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Nuclear-Powered Submarine Construction Yard EIS

Noise and Vibration Technical Report

A240248RP1 Revision B

Thursday, 28 November 2024

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Document Information

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Revision Table

Report revision	Date	Description	Author	Reviewer
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A	17/06/2024	DRAFT UPDATE	LN/DJ	DJ
B	28/11/2024	Response to comments and include traffic assessment	AL/DJ	DJ

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Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Ambient sound	Sound that would be present in the absence of a specified activity. Ambient sound can be anthropogenic (e.g. industrial or shipping) or natural (e.g. wind, biota).
ANI	Australian Naval Infrastructure
Auditory frequency weighting	The process of band-pass filtering sounds to reduce the importance of inaudible or less-audible frequencies for individual species or groups of species of aquatic mammals. In other terms, a frequency weighting function that compensates for a species' (or functional hearing group's) frequency-specific hearing sensitivity.
CEMP	Construction Environmental Management Plan
CNVMP	Construction Noise and Vibration Management Plan
Continuous noise level	A-weighted noise level of a continuous steady sound that, for the period over which the measurement is taken using fast time weighting, has the same mean square sound pressure as the noise level which varies over time when measured in relation to a noise source and noise-affected premises in accordance with the Noise EPP
Day	Between 7 am and 10 pm as defined in the Noise EPP
dB	Decibel—a unit of measurement used to express sound level. Decibels express the ratio of sound relative to a reference level on a logarithmic scale. For airborne noise the reference level is 20 μPa, while for underwater noise the reference level is typically 1 μPa.
dB(A)	Units of the A-weighted sound level.
dBpeak	Peak sound pressure over the measurement period, expressed in dB re 1 μPa.
dBrms	Root mean square sound pressure over the measurement period, expressed in dB re 1 μPa.
EIS	Environmental Impact Statement
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second.

Hearing group	Category of animal species when classified according to their hearing sensitivity and to the susceptibility to sound. Examples for marine mammals include low-frequency (LF) cetaceans, high-frequency (HF) cetaceans, very high-frequency (VHF) cetaceans, otariid pinnipeds in water (OPW), phocid pinnipeds in water (PPW), sirenians (SI), other marine carnivores in air (OCA), and other marine carnivores in water (OCW). (Southall et al. 2019).
Hearing threshold	The hearing threshold represents the lowest signal level an animal can detect at a particular frequency, usually referred (and measured) as the threshold at which an animal will indicate detection 50% of the time.
HF	High frequency cetaceans hearing group.
Impulsive sound	Transient sound that has extremely short duration and a high peak sound pressure level.
Indicative noise level	Indicative noise level determined under clause 5 of the Noise EPP.
LF	Low frequency cetaceans hearing group.
L_{90}	Noise level exceeded for 90 % of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{95}	Noise level exceeded for 95 % of the measurement time.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	The maximum instantaneous noise level.
MFO Level 1	Marine Fauna Observer, Level 1. A person with qualifications in ecology, zoology or environmental sciences and demonstrated experience with the identification and management of dolphins or whales, including behaviour, as well as distance estimation.
MFO Level 2	Marine Fauna Observer, Level 2. A person who has sufficient experience in marine fauna identification and distance estimation.
Night	Between 10.00 p.m. on one day and 7.00 a.m. on the following day as defined in the Noise EPP.
Noise source	Premises or a place at which an activity is undertaken, or a machine or device is operated, resulting in the emission of noise.
OCA	Other carnivores in air hearing group.
OCW	Other carnivores in water hearing group.
OPW	Otariid pinnipeds in water hearing group.
PPW	Phocid pinnipeds in water hearing group.

PTS	Permanent threshold shift (PTS) is a permanent reduction in hearing sensitivity caused by irreversible damage to the sensory hair cells of the ear.
SCY	Submarine Construction Yard
SEL	Level of the sound exposure as defined in ISO 18405. In underwater acoustics, the reference value of time-integrated squared sound pressure is 1 µPa^2 s.
$SEL_{24\ hour}$	The cumulative sound exposure level, which includes multiple acoustic pulses from piling or the time duration of dredging within a 24 hour period. It is also assumed for intermittent, repeated exposure that there is no recovery between subsequent exposures.
SI	Sirenians hearing group.
Source level	Source level (SL) is the sound pressure level at a distance of 1 m from a hypothetical point source radiating the same amount of sound energy as the actual source. Units: dB re 1 µPa^2·m^2 (sound pressure level), dB re 1 µPa^2·m^2 s (sound exposure level).
SPL	Sound pressure level (SPL) is the root-mean-square sound pressure expressed in the decibel (dB) scale. Units: dB re 1 µPa^2 (underwater), dB re 20 µPa (air).
TTS	Temporary threshold shift (TTS) is a temporary reduction in hearing sensitivity as a result of exposure to sound. Exposure to high levels of sound over relatively short time periods can cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The duration of TTS varies depending on the nature of the stimulus.
VHF	Very high frequency cetaceans hearing group.

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Executive Summary

The Minister for Planning declared the nuclear-powered Submarine Construction Yard (SCY) as an impact assessed development under section 108 (1)(c) of the *Planning, Development and Infrastructure Act 2016*, which requires the preparation of an Environmental Impact Statement (EIS).

The purpose of this report is to document the noise and vibration impact assessment undertaken to satisfy the project specific *Environmental Impact Statement: Assessment Requirements* to 'ensure the development does not have unacceptable adverse noise or vibration impacts on the surrounding environment, in particular sensitive receivers in proximity to noise sources'.

The existing noise and vibration in the study area is summarised as follows:

- Noise at the nearest residences to the proposed SCY development is largely dominated by road traffic and other industrial sources, with extraneous noises from birds and trains. The following outlines the average ambient (L_{Aeq}) and background (L_{A90}) noise levels, respectively, across 5 logging locations:
  - Day = 64 dB(A)L_{eq} and 48 dB(A)L_{90}
  - Night = 59 dB(A)L_{eq} and 45 dB(A)L_{90}
- Vibration at the residences nearest to Victoria Road is dominated by road traffic, particularly from Medium and Large Combination (AUSTROADS Class 11 (Double Road Train) and Class 12 (Triple Road Train)) vehicles. Vibration levels typically ranged from 0.1 to 1.5 mm/s PPV.
- Existing underwater noise conditions in the marine area consist mainly of snapping shrimp noise underpinned by continuous low frequency mechanical noise (<250 Hz). However, this background noise is largely masked as vessels pass by. The number of vessel movements traversing along Port River is significant, including operating at all times of the day or night. Given that the channel width at the location of measurements is 200 m and in the assumption that vessels are largely traversing in the centre of the channel, the source levels of the various vessels measured are calculated to be in the range 150 to 175 dB re 1 μPa^2 at 1 m.

Operational noise levels have been predicted for all noise-sensitive receptors in the vicinity of the SCY Subject Site. The predicted noise level at the most affected residential receptor for each scenario is presented in the table below.

Prediction location	**Relevant Criteria L_{eq} dB(A)**	**Predicted noise level L_{eq} dB(A)**	**Predicted to Comply**
Scenario A (Day)			
Most affected residential receptor in the General Neighbourhood zone	52	43	✓
Most affected residential receptor in the Rural Living zone	47	<35	✓
Scenario B (Night)			
Most affected residential receptor in the General Neighbourhood zone	45	44	✓
Most affected residential receptor in the Rural Living zone	40	<35	✓

In summary, the noise levels from continuous, simultaneous operation of all facilities at the site are predicted to comply with the relevant Noise EPP criteria.

Furthermore, the following provides a tabulated summary of the expected impacts and recommended control measures from the construction and operation of the SCY facility.

<table>
<tr><th>Potential Impact</th><th>Consequence</th><th>Certainty</th><th>Recommended Control Measures</th></tr>
<tr><td>Noise from land-based construction activities on residential receivers.</td><td>Minor</td><td>Medium</td><td rowspan="8">Before the commencement of works, the construction team shall prepare a Construction Noise and Vibration Management Plan (CNVMP), a sub plan of the Construction Environmental Management Plan (CEMP).

The CNVMP shall consider the adopted terrestrial and marine assessment criteria, sensitive receptors, and heritage structures as well as mitigation and management measures contained within this document (unless superseded by new information or government policy), namely:
• Section 5 Assessment criteria
• Section 8.4 Construction noise mitigation and management
• Section 9.6 Construction vibration mitigation and management
• Section 10.4 Noise mitigation and management for terrestrial fauna
• Section 11.7 Noise mitigation and management for marine fauna</td></tr>
<tr><td>Vibration from land-based construction activities on residential receivers.</td><td>Negligible</td><td>Medium</td></tr>
<tr><td>Vibration from land-based construction activities on existing ONS office/workshop receivers.</td><td>Minor</td><td>Medium</td></tr>
<tr><td>Noise from land or water-based construction activities on terrestrial fauna.</td><td>Minor</td><td>Medium</td></tr>
<tr><td>Vibration from land or water-based construction activities on heritage structures.</td><td>Moderate</td><td>Medium</td></tr>
<tr><td>Noise from water-based construction activities on marine fauna -
Fish, sharks and marine turtles</td><td>Minor</td><td>Medium</td></tr>
<tr><td>Noise from water-based construction activities on marine fauna -
LF Cetaceans and Phocid Carnivores (PCW)</td><td>Minor</td><td>Medium</td></tr>
<tr><td>Noise from water-based construction activities on marine fauna -
HF Cetaceans (including Port River Dolphin) and Other Carnivores (OCW)</td><td>Minor</td><td>Medium</td></tr>
<tr><td>Noise from operation of the SCY facilities on residential receptors</td><td>Minor</td><td>Low</td><td>Development of a master noise model to assign a ‘noise budget’ to each building facility and associated external plant based on functional operating requirements. Building facilities with noisier operational activities may be assigned a greater noise budget within the cumulative noise emission allowance for the ONS and SCY precinct to optimise noise mitigation for the Development. Note that it is expected that Work Health and Safety (WHS) requirements will also positively influence the design outcome in terms of mitigating internal/external noise emissions of plant and equipment.</td></tr>
</table>

Potential Impact	Consequence	Certainty	Recommended Control Measures
Traffic noise from operation of the SCY facilities on residential and other sensitive receptors	Moderate	Low	Given the current assessment work completed for the development by SMEC in partnership with DIT, and the on-going work that will need to be completed by DIT and authorities for the Lefevre Peninsula Masterplan, it is considered that suitable mitigation would be able to be implemented to reduce the impact to the road network incurred by the development and other growth on the Lefevre Peninsula in the future thus reducing the overall significance of effects. It is the responsibility of DIT to implement suitable noise mitigation as required.
Noise from operation of the SCY facilities on terrestrial fauna.	Negligible	Low	NIL
Noise from operation of the SCY facilities on marine fauna	Negligible	Low	NIL

Given the "Low" level of assessment certainty associated with the 5% design status of the facility, it is recommended that an updated noise and vibration model/impact assessment be prepared once the design progresses further.

However, after reviewing the information, we anticipate that the planned construction and operation of the SCY precinct will be able to meet its environmental obligations as required by national and state legislation. This will be achieved through the implementation of recommended mitigation and management measures outlined in this report. These measures may be refined and reviewed as the design progresses.

1 Introduction

The Australian Submarine Agency (ASA) was established in July 2023 to safely and securely acquire, construct, deliver, technically govern, sustain and dispose of Australia's conventionally-armed nuclear-powered submarine capability for Australia.

Australian Naval Infrastructure (ANI) as the owner and manager of the existing Osborne Naval Shipyard is proposing the development of adjacent land to construct a new, purpose-built, secure, nuclear-powered Submarine Construction Yard (SCY). The SCY will provide a facility for the construction of the submarines by a third-party ship builder, for delivery to ASA.

The Minister for Planning declared the SCY as an impact assessed development under section 108 (1)(c) of the *Planning, Development and Infrastructure Act 2016*, which requires the preparation of an Environmental Impact Statement (EIS).

1.1 Scope of development

The Government Gazette Notice that declares the SCY as an Impact Assessed Development describes the scope of the development as follows:

Development for the purposes of establishing and operating a nuclear-powered Submarine Construction Yard at Osborne (being on the land and coastal waters specified in Table 1 and Figure 1), including:

(a) development associated with the construction and operation of a submarine construction yard, including:

- (i) facilities associated with maritime construction works in respect of submarines for defence of the Commonwealth, including:
  - i. the processing of raw steel and other products to manufacture submarine components;
  - ii. general steel processing including cutting, forming, welding and nondestructive evaluation;
  - iii. general and specialist machining in support of fabrication and outfitting;
  - iv. outfitting of submarine sections and other structures with welded components such as submarine decks and fixed pipework;
  - v. outfitting units and other structures with electrical, mechanical and piping components;
  - vi. assembly, testing, commissioning and services installation in support of combat system integration;
  - vii. manufacture of pipe and electrical components;
  - viii. assembly, testing and commissioning of the nuclear propulsion system (but excluding the manufacture of the reactor power module);
  - ix. assembly, construction and commissioning of submarines;
  - x. on-site system testing, commissioning and set-to-work activities; and
  - xi. mechanical, hydraulic and electrical conveyance for the purpose of moving submarine components and submarine launch activities;
- (ii) the storage or warehousing of chemicals or chemical products, including appropriate bunding/hardstand,
- (iii) facilities and works associated with abrasive blasting and surface coating of submarines;

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(iv) wet basin, wharf and related support facilities including any associated works (including dredging for the purposes of construction and operation of vessel berths but excluding dredging for the purposes of deepening the Port River Channel);

(v) truck loading and unloading facilities, access and egress;

(vi) ancillary infrastructure, including guard houses, car parking, warehousing, office accommodation, health centre, data centre and general information and communication technology services, sleeping quarters, and general amenities including training facilities and other staff and visitor support facilities, security, and access; (vii) temporary construction compound and laydown areas; and

(vii) temporary protected storage of waste, including low-level radioactive waste;

(b) development associated with any change in the use of land and coastal waters associated with any development within the ambit of the preceding paragraphs;

(c) development associated with the construction, installation or provision of any or all of the following infrastructure, facilities and services:

(i) stormwater;

(ii) water supply;

(iii) power supply;

(iv) telecommunications; and

(v) waste water treatment or disposal

in each case, associated with any development within the ambit of the preceding paragraphs;

(d) development (including development undertaken on land or coastal waters in the State, inclusive but not limited to the land and coastal waters specified in Table 1 and Figure 1) associated with any excavation or filling of land associated with any development within the ambit of the preceding paragraphs;

(e) development (including development undertaken on land or coastal waters in the State, inclusive but not limited to the land and coastal waters specified in Table 1 and Figure 1) associated with the division of land associated with any development within the ambit of the preceding paragraphs; and

(f) any related or ancillary development (including development undertaken on land or coastal waters in the State, inclusive but not limited to the land and coastal waters specified in Table 1 and Figure 1) associated with any development within the ambit of the preceding paragraphs;

(g) but excluding:

(i) the relocation of existing electricity transmission lines, substation and gas pipelines;

(ii) works and activities associated with existing port and harbour operations; and

(iii) works associated with the construction and alteration of a road on Lot 103 DP82690, Lot 110 DP118046, Lot 777 DP87145, QP7 DP74306, Lot 208 DP 64682, Lot 801 DP76925 and Lot 601 DP121984.

Fabrication buildings will be of a significant scale, up to 50 metres in height and 200 metres in length.

The SCY subject site is located on the north-eastern side of the Lefevre Peninsula in Port Adelaide, South Australia. It encompasses the following Certificate of Titles shown in Table 1 and Figure 1.

Table 1 SCY Subject Site Certificate of Titles

CT6 191/179	CT6191/1 80	CT61 9 I/181	CT619I/182	CT6268/862	CT6236/388
CT6262/182	CT6289/763	CT6088/I 74	CT6088/171	CT6088/1 70	CT6088/1 77
CT6282/172	CT6088/ I 75	CT6282/I 78	CT5858/2 14	CT5855/133	CT5856/1 4
CT6088/188	CT6088/ 186	CT6088/185	CT6088/184	CT6088/183	CT623 1/I 7
CT6231/5	CT6282/169	CT6088/193	CT6088/190	CT6088/189 CT	619 1/178
CT6 191/176	CT6060/497	CT6282/I 75			

Figure 1: SCY Subject Site

1.2 Noise and vibration project specific assessment requirements

The objective and methods of investigation for noise and vibration are replicated from the draft *Environmental Impact Statement: Assessment Requirements* dated May 2024.

The objective of the noise and vibration project-specific assessment requirements is to 'ensure the development does not have unacceptable adverse noise or vibration impacts on the surrounding environment, in particular sensitive receivers in proximity to noise sources'. The level of assessment is required to be 'detailed'.

- Provide an impact assessment of noise / vibration from or on the proposed development, prepared in accordance with the Guidelines for the use of the Environment Protection (Commercial and Industrial Noise) Policy 2023 by a suitably experienced, professional acoustic engineering consultant. Indicative Noise Levels to be confirmed based on consideration of different zones and subzones.
- The assessment should describe changes to noise and vibration levels as a result of the development (during both the construction and operational phases). Sufficient data should be gathered to provide baseline information for comparison with any future monitoring undertaken during the construction and operational phases. This should include monitoring within the marine environment.
- The noise assessment should include noise contours from a suitable acoustic model for all significant noise generating activities operating under worst case acoustic and meteorological (and/or oceanographic for marine underwater noise) conditions for the transmission of noise from source to marine animals, including the Adelaide Dolphin Sanctuary which is both adjacent to and within the development site, and sensitive receivers, including those residents located on the Le Fevre Peninsula and St Kilda township (including transmission of noise sources across water).
- Provide a vibration assessment prepared by a suitably experienced, professional acoustic engineering consultant, assessing the worst case predicted vibration from the development. The report must describe what reasonable and practicable measures will be taken to minimise vibration impacts on sensitive receivers, including marine mammals where relevant, and adjacent State Heritage Places (including Torrens Island Quarantine Station Complex (State Heritage Place (SHP) 26583 & 13931) and the Former Outer Harbour Pilot Station (SHP 11904)), and the likely effectiveness of these measures, with a view to demonstrating how the 'General Environmental Duty' (as described in section 25 of the Environment Protection Act 1993) will be met.
- Underwater noise modelling must be undertaken by suitably experienced specialist. Modelling must include modelling of bed substrates (acoustically reflective or acoustically absorptive) to understand the propagation beyond the proximity of the noise source (whether this be from construction or operational activities). The assessment must identify the distance to which there would be a biological impact to aquatic species.
- Describe how environmental management objectives for noise and vibrations would be achieved, monitored, audited and reported, and how corrective actions would be managed.
- Propose environmental management strategies that will avoid long-term impacts, including behavioural changes, of underwater noise on marine fauna and describe how objectives would be monitored and audited, and how corrective actions would be managed.

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2 Project Context

For context, the Osborne Naval Shipyard is located in Osborne, South Australia and currently consists of the following sites and facilities:

- BAE Systems Australia – Systems Center – 620 Mersey Road Nort, Osborne, SA 5017
- Naval Shipbuilding College (NSC) – 630 Mersey Road North, Osborne, SA 5017
- The Southern Shipyard, consisting of existing Australian Submarine Corporation Shipbuilding (ASCSB) facilities and the recently completed Osborne South Development Project (OSDP) buildings 18, 20, 21 and 22. – 640 Mersey Road North, Osborne, SA 5017
- Common User Facility (CUF) – 61 Veitch Road, Osborne, SA 5017
- Collins Class Submarine Facility (CCSF) – 694 Mersey Road North, Osborne, SA 5017
- Osborne North Development Project (ONDP) – Lot 3000 Mersey Road North, Osborne, SA 5017.

Submarine fabrication, outfitting, completion, launching, testing and commissioning are proposed to be undertaken in the new, purpose-built, secure, nuclear-powered Submarine Construction Yard (SCY) according to the following.

Location Description	Type of Activities
The land east of the railway line, and west of the Collins Class submarine sustainment facility	Submarine fabrication
The land between the railway line and Mersey Road North, north of Archie Badenoch Court towards the Pelican Point Power Station on Pelican Point Road.	Submarine outfitting
The land to the east of Mersey Road North, north of Mutton Cove and the Pelican Point Power Station bordering the Port Adelaide River.	Submarine completion, launching, testing, and commissioning.

The SCY Subject Site is shown with respect to the existing Osborne Naval Shipyard precinct and baseline noise, vibration, and underwater noise monitoring locations in Figure 2.

The closest noise affected premises are located to the west of the site along Victoria Road. These premises are residential dwellings constituting the suburbs of North Haven and Osborne, South Australia. The nearest residences face away from the subject site, with backyards, sheds and boundary fences separating the dwellings from the Key Freight Route of Victoria Road.

More distant residential dwellings are situated approximately 7 kilometres to the east of the site, in the suburb of Globe Derby Park as well as approximately 3.5 kilometres north of the site in St Kilda. The Globe Derby Park receptors are separated from the site by the Port River, Torrens Island, Dry Creek wetlands, and the Northern Connector/North-South Motorway. The St Kilda receptors are separated from the site by the Port River, Torrens Island Conservation Park and the Adelaide International Bird Sanctuary National Park - Winaityinaityi Pangkara.

There are several adjacent commercial and industrial land uses on the southern boundary of the site along Veitch Road, including BlastOne Adelaide, Semaphore Container Services, Pelican Point Power Station and Australian Civil & Mining Training.

Nearby State Heritage Places include the Torrens Island Quarantine Station Complex (SHP 26583 & 13931) and the Former Outer Harbor Pilot Station (SHP 11904). The locality of these State Heritage Places with respect to the SCY Subject Site is visualised on Figure 3.

Furthermore, the Dolphin Sanctuary (also shown on Figure 3), Mutton Cove Conservation Reserve, Torrens Island Conservation Park and Port River interface with the SCY site.

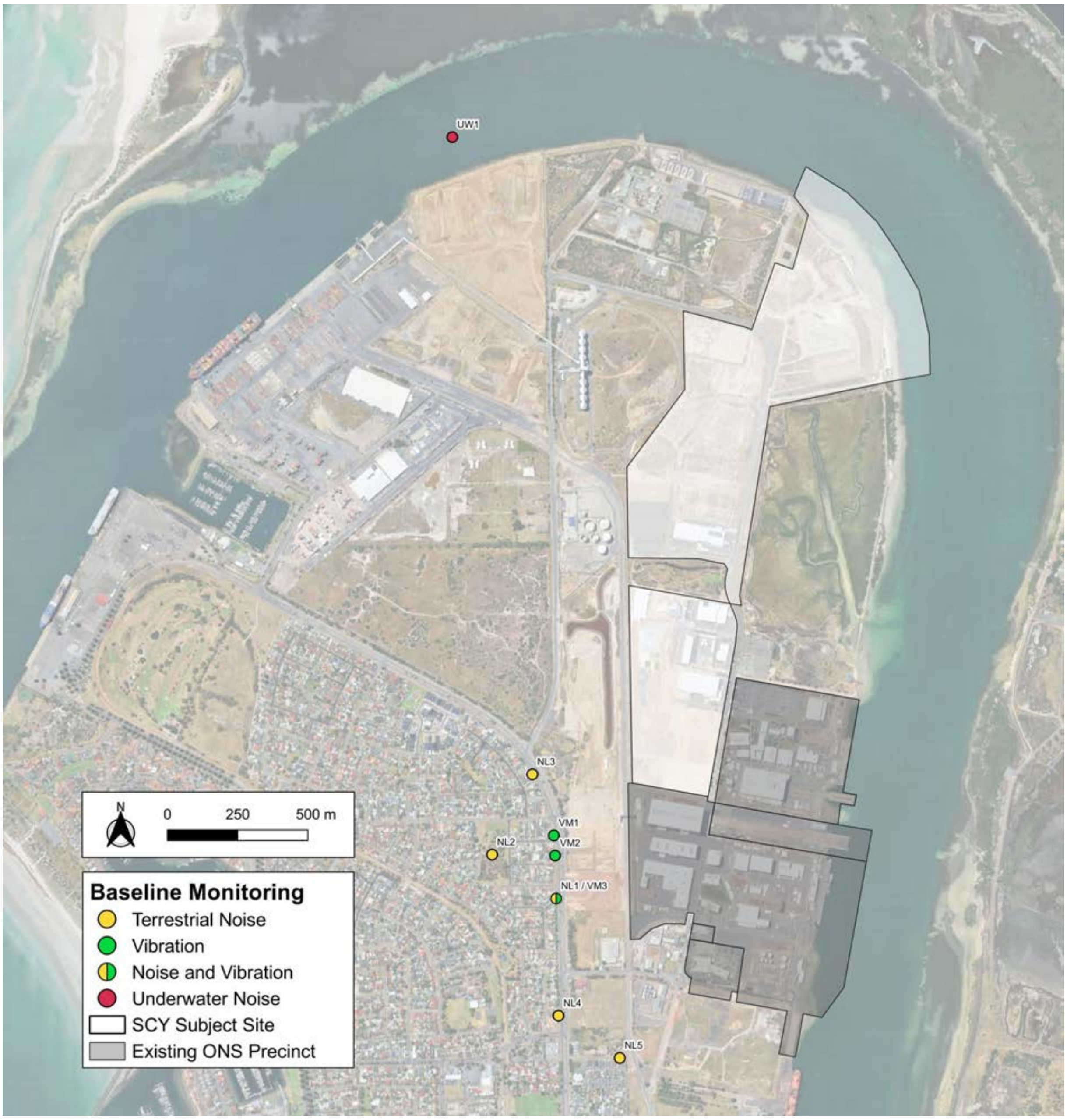

Figure 2: SCY Subject Site and Osborne Naval Shipyard with respect to baseline monitoring locations

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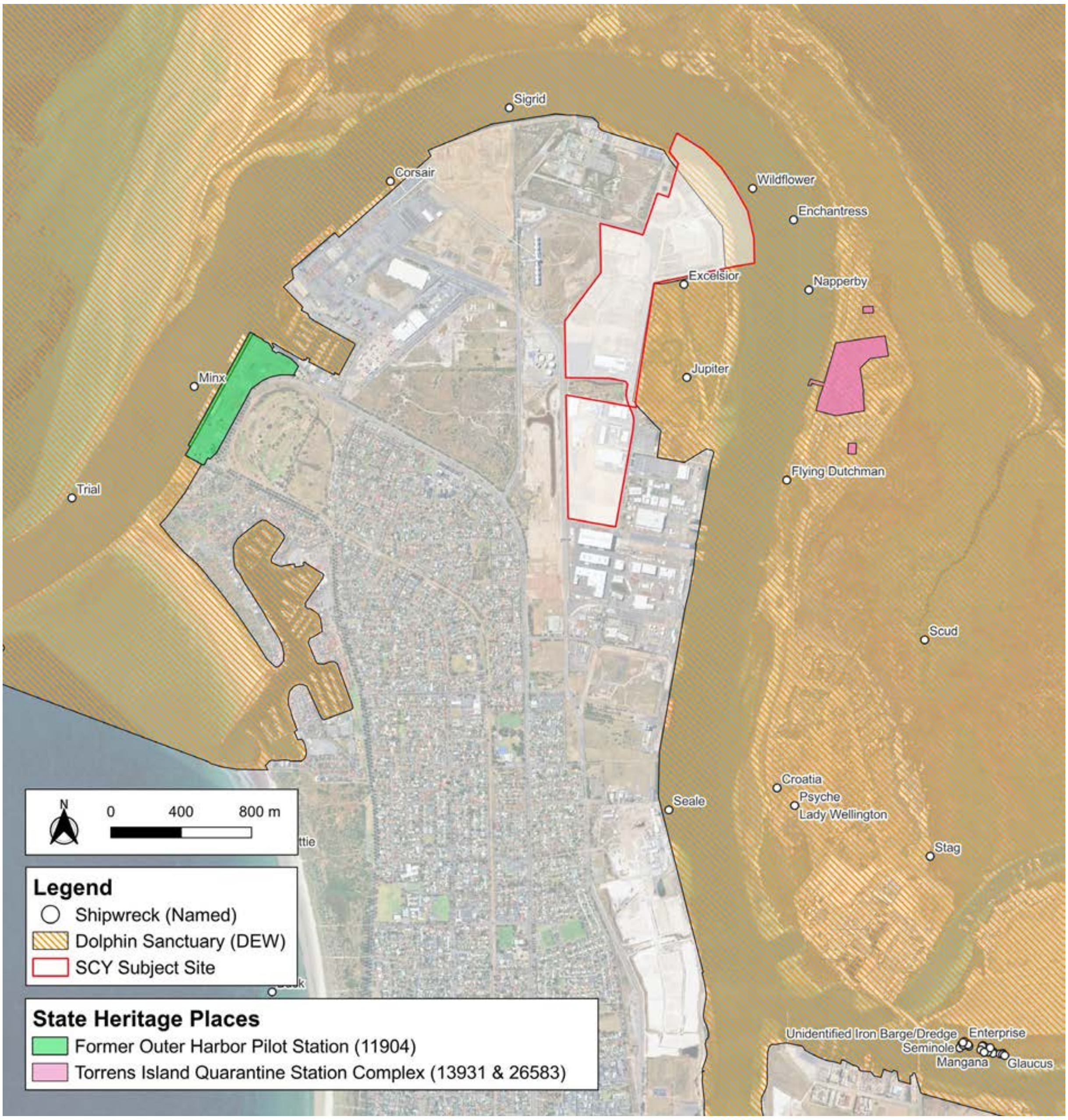

Figure 3: SCY Subject Site and Osborne Naval Shipyard with respect to Dolphin Sanctuary and State Heritage Places

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3 Existing environment

3.1 Terrestrial noise

Background noise monitoring in the vicinity of the ONS and SCY precinct area was previously undertaken by Resonate. Noise logging was conducted at 5 locations during the period of 21 August – 31 August 2020. The monitoring locations are described in Table 2 below and are visualised in Figure 2.

Table 2: Noise logging locations

ID	Address	Notes
NL1	Victoria Road, adjacent to 26 Grose Crescent	Previous Resonate logging location. Provides an indication of the existing road traffic noise (excluded from the Noise EPP) on the receivers in the vicinity of Victoria Road.
NL2	RB Connolly Reserve	Previous Resonate logging location. Provides an indication of baseline levels for residents at a distance from Victoria Road (and road traffic noise).
NL3	Victoria Road, adjacent to 12 Steadman Street	New location. Provides an indication of baseline levels for residential receivers in the near vicinity to the northern expansion site of ONS.
NL4	Victoria Road, adjacent to 12 Kestel Crescent	New location. Provides an indication of baseline levels for residential receivers in the near vicinity to the southern expansion site of ONS.
NL5	20 Mascotte Street	New location. Provides an indication of baseline levels for residential receivers located on Furniss Court (to the south).

All sound level measurement instrumentation used for the purposes of this assessment are classified as either a Class 1 or Class 2 measurement device, as described in Australian Standard AS IEC 61672.1—2004. Acoustic calibration was conducted before and after the logging period and no significant calibration drift was observed. Each sound level meter unit holds current calibration certification by an independent NATA certified laboratory. Copies of the certificates are available on request.

Table 3: Noise monitoring results summary - Day

Location	Type/SN	Date period	Average measured noise level, dB(A)		
			L_{eq}	L_{90}	L_{max}
26 Grose Crescent	NL-21 888253	21/08/20 – 31/08/20	67	48	88
RB Connolly Reserve	NL-21 187470	26/08/20 – 31/08/20[1]	65	47	88
12 Steadman Street	NL-42 709535	21/08/20 – 31/08/20	67	47	89
12 Kestel Crescent	NL-21 709535	21/08/20 – 31/08/20	68	51	90
20 Mascotte Street	NL-22 772983	21/08/20 – 31/08/20	54	46	80

(1) Earlier data prior to the 26th of August was lost due to a battery malfunction.

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Table 4: Noise monitoring results summary - Night

Location	Type/SN	Date period	Average measured noise level, dB(A)		
			L_{eq}	L_{90}	L_{max}
26 Grose Crescent	NL-21 888253	21/08/20 – 31/08/20	64	45	86
RB Connolly Reserve	NL-21 187470	26/08/20 – 31/08/20[1]	57	45	87
12 Steadman Street	NL-42 709535	21/08/20 – 31/08/20	64	45	89
12 Kestel Crescent	NL-21 709535	21/08/20 – 31/08/20	64	48	87
20 Mascotte Street	NL-22 772983	21/08/20 – 31/08/20	48	41	69

(1) Earlier data prior to the 26th of August was lost due to a battery malfunction.

Summary plots showing the measured time series for the week starting 24 August 2020 at each location are presented below.

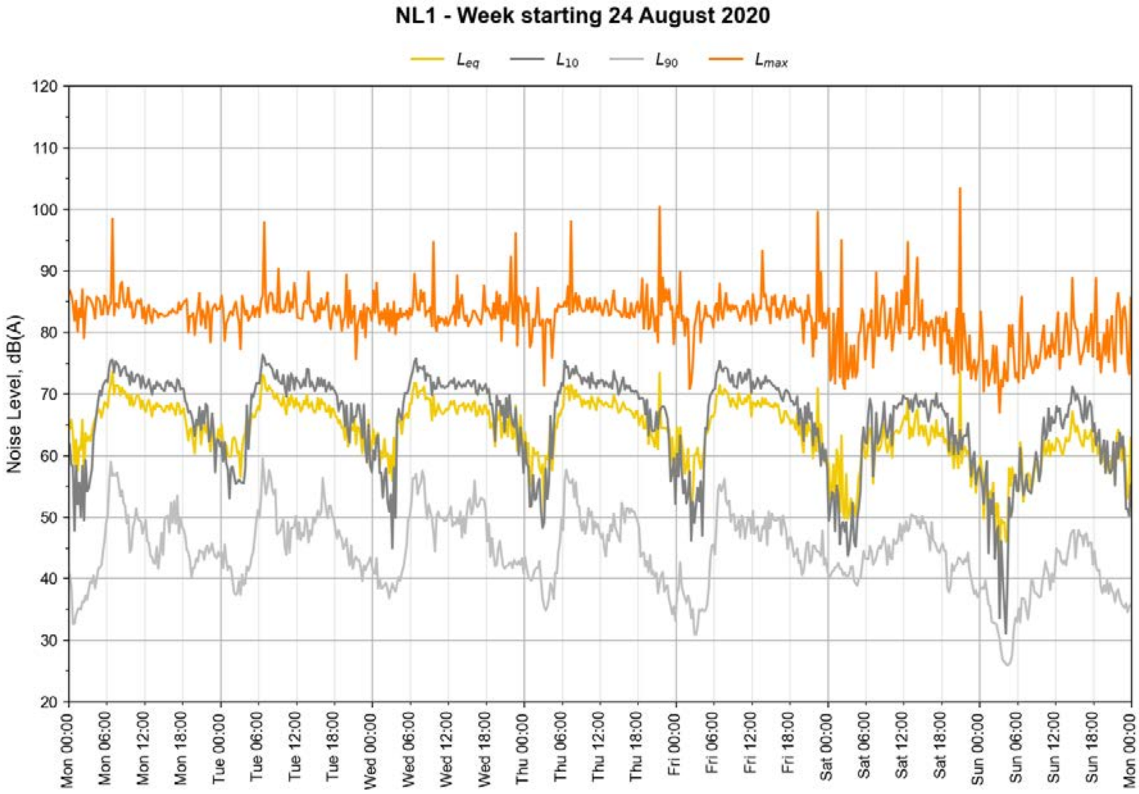

Figure 4: Baseline noise summary - NL1 - adj. 26 Grose Crescent

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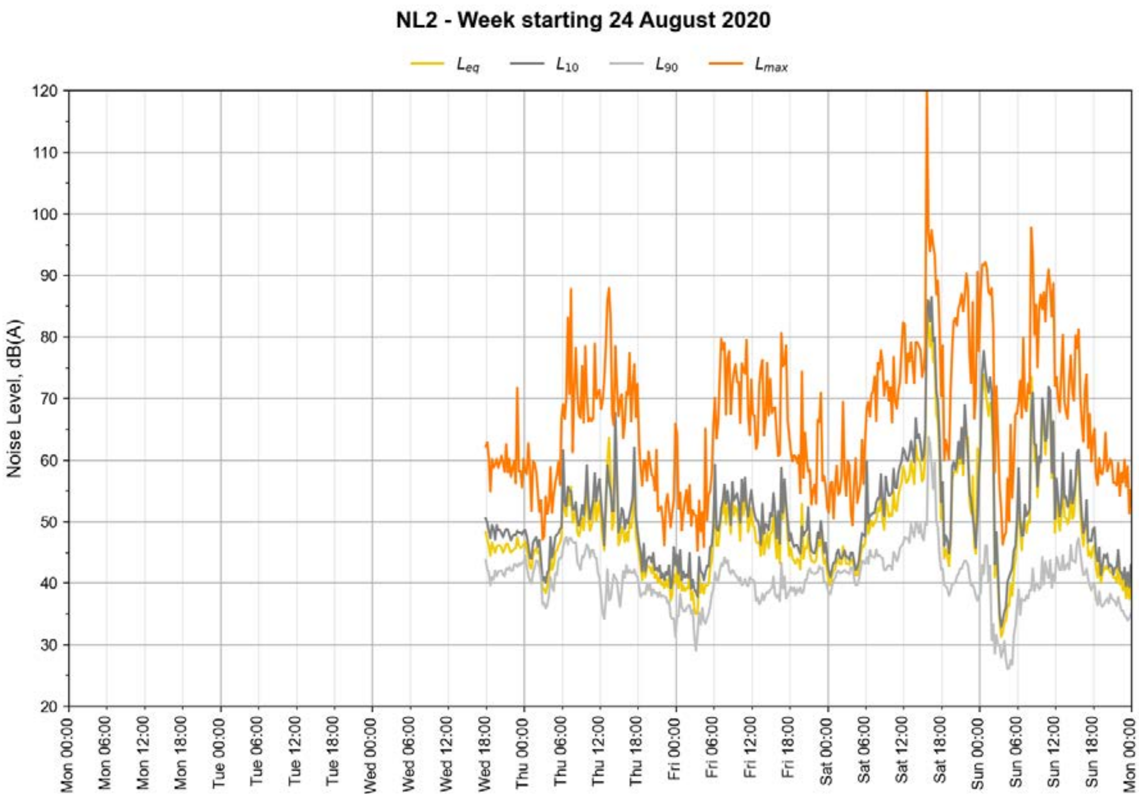

Figure 5: Baseline noise summary - NL2 - RB Connolly Reserve

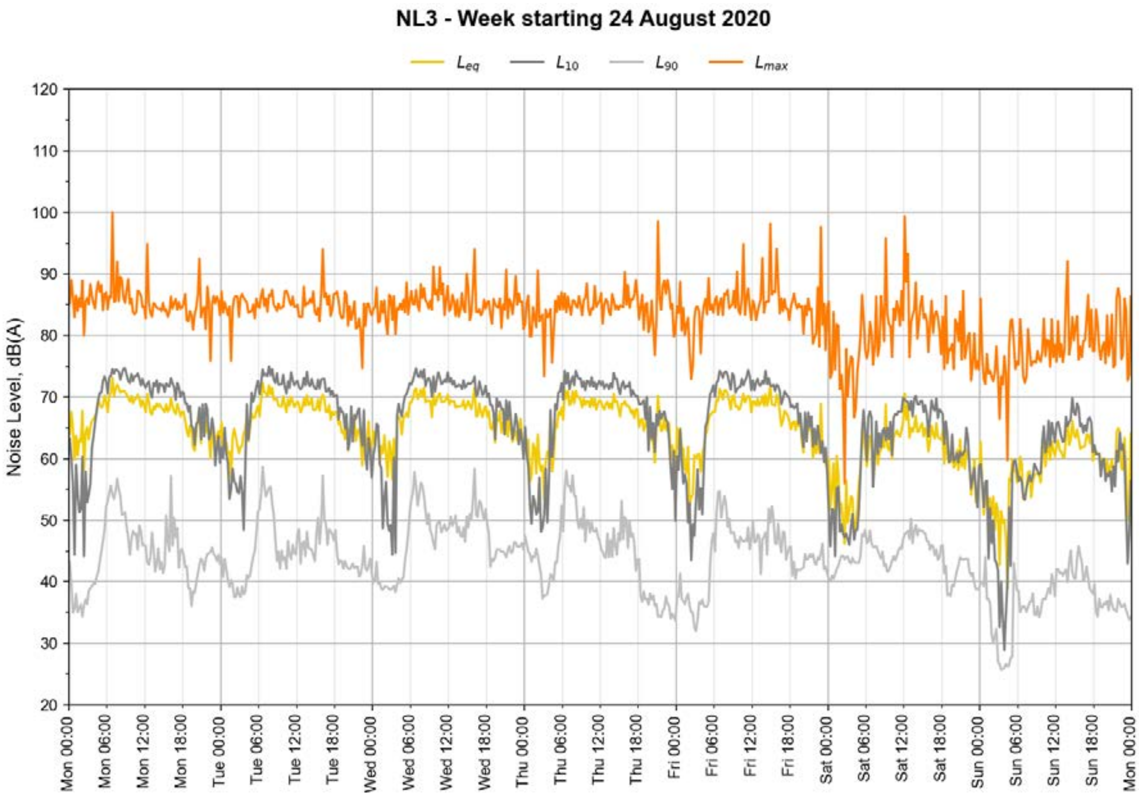

Figure 6: Baseline noise summary – NL3 – adj. 12 Steadman Street

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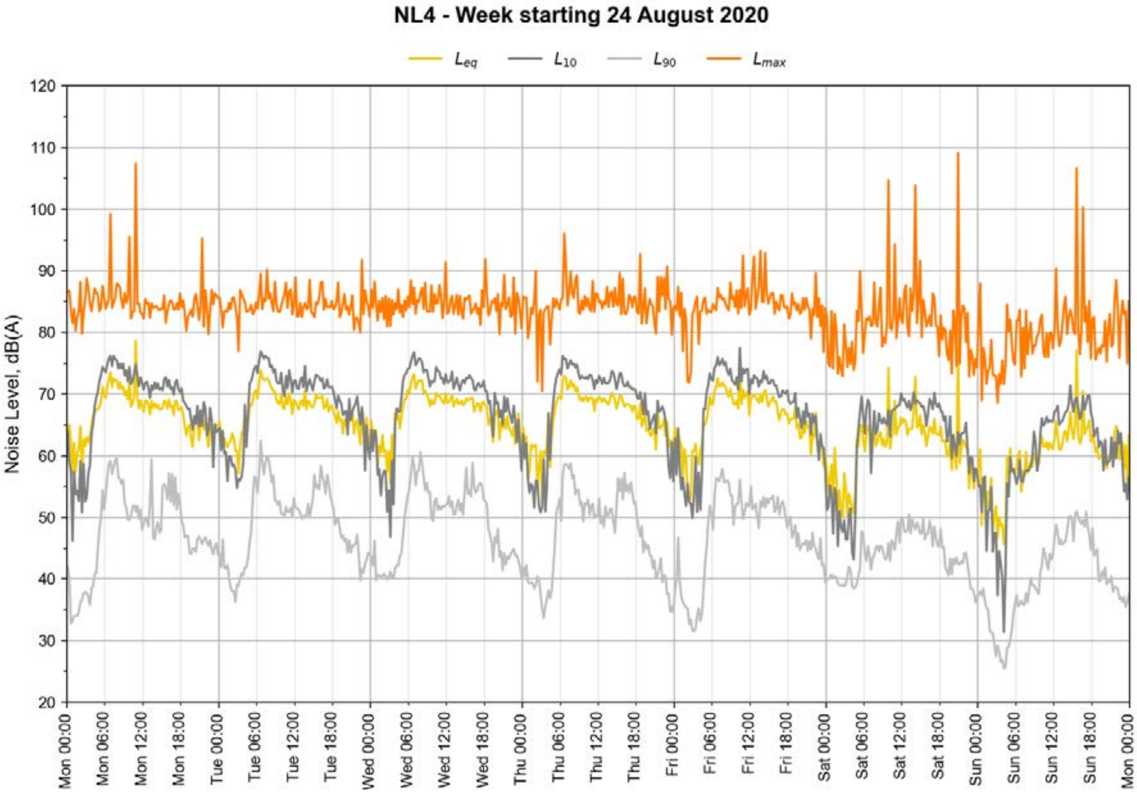

Figure 7: Baseline noise summary - NL4 - adj. 12 Kestel Crescent

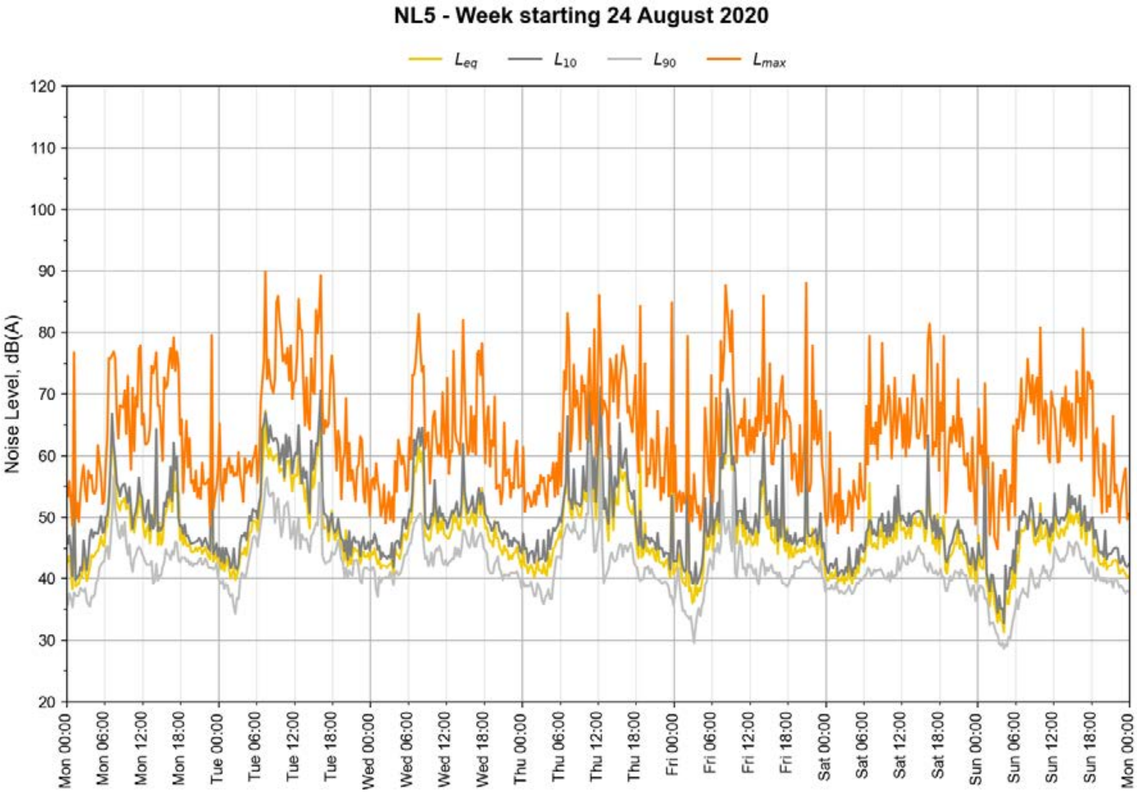

Figure 8: Baseline noise summary - NL5 – 20 Mascotte Street

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Attended measurements are presented in the following tables. Daytime period measurements were taken during the deployment and collection of the noise loggers. Night-time measurements were taken on the 28th of August, 2020. All measurements were taken with a Class 1 Sound Level meter.

