assessed in the Underwater Noise Assessment (Appendix P of the EIS).

The typical worst-case situation (i.e. full capacity) for each wharf was modelled for a 15-minute period wherein one public ferry is arriving, berthing and then departing with sounding of horn during arrival and departure, at each location; and one commercial vessel is arriving, berthing and idling for 7.5 minutes at each location. It is assumed that a commercial vessel would not be departing within the same 15-minute period. Based on this scenario, the predicted noise levels are well below project noise trigger levels for most receivers except for the Gujaga MACS Childcare Centre in La Perouse. A level of 41 $dBL_{Aeq15min}$ with a minor exceedance of 1 dB for enhanced meteorological conditions was predicted. Given that the criteria is conservative and the existing ambient noise level is much higher at 48 $dBL_{Aeq15min}$, the operations of the La Perouse ferry wharf would not cause a significant impact to the existing ambient noise environment.

It should be noted that the assessment is conservative as it has included a 5 dB correction to account for the potential that noise emission from the operations triggers either the tonal or low frequency characteristic correction. It is recommended that a confirmation of this assessment be undertaken once a ferry operator has been appointed and details of the ferry sound power levels are made available.

Contents

Appendices

1 Introduction

1.1 Project overview

Transport for New South Wales (TfNSW) is seeking approval to reinstate the ferry wharves at La Perouse and Kurnell in Botany Bay (the project) under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (see Figure 1) as State significant infrastructure. The project would allow for an alternative connection between La Perouse and Kurnell rather than by road. The primary purpose of this infrastructure would be to operate a public ferry service to service visitors to the area and by the local community for cultural and recreational purposes, as well as for commuting. It would also provide supplementary temporary mooring for tourism-related commercial vessels and recreational boating.

The project provides opportunities for significant cultural, health and economic benefits to the local Aboriginal community by providing improved access to culturally significant sites. It is also expected to deliver benefits and opportunities to wider communities on either side of Botany Bay such as investment opportunities in ferry service(s) and other new visitor/tourist experiences.

Key features of the project include:

- Two new wharves, one at La Perouse and one at Kurnell that would include:
  - Berth for ferries
  - Berth for recreational vessels
  - Facilities for recreational fishing
  - Sheltered waiting areas
  - Landside tie-in and landscaping
- Reconfiguration of existing car parking areas at La Perouse to increase the number of spaces
- Installation of utilities to service the wharves.

The total construction period is anticipated to take up to 13 months, starting in 2022. The construction would occur across both sites at the same time.

A concept design has been developed for the project, which forms the basis of this assessment. This noise and vibration assessment supports the Environmental Impact Statement (EIS) prepared for the project.

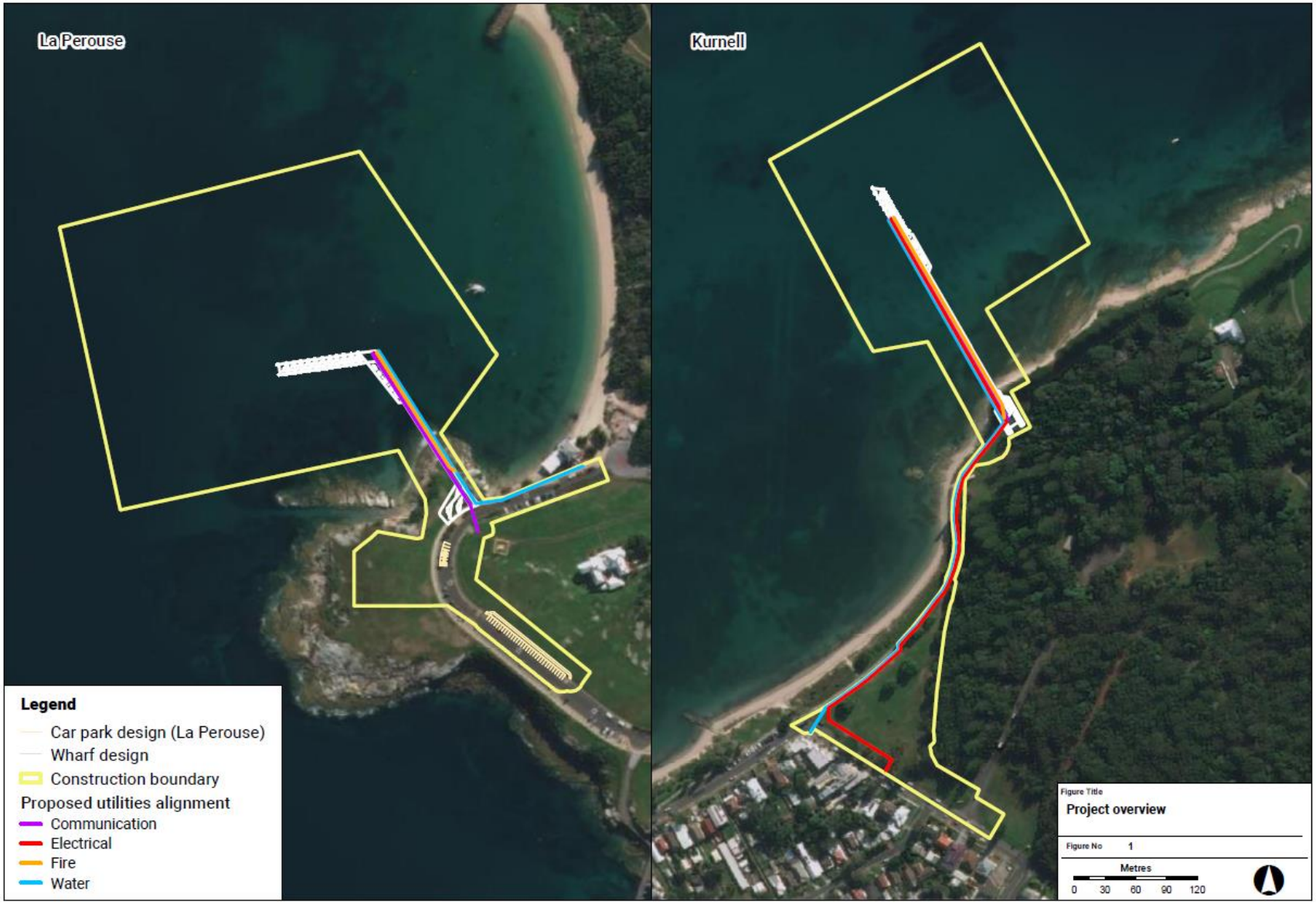


Figure 1: Project overview

1.2 Secretary's Environmental Assessment Requirements relevant to this report

Table 1 identifies the Secretary's Environmental Assessment Requirements (SEARs) which are relevant to this technical assessment.

Table 1: SEARs for noise and vibration

SEARs relevant to this technical report	Where addressed in this technical report
For each key issue the Proponent must: (a) describe the biophysical, social and economic environment, as far as it is relevant to that issue, including baseline data that is reflective of current guidelines where relevant; (b) describe the legislative and policy context, as far as it is relevant to the issue; (c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), the impact (comprehensive risk assessment), the impacts of concurrent activities within the project and cumulative impacts; (d) demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies); (e) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant); and detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures.	Section 2; Section 3; Section 5 and Section 6 Section 7 Section 7
Where multiple reasonable and feasible options to avoid or minimise impacts are available, they must be identified and considered, and the proposed measure justified taking into account the public interest.	Section 7
6. Noise and Vibration Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community.	Section 7
1. Land, water and under-water-based construction noise and vibration impacts of the project in accordance with relevant NSW noise and vibration guidelines. The assessment must include noise impacts of construction related traffic.	Section 3.1; Section 3.2; Section 3.4; Section 4.1; Section 5
2. Operational noise impacts on the amenity of sensitive receivers, employees and visitors to the Kamay Botany Bay National Park, vessels approaching, mooring and departing the infrastructure, and vehicular traffic.	Section 3.3; Section 3.4; Section 4.2; Section 6
3. Impacts to the structural integrity and heritage significance of items (including Aboriginal places, items of environmental heritage and maritime archaeology).	Section 4.3

Agency comments	
Environment Protection Authority	
Land and water-based construction noise and vibration impacts of the project in accordance with relevant NSW noise and vibration guidelines, including construction related traffic.	Section 3.1; Section 3.2; Section 3.4; Section 4.1; Section 5
Operational noise impacts on the amenity of local residents and other noise sensitive receivers, and visitors to the Kamay Botany Bay National Park from the use of the infrastructure, including vessels approaching, moored and departing the wharves and increased vehicular traffic.	Section 3.3; Section 3.4; Section 4.2; Section 6
Impacts to the structural integrity and heritage significance of items (including Aboriginal places, items of environmental heritage and maritime archaeology).	Section 4.3
Randwick City Council	
An acoustic report should be prepared in relation to the proposed construction activity. This is important some works may be sited close to residential properties and there may be reverberations and vibration from drilling, digging or excavation works.	Section 3.1; Section 3.2; Section 3.4; Section 4.1; Section 5

1.3 Purpose of this report

This report supports the EIS for the redevelopment of the ferry wharves at La Perouse and Kurnell in Botany Bay. This report assesses the noise and vibration which effect structures on land, this report does not assess noise and vibrations underwater refer to Underwater Noise Assessment for further details.

It is noted that the SEARs do not outline the specific policy for construction and operational noise, however consistent with other SSDAs, this report assesses construction and operational noise and vibration in Table 2.

Table 2: Construction and operational noise and vibration policies and guidelines

Acoustic aspect	Policy or guideline	Report section
Construction noise and vibration	Interim Construction Noise Guideline (ICNG) (Department of Environment and Climate Change NSW, 2009)	Section 5
	Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment Council, 1990)[1]	
	German Standard DIN4150-3 (German Institute for Standardisation, 2016).	
	BS 7385:1993 (British Standard, 1993)	
	Assessing Vibration: A Technical Guideline (Department of Environment and Conservation (NSW), 2006)	

Acoustic aspect	Policy or guideline	Report section
Operational noise from site	NSW Noise Policy for Industry (Environment Protection Authority, 2017)	Section 6
Construction and operational road traffic generated on local road network	Road Noise Policy (Department of Environment, Climate Change and Water NSW, 2011)	Section 5.4 and Section 6.3

1- SEARs makes reference to this guideline, but it has not been taken into account as there are no blasting works in this project

The following outlines the scope of assessment with respect to the above acoustic aspects and relevant policies and guidelines:

- Examine the proposed development to identify acoustic aspects of the construction and operation of the project
- Identify the noise sensitive structures surrounding the site, which are to be assessed regarding construction and operational activities.
- Conduct noise level monitoring to quantify the existing acoustic environment at relevant surrounding receiver locations to set project targets in accordance with relevant policy.
- Where appropriate, carry out a quantitative acoustic assessment of potential impacts and compare against the relevant noise and vibration targets.
- Identify in-principle mitigation or management methods for the control of noise and vibration where required.

A glossary of the acoustic terminology used in this document is presented in Appendix A.

2 Existing environment

2.1 Sensitive receivers

Sensitive receivers which may be affected by the project were identified for the La Perouse and Kurnell. The sensitive receivers assessed are the structures and key sensitive land uses closest to the site most likely affected by noise and vibration, these receivers are the representative sample of all structures in the project area. Assessment of residential and non-residential receivers presented in this report is isolated to the reasonably most-affected receivers.

An assessment for heritage structures and features has been carried and identified in the Aboriginal Cultural Heritage Assessment Report (refer to Appendix E of the EIS) and Statement of Heritage Impact Report (refer to Appendix F of the EIS). While the entire Kamay Botany Bay National Park and La Perouse Point are identified as heritage sites, the list focuses on significant items or structures.

2.1.1 La Perouse

Residential receivers with the potential to be impacted by the project at La Perouse are listed in Table 3. The reasonable most-affected non-residential sensitive receivers are listed in Table 4. All residential and non-residential receivers are also shown in Figure 2.

Table 3: Residential receivers at La Perouse

Receiver ID	Address	No. of floors	Approximate distance to the project area [m]
RES1	51-52 Endeavour Avenue	3	90
RES2	28 Goorawahl Avenue	1	115
RES3	3/1599 Anzac Parade	5	100
RES4	31 Endeavour Avenue	2	170
RES5	1605 Anzac Parade	3	60

Table 4: Reasonably most-affected non-residential sensitive receivers in La Perouse

Receiver ID	Name	Address	No. of floors	Approximate distance to the project area[m]
Commercial				
COM1	The Boatshed	1609 Anzac Pde	2	15
Active Recreation Area				
ARC1	Frenchmans Bay Reserve Playground	46-50 Endeavour Ave	n/a	30
ARC2	Congwong Trail	Henry Head	n/a	215

Receiver ID	Name	Address	No. of floors	Approximate distance to the project area[m]
Passive Recreation Area				
PRC1	Frenchmans Beach	Frenchmans Beach	n/a	130
Cultural				
CUL1	La Perouse Museum	1542 Anzac Pde	2	55
CUL2	Macquarie Watchtower	1599-1601 Anzac Pde	1	90
Child Care				
CHC1	Gujaga MACS Childcare Centre	1 Elaroo Ave	1	420
Community				
CMU1	La Perouse Local Aboriginal Land Council	1 Elaroo Ave	1	450

Non-Aboriginal, Aboriginal heritage receivers and potential archaeologically with the potential to be impacted by the project at La Perouse are listed in Table 5, Table 6 and Table 7 respectively. The sensitive heritage and potential archaeological receiver locations are provided in Figure 3, Figure 4 and Figure 5.