The purpose of the measurements was to qualify the existing sources in the vicinity of each noise logging position, and to identify if existing ONS operations were audible. Each measurement was taken for a duration of 5-10 minutes, a duration deemed long enough to qualify the existing noise sources in the area.

Table 5: Attended measurement results and observations, Friday 21 August 2020 (Daytime period)

Location	Start Time	Measured noise level, dB(A)			Observations
		L_{eq}	L_{90}	L_{max}	
NL1	21/8/20 15:13	68	50	83	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible.
NL2	21/8/20 15:28	51	44	72	Local traffic and Victoria Road traffic noise audible. ANI operations not audible. Local distant lawn mower also audible.
NL3	21/8/20 15:54	70	51	87	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible.
NL4	21/8/20 16:17	67	56	82	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible.
NL5	21/8/20 16:36	53	50	61	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible. Noise from horse whinnying intermittently audible.

Table 6: Attended measurement results and observations, Friday 28 August 2020 (Night-time period)

Location	Start Time	Measured noise level, dB(A)			Observations
		L_{eq}	L_{90}	L_{max}	
NL1	28/8/20 22:32	58	44	73	Industrial noise identified to the east and north of the measurement location. Precise source of the noise unknown, however the predominant industrial noise appeared to be shipping containers being loaded to the north. Intermediate road traffic noise from Victoria Road also present.
NL2	28/8/20 22:44	53	42	73	Industrial noise to the north audible. Precise source of the noise unknown, however the predominant industrial noise appeared to be shipping containers being loaded to the north. Local traffic and Victoria Road traffic noise audible.

Location	Start Time	Measured noise level, dB(A)			Observations
		L_{eq}	L_{90}	L_{max}	
NL3	28/8/20 22:54	55	44	73	Industrial noise identified to the east and north of the measurement location. Precise source of the noise unknown, however the predominant industrial noise appeared to be shipping containers being loaded to the north. Intermediate road traffic noise from Victoria Road also present.
NL4	28/8/20 23:02	65	46	86	Industrial noise identified to the east of the measurement location. Precise source of the noise unknown, however the predominant industrial noise appeared to be a hum from the direction of the Torrens Island Power Station. Intermediate road traffic noise from Victoria Road also present.
NL5	28/8/20 23:10	49	44	58	Industrial noise identified to the east of the measurement location. Precise source of the noise unknown, however the predominant industrial noise appeared to be a hum from the direction of the Torrens Island Power Station. Intermediate road traffic noise from Victoria Road also present.

Table 7: Attended measurement results and observations, Friday 31 August 2020 (Daytime period)

Location	Start Time	Measured noise level, dB(A)			Observations
		L_{eq}	L_{90}	L_{max}	
NL1	31/8/20 13:44	67	45	83	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible. Bird noise also present, and a small aircraft.
NL2	31/8/20 13:59	45	37	67	Birds, local traffic and Victoria Road traffic noise audible. ONS operations not audible.
NL3	31/8/20 14:10	64	41	81	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible. Bird noise also present, and a small aircraft.
NL4	31/8/20 14:20	67	48	82	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible. Train crossing signal and train audible during the measurement.

Location	Start Time	Measured noise level, dB(A)			Observations
		L_{eq}	L_{90}	L_{max}	
NL5	31/8/20 14:28	47	41	62	Noise from Victoria Road traffic (light and heavy vehicles) dominant. ONS operations not audible.

The attended measurements indicate that on the 21st, 28th and 31st of August noise from the ONS precinct was not audible from the measurement locations.

During most of the attended measurements, noise levels were dominated by road traffic and other industrial sources. Birds and trains also contributed to noise during some measurements. At all measurement locations, the noise from the existing ONS precinct was not audible. At the time of measurement, limited operational or construction related activities were being conducted at the precinct.

The measurements recorded are representative of the baseline noise conditions, prior to any measurable noise being generated by the SCY development.

3.2 Vibration

Background vibration monitoring in the vicinity of the ONS precinct area was previously undertaken by Resonate. Vibration logging was conducted at 3 locations during the period of 11 February – 18 February 2018. The monitoring locations are described in Table 2 below and are visualised in Figure 2. The measured baseline vibration levels, even though undertaken in 2028, are considered representative of the existing levels for the purpose of this assessment. The undertaking of further baseline vibration levels is not considered necessary.

It should be noted that the intent of the survey was to quantify the baseline conditions prior to construction of Buildings 18, 20, 21 and 22 in the ONS precinct. The baseline environment was dominated by road traffic on Victoria Road, particularly from Medium and Large Combination (AUSTROADS Class 11 (Double Road Train) and Class 12 (Triple Road Train)) vehicles. It is considered that the 2018 measurement survey is indicative of current 2024 conditions, used as the baseline for this assessment.

Table 8: Vibration logging locations

ID	Address
VM1	Victoria Road, adjacent to 7 Anderson Close
VM2	Victoria Road, adjacent to 5 Rofe Close
VM3	Victoria Road, adjacent to 26 Grose Crescent

Three AvaTrace M80 vibration monitors (with tri-axial geophone measuring the Peak Particle Velocity (PPV) vibration level in the transverse, vertical and longitudinal directions) were installed at the locations identified in Figure 1. The AvaTrace monitors were configured to record the peak particle velocity (PPV) per 15-minute storage interval throughout the duration of the monitoring period. Weekly summary plots at each location for the monitoring period are presented in Figure 9 to Figure 11.

Baseline vibration levels ranged from 0.1 to 1.5 mm/s PPV at VM1, 0.1 to 0.8 mm/s PPV at VM2, and 0.1 to 0.5 mm/s PPV at VM3. On one occasion, measured vibration levels reached 5.9 mm/s at VM1. The maximum occurred between 4:00 and 4:15 a.m. on Tuesday, 13 February 2018. Based on the time of morning and the vibration level compared to the other two locations, this is from an extraneous source. As the survey was unattended, it is not possible to accurately determine the cause of this extraneous event.

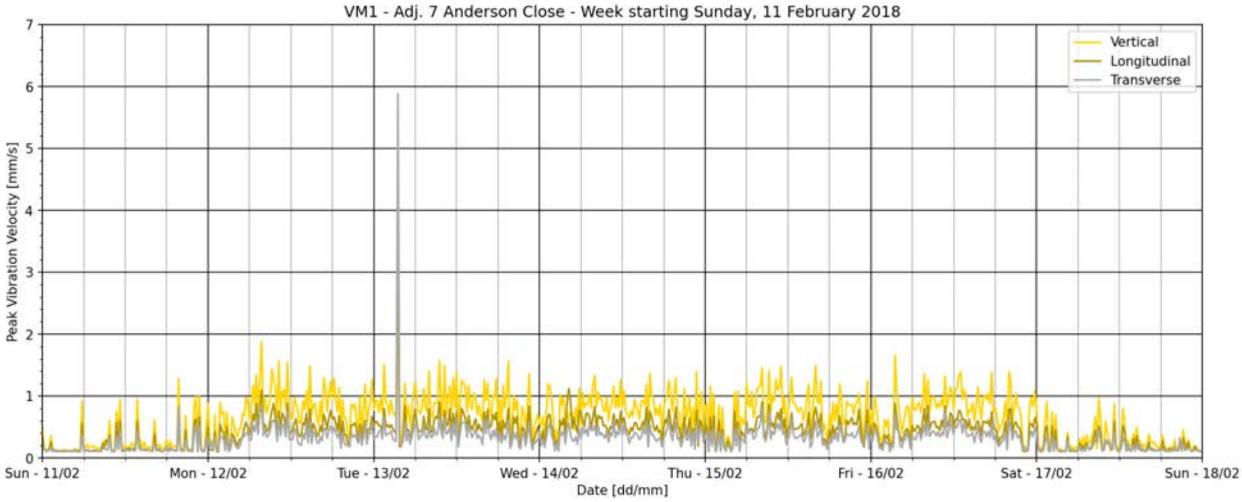

Figure 9: Baseline vibration summary - VM1 - adj. 7 Anderson Close

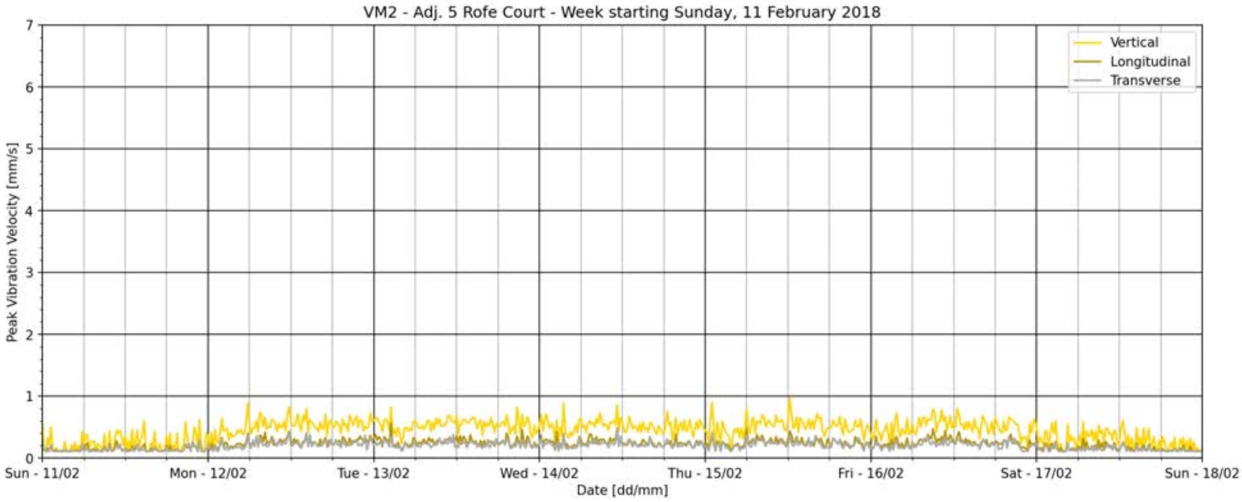

Figure 10: Baseline vibration summary - VM2 - adj. 5 Rofe Court

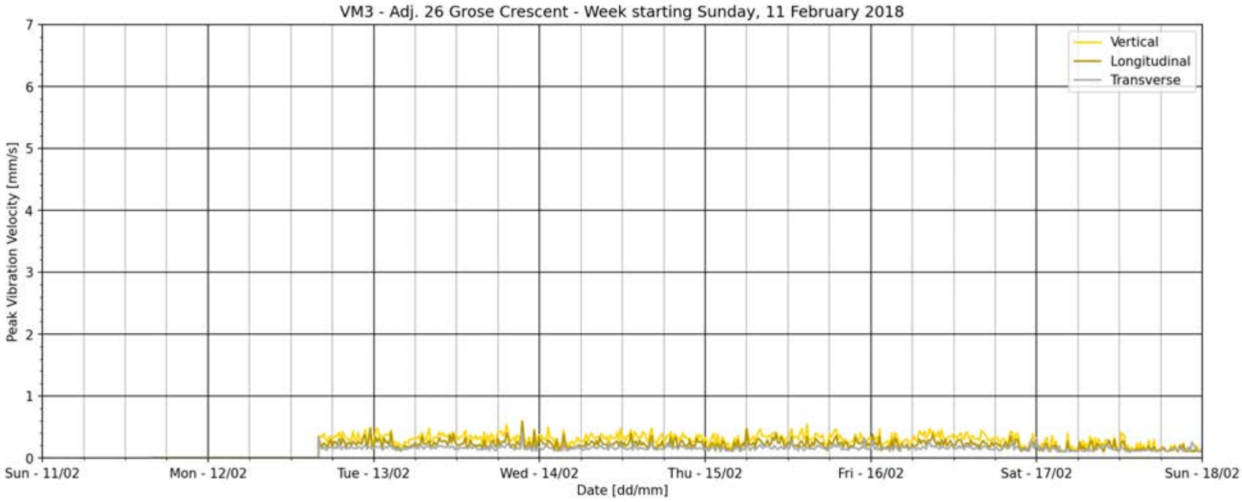

Figure 11: Baseline vibration summary – VM3 - adj. 26 Grose Crescent

3.3 Underwater noise

The ocean is filled with sound that is generated by a variety of natural sources, such as rain, breaking waves, marine life, and man-made sources, such as shipping and sonar activity.

The study area is a shallow water river and coastal environment. Ambient noise levels in shallow water vary widely in frequency and level distributions depending on time and location. The three primary sources in most shallow water regions are shipping, industrial, or geophysical-survey noise; wind and wave noise; and biological noise.

In comparison to deep water, a wider range of ambient noise levels occurs in shallow water under corresponding wind and wave conditions (Richardson et al. 1995). Above approximately 500 Hz, ambient noise levels in coastal areas are often 5-10 dB higher than in deep water for the same wind speeds. In the absence of shipping and biological noise, however, low-frequency (<300 Hz) ambient noise levels can be lower in shallow water than in deep water.

Ambient noise levels in shallow waters are directly related to wind speed. For wind speeds above 2.5 m/s, the ambient noise level in the frequencies range between 50 Hz and 20 kHz is better predicted by wind speed than by wave height (Richardson et al. 1995).

The marine traffic density in the vicinity of the project site is shown in Figure 12. The figure indicates considerable marine traffic in Port River, which also means that the underwater ambient noise in the Port River will include regular marine traffic noise as a feature of the area.

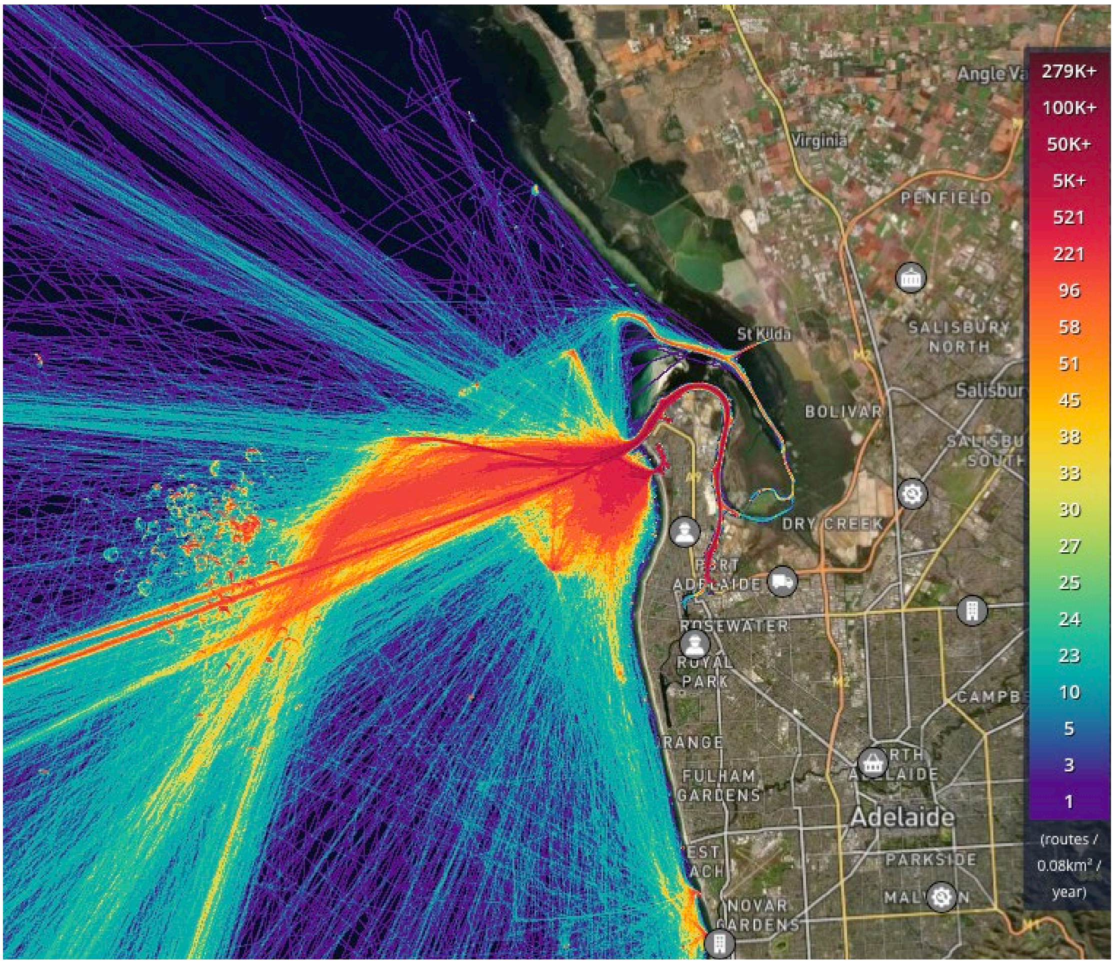

Figure 12: Marine traffic density in the vicinity of the project site, 2022 (Source: www.marinetraffic.com)

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3.3.1 Baseline underwater noise measurements

Resonate have previously undertaken underwater noise measurements within the Port River between the 22nd to 24th June 2020 continuously, using a Loggerhead Instruments DSG-ST Ocean Acoustic Datalogger Hydrophone. Data was collected at a sampling rate of 50 kHz. We believe the data collected is sufficient to characterise the ambient underwater noise levels in the marine area of interest.

Measurements were undertaken in the location shown in Figure 2, with the hydrophone located at a depth of approximately 6 m adjacent the Port River shipping channel. The hydrophone was deployed from a boat and anchored to the seabed using weights. The instrument was suspended in the water column by a combination of self-buoyancy and a supplementary buoy, such that the transducer was approximately 1.5 m above the seabed. The hydrophone was tethered to the adjacent channel marker (23) to assist retrieval, rather than using a surface buoy.

3.3.2 Results

Underwater noise data were processed in intervals of 100 seconds. For each interval, the overall average sound pressure level (dBrms) and spectra were calculated from the raw waveform data. The variation of overall sound pressure level (SPL dB re 1 μPa^2) over time is shown in Figure 13. In summary, the results indicate:

- SPLs generally varied between 104 and 144 dB dB re 1 μPa^2
- Over a 2 day period, there were more than 20 vessel movements passing by the measurement location (i.e. with reference to Figure 13, the SPL 'spikes' indicate vessel pass-bys). The audio signature of the movements also indicated that they were various larger vessels (rather than smaller outboard craft). The SPL ranged between 122 to 144 dB.
- The quietest periods measured were during a slack tide (i.e. the lull in tidal movement as the direction changes).
- The typical background level (i.e. 104 to 110 dB), was dominated by 'snapping shrimps' and a constant mechanical hum (potentially seawater intakes pumps from Pelican Point Power Station and other distant mechanical noise).

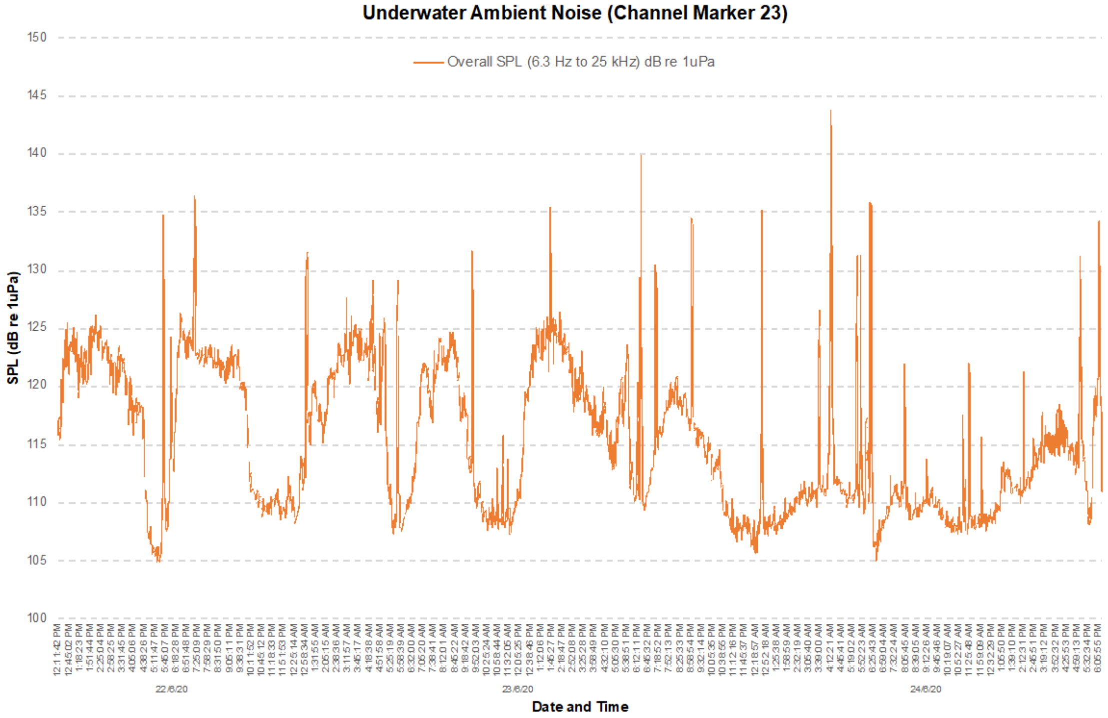

Figure 13: Overall sound pressure level variation over time

A summary of the wind speed recorded at the Bureau of Meteorology weather station located at Outer Harbor over the logging period is also provided in Figure 14. Some correlation between wind speed and overall sound pressure level is evident i.e. less extraneous noise was noted.

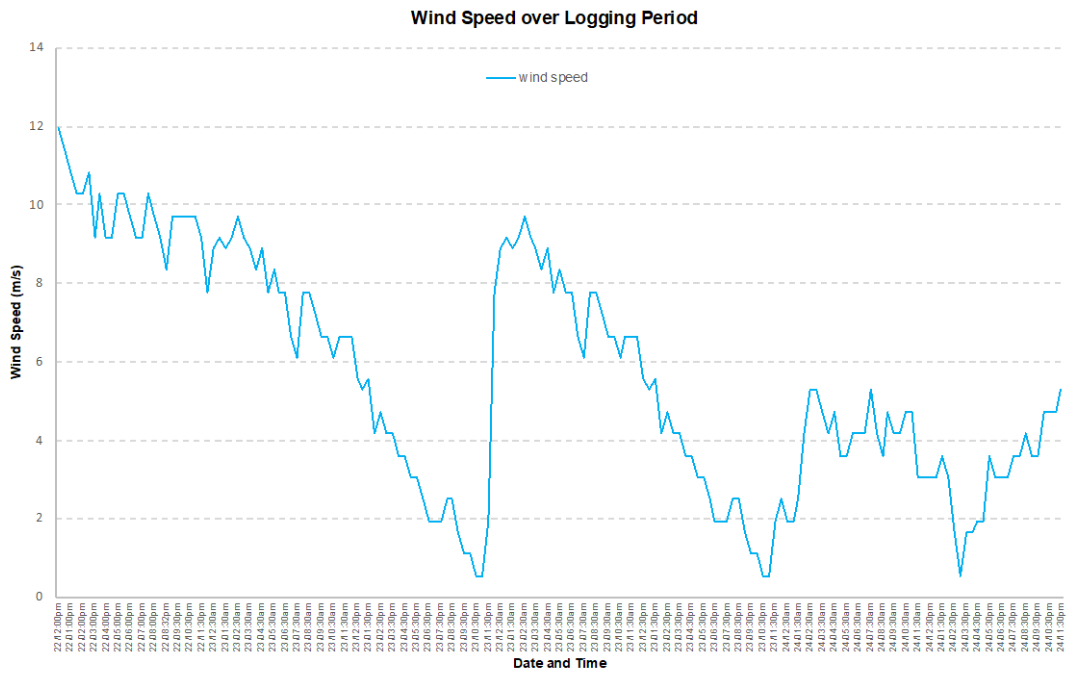

Figure 14: Overall sound pressure level variation over time

One third octave spectra were also determined for a typical range as well as the noisiest vessel movements for comparison against the typical lowest background noise level. The spectra are presented in Figure 15.

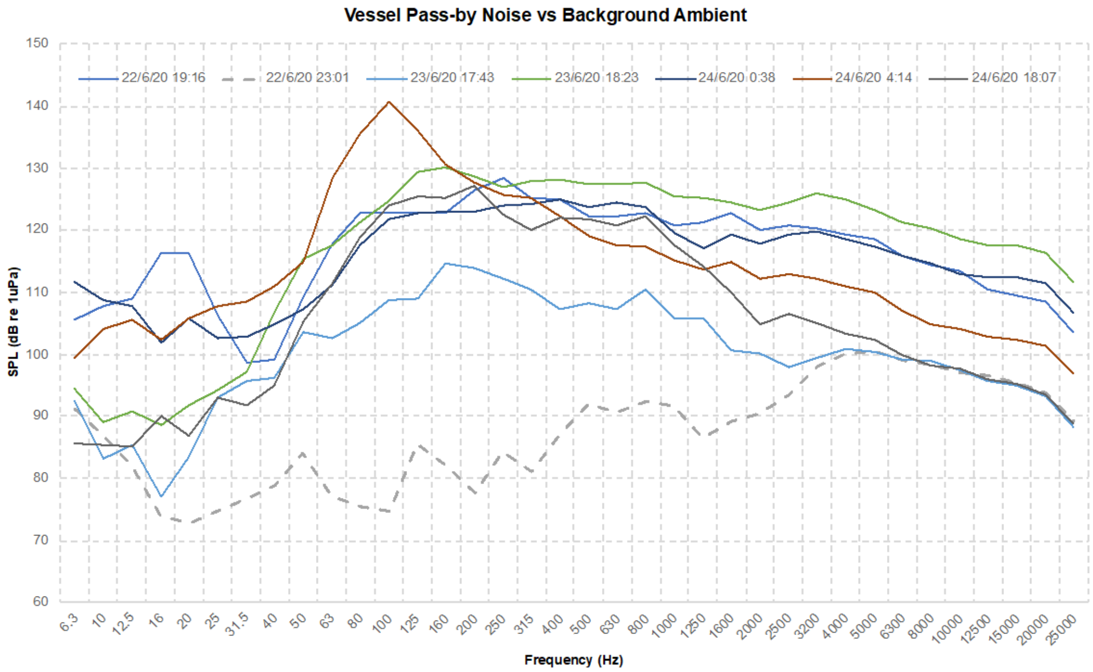

Figure 15: One third octave band sound pressure levels to compare a selection of typical vessel pass-by by noise with the typical lowest background noise level (dashed line)

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The results indicate a significant increase in ambient sound pressure level during a ship pass-by. Although the SPLs increased across the entire frequency range measured, the dominant energy is generally between 63 Hz to 6300 Hz, with the highest levels between 63 to 200 Hz.

Analysis of the background noise level also indicates constant mechanical noise occurring as evidenced by the one-third octave band tones prevalent at 50 and 125 Hz. This is further illustrated by the 'red' bands in the spectrogram shown in Figure 16.

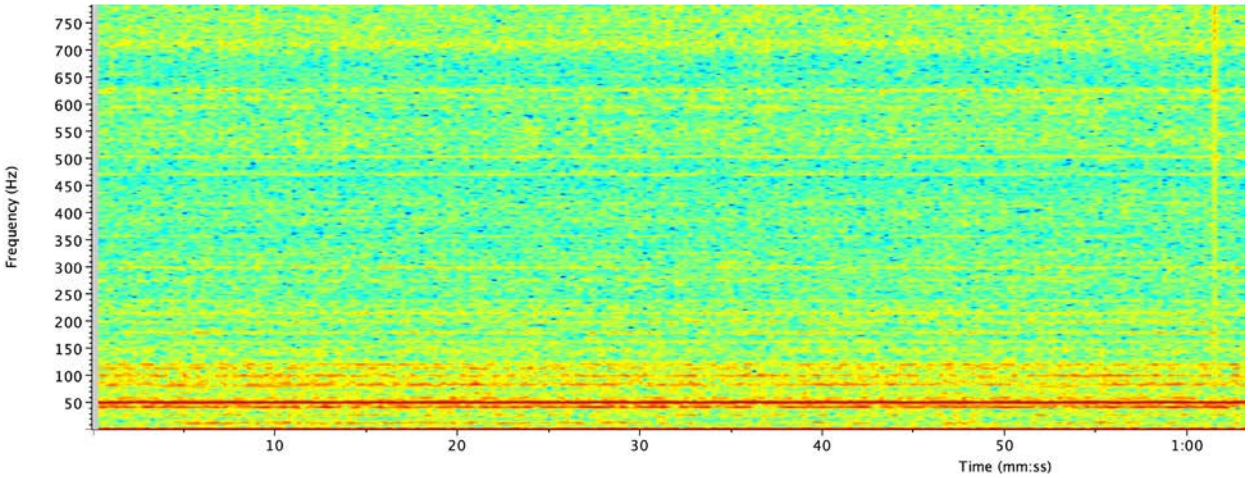

Figure 16: Spectrogram showing constant mechanical noise (red banding) at nominally 50 to 125 Hz

3.3.3 Summary

In summary, the underwater baseline noise conditions in the marine area consist mainly of snapping shrimp noise underpinned by continuous low frequency mechanical noise (<250 Hz). However, this background noise is largely masked in the immediate vicinity of the site as vessels pass by. The number of vessel movements traversing along Port River are significant, including operating at all times of the day or night. Given that the channel width at the location of measurements is 200m and in the assumption that vessels are largely traversing in the centre of the channel, the source levels of the various vessels measured are calculated to be in the range 150 to 175 dB re 1 μPa^2 at 1m.

3.4 Meteorological conditions

A summary of average wind speed (m/s) and direction spanning the last 5 years from Bureau of Meteorology (BOM) Weather Station *Outer Harbor (Black Pole)* is presented in Figure 17. Due to the distance between the observation station and the subject site, this data should be interpreted as a general indication of prevailing conditions only. The wind speed is as measured – no surface wind speed adjustment has been made.

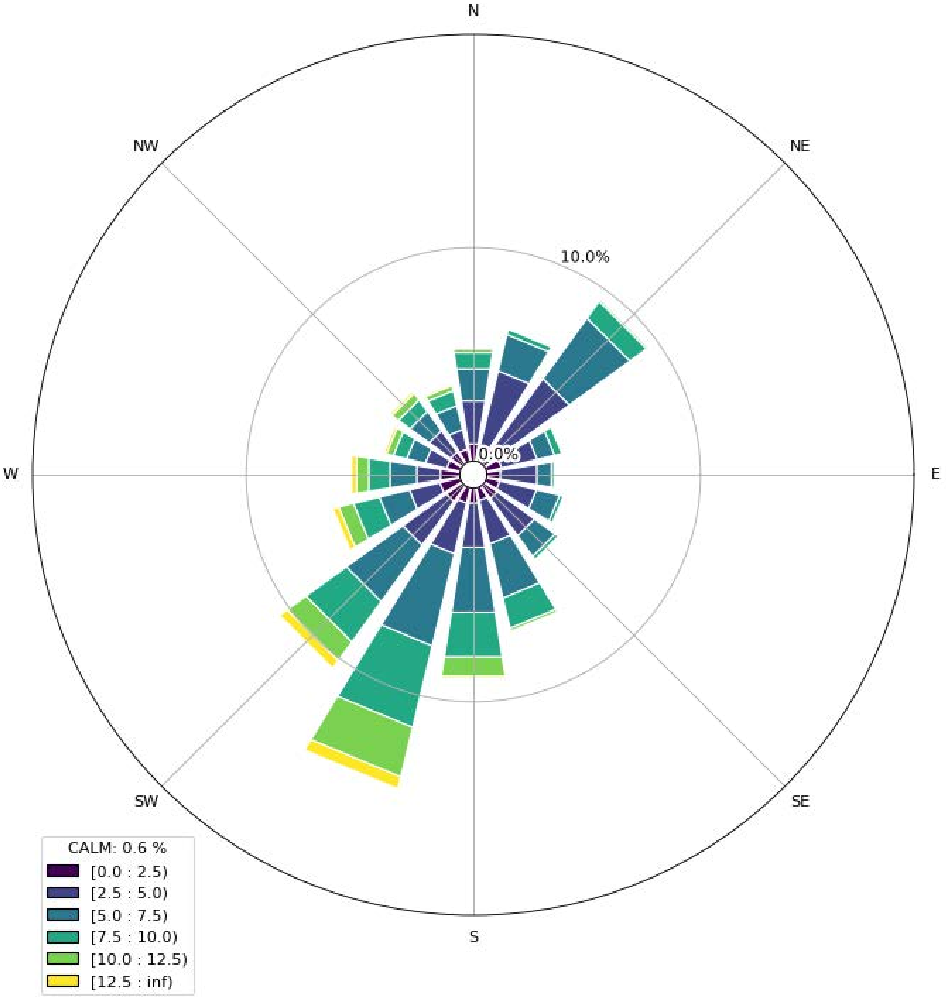

Figure 17: 5-year average wind rose - Outer Harbor (Black Pole) - Wind Speed (m/s)

It should be noted that BOM observations of average wind speed are a 10-minute average speed reported in half hourly intervals. The Outer Harbor weather station records wind speed and direction only. As a result, there are no cloud cover metrics available at this location to determine the historical Pasquil stability during the nighttime.

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4 Planning & Design Code

4.1 Zoning

Figure 18 shows the relevant zones and sub-zones of the SCY Subject Site and surrounding areas.

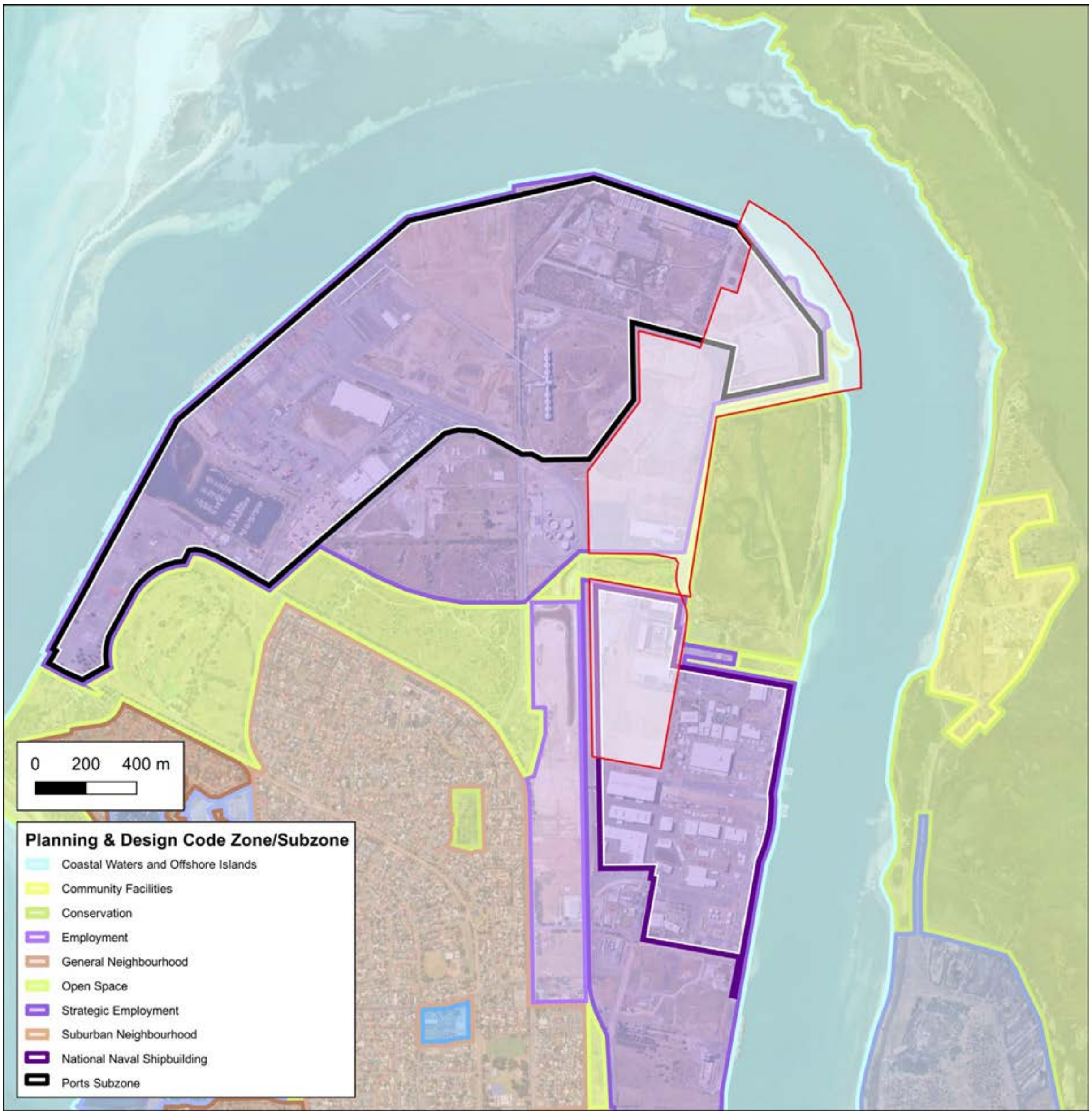

Figure 18: Relevant Planning & Design Code Zones

4.1.1 Subject site

The SCY Subject Site spans a total of four zones, including two sub-zones located within the Port Adelaide Enfield Council.

The zones and sub-zones spanned by the subject site include:

- Strategic Employment – National Naval Shipbuilding (NNS) sub-zone
- Strategic Employment – Ports sub-zone
- Strategic Employment
- Employment
- Open Space
- Coastal Waters and Offshore Islands

It is anticipated that the proposed expansion of the ONS may result in revisions to the extent of the existing zones and sub-zones on the Lefevre Peninsula, namely increased coverage of the Strategic Employment – National Naval Shipbuilding (NNS) sub-zone. The relevant Desired Outcome for this zone is outlined in Table 9. The Desired Outcomes for the remaining zones and sub-zones have been omitted for brevity.

Table 9: Relevant Desired Outcome—National Naval Shipbuilding sub-zone

Desired Outcome	
DO1	Ship building and the long-term growth of defence related support industry uses generating wealth and employment for the state and nation.

4.1.2 Adjacent land

The closest noise affected premises are located to the west of the site along Victoria Road. These premises are residential dwellings constituting the suburbs of North Haven and Osborne, South Australia. The nearest residences face away from the subject site, with backyards, sheds and boundary fences separating the dwellings from the Key Freight Route of Victoria Road.

The receptors are located in the General Neighbourhood zone. The relevant Desired Outcome for the General Neighbourhood zone is outlined in Table 10.

Table 10: Relevant Desired Outcome —General Neighbourhood zone

Desired Outcome	
DO1	Low-rise, low and medium-density housing that supports a range of needs and lifestyles located within easy reach of services and facilities. Employment and community service uses contribute to making the neighbourhood a convenient place to live without compromising residential amenity.

More distant residential dwellings are situated approximately 7 kilometres to the east of the site, in the suburb of Globe Derby Park. The receptors are separated from the site by the Port River, Torrens Island, Dry Creek wetlands, and the Northern Connector/North-South Motorway. The relevant Desired Outcome for the Rural Living Zone is outlined in Table 11. The Animal Husbandry Subzone is also applicable to these receptors with the Desired Outcome outlined in Table 12.

Table 11: Relevant Desired Outcome —Rural Living zone

Desired Outcome	
DO1	A spacious and secluded residential lifestyle within semi-rural or semi-natural environments, providing opportunities for a range of low-intensity rural activities and home-based business activities that complement that lifestyle choice.

Table 12: Relevant Desired Outcome — Animal Husbandry Subzone

Desired Outcome	
DO1	Large-scale horse keeping and dog kennelling in association with detached dwellings on large allotments.

Furthermore, distant residential receivers are also located approximately 3.5 kilometres north of the site in St Kilda. The St Kilda receptors are separated from the site by the Port River, Torrens Island Conservation Park and the Adelaide International Bird Sanctuary National Park - Winaityinaityi Pangkara. These receptors are located within the Rural Shack Settlement Zone, with the Desired Outcome outlined in Table 13.

Table 13: Relevant Desired Outcome — Rural Shack Settlement Zone

Desired Outcome	
DO1	Limited development within an environment where natural processes such as flooding, sea-level rise, sand drift and erosion occur. The natural environment is protected from inappropriate development and existing development is upgraded to incorporate environmental improvements.

The distant receptors located in the Globe Derby Park (Rural Living Zone) and St Kilda (Rural Shack Settlement Zone), are identified, in context with the project site, in Figure 19.

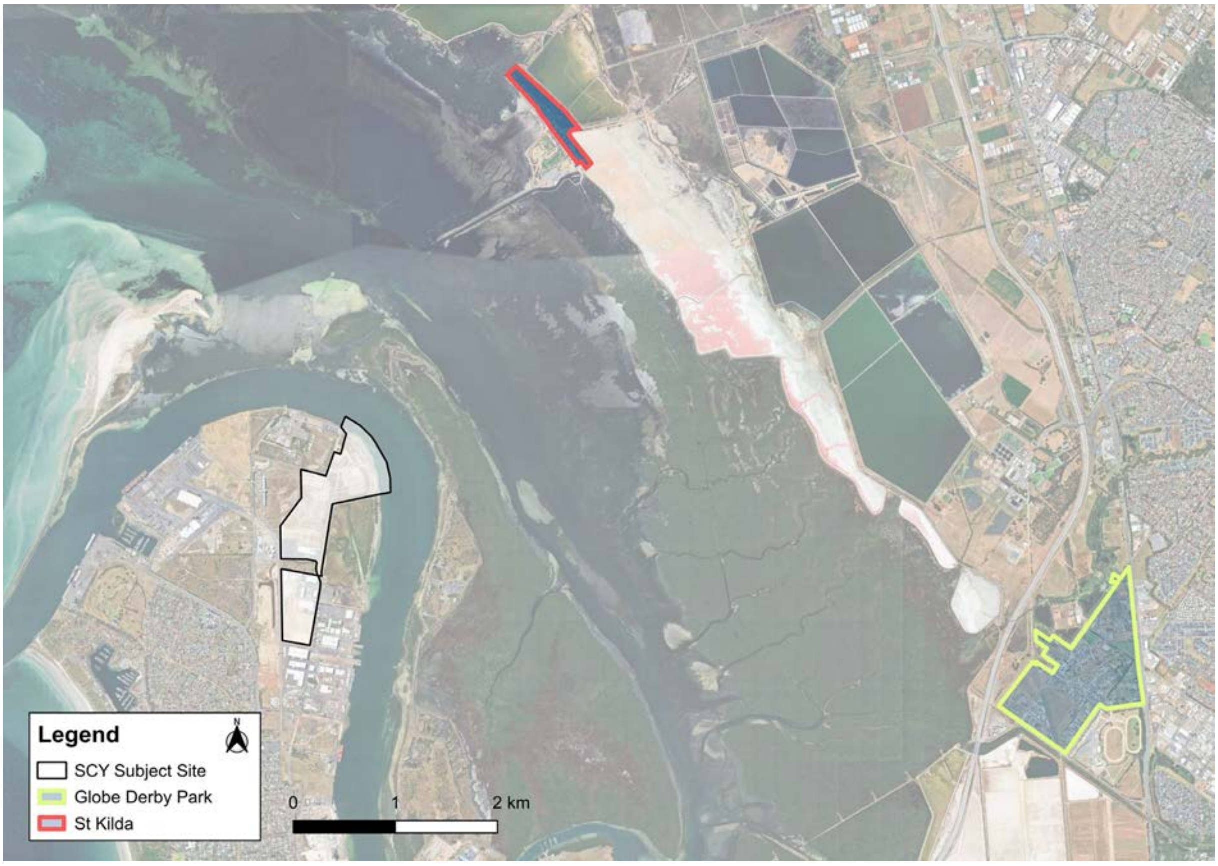

Figure 19: Locality of the SCY Subject Site with respect to distant receptors.

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4.2 Interface between land uses

Interface between Land Uses is a General Development Policy that is relevant to the subject site. The relevant Assessment Provisions relating to noise are outlined in Table 14.

Table 14: Relevant Assessment Provisions—Activities generating noise or vibration

Relevant Assessment Provisions	
Desired Outcome	
DO1	Development is located and designed to mitigate adverse effects on or from neighbouring and proximate land uses.
Performance Outcome	**Deemed-to-Satisfy Criteria / Designated Performance Feature**
PO 4.1 Development that emits noise (other than music) does not unreasonably impact the amenity of sensitive receivers (or lawfully approved sensitive receivers).	DTS/DPF 4.1 Noise that affects sensitive receivers achieves the relevant Environment Protection (Noise) Policy criteria.

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5 Assessment criteria

5.1 National Legislation

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) is the central piece of environmental legislation relevant to this assessment. It provides the legal framework to protect and manage nationally and internationally important biota, ecological communities and heritage places, which are defined in the Act as 'matters of National Environmental Significance' (MNES). Under the provisions of the Act, it is an offence for any person to take an action that is likely to have a significant impact on MNES without approval.

5.2 State Legislation

5.2.1 Adelaide Dolphin Sanctuary Act 2005

The *Adelaide Dolphin Sanctuary Act 2005* was proclaimed in June 2005 to protect the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) that live in and around the Port River estuary and Barker Inlet. About 30 or more individuals are seen on a regular basis in this vicinity, with around 400 more thought to visit the area. The Adelaide Dolphin Sanctuary was established for their protection and the protection of their habitat. The dolphins habitat and food requirements can all be found in the mangroves, seagrass, saltmarsh, tidal flats, tidal creeks and estuarine rivers in the region (DENR 2011). Section 32 of this Act states that there is a general duty of care for a person to take all reasonable measures to prevent or minimise any harm to the sanctuary through his or her actions or activities.

5.2.2 Environment Protection Act 1993

The general environmental duty in section 25 of the *Environment Protection Act 1993* (EP Act) states that:

> A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

5.2.3 Fisheries Management Act 2007

Section 77 of the *Fisheries Management Act 2007* (FM Act) states that a person must not engage in an operation involving or resulting in interference with aquatic animals of any waters forming part of an aquatic reserve, except as authorised by the regulations or a permit issued by the Minister.

5.2.4 Heritage Places Act 1993

The *Heritage Places Act 1993* (*HP Act*) makes provision for the identification, recording and conservation of places and objects of non-Aboriginal heritage significance; to establish the South Australian Heritage Council; and for other purposes.

5.2.5 Historic Shipwrecks Act 1981

Any wreck in South Australian waters which is 75 years old is automatically protected under the Historic Shipwrecks Act 1981. Under this Act, historically significant shipwrecks that are less than 75 years old, may be protected by Ministerial declaration. A protected historic shipwreck includes articles associated with the ship, including moveable artefacts. It is illegal to damage, destroy, interfere with, or to dispose of, any historic shipwrecks or historic relics.

5.2.6 Local Nuisance and Litter Control Act 2016

The *Local Nuisance and Litter Control Act 2016* (*LNLC Act*) is administered by local government and provides the community with an effective and consistent local service for the management of nuisance complaints and heightened deterrence for littering and illegal dumping. The *LNLC Act* is designed so that the majority of activities licensed by the EPA are excluded as these are already regulated under the *EP Act*. The exceptions are activities associated with a vehicle, such as earthworks drainage, dredging and waste transport.

In most cases, the responsible authority for managing construction noise that is not associated with public infrastructure works is the local council under the *LNLC Act*. However, the Environment Protection Authority (EPA) is responsible for managing construction noise at sites where an authorisation to conduct an activity of environmental significance applies.

5.2.7 National Parks and Wildlife Act 1972

Section 68 of the *National Parks and Wildlife Act 1972* (NPW Act) states that a person must not interfere with, harass or molest a protected animal, or undertake or continue an act or activity that is, or is likely to be, detrimental to the welfare of a protected animal unless authorised by a permit granted by the South Australian Department for Environment and Water. The marine mammal species listed as 'protected animals' under the Act are also listed under the EPBC Act.

5.2.8 Planning, Development and Infrastructure Act 2016

The *Planning, Development and Infrastructure Act 2016* (*PDI Act*) provide for matters that are relevant to the use, development and management of land and buildings, including by providing a planning system to regulate development within the State, rules with respect to the design, construction and use of buildings, and other initiatives to facilitate the development of infrastructure, facilities and environments that will benefit the community.

5.3 Operational Noise

5.3.1 Environmental noise policy

As noted in DTS/DPF 4.1, environmental noise emissions from the subject site should comply with the *Environment Protection (Commercial & Industrial Noise) Policy 2023* (Noise EPP). Compliance with the Noise EPP will also satisfy the requirements of the *EP Act* in relation to noise pollution.

The noise goals in the Noise EPP are based on the zoning of the development and the closest noise affected premises in the relevant development plan. The land uses primarily promoted by the zones are used to determine the environmental noise criteria with the indicative noise factors shown in Table 15.

Table 15: Excerpt from Noise EPP—Table 2(subclause(1)(b))

Land use category	Indicative noise factor dB(A)	
	Day (7 am to 10 pm)	Night (10 pm to 7 am)
Rural living	47	40
Residential	52	45
Rural industry	57	50
Light industry	57	50
Commercial	62	55
General industry	65	55
Special industry	70	60

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The noise level criteria are based on the Indicative noise factors contained within the Noise EPP, in context with the relevant Planning & Design Code zones.

As the noise affected premises is situated in a 'quiet noise designated area', being a zone where the Residential land use is principally promoted, a continuous noise criterion of L_{eq} 52 dB(A) day, and L_{eq} 45 dB(A) and L_{max} 60 dB(A) at night, 10 pm to 7 am, is also applicable.

Notwithstanding the above, the noise sensitive receivers are generally separated from some or all of the study area by an intervening land use that spans at least 100 metres. We have therefore conservatively applied the indicative noise factors to the Residential land use category to determine the indicative noise level criteria. We note that the indicative noise factor for the residential land use category is the same as the continuous noise requirements for a 'quiet noise designated area'.

Based on the commentary above, the indicative noise level criteria for the residential receivers are as follows.

West of the site in North Haven (General Neighbourhood Zone):

- 52 dB(A) during the day, 7 am to 10 pm
- 45 dB(A) at night, 10 pm to 7 am.

East of the site in Globe Derby Park (Rural Living Zone, with Animal Husbandry Subzone):

- 52 dB(A) during the day, 7 am to 10 pm
- 45 dB(A) at night, 10 pm to 7 am.

North of the site in St Kilda (Rural Shack Settlement Zone):

- 52 dB(A) during the day, 7 am to 10 pm
- 45 dB(A) at night, 10 pm to 7 am.

The 5 dB(A) planning penalty has not been applied to the criteria derived above on the basis that the assessment considers the cumulative noise for the precinct.

We note that the 5 dB(A) planning penalty (under Part 5 of the Noise EPP) is in recognition of the increased scope for the inclusion of reasonable and practicable noise reduction measures, and the cumulative effect of noise with other industrial sources. As the operational noise assessment presented in this report considers the impact of cumulative noise from existing and proposed industrial buildings and external plant across the entire precinct, we believe the intent of the planning penalty has been met.

We also note that under Part 5, Clause 19(6) of the Noise EPP, exceedance of the recommended criterion does not necessarily mean action is required under the Noise EPP. Some of the following matters should be considered when considering action:

- the amount by which the criterion is exceeded (in dB(A))
- the frequency and duration for which the criterion is exceeded
- the ambient noise that has a noise level similar to the predicted noise level
- the times of occurrence of the noise source
- the number of persons likely to be adversely affected by the noise source and whether there is any special need for quiet.

Characteristic penalties

Penalties can also be applied to a noise source for a variety of characteristics, such as impulsive, low frequency, modulating or tonal characters. For a characteristic penalty to be applied to a noise source is must be fundamental to the impact of the noise and dominate the overall noise impact. Given the proximity of the noisy Victoria Road to the nearest noise sensitive receivers, operation of the proposed SCY is not expected to dominate the overall noise impact, as evidenced by the existing noise environment characterised in Section 3.

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5.3.2 Road traffic noise policy

At this stage, the project is not eligible for consideration under the South Australian Department for Infrastructure and Transport (DIT) *Environment and Heritage Technical Manual Attachment 7A: Road Traffic Noise Guidelines*. However, this may change following future road network assessments by DIT (refer Section 7.1.1 for more information). The guidelines apply specifically to DIT road infrastructure upgrades and do not cover future developments that may increase traffic noise on public roads. Currently, South Australia lacks a noise policy for this situation, necessitating an alternative policy approach to assess under the *General Environmental Duty*.

An alternative noise policy approach in this case is obtained from NSW Environmental Protection Authority's (EPA) *NSW Road Noise Policy* (RNP, Department of Environment, Climate Change and Water NSW 2011), where applicable noise criteria for residential land uses are presented in Table 16.

Table 16: RNP criteria for residential land uses

Road category	Type of proposal/land use	Assessment criteria – dB	
		Day (7am–10pm)	Night (10pm–7am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15hour)}$ 55 (external)	$L_{Aeq(9hour)}$ 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from new local road corridors 5. Existing residences affected by noise from redevelopment of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Non-residential land uses

The criteria for other non-residential sensitive receivers relevant to the proposal are summarised in Table 17.

Table 17: RNP criteria for non-residential sensitive land uses

Existing sensitive land use	Assessment criteria – dB(A)		Additional considerations
	Day (7am–10pm)	Night (10pm–7am)	
School classrooms	$L_{Aeq(1hour)}$ 40 (internal)	–	Applies when in use only. In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation

Existing sensitive land use	Assessment criteria – dB(A)		Additional considerations
	Day (7am–10pm)	**Night (10pm–7am)**	
Hospital wards	$L_{Aeq(1hour)}$ 35 (internal)	$L_{Aeq(1hour)}$ 35 (internal)	from the 'maximum' levels shown in Australian Standard 2107:2016 (Standards Australia 2016).
Places of worship	$L_{Aeq(1hour)}$ 40 (internal)	$L_{Aeq(1hour)}$ 40 (internal)	Applies when in use only. Areas outside of a place of worship may also warrant consideration. Refer to passive recreation area criteria.
Open space (active use)	$L_{Aeq(15hour)}$ 60 (external)	–	Applies when in use only. Active recreation is characterised by sporting activities and activities that generate their own noise or focus for participants. Passive recreation is characterised by contemplative activities that generate little noise and where benefits may be compromised by noise intrusion (e.g. playing chess or reading).
Open space (passive use)	$L_{Aeq(15hour)}$ 55 (external)	–	
Child care facilities	Sleeping rooms $L_{Aeq(1hour)}$, 35 (internal) Indoor play areas $L_{Aeq(1hour)}$, 40 (internal) Outdoor play areas $L_{Aeq(1hour)}$ 55 (external)	–	Applies when in use only. Each component of use in a mixed-use development should be considered separately. For example, in a mixed-use development containing residences and a child care facility, the residential component should be assessed against the appropriate criteria for residences and the child care component should be assessed against the appropriate criteria for child care facilities. Multipurpose spaces, e.g. Shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	–	–	Refer to the residential land use criteria defined in Table 16.

Cumulative impacts from traffic-generating developments

The RNP advises that for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the existing traffic noise without the proposal in operation. The RNP also notes that the assessment criteria aim to limit any additional traffic noise impacts as far as practicable. However, their application would need to take into account the prevailing circumstances.

It is also acknowledged that new industrial, commercial or residential developments that generate additional traffic on existing roads are likely to provide limited potential for noise control because these developments are not usually linked to road improvements. However, strategies to minimise traffic-related noise associated with the development should be applied where reasonable and practicable.

5.4 Construction noise impact on humans

Construction noise may be governed by local council under the LNLC Act or the Environment Protection Authority (EPA) under the EP Act.

The LNLC Act declares construction noise a local nuisance in Part 2 (section 4 (a)(i)):

(c) in the case of construction noise—the noise has travelled from the location of the construction activity to neighbouring premises—

- *on any Sunday or public holiday; or*
- *after 7pm or before 7am on any other day;*

For sites that hold EPA authorisation, construction noise that causes an adverse impact on amenity is only permitted between 7am and 7pm, Monday to Saturday.

For construction activities, an adverse impact on amenity is defined as an average noise of 45dB(A) or any singular noise event with a maximum noise level of 60dB(A) at a noise receiver.

5.5 Construction vibration impact on humans and structures

Ground vibrations from construction works as part of the Project can have the following effects:

- Human disturbance – disturbance to building occupants: vibration which inconveniences or interferes with the activities of the occupants or users of the building
- Effects on building structures, including underground pipework – vibration which may compromise the condition of the building structure itself.
- Disruption or damage to sensitive equipment.

In general, vibration criteria for maintaining human comfort are more stringent than vibration criteria aimed at lowering the potential risk of building damage due to vibration. Building occupants will normally feel vibration at levels well below those which may cause a risk of cosmetic or structural damage to a building (i.e. 0.3 to 0.5 mm/s).

In recognition of the above, this EIS identifies vibration targets for human comfort and vibration goals to lower the risk of vibration damage to residential dwellings, state heritage places and buildings and infrastructure within the ONS.

5.5.1 Vibration targets for human comfort

Vibration screening criteria applicable to occupied spaces within buildings are detailed in Table 18.

The screening criteria are derived from British Standard BS 6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings*, and *Assessing Vibration: A technical guideline* (NSW Department of Environment and Conservation, 2006).

The vibration criteria are given as a range, with the lower value indicating the preferred vibration level and the upper value representing the maximum.

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Table 18: Human comfort vibration screening criteria

Sensitive receiver	Vibration Screening Criteria Vibration Velocity (PPV) mm/s	
	Day	Night
Critical working areas(1) (for example, hospital operating theatres)	0.14 – 0.28	
Residential	0.28 – 0.56	0.2 – 0.4
Other non-residential buildings	0.56 – 1.1	

(1) This does not include sensitive research or manufacturing equipment (for example lithography or microscopy) which may be affected by vibration levels below the threshold of human perception. Specialist advice should be sought where this equipment exists adjacent the project area of works.

The vibration criteria presented above are conservative screening levels and it does not necessarily follow that an exceedance will result in disturbance.

5.5.2 Vibration goals for structural damage

Potential vibration impacts should be managed such that damage does not result to building structures and underground pipework. The limits presented in this assessment are typically adopted as part of the project vibration management framework in infrastructure projects in South Australia, and are referred to in the Department for Infrastructure and Transport's (DIT) *Guideline for the Management of Noise and Vibration: Construction and Maintenance Activities*, available as Attachment 7D to DIT's Environment and Heritage Technical Manual.

Buildings and structures

German Standard DIN 4150-3 *Structural Vibration, Part 3 – Effects of Vibration on Structures* is a suitable reference for guideline vibration limits to avoid cosmetic and structural damage to buildings. The following DIN 4150-3 values are specified as PPV levels measured in any direction at or adjacent to the building foundation. The presented levels in Table 19 are the lowest applicable limit for each structure category.

Table 19: DIN 4150-3 Vibration guideline values

Reference: DIN 4150, Part 3, Table 1	Vibration Velocity, mm/s (PPV)			
	At foundation, at a frequency of:			Plane of floor of uppermost storey
Type of Structure	<10Hz	10-50Hz	>50Hz	All frequencies
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 - 40	40 - 50	40
Dwellings and buildings of similar design and/or use	5	5 - 15	15 - 20	15
Structures that because of their particular sensitivity to vibration do not correspond to those listed above and have intrinsic value	3	3 - 8	8 - 10	8

DIN 4150-3 states that exposing buildings to vibration levels higher than that recommended above would not necessarily result in damage. Rather it recommends these values as maximum levels of short-term construction vibration at which experience has shown that damage that reduces the serviceability of structures will not occur due to vibration effects. DIN 4150-3 is considered to be suitable for the assessment of both structural and cosmetic damage as the Standard considers a reduction in serviceability of the structure is deemed to have occurred if:

- Cracks form in plastered surfaces of walls
- Existing cracks in the building are enlarged
- Partitions become detached from loadbearing walls or floors.

Underground infrastructure

The DIN 4150 also provides guidelines for the short-term vibration exposure of buried pipelines. The guidelines provide peak particle velocity (PPV) vibration limits applicable at the pipe surface in any of the three orthogonal directions (i.e. x, y, z). These limits are provided in Table 20.

Table 20: Underground Pipework Vibration Limits

Pipe material	Peak Particle Velocity (PPV) limit, mm/s
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plaster	50

It is noted that these limits are based on pipework built to modern construction standards. Where the integrity of the pipework is uncertain, further investigation may be required.

Electrical and communications infrastructure

If construction activities occur in close vicinity of existing electrical and communications infrastructure the vibration goals presented in the Australian Coal Industry's Research Program (ACARP) Report *Effect of Blasting on Infrastructure, ACARP Project No C14057*, dated 20 October 2008 will be utilised (presented in Table 21).

Table 21: Suggested vibration limits near electrical and communications infrastructure

Service	Peak Particle Velocity (PPV) limit, mm/s
Power lines – concrete and timber poles	100
Power lines – steel towers	100
Buried communication cables and pipelines	100

5.6 Noise impacts on terrestrial fauna

The potential impact of noise on fauna has been described as including physiological and behavioural responses, permanent and temporary damage to hearing organs, interference with breeding, and the masking of vital communication (Patricelli, 2006; Dooling, 2007; Parris, 2009; Ortega, 2012). The noise impact on fauna can be classified as one of four categories:

- **Permanent threshold shift (PTS)** is defined as a noise-induced threshold shift that persists after a recovery period subsequent to exposure (Ryan, 2016). It results in a permanent loss of hearing in fauna and may occur during to impulsive noise, or continuous exposure to high intensity noise. This impairs their ability to detect predators, and communicate with other fauna. As birds rely on vocal stimuli and the transmission of vocal signals for predator detection, the loss of hearing will lead to higher risks of predation (Ramírez-Santos, 2018).
- **Temporary threshold shift (TTS)** is similar to PTS, however the hearing loss is only temporary. The length of time at which hearing is lost will depend on the properties of the noise, and the species of fauna.

- **Masking** is the interference with the detection of one (biologically relevant) sound by another (Dooling, 2007). It impairs the ability to communicate effectively, and detect predators. This will only occur during the time at which the noise is present, and will not cause any damage to the hearing ability of fauna. Some birds have been known to alter the frequency of their communication to avoid masking by other noise (Francis, 2011).
- **Physiological and/or behavioural response** is defined as noise that causes any kind of response in fauna. The most common behavioural response for birds is flight as they perceive the noise as a threat, it is noted that the visual stimuli of humans also influences their response (Wright, 2010).

The level of impact on fauna depends on the type of noise produced, including frequency, loudness, consistency, and duration (Ortega, 2012), the species of animal and other physical and environmental factors, such as age, season, weather, ambient noise level and degree of previous exposure (Cayford, 1993; Yasue et. al, 2003; Yasue, 2006).

Currently there is limited knowledge on the specific hearing sensitivity of fauna native to the area of interest. As such there is no current government or other widely accepted guidelines. Interim guidelines for potential effects from different noise sources were recommended previously for the average bird (Dooling, 2007) and later adopted within the *Technical Guidance for Assessment and Mitigation of the Effects of Traffic Noise and Road Construction Noise on Birds* (2016 California Department of Transportation). These guidelines are outlined in Table 22.

Table 22: Recommended Interim Guidelines for Potential Effects from Different Noise Sources

Noise Source Type	PTS	TTS	Masking	Behavioural or Physiological Effects
Single Impulse (e.g. blast)	140 dB(A)[1]	NA[3]	NA[5]	Any audible component of traffic and construction noise has the potential of causing behavioural and/or physiological effects independent of any direct effects on the auditory system of PTS, TTS, or masking
Multiple Impulse (e.g. jackhammer, pile driver)	**125 dB(A)[1]**	**NA[3]**	**ambient dB(A)[6]**	
Non-Strike Continuous (e.g. construction noise)	**None[2]**	**93 dB(A)[4]**	**ambient dB(A)[6]**	
Traffic and Construction Noise	None[2]	93 dB(A)[4]	ambient dB(A)[6]	
Alarms (97 dB/100 ft)	None[2]	NA[2]	NA[6]	

(1) Estimates based on bird data Hashino et al. 1988 and other impulse noise exposure studies in small mammals.

(2) Noise levels from these sources do not reach levels capable of causing auditory damage and/or permanent threshold shift based on empirical data on hearing loss in birds from the laboratory.

(3) No data available on TTS in birds caused by impulse sounds.

(4) Estimates based on study of TTS by continuous noise in the budgerigar and similar studies in small mammals.

(5) Cannot have masking to a single impulse.

(6) Conservative estimate based on addition of two uncorrelated noises. Above ambient noise levels, critical ratio data from 14 bird species, well documented short term behavioural adaptation strategies, and a background ambient noise typical of a quiet suburban area would suggest noise guidelines in the range of 50-60 dB(A).

(7) Alarms are non-continuous and therefore unlikely to cause masking effects.

There is limited information on the hearing sensitivity of reptiles and mammals, however some reptile species tested under laboratory conditions have shown to experience a TTS when exposed to 95 dB(A) for several minutes (Defour, 1980). A study into the effect of dune buggy noise on the mammalian kangaroo rat reported that a TTS was present when subjecting the rat to 95 dB(A) for 500s (Brattstrom, 1983). From this information, it is inferred that birds are the most noise sensitive fauna in the study area, and will form the basis of the criteria.

Compliance with this criterion will be achieved if noise from the Project is below the following levels at the expected location of noise-sensitive fauna receptors:

- 93 dB(A) for non-strike continuous noise sources
- 125 dB(A) for impulsive sources (such as impact pile driving).

5.7 Noise impacts on marine fauna

The *Underwater Piling and Dredging Noise Guidelines* (2023) (the Guidelines) have been developed by the Department for Infrastructure and Transport (DIT) to provide guidance for addressing underwater noise for marine maintenance activities or a marine infrastructure project.

Substantial progress has been made in quantifying marine mammal hearing and the effects of noise on hearing for a range of taxa since the review provided by Southall et al. (2007), which formed the basis of the former DIT (2012) underwater piling noise Guidelines. Southall et al. (2019), considering subsequent scientific findings over the past decade, presented estimated audiograms for six species groupings, including all marine mammal species. Southall et al. (2019) also advise that substantial uncertainties and data gaps remain in the understanding marine mammal hearing.

Southall et al. (2019) provides dual exposure metrics for impulsive noise criteria, including frequency-weighted SEL and unweighted peak sound pressure level. Exposures exceeding the specified respective criteria level for any exposure metric are interpreted as resulting in predicted temporary threshold shift (TTS) or permanent threshold shift (PTS) onset. For continuous noise sources, exposure criteria are given in frequency-weighted SEL.

5.7.1 Physiological impacts on marine mammals

Table 23 summarises the Southall et al. (2019) noise exposure criteria for physiological impacts adopted by the DIT Guidelines. The criteria are essentially also identical to that adopted by NFMS (2018). Note that SEL_{cum} is expressed as $SEL_{24\ hour}$ under the Guidelines for clarity on the assessment period.

Table 23: Underwater noise exposure criteria for physiological impacts on marine mammals

Functional hearing group	Impact	Physiological noise exposure onset criteria	
		Impact piling (Impulsive)	Vibratory / DTH piling and Dredging (Continuous)
Low-frequency cetaceans	TTS	Peak 213 dB $SEL_{24\ hour}$ 168 dB(LF)	$SEL_{24\ hour}$ 179 dB(LF)
	PTS	Peak 219 dB $SEL_{24\ hour}$ 183 dB(LF)	$SEL_{24\ hour}$ 199 dB(LF)
High-frequency cetaceans	TTS	Peak 224 dB $SEL_{24\ hour}$ 178 dB(HF)	$SEL_{24\ hour}$ 179 dB(HF)
	PTS	Peak 230 dB $SEL_{24\ hour}$ 185 dB(HF)	$SEL_{24\ hour}$ 198 dB(HF)

Functional hearing group	Impact	Physiological noise exposure onset criteria	
		Impact piling (Impulsive)	Vibratory / DTH piling and Dredging (Continuous)
Very high-frequency cetaceans	TTS	Peak 196 dB $SEL_{24\ hour}$ 140 dB(VHF)	$SEL_{24\ hour}$ 153 dB(VHF)
	PTS	Peak 202 dB $SEL_{24\ hour}$ 155 dB(VHF)	$SEL_{24\ hour}$ 173 dB(VHF)
Pinnipeds (Phocid carnivores in water)	TTS	Peak 212 dB $SEL_{24\ hour}$ 170 dB(PCW)	$SEL_{24\ hour}$ 181 dB(PW)
	PTS	Peak 218 dB $SEL_{24\ hour}$ 185 dB(PCW)	$SEL_{24\ hour}$ 201 dB(PCW)
Pinnipeds (other carnivores in water)	TTS	Peak 226 dB $SEL_{24\ hour}$ 188 dB(OCW)	$SEL_{24\ hour}$ 199 dB(OCW)
	PTS	Peak 232 dB $SEL_{24\ hour}$ 203 dB(OCW)	$SEL_{24\ hour}$ 219 dB(OCW)
Pinnipeds – Phocid Carnivores in Air(2)	TTS	Peak 128 dB $SEL_{24\ hour}$ 123 dB(PCA)	$SEL_{24\ hour}$ 134 dB(PCA)
	PTS	Peak 144 dB $SEL_{24\ hour}$ 138 dB(PCA)	$SEL_{24\ hour}$ 154 dB(PCA)
Pinnipeds – Other Carnivores in Air(2)	TTS	Peak 161 dB $SEL_{24\ hour}$ 146 dB(OCA)	$SEL_{24\ hour}$ 157 dB(OCA)
	PTS	Peak 167 dB $SEL_{24\ hour}$ 161 dB(OCA)	$SEL_{24\ hour}$ 177 dB(OCA)

(1) Note: TTS = Temporary threshold shift, PTS = Permanent threshold shift

(2) dB re 20 μPa

5.7.2 Behavioural response of marine mammals

Summaries of behavioural responses of marine mammals to human-made noise show a large variability in the received levels (differing by many tens of decibels) and the severity in the response from minor to severe (C.Erbe et al. 2018).

Furthermore, there is limited data on behavioural responses of marine mammals exposed to pile driving activities (both impact and vibratory), especially associated with smaller near shore projects (Appendix B - NOAA Ocean Noise Strategy).

Table 24 summarises noise exposure criteria adopted by the Guidelines for the assessment of behavioural impacts.

Table 24: Underwater noise exposure criteria for behavioural response

Species	Behavioural noise exposure criteria	
	Impact piling	Vibratory / DTH Piling and Dredging [1]
Cetaceans	SPL 160 dB rms	SPL 120 dB rms
Pinnipeds	SPL 160 dB rms	SPL 120 dB rms

(1) The 120 dB rms threshold may be adjusted if it can be demonstrated that the ambient levels are above this level.

5.7.3 Fishes and marine turtles

Table 25 provides the underwater noise exposure criteria adopted by the Guidelines for noise impacts on fishes and marine turtles. Popper et al. (2014) note that where insufficient data exist to make a recommendation for guidelines development, a subjective approach is adopted in which the relative risk of an effect is placed in order of rank at three distances from the source:

- Near (N) = tens of meters from the source
- Intermediate (I) = hundreds of meters from the source
- Far (F) = thousands of meters from the source.

Table 25: Underwater noise exposure criteria for fishes and marine turtles

Functional Hearing Group	Source character	Organ damage / increased risk of fatality	PTS	TTS	Behavioural Response
Fish (no swim bladder) For example: • Great White Shark Mackeral Shark	Continuous	**N**: Low **I**: Low **F**: Low	**N**: Low **I**: Low **F**: Low	**N**: Moderate **I**: Low **F**: Low	**N**: Moderate **I**: Moderate **F**: Low
	Impulsive	Peak 213 dB $SEL_{24\ hour}$ 219 dB	Peak 213 dB $SEL_{24\ hour}$ 216 dB	$SEL_{24\ hour}$ 186 dB	**N**: High **I**: Moderate **F**: Low
Fish (with swim bladder) For example: • Pipefish • Seahorses Seadragons	Continuous	**N**: Low **I**: Low **F**: Low	SPL 170 dB for 48 h	SPL 158 dB for 12 h	**N**: High **I**: Moderate **F**: Low
	Impulsive	Peak >207 dB $SEL_{24\ hour}$ 207 dB	Peak >207 dB $SEL_{24\ hour}$ 203 dB	$SEL_{24\ hour}$ 186 dB	**N**: High **I**: High **F**: Moderate

<table>
<tr><th>Functional Hearing Group</th><th>Source character</th><th>Organ damage / increased risk of fatality</th><th>PTS</th><th>TTS</th><th>Behavioural Response</th></tr>
<tr><td rowspan="2">Marine Turtles

For example:
• Loggerhead Turtle
• Green Sea Turtle
• Leatherback Turtle
• Pacific Ridley Turtle</td><td>Continuous</td><td>N: Low
I: Low
F: Low</td><td>N: Low
I: Low
F: Low</td><td>N: Moderate
I: Low
F: Low</td><td>N: High
I: Moderate
F: Low</td></tr>
<tr><td>Impulsive</td><td>Peak 207 dB
$SEL_{24\ hour}$ 210 dB</td><td>N: High
I: Low
F: Low</td><td>N: High
I: Low
F: Low</td><td>N: High
I: Moderate
F: Low</td></tr>
</table>

(1) TTS = Temporary threshold shift, PTS = Permanent threshold shift

(2) Relative risk of an effect is placed in order of rank at three distances from the source: Near (N) = tens of meters from the source, Intermediate (I) = hundreds of meters from the source, Far (F) = thousands of meters from the source.

Given that it is generally not practical to assign safety zones for these species, a potential effects zone is defined by the Guidelines to assist a risk-based assessment for those species known to occur within the marine area of interest.

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6 Operational noise assessment on humans

A master noise model has been developed by Resonate to assess potential worst-case cumulative environmental noise impacts from current and proposed operations at the ONS. The revision of the master noise model used in this assessment is based on previous assessments outlined below, and the 5% design for the SCY. With consideration of defence security requirements, the 5% layout cannot be shared. Noise contour information that may undermine these requirements has been obscured with an overlay of the SCY Subject Site area.

The noise levels from continuous, simultaneous operation of all facilities at the site is predicted to comply with the relevant Noise EPP criteria.

6.1 Previous precinct modelling and acoustic reports

The master noise model includes buildings and external mechanical plant assessed under previous planning submissions. The scope of these assessments with document reference is provided below:

- Buildings S18, S20, S21, S22 – Environmental Noise Assessment - Aurecon Report *SASIU-PH3-SIT-MEM-KB-0003 rev6* dated 4 October 2018.
- 2021 ONS precinct master noise model (based on the defunct Future Submarines Project) – Environmental Noise Assessment – Resonate Report A200394RP2A dated 10 June 2021.
- Building S10 and S18A – Environmental Noise Assessment – Resonate Report A230348RP1A dated 24 July 2023.

6.2 Noise modelling methodology

6.2.1 Model parameters

Noise emissions from the site have been modelled in SoundPLAN Environmental Software v9 program, using the Conservation of Clean Air and Water in Europe (CONCAWE) algorithms. The model takes into consideration:

- attenuation of noise source due to distance
- barrier effects from buildings, topography and the like
- air absorption
- ground effects
- meteorological conditions (wind speed, wind direction, time of day, and cloud cover).

CONCAWE has six different meteorological categories—CONCAWE meteorological category 1 represents meteorological conditions that are least conducive to noise propagation (best case situation with the lowest predicted noise levels), CONCAWE meteorological category 4 represents neutral meteorological conditions, and CONCAWE meteorological category 6 represents meteorological conditions that are the most conducive to noise propagation (the worst case situation with the highest predicted noise levels).

In accordance with the *Guidelines for the use of the Environmental Protection (Commercial & Industrial Noise) Policy 2023*, CONCAWE meteorological category 5 has been used for day time noise emissions and CONCAWE meteorological category 6 has been used for night time noise emissions.

6.2.2 Industrial noise

The noise emissions from existing and future fabrication, consolidation, outfitting, blast and paint, and workshop facilities have been modelled using Industrial Buildings in SoundPLAN. In general, noise emissions from industrial buildings are modelled as the breakout of the internal reverberant noise level through facades, including features such as the external wall build-up, ceilings, glazing, louvres and doors.

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The modelled internal noise levels are based on the noise generating activity categories in Table 26. The low, medium, high, or blasting noise intensity categories have been assigned to existing buildings in the ONS (refer Appendix A) and proposed buildings in the SCY Subject Site based on their intended use.

The general types of SCY building classifications and their assigned low, medium and high internal noise levels are listed below. Note that further detailed information on each building activity has not been provided for security reasons:

- Office & Administration – Low
- Warehouse & Storage – Low
- Manufacturing – Low, Medium or High, depending on the activity within each building
- Amenity – Low
- Marine/Infrastructure – Low
- Transport & Access – Low

The categories, except for blasting, are based on Resonate's previous measurements of medium to large scale industrial warehousing and manufacturing facilities where a range of activities, including sanding, welding, grinding and the operation of gantry cranes have been observed. Internal noise levels for blasting are based on measurements of a similar facility in Lindø, Denmark, detailed in Lendlease acoustic report *T608-ONSP-T608-ONSP-000-124 Acoustics report of Hall 4 at Lindø* dated 28 June 2016.

It is anticipated that the internal noise levels in this assessment, applied to the entire facade and roof areas, are likely to be lower in practice, particularly at parts of the building facade more distant to noise generating plant and activities.

Table 26: Internal noise generating activity categories

Internal Noise Category	Overall, dB(A)	Internal reverberant noise level, dB L_{eq}						
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Consolidation, warehousing, workshops, and machining facilities								
Low	77	79	77	75	73	71	69	67
Medium	80	82	80	78	76	74	72	70
High	85	87	85	83	81	79	77	75
Blast & Paint								
Blasting (2 Nozzles)(1)	102	85	81	82	86	91	94	96

(1) Overall level adjusted for each building based on the number of blasting nozzles operating simultaneously, with the adjustment calculated as Overall + 10log(N/2) where N is the number of nozzles.