Table 5: Heritage - Non-Aboriginal at La Perouse

Heritage	Address	No. of floors	Approximate distance to the project area [m]
Yarra Bay Beach and Reserve	1 Elaroo Ave	n/a	360
Yarra Bay House	1 Elaroo Ave	1	350
Kamay Botany Bay: Botanical collection sites	La Perouse Point	n/a	<5
Kamay Botany Bay National Park and Towra Point Reserve	La Perouse Point	n/a	<5
Botany Bay National Park	La Perouse Point	n/a	<5
La Perouse Museum	La Perouse Point	2	58
Tomb of Pere le Receveur	La Perouse Point	n/a	55
Macquarie Watchtower	La Perouse Point	1	93
La Perouse Memorial	La Perouse Point	n/a	<5
Bare Island Fort	Bare Island Rd	1	400

Table 6: Heritage - Aboriginal at La Perouse

Heritage	Address	Approximate distance to the project area [m]
45-6-1144 - Engraving	La Perouse Point	10
45-6-0653 – Engraving	La Perouse Point	<5
45-6-0651 - Engraving	La Perouse Point	45

Heritage	Address	Approximate distance to the project area [m]
45-6-0649 - Engraving	La Perouse Point	23
45-6-0648- Engraving	La Perouse Point	49

Table 7: Potential archaeology receivers at La Perouse

Heritage	Address	Approximate distance to the project area [m]
Cable Tanks	La Perouse Point	<5
Gear House	La Perouse Point	<5
Wharf Approach Road	La Perouse Point	<5
Cable House	La Perouse Point	<5
Tennis Court	La Perouse Point	<5
Boat Shed	La Perouse Point	<5

2.1.2 Kurnell

Residential receivers with the potential to be impacted by the project at Kurnell are listed in Table 8. The reasonable most-affected non-residential sensitive receivers are listed in Table 9. All sensitive receivers are also shown in Figure 6 and heritage receivers are shown in Figure 7.

Table 8: Residential receivers for Kurnell works

Receiver ID	Address	No. of floors	Approximate distance to the project area [m]
RES1	3/1 Captain Cook Drive	2	15
RES2	Kamay Botany Bay National Park (Rangers House)	1	155
RES3	10 Prince Charles Parade	1	50
RES4	33 Captain Cook Drive	1	20

Table 9: Reasonably most-affected non-residential sensitive receivers in Kurnell

Receiver ID	Name	Address	No. of floors	Approximate distance to the project area [m]
Commercial				
COM1	Endeavour Coffee and Ice-cream	2/4 Prince Charles Parade	2	15
Educational Facilities				
EDU1	Kamay Botany Bay Environmental Education Centre	21 Cape Colander Drive	1	315
Active Recreation Area				
ACR1	Marton Park	96 Captain Cook Drive	n/a	580

Receiver ID	Name	Address	No. of floors	Approximate distance to the project area [m]
ACR2	Yena Walking Trail	Kamay Botany Bay National Park	n/a	330
Passive Recreation Area				
PRC1	Commemoration Flat	Kamay Botany Bay National Park	n/a	400
Child Care				
CHC1	Kurnell Preschool Kindergarten	96 Captain Cook Drive	1	640
Place of Worship				
POW1	St John Fisher Catholic Church	62 Prince Charles Parade	2	325
Industrial Area				
IND1	Caltex Kurnell Terminal	2 Solander Street	1	300

Non-Aboriginal, Aboriginal heritage and potential archaeologically with the potential to be impacted by the project at Kurnell are listed in Table 10, Table 11 and Table 12 respectively. The sensitive heritage and potential archaeological receiver locations are provided in Figure 7, Figure 8 and Figure 9.

Table 10: Heritage - Non-Aboriginal at Kurnell

Receiver	Address	Approximate distance to the project area [m]
Landing Place Wharf Abutment	Kamay Botany Bay National Park	<5
Captain Cook's Landing Site	Kamay Botany Bay National Park	5
Kurnell Peninsula Headland	Kamay Botany Bay National Park	<5
Kamay Botany Bay: Botanical collection sites	Kamay Botany Bay National Park	<5
Kamay Botany Bay National Park and Towra Point Reserve	Kamay Botany Bay National Park	<5
Silver Beach and Roadway	Silver Beach Kurnell	115
Kurnell Monuments	Kamay Botany Bay National Park	<5
Kurnell Historic site	Kamay Botany Bay National Park	<5
Captain Cook Watering Well	Kamay Botany Bay National Park	<5
Captain Cook Monument	Kamay Botany Bay National Park	<5
Captain Cook Watering Hole	Kamay Botany Bay National Park	40
Banks Memorial	Kamay Botany Bay National Park	100
Alpha Farm site	Kamay Botany Bay National Park	155
Captain Cook's Landing Place	Kamay Botany Bay National Park	45

Receiver	Address	Approximate distance to the project area [m]
Flagpole	Kamay Botany Bay National Park	300
Solander Monument	Kamay Botany Bay National Park	250
Forby Sutherland Monument	Kamay Botany Bay National Park	240

Table 11:Heritage - Aboriginal at Kurnell

Receiver	Address	Approximate distance to the project area [m]
KMT ISO 01 - AHIMS Site	Kamay Botany Bay National Park	<5
KMT ISO 02 – AHIMS Site	Kamay Botany Bay National Park	<5
Foreshore Midden	Kamay Botany Bay National Park	<5

Table 12: Potential archaeology at Kurnell

Receiver	Address	Approximate distance to the project area [m]
Former Sea Wall	Kamay Botany Bay National Park	<5
Boat Shed	Kamay Botany Bay National Park	<5
Cottage Number 2	Kamay Botany Bay National Park	<5

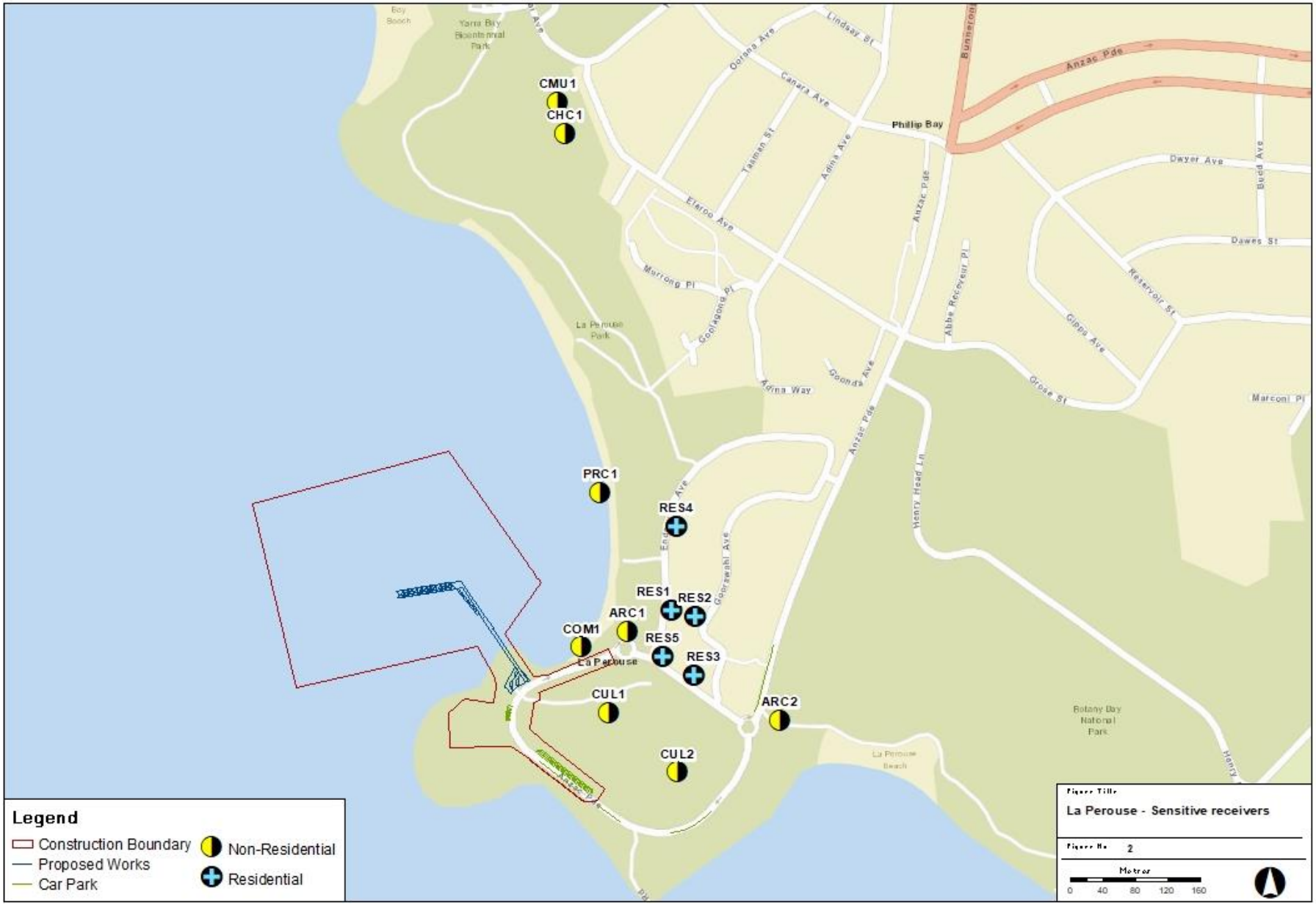


Figure 2: Site map showing La Perouse noise sensitive receivers

Figure 3: Non-Aboriginal heritage at La Perouse

Figure 4: Aboriginal heritage at La Perouse

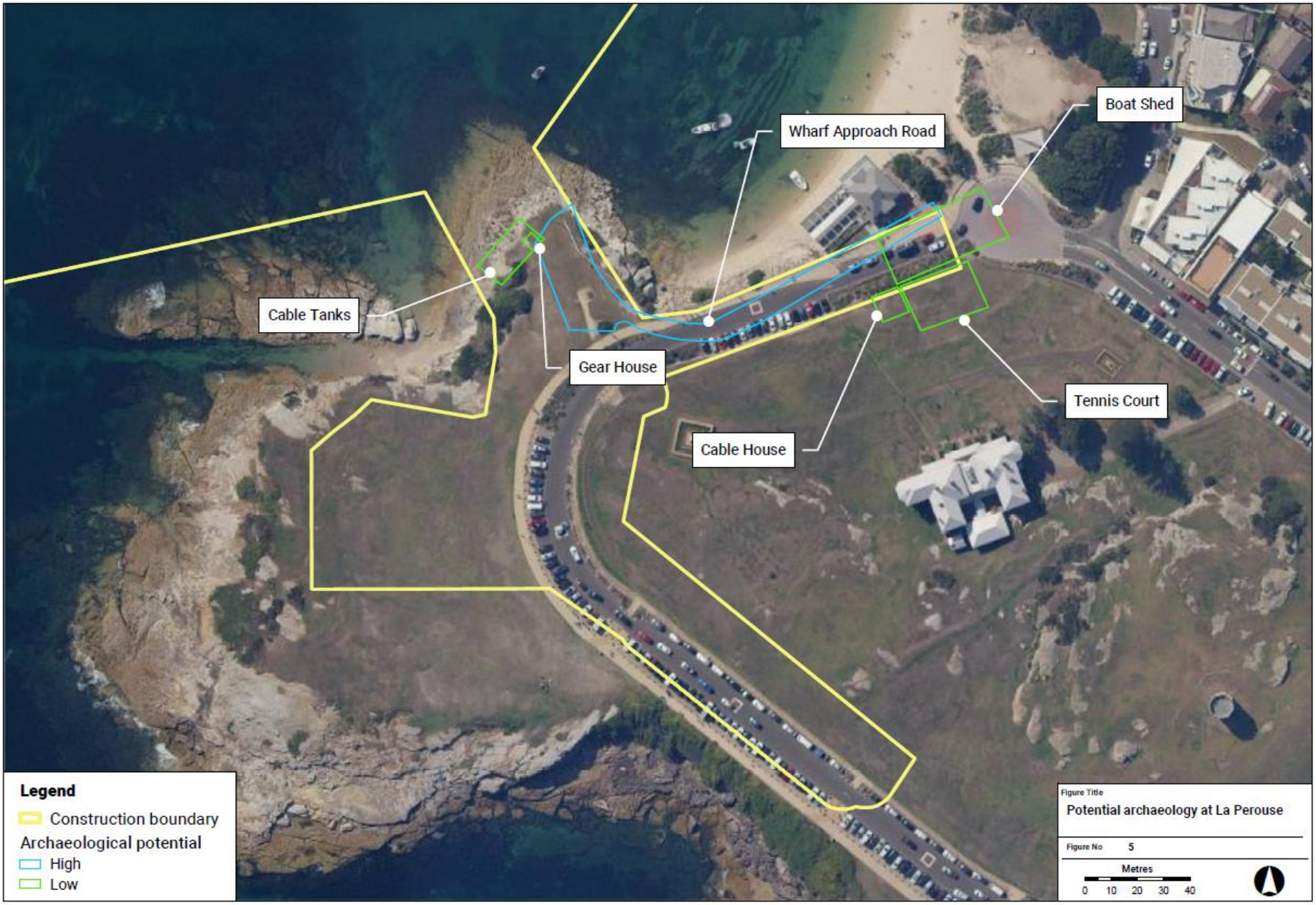


Figure 5: Potential archaeology at La Perouse

Figure 6: Site map showing Kurnell noise sensitive receivers

Figure 7: Non-Aboriginal heritage at Kurnell

Figure 8: Aboriginal heritage at Kurnell

Figure 9: Potential archaeology at Kurnell

2.2 Noise monitoring locations

Criteria for the assessment of construction and operational noise are usually derived from the existing noise environment of an area, excluding noise from the subject development.

Fact Sheet B of the NSW EPA *Noise Policy for Industry* (NPfI) outlines two methods for determining the background noise level of an area, being 'B1 – Determining background noise using long-term noise measurements' and 'B2 – Determining background noise using short-term noise measurements'. This assessment has used a combination of long-term and short-term noise monitoring.

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

At the time of initial site investigations for the project, Sydney had just gone into lockdown as a result of the Covid-19 pandemic. This resulted in limited options with regard to access of properties. Further, there were concerns that monitoring data would not be representative of typical ambient noise levels due to reduced activity in the area. Notwithstanding, access was made to two locations for the purpose of monitoring, however one location was impacted by extraneous noise from mechanical plant.

As a result, reference has also been made to measurements conducted by Wilkinson Murray as part of the Botany Bay Cable Project EIS between Friday 21 July and Friday 28 July in 2006 (Wilkinson Murray, 2006).

Long-term and short-term noise monitoring was carried out using the equipment shown in Table 13 at locations shown in Figure 10 and Figure 11.

Table 13: Noise monitoring equipment

Meas. Loc.	Equipment/model	Description of Equipment	Serial No.
Arup monitoring			
La Perouse Logger - 51-52 Endeavour Avenue	Ngara	Environmental noise logger	878060
Kurnell Logger - 3/1 Captain Cook Drive	Ngara	Environmental noise logger	878061
Attended locations Kurnell	B&K 2250	Sound level meter	2445716
Attended location La Perouse	B&K 2250	Sound level meter	2445716
Botany Bay Cable EIS – Wilkinson Murray monitoring			
La Perouse Logger - 1593 Anzac Parade	Not available	Not available	Not available

Meas. Loc.	Equipment/model	Description of Equipment	Serial No.
Kurnell Logger - 10 Prince Charles Parade	Not available	Not available	Not available
Note: All meters comply with AS IEC 61672.1 2019 "Electroacoustics - Sound Level Meters" designated either Class 1 and are suitable for field use. The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.			

2.3 Baseline noise monitoring results

2.3.1 Long term unattended noise monitoring

Long-term noise monitoring was carried out from Friday 27 March to Thursday 2 April 2020. The long-term noise monitoring methodology and noise level-vs-time graphs of the data are included in Appendix B.

Table 14 presents the overall single Rating Background Levels (RBL) and representative ambient L_{eq} noise levels for each assessment period, determined in accordance with the NPfI.

Table 14: Long-term noise monitoring results

Company	ID	Location	Time Period[1]	Ambient $dBL_{Aeq(period)}$	Rating background level, $dBL_{A90(period)}$
La Perouse					
Arup	AL	51-52 Endeavour Avenue	Day	64	43
			Evening	60	41
			Night	48	38
Wilkinson Murray	WL	1593 Anzac Parade, La Perouse	Day	56	43
			Evening	56	42
			Night	51	40
Kurnell					
Arup	AL	3/1 Captain Cook Drive	Day	58	43
			Evening	54	40
			Night	53	38
Wilkinson Murray	WL	10 Prince Charles Parade, Kurnell	Day	57	41
			Evening	54	42
			Night	49	40
Notes: 1 - The NPfI defines day, evening and night-time periods as: Day: the period from 7am to 6pm Monday to Saturday; or 8am to 6pm on Sundays and Public Holidays. Evening: the period from 6pm to 10pm. Night: the remaining period.					

The noise levels display a typical trend with lower noise levels during the night-time than the daytime and evening periods. This is a characteristic of suburban areas where the ambient noise environment is primarily influenced by road traffic

2.3.1.1 Noise monitoring results validity

The noise monitoring was carried out from Thursday 26 March to Monday 2 April 2020 just after the start of Covid19 restrictions lockdown. The results of the noise monitoring may have been affected by the reduced activity however for both locations, the measured RBLs are consistent with the referenced data from 2006.

It should be noted that the measured background noise levels for Kurnell are similar to that of La Perouse and the unaffected measured RBLs are also consistent with the Wilkinson Murray measurements in 2006.

For the La Perouse location, the noise monitoring was also affected by the operation of mechanical plant between the hours of 11:00 to 20:00. While this results in data that does not strictly accord with the NPfI, provisions in Section B1.3 of the NPfI relating to the analysis procedure of monitoring data allows use of data where it can be demonstrated that the affected period would not materially alter the established RBLs.

The RBL is calculated as the median of the Assessment Background Level (ABL) being the 10^{th}-percentile of the 15-minute background levels over each period. For the day period this is the fifth lowest 15-minute level. As mechanical plant did not affect levels between 7:00 to 11:00, and background levels generally trend to higher levels later in the day, the periods of affected data are not considered to impact the established RBL. On Monday 30 March 2020, there is a period where the mechanical plant ceases around 12:00 to 14:00, the background level is a similar level to the morning period. On Thursday 2 April 2020, from 13:30 to 14:00 and 15:30 to 17:30, the mechanical plant also seems to have been turned off and the background level is higher than the morning period. Furthermore, the daytime RBLs are only 5 dB higher than the night period which is not unreasonable. The determined RBL is also consistent with the 2006 data.

Accordingly, it is considered that the data for La Perouse is appropriate for establishing project specific noise levels for the subject assessment.

2.3.2 Short term attended noise measurements

Short-term operator attended noise measurements were conducted on Monday 6^{th} of April 2020 at each logger location. Noise measurements were conducted over a 15-minute period. Weather conditions were warm, still and clear during measurements.

Table 15 presents the measured L_{eq} and L_{90} noise levels for each measurement location, determined in accordance with the AS1055:2018. The measurements were taken more than one metre away from any building façade and at a height of 1.2 - 1.5 m above ground level.

Table 15: Short-term noise monitoring

ID	Location	Date/Time	Description of Noise Environment	$dBL_{Aeq,15min}$	$dBL_{A90,\ 15min}$
La Perouse					
1	Behind 11 Goolagong Place	06/04/20 – 2:34pm	Music, breeze, aircraft noise	52	43
2	8 Goorawahl Avenue	06/04/20 – 1:46pm	Breeze, minimal vehicles, car idling	48	35
3	Cnr Elaroo Avenue, 7 Anzac Parade	06/04/20 – 2:10pm	Predominantly traffic noise	60	49
Kurnell					
4	Opposite 16 Prince Charles Parade	06/04/20 – 10:28am	Breeze present, dogs barking, waves, vehicles, constant distant saw noise on pier	54	45
5	9 Silver Beach Road	06/04/20 – 11:35am	Breeze, occasional vehicles, hand tools, human activity movement	57	43
6	22 Captain Cook Drive	06/04/20 – 10:57am	Breeze, traffic noise, aircraft noise	62	38

A full set of long term and short-term measurement details and results are presented in Appendix B.

Figure 10: La Perouse monitoring locations

Figure 11: Kurnell monitoring locations

3 Guidelines and criteria

3.1 Construction noise criteria

The *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change NSW, 2009) provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction management noise levels above which all 'feasible and reasonable' work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG sets out management levels for noise at sensitive receivers and how they are to be applied. For residential receivers, the rating background level (RBL) is used when determining the management level. The management level for residential receivers is reproduced in Table 16. For other sensitive land uses, the management levels are reproduced in Table 17.

Table 16: Construction noise management levels at residential receivers

Time of day	Management level [1] $dBL_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: • Monday to Friday 7am to 6pm • Saturday 8am to 1pm • No work on Sundays or public holidays	Noise affected RBL + 10dB	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	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: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of day	Management level [1] $dBL_{Aeq\ (15\ min)}$	How to apply
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Note:
[1] - 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.

Table 17: Construction noise management levels at other noise sensitive land uses

Land use	Where objective applies	Management level [1] $dBL_{Aeq\ (15\ min)}$
Passive recreation areas	External noise level	60
Active recreation areas	External noise level	65
Educational institutions	Internal noise level	45
Childcare premises	Internal noise level	45[2]
Museums	Internal noise level	45[2]
Community premises	Internal noise level	45[2]
Commercial premises	External noise level	70
Place of Worship	Internal noise level	45
Industrial	External noise level	75

Notes
1 – Noise management levels apply when properties are in use.
2 – Based on AS/NZS2107:2016 max design level for Public Buildings – Museums (exhibition space)

3.1.1 Sleep disturbance

Where construction works are planned to extend over more than two consecutive nights, the ICNG recommends that an assessment of sleep disturbance impacts should be undertaken.

The ICNG refers to the NSW *Environmental Criteria for Road Traffic Noise* (Environment Protection Authority, 1999) for assessing the potential impacts, which notes that to limit the level of sleep disturbance the $L_{AF1,(1\ minute)}$ level (equivalent to the L_{Amax}) of a noise event which should not exceed the ambient L_{A90} noise level by more than 15 dB is not applied to traffic noise.

3.1.2 Project construction noise management levels

Noise criteria at residential receivers for construction works proposed at La Perouse and Kurnell were derived from noise monitoring data from the noise survey conducted by Arup in March 2020.

The rating background level (RBL) from a monitoring location in close proximity to the residential receivers was used to determine the noise management level (NML) for the Day, Evening and Night-time periods.

Table 18: Noise Management Levels for residential receivers

Receiver ID	Address	Standard Hours[1] $dBL_{Aeq(15min)}$	Out of Hours[2] $dBL_{Aeq(15min)}$		Sleep disturbance[3] dBL_{Amax}
		Day	Evening	Night	
La Perouse					
RES1	51-53 Endeavour Avenue	53	46	43	53
RES2	28 Goorawahl Avenue	53	46	43	53
RES3	3/1599 Anzac Parade	53	46	43	53
RES4	31 Endeavour Avenue	53	46	43	53
RES5	1605 Anzac Parade	53	46	43	53
Kurnell					
RES1	3/1 Captain Cook Drive	53	45	43	53
RES2	Ranger's house	53	45	43	53
RES3	33 Captain Cook Drive	53	45	43	53
RES4	10 Prince Charles Parade	53	45	43	53

Notes:
1 - Standard hours are Monday to Friday 7 am to 6 pm and Saturday from 8 am to 1 pm.
2 - Out of Hours Night-time hours are 10 pm to 7am.
3 – Sleep disturbance criteria is L90 + 15 dB

Table 19: Non-residential Noise Management Levels

Usage	Receiver ID	Name	NML, $dBLA_{eq\ 15minute}$[1]
La Perouse			
Active recreation	ARC1	Frenchmans bay reserve playground	65
	ARC2	Congwong trail	65
Commercial premise	COM1	The boatshed	70
Community premise	CMU1	La Perouse local aboriginal land council	45 (Internal)
Childcare premise	CHC1	Gujaga MACS Childcare Centre	45 (Internal)
Cultural premise	CUL1	La Perouse museum	45 (Internal)

Usage	Receiver ID	Name	NML, $dBLA_{eq\ 15minute}$[1]
	CUL2	Macquarie watchtower	45 (Internal)
Passive recreation area	PRC1	Frenchmans beach	60
Kurnell			
Active recreation	ARC1	Marton park	65
	ARC2	Yena walking track	65
Commercial premise	COM1	Endeavour coffee and ice-cream	70
Childcare premise	CHC1	Kurnell preschool kindergarten	45 (Internal)
Educational institution	EDU1	Kamay botany bay environmental education centre	45 (Internal)
Industrial premise	IND1	Caltex Kurnell terminal	75
Passive recreation area	PRC1	Commemoration flat	60
Place of worship	POW1	St John Fisher catholic church	45 (Internal)
Note: 1 - When in use			

3.2 Construction vibration criteria

Vibration criteria for construction works are established in the following sections.

3.2.1 Human comfort

The NSW EPA's *Assessing Vibration – A Technical Guideline* (Department of Environment and Conservation (NSW), 2006) provides vibration criteria for maintaining human comfort within different space uses. The guideline recommends 'preferred' and 'maximum' weighted vibration levels for both continuous vibration sources, such as steady road traffic and continuous construction activity, and for impulsive vibration sources. The weighting curves are obtained from BS 6472-1:2008 (British Standards, 2008).

For intermittent sources (e.g. passing heavy vehicles, impact pile driving, intermittent construction), the guideline uses the vibration dose value (VDV) metric to assess human comfort effects of vibration. VDV considers both the magnitude of vibration events and the number of instances of the vibration event. Intermittent events that occur less than 3 times in an assessment period (either day, 7 am to 10 pm, or night, 10 pm to 7 am) are counted as 'impulsive' sources for the purposes of assessment.

As noted in the Guideline, situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances, such as a construction or excavation projects. Notwithstanding, the recommended vibration limits for maintaining human comfort in residences and other relevant receiver

types are given for continuous/impulsive and intermittent vibration in Table 20 and Table 21 respectively.

Table 20: Preferred and maximum weighted root-mean-square (rms) values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

Location	Period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous Vibration					
Critical areas[1]	Day- or Night-time	0.005	0.0036	0.01	0.0072
Residences	Daytime 0700-2200h	0.010	0.0071	0.020	0.014
	Night-time 2200-0700h	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
Impulsive Vibration					
Critical areas[1]	Day- or Night-time	0.005	0.0036	0.01	0.0072
Residences	Daytime 0700-2200h	0.30	0.21	0.60	0.42
	Night-time 2200-0700h	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
1 - Criteria for sensitive areas are only indicative, and have been provided as guidance to acceptable vibration levels for the use of sensitive equipment, eg. camera equipment at Fox Studios.					

Table 21: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime 0700-2200 h		Night-time 2200-0700 h	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas[1]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Note: 1 - Criteria for sensitive areas are only indicative, and there may be a need to assess intermittent vibration against impulsive or continuous criteria.				

3.2.2 Building damage

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2-1993 and/or

German Standard DIN4150-3 (German Institute for Standardisation, 2016). British Standard 7385 Part 1: 1990 defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 of BS7385-2 sets limits for the protection against cosmetic damage, however the following guidance on minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1* [Not reproduced].
>
> *In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3 (German Institute for Standardisation, 2016), damage is defined as “any permanent effect of vibration that reduces the serviceability of a structure or one of its components” (p.2). The Standard also outlines:

> *"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if cracks form in plastered surfaces of walls; existing cracks in the building are enlarged; partitions become detached from loadbearing walls or floors.*
>
> *These effects are deemed ‘minor damage."*

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

British Standard BS7385-2

BS 7385-2:1993 (British Standards, 1993) is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 22 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings, British Standard 7385 Part 2 (1993, p.5) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*".

Table 22: BS 7385-2 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200
1 - Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer. 2 - Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2					

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

German Standard DIN 4150-3

German Standard DIN 4150 - Part 3 'Structural vibration in buildings - Effects on Structure' (DIN 4150-3) are generally recognised to be conservative. DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The criteria are presented in Table 23.