The acoustic performance of the roof, facades and facade elements have been modelled on a similar basis, using low, medium and high categories for acoustic separation performance. The overall weighted Sound Reduction Index for each category, and an indicative construction, are presented in Table 27.

Note that facade penetrations and elements such as doors, roller doors, windows, louvres, and other ventilation systems may reduce the acoustic performance of the facade if a product with sufficient acoustic performance is not selected.

Table 27: Facade acoustic performance categories

Sound Reduction Category	R_W	Transmission Loss, dB						
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Consolidation, warehousing, workshops, and machining facilities								
Low (0.6mm steel sheet)	17	9	12	15	15	16	20	23
Medium (as above with insulated panel)	32	20	24	28	32	31	30	44
High (>100mm pre-cast concrete or equivalent)	>49	39	42	40	43	51	58	63

The intent of the low, medium, and high noise level and acoustic performance approach is to identify where improved facade performance may be required to reduce potential environmental noise impacts, that is, for noise mitigation measures to be targeted where the most benefit will be afforded to noise sensitive receptors.

Existing external plant has been included in the master noise model and reflects current information available to Resonate. Indicative locations and acoustic data, including attenuators, from architectural drawings and previous acoustic reports has been used where available.

Given the preliminary nature of SCY Subject Site planning, proposed external plant to these facilities have not been included in this assessment as their inclusion would be highly speculative. Nevertheless, there is the potential for external mechanical plant to have an adverse noise impact. Noise levels from mechanical plant are required to achieve the noise goals in the Noise EPP at noise sensitive receptors, and consideration should be given to:

- Selection of units with a lower overall noise level
- Locating plant where noise sensitive receptors are afforded shielding from site buildings and other structures
- The selection of suitable attenuators and enclosures to control noise emissions from the plant.

A schedule of the mechanical plant currently included (including attenuators and enclosures) and modelled sound power levels for the existing ONS facility is provided in Appendix A.

6.2.3 Modelling scenarios

At this stage it has been considered that all anticipated noise intensive activities at the shipyard will be operating simultaneously at any time, 24-hours a day, 7-days a week. Whilst unlikely, this approach considers conservative, worst-case noise emissions from current and future operations at the site.

6.3 Predicted noise levels

Operational noise levels have been predicted for all noise-sensitive receptors in the vicinity of the SCY Subject Site. The predicted noise level at the most affected residential receptor for each scenario is presented in Table 28.

Table 28: Predicted noise levels at the most affected residential receivers for each model scenario

Prediction location	Relevant Criteria L_{eq} dB(A)	Predicted noise level L_{eq} dB(A)	Predicted to Comply
Scenario A (Day)			
Most affected residential receptor in the General Neighbourhood zone	52	43	✓
Most affected residential receptor in the Rural Living zone	47	<35	✓
Scenario B (Night)			
Most affected residential receptor in the General Neighbourhood zone	45	44	✓
Most affected residential receptor in the Rural Living zone	40	<35	✓

In summary, the noise levels from continuous, simultaneous operation of all facilities at the site are predicted to comply with the relevant Noise EPP criteria.
Note that the only difference between the two scenarios is the CONCAWE meteorological categories 5 and 6 for day and night time predictions respectively. Category 6 conditions are most conducive to noise propagation and explain the marginally (1 dB) higher predicted noise level during night time hours.

Predicted noise level contours for the night time Scenario B are presented in Figure 20.

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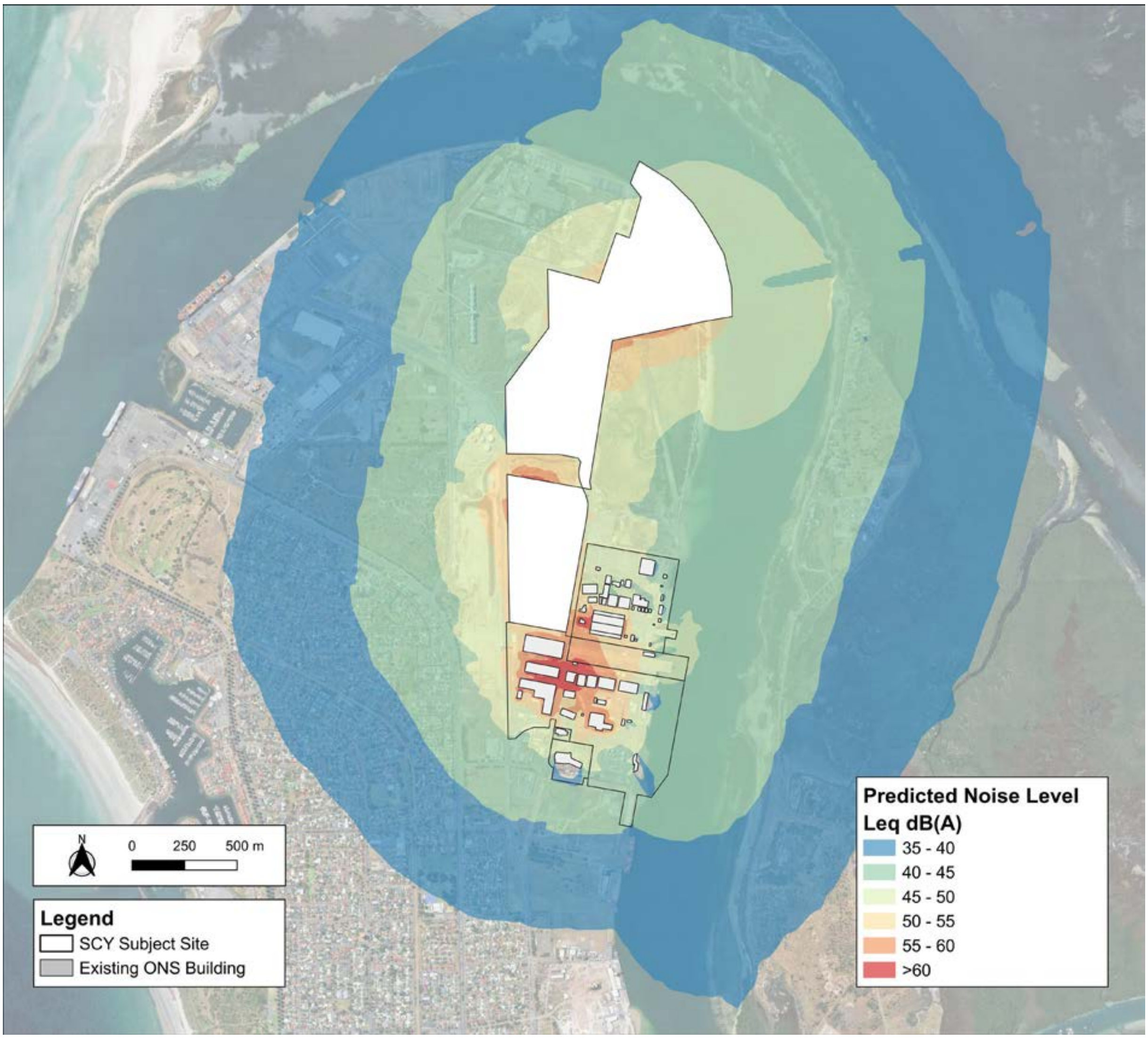

Figure 20: Predicted noise level contours from continuous operation of the site during night time hours (with the site masked for defence security reasons)

6.4 Operational noise mitigation and management measures

Given the preliminary 5% design stage of the SCY precinct, it is recommended that continued development of the master noise model to assign a noise budget to each building facility and associated external plant is undertaken based on functional operating requirements. Building facilities with noisier operational activities may be assigned a greater noise budget within the cumulative noise emission allowance for the ONS and SCY precinct to optimise noise mitigation for the Development. Note that it is expected that Work Health and Safety (WHS) requirements will also positively influence the design outcome in terms of mitigating internal/external noise emissions of plant and equipment.

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7 Road traffic noise assessment on humans

7.1 Road traffic noise modelling methodology

A computer noise model of the existing scenario and the proposed future scenario was developed using SoundPLAN V9 noise prediction software. SoundPLAN implements the UK Calculation of Road Traffic Noise (CoRTN) algorithms for the prediction of road traffic noise. The CoRTN methodology is an accepted road traffic noise prediction method across Australia.

SMEC were engaged by ANI to work in partnership with the Department for Infrastructure and Transport (DIT) to undertake an initial assessment of the strategic impacts of the potential traffic demand associated with the development and future growth on the Lefevre Peninsula. The SMEC Traffic Assessment Report (October 2024) (the 'traffic assessment') is included as Appendix 1.3 of the EIS. The information contained within the traffic assessment has been used to inform the road traffic noise modelling.

To assess the road traffic noise impact of the SCY development, the following scenarios have been modelled:

- Existing scenario based on existing road alignments and traffic volumes obtained for 2022 from DIT. It is conservatively assumed that the traffic growth from 2022 to the year of the SCY development becoming operational is negligible. The purpose of this scenario is to determine existing road traffic noise levels before the SCY development is constructed.
- Future scenario based on existing road alignments (assumed to be unchanged) and future predicted traffic volumes (obtained from the traffic assessment) at year 2041. The future scenario (including the development), comprising the 2041 future baseline which assumes growth across Metropolitan Adelaide, including the Lefevre Peninsula. The purpose of this scenario is to determine the potential increase in road noise levels on the road network due to the planned growth in the Lefevre Peninsula.

The development is expected to generate additional traffic in the surrounding area, particularly on Semaphore Road, Francis Street/Port River Expressway and Victoria Road. For this assessment, only these roads have been modelled for both scenarios. Note that the traffic volumes on these roads are assumed to be the same at all localities without more granular traffic modelling data. Therefore this noise assessment is considered preliminary and conservative until further detailed information becomes available.

7.1.1 Lefevre Peninsula Masterplan

Separate to the development, a Lefevre Peninsula Masterplan (the Plan) is to be prepared that will provide a structured approach to planning on the Lefevre Peninsula. It will provide clear guidance as to the future investment in necessary infrastructure, including housing and transport, to support the new submarine enterprise as well as meeting the needs of other industry in the area and local residents. It will also support future local activity and inform broader strategic planning including the development of the Greater Adelaide Regional Plan to make sure that it responds to the needs associated with construction and operation of the development and broader Project.

The Plan is being commissioned by the South Australian Office for AUKUS, (part of the South Australian Department of the Premier and Cabinet), to make sure that future growth of a defined area is sustainable with the aim for liveable, economically supported communities.

The Plan is anticipated to commence in late 2024, with delivery and implementation of the Masterplan in 2026. Through the involvement of Approval Holders in future planning that provides direct support to the development, coupled with investment and strategic support from various levels of government, it is anticipated that potential impacts, including traffic, to the Lefevre Peninsula Masterplan can be minimised.

7.1.2 Road traffic noise modelling parameters

The road traffic noise modelling parameters assumed for each scenario are presented in Table 29.

Table 29: Road traffic noise modelling parameters

Parameter	Detailed design noise model
Vehicle speeds	• Existing posted speeds have been applied to both scenarios.
Traffic volumes	• Refer to Table 30 and Table 31.
Proposal study area	• The study area encompasses the first row of receiver buildings adjacent the relevant roads.
Road traffic noise prediction algorithm	• Calculation of Road Traffic Noise (CoRTN) 1988, using the CoRTN prediction method.
'Appropriate adjustments for NSW noise descriptors'	• The 15 hour and 9 hour traffic flows have been divided by 15 and 9 respectively • The CoRTN $L_{10,1hr}$ predictions have been converted to $L_{eq,15h}$ and $L_{eq,9h}$ by subtracting 3 dB from the result for each period • A 3 dB difference between L_{10} and L_{eq} levels is widely accepted.
Pavement corrections	• 0 dB(A) for Densely Graded Asphalt (DGA) applied to the road string for all sections of road.
Receiver heights	• 1.5 metres above ground for ground floor receiver • 4.5 metres above ground for first floor receiver
Ground absorption factor	• 50 per cent over all areas
Grid spacing and height above ground	• 5 metre grid • 1.5 metres above ground.
Model validation	• Model validation has not yet been undertaken
Facade reflection correction	• + 2.5 dB(A) at 1 metre from facade (single point receiver calculations) • Noise contour plots (grid noise maps) are presented as free field noise levels (i.e. with no + 2.5 dB(A) facade reflection correction).
Standard Australian condition correction based on ARRB	• -1.7 dB(A) for standard correction at 1 metre from façade for day time and +0.5 dB(A) for night time

The adopted traffic volumes for both the existing and future scenarios are shown in Table 30 and Table 31.

Table 30: Existing traffic volumes

Road	Section	Speed	AADT		%CV	
			Day	Night	Day	Night
Semaphore Road	Between Esplanade and Military Road	50	6630	870	2	2
	Between Military Road and Swan Terrace	50	7070	930	3	3

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Road	Section	Speed	AADT		%CV	
			Day	Night	Day	Night
	Between Swan Terrace and Causeway Road	50	11700	1530	1.5	1.5
	Between Causeway Road and Fletcher Road	50	10960	1440	5.5	5.5
	Between Fletcher Road and Nelson Street	50	9460	1240	7	7
	Between Nelson Street and Victoria Road	50	17150	2250	4.5	4.5
Francis St / Port River Expressway	Between Semaphore Road and Perkins Drive	60	25200	3430	14	14
	Between Perkins Drive and Evans St	60	27200	3700	10	10
	Between Evans St and Hanson Road	60	32030	4370	12.5	12.5
Victoria Road	Between Coghlan Road and Klingberg Drive	60	3220	390	43	43
	Between Klingberg Drive and Pelican Point Road	60	4020	480	34.5	34.5
	Between Pelican Point Road and Sir Keith Smith Drive	60	7500	900	27.5	27.5
	Between Sir Keith Smith Drive and Veitch Road	60	8840	1060	23	23
	Between Veitch Road and Osborne Road	60	11800	1410	19	19
	Between Osborne Road and Gedville Road	60	14650	1760	14.5	14.5
	Between Gedville Road and Strathfield Terrace	60	17950	2150	12	12
	Between Strathfield Terrace and Swansea Street	60	18900	2270	11.5	11.5
	Between Swansea Street and Jetty Road	60	23400	2800	10.5	10.5
	Between Jetty Road and Wills Street	60	24820	2980	11	11
	Between Wills Street and Semaphore Road	60	28670	4340	12	12

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Table 31: Future traffic volumes at 2041

Road	Section	Speed	AADT		%CV	
			Day	Night	Day	Night
Semaphore Road	All	50	15300	2000	2.3	2.8
Francis St / Port River Expressway	All	60	58900	8000	15.5	20
Victoria Road	All	60	36700	4400	14	19.7

7.1.3 Predicted noise levels without mitigation

Road traffic noise levels have been predicted in the form of noise contours and facade noise levels assessed at 1.5 metres above the ground level for the existing and future scenarios for both daytime (7 am–10 pm) and night-time (10 pm–7 am) time periods.

Noise levels have also been predicted at every facade and every floor for each potentially affected noise-sensitive receiver. The predicted noise level range for the receivers nearest the roads and the expected noise level increase in the future scenario at year 2041 have been determined and are displayed for day and night time in Table 32 and Table 33 below.

Table 32: Predicted road traffic noise levels – Daytime (2041)

Road	Section	Typical noise level range, dB(A)		Typical noise level increase, dB(A)
		Existing	Future	
Semaphore Road	Between Esplanade and Military Road	58 – 66	62 – 69	4
	Between Military Road and Swan Terrace	61 – 66	64 – 69	3
	Between Swan Terrace and Causeway Road	61 – 67	62 – 68	1
	Between Causeway Road and Fletcher Road	61 – 69	62 – 70	1
	Between Fletcher Road and Nelson Street	61 – 67	61 – 68	1
	Between Nelson Street and Victoria Road	60 – 61	61 – 63	1
Francis St / Port River Expressway	Between Semaphore Road and Perkins Drive	66 – 71	70 – 75	4
	Between Perkins Drive and Evans St	68 – 74	73 – 78	5
	Between Evans St and Hanson Road	66 – 69	69 – 73	3

Road	Section	Typical noise level range, dB(A)		Typical noise level increase, dB(A)
		Existing	Future	
Victoria Road	Between Coghlan Road and Klingberg Drive	59 – 65	68 – 72	7
	Between Klingberg Drive and Pelican Point Road	60 – 66	67 – 73	7
	Between Pelican Point Road and Sir Keith Smith Drive	60 – 67	66 – 72	5
	Between Sir Keith Smith Drive and Veitch Road	62 – 67	67 – 72	5
	Between Veitch Road and Osborne Road	62 – 67	67 – 72	4
	Between Osborne Road and Gedville Road	63 – 69	69 – 74	4
	Between Gedville Road and Strathfield Terrace	62 – 70	66 – 73	4
	Between Strathfield Terrace and Swansea Street	63 – 70	67 – 73	3
	Between Swansea Street and Jetty Road	60 – 70	63 – 72	3
	Between Jetty Road and Wills Street	68 – 70	67 – 72	2
	Between Wills Street and Semaphore Road	65 – 72	68 – 75	2

Table 33: Predicted road traffic noise levels – Nighttime (2041)

Road	Section	Typical noise level range, dB(A)		Typical noise level increase, dB(A)
		Existing	Future	
Semaphore Road	Between Esplanade and Military Road	53 – 61	58 – 65	4
	Between Military Road and Swan Terrace	56 – 61	60 – 65	4
	Between Swan Terrace and Causeway Road	56 – 62	58 – 64	2
	Between Causeway Road and Fletcher Road	57 – 65	58 – 66	1
	Between Fletcher Road and Nelson Street	57 – 63	58 – 65	1

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Road	Section	Typical noise level range, dB(A)		Typical noise level increase, dB(A)
		Existing	Future	
	Between Nelson Street and Victoria Road	55 – 56	57 – 59	2
Francis St / Port River Expressway	Between Semaphore Road and Perkins Drive	62 – 67	66 – 71	4
	Between Perkins Drive and Evans St	64 – 70	69 – 75	5
	Between Evans St and Hanson Road	62 – 65	65 – 70	4
Victoria Road	Between Coghlan Road and Klingberg Drive	53 – 59	64 – 68	9
	Between Klingberg Drive and Pelican Point Road	55 – 61	63 – 69	8
	Between Pelican Point Road and Sir Keith Smith Drive	55 – 62	62 – 68	6
	Between Sir Keith Smith Drive and Veitch Road	57 – 62	63 – 68	6
	Between Veitch Road and Osborne Road	57 – 62	63 – 68	6
	Between Osborne Road and Gedville Road	58 – 64	65 – 70	5
	Between Gedville Road and Strathfield Terrace	57 – 65	62 – 69	4
	Between Strathfield Terrace and Swansea Street	58 – 65	63 – 69	4
	Between Swansea Street and Jetty Road	55 – 65	59 – 68	3
	Between Jetty Road and Wills Street	63 – 65	63 – 68	3
	Between Wills Street and Semaphore Road	60 – 67	64 – 71	4

This traffic growth will not all be due to the development as some will be natural traffic growth, especially the further away the roads are from the development. The proposed development will contribute to the noise impact, however will not be fully responsible.

Discussion on the noise impact that traffic generated by the proposed development and natural road traffic growth has on each relevant section of road is included below in Table 34.

Table 34: Noise impact of SCY development on surrounding road network by section

Road	Section	Typical land use and noise impact discussion
Semaphore Road	Between Esplanade and Military Road	Residential and commercial land use in general. Predicted noise levels at day and night time are above the noise criterion and experience an increase of at least 2 dB at day and night.
	Between Military Road and Swan Terrace	Primarily commercial land use with some potential residential land uses. Predicted noise levels at day and night time are above the noise criterion and experience an increase of at least 2 dB at day and night.
	Between Swan Terrace and Causeway Road	Primarily commercial land use with some residential land use, a hotel and a place of worship. Predicted noise levels at day and night time are above the noise criterion and experience an increase of at least 2 dB at night.
	Between Causeway Road and Fletcher Road	Primarily residential land use and an educational land use. Predicted noise levels at day and night time are above the noise criterion but do not experience an increase of at least 2 dB at day or night.
	Between Fletcher Road and Nelson Street	Primarily residential land use. Predicted noise levels at day and night time are above the noise criterion but do not experience an increase of at least 2 dB at day or night.
	Between Nelson Street and Victoria Road	Primarily residential land use Predicted noise levels at day and night time are above the noise criterion and experience an increase of at least 2 dB at day and night..
Francis St / Port River Expressway	Between Semaphore Road and Perkins Drive	Primarily industrial land use with some distant residential land use. Industrial receivers will not be eligible for any further assessment.
	Between Perkins Drive and Evans St	Primarily industrial land use. Industrial receivers will not be eligible for any further assessment.
	Between Evans St and Hanson Road	Primarily industrial land use. Industrial receivers will not be eligible for any further assessment.
Victoria Road	Between Coghlan Road and Klingberg Drive	Primarily residential and recreational open space land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.

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Road	Section	Typical land use and noise impact discussion
	Between Klingberg Drive and Pelican Point Road	Primarily residential and recreational open space land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Pelican Point Road and Sir Keith Smith Drive	Primarily residential and recreational open space land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Sir Keith Smith Drive and Veitch Road	Primarily residential land use Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Veitch Road and Osborne Road	Primarily residential land use Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Osborne Road and Gedville Road	Primarily residential land use with an educational land use, child care facility and some commercial land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Gedville Road and Strathfield Terrace	Primarily residential land use with an educational land use, a place of worship, active recreation and some commercial land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Strathfield Terrace and Swansea Street	Primarily residential land use with an aged care facility, active recreation, and some industrial and commercial land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Swansea Street and Jetty Road	Primarily residential and industrial land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.
	Between Jetty Road and Wills Street	Primarily residential and industrial land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.

Road	Section	Typical land use and noise impact discussion
	Between Wills Street and Semaphore Road	Primarily residential and industrial land use with some commercial land use. Predicted noise levels at day and night time are above the noise criteria and experience an increase of at least 2 dB at day and night.

The existing road traffic noise levels on the surrounding road network is shown in Figure 21.

The road traffic noise level increase at 2041 for the entire assessed road network is shown in Appendix C.

7.1.4 Operational road traffic noise mitigation

The Department of Infrastructure and Transport (DIT) holds ultimate responsibility for implementing both any road upgrades and the associated mitigation measures, as such it is not possible to state with any certainty what the final mitigation measures would be. Traffic investigations in partnership with DIT will be ongoing to help inform the selection of the final mitigation options and will likely include:

- Ongoing model development and refinement consistent with that needed for more detailed option assessment and comparison;
- Ongoing refinement of assumptions for the ONS precinct (e.g. workforce demand, shift times etc) and Lefevre Peninsula Masterplan, and
- More detailed modelling and assessment of specific options aimed at short-listing to a small number of viable approaches ahead of progression towards a preferred overall network approach.

The traffic assessment has identified the following range of mitigation options which could reduce the traffic impacts of the development, which would help reduce road traffic related noise associated with the development. Options include:

- **Road infrastructure upgrades**: Upgrade the existing road network to suitably accommodate the demand. Such infrastructure upgrades could include grade separations at key intersections, at-grade road intersection widenings and/or restricted access or restricted movements at various locations.
- **Public transport:** Establish new or enhanced public transport services (rail and/or bus) to the precinct to reduce the private car transport demand.
- **Car park and dedicated ONS precinct services:** Provide dedicated services for ONS precinct staff (bus or train) which could include off-site car parks, to enable simple and effective transfer from car to dedicated public transport service.
- **ONS precinct operations:** Changes to Project workforce demand, shift allocations and start and finish times and on-site car parking facilities.
- **Combination:** A combination of the above approaches is considered likely to provide the optimal solution.

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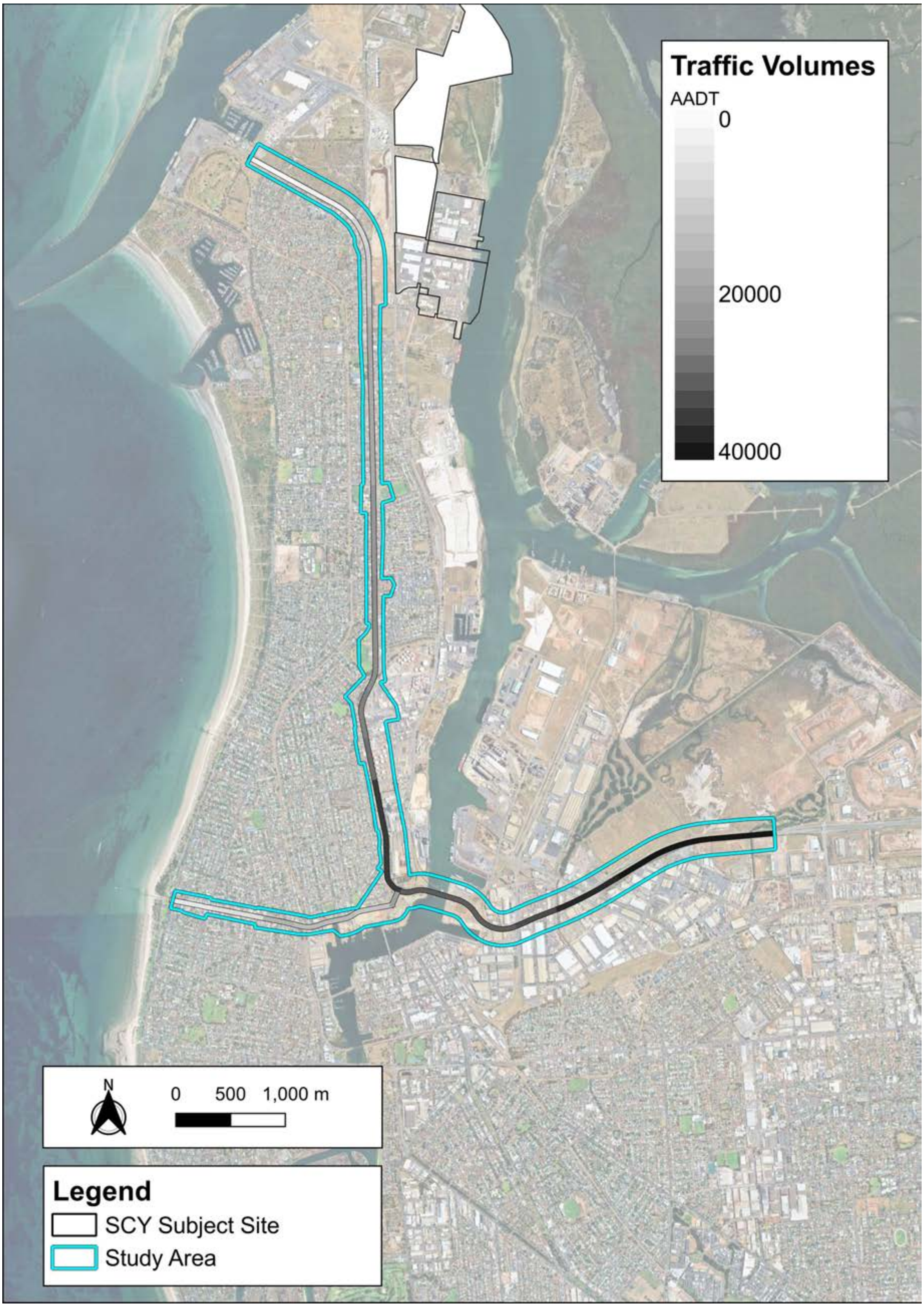

Figure 21 Existing road traffic volumes on road network (DIT 2022)

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8 Construction noise assessment on humans

8.1 Typical noise levels

Table 35 presents the typical plant and equipment expected for the Project and the predicted typical worst-case sound pressure levels at distance from each item of plant.

The predicted noise levels are based on sound power level data for various construction activities from Resonate's database and noise propagation loss from geometric spreading only. Note that these predicted noise levels are based on continuous operation over a 15-minute period and do not consider any shielding from buildings and fences and are therefore conservative. Where an activity is expected to have a dominant tonal or impulsive characteristic, a 5 dB penalty may be applicable to the predicted noise level.

Table 35: Typical worst-case construction noise levels with distance (geometric spreading only)

Plant and Equipment	Reference level at 10 m		Penalty	Typical worst-case $L_{eq,15min}$ at distance (m), dB(A)				Typical worst-case L_{max} at distance (m), dB(A)			
Item of plant / equipment	dB(A) L_{eq}	dB(A) L_{max}	dB	20	40	80	120	20	40	80	120
Excavator (40T)	86	92	–	80	74	68	64	83	77	71	67
Excavator (20-25T)	76	82	–	70	64	58	54	76	70	64	60
Excavator (14T)	75	80	–	69	63	57	53	74	68	62	58
Excavator (3.5T)	61	67	–	55	49	43	39	61	55	49	45
Trucks	80	87	–	74	68	62	58	81	75	69	65
Road saw	90	90	5	84	78	72	68	84	78	72	68
Vibrating hammer (60HV) and impact hammer (S-70 IHC)[1]	97	110	5	96	90	84	80	98	92	86	82
Sheet pile driving frame including gangway	95	102	5	94	88	82	78	96	90	84	80
Plate Compactor	88	88	–	82	76	70	66	82	76	70	66
Vibratory Roller	81	82	–	75	69	63	59	76	70	64	60
Crane (Franna)	88	90	–	82	76	70	66	84	78	72	68
60ton mobile crane	65	65	–	59	53	47	43	59	53	47	43
250ton mobile crane	74	74	–	68	62	56	52	68	62	56	52
Vacuum truck	88	92	–	82	76	70	66	86	80	74	70
Concrete truck	80	87	–	74	68	62	58	81	75	69	65
Concrete pump	75	75	–	69	63	57	53	69	63	57	53
Asphalt paver	80	80	–	74	68	64	60	74	68	64	60
Tug	81	81	–	75	69	63	59	75	69	63	59

Plant and Equipment	Reference level at 10 m		Penalty	Typical worst-case $L_{eq,15min}$ at distance (m), dB(A)				Typical worst-case L_{max} at distance (m), dB(A)			
Dredging	85	85	–	79	73	67	63	79	73	67	63
Welding equipment	77	82	–	71	65	59	55	76	70	64	60
200t Crawler crane	74	74	–	68	62	56	52	68	62	56	52
Telehandler	65	65	–	59	53	47	43	59	53	47	43
Dewatering pump[2]	64	64	–	58	52	46	42	58	52	46	42
Bobcat/Skid steer	76	79	–	70	64	58	54	73	67	61	57
30t rubber tyre roller	78	78	–	72	66	60	56	72	66	60	56
Piling rig / Hammer (HHK7/9A)	88	100	5	82	76	70	66	104	98	92	88
Spider Crane	63	63	–	57	51	46	42	57	51	46	42
600t S/L Crane	71	71	–	65	59	53	49	65	59	53	49
Forklift	65	68	–	59	53	47	43	62	56	50	46
Scissor lift	72	72	–	66	60	54	50	66	60	54	50
Compressor	81	81	–	75	69	63	59	75	69	63	59
Vessels	77	77	–	71	65	59	55	71	65	59	55
Loader	77	80	–	71	65	59	55	74	68	62	58
Moxy dump trucks	73	76	–	67	61	55	51	70	64	58	54
400 kVa Generator	58	58	–	52	46	40	36	52	46	40	36
Booster pump	64	64	–	58	52	46	42	58	52	46	42
Transfer pumps	64	64	–	58	52	46	42	58	52	46	42

(1) Note that noise levels of the impact and vibratory piling measured by Resonate are similar (within 2 dB) – for simplicity the two activities are assumed to be the same worst-case level

(2) Assumes associated fuel pump in operation simultaneously

(3) Grey highlight = less than the nighttime 45 dB(A)L_{eq} or 60 dB(A)L_{max} criteria.

Generally speaking, noise levels at 10m from most sources are typical of those that may be expected in an industrial area. The results also indicate that most of the construction plant and equipment have the potential to exceed the nighttime noise criteria at operating distances less than 80m from sensitive receptors.

8.2 Piling activities

Given that piling activities are likely to be the worst case construction noise activity, noise contours have been calculated to visually identify the extent of noise propagation within the level range assessed. Noise emissions from piling have been modelled in SoundPLAN Environmental Software v9 program, using the ISO 9613-2:1996 algorithm.

The model takes into consideration:

- attenuation of noise source due to distance

- barrier effects from buildings, topography, and the like
- air absorption
- ground absorption (including negligible sound absorption propagating over water).

The modelling produces noise prediction contours indicative of worst-case noise expected from the works. Figure 22 shows the predicted noise levels for Piling activities at a potential building location nearest to residential noise sensitive receptors.

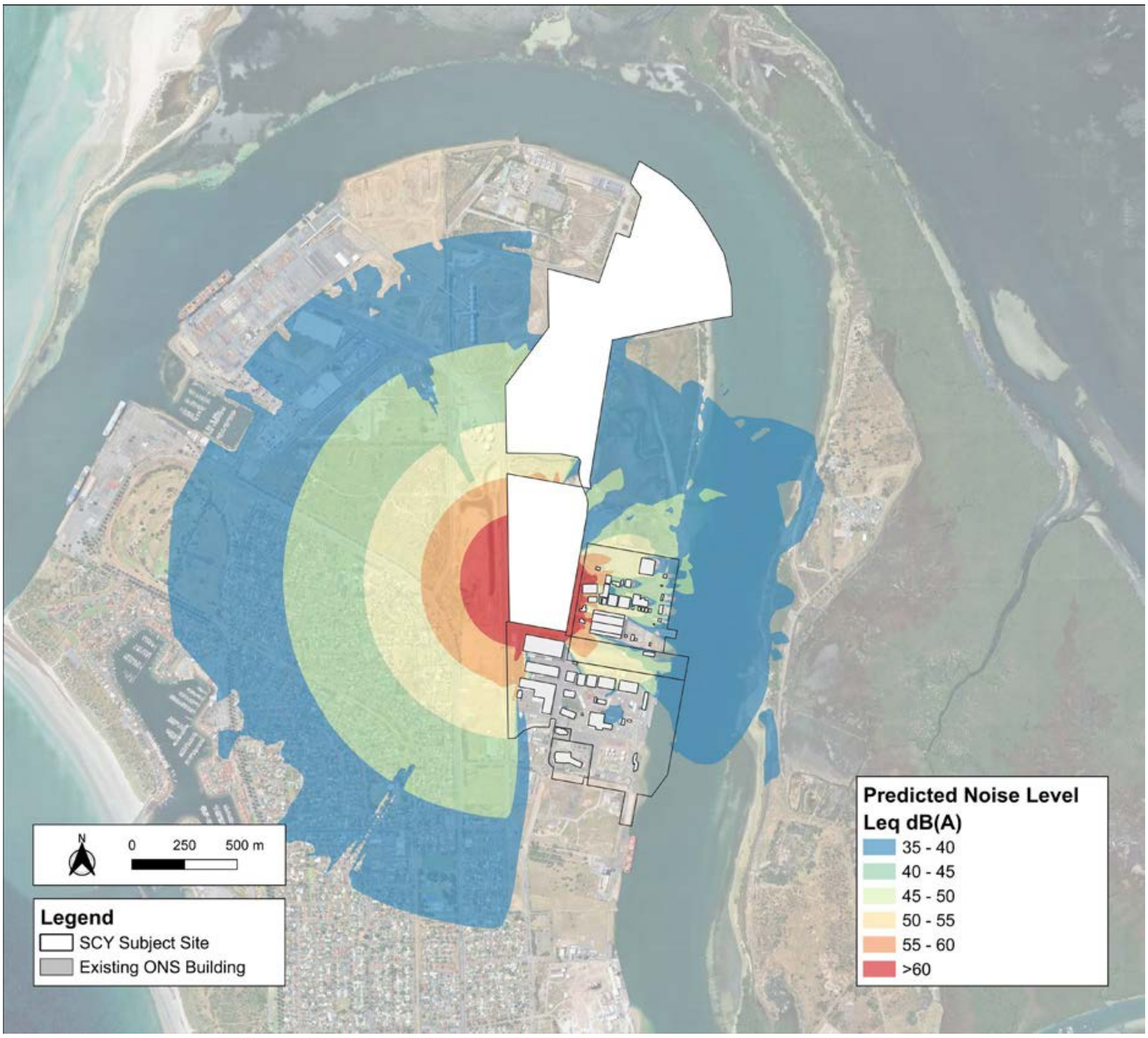

Figure 22: Indicative worst-case noise contours from impact piling activities (with the site masked for defence security reasons)

The modelling results show that nearest residential receivers with a direct line of site to the works may experience external noise levels of up to 65 dB(A)L_{eq} in the worst case (i.e. 20 dB(A) above the nighttime criterion). Discussion on construction noise mitigation and management is provided in Section 8.4.

Figure 23 shows the predicted noise levels for impact piling at a representative location approximately 2 kilometres from the nearest residences.

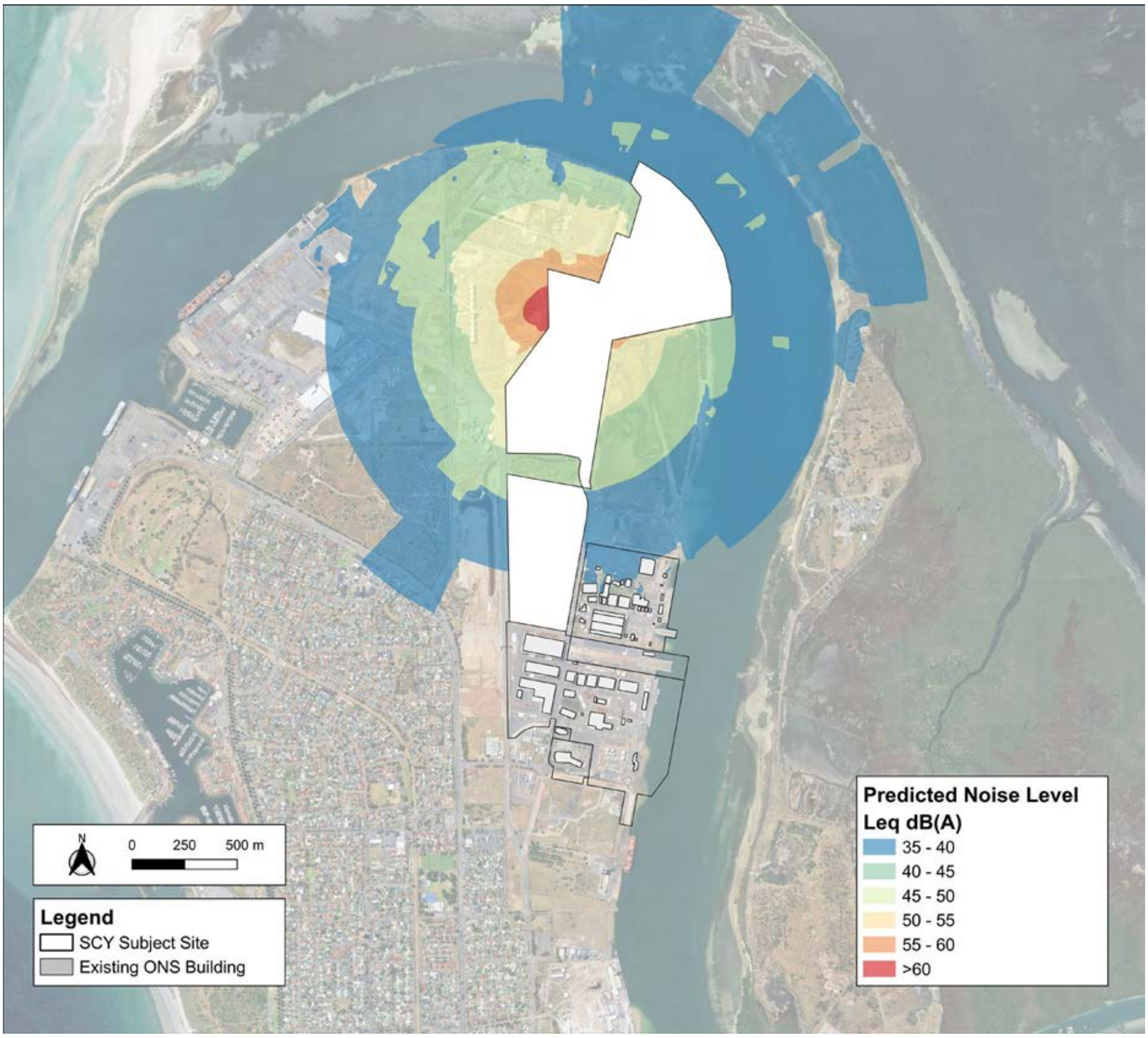

Figure 23: Indicative worst-case noise contours from impact piling at distance (with the site masked for defence security reasons)

The modelling indicates, for this scenario, that the nearest residential receivers with a direct line of sight to the works may experience external noise levels of 45 dB(A)L_{eq} in the worst case. Works undertaken at greater distances to the residential receptors (north-east towards the Port River) are expected to result in construction noise levels below 45 dB(A)L_{eq} .

Note that predictions at the residents west of Victoria road are marginally more than 45 dB(A)L_{eq} in some cases. Impact piling noise may be perceived at these locations for piling works at distances of greater than 1km; however, the impact may also be masked by traffic noise from Victoria Road. Since the works are to take place during standard hours there is no further action required to mitigate noise to these locations. Members of the community may enquire about the works should they perceive the noise from the piling.

8.3 Dredging activities

Noise emissions from dredging activities have been modelled in SoundPLAN Environmental Software v9 program, using the Conservation of Clean Air and Water in Europe (CONCAWE) algorithms. The model takes into consideration:

- attenuation of noise source due to distance
- barrier effects from buildings, topography and the like
- air absorption
- ground effects
- meteorological conditions (wind speed, wind direction, time of day, and cloud cover).

Dredging activities have been assessed for the potential impact out of hours between 6:00am and 7:00am. Figure 24 shows the predicted noise levels for backhoe dredging activities undertaken at the shoreline of the SCY Subject Site.

Figure 24: Indicative worst-case noise contours from dredging activities (with the site masked for defence security reasons)

The noise predictions indicate that, according to EPA requirements, an adverse impact on amenity will not occur for the nearest residential receivers, with average noise levels to be significantly below 45 dB(A) west of Victoria Road, and also to the southwest on Furniss Court. Similarly, maximum noise levels will not exceed 60 dB(A). Nearby residents are unlikely to perceive worst-case noise from dredging activities and no further management or mitigation procedures are required with respect to the terrestrial noise impact.

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8.4 Construction noise mitigation and management

It is a requirement of the EPA that construction activities must only be undertaken during the hours 7 am to 7 pm, Monday to Saturday, unless it can be demonstrated that the noise levels from activities at the nearest residential receivers do not exceed 45 dB(A)L_{eq} or 60 dB(A)L_{max}. Construction activity is not permitted to occur outside of these hours or on a Sunday or public holiday without written permission from the relevant authority. The EPA advises that some grounds may exist for construction work to occur outside these hours if consent is given and procedures are followed.

Given this requirement, it is recommended that the contractor responsible for managing the construction works prepare a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP is required to specifically address any noisy works that may be undertaken outside of the hours identified above.

Table 36 summarises general noise mitigation and management measures, including who is typically accountable, to be considered during the development of the CNVMP.

Table 36: Typical noise mitigation and management measures

Control Measure	Accountability
The site induction shall cover noise (and vibration) management and complaints, which will be reiterated through on-site training, such as toolbox talks or pre-starts.	Site Manager/Site Supervisor
Effective communication with the potentially affected community is a key mitigation measure.	Community Team
The potential shielding provided by site topography shall be considered in locating equipment.	Site Manager/Site Supervisors
Equipment that emits noise predominantly in a particular direction shall be sited such that noise is directed away from occupied premises where feasible.	Site Manager/Site Supervisor
Works planning shall consider preventing vehicles and equipment queuing, idling or reversing near occupied premises where practicable.	Site Manager/Site Supervisor
Truck movements on local roads shall be limited as much as is practicable.	Site Manager/Site Supervisor
Truck operators shall ensure tailgates are cleared and locked at the designated points.	Site Manager/Site Supervisor
Truck movements along uneven surfaces shall be restricted to minimum speed near sensitive receivers.	Site Manager/Site Supervisor
Equipment that is used intermittently shall be shut down or throttled down to a minimum during periods where it is not in use.	Site Manager/Site Supervisor
Equipment shall be well maintained and have mufflers and silencers installed that meet the manufacturer's specifications where relevant.	Site Manager/Site Supervisor
Where a noisy plant is to be fixed in a stationary location, such that it may impact sensitive receivers for a significant length of time, an acoustic enclosure shall be installed where reasonable or practical, or an appropriately silenced generator or lighting tower used.	Site Manager/Site Supervisor
Acoustic screening shall be considered and implemented around noisy above ground equipment where noise levels are predicted to exceed the relevant noise level targets at sensitive land uses, where safe and practical.	Site Manager/Site Supervisor

Control Measure	Accountability
Two-way radio chatter and volume settings shall be kept to the minimum practical.	Operators
The beeping of horns shall not used as a communication method, except for safety reasons in an emergency.	Operators
Where practical, all reversing plants used at night will be fitted with broadband reversing alarms, noting that it may not be possible to do so where the plant is called in at short notice to replace other plant requiring maintenance. All broadband reversing alarms shall be installed and operating in accordance with all relevant Occupational Health and Safety requirements.	Project Engineer
Where it cannot be guaranteed that plant will not be fitted with broadband reversing alarms (e.g., trucks that only attend the site on occasion), the site shall be set up as far as practicable so that those vehicles do not need to reverse.	Project Engineer
Materials shall not be dropped from a height, causing a loud noise wherever possible.	Operators
Where materials are to be dropped into an empty truck tray or disposal bin and may cause a loud noise, the tray/bin shall be lined with soil or an equivalent material to reduce impact noise where feasible.	Operators
Consideration should be given to minimising impact piling and instead adopting alternative lower noise options, such as bored or CFA piling, where possible from an engineering perspective.	Project Engineer and Piling Contractor

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9 Construction vibration assessment on humans and structures

9.1 Vibration generating plant and equipment

Typical conservative vibration levels versus distance for various plant and equipment that are likely to be used or comparable to the equipment to be used are presented Table 37. Vibratory and impact piling predictions are detailed in Sections 9.2 and 9.3. The presented vibration levels are representative of vibration energy propagating through the ground. The predicted levels are based upon various measurements undertaken by Resonate over the Adelaide Metropolitan region.

Table 37 Typical distance to achieve predicted vibration level

Equipment	Predicted Vibration Level		
	5 mm/s	3 mm/s	0.4 mm/s
	Distance to Achieve Predicted Vibration Level (m)		
12T Vibratory Roller	15	20	77
12T Oscillating Roller	6	9	33
18T Vibratory Pad Foot Roller	16	22	85
32T Excavators with Hydraulic Rockbreaker	9	13	51
20T Excavators with Hydraulic Rockbreaker	7	10	39
12-15T Excavators with Hydraulic Rockbreaker	6	8	31
7T Excavators with Hydraulic Rockbreaker	5	7	25
Tamper Rammer	1	2	6
Bored Piling	3	4	14
Continuous Flight Auger (CFA) Piling	3	4	17
Bulldozer	5	6	24
Jackhammer	2	3	13

Other plant and equipment not listed above, such as excavation or backhoe dredging plant, comparatively produce negligible vibration to that listed above under normal operation.

9.2 Vibratory piling

Vibration generated by vibratory hammer piling is explained as follows:

- Vibratory drivers produce a steady-state vibration, forcing the ground particles to vibrate in a certain mode, regardless of the ground characteristic frequency. The vibration typically consists of several frequencies, but the dominant frequency is that of the vibratory driver itself. Resonance can also occur when the vibration frequency coincides with the characteristic pile/ground frequency.
- When sheet piles connect, friction between them increases vibration (3-5 times) especially with worn piles or misaligned driving. New piles and precise driving reduce this effect (Deckner et al., 2010).
- Clamping the piles off-centre also creates an uneven bending force, causing larger lateral vibrations (2-3 times) compared to vertical ones (Deckner et al., 2010).

- Vibration propagates away from the pile in the form of different wave types depending on whether the waves are emitted along the pile shaft and/or from the pile toe. At the toe (bottom of the pile), compression waves (P-waves) and shear waves (S-waves) occur, which both extend as spherical waves in all directions. When the waves reach the surface, they are reflected and refracted. The refracted waves are spread as surface waves (R-waves), which propagate with lower attenuation than body waves (e.g. P or S-waves) along the ground surface.

9.2.1 Vibratory piling predictions

Vibratory sheet piling vibration predictions have been undertaken utilising the approach described by Attwell et al. 1992, which uses an empirically derived quadratic regression model.

Modelling assumptions:

- Sheet pile = AZ 24-700
- Pile length = 14m
- Vibratory driver = 1000 kN centrifugal force, 250 kW hydraulic power
- Driving frequency = 27 Hz

Table 38 provides a summary of the predicted sheet piling vibration levels (mm/s PPV) from the pile with distance.

Table 38: Predicted vibration levels (mm/s PPV) in accordance with Attwell et al. 1992 – sheet vibratory piling

Distance (m)	Best Fit, mm/s PPV	Half Standard Deviation, mm/s PPV	One Standard Deviation, mm/s PPV
10m	6.7	11.9	21.2
20m	3.2	5.6	10.0
50m	0.9	1.7	3.0
100m	0.3	0.6	1.0
200m	0.1	0.2	0.3

9.3 Impact piling

Vibration generated by impact piling is explained as follows:

- The impact of the pile hammer on the pile helmet generates a stress wave that propagates through the pile.
- Dynamic forces develop along the interface between the pile and the surrounding soil, which causes vibration. The magnitude of the vibration generated varies with respect to the dynamic soil resistance.
- Vibration propagates in the form of different wave types depending on whether the waves are emitted along the pile shaft and/or from the pile toe. At the toe (bottom of the pile), compression waves (P-waves) and shear waves (S-waves) occur, which both extend as spherical waves in all directions. When the waves reach the surface, they are reflected and refracted. The refracted waves are spread as surface waves (R-waves), which propagate with lower attenuation than body waves (e.g. P or S-waves) along the ground surface.
- Vibrations attenuate with increasing distance from the pile, although in some soil layers and buildings, they may become amplified due to resonance effects.

9.3.1 Impact piling predictions

Impact piling vibration predictions have been undertaken utilising the Attwell et al. 1992 (quadratic regression model).

Modelling assumptions:

- Impact hammer = IHC S-150 Hydrohammer (7500 kg hammer, 150 kJ maximum energy)
- Hammer efficiency = 95% (conservative, typically we would expect the hammer to be less efficient than this)
- Pile diameter = 610 mm
- Pile length = 22 m
- Pile material = Steel

Table 39 provides a summary of the predicted impact piling vibration levels (mm/s PPV) from the pile with distance.

Table 39: Predicted vibration levels (mm/s PPV) in accordance with Attwell et al. 1992 – impact piling

Distance (m)	Best Fit, mm/s PPV	Half Standard Deviation, mm/s PPV	One Standard Deviation, mm/s PPV
10m	11.9	19.9	33.2
20m	7.3	12.1	20.3
50m	3.3	5.4	9.1
100m	1.6	2.6	4.4
200m	0.7	1.1	2.0

9.4 Assessment of vibration impacts

Note that in relation to the above predictions, it is typical to expect a reduction in vibration level as the vibration energy transfers from the ground to the building foundation or structure (e.g. Jurevicius et al. 2015). Therefore, the predictions are conservative in nature and a general guideline for the potential vibration impacts.

9.4.1 Potential impact on humans

The vibration targets for human comfort are unlikely to be exceeded at residential premises given the distance from the works, being between 300 to 2,000 metres. We note that the maximum baseline vibration levels resulting from road traffic on Victoria Road are generally above the adopted criteria.

Office and workshop criteria may be exceeded on the existing Osborne Naval Precinct site; in which case appropriate consultation with the stakeholders should occur and reasonable mitigation measures considered.

In many cases, achieving compliance with human comfort targets, particularly within the ONS precinct, may be impractical or result in prolonged construction works. Vibration management in these instances should, therefore, focus on communication with potentially affected parties, avoiding work during the most sensitive times where practicable, and mitigating the risk of building damage.

9.4.2 Potential impact on heritage structures

The distance of heritage structures from the nearest potential vibration-intensive construction activities are listed in Table 40 and presented in Figure 3. Based on the predicted vibrational levels outlined in Section 9 above, it can be concluded that potential vibration impacts on heritage structures are not expected, except for the extant shipwreck *Excelsior*. Refer to the DASH Architects Heritage Report prepared for the project for more information.

Impact piling associated with the construction of building foundations (if required) may present a risk to *Excelsior* without consideration of alternative piling methods, such as bored piling.

Table 40: Distance from the land-based SCY boundary to the nearest heritage structures and shipwrecks

Heritage Structures	Distance from SCY Boundary (m)	Source of Potential Impact
Outer Harbor Pilot Station	1809	-
Torrens Island Quarantine Station	784	-
Excelsior shipwreck	27	Impact piling
Jupiter shipwreck	260	-

From the Department for Environment and Water (DEW) fact sheet publication on the *Excelsior*, we note that it is a steel-hulled vessel with the bow intact, but sections of the stern largely collapsed. Under normal circumstances, a steel hulled vessel would be expected to withstand significant vibration and shock loading from pounding waves against the hull during ocean travel.

In this case however, we understand the steel hull is significantly rusted and beyond salvage, and potentially at risk of further collapse. It is our opinion that the DIN 4150 guideline level applicable to sensitive structures with intrinsic value, is conservatively appropriate in this case. The DIN 4150 guideline is predicted to be achieved where impact piling is undertaken at distances greater than 100 m from the shipwreck.

9.5 Previous measurements

Measurements of impact piling were undertaken during construction works at the existing ONS precinct of Buildings 20, 21 and 22 in 2018 at the baseline vibration measurement locations detailed in Section 3.2. The works were separated from the monitoring location by approximately 350 metres. In summary, the measured vibration levels during impact piling did not appear to change compared to baseline conditions when no construction activity was occurring.

Weekly summary plots spanning the baseline and piling works measurements are provided for the VM2 (adj. 5 Rofe Court) below. The measured levels are significantly below the adopted criteria for potential building damage as a result of the works.

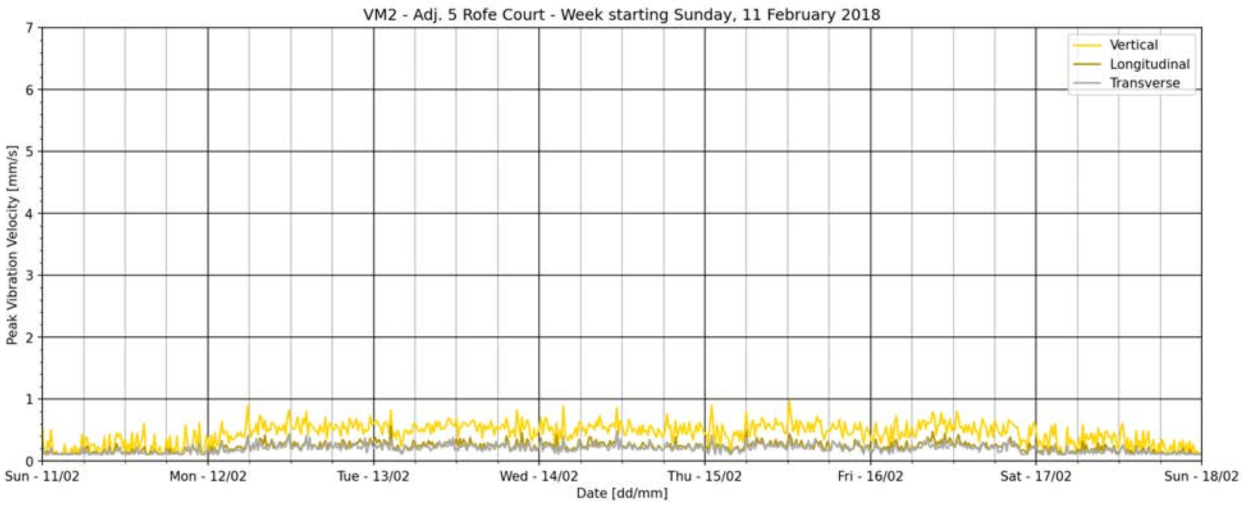

Figure 25: VM2 - Baseline vibration measurement summary

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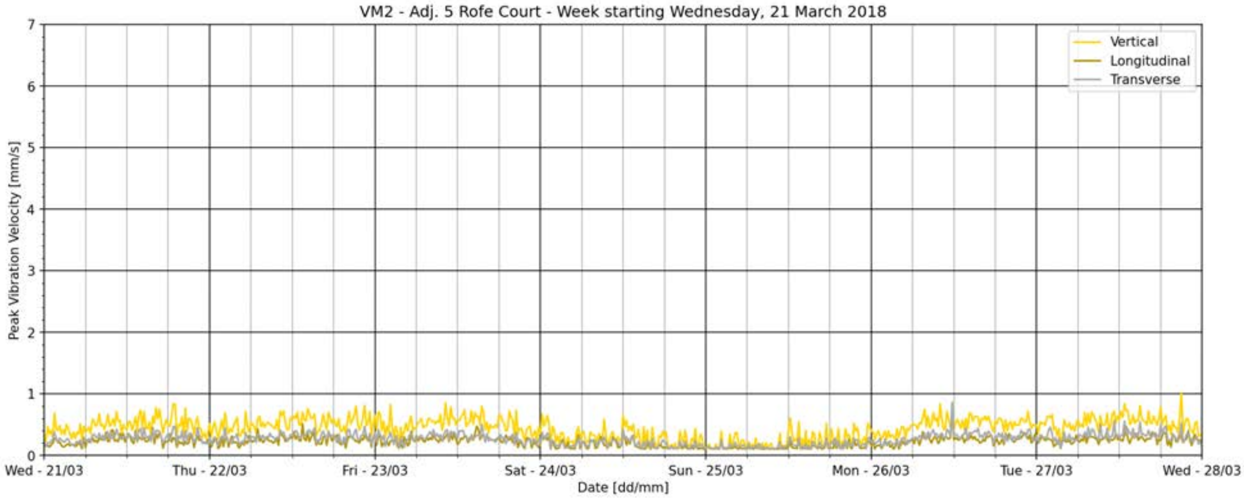

Figure 26: VM2 - Impact piling vibration measurement summary

9.6 Construction vibration mitigation and management

Similarly to construction noise, the mitigation and management of vibration generated from construction activities should be assessed and documented in a Construction Noise and Vibration Management Plan (CNVMP) developed by the contractor responsible for managing the construction works.

The CNVMP should consider the potential impact of vibration on human comfort to any occupied building as well as any damage to nearby structures and heritage assets (such as the *Excelsior*) that occur both on/off the SCY site.

In particular, the *Excelsior* should be inspected to assess the risk of further damage to vibration, including the preparation of a detailed dilapidation record/report prior to any construction works occurring within 200 m of the shipwreck. Furthermore, the following control measures are to be observed:

- For piling that is planned to be conducted within 100 m of the *Excelsior*, alternative piling methodologies to impact piling should be investigated, for example: bored or CFA piling. Vibratory piling may also present a risk to the *Excelsior* within 50 m of the shipwreck.
- Where impact piling (or dynamic pile testing) must be undertaken for engineering reasons, vibration measurements during a trial pile that is located further than 100m from the *Excelsior* should be undertaken to assess the vibration propagation characteristics of the site soil conditions. These vibration measurements may then inform a risk assessment and vibration management approach that considers the potential vibration levels received at the *Excelsior* for comparison to DIN 4150.
- Where major soil compaction works are required to be undertaken on the SCY site boundary within approximately 100 m of the *Excelsior*, the machine size and method of compaction should be considered with the intent to reduce the risk of potential vibration damage. In our experience, there is a greater risk of the DIN4150 criteria being exceeded at distances less than 30 m from larger compaction plant (i.e. ~18T). However, in this case, caution is advised as the transmission efficiency of vibration from the ground to the shipwreck, as well as the response of the shipwreck structure to vibration that is continuous and sinusoidal in nature, is unknown. Compliance with the DIN4150 criteria, when measured on the ground adjacent to the shipwreck, cannot be relied upon as a sufficient risk management measure without further investigation.
- In any case, vibration measurements should be continuously recorded at the *Excelsior* for the duration of all construction activities that involve significant earthworks, compaction or piling works that occur within 200 m of the shipwreck to provide a record.

10 Terrestrial fauna noise assessment

10.1 Introduction

Succession Ecology, in collaboration with Resonate, has prepared this section of the report, which discusses the impacts on terrestrial fauna, with a primary focus on threatened species that are protected by the *EPBC Act* and/or *NPW Act*. Common species that were identified within the subject site, most of which are birds, are not further discussed as these species are highly mobile and are likely to move away from noise. The noise impact on common species is considered negligible. They are listed in Appendix A.

10.2 Terrestrial fauna potentially impacted by development works

Opportunistic fauna surveys were undertaken by Succession Ecology (2023) and targeted bird surveys were undertaken by GHD (2024b). Succession Ecology only observed fauna within the subject site. In contrast, GHD, as part of the targeted surveys, observed fauna both within the subject site and at reference locations (Table 41 and Figure 27).

Table 41: GHD Survey Locations (GHD 2024b).

GHD Survey Location	Relevance to subject site
Port Adelaide River shoreline site – at the interface of the Strategic Assessment area and the Port Adelaide River	• Within the subject site (Figure 27: Strategic Assessment Area reference sites) • Contains migratory species habitat
Swale drain site – the constructed stormwater drain along the northern boundary of Mutton Cove Conservation Reserve.	
Mutton Cove inlet site – the area to the north of the existing Osborne Naval Shipyard where tides enter Mutton Cove Conservation Reserve through the breached seawall.	• Adjacent the subject site (Figure 27: Reference survey site) • Lefevre Peninsula reference site – site likely to be used by the same fauna populations that utilise the Strategic Assessment Area survey sites.
Falie Reserve detention basin	• Within the subject site (Figure 27: Reference survey site) • Lefevre Peninsula reference site – site likely to be used by the same populations that utilise the Strategic Assessment Area survey sites.
Eight reference sites within the region, including: • St. Kilda Beach • Port Gawler foreshore • Port Gawler swale drain • Thompson Beach shoreline • Thompson Beach North, estuary • Middle Beach • Torrens Island mangrove foreshore • Bird Island Conservation Area	• Adjacent or within the wider locality to the subject site (Figure 27: Reference survey site).

Figure 27: Migratory bird survey locations (GHD 2024).

10.2.1 Protected species under the *EPBC Act* / *NPW Act*

A total of 61 fauna species were observed within the subject site (Appendix B), of which a total of 16 are protected or threatened species. Species listed as threatened under the *EPBC Act* and/or the *NPW Act* are of particular importance.

A total of 16 threatened or protected species were identified within the subject site, of which six are listed as threatened under the *EPBC Act* and/or the *NPW Act*. The remaining ten species are either listed as Migratory or Marine under the *EPBC Act*. An additional three species, including one species listed as threatened under the *EPBC Act* (Grey Plover; *Pluvialis squatarola*) was observed during surveys of the reference sites (GHD 2024b), and may occur within the subject site. Two species that are known to occur in the wider locality but were not observed during the surveys are also considered to be potentially impacted by the Development.

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Table 42: Species listed under the *EPBC Act* and/or *NPW Act* that are relevant to the development

Species (Common Name)	Conservation Status	Description and Occurrences
Observed Within Subject Site		
Actitis hypoleucos (Common Sandpiper)	*EPBC Act*: Mi *NPW Act*: R	A migratory species that breeds in the Northern Hemisphere. The species shows a preference for pebbly, sandy or rocky margins of fast-flowing rivers, as well as small ponds, pools and dams, clear freshwater lake shores, sheltered sea coasts with rocky or sandy beaches, tidal creeks and estuaries and often forages in patches of dry meadow. (Australian Museum 2020). Four individuals were observed within subject site utilising the intertidal flat within the survey area.
Anthus australis (Australian Pipit)	*EPBC Act*: Ma	This species is not threatened and is common in the region. It was observed on multiple occasions within the subject site during the baseline and targeted shorebird surveys.
Calidris acuminata (Sharp-tailed Sandpiper)	*EPBC Act*: VU, Mi, Ma	Spends the non-breeding season in Australia and is widespread in both inland and coastal locations and in both freshwater and saline habitats. In Australasia, prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh, or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans, and hypersaline salt lakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry (DCCEEW 2016). A total of 333 observations were made within the coastal swale drain / wetland during the migratory season, mostly in flocks of up to 30-50 individuals (GHD 2024b). The species utilises the site for foraging, roosting and sheltering.

Species (Common Name)	Conservation Status	Description and Occurrences
Calidris ruficollis (Red-necked Stint)	*EPBC Act*: Mi, Ma	A migratory shorebird, mostly found in coastal areas, including in sheltered inlets, bays, lagoons, and estuaries with intertidal mudflats, often near spits, islets, and banks and, sometimes, on protected sandy or coralline shores. Occasionally recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs, or shoals. They also occur in saltworks and sewage farms, saltmarsh, ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks, and pools in salt flats. They sometimes use flooded paddocks, damp grasslands, or even dry gibber plains with little or no perennial vegetation (DCCEEW 2023a). Four individuals were observed within subject site utilising the coastal swale drain / wetland within the survey area.
Haematopus fuliginosa (Sooty Oystercatcher)	*NPW Act:* R	Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries (DEH 2022). A total of 189 observations were made within the intertidal zone of the subject site.
Haematopus longirostris (Pied Oystercatcher)	*NPW Act*: R	Prefers mudflats, sandbanks and sandy ocean beaches and is less common along rocky or shingle coastlines. Although rarely recorded far from the coast, it may occasionally be found in estuarine mudflats and short pasture (Birdlife Australia 2022) A total of 146 observations were made in the intertidal zone of the subject site.
Himantopus himantopus (Black-winged Stilt)	*EPBC Act*: Ma	This species is not threatened and is common in the region. It was observed on multiple occasions within the subject site during the baseline and targeted shorebird surveys.

Species (Common Name)	Conservation Status	Description and Occurrences
Hydroprogne (Sterna) *caspia* (Caspian Tern)	*EPBC Act*: Mi	Mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries, and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers, and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks. In offshore areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs (DCCEEW n.d.). A total of 26 observations of the species were made within the intertidal zone of the subject site, with 4-8 individuals present at any one time (GHD 2024b).
Neophema elegans (Elegant Parrot)	*NPW Act*: R	Utilises a wide range of open habitats, including grasslands, shrublands, mallee, woodlands and thickets, bluebush plains, heathlands, saltmarsh, and farmland (Birdlife Australia 2021). This species was observed at three locations across the subject site during the baseline survey (GHD 2024a).
Pelecanus conspicillatus (Australian Pelican)	*EPBC Act*: Ma	This species is not threatened and is common in the region. It was observed on multiple occasions within the subject site during the baseline and targeted shorebird surveys.
Thalasseus bergii (Greater Crested Tern)	*EPBC Act*: Mi	This species is not threatened and is common in the region. It was observed on multiple occasions within the subject site during the baseline and targeted shorebird surveys.
Threskiornis molucca (Australian White Ibis)	*EPBC Act*: Ma	This species is not threatened and is common in the region. It was observed on multiple occasions within the subject site during the baseline and targeted shorebird surveys.

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Species (Common Name)	Conservation Status	Description and Occurrences
Tringa glareola (Wood Sandpiper)	*EPBC Act:* Mi, Ma	Uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools, and waterholes. Typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially *Melaleuca* and River Red Gums (*Eucalyptus camaldulensis*) and often with fallen timber. They also frequent inundated grasslands, short herbage, or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops (DCCEEW 2022a).They also frequent inundated grasslands, short herbage, or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops (DCCEEW 2022a). One individual of the species was observed utilising the coastal swale drain / wetland (GHD 2024b).
Tringa nebularia (Common Greenshank)	*EPBC Act:* EN, Mi	Inhabits wetlands, mudflats, and channels. It occurs in areas situated near or among mangroves or other sparse, emergent or fringing vegetation such as sedges or saltmarsh, and occasionally feeds amongst seagrass beds (DCCEEW 2023b). The species was observed both within the intertidal flat (one individual) as well as the coastal swale drain / wetland (seven observations of one or two individuals) within the subject site.
Tringa stagnatilis (Marsh Sandpiper)	*EPBC Act:* Mi	Found in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes (DCCEEW 2023c). Four observations of this species were made in Mutton Cove Mangrove Inlet.

Species (Common Name)	Conservation Status	Description and Occurrences
Observed at Reference Sites		
Calidris alba (Sanderling)	*EPBC Act:* Mi	Almost always found on the coast, mostly on open sandy beaches exposed to open sea-swell, and on exposed sandbars and spits and shingle banks where they forage in the wave-wash zone amongst rotting seaweed. They may also occur on beaches that may contain wave-washed rocky outcrops. Less often, the species occurs on more sheltered sandy shorelines of estuaries, inlets, and harbours. Rarely, they are recorded in near-coastal wetlands, such as lagoons, hypersaline lakes, salt ponds, and samphire flats (DCCEEW 2023d). Although the species was not identified within the subject site, suitable habitat exists for it.
Calidris subminuta (Long-toed Stint)	*EPBC Act*: Mi	Inhabits terrestrial wetlands and prefers shallow freshwater or brackish wetlands, muddy shoreline, short grass, weeds, sedges, and reeds. Uncommon at tidal estuaries and saline lakes (DCCEEW 2022b). Although the species was not identified within the subject site, suitable habitat exists for it.
Pluvialis squatarola (Grey Plover)	*EPBC Act:* VU, Mi	Occurs almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes (DCCEEW 2024). Although the species was not identified within the subject site, it was observed within reference sites, and suitable habitat exists for it.
Species with Known Occurrences and Habitat Preferences		
Acanthiza iredalei rosinae (Samphire Thornbill, Slender-billed Thornbill (Gulf St Vincent))	*EPBC Act:* VU *NPW Act:* V	Mainly restricted to chenopod shrublands, particularly samphire dominated by shrubby glasswort (*Tecticornia arbuscula*), on narrow coastal saline mudflats usually within 20 m of a tidal channel or saline lake. It mostly forages in dense, tall samphire, but occasionally forages from the surface of mud and among smaller samphire, and in grey mangrove (*Avicennia marina*) adjacent to samphire shrublands (DCCEEW 2015). The subject site contains this species' preferred vegetation only in low densities, thereby providing low-value potential habitat.

Species (Common Name)	Conservation Status	Description and Occurrences
Anhinga novaehollandiae novaehollandiae (Australasian Darter)	*NPW Act:* R	Found in wetlands and sheltered coastal waters, mainly in the tropics and sub-tropics. In South Australia, it is most often seen inland around permanent or temporary water bodies. Prefers smooth, open waters for feeding, with tree trunks and branches for drying. Can sometimes be seen in calm seas near the shore (iNaturalist 2022). Suitable habitat is present within the subject site for the species.
EPBC Act: Mi - Migratory, Ma - Marine, CR - Critically Endangered, EN - Endangered, VU - Vulnerable *NPW Act*: E - Endangered, V - Vulnerable, R - Rare.		

10.3 Noise impacts on terrestrial fauna

The impact on fauna from construction and operation of the Project has been determined for the major noise sources. Given the current paucity of detail on construction or operational activities, a conservative (worst-case) scenario has been modelled (Table 43).

To assess the impact in this case, the distance at which the noise generating activity will exceed the recommended fauna noise criteria has been determined.

Table 43: Fauna criteria exceedance distances for expected typical worst-case noise sources

Noise source	Fauna criteria	Lw, dB(A)	Exceedance distance[1], m
Vibratory Hammer Piling	93 dB(A)[2]	125	16
Compaction		109	3
Dredging		113	4
Extraction fans		106	2
Impact piling	125 dB(A)[3]	128	1

(1) Exceedance distance has been determined as an absolute distance between the source and receptor, as the receptor height is unknown and is likely to change unexpectedly.

(2) Non-strike continuous TTS

(3) Impulsive PTS

Permanent threshold shift (permanent hearing loss) and temporary threshold shift (temporary hearing loss) are considered to be unlikely for threatened fauna, as the species are all birds with the ability to relocate themselves away from sources of noise. Furthermore, extensive laboratory data show that birds are much more resistant to hearing loss, auditory damage, and decline in vocal quality from acoustic overexposure than are humans and other mammals (e.g., Ryals et al., 1999; Saunders and Dooling, 2018). This is in part because birds can regenerate the auditory hair cells of the inner ear that are responsible for hearing even after they have been damaged by intense noise exposure. Birds, unlike mammals (including humans; e.g., Lewis et al., 2016), with damaged auditory hair cells subsequently recover a good deal of their hearing and vocal precision when the damaged hair cells are naturally replaced with new hair cells (Dooling et al., 2008).

Nevertheless, the potential of noise to cause masking and physiological and/or behavioural responses in threatened fauna was also assessed. Noises can interrupt or prevent feeding during time-limited periods of foraging, roosting, resting, and breeding. High and sustained levels of disturbance such as noise can prevent shorebirds from using all or parts of their habitat (DCCEEW 2017). Shorebirds are most susceptible to disturbance during daytime roosting and foraging periods (Commonwealth of Australia 2015). Sudden, loud, or unpredictable noises are the most threatening to shorebirds (Department of Environment, Science and Innovation, Queensland Government 2021). However, some shorebirds are able to adapt to regular disturbances at predictable distances (Department of Environment, Science and Innovation Queensland Government 2021). Activities such as vibratory hammer piling, compaction, dredging, impact piling, and extraction fans have the potential to impact terrestrial fauna in two main ways, by masking and by physiological and/or behavioural responses.

Masking is the interference with the detection of a biologically relevant sound by another, usually anthropogenic, sound (Dooling, 2007). It impairs an organism's ability to communicate effectively and detect predators. Masking occurs during the production of the noise is present and does not cause damage to the hearing ability of fauna. Some birds alter the frequency of their communications to avoid masking by other noise (Francis, 2011). Additionally, like humans, birds also exhibit the Lombard effect, which means that they increase vocalisation levels in the presence of background noise (Lane and Tranel, 1971). The Lombard effect has been demonstrated in the field in various bird species (Brumm and Todt, 2002; Brumm and Zollinger, 2011) where it has been shown that birds can raise the level of their vocalisations in response to noise by as much as 10 dB (Manabe et al., 1998). Both laboratory and field data show that birds use remarkably similar[1] strategies for maximising communication in noisy environments to humans (California Department of Transportation, 2016; Dooling and Leek, 2018).

Masking is most likely to occur in the following ways:

- Noise may impact the ability to of birds that prey on fish, molluscs, or insects to detect prey.
- Noise from the Development may impact shorebirds' ability to detect predators such as foxes, feral cats, and rats. European foxes have been observed preying on shorebirds within the subject site (GHD 2024).
- Noise may interfere with breeding calls, songs and displays of bird species that depend on communication in order to detect or attract mates, and breed.

Physiological and/or behavioural responses are defined as the changes in animal physiology or behaviour that result from noises. Noise, particularly from activities that create impulsive noise, can disrupt bird foraging, roosting, and breeding behaviour and physiology, while also making them more susceptible to predators, thereby impacting their overall health, survival, and reproductive success. The most common behavioural response for birds is flight, as they perceive the noise as a threat. It is noted that the visual stimuli of humans also influence their responses (Wright, 2010). Physiological and behavioural responses are most likely to arise in the following situations:

- Species may startle or take flight away from sources of impulsive noise. This may result in disruption to feeding, roosting, or breeding.
- Non-impulsive construction noises may interfere with the breeding and nesting of resident bird species, if they occur within or adjacent to the subject site.

10.4 Noise mitigation and management for terrestrial fauna

Table 44 presents the likelihood that each of the species listed in Table 42 will be impacted by sound from the Project that results in masking or physiological and/or behavioural responses. It also proposes basic mitigation measures to avoid these impacts.

[1] Humans adopt a variety of strategies to hear better in a noisy environment (Roy and Siebein, 2019). This includes speaking louder, turning the head, moving closer, changing location, or only vocalising during pauses in the noise.

Table 44: Noise Impact Assessment on threatened species under the *NPW Act* and *EPBC Act*, as well as Migratory species under the EPBC Act

<table>
<tr><th>Species (Common Name)</th><th>Masking</th><th>Physiological and/or behavioural response</th><th>Mitigation</th></tr>
<tr><td colspan="4">Migratory and Resident Shorebirds</td></tr>
<tr><td>Actitis hypoleucos (Common Sandpiper)</td><td rowspan="6">Noise from construction or operation has the potential to interfere with foraging behaviour and the ability to detect predators for these species.</td><td rowspan="6">It is likely that the behavioural response of these species would be to take flight away from sudden, loud noises. This may disrupt their feeding or roosting.

These species do not breed in South Australia, therefore no impacts to breeding behaviour are expected.</td><td rowspan="7">• Use of designated tracks for vehicle and machinery movements.
• Minimise noise levels where practicable during the migratory bird season (September to February). This also coincides with the breeding season of Pied and Sooty Oystercatchers, which breed between September and January.
• Minimise noise within 50 m of protected areas such as Mutton Cove CP to reduce disturbance impacts to fauna utilising resources within the protected area.
• Do not start works if resident or migratory shorebirds are foraging or roosting within exceedance distances.</td></tr>
<tr><td>Calidris acuminata (Sharp-tailed Sandpiper)</td></tr>
<tr><td>Calidris ruficollis (Red-necked Stint)</td></tr>
<tr><td>Tringa glareola (Wood Sandpiper)</td></tr>
<tr><td>Tringa nebularia (Common Greenshank)</td></tr>
<tr><td>Tringa stagnatilis (Marsh Sandpiper)</td></tr>
<tr><td>Haematopus longirostris (Pied Oystercatcher)</td><td>This species is readily disturbed by human activity. Noise from construction or operation has the potential to interfere with its foraging behaviour and ability to detect predators.</td><td>It is likely that the behavioural response of this species would be to take flight away from sudden, loud noises. This may disrupt its feeding and roosting.

The species is a resident. Breeding occurs from September to December (Birdlife Australia 2022). It nests on the high-water mark on beaches, sandbars and on the margins of estuaries and lagoons. If breeding pairs are present within or adjacent to the subject site, it is likely that construction noises would interfere with breeding and nesting.</td></tr>
</table>

Species (Common Name)	Masking	Physiological and/or behavioural response	Mitigation
Haematopus fuliginosa (Sooty Oystercatcher)	Noise from the construction or operation has the potential to interfere with the species foraging behaviour and ability to detect predators.	It is likely that the behavioural response of this species would be to take flight from sudden, loud noises. This may disrupt feeding and roosting. The species breeds from August to January. If breeding pairs are present within or adjacent to the subject site, it is likely that construction noises would interfere with breeding and nesting.	
Other Species of Conservation Interest			
Neophema elegans (Elegant Parrot)	Noise from the construction or operation has the potential to interfere with the ability of this species to detect predators, particularly when foraging on the ground.	It is likely that the behavioural response of this species would be to take flight away from sudden, loud noises. This may disrupt its feeding and roosting.	• Use of designated tracks for vehicle and machinery movements. • Minimise noise within 50 m of protected areas such as Mutton Cove CP to reduce disturbance impacts to fauna utilising resources within the protected area. • Do not start works if individuals of the species are observed foraging or roosting within exceedance distances.
Acanthiza iredalei rosinae (Slender-billed Thornbill (Gulf St Vincent))	This species is readily disturbed by human activity. Noise from the construction or operation has the potential to interfere with the species' foraging and breeding behaviour, as well as its ability to detect predators.	It is likely that the behavioural response of this species would be to take flight away from the sudden, loud noises. This may disrupt its feeding and roosting. The species breeds from June to September. If breeding pairs are present within the subject site or in adjacent areas, it is likely that construction noises would interfere with breeding and nesting.	

Species (Common Name)	Masking	Physiological and/or behavioural response	Mitigation
Hydroprogne (*Sterna*) *caspia* (Caspian Tern)	Noise from the construction or operation may interfere with foraging behaviour and ability to detect predators of this species.	It is likely that the behavioural response of this species would be to take flight at sudden loud noises. This may disrupt feeding and roosting. There is minimal breeding habitat for the species on-site. Therefore no impacts to breeding behaviour are expected.	
Thalasseus bergii (Greater Crested Tern)	Noise from the construction or operation has the potential to interfere with foraging behaviour and ability to detect predators of this species.	It is likely that the behavioural response of this species would be to take flight away from sudden, loud noises. This may disrupt its feeding and roosting. There is minimal breeding habitat for the species on-site. Therefore no impacts to breeding behaviour are expected.	
Anhinga novaehollandiae novaehollandiae (Australasian Darter)	Noise from the construction or operation has the potential to interfere with foraging behaviour and ability to detect predators of this species.	It is likely that the behavioural response of this species would be to take flight away from sudden, loud noises. This may disrupt its feeding and roosting. The species breeds opportunistically in response to food and water levels. If breeding pairs are present within the subject site, it is likely that construction noises would interfere with breeding and nesting.	

10.5 Summary of noise impacts on terrestrial fauna

Noise will unavoidably result from the Development, which is surrounded by areas of preferred habitat for a variety of threatened terrestrial fauna species, most of which are migratory shorebirds. Permanent threshold shift (permanent hearing loss) and temporary threshold shift (temporary hearing loss) are considered to be unlikely, as the threatened species are all able to relocate themselves away from sources of noise.

Local conservation areas, including Mutton Cove Conservation Park, Torrens Island Conservation Park and the Adelaide International Bird Sanctuary National Park - Winaityinaityi Pangkara, will provide refuge from noise from the Project.

The noise impacts to threatened species may manifest themselves through masking and physiological and/or behavioural response. Noise from the Development may result in complete avoidance of the foraging and roosting areas within the subject site. However, noise impacts on terrestrial fauna are not expected to be significant for the following reasons:

- Threatened species are unlikely to remain in the subject site once habitats have been cleared for the Development.
- The duration of impacts will be limited to noisy construction activities and will return to baseline levels once they are completed.
- The scale of direct noise impacts will affect only individuals within the exceedance distances of threatened fauna, rather than populations.
- Species are mobile and have the ability to move away into nearby suitable habitat.

Implementation of mitigation measures will reduce risk of impact to individuals and indirect impacts to species (Table 44).

11 Marine fauna noise assessment

11.1 What is underwater noise?

Sound is an acoustic pressure wave that travels through a medium, such as water or air, and occurs as an oscillatory motion of the water or air particles driven by a vibrating source. The magnitude of the water or air particle motion determines the intensity of the sound. The rate at which the water or air particles oscillate determines its frequency, given in cycles per second or Hertz (Hz).

Sound travels about four-and-a-half times faster in water than in air. The absorption of sound at frequencies where man-made noise generally has the most energy is much smaller in water than in air. As a result, noise is typically audible over much greater ranges underwater than in air. Most sources of noise, including pile driving, and movement of large shipping vessels generate acoustic energy over a broad range of frequencies. Screeching or whistling noises are composed mainly of high frequency sounds while rumbles or booms are composed mainly of low frequency sounds.

Sounds are usually characterized according to whether they are continuous or impulsive in character. Continuous sounds occur without pauses and examples include shipping noise and dredging. Impulsive sounds are of short duration and can occur singularly, irregularly, or as part of a repeating pattern. Blasting represents a single impulsive event whereas the periodic impacts from a pile driving rig results in a patterned impulsive sequence. Impulsive signals typically sound like bangs and generally include a broad range of frequencies.