Table 23: DIN 4150-3 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration,	3	3 to 8	8 to 10	8

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
	do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)				

3.2.3 Buried services

DIN 4150-3:2016 sets out guideline values for vibration effects on buried pipework and reproduced in Table 24 below.

Table 24: Guideline values for short-term vibration impacts on buried pipework

Pipe material	Guideline values for vibration velocity measured on the pipe, mm/s
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastic	50
Note: For gas and water supply pipes within 2m of buildings, the levels given above should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.	

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/sec the ground vibration is required to be monitored.

Other services that may be encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

3.3 Operational noise

There is no existing policy in NSW to assess noise impacts of marine based transport including ferry operations.

To provide a quantitative assessment of the project, reference has been to the *Noise Policy for Industry* (NPfI) (Environment Protection Authority, 2017), as while intended for industrial type activities, the policy has been applied to other fixed infrastructure such as rail stations and light rail stops. Accordingly, it has been used to assess noise emission from the ferry wharves.

The NPfI is primarily concerned with controlling intrusive noise impacts in the short-term for residences and maintaining long-term noise level amenity for residences and other land uses.

The NPfI sets out the procedure to determine the project noise trigger levels relevant to an industrial development. The project noise trigger level is a level that, if exceeded would indicate a potential noise impact on the community and so 'trigger' a management response.

3.3.1 Intrusive noise trigger level

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5 dB

(where $L_{Aeq,15minute}$ represent the equivalent continuous noise level of the source)

Note that as the Intrusive Noise Trigger Level is established from the prevailing background noise levels at the residential receiver location, the existing background noise level is to be measured.

3.3.2 Recommended and project amenity noise level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from **all** industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 25 of the NPfI where feasible and reasonable.

Table 25: NPfI Recommended Amenity Noise Levels (RANLs)

Receiver	Noise amenity area	Time of Day[1]	Recommended amenity noise levels (RANLs) $dBL_{Aeq,period}$
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45

Receiver	Noise amenity area	Time of Day[1]	Recommended amenity noise levels (RANLs) $dBL_{Aeq,period}$
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Place of worship – internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, gold course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70

Notes:

- The recommended amenity noise levels (RANLs) refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

[1] - The NPfI defines day, evening and nighttime periods as:

- Day: the period from 7am to 6pm Monday to Saturday; or 8am to 6pm on Sundays and Public Holidays.
- Evening: the period from 6pm to 10pm.
- Night: the remaining period.

The recommended amenity noise levels (RANLs) represent the objective for **total** industrial noise at a receiver location, whereas the **project amenity noise level (PANL)** represents the objective for noise from a **single** industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB

The area surrounding the project at both La Perouse and Kurnell can be categorised as Suburban under the NPfI.

Table 26 summarises the RANLs and the PANLs applicable for the project.

Table 26: NPfI RANLs and PANLs

Receiver	Indicative Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level (RANL) $L_{Aeq(period)}$	Project Amenity Noise Level (PANL) $L_{Aeq(period)}$
La Perouse residential receivers	Suburban	Day	55	50
		Evening	45	40
		Night	40	35

Receiver	Indicative Noise Amenity Area	Time of day[1]	Recommended Amenity Noise Level (RANL) $L_{Aeq(period)}$	Project Amenity Noise Level (PANL) $L_{Aeq(period)}$
Kurnell residential receivers	Suburban	Day	55	50
		Evening	45	40
		Night	40	35

Notes
[1] - The NPfI defines day, evening and night time periods as:
- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

3.3.3 NPfI Project specific noise levels

Based on the background and ambient noise monitoring, Table 26 summarises the derived project specific noise levels based on the NPfI.

Project Noise Trigger Levels (PNTLs) for residential receivers represent the lower of the intrusive criteria and the adjusted $L_{Aeq,15min}$ amenity criteria, shown in Table 27.

Table 27: NPfI Project specific noise levels for **residential receivers**

Receiver	Time Period[1]	Project Specific Noise Levels		Project Noise Trigger Levels, $dBL_{Aeq(15minute)}$
		Intrusive Noise Trigger Levels $L_{Aeq,15minute}$	Project Amenity Noise Level (PANL) $(L_{Aeq,15minute})^2$	
La Perouse residential receivers	Day	48	53	48
	Evening	46	43	43
	Night	43	38	38
Kurnell residential receivers	Day	48	53	48
	Evening	45	43	43
	Night	43	38	38

Notes
[1] - The NPfI defines day, evening and night time periods as:
- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

[2] – The NPfI has simplified assessment for the amenity criteria, making a crude assumption regarding the relationship between the $L_{Aeq(15min)}$ and $L_{Aeq(period)}$, applying a +3 dB correction to adjust the Project Amenity Level $L_{Aeq(period)}$ to an $L_{Aeq(15min)}$.

For non-residential receivers where the RANLs are internal criteria such as community premises, childcare centres and educational institutions, their external

PNTLs have been derived by assuming a 10 dB reduction through an open window.

Table 28: Project Noise Trigger Levels – **non-residential receivers**

Usage	Receiver ID	Name	Project Noise Trigger Levels, $dBL_{Aeq(15minute)}$[2]
La Perouse			
Commercial premise	COM1	The Boatshed	63
Community premise	CMU1	La Perouse Local Aboriginal Land Council	53[1]
Childcare premise	CHC1	Gujaga MACS Childcare Centre	40[1]
Cultural premise	CUL1	La Perouse Museum	63
Cultural premise	CUL2	Macquarie Watchtower	63
Passive recreation area	PRC1	Frenchmans Beach	48
Active recreation	ARC1	Frenchmans Bay Reserve Playground	53
Active recreation	ARC2	Congwong Trail	53
Kurnell			
Commercial premise	COM1	Endeavour Coffee and Ice-cream	63
Childcare premise	CHC1	Kurnell Preschool Kindergarten	40[1]
Educational institution	EDU1	Kamay Botany Bay Environmental Education Centre	40[1]
Industrial premise	IND1	Caltex Kurnell Terminal	68
Place of worship	POW1	St John Fisher Catholic Church	48
Passive recreation area	PRC1	Commemoration Flat	48
Active recreation	ARC1	Marton Park	53
Active recreation	ARC2	Yena Walking Track	53

Notes:
1 - External noise levels have been determined by assuming a 10 dB reduction through an open window.
2- The project noise trigger levels apply only when in use.

3.4 Road traffic noise criteria

Increased traffic generated on the surrounding road network due to the construction activities or by the operation of the ferry wharves in La Perouse and Kurnell is assessed in accordance with the NSW *Road Noise Policy* (RNP) (Department of Environment, Climate Change and Water NSW, 2011).

Table 3 of the RNP which sets out the assessment criteria for types of project, road category and land use, shown in Table 29. It should be noted that although commercial receivers may be impacted by increases of road traffic due to the construction works or ferry wharve operations, the RNP does not stipulate any criteria for commercial land uses.

Table 29: Road traffic criteria for traffic generating development - residential receivers

Road category	Type of project / land use	Assessment criteria – dBL_{Aeq}	
		Day (7:00am-10:00pm)	**Night (10:00pm-7:00am)**
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,(1\ hour)}$ 55 (external)	$L_{Aeq,(1\ hour)}$ 50 (external)
Note: These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.			

Regarding the application of the assessment, the RNP states:

> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

4 Assessment of potential construction impacts

4.1 Basis of assessment

4.1.1 Hours of work

Construction would take place between standard working hours:

- Monday to Friday 7 am to 6 pm; and
- Saturday 8 am to 1 pm.

There would be no construction work on Sundays or public holidays.

Out of Hours work

However, being within a marine environment, the project would require several activities to be undertaken outside standard working hours for safety reasons. These activities would need to take place at night when the water is calm and still and the harbour is least busy. These activities would include:

- Relocating the jack-up barge depending on the tides to maintain enough clearance distance between the vessel and the sea floor
- Completing safety critical activities and movements of vessels prior to forecast weather events
- Setting up of the construction pump for in-situ concrete placing works to ensure concrete can set before warmer temperature rise during the day in the summer months
- Most of the drilling or piling activities would be undertaken during standard working hours, however if required some drilling and piling activities may have to be undertaken outside of these standard hours. Night-time piling activities would adopt the following work schedule:

Table 30: OOHW schedule for night-time piling

Activity	Timing
Drilling of Piles	Setup: 11pm to 12am Drilling: 12am to 6am Pack up: generally, 6am to 7am.
Hammering of Piles	Setup: 4am to 5am Hammering: 5am to 7am.

Pile drilling or hammering would take place intermittently during the above periods. On average, a pile would be drilled or hammered for about 10 minutes followed by a relatively quiet period for the next 30 minutes or more before the next stage is progressed.

4.1.2 Activities

The total construction period is anticipated to take up to 13 months, starting in early 2022. The construction of the two wharves are likely to occur at the same time. The construction would involve the stages outlined in Table 31.

Table 31: Construction stages

Stage	Activities
Stage 1: Early works and site establishment	Security and fencing Setting up site offices and access Demolishing of the existing Kurnell viewing platform
Stage 2: Main construction	Establishing temporary causeway at Kurnell Piling Wharf construction Car parking reconfiguration at La Perouse Earthworks for footpaths and landscaping Installation of wharf furniture Earthworks and installation of utilities Final landscaping
Stage 3: Site demobilisation	Removal of temporary work areas

The proposed construction equipment, quantity and operating duration has been provided by TLM Project Services, who provided constructability advice for the project, and are summarised in Table 32 and Table 33.

Equipment sound power levels have been determined by reference to AS2436 (Standards Australia, 2010), BS 5228-1:2009 (British Standards, 2009) and Arup's measurement database. The equipment sound power levels have been adjusted using number of sources and time corrections.

The locations of equipment have been based the on the construction works areas in and around La Perouse and Kurnell as shown in Figure 12 and Figure 13.

Table 32: Construction equipment and associated sound power levels at La Perouse site

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w	
			$dBL_{Aeq\ (15min)}$[1]	dBL_{Amax2}
STAGE 1 - ENABLING WORKS & SITE ESTABLISHMENT				
Security and Fencing				
Construction area[3]: L1A, L1B				
Hand Tools (Electric)	2	5	100	-
Light Vehicle - 4WD	4	10	99	-
Truck	2	10	100	-
Setting up site offices and access				
Construction area[3]: L1A				
Hand Tools (Electric)	4	20	109	-

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w $dBL_{Aeq\ (15min)}$[1]	dBL_{Amax2}
Light Vehicle - 4WD	4	10	99	-
Truck	2	10	100	-
Generator (diesel)	2	50	113	
STAGE 2 – MAIN CONSTRUCTION				
Piling				
Construction area[3]: L1A, L1B				
Road Lorry (Empty)	2	1.5	104	112
Piling				
Construction area[3]: L2A				
Piling (Vibratory)	1	50	118	126
Hand Tools (Electric)	1	10	100	108
Crane (200t)	1	50	100	108
Crane (Mobile 50t)	1	50	95	103
Crane (150t)	1	50	100	108
Barge Crane	1	50	101	109
Barge (unpowered)	2	50	90	98
Piling				
Construction area[3]: L2B				
Hand Tools (Pneumatic)	2	10	110	118
Crane (200t)	1	50	100	108
Crane (Mobile 50t)	1	50	95	103
Crane (150t)	1	50	100	108
Barge Crane	1	50	101	109
Barge (unpowered)	1	50	100	108
Drill Rig	2	25	90	98
Piling				
Construction area[3]: L2C				
Piling (Bored)	1	75	110	118
Hand Tools (Pneumatic)	2	10	110	118
Crane (200t)	1	50	100	108
Crane (Mobile 50t)	1	50	95	103
Crane (150t)	1	50	100	108
Barge Crane	1	50	101	109
Barge (unpowered)	1	50	100	108

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w $dBL_{Aeq\ (15min)}$[1]	dBL_{Amax2}
Wharf Construction				
Construction area[3]: L2A				
Hand Tools (Electric)	6	10	108	-
Concrete Pump Truck	1	100	113	-
Truck	4	5	100	-
Light Vehicle - 4WD	2	5	101	-
Carparking Reconfiguration				
Construction area[3]: L1A, L1B				
Hand Tools (Pneumatic)	2	10	110	-
Truck	2	5	97	-
Light Vehicle - 4WD	2	10	101	-
Earthworks for Footpaths and Landscaping				
Construction area[3]: L1A, L1B				
Hand Tools (Pneumatic)	2	10	110	-
Truck	2	5	97	-
Light Vehicle - 4WD	2	10	101	-
Excavator	1	75	116	-
Compactor Whacker Plate	2	10	101	-
Installation of Wharf Furniture				
Construction area[3]: L2A				
Hand Tools (Electric)	2	25	107	-
Truck	1	5	94	-
Light Vehicle - 4WD	1	10	101	-
Installation of Utilities				
Construction area[3]: L1A, L1B				
Hand Tools (Pneumatic)	2	10	110	-
Truck	1	5	94	-
Light Vehicle - 4WD	2	10	104	-
Excavator	1	25	111	-
Landscaping				
Construction area[3]: L1A, L1B				
Hand Tools (Pneumatic)	2	5	107	-
Truck	1	10	97	-

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w $dBL_{Aeq\ (15min)}$[1]	dBL_{Amax2}
STAGE 3 – SITE DEMOBILISATION				
Removal of Temporary Work Areas				
Construction area[3]: L1A, L1B, L2A, L2B, L2C				
Truck & Dog	2	10	101	-
Truck	2	10	100	-
Light Vehicle - 4WD	2	10	104	-
Crane (200t)	1	10	93	-
Barge Crane	1	10	101	-
Barge	2	10	93	-
1 – Sound power level of the equipment including number of sources and time corrections 2 – L_{AMax} is 8 dB above the L_{Aeq} value, except for impact piling which is 21 dB (exact level is dependent on a number of factors, so a conservative estimate has been utilised based on maximum levels) 3 – To view construction areas refer to Figure 8				