11.1.1 Overview of noise effects

The following provides a brief overview of the effects that may occur because of an animal being exposed to underwater noise. Consideration of this information, together with information on the biological importance of the habitat for the considered species, e.g. breeding, calving or resting areas, or confined migratory routes or feeding areas, is used to assess the likely impact of a noise source.

- Risk of fatality – When exposed to significant noise levels, either immediate mortality or tissue and/or physiological damage can result. The injury may be sufficiently severe that death occurs sometime later due to decreased fitness. Mortality can also have a direct effect upon animal populations, especially if it affects individuals close to maturity. Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.
- Hearing injury – Short or long term changes in hearing sensitivity (TTS or PTS) may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, as well as cause deterioration in communication between individuals. This may affect growth, survival, and reproductive success.
- Masking – The presence of man-made sounds may make it difficult to detect biologically significant sounds against the noise background. Masking of sounds from predators may result in reduced survival. Masking of sounds used for orientation and navigation may affect the ability to find preferred habitats and in the case of fish, spawning areas, affecting recruitment, growth, survival, and reproduction.
- Behavioural responses – Behavioural responses may cause displacement from preferred habitats, which could affect feeding, growth, predation, survival, and reproductive success (if a mammal is displaced from preferred habitat).

Figure 28 acknowledges that the severity of noise effects relates to distance from the noise source, however, note that the ‘zones’ of hearing injury, masking and behavioural response may overlap. Overlap, results, from comparing cumulative sound exposure threshold metrics with single event peak or behavioural sound level metrics.

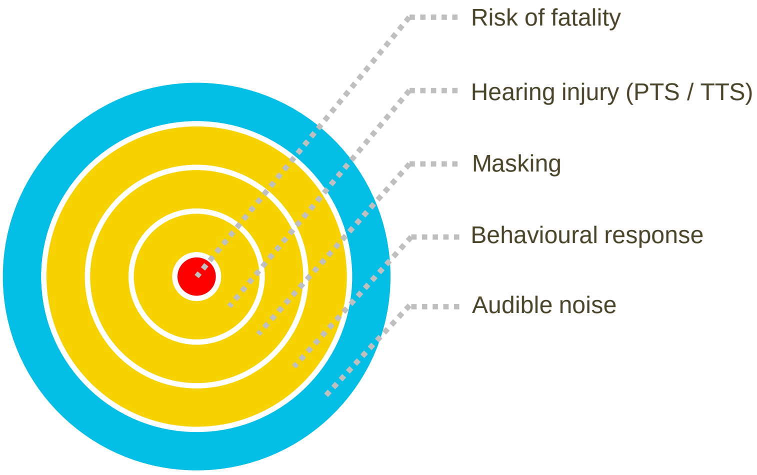

Figure 28Overview of potential noise effects upon marine fauna (source: DIT)

11.2 Significant marine fauna

A marine ecological assessment has been undertaken by J Diversity (2023). Table 45 provides an overview of the Matters of National Environmental Significance (MNES) and other species of significance identified by J Diversity (2023) within 5 km of the Outer Harbor breakwaters. Furthermore, Succession Ecology (2024) reviewed the J Diversity (2023) report and identified that a total of five threatened or protected marine fauna species under the EPBC Act and/or NPW Act were identified as *possible, likely or certain* to be impacted by the Development.

Those species highlighted in **bold** are listed as MNES. Species that are not protected by the EPBC, NPW Act and FM Act have not been listed. Species with a 'rare' SA status only are also not listed. In relation to other species, all Syngnathids (fish) are listed under the FM Act and the remaining are listed under the NPW Act.

Table 45: List of significant species recorded within 5 km of the Outer Harbor breakwaters (Succession Ecology 2024)

Types of species	***EPBC Act* and/or *NPW Act* species identified as possible, likely or certain to be impacted by the Development – Succession Ecology (2024)**
Fish	
Pipefish (*Syngnathinae*)	×
Seahorses (*Hippocampus abdominalis* and *breviceps*)	×
Seadragon (*Phyllopteryx taeniolatus*)	×
Sharks	
White Shark (*Caracharondon carcharias*)	×
Mackerel Shark (*Lamna nasus*)	×
Marine Turtles	
Loggerhead Turtle (*Caretta caretta*)	×
Green Turtle (*Chelonia mydas*)	×

Types of species	*EPBC Act* and/or *NPW Act* species identified as possible, likely or certain to be impacted by the Development – Succession Ecology (2024)
Leatherback Turtle (*Dermochelys coriacea*)	×
Pacific Ridley Turtle (*Lepidochelys olivacea*)	×

Table 46: List of significant marine mammals recorded within 5 km of the Outer Harbor breakwaters (Succession Ecology 2024)

Marine Mammals	*EPBC Act* and/or *NPW Act* species identified as possible, likely or certain to be impacted by the Development – Succession Ecology (2024)
Low Frequency Cetaceans	
Humpback Whale (*Megaptera novaeangliae*)	×
Southern Right Whale (*Eubaleana australis*)	×
Pygmy Right Whale (*Caperea marginata*)	×
Bryde's Whale (*Balaenoptera edeni*)	×
High Frequency Cetaceans	
Common Dolphin, Short-beaked Common Dolphin (*Delphinus delphis*)	✓
Indian Ocean bottlenose dolphin (*Tursiops aduncus*)	✓
Common bottle-nosed dolphin (*Tursiops truncatus*)	✓
Dusky Dolphin (*Lagenorhynchus obscurus*)	×
Killer Whale (*Orcinus orca*)	×
Sperm Whale (*Physeter macrocephalus*)	×
Pinnipeds – Other Carnivores	
Australian Sea Lion (*Neophoca cinerea*)	✓
Subantarctic fur seal (*Arctocephalus tropicalis*)	×
Long-nosed fur seal (*Arctocephalus forsteri*)	✓
Australian fur seal (*Arctocephalus pusillus*)	×
Pinnipeds – Phocid Carnivores	
Leopard seal (*Hydrurga leptonyx*)	×

The following sections (0 to 11.2.4) discuss the hearing sensitivity for each of the species listed above for assessment completeness and context.

11.2.1 Fish and sharks

All fishes have ears to detect sound and convey sensitivity to gravity and to linear and angular acceleration (Popper et al. 2014). The adaptations that provide fish with additional sensitivity to sound pressure are gas-filled structures near the ear and/or extensions of the swim bladder that functionally affect the ear. The enclosed gas changes volume in response to fluctuating sound pressure, generating particle motion.

In fishes where the swim bladder is near the ear (or connected to it mechanically as in the *Otophysi)*, the particle motion radiated from the bladder is sufficiently large to cause the sensory epithelium to move relative to the otolith. Fishes with these adaptations generally have lower sound pressure thresholds and wider frequency ranges of hearing than do the purely particle motion-sensitive species.

Conversely, fish species that lack a gas-filled cavity, including sharks, are not as vulnerable to trauma from extreme sound pressure changes as fish with a gas-filled space. This difference has been demonstrated by comparing the effects of pile driving sounds on fishes with and without a swim bladder (Halvorsen et al. 2012c).

Hearing abilities among sharks have demonstrated highest sensitivity to low frequency sound (40Hz to approximately 800Hz), which is sensed solely through the particle-motion component of an acoustical field. Free-ranging sharks are attracted to sounds possessing specific characteristics: irregularly pulsed, broad-band (most attractive frequencies: below 80Hz), and transmitted without a sudden increase in intensity. Such sounds are reminiscent of those produced by struggling prey. A sound, even an attractive one, can also result in immediate withdrawal by sharks from a source, if its intensity suddenly increases 20 dB or more above a previous transmission (Myrberg 2001).

11.2.2 Marine turtles

Data on hearing of marine turtles is very limited. Electrophysiological studies on hearing have been conducted on juvenile green sea turtles, juvenile Kemp's Ridleys, and on juvenile loggerheads. Ridgway et al. (1969) obtained an auditory evoked potential (AEP) audiogram to aerial and vibrational stimuli that extended from below 100 Hz to 2000 Hz with the lowest threshold at 400 Hz. Other studies using AEPs found similar low-frequency responses to vibrations delivered to the tympanum (the external ear on the surface of the head) for the loggerhead sea turtle, and to underwater sound stimuli for the loggerhead, Kemp's Ridley, and green sea turtles.

Martin et al. (2012) measured underwater thresholds in the loggerhead sea turtle (*Caretta caretta*) by both behavioural and AEP methods. Behavioural sensitivity showed the lowest thresholds between 100 and 400 Hz, with thresholds at about 100 dB re 1 μPa. AEP measurements on the same individual were up to 8 dB higher; however, both techniques showed a similar frequency response and a high frequency loss of sensitivity above 400 Hz of about 37 dB per octave. These results are presented in Figure 29.

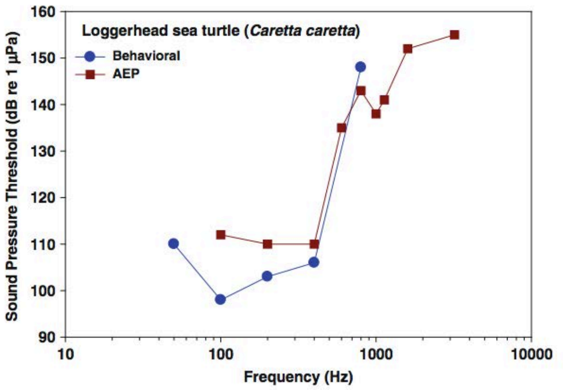

Figure 29: Behavioural and auditory evoked potential thresholds for the Loggerhead sea turtle (Martin et al. 2012)

Resonate

Morphological examinations of green and loggerhead sea turtles (Ridgway et al. 1969; Wever 1978; Lenhardt et al. 1985) describe the sea turtle as having a typical reptilian ear with a few underwater modifications, supporting the proposal that fish hearing, rather than mammalian hearing, is the better model to use for sea turtles until there are much more data.

11.2.3 Marine mammal sounds

Marine animals live in an environment in which vision is not the primary sense because light does not penetrate far beneath the surface of the ocean. As such, marine mammals have become reliant upon sound, instead of light, as their primary sense for communication and being aware of their surrounding environment. Marine mammal communication has a variety of functions such as intra-sexual selection, mother/calf cohesion, group cohesion, individual recognition and danger avoidance.

Baleen whales produce sounds that are primarily at frequencies below 1kHz and have durations from approximately 0.5 to over 1 second and sometimes much longer (Richardson et al. 1995). Humpback whales and some other species produce sounds with frequencies above 1kHz. Many baleen whale sounds are uncomplicated tonal moans or sounds described as knocks, pulses, ratchets, thumps, and trumpet-like. Blue whales for example produce low frequency moans in the frequency range of 10-15Hz.

Pinnipeds, including hair and eared seals and sea lions, produce underwater vocalisations sounding like barks and clicks with frequencies ranging from below 1kHz to 4kHz (Richardson et al. 1995). Pinnipeds are especially vocal during the breeding season.

Bottlenose dolphins make many different sounds that have been recorded and described by researchers for over 60 years. This species, *Tursiops truncatus*, has the ability to hear and produce sounds over a range of at least 150 kilohertz (kHz). Although human hearing is limited in bandwidth to less than 20 kHz, dolphin sounds have historically been described as humans perceive them e.g. whistles, squeals, buzzes, barks, quacks, pops, etc. (Jones et al. 2019).

In summary, baleen whales produce sounds that are dominant at frequencies that overlap with man-made industrial noise (e.g. drilling). In contrast, the social sounds produced by pinnipeds and dolphins (toothed whales) occur above the low-frequency range where most man-made sounds have their dominant energy (with the exception of sonar).

11.2.4 Marine mammal hearing sensitivity

The hearing sensitivity of marine animals generally varies with frequency. Audiograms are therefore used to represent an animal's sensitivity to sounds of different frequencies. An audiogram of a species relates the absolute threshold of hearing (in dB re 1μPa) of that species to frequency. An animal is most sensitive to sounds at frequencies where its absolute threshold of hearing is lowest. As an example, human beings are most sensitive to sounds between 2-4kHz where the absolute threshold is lowest.

Substantial progress has been made in quantifying marine mammal hearing and the effects of noise on hearing for a range of taxa since the review provided by Southall et al. (2007). Southall et al. (2019), in light of subsequent scientific findings over the past decade, presents estimated audiograms for six species groupings, including all marine mammal species. In-air audiograms are also provided for amphibious species.

The intent of Southall et al. (2019) was to provide the best scientific interpretation and application of the available information within different marine mammal hearing groups while acknowledging data limitations for specific topics and for some hearing groups. However, substantial uncertainties and data gaps remain in understanding marine mammal hearing (Southall et al. 2019).

The following sections briefly summarise the audiograms that relate to specific hearing groups of marine mammals considered in this assessment.

Resonate

Low Frequency Cetaceans

With reference to Table 46, the low frequency (LF) cetaceans relevant to this study include:

- Humpback Whale (*Megaptera novaeangliae*)
- Southern Right Whale (*Eubaleana australis*)
- Pygmy Right Whale (*Caperea marginata*)
- Bryde's Whale (*Balaenoptera edeni*).

The Southall et al. (2019) estimated audiogram for this hearing group is presented in Figure 31.

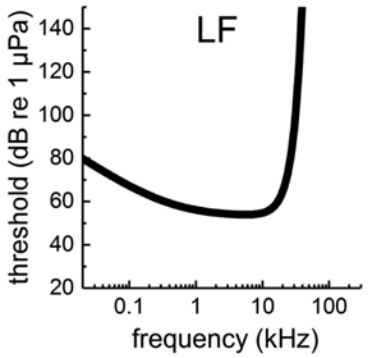

Figure 30: Estimated group audiogram for low-frequency (LF) cetaceans (Southall et al., 2019)

In relation to the audiogram presented in Figure 30, Southall et al. (2019) advise that no direct hearing data (behavioural or electrophysiological) were available at any frequency for any species. That is, there are no comprehensive, directly measured audiograms for any baleen whale from which an estimate of the LF cetacean group audiogram can be made (as was with all the other hearing groups), where an alternative approach was adopted. Nevertheless, the presented audiogram represents the latest scientific understanding for this hearing group.

Baleen whale vocalisations are low in frequency content for a number of species, and the frequency range of acute hearing presumably includes the frequency range of vocalisations. From behavioural observations, it is apparent that baleen whales are quite sensitive to frequencies below 1kHz, but can hear sounds up to a considerably higher but unknown frequency (Richardson et al*.* 1995).

The audiogram in Figure 30 indicates that the frequencies where the hearing is most sensitive ranges from 100Hz to 10kHz.

High Frequency Cetaceans

With reference to Table 46, the high frequency (HF) cetaceans relevant to this study include:

- Common Dolphin, Short-beaked Common Dolphin (*Delphinus delphis*)
- Indian Ocean bottlenose dolphin (*Tursiops aduncus*)
- Common bottle-nosed dolphin (*Tursiops truncatus*)
- Dusky Dolphin (*Lagenorhynchus obscurus*)
- Killer Whale (*Orcinus orca*)
- Sperm Whale (*Physeter macrocephalus*).

The Southall et al. (2019) estimated audiogram for this hearing group is presented in Figure 31.

Resonate

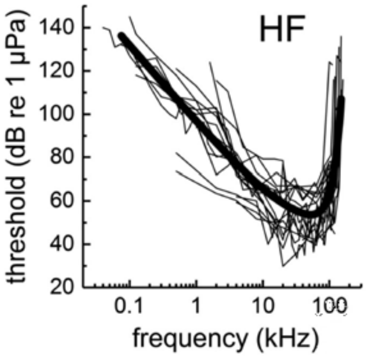

Figure 31: Estimated group audiograms based on original behavioural threshold data for high-frequency (HF) cetaceans (Southall et al., 2019).

The audiogram in Figure 31 indicates that the frequencies where the hearing is most sensitive for this group ranges from 8kHz to 100kHz. Note that noise from shipping, drilling and piling activities occur predominantly in the frequency region where the high frequency cetaceans hearing is the least sensitive.

Pinnipeds

Pinnipeds, comprise the extant families *Odobenidae* (walrus), *Otariidae* (the eared seals: sea lions and fur seals), and *Phocidae* (the earless seals, or true seals). The relevant species to this study can be split into two hearing groups (Southall et al., 2019), namely ‘Phocid Carnivores’ and ‘Other Carnivores’.

Phocid Carnivores (PC):

- Leopard seal (*Hydrurga leptonyx*)

Other Carnivores (OC):

- Australian Sea Lion (*Neophoca cinerea*)
- Subantarctic fur seal (*Arctocephalus tropicalis*)
- Long-nosed fur seal (*Arctocephalus forsteri*)
- Australian fur seal (*Arctocephalus pusillus*).

The audiograms for Phocid Carnivores in water/air (PCW / PCA) and Other Carnivores in water/air (OCW / OCA) are presented in Figure 32 and Figure 33.

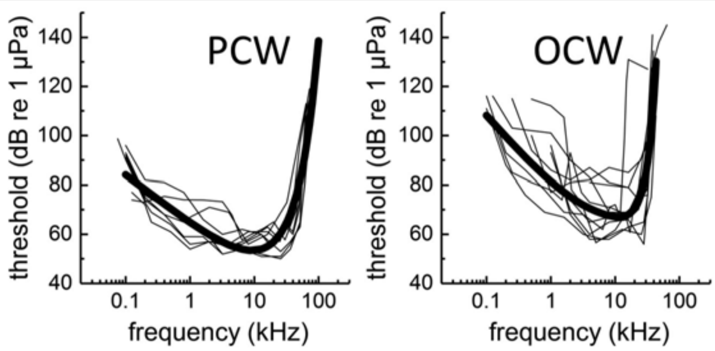

Figure 32: Estimated group audiograms based on original behavioural threshold data for phocid carnivores in water [PCW] and other carnivores in water [OCW] (Southall et al., 2019)

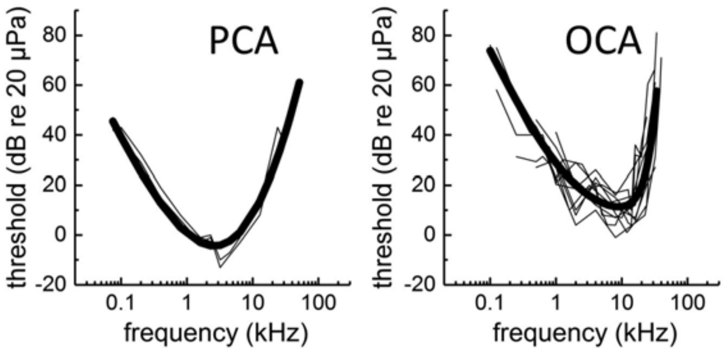

Figure 33: Estimated group audiograms based on original behavioural threshold data for phocid carnivores in air [PCA] and other carnivores in air [OCA] (Southall et al., 2019)

The audiograms indicate that phocid carnivores are generally more sensitive over a wider frequency range than other carnivores in both water and air. Phocid carnivores are also more sensitive to the lower frequencies where piling and shipping noise emissions are mostly dominant. Of note, the maximum hearing sensitivity of phocid carnivores is 10 kHz in water and 3 kHz in air, while other carnivores are similar at around 10 kHz in both water and air. Furthermore, both species have greater hearing sensitivity in water than in air, particularly at lower frequencies.

In comparison to toothed whales (i.e. high frequency cetaceans), pinnipeds generally tend to have maximum hearing sensitivity at lower frequencies and therefore more able to hear man-made noise.

11.3 Construction noise source characterisation

As described above, the construction activities likely to impact the marine environment include dredging and piling and to a lesser extent, support vessel movements.

11.3.1 Dredging

At the time of preparation of this assessment, the proposed dredge method had not been confirmed. However, for localised dredging along the shoreline it is envisaged that a backhoe dredge will be utilised for dredging works.

A focused literature review undertaken by McQueen et. al. (2019) summarised that underwater dredging sounds are typically low-intensity (i.e. sound pressure levels [SPLs] <190 dB re 1μPa^2 at 1 m) and non-impulsive, with frequencies below 1,000 kHz. Dredging sound exposure characteristics, in terms of SPLs and frequencies, are similar to sounds emanating from commercial ship traffic (i.e. vessel propulsion). For this assessment, the following source levels have been adopted:

- SEL = 175 dB re 1μPa^2 m^2 s at 1 m
- SPL RMS = 175 dB re 1μPa^2 at 1 m.

Figure 34 provides an overview of the underwater sounds generated by backhoe dredging activities.

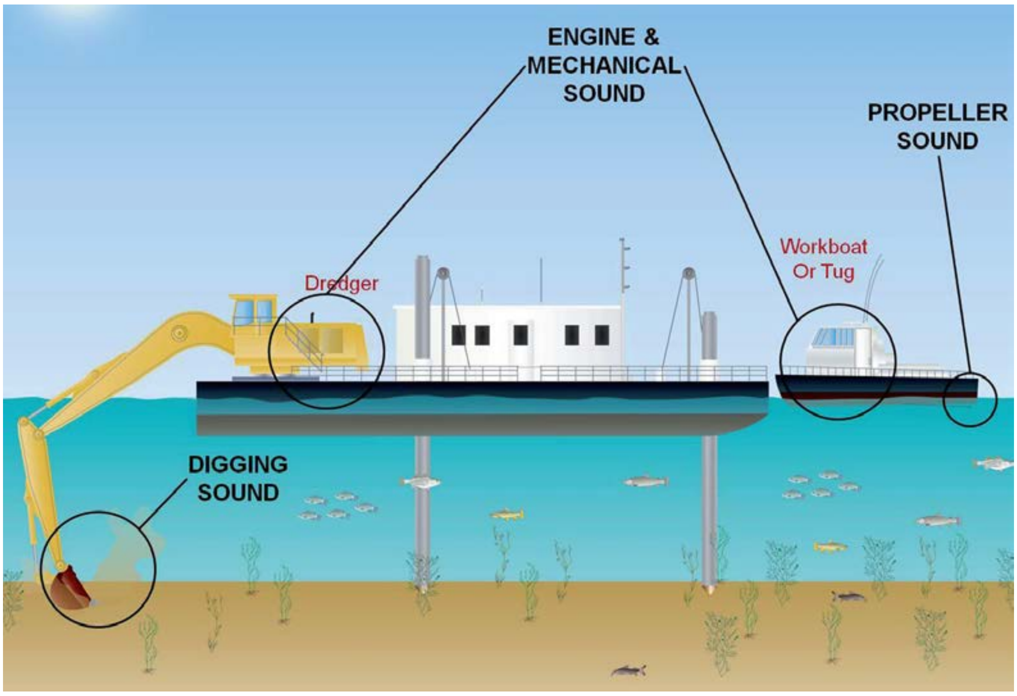

Figure 34: Backhoe dredging noise sources (CEDA, 2011)

11.3.2 Piling

At the time of this assessment, limited details are available regarding the sheet piling design for the site. This assessment therefore considers a worst-case design option which involves sheet pile driving in the water.

Pile driving techniques include impact pile driving, where a pile is hammered into the ground by a hydraulic ram, and vibro-driving, where rotating eccentric weights create an alternating force on the pile, vibrating it into the ground.

- Impact piling – Impulsive in character with multiple pulses occurring at blow rates in the order of 30 to 60 impacts per minute. Typical source levels range from SEL 170–225 dB re 1 µPa^2·s for a single pulse, and peak level 190–245 dB re 1 µPa^2. Most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz. Factors that influence the source level include the size, shape, length and material of the pile, the weight and drop height of the hammer, and the seabed material and depth.
- Vibro-driving – Continuous in character and usually of a much lower level than impact piling. Typical source levels range from SPL 160–200 dB re 1 µPa^2, with most of the sound energy occurring between 100 Hz and 2 kHz. Strong tones at the driving frequency and associated harmonics may occur with the driving frequency typically ranging between 10 and 60 Hz. Sound propagation at such low frequencies is often poor in shallow water environments, such that the tones may not be noticeable at greater distances from the source.

Sheet piles are likely to be installed using a vibratory hammer (i.e. vibro-driving) fitted to a 150T crawler crane (or similar). In the event that the vibratory hammer cannot penetrate the pile into a rock layer, an impact hammer could also be mobilised to install the sheet pile to the correct depth.

Summaries of measured sound pressure data for vibro-driving sources are presented in Table 47 (Burgess et al. 2006; URS 2007; Illinworth & Rodkin 2007; Stadler et al. 2009).

Table 47: Comparison of sound pressure levels for pile driving using vibratory hammers

Vibratory Hammer	Drive Force	Pile Type	Distance from Pile (m)	Relative Water Depth (m)	Maximum Received Levels		
					SEL (dB re 1 µPa²s)	RMS (dB re 1 µPa²)	Peak (dB re 1 µPa²)
APE 200	202 US ton	Sheet pile	15	10	-	169	189
APE400B	362 US ton	0.6m AZ Sheet pile	10	15	165	165	182
APE400B	362 US ton	Sheet pile	56	18	-	162	-

It is recognised that the adopted vibro hammer for the Project is likely to be smaller than those presented in Table 47 , i.e. with a driving force in the order of 50 – 70 tonnes.

Table 48 provides a summary of measured sound pressure data for an impact sheet piling source obtained from Rodkin & Pommerenck (2014) for sheet steel and steel and concrete piles at indicative diameters. Note that the tabulated data relates to a single pile blow only.

Table 48: Summary of near-source (10m) sound pressure levels for pile driving using an impact hammer

Pile size (m)	Pile Type	Relative water depth (m)	Sound pressure levels level at near-source (10m) per hammer blow		
			SEL (dB re 1 µPa² s)	RMS (dB re 1 µPa²)	Peak (dB re 1 µPa²)
0.61	AZ steel sheet	~15	180	205	205
0.36	Steel Pipe Pile	~15	174	184	200
0.61	Steel Pipe Pile	~15	178	194	207
0.61	Steel Pipe Pile	~5	177	190	203
0.3	Concrete Pile	Land based	146	-	176
0.46	Concrete Pile	<3	155	166	185
0.61	Concrete Pile	~5	160	170	185
0.61	Concrete Pile	~15	166	176	188

In summary, the impact piling of sheet piles generates a 15 dB higher SEL than vibro-driving. Furthermore, the adoption of concrete tubular piles as opposed to steel tubular piles results in a significantly lower underwater noise emission (ie.12 – 17 dB reduction) if practical. For the purposes of this study, steel sheet piles have been adopted to present a worst case scenario.

11.3.3 Vessels

The underwater noise associated with construction will vary significantly depending on the type of vessels used and how they are operated. The range of noise from boats is generally SEL 110 to 195 dB re 1 µPa^2 m^2 s at 1m. A source level of 170 dB re 1 µPa^2 m^2·s at 1m has been assumed for this assessment and is considered to represent the upper range of expected vessels.

11.3.4 Operational noise

Submarines are designed to operate as quietly as possible to avoid detection. Marine operational noise associated with the facility has, therefore, not been assessed.

Resonate

11.4 Modelling methodology

11.4.1 Basic principles

An underwater noise model can predict the sound propagation loss (PL) between the source and a receiver. The source level (SL) of the considered noise source and the predicted PL in a particular direction is used to predict the sound pressure level (SPL) at the receiver location as SPL = SL – PL.

Factors that determine the propagation loss are discussed below.

- *Spherical spreading* – Along the direct path between the source and the receiver, spherical spreading of the sound energy causes the noise level to drop off at $20\log_{10}$ (R) with R the distance from the source.
- *Reflection, absorption, scattering and refraction* – The transmission path is often not only the direct path between the source and receiver. Multiple transmission paths can occur due to reflections from the surface and seafloor. A rough surface or seafloor causes scattering of the source noise, and some of the noise impacting on the seafloor is absorbed. Temperature variations in the water column cause refraction of sound. These transmission loss mechanisms are generally frequency-dependent and depend on the seafloor geo-acoustic properties and the surface and seafloor roughness.
- *Substrate-borne sound* – When impact pile driving is the sound source, there is the potential for substrate-borne sound caused when the hammer strikes the pile to be re-radiated back into the water. This can significantly complicate the prediction of sound to any point within the water column and potentially degrade the effect of a bubble curtain or coffer dam in shallow water.
- *Total transmission loss* – The combination of the various transmission loss mechanisms gives a total transmission loss that may be smaller than due to spherical spreading alone, especially in shallow water environments. For example, this occurs when surface and seafloor reflected sound waves interfere at the receiver location such that the noise level is increased, i.e. the transmission loss is reduced.

Given the complexities described above, empirical data rather than mathematical models are generally used to predict the propagation of sound in shallow water environments. For this assessment, the following modelling methodology has been adopted in accordance with the *Underwater Piling and Dredging Noise Guidelines*.

The auditory weighted levels for marine mammals have been calculated in accordance with Southall et al. 2019 assuming a weighted factor adjustment frequency (defined as the upper frequency below which 95% of total cumulative energy is contained) of:

- 2 kHz for impact piling
- 2 kHz for dredging
- 2.5 kHz for vibratory pile driving.

The underwater noise propagation models assume:

- Sound propagation for impact piling based on Lippert et al. (2018), which adopts a damped cylindrical spreading (DCS) sound propagation model. The DCS modelling assumptions are:
  - Worst case grazing angle (mach cone angle) of 17 degrees.
  - Horizontal decay rate based on the plane wave reflection coefficient of sand.
- Vibratory pile driving adopts a conservative $10\log_{10}(r_1/R_1) + 15\log_{10}(r_2/R_2)$, where R_1=Range ≤ 100 m and R_2=Range > 100 m. r_1 = 10m and r_2=100 m.
- Dredging adopts $15\log_{10}(1/R)$, where R=Range.

Detailed underwater noise modelling that factors bathymetry information and sediment conditions has not been undertaken due to lack of information available at this stage of the project.

11.4.2 Study area bathymetry

The light passage river channel area which traverses the site (shown in Figure 35) has a maintained depth of 9.3 m below the lowest astronomical tide. For the purposes of this assessment, noting that the mean high spring tide is 2.4 m, the water depth has been assumed at 12 m.

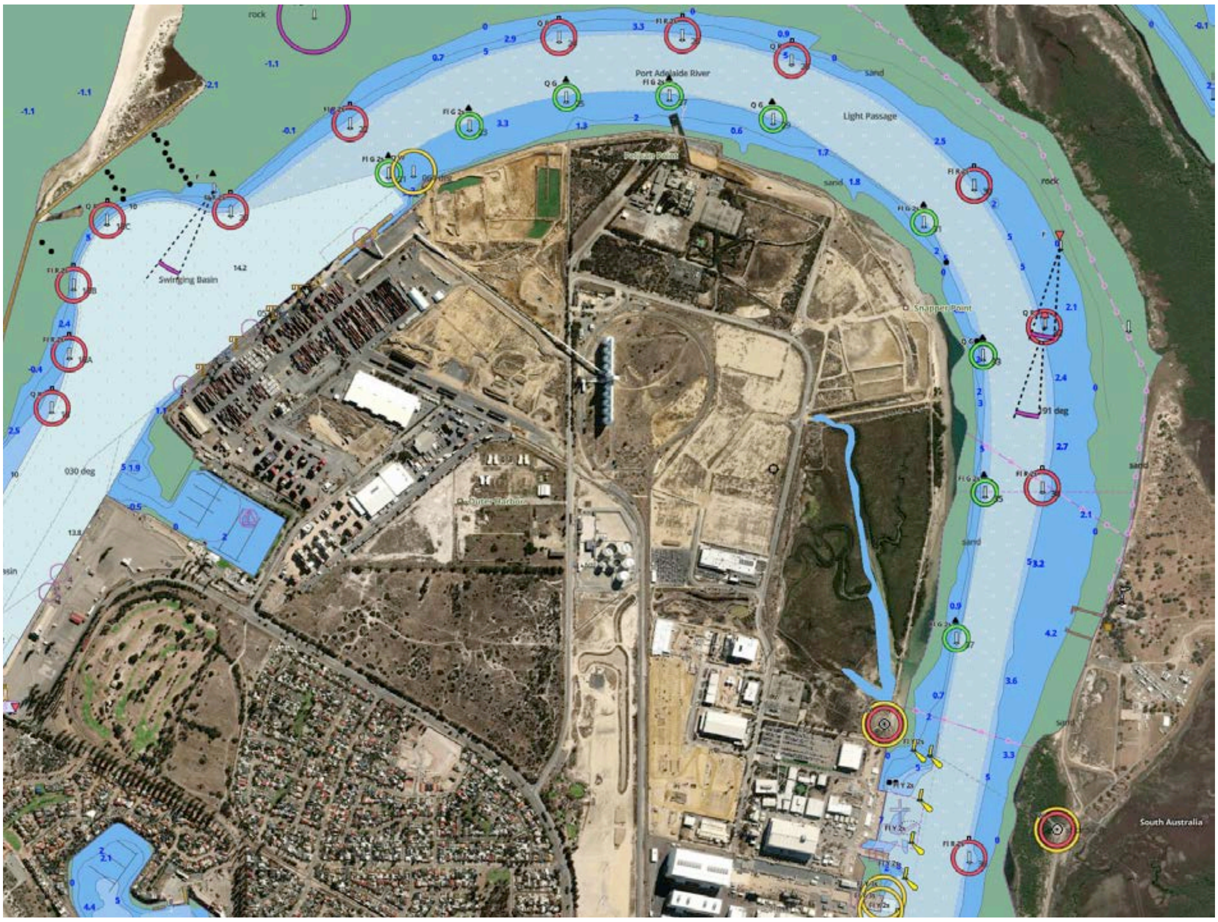

Figure 35: Port River bathymetry (Source: i-Boating nautical map used under licence from Australian Hydrographic Office)

11.5 Construction works modelling results

In relation to the envisaged construction methodology, impact piling is anticipated to be the highest-energy source of underwater noise during the construction and/or operation of the Project. Noise from impact piling will be considerably louder than the ambient underwater noise environment in the vicinity of the piling. Furthermore, the impacts from dredging and vessel movements have also been assessed.

11.5.1 Dredging

The predicted noise impact from dredging activities on marine mammals, fish, sharks and marine turtles based on worst case emissions (i.e. backhoe dredge) are presented below.

Fish, sharks and marine turtles

The adopted marine noise criteria has objective ‘continuous (non-impulsive)’ noise criteria for fish with swim bladders only i.e. TTS = 158 dB rms for 12 hours and PTS = 170 dB rms for 48 hours.

This means, that for dredging with an SPL source level of 175 dB re 1 μPa^2 at 1 m:

- TTS could occur at distances < 14 m under the assumption of a continuous 12-hour exposure
- PTS could occur at distances < 3 m under the assumption of a continuous 48-hour exposure.

Given the above predictions, the potential for permanent physiological injury is low, particularly in the understanding that a behavioural response to avoid higher noise levels is likely (Popper et al. 2014).

Marine mammals

Although the dredge is likely to operate over a full day, our calculations have assumed that the dredge would have no more than an equivalent 4 hour exposure over a 24 hour period upon marine mammals moving in the vicinity of Project area.

Table 49: Predicted dredging weighted distance to TTS/PTS in water for marine mammals

Hearing Group	Exposure time within a 24 hour period	Weighted distance to TTS/PTS criteria compliance (m)	
		TTS	**PTS**
Low Frequency (LF) Cetaceans	15 minutes	55	3
	60 minutes	130	6
	2 hours	210	10
	4 hours	**320**	**15**
	15 hours	780	40
High Frequency (HF) Cetaceans	15 minutes	3	0
	60 minutes	7	0
	2 hours	10	0
	4 hours	**16**	**0**
	15 hours	40	3
Pinnipeds – Phocid Carnivores in water (PCW)	15 minutes	27	2
	60 minutes	70	4
	2 hours	110	6
	4 hours	**180**	**8**
	15 hours	420	20
Pinnipeds – Other Carnivores in Water (OCW)	15 minutes	2	0
	60 minutes	5	0
	2 hours	8	0
	4 hours	**13**	**0**
	15 hours	35	2

(1) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

The results indicate that the effect on marine mammals relates to the length of exposure time, which also relates to the mobility of the animals in the area during dredging activities.

The greatest impact potential is on low frequency cetaceans and phocid carnivores, given their increased hearing sensitivity at low frequencies. For these species, prolonged exposure (i.e. > 15 minutes) at distances of 3 m or less from the dredging noise source may cause permanent hearing injury, which is considered unlikely given the required small exposure distances from the dredge. Temporary hearing injury could occur for these mobile animals for 15 minutes exposure within approximately 27 to 55 m, or 420 to 780 m for 15 hours exposure. Therefore, the potential for hearing injury would depend on the direction of travel and behavioural response to the noise.

Permanent or temporary physiological impacts are unlikely to occur for low or high frequency cetaceans and other carnivores given the short distances to meet the adopted criteria relative to the mobility potential of the animal and likely behavioural response to the noise.

11.5.2 Vibratory sheet piling

Our assessment has assumed that 50 piles will be vibro-driven in the water for a duration of 1 minute each within a 24 hour period with the addition of impact piling if required to ensure the sheet pile is driven to the correct depth (should hard/dense soil substrates be encountered).

Fish, sharks and marine turtles

Similarly, to the dredging (refer Section 11.5.1), vibro-driving is considered a continuous non-impulsive noise source. This means, that for a source level of 163 dB re 1 μPa^2 at 10 m, the predicted physiological impacts are:

- TTS could occur at distances < 35 m under the assumption of a continuous 12 hour exposure
- PTS could occur at distances < 2 m under the assumption of a continuous 48 hour exposure.

Given the above predictions, the potential for permanent physiological injury is low, particularly in the understanding that a behavioural response to avoid higher noise levels is likely (Popper et al., 2014).

Marine mammals

Table 50 provides cumulative SEL comparisons versus exposure time and distance to meet the adopted criteria for marine mammals.

Table 50: Marine mammals weighted distance to TTS/PTS – Vibro driven sheet piling

Hearing Group	Exposure time within a 24 hour period	Weighted distance to TTS/PTS criteria compliance (m)	
		TTS	PTS
Low Frequency (LF) Cetaceans	50 minutes	390	8
High Frequency (HF) Cetaceans	50 minutes	16	1
Pinnipeds – Phocid Carnivores in water (PCW)	50 minutes	240	4
Pinnipeds – Other Carnivores in Water (OCW)	50 minutes	7	1

(1) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

The greatest impact potential is on low frequency cetaceans and phocid carnivores, given their increased hearing sensitivity at low frequencies. For these species, even with a 50 minute exposure time, the potential for permanent hearing injury is considered negligible, given the very short distances in comparison to the mobility potential of the animals. The potential is even less for high frequency cetaceans and other pinniped carnivores.

Furthermore, the potential for temporary hearing impacts is possible for phocids and low frequency cetaceans remaining within approximately 400 m of vibro-driving, however given the mobility potential of these animals, particularly for migratory low frequency cetaceans, this is considered unlikely. The potential for temporary hearing impacts for high frequency cetaceans and other pinniped carnivores is considered unlikely given the significantly shorter distances in comparison to the mobility potential of these animals.

Pinnipeds in air

Given that pinnipeds are amphibious, the airborne exposure also needs to be considered, particularly for impact piling. The predicted results for air borne noise exposure results are presented in Table 54. Note that the airborne noise level drops off at 20 $\log_{10}(r)$ with r the distance from the source and the dB level relates to a different reference pressure i.e. 20 µPa (air) instead of 1 µPa (water).

The predicted results for pinnipeds in air are presented in Table 51.

Table 51: Pinnipeds weighted distance to TTS/PTS in air – Vibro driven sheet piling

Hearing Group	SPL (RMS) [1] dB re 20 µPa at 1 m	Exposure time within a 24 hour period	Weighted Cumulative SEL @ 1m (dB re 20 µPa^{2}s)	Weighted distance to PTS criteria compliance (m) [20logR propagation]	
				TTS	PTS
Phocid Carnivores in Air (PCA)	130	50 minutes	163	-	-
Other Carnivores in Air (OCA)	130		164	-	-

(1) SPL derived from BS 5228-1 2009 for vibratory sheet piling.

(1) Weighting factor adjustment 2.5 kHz determined in accordance with Southall et al. 2019

(2) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

The results indicate a nil potential noise exposure impact on pinnipeds in air.

11.5.3 Impact sheet piling

To calculate the cumulative SEL (SEL_{24}), the number of pile blows needs to be considered. This is calculated using the following equation.

$$SEL\ cumulative = SEL\ single\ blow + 10log(total\ number\ of\ blows)$$

The following sections provide the cumulative SEL comparisons versus exposure time and distance to meet the noise criteria. Our calculations have assumed sheet steel pile being driven with a source level of 180 dB re 1 µPa^{2}s water at 10 m.

The following predictions assume an equivalent exposure time of 1 minute up to 4 hours (i.e. 7200 hammer blows) of cumulative piling noise over a 24-hour period. It is estimated that the number of sheet piles that may require to be driven by an impact hammer is the equivalent of one fully driven pile per day, that is, approximately 1800 hammer blows.

Fish, sharks and marine turtles

The following predictions presented in Table 52 calculate the impact of various exposure times of cumulative piling noise over a 24-hour period on fish, sharks and marine turtles.

Resonate

Table 52: Fish, Sharks and Marine Turtles – distance to physiological criteria – Impact driven sheet steel pile

Hearing Group	Total number of hammer blows	Exposure time @ 30 blows /minute	Un-weighted distance to criteria compliance (m)		
			Organ damage / increased Risk of fatality	TTS	PTS
Fish (no swim bladder) • Great White Shark • Mackeral Shark	30	1 minute	0	75	0
	60	2 minutes	0	140	0
	150	5 minutes	0	290	0
	450	15 minutes	0	610	1
	1800	**60 minutes**	**3**	**1300**	**5**
	3600	2 hours	5	1700	8
Fish (with swim bladder) • Pipefish • Seahorses • Seadragons	30	1 minute	0	75	2
	60	2 minutes	2	140	3
	150	5 minutes	3	290	8
	450	15 minutes	9	610	23
	1800	**60 minutes**	**35**	**1300**	**85**
	3600	2 hours	70	1700	160
Marine Turtles • Loggerhead Turtle • Green Sea Turtle • Leatherback Turtle • Pacific Ridley Turtle	30	1 minute	0	n/a	n/a
	60	2 minutes	0	n/a	n/a
	150	5 minutes	2	n/a	n/a
	450	15 minutes	5	n/a	n/a
	1800	**60 minutes**	**18**	**n/a**	**n/a**
	3600	2 hours	35	n/a	n/a

(1) Assumed maximum piling duration over 24 hours indicated in **bold**.

The results indicate that the effect on fish, sharks and turtles relates to the length of exposure time, which also relates to the mobility of the animals in the area during piling activities. The greatest impact potential is on fish with swim bladders given their increased hearing sensitivity. For marine turtles, the distance is approximately half that of fish with swim bladders at longer exposure times. For an assumed 60 minutes equivalent of continuous piling noise over a 24 hour period, fish with swim bladders and marine turtles, may incur organ damage and an increased risk of fatality within 35 m and 18 m respectively.

A temporary hearing threshold shift could occur for fish (both with/without swim bladders) within approximately 75 m of initial piling commencement, depending upon the direction of travel and behavioural response to the noise to move away from the noise. For an assumed 60 minutes equivalent of continuous piling noise over a 24 hour period, fish remaining within an area of approximately 1300 m from the piling noise, may incur temporary hearing threshold shift.

Resonate

Marine mammals

The predicted results for impact driven sheet steel piles are presented in Table 53.

Table 53: Marine mammal weighted distance to TTS / PTS – Impact driven sheet steel pile

Hearing Group	Total number of Hammer blows	Exposure time @ 30 blows/ minute	Weighted distance to TTS/PTS criteria compliance (m)	
			TTS	PTS
Low Frequency (LF) Cetaceans	150	5 minutes	2300	470
	450	15 minutes	3100	890
	1800	**60 minutes**	**4100**	**1700**
	3600	2 hours	4700	2100
High Frequency (HF) Cetaceans	150	5 minutes	25	6
	450	15 minutes	75	15
	1800	**60 minutes**	**240**	**60**
	3600	2 hours	400	110
Pinnipeds – Phocid Carnivores in water (PCW)	150	5 minutes	1700	240
	450	15 minutes	2400	520
	1800	**60 minutes**	**3400**	**1200**
	3600	2 hours	3900	1500
Pinnipeds – Other Carnivores in Water (OCW)	150	5 minutes	160	6
	450	15 minutes	380	18
	1800	**60 minutes**	**880**	**65**
	3600	2 hours	1300	130

(1) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

(2) Assumed maximum piling duration over 24 hours indicated in **bold**.

The results indicate that the effect on marine mammals relates to the length of exposure time, which also relates to the mobility of the animals in the area during piling activities. The greatest impact potential is on low frequency cetaceans and phocid carnivores, given their increased hearing sensitivity at low frequencies. For these species, even short exposure times (i.e. 5 minutes) at distances of 240 m (PCW) to 470 m (LFC) from the piling noise source may cause permanent hearing injury.

A temporary hearing threshold shift could occur for these mobile animals within approximately 1700 m (PCW) to 2300 m (LFC) of the noise source for only 5 minutes of exposure and the level of exposure beyond 5 minutes would depend on the direction of travel and behavioural response to move away from the noise.

Comparatively, the potential for permanent or temporary physiological impacts for high frequency cetaceans and other carnivores is significantly less than low frequency cetaceans and phocid carnivores. This is because the significantly shorter distances to meet the adopted criteria relative to the mobility potential of the animal and likely behavioural response to the noise. Whilst the two species (i.e. HFC, OCW) have a similar sensitivity to permanent hearing injury with distance, the other pinniped carnivores have the greater potential for a temporary threshold shift to their hearing, with the exposure time versus distance almost 4 times that of high frequency cetaceans at 60 minutes of exposure.

Resonate

Pinnipeds in air

The predicted results for air borne noise exposure results are presented in Table 54.

Table 54: Pinnipeds weighted distance to TTS / PTS in air – Impact driven sheet steel pile

Hearing Group	SEL single blow @ 10m[1] (dB re 20 μPa²s)	Total number of Hammer blows	Exposure time @ 30 blows/minute	Weighted Cumulative SEL @ 1m (dB re 20 μPa²s)	Weighted Distance to TTS / PTS criteria compliance (m) [20logR propagation]	
					TTS	PTS
Phocid Carnivores in Air (PCA)	110	30	1 minute	143	2	1
	110	60	2 minutes	146	2	1
	110	150	5 minutes	150	4	2
	110	450	15 minutes	154	7	3
	110	**1800**	**60 minutes**	160	13	7
	110	**3600**	**2 hours**	163	19	9
	110	7200	4 hours	166	27	13
Other Carnivores in Air (OCA)	110	30	1 minute	144	1	0
	110	60	2 minutes	147	1	0
	110	150	5 minutes	151	2	0
	110	450	15 minutes	155	3	1
	110	**1800**	**60 minutes**	161	6	1
	110	**3600**	**2 hours**	164	8	1
	110	7200	4 hours	167	12	2

(1) SEL derived from BS 5228-1 2009 for vibratory sheet piling.

(2) Weighting factor adjustment 2 kHz determined in accordance with NFMS 2018

(3) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

The results clearly indicate that pinnipeds (particularly the phocid carnivores) are significantly less sensitive to piling noise exposure in air than in water. As an example, for phocids, for an exposure time of 5 minutes the TTS comparison between water and air is 1700 m and 4 m respectively. In summary, controlling the waterborne noise exposure impact would also effectively eliminate the air borne noise exposure impact.

11.5.4 Vessel movements

Our assessment has assumed that vessel movements will be short term and transient in nature, to assist with construction activities, with a total equivalent operating period of 2 hours over a 24-hour period. It has been assumed that vessels will not remain stationary for long periods with the engine running.

Fish, sharks and marine turtles

Similarly, to the dredging (refer Section 11.5.1), vessel movements are considered a continuous non-impulsive noise source. Given that vessel movements are expected to be operating for short transit periods, the predicted impacts are nil.

Resonate

Marine mammals

Table 50 provides cumulative SEL comparisons versus exposure time and distance to meet the adopted criteria for marine mammals.

Table 55: Marine mammals weighted distance to TTS/PTS – Vessel movements

Hearing Group	Exposure time within a 24 hour period	Weighted distance to TTS/PTS criteria compliance (m)	
		TTS	PTS
Low Frequency (LF) Cetaceans	2 hours	6	0
High Frequency (HF) Cetaceans	2 hours	0	0
Pinnipeds – Phocid Carnivores in water (PCW)	2 hours	3	0
Pinnipeds – Other Carnivores in Water (OCW)	2 hours	0	0

(1) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

The greatest impact potential is on low frequency cetaceans and phocid carnivores, given their increased hearing sensitivity at low frequencies. For these species, even with a 2 hour exposure time, the potential for permanent hearing injury is considered nil. The potential is even less for high frequency cetaceans and other pinniped carnivores.

Furthermore, the potential for temporary hearing impacts for phocids and low frequency cetaceans is considered negligible given the predicted short TTS distances and the mobility potential of these animals.

Pinnipeds in air

Given the negligible predicted hearing impacts for Pinnipeds in water, it is also expected that the potential for noise exposure impact on pinnipeds in air is nil.

11.6 Summary of noise impacts on marine fauna

The following provides a summary of the predicted noise impacts associated with the proposal in context with the existing conditions.

11.6.1 Fish, sharks and marine turtles

Objective criteria for the assessment of noise exposure impacts associated with continuous and non-impulsive noise sources (i.e. dredging, vibro-driving, and supporting vessels) are only applicable to fish with swim bladders. All of the noise sources assessed are similar in comparison to the noise emissions generated by the existing vessel traffic as they pass by the study area. Furthermore, the noise exposure duration of these noise sources (in context with the mobility of the animals) with respect to the adopted 12 hour and 48 hour criteria for TTS and PTS respectively is expected to be short (i.e. 1 to 2 hours).

In summary, the potential for temporary or permanent physiological impact from non-impulsive sources is very low, particularly in the understanding that a behavioural response to avoid higher noise levels is likely (Popper et al., 2014).
In relation to impact piling (i.e. impulsive noise source), the results indicate that the effect on fish, sharks and turtles relates to the length of exposure time, which also relates to the mobility of the animals in the area during piling activities. The greatest impact potential is on fish with swim bladders given their increased hearing sensitivity.

However, marine turtles also have a similar (albeit marginally lower) risk of organ damage or fatality compared to fish with swim bladders. For these species, prolonged exposure (i.e. > 15 minutes) at distances of <9 m from the piling noise source may cause organ damage or fatality.

A temporary hearing threshold shift could also occur for fish (both with/without swim bladders) within approximately 75 m of initial piling commencement, depending upon the direction of travel and behavioural response to the noise to move away from the noise. For an assumed 1 hour equivalent of continuous piling noise over a 24 hour period, fish remaining within an area of approximately 1300 m from the impulsive piling noise, may incur temporary hearing threshold shift.

11.6.2 Marine mammals

The results indicate that the effect on marine mammals relates to the length of exposure time, which also relates to the mobility of the animals relative to the distance from each noise source.

In general terms, the greatest impact potential is on low frequency cetaceans and phocid carnivores, given their increased hearing sensitivity at low frequencies. A summary of the predicted noise exposure impact upon these species is provided below for each noise source:

- Dredging - prolonged exposure (i.e. > 15 minutes) at distances less than 3m from the dredging noise source may cause permanent hearing injury. Temporary hearing injury could occur for these mobile animals within approximately less than 55 m of the noise source and would depend on the direction of travel and their behavioural response to the noise.
- Vibro-driving - in comparison to impact piling, vibro-driving of sheet piles has a significantly lower potential to impact. Even with a 50 minute exposure time, the potential for permanent hearing injury is considered negligible, given the very short distances in comparison to the mobility potential of the animals. Furthermore, the potential for temporary hearing impacts is possible for phocids and low frequency cetaceans remaining within approximately 240 and 390 m of vibro-driving respectively, however given the mobility potential of these animals, particularly for migratory low frequency cetaceans, this is considered unlikely.
- Impact piling - even short exposure times (i.e. 5 minutes) at distances of 240 m (phocids) to 470 m (low frequency cetaceans) from the piling noise source may cause permanent hearing injury. A temporary hearing threshold shift could occur for these mobile animals within approximately 1700 m (phocids) to 2300 m (low frequency cetaceans) of the noise source for only 5 minutes of exposure and the level of exposure beyond 5 minutes would depend on the direction of travel and their behavioural response to move away from the noise.
- Vessel movements - the potential for both temporary and permanent hearing impacts for phocids and low frequency cetaceans is considered negligible given the significantly shorter distances to meet physiological criteria in comparison to the mobility potential of these animals.

However, as discussed in Section 5.7, the above species have not been identified by Succession Ecology (2023) as *possible, likely or certain* to be impacted by the Development. In relation to high frequency cetaceans (e.g. Port River Dolphin) and other pinniped carnivores, which have been identified, a summary of the predicted noise exposure impact upon these species is provided below for each noise source:

- Dredging - permanent or temporary physiological impacts are unlikely to occur for high frequency cetaceans and other carnivores given the short distances to meet the physiological impact criteria relative to the mobility potential of the animal and likely behavioural response to the noise.
- Vibro-driving - the potential for permanent or temporary hearing impacts for high frequency cetaceans and other pinniped carnivores is considered unlikely given the significantly short distances to meet the physiological impact criteria relative to the mobility potential of these animals.
- Impact Piling - comparatively, the potential for permanent or temporary physiological impacts for high frequency cetaceans and other carnivores is significantly less than low frequency cetaceans and phocid carnivores. This is because the significantly shorter distances to meet the physiological impact criteria relative to the mobility potential of the animals and their likely behavioural response to the noise. Whilst the two species have a similar noise exposure sensitivity to permanent hearing injury with distance, the other pinniped

carnivores have the greater potential for a temporary threshold shift to their hearing, with the exposure versus time distance almost four times that of high frequency cetaceans.
- Vessel movements - the potential for both temporary and permanent hearing impacts is predicted to be nil.
- Operational activities - In comparison to the construction noise sources and existing vessel movements, submarine related operational activities are expected to have negligible impact.

The assessment has indicated that pinnipeds (particularly the phocid carnivores) are significantly less sensitive to noise exposure in air than in water. In summary, controlling the waterborne noise exposure impact would also effectively eliminate the air borne noise exposure impact upon these species.

11.7 Noise mitigation and management for marine fauna

From the impact assessment undertaken, mitigation and management measures are considered necessary for impact sheet piling in particular and to a lesser extent dredging and vibratory piling. In relation to impact piling however, it is expected that most of the piling would be undertaken using vibro-driving, and impact piling only required if very stiff soils are encountered. Mitigation and/or management measures are not required for vessel movements.

The following sections outline the range of practical options available.

11.7.1 Mitigation options

Piling in low tide or dry conditions

Piling noise propagates less efficiently in very shallow water (i.e. <1 m), and is negligible during dry conditions. Consideration of the low tide times with respect to the piling plan may provide an opportunity to reduce the underwater noise propagation and associated noise exposure.

Soft start

Adopting a soft start procedure in which the piling impact energy is gradually increased over a 10 minute time period may alert marine mammals (including fish, sharks and marine turtles) to the presence of the piling rig and enable animals to move away to distances where injury is unlikely. The soft start procedure should also be used after long breaks of more than 30 minutes in piling activity.

Note that when comparing the SPL of soft start versus full hammer energy, the difference is likely to be in the order of 10 dB (e.g. Bailey et. al. 2010).

Avoid whale migration season

To reduce the potential for noise impact on low frequency cetaceans, impact piling works should ideally be undertaken outside of the whale migration season (May to September).

Bubble curtains

A bubble curtain may be utilised to attenuate impact piling activities, where practical and cost effective. A bubble curtain is a sheet of air bubbles that are produced around the location where piling activity occurs. The bubbles in the bubble curtain create an acoustic impedance mismatch between the water and air trapped in the bubble, which results in sound attenuation across the bubble curtain (i.e. the bubble curtain acts as a reflector, the bubbles also resonate in response to sound and absorb sound energy).

Reported noise reductions range from 3 to 20 dB. However, bubble curtains may not be as effective in shallow water, and care is required in these situations so as not to overprescribe expected attenuation performance. At this stage, we envisage that a bubble curtain is unlikely to be reasonable and practicable. However, the merits of utilising a bubble curtain are expected to be assessed while preparing the construction noise and vibration management plan.

Table 56 illustrates the effectiveness of bubble curtains for varying levels of attenuation performance upon marine mammals that have the potential to be impacted by the project.

Table 56: Bubble curtain attenuation level versus TTS/PTS distances for 1800 sheet pile hammer impacts over 24 hours

Hearing Group	Attenuation	Weighted distance to TTS/PTS criteria compliance (m)	
		TTS	PTS
High Frequency (HF) Cetaceans	3 dB	140	30
Pinnipeds – Other Carnivores in Water (OCW)	3 dB	600	35
High Frequency (HF) Cetaceans	5 dB	90	19
Pinnipeds – Other Carnivores in Water (OCW)	5 dB	440	22
High Frequency (HF) Cetaceans	10 dB	30	7
Pinnipeds – Other Carnivores in Water (OCW)	10 dB	190	7

(1) TTS = Temporary Threshold Shift, PTS = Permanent Threshold Shift

11.7.2 Safety Zones

In accordance with the DIT Guidelines, Safety Zones include an *Observation Zone* and *Shut-down Zone* for marine mammals, which are a defined radius around the works with intent to be monitored for the presence of mega fauna (in particular) prior to and/or during noisy activities. Safety zones are not applicable to fishes and marine turtles.

Safety zones aim to minimise the likelihood of temporary or permanent hearing injury to occur to marine mammals, where the sizing of which is only applicable in non-biologically important habitat. The zones are not intended to prevent behavioural responses to audible, but non-physical injury noise events.

It is likely that marine mammals in the vicinity of a noisy activity will show an avoidance reaction to the noise, which reduces the chance of marine mammals approaching the source close enough to enter the zone of hearing injury (i.e. shut-down zone). The impacts of such a temporary displacement are unlikely to be significant unless it occurs during critical behaviours, such as breeding, feeding and resting, or in important areas such as migratory corridors, calving or nursery grounds and foraging areas.

Safety zones are not applicable when piling in dry (or very shallow <1m) conditions.

Observation Zone

In the observation zone, the movement of marine mammals shall be monitored to determine whether they are approaching or entering the shut-down zone. When a marine mammal is sighted within or appears to enter the shut-down zone, piling or dredging activities must be stopped as soon as reasonably practical.

Under the DIT Guidelines, the shut-down zone is equivalent to an exclusion zone. The observation zone is sized based on a nominal 250 m distance from the outer edge of the shut-down zone. In this report, only the shutdown zones are illustrated.

Shutdown Zone

Shut-down zones are sized based on the potential for a Temporary Threshold Shift (TTS) in marine mammals.

The shut-down zone allows for the cumulative effect of multiple hammer strikes during impact piling and the time duration of a continuous noise source. This allows some time for the marine mammal to move away from the noise source thereby reducing the likelihood of hearing injury to occur. However, the cumulative sound exposure from other underwater noise sources (i.e. industrial sources of noise, major shipping channels), in addition to the piling or dredging activity, may also contribute to the cumulative sound exposure.

11.7.3 Potential Effects Zones

Under the DIT Guidelines, the potential effects zones are applicable to the impact assessment upon fishes and marine turtles for impact piling activities (i.e. impulsive sound) only. The potential effects zones are not applicable for vibratory or dredging activities (i.e. continuous sound sources).

The potential effects zones for fishes and marine turtles are not to be considered a shut-down zone, but zones to inform the projects risk evaluation process and identification of reasonable and practicable noise mitigation measures where required. Mitigation measures could include the adoption of alternative lower noise methods, design changes (e.g. pile material type, number of piles required) and soft starts to warn fish and marine turtles. With reference to the marine species that have been identified by Succession Ecology (2023) as *possible, likely or certain* to be impacted by the Development (Table 45 and Table 46), a potential effects zone has not been identified in this case.

11.7.4 Preliminary Safety Zones

To effectively manage the shutdown zone to minimise the potential for temporary hearing impacts (i.e. TTS) requires consideration of the:

- modelled TTS distances versus exposure time
- mobility potential of the animals as well as in response to the noise.

Note that the proposed safety zones are preliminary and are based on conservative assumptions, which is that the noise source levels and noise propagation characteristics adopted for this assessment are conservative.

With reference to the marine species that have been identified by Succession Ecology (2023) as *possible, likely or certain* to be impacted by the Development (Table 45 and Table 46), the preliminary shutdown zones distances (without additional attenuation measures) are summarised as follows:

- Dredging – Nil
- Vibro-driven sheet piles – Nil
- Impact-driven piles:
  - 880 m for pinniped ‘other’ carnivores
  - 240 m for high frequency cetaceans.
- Vessel movements – Nil.

In consideration of the above, the preliminary shutdown zones are presented in Figure 36 and Figure 37.

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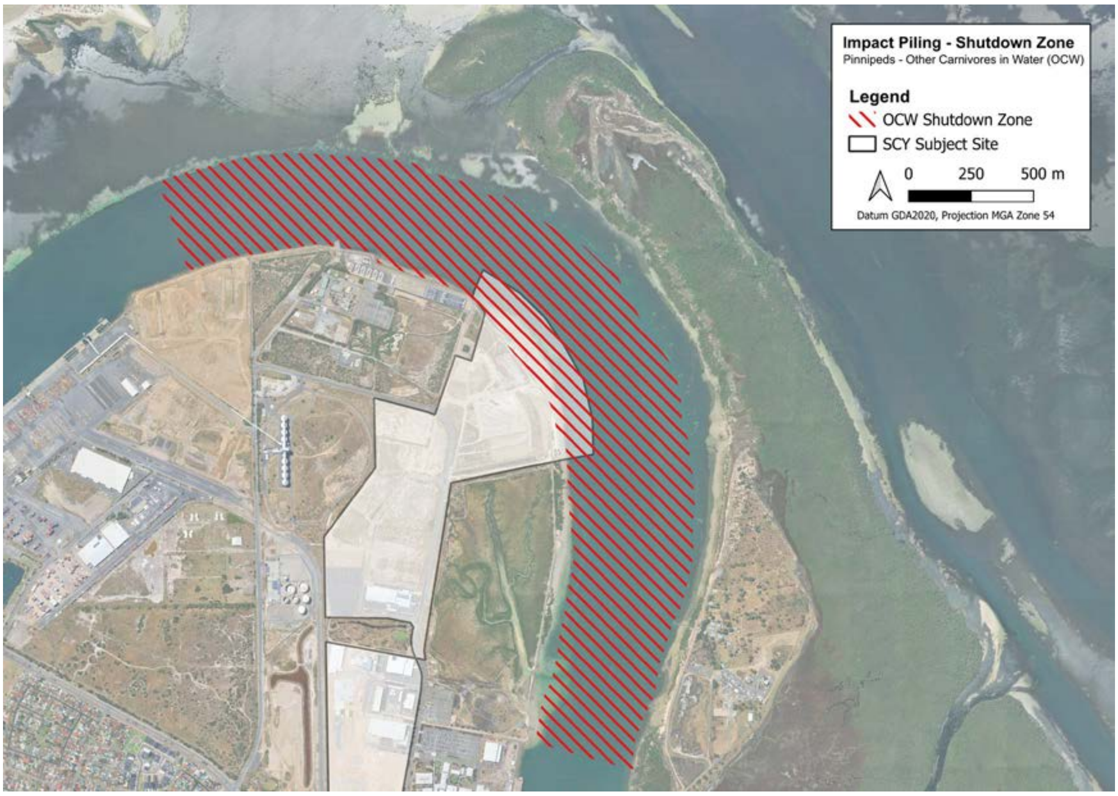

Figure 36 Shut-down zone for pinnipeds – other carnivores (in water) from impact-driven piling activities

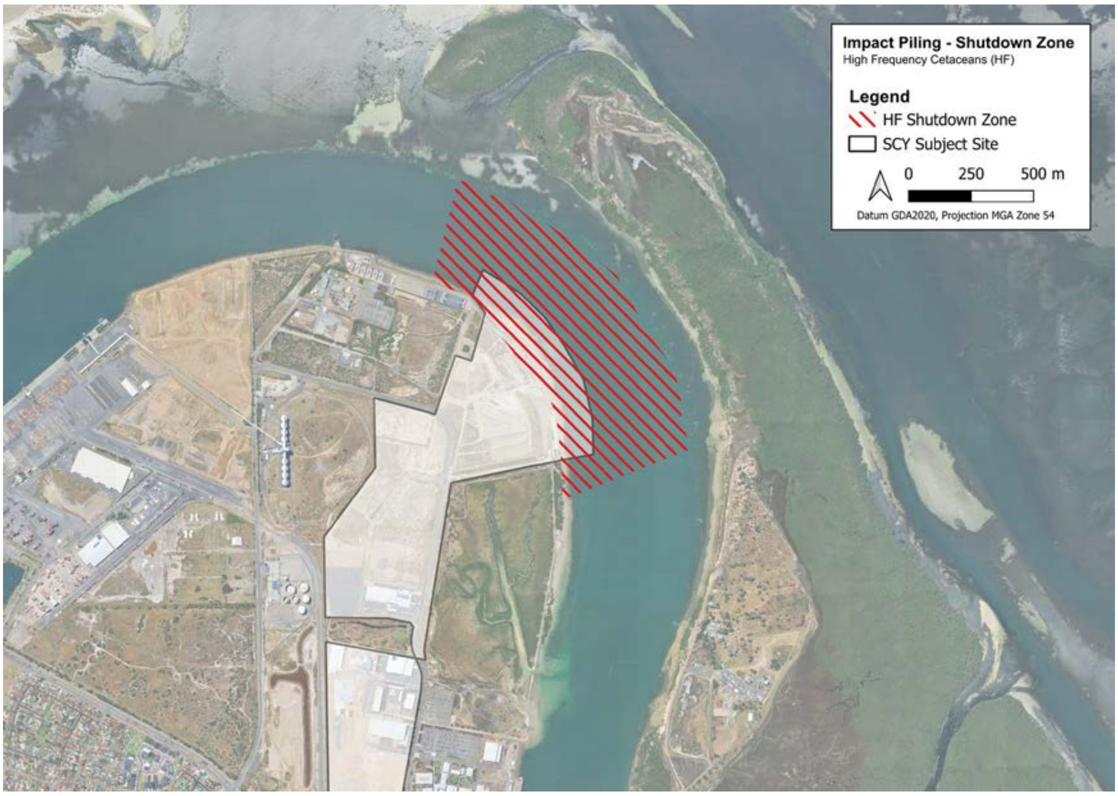

Figure 37 Shut-down zone for high frequency cetaceans from impact-driven piling activities

11.7.5 Marine Fauna Observers

Under the DIT Guidelines, the requirements for different levels of marine fauna observers are as follows:

- Marine Fauna Observer (MFO) Level 1 – a person who is a suitably qualified marine fauna specialist with experience in marine mammal identification, including behaviour, as well as distance estimation.
- Marine Fauna Observer (MFO) Level 2 – a person who has sufficient experience in marine fauna identification and distance estimation.

The MFO level relates the likelihood for the project activities to be significant under the definition contained within the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance*. In these cases, a marine fauna observer (MFO) Level 1 required to be present for the duration of related works or to train MFO Level 2 with project and site-specific details.

Table 57 provides an overview of the Matters of National Environmental Significance (MNES) and other species of significance identified by J Diversity (2023) within 5 km of the Outer Harbor breakwaters, for the attention of the MFO. In particular, those species highlighted in red have been identified by Succession Ecology (2023) as *possible, likely or certain* to be impacted by the Development.

Table 57: Relevant species for monitoring for MFO reference

Low Frequency Cetaceans	High Frequency Cetaceans	Pinnipeds Phocid Carnivore (PC)	Pinnipeds Other Carnivore (OC)
Humpback Whale (*Megaptera novaeangliae*)	**Common Dolphin, Short-beaked Common Dolphin** (*Delphinus delphis*)	**Leopard seal** (*Hydrurga leptonyx*)	**Australian Sea Lion** (*Neophoca cinerea*)
Southern Right Whale (*Eubaleana australis*)	**Indian Ocean bottlenose dolphin** (*Tursiops aduncus*) a.k.a. Port River Dolphin		**Subantarctic fur seal** (*Arctocephalus tropicalis*)
Pygmy Right Whale (*Caperea marginata*)	**Common bottle-nosed dolphin** (*Tursiops truncatus*)		**Long-nosed fur seal** (*Arctocephalus forsteri*)
Bryde's Whale (*Balaenoptera edeni*)	**Dusky Dolphin** (*Lagenorhynchus obscurus*)		**Australian fur seal** (*Arctocephalus pusillus*)
	Killer Whale (*Orcinus orca*)		
	Sperm Whale (*Physeter macrocephalus*)		

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12 Risk assessment

This section outlines the risk assessment undertaken to identify if further control measures are required.

12.1 Impact consequence

The expected consequence of each identified impact needs to be considered to determine whether they are acceptable in the context of the Project. The consequence of each impact is ranked using Table 58, which requires consideration of the scale, intensity, duration and frequency of impacts and the sensitivity of the receptor.

Table 58: Acceptability of impacts

Impact category	Acceptability of impact
Negligible	Impacts are considered to be as low as reasonably practicable and no further control measures are required.
Minor	Review to determine if impacts are as low as reasonably practicable and, if not, modify control measures or consider Project design changes to lessen impacts.
Moderate	Review to determine if impacts are as low as reasonably practicable and, if not, modify control measures or consider Project design changes to lessen impacts.
Major	Impacts are unacceptable. Review Project design and control measures to ensure impacts are no higher than 'moderate'. Further review to ensure impacts are as low as reasonably practicable.
Catastrophic	Impacts are unacceptable. Review Project design and control measures to ensure impacts are no higher than 'moderate'. Further review to ensure impacts are as low as reasonably practicable.

Table 59 shows how each impact consequence is categorised in terms of the environmental values identified as being related to the Project.

Table 59: Categorisation of impact consequence

Category	Public health and safety	Socio-economic	Listed fauna species	Other fauna
Negligible	No injury or illness.	No impact or minor reparable socio-economic impacts on local population.	Insignificant effect.	Local short-term decrease in abundance of some species without reduction in local community viability.
Minor	An injury or illness that does not require first aid or medical treatment	Short-term impacts on local businesses and/or wellbeing of local communities.	Local short-term decrease in abundance with no lasting effects on local population.	Local long-term decrease in abundance of some species resulting in little or no change to community structure.

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Category	Public health and safety	Socio-economic	Listed fauna species	Other fauna
Moderate	Injury or illness requiring first aid or medical treatment.	Ongoing impacts on the wellbeing of local communities that results in a significant proportion of the community leaving the area and/or significant mental health issues across the community. Ongoing impacts on local businesses that result in closures and (direct and indirect) loss of employment for up to 20 people. Suspension of important community services (e.g. transport, telecommunications, energy) for up to one week.	Local long-term decrease in abundance without reduction in regional population viability.	Regional long-term decrease in abundance of some species and/or local loss of some species diversity resulting in some change to the community structure.
Major	Injury or illness that results in hospitalization or disablement.	Ongoing impacts on the wellbeing of regional communities that results in a significant proportion of the community leaving the area and/or serious mental health issues across the affected communities. Ongoing impacts on local businesses that result in closures and (direct and indirect) loss of employment for up to 100 people. Suspension of important community services (e.g. transport, telecommunications, energy) for over one week.	Regional long-term decrease in abundance and/or local loss resulting in reduction in regional viability.	Regional long-term decrease in abundance of numerous species and/or some loss of species diversity resulting in significant changes to community structure.

Category	Public health and safety	Socio-economic	Listed fauna species	Other fauna
Catastrophic	Injury or illness that results in fatality	Complete breakdown of social order. Ongoing impacts to regional businesses that result in closures and (direct and indirect loss of employment for more than 100 employees and/or towns in the region becoming unviable. Suspension of important community services (e.g. transport, telecommunications, energy) for several weeks or more.	Regional extinction of the species.	Regional long-term loss of numerous species resulting in the dominance of only a few species.

To allow each impact consequence to be categorised, the intensity of noise and vibration, duration of activity, frequency of impact and impact on receptors have been determined for each impact. The consequence of each impact can then be inferred. Table 60 contains the impact consequence analysis with the above information.

Table 60: Impact consequence analysis

Potential Impact	Intensity	Duration	Frequency	Category
Noise from land-based construction activities on residential receivers.	Predictions of the worst case activity, impact piling, indicate noise levels ranging 45 to 60 dB(A)L_{eq} at the nearest residential receivers. These predicted levels are above the EPA night noise criteria.	The entire construction phase of the project, which is expected to be years.	For building foundations or other similar structures where impact piling is required.	Minor
Vibration from land-based construction activities on residential receivers.	Predictions of the worst case activity, impact piling, indicate compliance with the human comfort criteria at distances greater than 200 m from impact piling. The nearest residential receivers are greater than 300 m from potential works.	The entire construction phase of the project, which is expected to be years.	For building foundations or other similar structures where impact piling is required.	Negligible

Potential Impact	Intensity	Duration	Frequency	Category
Vibration from land-based construction activities on existing ONS office/workshop receivers.	Predictions of the worst case activity, impact piling, indicate compliance with the human comfort criteria at distances greater than 200 m from impact piling. The nearest ONS receivers are less than 20 m from potential works.	The entire construction phase of the project, which is expected to be years.	For building foundations or other similar structures where impact piling is required.	Minor
Noise from land or water-based construction activities on terrestrial fauna.	Predictions of the worst case activity, vibratory hammer piling, indicate impact on fauna if the animal is at distances less than 16 m from the noise source. The distance from all other noise sources is less than 4 m. Refer to Section 10.5 for noise impact summary.	Port River waterfront construction works. Works envisaged to occur over months.	Sheet piling activities on the Port River waterfront. The frequency of impact would also depend on if an animal is present in the immediate area of works	Minor
Vibration from land or water-based construction activities on heritage structures.	Predictions of the worst-case activity, impact piling or dynamic pile testing indicate that vibration levels have the potential to impact the *Excelsior* within 100 m. Furthermore, vibratory piling and major compaction works may also present a risk to the Excelsior within 50 to 100 m.	Construction piling and major compaction works within approximately 200 m of the *Excelsior*.	For building and retaining walls foundations as well as wharves or other similar structures where piling and major soil compaction is required.	Moderate – On the basis that it is illegal to damage, destroy, interfere with, or to dispose of, any historic shipwrecks or historic relics
Noise from water-based construction activities on marine fauna - *Fish, sharks and marine turtles*	Ref Section 11.6.1 for noise impact summary. Succession Ecology (2023) has determined that these species are not *possible, likely or certain* to be impacted by the Development.	Port River construction works. Works envisaged to occur over months.	Impact piling works are likely to only occur when vibratory driving cannot drive the pile to the required depth.	Negligible

Potential Impact	Intensity	Duration	Frequency	Category
Noise from water-based construction activities on marine fauna - *LF Cetaceans and Phocid Carnivores (PCW)*	Ref Section 11.6.2 for impact summary. Succession Ecology (2023) has determined that these species are not *possible, likely or certain* to be impacted by the Development.	Port River construction works. Works envisaged to occur over months.	The frequency of impact would depend on if an animal is present in the area, which is considered rare for these species.	Negligible
Noise from water-based construction activities on marine fauna - *HF Cetaceans (including Port River Dolphin) and Other Carnivores (OCW)*	Ref Section 11.6.2 for impact summary.	Port River construction works. Works envisaged to occur over months.	The frequency of impact would depend on if an animal is present in the area. Impact piling works are likely to only occur when vibratory driving cannot drive the pile to the required depth	Minor
Noise from operation of the SCY facilities on residential receptors	Predictions indicate noise levels to be less than 45 dB(A)L_{eq} at the nearest residential receivers in the assumption that the SCY facility adopts a master-planned approach to prescribing allowable noise emission levels from each building function (including external plant) operating in the precinct.	Constant	Constant	Minor
Traffic noise from operation of the SCY facilities on residential and other sensitive receptors in the area	Preliminary predictions indicate that traffic noise levels may increase by 1 to 9 dB(A) depending upon the road segment impacted by increased traffic.	Constant	Constant	Moderate

Potential Impact	Intensity	Duration	Frequency	Category
Noise from operation of the SCY facilities on terrestrial fauna.	Predictions indicate impact on fauna if the animal is at distances less than 2 m from the worst-case operational noise source	Constant	Constant	Negligible
Noise from operation of the SCY facilities on marine fauna	Submarines are designed to operate as quietly as possible to avoid detection and their source level and sound signature is classified. Given that the predicted noise impact from typical vessels is expected to be NIL, submarine related noise impacts are also expected to also be NIL within the study area.	The time taken for the submarine to traverse Port River	Ad hoc according to defence operational requirements	Negligible

(1) The construction and erection of towers will be occur intermittently with breaks between activities, however the total duration of each tower installation will be 5 days.

In relation to the assessed impacts that have a 'minor' impact category, further control measures have been identified in Section 12.3.

12.2 Impact certainty

It is our opinion that there are no significant sources of uncertainty present in the assessment of impacts for the Project that result in a risk to the environmental greater than expected. Nevertheless, the level of certainty has been categorised with respect to the quality of the data relied upon for this assessment.

Table 61 outlines the rating level adopted to categorise certainty.

Table 61: Rating level of certainty

Level of Certainty	Quality of data
High	Comprehensive data. Further studies are unlikely to generate additional information that would change the conclusions reached in the impact assessment.
Medium	Some site-specific information available to provide ground-truthing of regional desktop information. Further studies could change some of the conclusions reached in the impact assessment.
Low	Minimal site-specific data available. Reliance on regional desktop studies that may not accurately reflect site conditions. Low level of confidence in the impact assessment.

Table 62 shows the level of certainty for each identified noise impact with justification.

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Table 62: Noise impact certainty

Potential Impact	Certainty	Justification
Noise from land-based construction activities on residential receivers.	Medium	The exact locations and operating schedules of individual noise-generating construction activities are unknown at this stage. However, we have conservatively presented worst-case scenarios.
Vibration from land-based construction activities on residential receivers.	Medium	The exact locations and operating schedules of individual vibration-generating construction activities are unknown at this stage. However, we have conservatively presented worst-case scenarios.
Vibration from land-based construction activities on existing ONS office/workshop receivers.	Medium	The exact locations and operating schedules of individual vibration-generating construction activities are unknown at this stage. However, we have conservatively presented worst-case scenarios.
Noise from land or water-based construction activities on terrestrial fauna.	Medium	The information on fauna species is considered suitable in context with available research and guidelines. The modelling and assessment approach undertaken is conservative.
Vibration from land or water-based construction activities on heritage structures.	Medium	The exact locations and operating schedules of individual vibration-generating construction activities are unknown at this stage. However, we have conservatively presented worst-case scenarios.
Noise from water-based construction activities on marine fauna - *Fish, sharks and marine turtles*	Medium	Succession Ecology (2023) has determined that these species are not *possible, likely or certain* to be impacted by the Development.
Noise from water-based construction activities on marine fauna - *LF Cetaceans and Phocid Carnivores (PCW)*	Medium	Succession Ecology (2023) has determined that these species are not *possible, likely or certain* to be impacted by the Development.
Noise from water-based construction activities on marine fauna - *HF Cetaceans (including Port River Dolphin) and Other Carnivores (OCW)*	Medium	The exact locations and operating schedules of individual noise-generating construction activities are unknown at this stage. However, we have conservatively presented worst-case scenarios. Further detailed modelling may indicate additional sound-focusing effects due to the dredged river shipping channel.

Potential Impact	Certainty	Justification
Noise from operation of the SCY facilities on residential receptors	Low	We have assessed the SCY facility at 5% design with limited information available. The project is still in the concept phase and is subject to change during detailed design. Nevertheless, our noise modelling has been based on the types of noise sources and building constructions currently operating at the ONS precinct. Further detailed information is unlikely to change our assessment undertaken significantly. The project will incorporate noise control measures into the design to comply with environmental noise criteria.
Traffic noise from operation of the SCY facilities on residential and other sensitive receptors	Low	We have assessed the SCY facility at 5% design with limited information available. The project is still in the concept phase and is subject to change during detailed design. Nevertheless, our noise modelling has been based on the best available existing and future traffic data. Further detailed traffic volume modelling is likely to change the outcome of our noise assessment. Detailed design may also identify other traffic noise mitigation strategies. The project will incorporate noise control measures into the design where reasonable and practicable.
Noise from operation of the SCY facilities on terrestrial fauna.	Low	We have assessed the SCY facility at 5% design with limited information available. The project is still in the concept phase and is subject to change during detailed design. Nevertheless, our noise modelling has been based on the types of noise sources and building constructions currently operating at the ONS precinct and adopted the plant with the highest external noise emission. Further detailed information is unlikely to change our assessment undertaken significantly.
Noise from operation of the SCY facilities on marine fauna	Low	We have assessed the SCY facility at 5% design with limited information available. The project is still in the concept phase and is subject to change during detailed design. However, the operation of the facility in the marine environment is expected to primarily relate to the use of submarines. It is expected that this noise sources will have negligible noise impact upon marine fauna, particularly in context with existing activities generating underwater noise in the Port River. Further detailed information is unlikely to change our assessment undertaken significantly.

12.3 Risk summary and recommended control measures

Table 63 provides as summary of the expected impacts and recommended control measures from the construction and operation of the SCY facility.

Table 63: Impact assessment summary

Potential Impact	Consequence	Certainty	Recommended Control Measures
Noise from land-based construction activities on residential receivers.	Minor	Medium	Before the commencement of works, the construction team shall prepare a Construction Noise and Vibration Management Plan (CNVMP), a sub plan of the Construction Environmental Management Plan (CEMP).
Vibration from land-based construction activities on residential receivers.	Negligible	Medium	

Potential Impact	Consequence	Certainty	Recommended Control Measures
Vibration from land-based construction activities on existing ONS office/workshop receivers.	Minor	Medium	The CNVMP shall consider the adopted terrestrial and marine assessment criteria, sensitive receptors, and heritage structures as well as mitigation and management measures contained within this document (unless superseded by new information or government policy), namely: • Section 5 Assessment criteria • Section 8.4 Construction noise mitigation and management • Section 9.6 Construction vibration mitigation and management • Section 10.4 Noise mitigation and management for terrestrial fauna • Section 11.7 Noise mitigation and management for marine fauna
Noise from land or water-based construction activities on terrestrial fauna.	Minor	Medium	
Vibration from land or water-based construction activities on heritage structures.	Moderate	Medium	
Noise from water-based construction activities on marine fauna - *Fish, sharks and marine turtles*	Minor	Medium	
Noise from water-based construction activities on marine fauna - *LF Cetaceans and Phocid Carnivores (PCW)*	Minor	Medium	
Noise from water-based construction activities on marine fauna - *HF Cetaceans (including Port River Dolphin) and Other Carnivores (OCW)*	Minor	Medium	
Noise from operation of the SCY facilities on residential receptors	Minor	Low	Development of a master noise model to assign a 'noise budget' to each building facility and associated external plant based on functional operating requirements. Building facilities with noisier operational activities may be assigned a greater noise budget within the cumulative noise emission allowance for the ONS and SCY precinct to optimise noise mitigation for the Development. Note that it is expected that Work Health and Safety (WHS) requirements will positively influence the design outcome in terms of mitigating internal/external noise emissions of plant and equipment.