Table 33: Construction equipment and associated sound power levels at the Kurnell site

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w $dBL_{Aeq\ (15min)1}$	dBL_{Amax2}
STAGE 1 - ENABLING WORKS & SITE ESTABLISHMENT				
Security and Fencing				
Construction area[3]: K1A, K1B				
Hand Tools (Electric)	2	5	100	-
Light Vehicle - 4WD	4	10	99	-
Truck	2	10	100	-
Setting up Site offices and Access – K1B				
Construction area[3]: K1B				
Hand Tools (Electric)	4	20	109	-
Light Vehicle - 4WD	4	10	99	-
Truck	2	10	100	-
Generator (diesel)	2	50	113	-
Demolition of existing Kurnell Viewing Platform – K1A, K2B				
Construction area[3]: K1A, K2B				
Light Vehicle - 4WD	2	10	96	-
Truck	1	10	97	-
Excavator	1	75	116	-
Chainsaw	1	20	107	-
Crane (Tower)	1	10	95	-

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w	
			$dBL_{Aeq\ (15min)1}$	dBL_{Amax2}
Transport Float	1	15	103	-
Hand Tools (Electric)	2	10	103	-
STAGE 2 – MAIN CONSTRUCTION				
Establishing Temporary Causeway at Kurnell				
Construction area[3]: K1A, K2B				
Excavator	2	90	120	-
Truck	2	50	107	-
Truck (Dump)	2	90	120	-
Light Vehicle - 4WD	1	10	101	-
Piling				
Construction area[3]: K1A, K1B				
Road Lorry (Empty)	2	10	104	112
Piling				
Construction area[3]: K2A				
Piling (Vibratory)	1	50	118	126
Hand Tools (Pneumatic)	2	10	110	118
Crane (200t)	1	50	100	108
Crane (Mobile 50t)	1	50	95	103
Crane (150t)	1	50	100	108
Barge Crane	1	50	101	109
Barge (unpowered)	2	50	90	98
Piling				
Construction area3: K2B				
Hand Tools (Pneumatic)	2	10	110	118
Crane (200t)	1	50	100	108
Crane (Mobile 50t)	1	50	95	103
Crane (150t)	1	50	100	108
Barge Crane	1	50	101	109
Barge (unpowered)	1	50	100	108
Drill Rig	2	25	90	98
Wharf Construction				
Construction area3: K1A, K2A, K2B				
Hand Tools (Electric)	6	10	108	-
Concrete Pump Truck	1	100	113	-
Truck	4	5	100	-

Item / Description	Quantity	Operating duration in 15min period (%)	Sound Power Level, L_w	
			$dBL_{Aeq\ (15min)1}$	dBL_{Amax2}
Light Vehicle - 4WD	2	5	101	-
Earthworks for Footpaths and Landscaping				
Construction area[3]: K1A, K1B, K1C				
Hand Tools (Pneumatic)	2	10	110	-
Truck	2	5	97	-
Light Vehicle - 4WD	2	10	101	-
Excavator	1	75	116	-
Compactor Whacker Plate	2	10	101	-
Installation of Wharf Furniture				
Construction area[3]: K1A, K1B, K2A, K2B				
Hand Tools (Electric)	2	25	107	-
Truck	1	5	94	-
Light Vehicle - 4WD	1	10	101	-
Installation of Utilities				
Construction area[3]: K1A, K1B, K1C				
Hand Tools (Pneumatic)	2	10	110	-
Truck	1	5	94	-
Light Vehicle - 4WD	2	10	104	-
Excavator	1	25	111	-
Landscaping				
Construction area[3]: K1A, K1B, K1C				
Hand Tools (Pneumatic)	2	5	107	-
Truck	1	10	97	-
STAGE 3 – LANDSCAPING AND SITE DEMOBILISATION				
Removal of Temporary Work Areas – K1A, K1B, K1C, K2A, K2B				
Construction area[3]: K1A, K1B, K1C, K2A, K2B				
Truck & Dog	2	10	101	-
Truck	2	10	100	-
Light Vehicle - 4WD	2	10	104	-
Crane (200t)	1	10	93	-
Barge	1	10	101	-
Barge (unpowered)	2	10	93	-

1 – Sound power level of equipment with number of sources and time corrections

2 – LMax is 8 dB above the LAeq value, except for impact piling which is 21 dB (exact level is dependent on a number of factors, so a conservative estimate has been utilised based on maximum levels)

3 – To view construction areas refer to Figure 9

Figure 12: Construction work areas in the La Perouse site

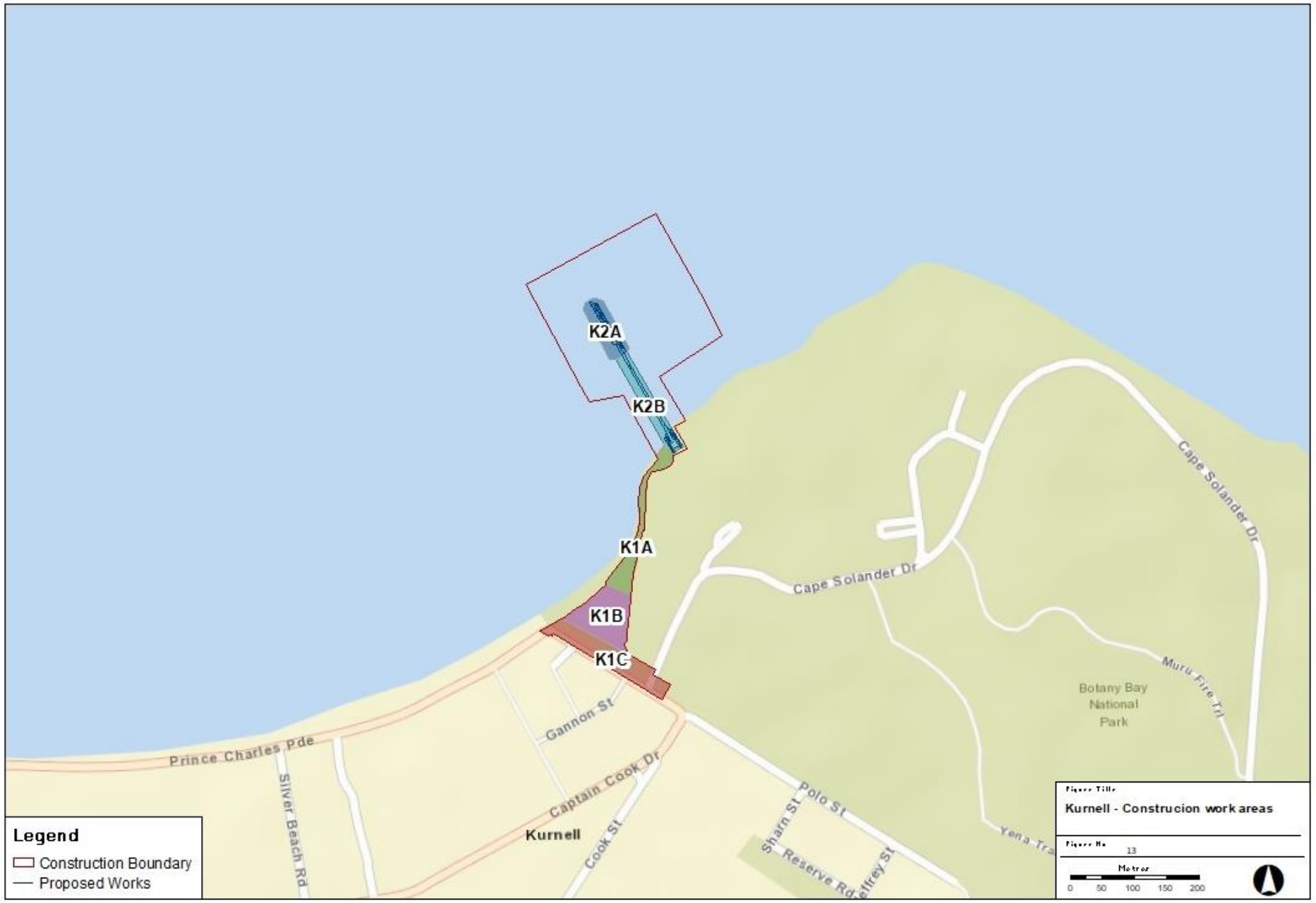


Figure 13: Construction work areas in the Kurnell site

4.1.3 Construction traffic

All land side traffic would be expected to access the construction sites using existing roads. At La Perouse, this would be via Anzac Parade, and at Kurnell this would be via Captain Cook Drive.

The key haulage routes are shown on Figure 14 and Figure 15.

Over the construction period at La Perouse, around 12 vehicles would arrive and leave the site every day on average. The highest number of vehicles arriving and leaving the site would be around 40 vehicles per day during the early works period.

Over the construction period at Kurnell, around 20 vehicles would arrive and leave the side every day on average. The highest number of vehicles arriving and leaving the site would be around 50 vehicles per day during the early works period.

The above estimates account for construction worker vehicle movements. It is anticipated construction workers would travel to site on public transport, by car or by construction vehicles.

Figure 14: Haulage route at La Perouse

Figure 15: Haulage route at Kurnell

4.2 Construction noise assessment

Construction noise has been assessed in accordance with the ICNG. Predicted construction noise levels during and outside standard construction hours are provided in Table 34 and Table 35 for La Perouse, and in Table 36 and Table 37 for Kurnell.

The noise assessment aims to provide a 'realistic worst-case' noise impact assessment based on construction works in a 15-minute period. The scenarios assessed are considered representative of the noisiest construction activities likely to occur across the project.

The predictions assume activities are located at the closest point of the works zone to the nearest sensitive receivers. In reality, the potential construction noise impacts at any particular location will vary depending on factors including:

- The position of the works within the site and distance to the nearest sensitive receiver
- The overall duration of the works
- The cumulative operation of works

An analysis of potential cumulative impacts due to works being undertaken concurrently within the project has not been included. As the predictions are based on worst-case nearest distances, the influence of cumulative works is not expected to be significantly higher than the levels predicted.

Noise levels have been compared to the receiver's Noise Management Level. It should be noted that in general, construction works are temporary in nature therefore any potential noise impact on the community and the surrounding environment will not be permanent. However, where possible the impacts due to construction noise should be minimised.

Where the predicted noise level is greater than the noise management levels all feasible and reasonable work practices should be applied, however it is unlikely mitigation measures would reduce the received noise levels below the noise management levels, this is further discussed in Section 6. Where activity is predicted to exceed the 'highly noise affected' levels of 75 $dBL_{Aeq(15minute)}$, it is recommended that respite periods should be considered during these phases.

Table 34: La Perouse residential construction predicted results

ID	Period		NML	Stage 1		Stage 2							Stage 3
				Security and fencing	Setting up Site Offices and access	Piling	Wharf Construction	Carpark Reconfiguration	Earthworks for footpaths & landscape	Installation of wharf furniture	Installation of utilities	Landscaping	Removal of site compound
RES1 51-53 Endeavour Ave, La Perouse	Standard Hours	Day	53	48	54	63	57	55	61	49	61	54	57
	OOHW	Night	43	-	-	63	-	-	-	-	-	-	-
RES2 28 Goorawahl Ave, La Perouse	Standard Hours	Day	53	37	44	59	55	44	50	47	50	43	54
	OOHW	Night	43	-	-	59	-	-	-	-	-	-	-
RES3 3/1599 Anzac Pde, La Perouse	Standard Hours	Day	53	49	54	61	54	56	62	49	62	55	56
	OOHW	Night	43	-	-	61	-	-	-	-	-	-	-
RES4 31 Endeavour Ave, La Perouse	Standard Hours	Day	53	45	53	60	56	52	58	49	58	51	55
	OOHW	Night	43	-	-	60	-	-	-	-	-	-	-
RES5 1605 Anzac Pde, La Perouse	Standard Hours	Day	53	51	56	67	57	58	64	53	64	57	59
	OOHW	Night	43	-	-	67	-	-	-	-	-	-	-

Note:
1 – The results are highlighted according to the level of exceedance above the NML according to ICNG criteria

Standard hours:	Out of Hours Works (OOHW):
Clearly audible – above NML	Clearly audible – above NML
Highly intrusive - >75dB	Highly intrusive - >75dB

Results in Table 34 indicate exceedances predicted during various stages of construction. The highest predicted noise levels are during Stage 2, specifically during phases of Piling where noise levels of up to 67 $dBL_{Aeq(15minute)}$ are predicted, and during Earthworks and Installation of utilities

levels reach up to 64 $dBL_{Aeq(15minute)}$ for the representative residential receivers. Smaller exceedances are predicted during the Setting up of site offices, Car park reconfiguration, Wharf construction, Landscaping phases and Removal of site compounds phases. Noise levels from Security and fencing and Installation of wharf furniture phases are predicted to comply with established NMLs.

Table 35: La Perouse construction other sensitive receiver predicted results

ID[2]	NML	Stage 1	Stage 2								Stage 3
		Security and fencing	Setting up Site Offices and access	Piling	Wharf Construction	Carpark Reconfiguration	Earthworks for footpaths & landscape	Installation of wharf furniture	Installation of utilities	Landscaping	Removal of site compound
ARC1- Frenchmans Bay Reserve Playground	65	51	53	63	56	58	64	47	64	57	58
ARC2 - Congwong Trail	65	39	43	45	44	46	52	41	52	45	46
PRC1 - Frenchmans Beach	60	43	51	58	53	50	56	47	56	49	53
CHC1 - Gujaga MACS Childcare Centre	55	38	45	54	50	45	51	42	51	44	48
COM1 - The Boatshed	70	53	61	65	61	60	66	59	66	59	64
CUL1 - La Perouse Museum	55	55	62	63	57	62	68	55	68	61	61
CUL2 - Macquarie Watchtower	55	48	54	52	42	55	61	41	61	54	53
CMU1 - La Perouse Local Aboriginal Land Council	55	36	45	53	50	43	49	42	49	42	48

Notes:
1 – The results are highlighted according to the level of exceedance above the NML according to ICNG criteria
2 – These receivers have been assessed to standard hours only.