Potential Impact	Consequence	Certainty	Recommended Control Measures
Traffic noise from operation of the SCY facilities on residential and other sensitive receptors	Moderate	Low	Given the current assessment work completed for the development by SMEC in partnership with DIT, and the on-going work that will need to be completed by DIT and authorities for the Lefevre Peninsula Masterplan, it is considered that suitable mitigation would be able to be implemented to reduce the impact to the road network incurred by the development and other growth on the Lefevre Peninsula in the future thus reducing the overall significance of effects. It is the responsibility of DIT to implement suitable noise mitigation as required.
Noise from operation of the SCY facilities on terrestrial fauna.	Negligible	Low	NIL
Noise from operation of the SCY facilities on marine fauna	Negligible	Low	NIL

Given the ‘Low’ level of assessment certainty associated with the 5% design status of the facility, it is recommended that an updated noise and vibration model/impact assessment be prepared once the design progresses further.

13 Conclusion

Resonate has undertaken an environmental noise and vibration impact assessment as part of the EIS for the proposed nuclear-powered Submarine Construction Yard. The assessment has considered both the construction and operation of the facility.

Given the "Low" level of assessment certainty associated with the 5% design status of the facility, it is recommended that an updated noise model/impact assessment be prepared once the design progresses further.

However, after reviewing the information, we anticipate that the planned construction and operation of the SCY precinct will be able to meet its environmental obligations as required by national and state legislation. This will be achieved through the implementation of recommended mitigation and management measures outlined in this report. These measures may be refined and reviewed as the design progresses.

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Appendix A—Operational noise assessment inputs

Resonate

Table 64: Summary of existing external mechanical plant and modelled noise levels

Plant	Overall SWL, dB(A)	Modelled Sound Power Level, dB						
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
S18								
Dust collector fan (x4)	101	108	110	104	97	91	89	85
Dehumidifier (x4)	95	96	100	91	89	91	87	85
Heater (x4)	75 dB(A) measured at 1 metre							
S18A								
Air handling unit	86	86	85	87	85	80	77	74
Heat Pump	86	86	85	87	85	80	77	74
Filtered fan unit	80	85	81	82	73	76	72	67
Dust collector fan (x5)	101	108	110	104	97	91	89	85
S20, S21, S22 Welding Extraction Fans								
EX-HP-B20-001	106	84	92	98	96	102	101	94
EX-HP-B20-002	105	83	91	96	95	100	100	92
EX-HP-B21-010	106	84	92	98	96	102	101	94
EX-HP-B21-011	106	84	92	98	96	102	101	94
EX-HP-B22-020	104	82	90	95	94	99	99	91
EX-HP-B22-021	105	83	91	96	95	100	100	92
EX-HP-B22-022	104	82	90	95	94	99	99	91
EX-HP-B22-023	105	83	91	96	95	100	100	92
EX-LP-B21-015	110	88	96	102	100	106	105	98
EX-LP-B22-025	114	92	100	106	104	110	109	102
EX-LP-B22-026	114	92	100	106	104	110	109	102
EX-LP-B22-027	114	92	100	106	104	110	109	102
S20, S21, S22 General Exhaust Systems (operating at 50% capacity under standard conditions)								
SEF-B20-01	83	82	85	82	79	78	75	73
SEF-B20-03	79	80	80	81	76	73	72	68
SEF-B20-05	79	80	80	81	76	73	72	68
SEF-B20-07	79	80	80	81	76	73	72	68
SEF-B20-09	83	87	81	79	79	78	76	74
SEF-B20-11	83	87	81	79	79	78	76	74

Resonate

Plant	Overall SWL, dB(A)	Modelled Sound Power Level, dB						
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
SEF-B20-13	83	87	81	79	79	78	76	74
SEF-B20-15	83	87	81	79	79	78	76	74
SEF-B20-17	79	80	80	81	76	73	72	68
SEF-B21-01	84	88	82	80	80	79	77	75
SEF-B21-05	84	88	82	80	80	79	77	75
SEF-B21-09	84	88	82	80	80	79	77	75
SEF-B21-13	84	88	82	80	80	79	77	75

Table 65: Summary of existing external mechanical plant attenuation

Equipment	Attenuator specification	Attenuator insertion loss / transmission loss, dB						
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
High pressure (HP) extract fans	2,100mm long, 27% open area to fan discharge	10	23	40	50	49	46	43
Low pressure (LP) extract fans	2,400mm long, 27% open area to fan discharge	11	25	44	50	50	48	45
B18 Plant Room	300mm deep acoustic louvre	5	8	13	20	23	23	19
Dust collector fans	2,100 mm long, 27% open area to fan discharge	10	23	40	50	49	46	43
Fan sound enclosure	-	6	12	5	20	8	3	6

Table 66: Modelled internal noise and acoustic performance categories for ONS buildings

Facility Code	Function	Internal noise level category	Acoustic performance category
Shipyard			
S02	Pipe Workshop, Module Outfitting Workshops + Test & Qualification	Low - 77 dB(A)	Low - R_W 17
S03	Blast & Paint Facilities + CNC	Low - 77 dB(A)	Low – R_W 17
S04	Block Outfitting	Low - 77 dB(A)	Low - R_W 17
S18	Blast & Paint Facilities	Blasting - 106 dB(A)(1)	Medium - R_W 32
S18A	Blast & Paint Facilities	Blasting - 108 dB(A)(2)	Medium - R_W 32
S20	Steel Fabrication & Unit Assembly	Low - 77 dB(A)	Low - R_W 17
S21	Block Assembly Hall	Medium - 80 dB(A)	Low - R_W 17

Facility Code	Function	Internal noise level category	Acoustic performance category
S22	Block Outfitting & Erection Hall	Low - 77 dB(A)	Low - R_W 17
Collins Class Submarine Facility			
N15	Outfitting Workshop	Medium - 80 dB(A)	Low - R_W 17
N16	Blast & Paint Facility	Blasting - 102 dB(A)(3)	Medium - R_W 32
N17	Hull Workshop	Medium - 80 dB(A)	Low - R_W 17

(1) Continuous operation of 6 blasting nozzles

(2) Continuous operation of 10 blasting nozzles

(3) Continuous operation of 2 blasting nozzles

Appendix B—Terrestrial fauna species list

Resonate

Table 67: Fauna species observed within the subject site (Succession Ecology 2023 and GHD 2024a). Exotic species are indicated with an asterisk (*)

Species (Common name)	*EPBC Act*	*NPW Act*	*LSA Act*	Data source
Birds				
Acrocephalus australis (Australian Reed Warbler)				3
Actitis hypoleucos (Common Sandpiper)	Mi	R		4
Anas gracilis (Grey Teal)				1, 3
Anas platyrhynchos (Mallard) *				1
Anthochaera carunculata (Red Wattlebird)				3
Anthochaera chrysoptera (Little Wattlebird)				3
Anthus australis (Australian Pipit)	Ma			3
Ardea intermedia (Intermediate Egret)				3
Elseyornis melanops (Black-fronted Dotterel)				3
Himantopus himantopus (Black-winged Stilt)	Ma			3
Cacatua roseicapilla (Galah)				3
Cacatua sanguinea (Little Corella)				
Calidris acuminata (Sharp-tailed sandpiper)	VU, Mi, Ma			3, 4
Calidris ruficollis (Red -necked Stint)	Mi, Ma			
Chroicocephalus novaehollandiae (Silver Gull)				1, 3
Cincloramphus cruralis (Brown Songlark)				3
Colluricincla harmonica (Grey Shrike-thrush)				3
Columba livia (Feral Pigeon) *			Declared	1, 3
Corvus mellori (Little Raven)				1, 3
Coturnix ypsilophora australis (Brown Quail)				
Cracticus tibicen (Australian Magpie)				3
Cygnus atratus (Black Swan)				3
Egretta novaehollandiae (White-faced Heron)				1
Erythrogonys cinctus (Red-kneed Dotterel)				1, 3
Gallinula tenebrosa (Dusky Moorhen)				1, 3
Glossopsitta concinna (Musk Lorikeet)				3
Grallina cyanoleuca (Magpie-lark)				1,3
Haematopus longirostris (Pied Oystercatcher)		R		3
Hirundo neoxena (Welcome Swallow)				1
Hydroprogne (Sterna) caspia (Caspian Tern)	Mi			4
Lichenostomus virescens (Singing Honeyeater)				1

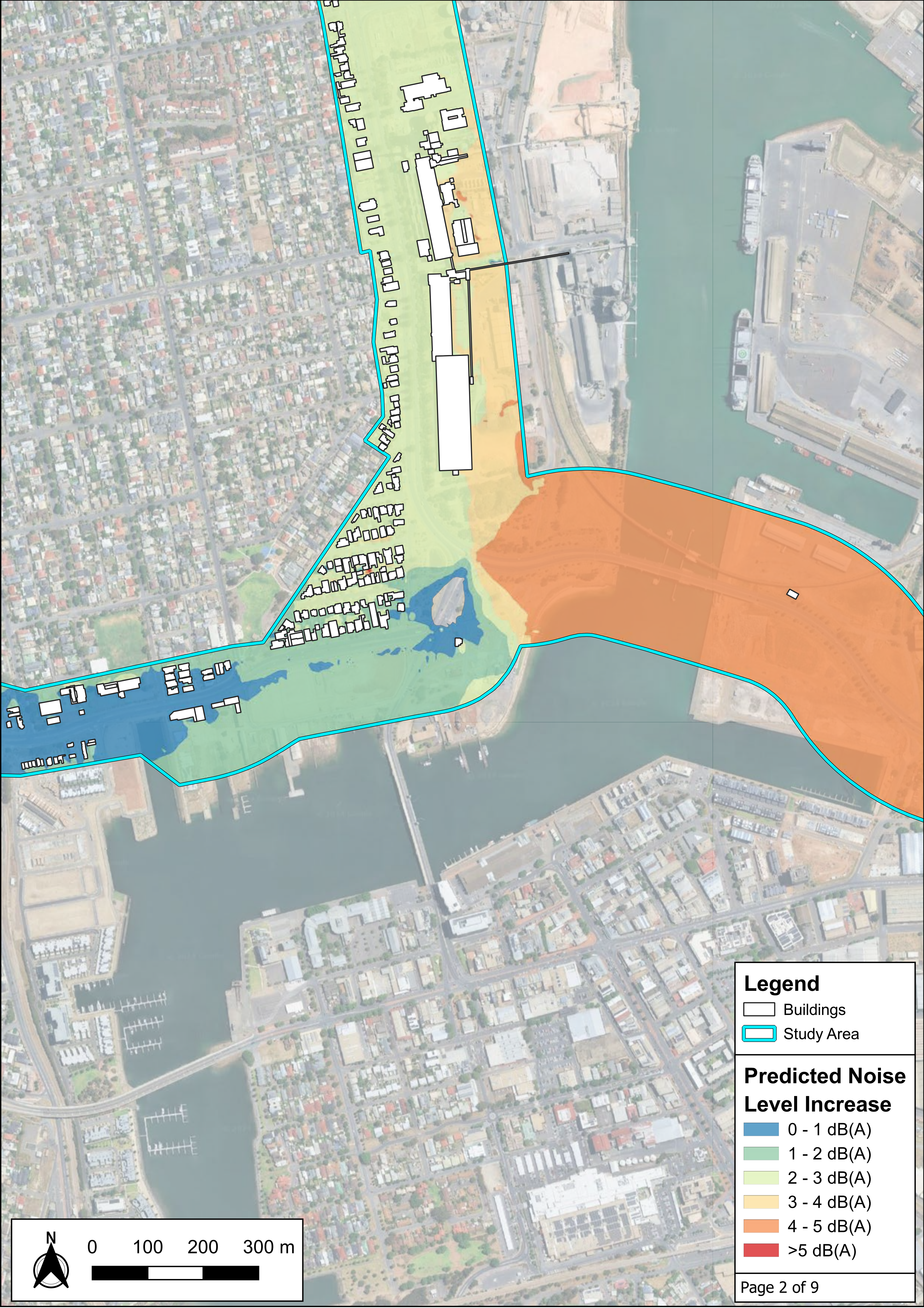
Resonate

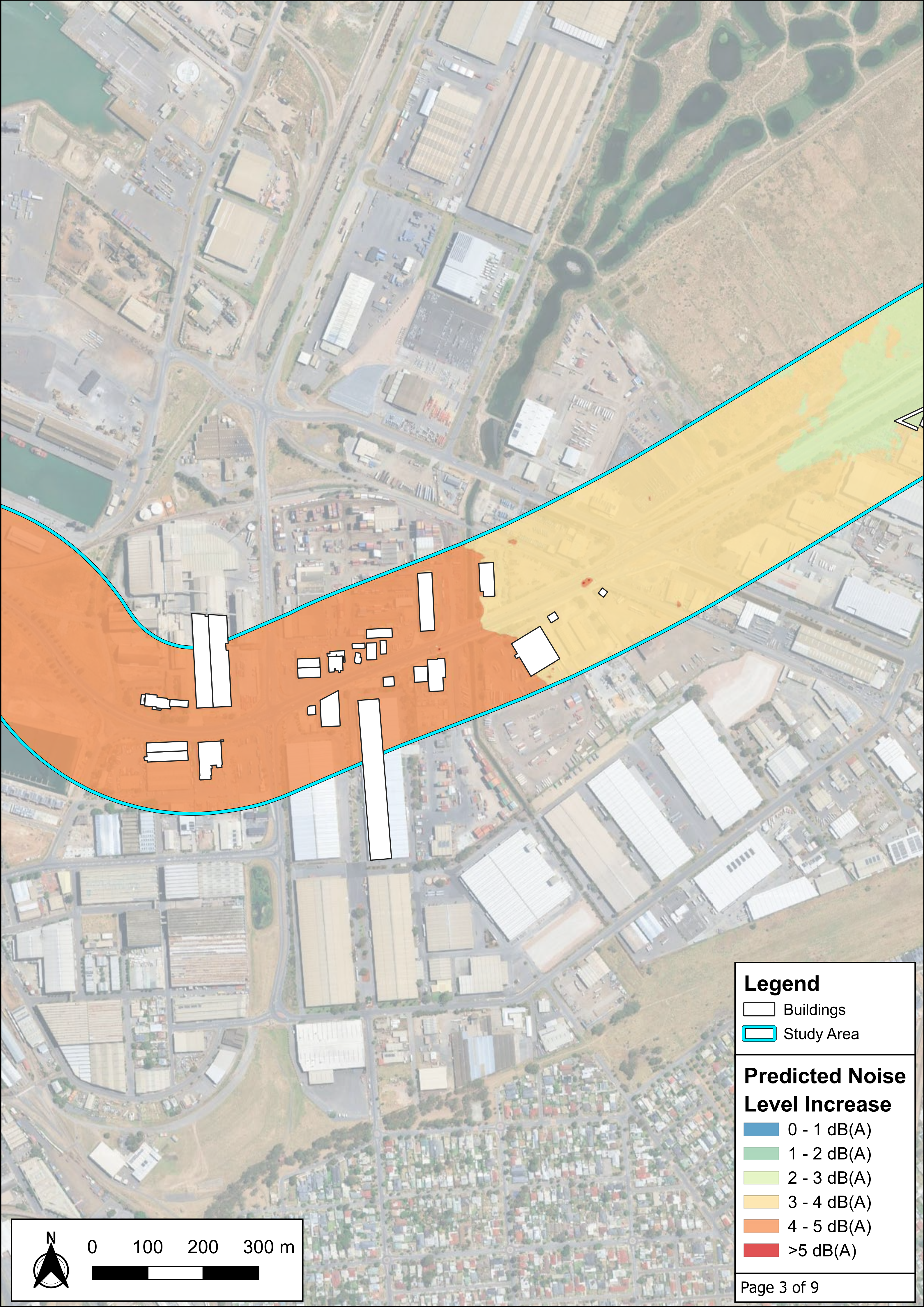
Species (Common name)	*EPBC Act*	*NPW Act*	*LSA Act*	Data source
Lichenostomus penicillata (White-plumed Honeyeater)				1
Manorina melanocephala (Noisy Miner)				1
Microcarbo melanoleucos (Little Pied Cormorant)				1, 3
Neophema elegans (Elegant Parrot)		R		3
Ocyphaps lophotes (Crested Pigeon)				1, 3
Passer domesticus (House Sparrow) *			Declared	3
Pelecanus conspicillatus (Australian Pelican)	Ma			3
Petrochelidon ariel (Fairy Martin)				3
Phalacrocorax carbo (Great Cormorant)				3
Phylidonyris novaehollandiae (New Holland Honeyeater)				1, 3
Platalea regia (Royal Spoonbill)				1, 3
Poliocephalus poliocephalus (Hoary Headed Grebe)				1
Porzana fluminea (Australian Spotted Crake)				3
Rhipidura leucophrys (Willie Wagtail)				1
Sturnus vulgaris (Common Starling) *			Declared	3
Thalasseus bergii (Greater Crested Tern)	Mi			3,4
Threskiornis molucca (Australian White Ibis)	Ma			3
Todiramphus sanctus (Sacred Kingfisher)				1
Tringa glareola (Wood Sandpiper)	Ma, Mi	R		4
Tringa nebularia (Common greenshank)	EN, Mi			3
Tringa stagnatilis (Marsh Sandpiper)	Mi			4
Turdus merula (Common Blackbird)			Declared	1, 3
Vanellus miles (Masked Lapwing)				1, 3
Zosterops lateralis (Silvereye)				
Mammals				
Vulpes vulpes (European Fox) *			Declared	1,3
Oryctolagus cuniculus (Rabbit) *			Declared	3
Hydromys chrysogaster (Water Rat)				3
Amphibians				
Limnodynastes tasmaniensis (Spotted Marsh Frog)				3
Reptiles				
Pseudonaja textilis (Eastern Brown Snake)				3
Tiliqua rugosa (Shingleback)				3

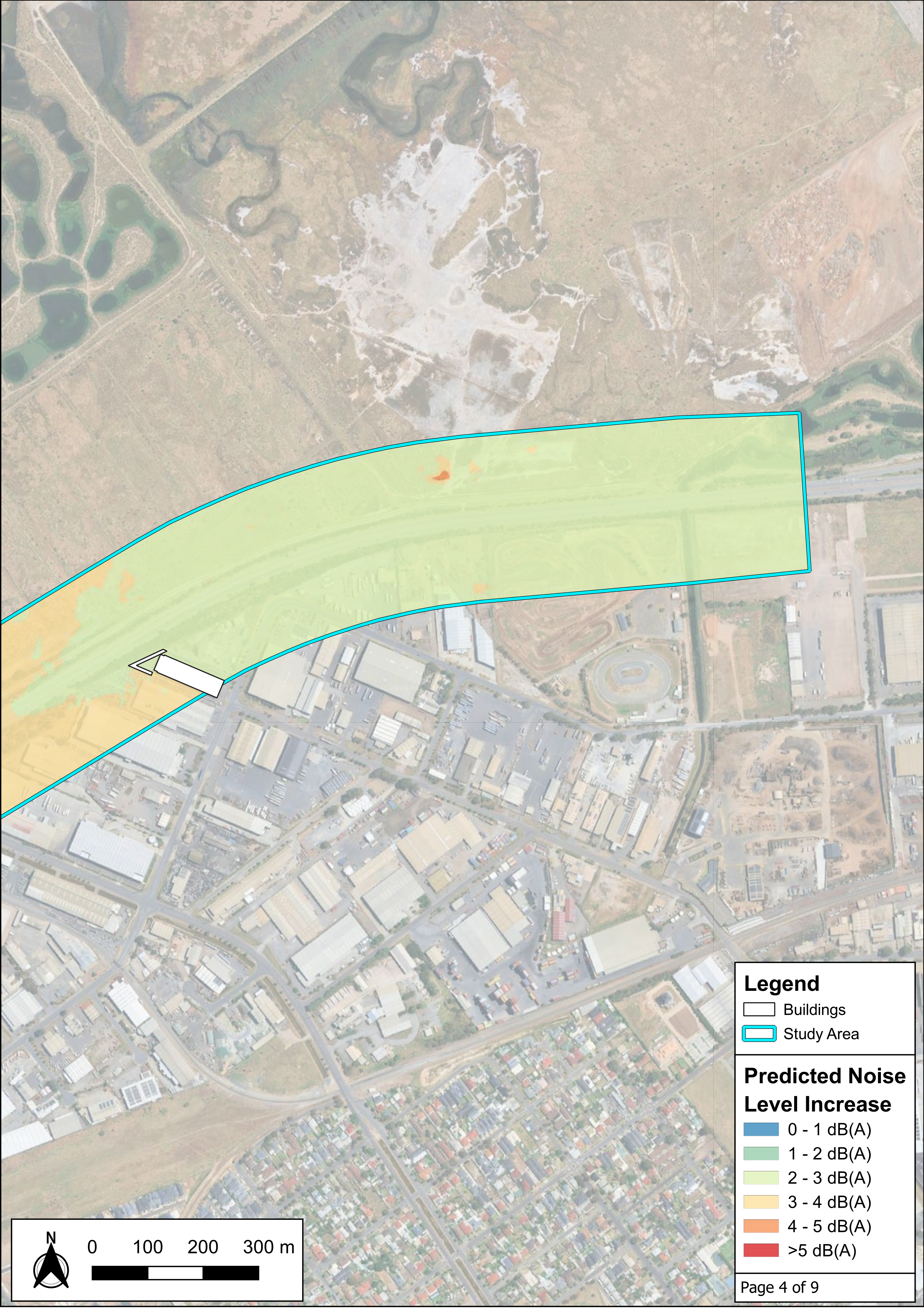
Species (Common name)	*EPBC Act*	*NPW Act*	*LSA Act*	Data source
Sources: 1. Succession Ecology. 2023. The Expansion of the Osborne Naval Shipyard, Baseline Environmental Report, Succession Ecology report ES0723-06, prepared for URPS. (Succession Ecology 2023). 2. GHD. 2024. Osbourne Preliminary Environmental and Hertiage Impact Assessment, Ecological Investigation report. (GHD 2024a). 3. GHD. 2023. Biodiversity Values Report - Osborne North Car Park and Grade Separated Road. (GHD 2023). 4. GHD. 2024. Migratory Bird Survey – Summer 2023-2024 Migration Period Osbourne Submarine Construction Yard. DRAFT. (GHD 2024b). Abbreviations: *EPBC Act*: (Mi) Migratory, Ma (Marine), (CR) Critically Endangered, (EN) Endangered, (VU) Vulnerable *NPW Act*: (E) Endangered, (V) Vulnerable, (R) Rare				

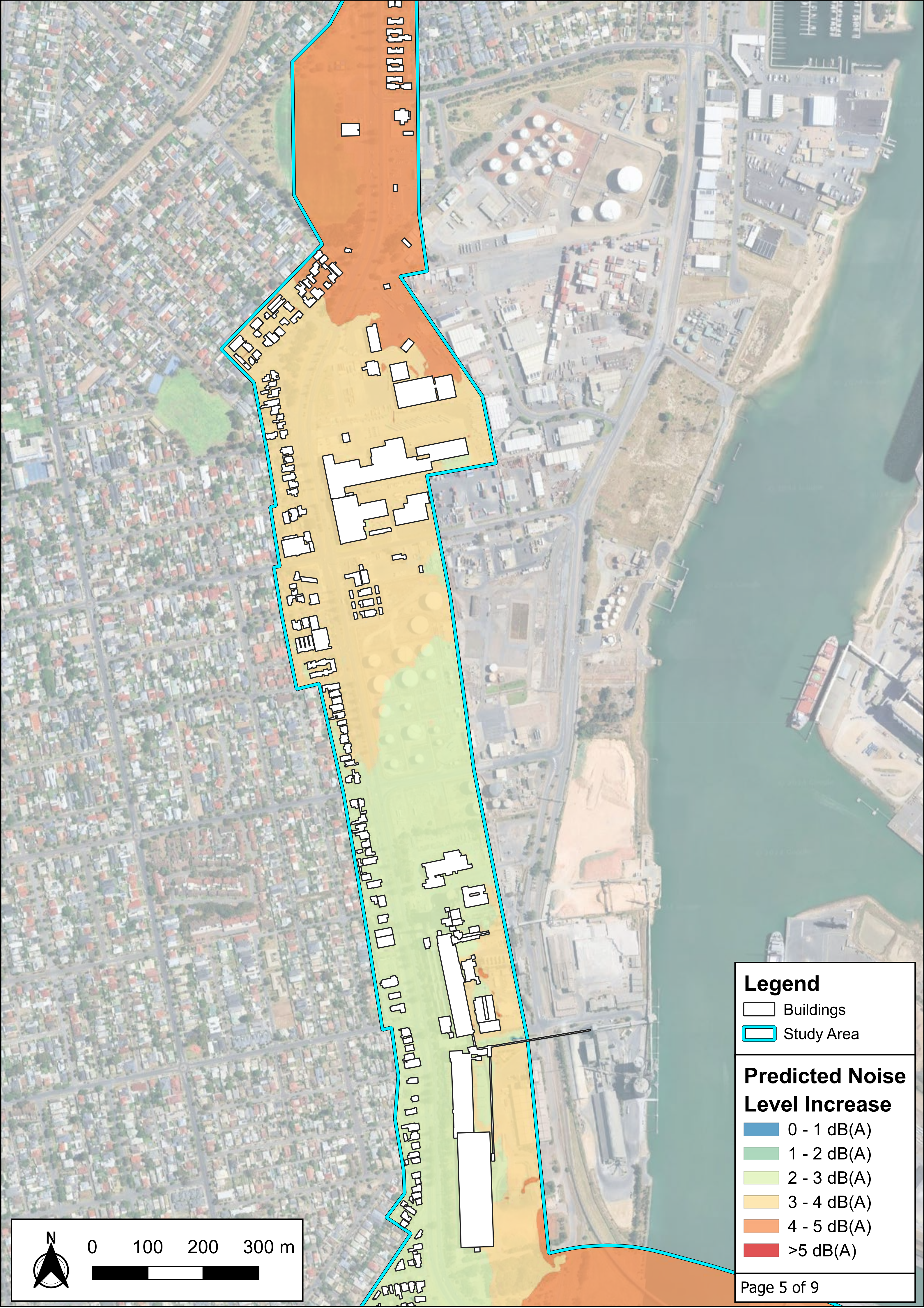
Appendix C—Road traffic noise level difference contours


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
0
100
200
300 m


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
0
100
200
300 m


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
0
100
200
300 m


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
0
100
200
300 m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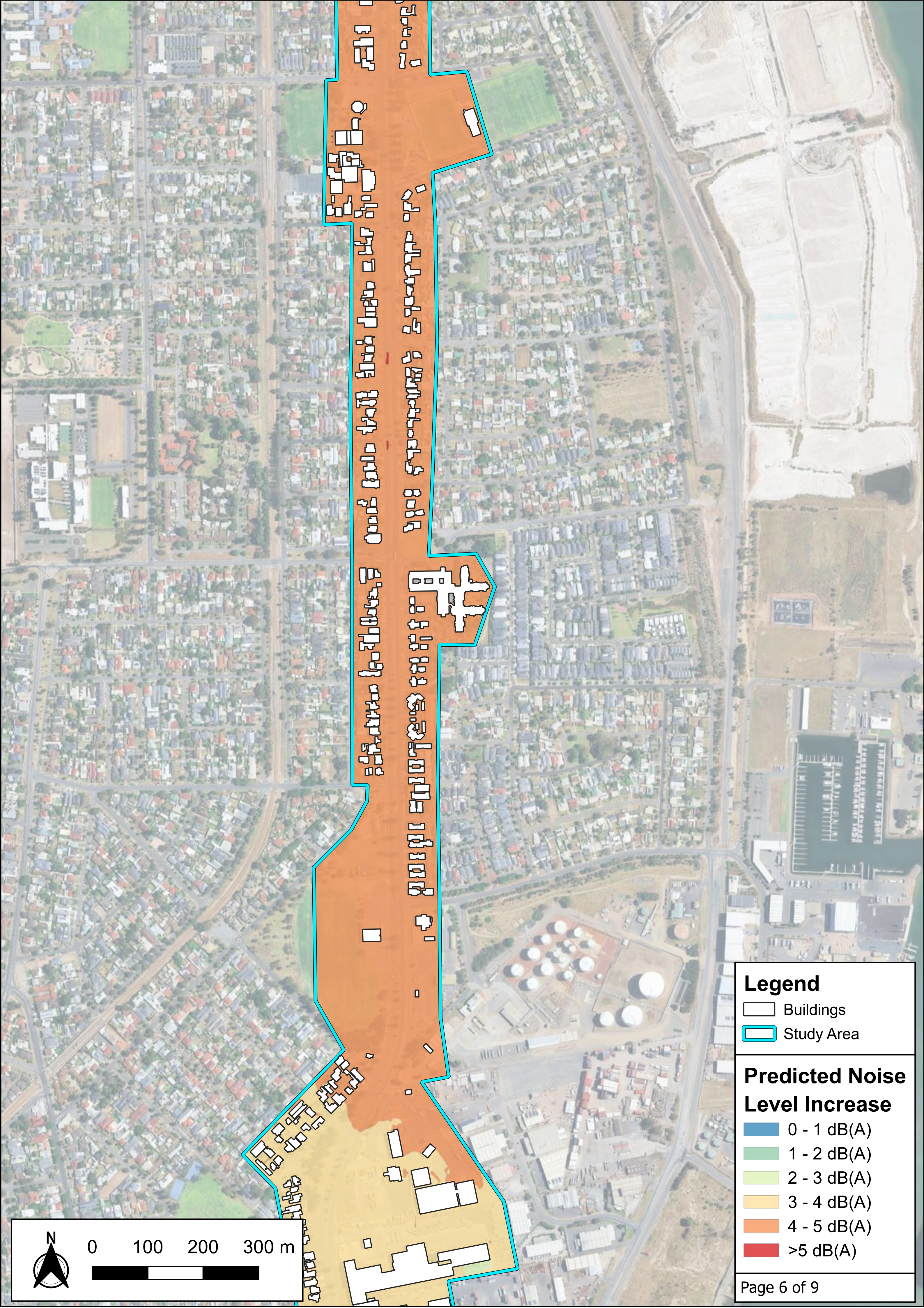
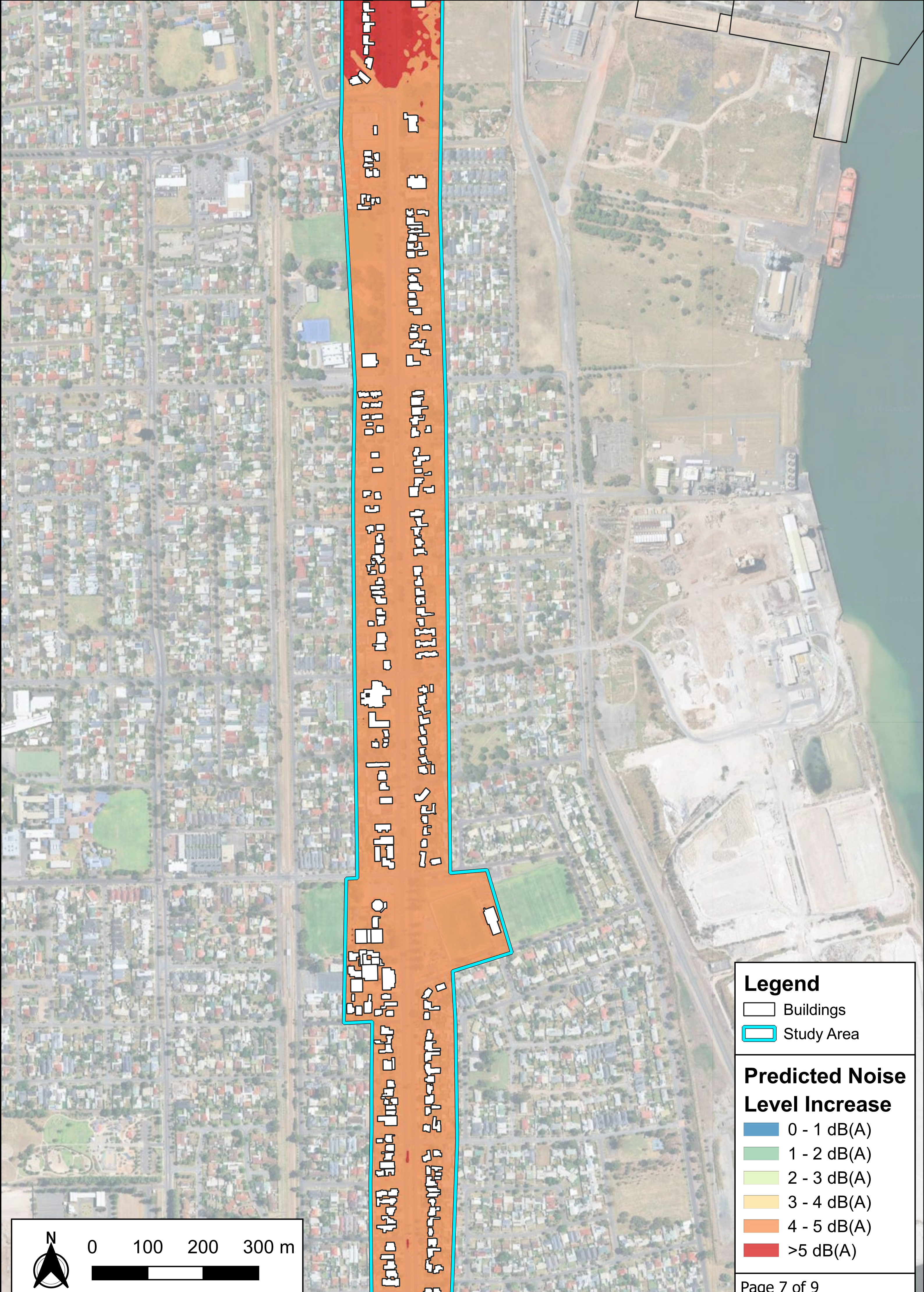
300 m
Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
0
100
200
300 m


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
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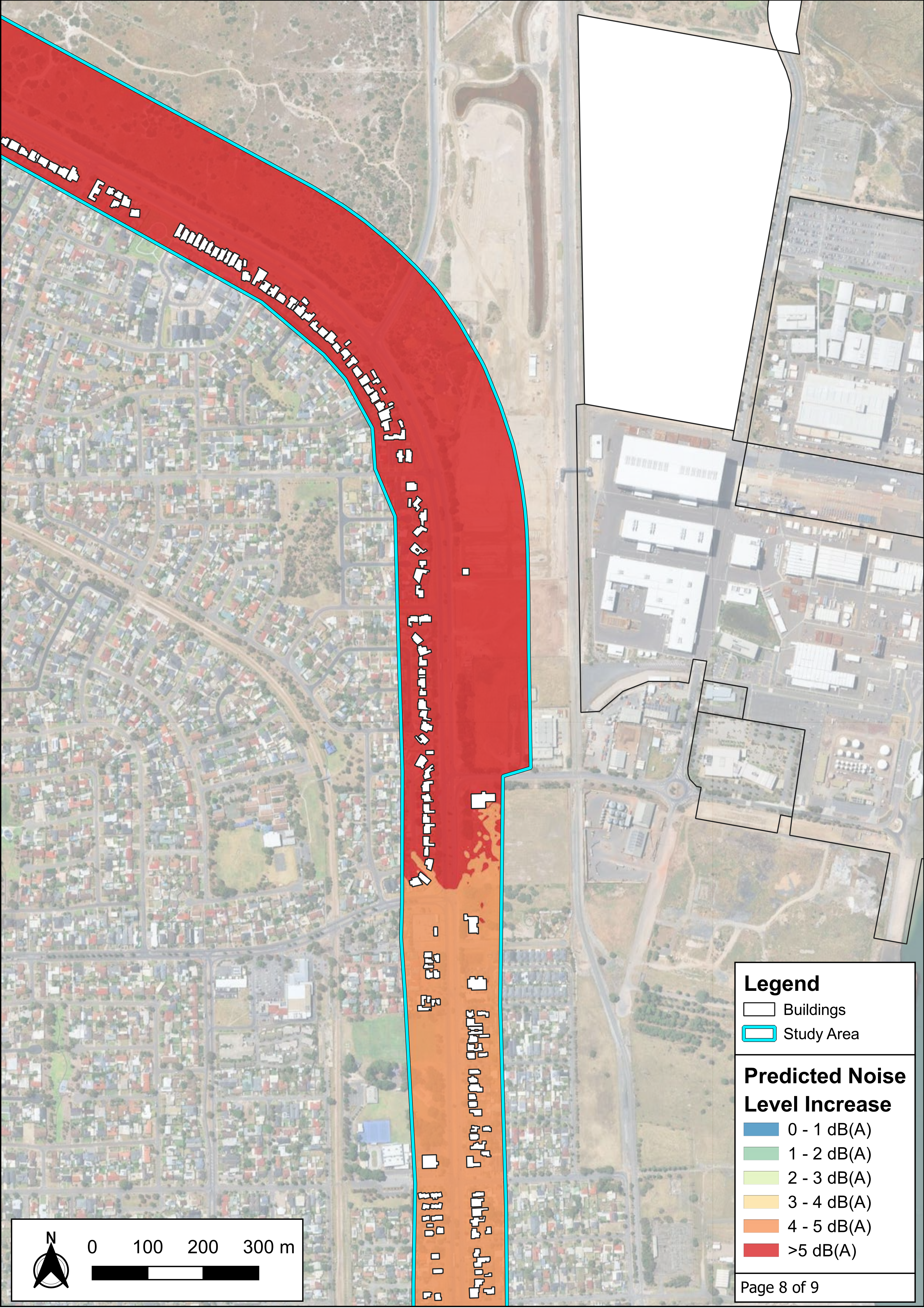
300 m


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
0
100
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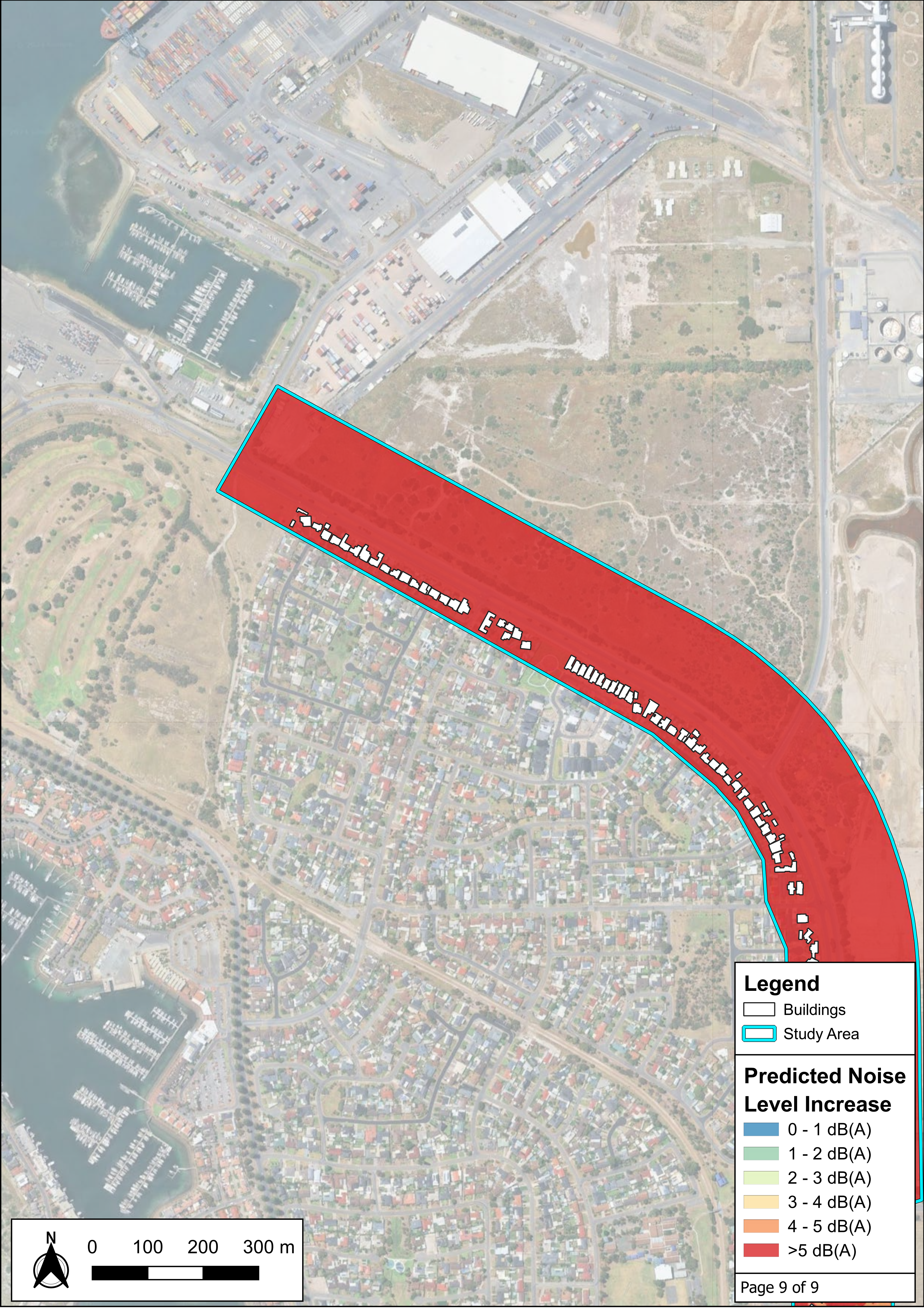
300 m


Legend
Buildings
Study Area
Predicted Noise Level Increase
0 - 1 dB(A)
1 - 2 dB(A)
2 - 3 dB(A)
3 - 4 dB(A)
4 - 5 dB(A)
>5 dB(A)
N
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300 m