Standard hours:
Clearly audible – above NML
Highly intrusive – < 75 dB

Results in Table 35 indicate some exceedances are predicted during various stages of construction. The La Perouse Museum and Macquarie Watchtower are the two locations that are most affected, with the La Perouse Museum having the highest predicted noise levels during Stage 2, specifically during both phases of Earthworks, where noise levels of up to 68 $dBL_{Aeq(15minute)}$ are predicted.

Smaller exceedances are predicted to reach Macquarie Watchtower for both Earthworks and Carpark reconfiguration phases. Noise levels from all other non-residential representative receivers at La Perouse are predicted to comply with established NMLs.

Table 36: Kurnell residential construction predicted results

ID	Period		NML	Stage 1	Stage 2									Stage 3
				Security & fencing	Setting up site offices and access	Demolition of existing Kurnell viewing platform	Establishing temporary causeway	Piling	Wharf construction	Earthworks for footpaths and landscape	Installation of wharf furniture	Installation of utilities	Landscaping	Removal of work site compound
RES1 3/1 Captain Cook Dr, Kurnell	Standard Hours	Day	53	62	67	62	58	56	60	75	53	75	68	66
	OOHW	Night	43	-	-	-	-	56	-	-	-	-	-	-
RES2 Rangers House	Standard Hours	Day	53	43	48	59	62	58	59	56	47	56	49	53
	OOHW	Night	43	-	-	-	-	58	-	-	-	-	-	-
RES3 33 Captain Cook Dr, Kurnell	Standard Hours	Day	53	46	44	56	57	55	56	59	44	59	52	52
	OOHW	Night	43	-	-	-	-	55	-	-	-	-	-	-
RES4 10 Prince Charles Pde, Kurnell	Standard Hours	Day	53	58	60	58	47	53	57	71	45	71	64	62
	OOHW	Night	43	-	-	-	-	53	-	-	-	-	-	-

1 – The results are highlighted according to the level of exceedance above the NML according to ICNG criteria

Standard hours:	Out of Hours Works (OOHW):
Clearly audible – above NML	Clearly audible – above NML
Highly intrusive - >75dB	Highly intrusive - >75dB

Results in Table 36 show exceedances for representative residential receivers in Kurnell. Residential receivers 1 and 4 are the closest in proximity to the works and are therefore affected for almost all stages of the construction period. The highest predicted noise levels are during Stage 2, specifically during installation of utilities and earthworks for footpaths and landscape phases, where noise levels reach up to 75 $dBL_{Aeq(15minute)}$ are predicted. The piling phase has exceedances for all representative receivers at both standard hours and out of hours.

Table 37: Kurnell other sensitive receiver construction predicted results

ID[2]	NML	Stage 1		Stage 2								Stage 3
		Security & fencing	Setting up site offices and access	Demolition of existing Kurnell viewing platform	Establishing temporary causeway	Piling	Wharf construction	Earthworks for footpaths and landscape	Installation of wharf furniture	Installation of utilities	Landscaping	Removal of work site compound
EDU1 - Kamay Botany Bay Environmental Education Centre	55	41	43	52	40	54	53	54	39	54	47	49
POW1 - St John Fisher Catholic Church	55	43	49	54	52	51	53	56	42	56	49	48
ARC1 - Marton Park	65	30	30	38	36	41	39	43	26	43	36	36
ARC2 - Yena Walking Trail	65	30	36	46	37	38	45	43	29	43	36	39
PRC1 - Commemoration Flat	60	41	46	44	39	51	48	54	37	54	47	46
CHC1 - Kurnell Preschool Kindergarten	55	33	37	49	47	47	48	46	36	46	39	42
COM1 - Endeavour Coffee and Ice cream	70	62	66	61	58	58	60	75	62	75	68	66
IND1 - Caltex Kurnell Terminal	75	39	47	49	41	48	49	52	32	52	45	45

Notes:
1 – The results are highlighted according to the level of exceedance above the NML according to CNVG criteria
2 – These non-residential sensitive receivers have been assessed to standard hours.

Standard hours:
Clearly audible – above NML
Highly intrusive - >75dB

Results in Table 37 indicate some exceedances are predicted during various stages of construction for non-residential receivers in Kurnell . The highest predicted noise levels are during Earthworks and Installation of utilities phases, where noise levels of up to 75 $dBL_{Aeq(15minute)}$ for Endeavour Coffee and Ice cream.

Noise levels from security and fencing, setting up site offices and access, demolition of existing Kurnell viewing platform, wharf construction, installation of wharf furniture, landscaping and removal of work site compounds are predicted to comply with established NMLs.

4.3 Construction vibration assessment

As a guide, the recommended minimum working distances for vibration intensive plant to be used in the project is presented in Table 38. This table provides an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers.

The minimum working distances presented are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

These are based on international standards and guidance.

Table 38: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating/Description	Minimum working distance (m)		
		Cosmetic damage		**Human response (OH&E Vibration Guideline) – Disturbance to building occupants**
		BS 7385 (Screening criterion of 25 mm/s)	DIN 4150 (Screening criterion of 3 mm/s)	
Vibratory pile driver	Sheet piles	2 m to 20 m	44 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	5 m	10 m (nominal)

The nearest sensitive receivers and their distance to the piling works is given in Table 39 below.

Table 39: Distance from sensitive receivers to piling works

Receiver ID	Name	Approximate distance to the piling works[m]
La Perouse		
RES2	28 Goorawahl Avenue	237 m
COM1	The Boatshed	15 m
Heritage	La Perouse Memorial	40m
	Redacted for public display	9m
	Cable Tanks	<5m
Kurnell		
RES1	3/1 Captain Cook Drive	360 m
COM1	Endeavour Coffee and Ice-cream	448 m
Heritage	Landing Place Wharf Abutment	<5m
	Redacted for public display	<5m
	Former Sea Wall	<5m

Residential receivers for both La Perouse and Kurnell are not expected to be adversely affected by vibration impact, either in terms of cosmetic damage or human comfort, due to their distance from the subject works.

For the Boatshed at La Perouse, mitigation will need to be considered as it is located closer to the construction work zone than these minimum working distances. It is noted that focus is on mitigating cosmetic damage to the receiver.

The Redacted for public display La Perouse could potentially be impacted by piling works if not managed appropriately. Mitigation will be needed as it is located within the minimum working distance. It is recommended that a vibration specialist would assess the minimum safe distance between the Aboriginal heritage site to the piling activities prior to construction.

The potential archaeology associated with the cable tanks at La Perouse may potentially be affected due to its proximity to piling works. This can be minimised through use of smaller equipment with lower vibration impact and vibration monitoring.

The non-Aboriginal heritage items are not expected to be impacted by vibration intensive construction works in La Perouse due to their separation distance from vibration intensive activities.

The heritage and potential archaeological items in Kurnell listed in Table 39 may be affected by the piling works. Mitigation may be required to minimise impacts to these items. It is recommended that a vibration specialist be engaged prior to construction to assess the minimum safe distance from the works to the items.

The contractor will be required to manage vibration as well as noise and make use of best practice in the management of vibration using simple and practicable techniques such equipment selection and as avoiding dropping heavy items. Vibration monitoring at the nearest potential affected building should be considered, where real-time alerts can be generated when measured vibration levels exceed criteria. Following the implementation of the proposed mitigation strategies, no impact to the site is expected. It should be noted that there is difficulty to provide certainty that there are no further vibration risks as potential archaeological structures can still be discovered.

Known and potential underwater heritage is outlined in Appendix G Underwater Cultural Heritage. For this assessment underwater heritage is considered to be anything below the mean high water mark. There would be less ground vibration at a given distance from a piling source used underwater than there would be from the same source in air (because more of the energy escapes into the water column). Conservatively, minimum safe working distances are considered the best approach to avoid vibration impacts. Any underwater heritage which is within safe working distances from piling activities could be impacted by vibration. Based on the assessment in Appendix G, it is likely that any vibration impacts from piling works would impact heritage features that are already likely to be physically impacted by piling construction. Therefore, any vibration impacts are considered to be negligible on underwater heritage including unidentified Aboriginal and non-Aboriginal heritage that is buried if present.

4.4 Construction traffic assessment

Road traffic noise levels including both existing and construction generated traffic, have been predicted using the Calculation of Road Traffic Noise (CoRTN) (Department of Transport Welsh Office, 1988) algorithm at the nearest residential receivers. The predicted external noise levels due to construction generated traffic is presented in Table 40 against RNP that considers residential receivers only.

Table 40: Traffic predicted results

Area	Traffic Route	Nearest receiver	Existing hourly traffic volumes[1]	Daily construction movements[2]	Predicted results	Assessment criteria – dBL_{Aeq}
La Perouse	Anzac Parade between Endeavour Ave and Goorawahl Avenue	RES2 and RES3	50	40	47dBL_{Aeq}	55$dBL_{Aeq,(1hour)}$ (external)
Kurnell	Captain Cook Drive	RES1 and RES4	58	50	48dBL_{Aeq}	55$dBL_{Aeq,(1hour)}$ (external)
Notes: 1 – Based on traffic data provided by SkyHigh and CfeIT 2 – Based on construction traffic data provided by TLM Consulting.						

Based on the assessment additional noise from construction traffic may be noticeable, given the comparative increase above the baseline traffic, however noise levels are predicted to comply with the RNP criteria.

5 Assessment of potential operational impacts

5.1 Basis of assessment

5.1.1 Wharf operations

The wharves would provide berthing access for ferry, commercial and recreational vessels. Each wharf would provide two berths, one for ferry vessels and one for other commercial and recreational vessels.

Each ferry berth would be capable of accommodating up to three vessels per hour and enable a turnaround time of around 15 minutes from berthing to departing. This would result in approximately 33 ferry movements a day during daylight hours. The actual vessel movements would depend on the operator. It is anticipated that vessels movements would be higher on weekends than on weekdays. Final timetables would be developed in consultation with relevant stakeholders.

Operating hours of the wharves are to be confirmed once an operator is selected. The noise assessment has assessed the operation of the wharves between 7am and 6pm.

As the ferry types have not been confirmed, the sound power levels adopted for the assessment, as presented in Table 42, have been sourced from the '*Barangaroo Ferry Hub Construction and Operation al Noise and Vibration Impact Assessment*' (SLR, 2014). The sound power levels have been derived from measured ferry activities at existing wharves at Cockatoo Island and Circular Quay of a range of vessels given in Table 41.

Table 41: List of vessel classes included in the SLR Barangaroo Ferry Hub NVIA

Vessel class	Fleet name	Average Length	Average service speed
River Cat	Marjorie Jackson, Marlene Mathews, Shane Gould, Betty Cuthbert, Dawn Fraser, Evonne Goolagong	36.8 m	40 kph
HarbourCat	Pam Burridge	29.6 m	40 kph
Captain Cook charter	Mary Reiby	23.9 m	46 kph
First Fleet	Golden Grove, Supply Sydney, Sirius, Alexander, Scarborough	25.4 m	22 kph

The assessment excludes a PA system on the wharf as it is not envisaged to be required for normal operations.

As a worst-case, the same sound power levels have been assumed for both the ferry and commercial vessel in the SoundPlan model. Smaller recreational vessel would exhibit lower sound levels than assessed.

Table 42: Operational marine vessel activity sound power levels

Activity	Type of noise source	Sound Power Level $dBL_{Aeq(period)}$[1]	Time operating in a 15-minute period	Sound Power Level, L_w $dBL_{Aeq\ (15min)}$
Ferry / commercial vessel accelerating	Moving point source (30 km/h)[2]	98	135 seconds (1150 m)	90
Ferry / commercial vessel reverse thrust	Point source	93	1 minute	81
Ferry / commercial vessel idling	Point source	92	7.5 minutes	89
Ferry horn	Point source	118	3 seconds	93
Notes: 1 – Sound power level not corrected for operating time 2 – It is assumed that the ferry will slow down as it nears the wharves and therefore an average speed of 30kph was applied to the moving point source.				

The following scenario have been modelled as it considers the typical worst-case situation (i.e. full capacity) for each wharf for a 15-minute period:

- One (1) public ferry is arriving, including sound of horn and use of reverse thrust to berth, idling and then departing with sounding of horn, at each location; and,
- One (1) commercial vessel is arriving, no horn, berthing and idling for 7.5 minutes at each location. It is assumed that a commercial vessel will not be departing within the same 15-minute period.

The ferry routes have been assumed and are shown in Figure 16 and Figure 17.

5.1.2 Operational road traffic

Based on the Arup Traffic and Transport Assessment (refer to Appendix K), the projected traffic volumes generated by the wharf on opening year is provided in Table 43.

Table 43: Project traffic volumes generated by the wharf on opening year

Area	Day of the week	Time					
		11:00am	12:00pm	1:00pm	2:00pm	15:00pm	16:00pm
La Perouse	Weekday	7	9	12	9	10	8
	Weekend	5	7	11	7	9	7
Kurnell	Weekday	41	49	49	39	41	35
	Weekend	35	42	39	32	33	28

A heavy vehicle percentage of 10% has been assumed for both existing traffic and generated traffic which is conservative.

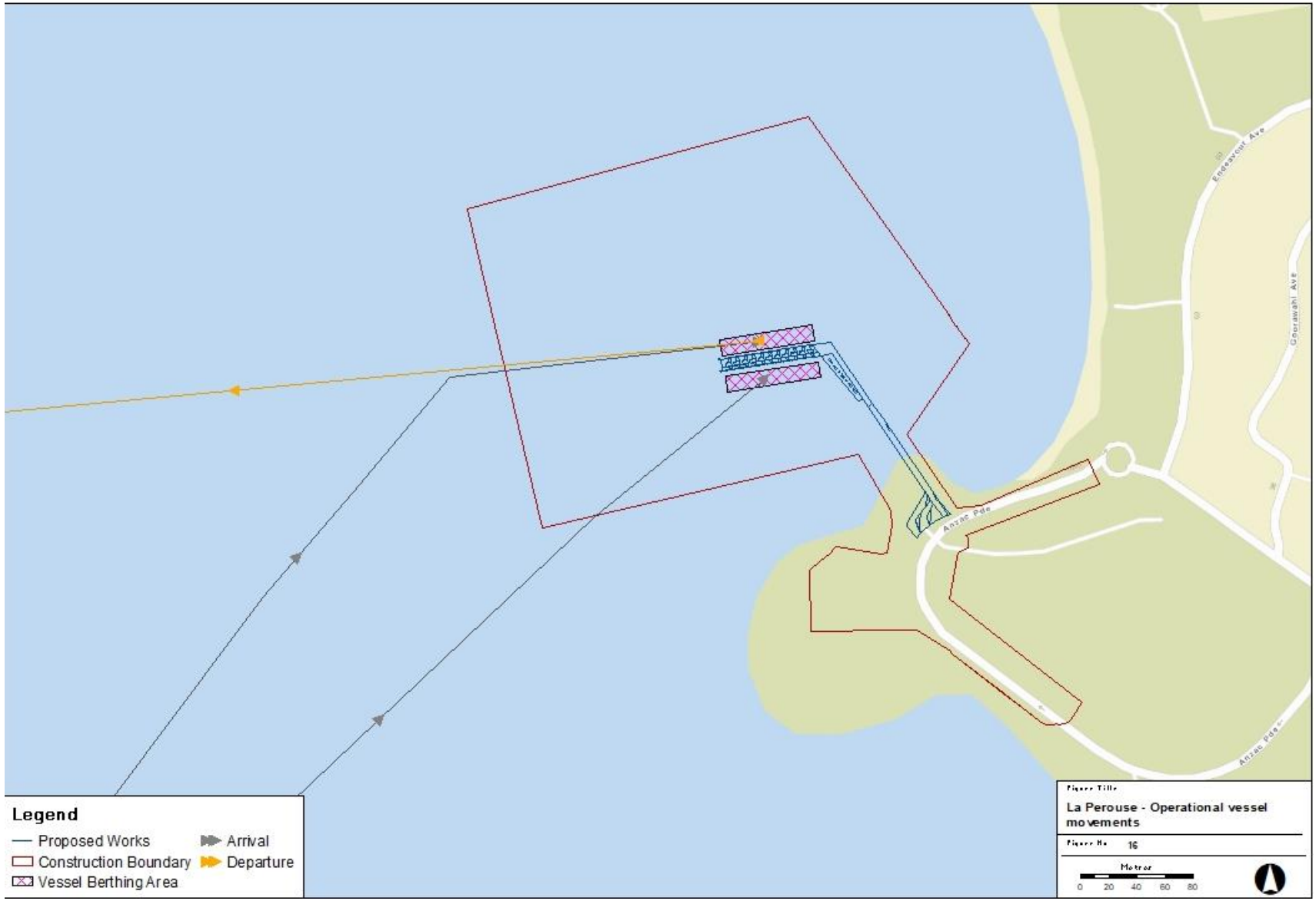


Figure 16: La Perouse operational vessel movements

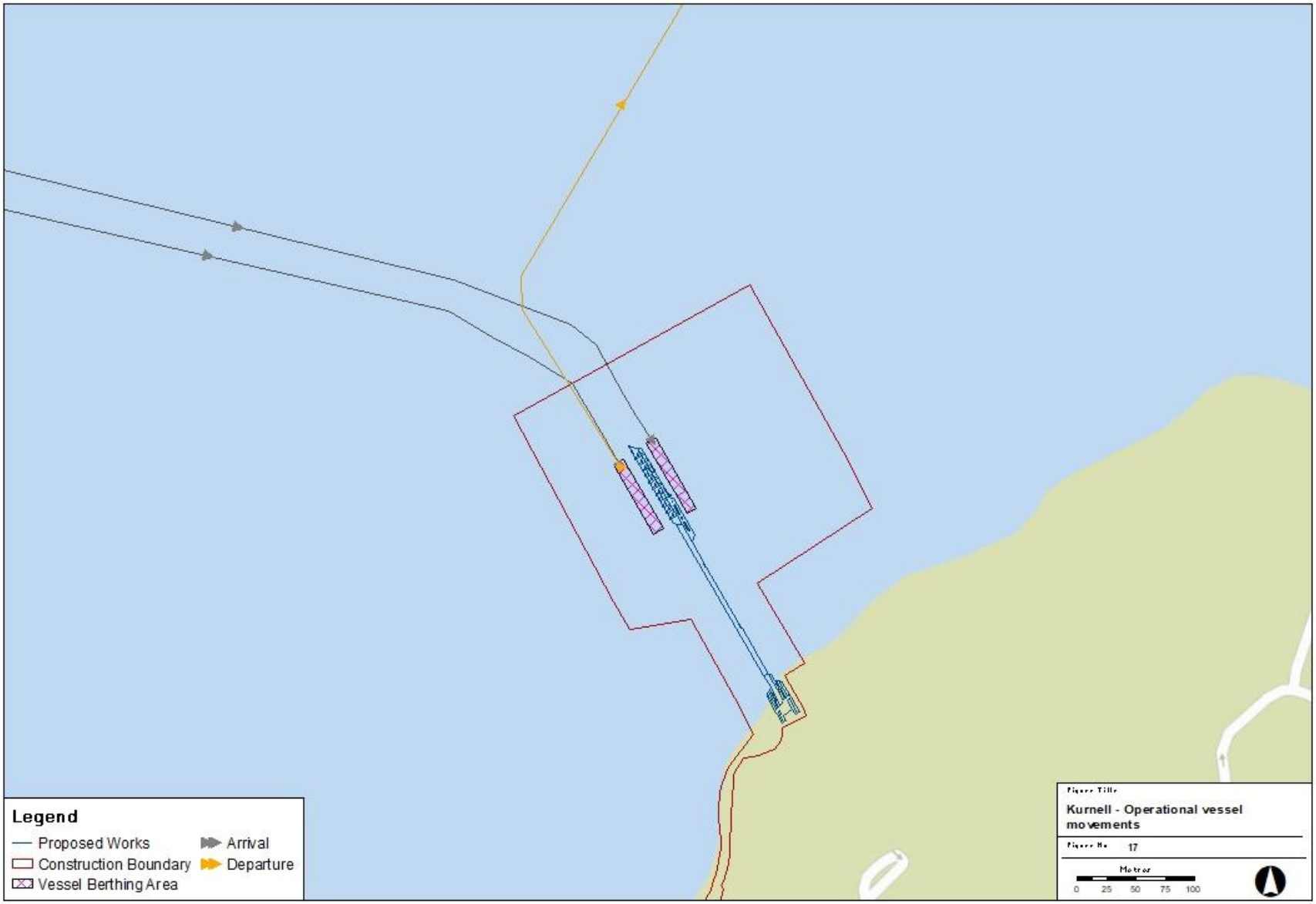


Figure 17: Kurnell operational vessel movements

5.2 Wharves operations assessment

Operational noise levels have been predicted at the nearest noise sensitive receivers using the SoundPLAN 8.1 noise modelling software in accordance with the Concawe (CONCAWE, 1981) algorithm.

The Concawe algorithm has been used which is considered appropriate for receivers more than 100 m away. The following meteorological conditions were adopted for this assessment for all receivers in accordance with the NPfI (Environment Protection Authority, 2017):

- Standard meteorological conditions - Stability Category D with no wind; and
- Enhanced meteorological conditions - Stability Category F with source-to receiver 3 m/s wind.

As details for the vessels and operations are not available during the time of this assessment, a conservative approach has been taken for the assessment of the ferry operations by including a 5 dB correction to account for the potential that noise emission from the operations triggers either the tonal or low frequency characteristic correction.

The predicted noise levels at each sensitive receiver are shown in Table 44 and Table 45.

Table 44: Ferry operations noise predictions – Residential receivers

ID	Period	Project Noise Trigger Level $L_{Aeq,15minute}$	Standard meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]	Enhanced meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]
La Perouse				
RES1 - 51-53 Endeavour Avenue, La Perouse	Day	48	41	46
RES2 - 28 Goorawahl Avenue, La Perouse	Day	48	40	45
RES3 - 3/1599 Anzac Parade, La Perouse	Day	48	39	44
RES4 - 31 Endeavour Avenue, La Perouse	Day	48	41	46
RES5 – 1605 Anzac Parade, La Perouse	Day	48	41	46
Kurnell				
RES1 - 3/1 Captain Cook Dr, Kurnell	Day	48	37	42
RES2 - Rangers House	Day	48	40	45
RES3 - 33 Captain Cook Dr, Kurnell	Day	48	37	43

ID	Period	Project Noise Trigger Level $L_{Aeq,15minute}$	Standard meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]	Enhanced meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]
RES4 - 10 Prince Charles Pde, Kurnell	Day	48	34	40
1- A 5dB correction is applied to the above predictions to account for the worst – case scenario wherein one modifying factor in accordance with NPfI has been assumed i.e. low frequency noise or tonal characteristics.				

Table 45: Ferry operations noise predictions - Other sensitive receivers

ID	Period	Project Noise Trigger Level $L_{Aeq,15minute}$	Standard meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]	Enhanced meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]
La Perouse				
ARC1 - Frenchmans Bay Reserve Playground	When in use	53	43	47
ARC2 - Congwong Trail	When in use	53	34	39
PRC1 -Frenchmans Beach	When in use	48	43	47
CHC1 - Gujaga MACS Childcare Centre	When in use	40	36	42
COM1 - The Boatshed	When in use	63	46	50
CUL1 - La Perouse Museum	When in use	63	41	45
CUL2 - Macquarie Watchtower	When in use	63	36	41
CMU1 - La Perouse Local Aboriginal Land Council	When in use	53	35	41
Kurnell				
EDU1 - Kamay Botany Bay Environmental Education Centre	When in use	40	35	40
PoW1 - St John Fisher Catholic Church	When in use	48	35	40
ARC1 - Marton Park	When in use	53	27	32
ARC2 - Yena Walking Trail	When in use	53	33	39

ID	Period	Project Noise Trigger Level $L_{Aeq,15minute}$	Standard meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]	Enhanced meteorological conditions Predicted Noise Level $L_{Aeq,15minute}$[1]
PRC1 - Commemoration Flat	When in use	48	33	38
CHC1 -Kurnell Preschool Kindergarten	When in use	40	26	31
COM1 - Endeavour Coffee and Ice cream	When in use	63	40	45
IND1 - Caltex Kurnell Terminal	When in use	68	29	34
1- A 5dB correction is applied to the above predictions to account for the worst – case scenario wherein one modifying factor in accordance with NPfI has been assumed i.e. low frequency noise or tonal characteristics.				

Operational noise prediction levels in Table 44 and Table 45 which exceed criteria are highlighted in red. The predicted results show a minor exceedance of 2 dB for Gujaga MACS Childcare Centre in La Perouse with enhanced meteorological conditions. The criteria applied to this receiver is conservative given that for educational institutions, an internal criteria applies. This internal criteria was converted to an external criteria by assuming a 10 dB reduction through an open window. Further, the ambient noise level in the area is much higher i.e. 48 $dBL_{AEq(15min)}$ and therefore, the operations of the ferry wharf is not considered to cause any significant impact to the existing noise environment.

It should be noted that assessment is conservative as it has included a 5 dB correction to account for tonal or low frequency modifying factors as per NPfI.

All other receivers including employees and visitors to the Kamay Botany Bay National Park are expected to not be negatively affected by the ferry operational noise as they are below the project noise trigger levels.

It is recommended that a confirmation of this assessment be undertaken once a ferry operator has been appointed and details of the ferry sound power levels are made available.

5.3 Operational traffic noise assessment

Increased traffic generated on the surrounding road network due to the operation of the Kamay Ferry Wharves development is assessed in accordance with the NSW *Road Noise Policy* (RNP).

From the projected traffic volumes during Opening year (2024) in Table 46, the busiest period is at 1pm for La Perouse and 12pm at Kurnell on both weekdays and weekends. These were adjusted to project the Opening and Design year volumes using a seasonality adjustment and a growth rate 1.32% provided by in the Landside Traffic and Transport Assessment (refer to Appendix K of the EIS).

A heavy vehicle percentage of 10% has been assumed for both existing traffic and generated traffic which is considered to be conservative.

Table 46: Assessment of the road traffic generated by Kamay ferry wharves

	Existing Traffic 2014[1]	Opening Year 2024	Design Year 2036
La Perouse - Anzac Parade			
Peak vehicle movement volume for the site at 1pm	186	289[2]	338[2]
Traffic generated by wharf at 1pm	-	12	14
increase in noise level		**0.2**	**0.2**
Kurnell - Captain Cook Drive			
Peak vehicle movement volume for the site at 12pm	140	229[2]	268[2]
Traffic generated by wharf at 12pm	-	49	57
increase in noise level		**0.8**	**0.8**
Note: 1 – Based on traffic data provided by SkyHigh and CfeIT 2 – Adjusted traffic volumes using a seasonality adjustment and growth rate of 1.32% from Arup Transport			

Based on the existing traffic numbers along Anzac Parade and Captain Cook Drive, the additional traffic created by wharves operations is predicted to increase the $L_{Aeq(15\ hour)}$ noise levels by 0.2 dB at Anzac Parade and 0.8 dB at Captain Cook Drive during the Opening Year (2024) and Design Year (2036).

This is less than the 2 dB ‘minor impact’ criteria, and therefore represents an insignificant effect on the ambient noise environment.

6 Environmental management measures

A summary of recommended mitigation measures is presented in Table 47.

Table 47: Environmental management measures for noise and vibration impacts

Impacts	Mitigation	Responsibility	Timing
Noise and vibration risks during construction	Noise and Vibration Management Plan A Noise and Vibration Management Plan will be prepared and implemented as part of the CEMP. The Plan will generally follow the approach in OEH's Interim Construction Noise Guideline (ICNG) and identify: All potential significant noise and vibration generating activities associated with the activity Measures to be implemented during construction to minimise noise and vibration impacts, such as restrictions on working hours, staging, placement and operation of work compounds, parking and storage areas, temporary noise barriers, haul road maintenance, and controlling the location and use of vibration generating equipment Feasible and reasonable mitigation measures to be implemented, taking into account the RMS Beyond the Pavement urban design policy, process and principles. A monitoring program to assess performance against relevant noise and vibration criteria Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. Note that ICNG does not provide firm guidance around the management of works outside standard hours, the Construction Noise and Vibration Strategy (CNVS) provides greater clarity in the implementation of OOHW mitigation measures.	Contractor	Pre-construction / Construction

Impacts	Mitigation	Responsibility	Timing
Equipment selection	Equipment shall be selected to have Sound Power Levels (Lw) to be the same or quieter as the levels used in this assessment. Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers. Consider using electric / hydraulic equipment where possible. Use only the necessary size and power equipment All plant and equipment used on site must be: • maintained in a proper and efficient condition; and • operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use. Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable. If rental equipment are to be used, the noise levels of plant and equipment items are to be considered in rental decisions.	Contractor	Construction
Risks to local sensitive receivers	Standard construction hours • Monday to Friday 7.00 am to 6.00 pm • Saturdays 8.00 am to 1.00 pm • No construction on Sundays or Public Holidays.	Contractor	Construction
Community notification	Local community notification - sensitive receivers All sensitive receivers (eg. schools, local councils) likely to be affected will be notified at least {30 days} prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will include details of: the project; construction period and construction hours; contact information for project management staff; complaint and incident reporting; and how to obtain further information.	Transport for NSW	Pre-construction / Construction

Impacts	Mitigation	Responsibility	Timing
Location of plant	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site. Plan truck movements to avoid residential streets where possible.	Contractor	Construction
Out of Hours work	Restrict the number of nights per week and/or the number of nights per calendar month that the works are undertaken, in consultation with residences and businesses most affected.	Contractor	Construction
Piling vibration impacts	Vibration specialist to assess the minimum safe distances between the identified sensitive heritage sites to the vibration generating activities	Vibration specialist	Pre construction

7 Conclusion

An assessment of noise and vibration impacts associated with the construction and operation of the Kamay Ferry Wharves has been conducted in accordance with Secretary's Environmental Assessment Requirements and relevant noise policies and guidance documents.

7.1 Construction noise and vibration

Noise generated from the various stages of demolition and construction have been predicted at surrounding noise sensitive receivers.

Based on the results of the assessment, piling works are predicted to generate the most significant noise impacts at La Perouse with noise levels of up to 67 $dBL_{Aeq(15minute)}$. For Kurnell, the highest predicted noise levels are during Stage 2, specifically during installation of utilities and earthworks for footpaths and landscape phases, where noise levels reach up to 75 $dBL_{Aeq(15minute)}$ are predicted. Construction works are temporary in nature therefore any potential noise impact on the community and the surrounding environment will not be permanent. However, where possible the impacts due to construction noise should be minimised.

Based on the identified nearest receiver locations, and proposed construction works, vibration from the piling work will likely affect heritage and potential arachnological items closest to the site. This is recommended to be mitigated through vibration specialist guidance.

High level recommendations are given for the control of construction noise for the periods where exceedances are predicted of relevant Noise Management Levels. The construction contractor is required to prepare a detailed Construction Noise and Vibration Management Plan which reviews the modelled construction details and noise and vibration impacts.

7.2 Operational noise

Operation noise criteria have been established for noise emissions, which include traffic generated by operation of the site and ferry operations at the La Perouse and Kurnell wharves.

Impacts due to the operational road traffic have been assessed against the RNP. From the assessment, the generated road traffic from the operation of the ferry wharves will generate a less than 2 dB increase in noise level during Opening Year, and therefore represents an insignificant effect on the ambient noise environment.

The operational noise from the wharves have been assessed against the NPfI policy. The predicted noise levels are well below project noise trigger levels for most receivers with the exception of Gujaga MACS Childcare Centre where an exceedance 1dB with enhanced meteorological conditions were predicted.

However, it should be noted that the assessment is conservative as it has included a 5 dB correction to account for the potential that noise emission from the operations triggers either the tonal or low frequency characteristic correction. It is recommended that a confirmation of this assessment be undertaken once a ferry operator has been appointed and details of the ferry sound power levels are made available.

References

Australian and New Zealand Environment Council, 1990. *Technical Basis for Guidelines to Minimise Annoyance due to Blasting and Overpressure and Ground Vibration,* s.l.: s.n.

Bernadini, M. et al., 2019. *Noise Assessment of Small Vessels for Action Planning in Canal Cities,* Pisa, Italy: MDPI.

British Standard, 1993. *BS 7385:1993 Evaluation and Measurement for Vibration in Buildings,* London: British Standard.

British Standards, 1993. *Evaluation and measurement for vibration in buildings,* London: General Mechanical Engineering Standards Policy Committee.

British Standards, 2008. *BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting,* s.l.: British Standards.

British Standards, 2009. *BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites. Noise,* s.l.: British Standards.

CONCAWE, 1981. *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities,* Brussels: Acoustic Technology Limited.

D, C. H. & Miller, G. I., 2000. *Transport Reseach Laboratory (TRL), GroundBorne vibration caused by mechanised construction works,* s.l.: s.n.

Department of Environment and Climate Change NSW, 2009. *Interim Construction Noise Guideline,* Sydney: Department of Environment and Climate Change NSW.

Department of Environment and Climate Change NSW, 2009. *Interim Construction Noise Guideline,* Sydney: State of NSW.

Department of Environment and Conservation (NSW), 2006. *Assessing Vibration: A technical guideline,* Sydney: Department of Environment and Conservation (NSW).

Department of Environment, Climate Change and Water NSW, 2011. *NSW Road Noise Policy,* Sydney: NSW Environmental Protection Authority.

Department of Transport Welsh Office, 1988. *Caculation of Road Traffic Noise,* Wales: Department of Transport Welsh.

Environment Protection Authority, 1999. *Envrionmental Criteria for Road Traffic Noise,* Sydney: Environment Protection Authority.

Environment Protection Authority, 2000. *Industrial Noise Policy,* Sydney: Environment Protection Authority.

Environment Protection Authority, 2017. *Noise Policy for Industry,* Sydney: State of NSW.

German Institute for Standardisation, 2016. *DIN 4150 - Part 3 'Structural vibration in buildings - Effects on Structure',* s.l.: German Institute for Standardisation.

NSW Environmental Protection Authority, 2012. *NSW Road Noise Policy,* Sydney: NSW Environmental Protection Authority.

SLR, 2014. *Barangaroo Ferry Hub Construction and Operational Noise and Vibration Impact Assessment,* Sydney: SLR.

Standards Australia, 2010. *AS 2436-2010 - Guide to noise and vibration control on construction, demolition and maintenance sites,* s.l.: Standards Australia.

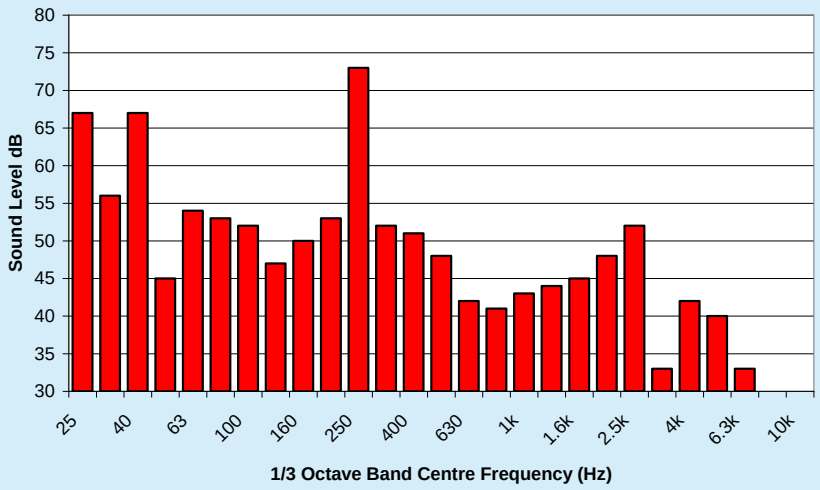
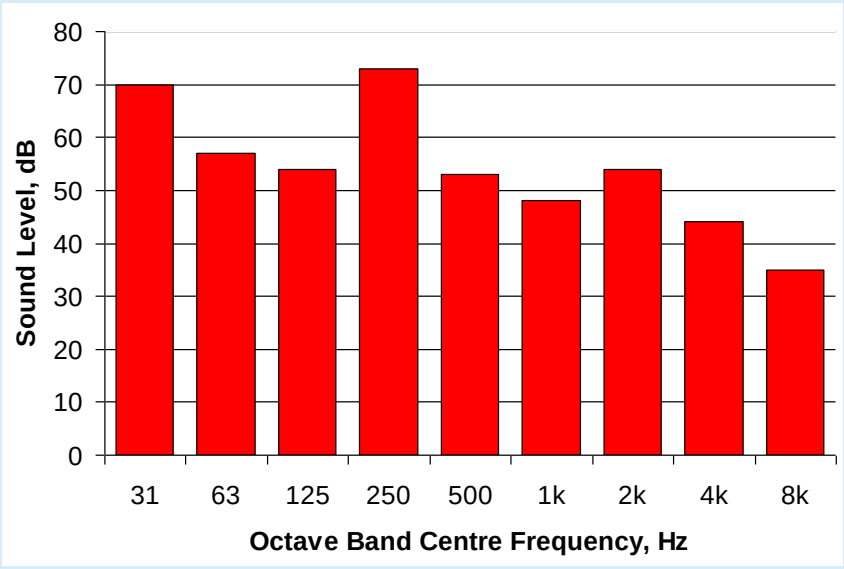
Wilkinson Murray, 2006. *Botany Bay Cable Project Construction & Operational Noise Assessment,* NSW: Wilkinson Murray.

Appendix A

Acoustic Terminology

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Ambient Noise Level</td><td>The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.</td></tr>
<tr><td>Background Noise Level</td><td>The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.
Assessment Background Level (ABL)
A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background LA90 noise levels – i.e. the measured background noise is above the ABL 90% of the time.
Rating Background Level (RBL / min $L_{A90,1hour}$)
A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min $L_{A90,1hour}$ in QLD.</td></tr>
<tr><td>Decibel</td><td>The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore, a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.
An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.</td></tr>
<tr><td>dBA</td><td>dBA denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level.
The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dBA.</td></tr>
<tr><td></td><td>Some typical dBA levels are shown below.
<table>
<tr><th>Sound Pressure Level dBA</th><th>Example</th></tr>
<tr><td>130</td><td>Human threshold of pain</td></tr>
<tr><td>120</td><td>Jet aircraft take-off at 100 m</td></tr>
<tr><td>110</td><td>Chain saw at 1 m</td></tr>
<tr><td>100</td><td>Inside nightclub</td></tr>
</table></td></tr>
</table>

Term	Definition		
		90	Heavy trucks at 5 m
		80	Kerbside of busy street
		70	Loud stereo in living room
		60	Office or restaurant with people present
		50	Domestic fan heater at 1m
		40	Living room (without TV, stereo, etc.)
		30	Background noise in a theatre
		20	Remote rural area on still night
		10	Acoustic laboratory test chamber
		0	Threshold of hearing
L_1	The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time. Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dBA or higher for 1% of the 15 minute measurement period.		
L_{10}	The L_{10} statistical level is often used as the "average maximum" level of a sound level that varies with time. Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dBA or higher for 10% of the 18 hour measurement period.		
L_{90}	The L_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time. Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dBA or higher for 90% of the 15 minute measurement period.		
L_{eq}	The 'equivalent continuous sound level', Leq, is used to describe the level of a time-varying sound or vibration measurement. Leq is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dBA weighting is applied, the level is denoted dB LAeq. Often the measurement duration is quoted, thus LAeq,15 min represents the dBA weighted energy-average level of a 15 minute measurement.		
L_{max}	The Lmax statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time. Mathematically, Lmax is the highest value recorded during the measurement period. As an example, 94 dB LAmax is a highest value of 94 dBA during the measurement period. Since Lmax is often caused by an instantaneous event, Lmax levels often vary significantly between measurements.		
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".		

Term	Definition
	 
Peak Particle Velocity (PPV)	Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure root mean squared (RMS) values; it is common to approximate the PPV based on an RMS measurement. PPV is commonly used as a vibration criterion, and is often interpreted as a PPV based on the Lmax or Lmax,spec index.
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Vibration	Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for

Term	Definition
	structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

Appendix B

Noise Monitoring

.

B1 Noise monitoring equipment

Unattended monitoring was carried out using the following equipment:

Measurement location	Equipment/model	Serial No.	SLM Type
La Perouse Logger - 51-52 Endeavour Ave	Ngara	878060	Class 1
Kurnell Logger - 3/1 Captain Cook Dr	Ngara	878061	Class 1
Notes: All meters comply with AS IEC 61672.1 2013 "Electroacoustics - Sound Level Meters" and designated either Class 1 as per table, and are suitable for field use.			

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

B2 Extraneous/weather affected data

Measurement samples affected by extraneous weather conditions, i.e wind greater than 5 m/s or rain, were excluded from the recorded data in accordance with the procedures outlined in Fact Sheet A of the NSW EPA's *Noise Policy for Industry* (NPfI 2017).

Weather data was obtained from the Bureau of Meteorology (BOM) collection station at Little Bay (AWS:66051) and Kurnell (AWS:66043) in 15-minute intervals for the monitoring period. Wind speed data was adjusted to account for the difference in measurement height and surrounding environment between the BOM weather station, measured 10 m above ground, and the microphone height, based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'

B3 Logger graphs

The following noise level vs time graphs present overall dB(A) levels recorded by the unattended logger(s) for a range of noise descriptors, including L_{Aeq}, L_{A90}, L_{A10} and L_{Amax}, while line graphs are presented, sampling is at 15 minute intervals.

Wind speeds are also show where relevant, and periods of excluded data are shaded grey