Environmental Impact Assessment Report (EIAR) – Volume 2

Chapter 12 – Underwater Noise and Vibration

Proposed ORE Capable Terminal on a 250m Wharf Extension & Ancillary Operational Support Infrastructure

Port of Waterford Company

Port of Waterford, Belview, Co. Kilkenny

CHAPTER 12

MALONE O'REGAN ENVIRONMENTAL

QUALITY
I.S. EN ISO 9001:2015
NSAI Certified

FIGURES

TABLES

APPENDICES

All appendices referenced in this document are presented in EIAR Volume III

APPENDICES CHAPTER 12

12 UNDERWATER NOISE AND VIBRATION

12.1 Introduction

This chapter of the EIAR was prepared by the MOR Environmental team and provides a description and assessment of the likely effects of the Proposed Development on underwater noise and vibration.

In this chapter, the following is presented:

- Quantification of the existing ambient and background acoustic / sound environment;
- Quantification of the likely construction and operational noise associated with the Proposed Development;
- Assessment of the likely significance of impacts arising from the Proposed Development; and,
- Outline any relevant and proportional mitigation measures to the project design.

This underwater noise assessment includes a description of the receiving environment, an outline of likely significant effects, recommendations for mitigation measures, a statement of residual impacts and monitoring proposals for the Proposed Development. The methodology used aligns with best practices for underwater noise assessments and involves collaboration with specialists in benthic and fisheries as well as marine mammals.

Underwater noise levels at the Port of Waterford have been monitored through the deployment of a hydrophone on the shipping channel route, and data gathered over 12 months. The noise from shipping traffic is influenced by the proximity of passing vessels.

The assessment is based on a series of measurements that describe the receiving environment, followed by an evaluation of activities likely to produce underwater noise. Potential impacts are detailed and assessed, with recommended mitigation measures and monitoring requirements provided.

12.2 Methodology

Underwater noise generated during the Construction and Operational Phases of the Proposed Development could affect marine mammals and fish protected under the EU Habitats Directive and Council Regulations and may impact human activities such as diving.

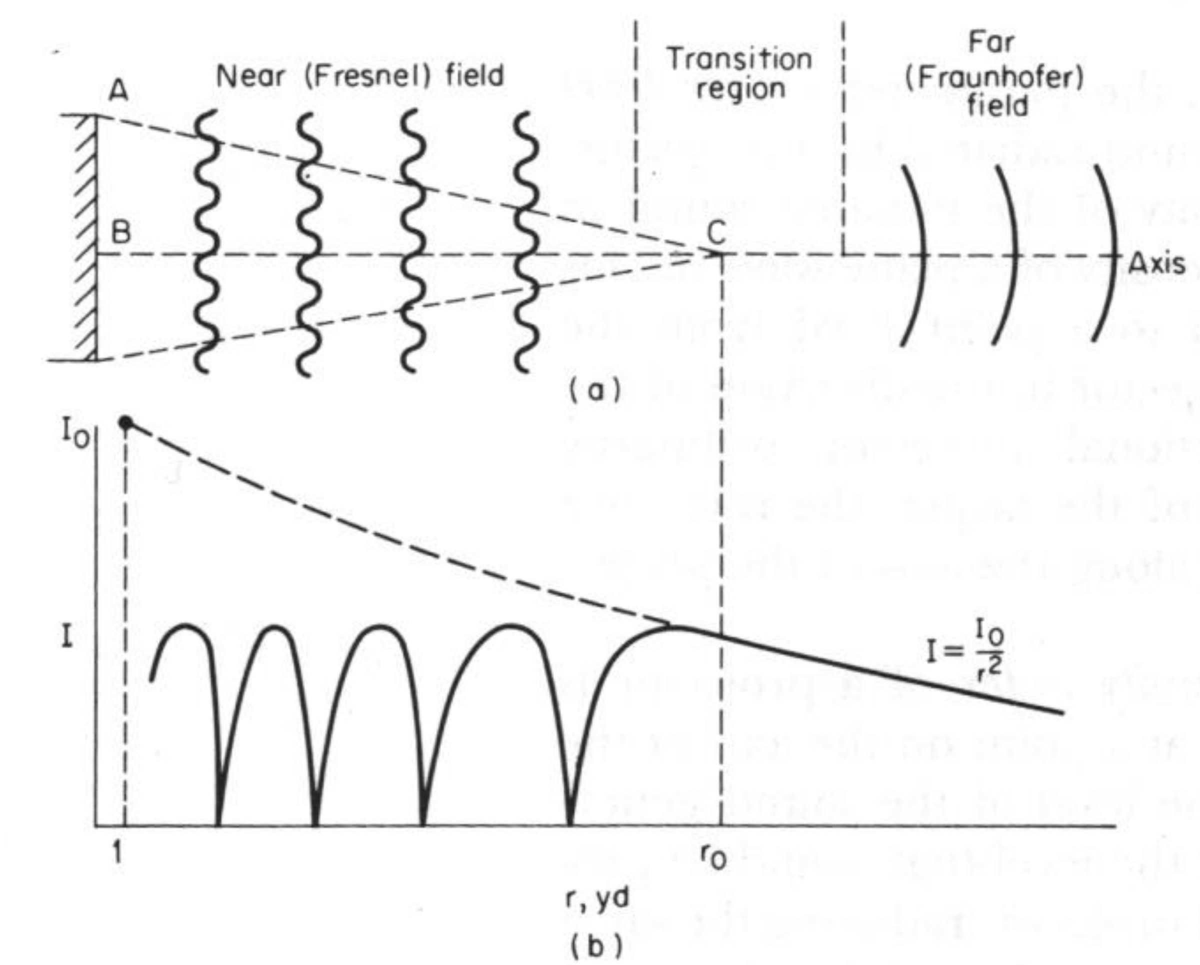
For underwater noise, absolute values express the ratio of an underwater sound pressure to a reference value of 1 micropascal ('µPa'). When expressing underwater noise levels, the decibel symbol is appended with the reference value, for example, 180 dB re 1 µPa. The level in decibels depends entirely on the reference level. It's important to note that the reference level for airborne (terrestrial) noise (Section 11.1) differs from that of underwater noise, and the acoustic impedance of air and water is also different. This results in significantly higher decibel levels for the same sound pressure level in water compared to air, meaning that direct comparisons between the two are not meaningful.

Another important aspect of noise is that it is not a persistent pollutant; once the noise source stops, noise levels quickly return to pre-existing levels. The natural underwater soundscape is not silent, as biological sounds from fish and marine mammals combine with sounds from waves, surface noise, current flow, turbulence, and rain or storm noise, creating a natural sound within the water. Additionally, human activities, including boating, water abstraction, pumps and recreational activities, also effect the sound levels within the water. The baseline sound monitoring has gathered data from all existing sources over the twelve-month monitoring period to present as a working baseline for this local environment.

12.2.1 Underwater Noise Sources

Quoted (peak) source levels for underwater noise sources are quoted in dB re µPa at 1 metre. This is a 'notional' figure extrapolated from far-field measurements, as it is not practicable to measure sound levels at 1m from an active source such as a ship or a pile-driver. Measurements are taken in what is known as the far field and extrapolated back to a notional 1m from the idealised point source. It is usual to take measurements at several hundred metres or kilometres in deep water and extrapolate the measured levels to what has become known as a 1m source level. This is illustrated in Figure 12-1 below [1].

Figure 12-1: Underwater Noise Source Levels Fields



The actual propagation of sound in the near (Fresnel) field produces an undulating curve, but the extrapolated (dashed) line indicates a much higher theoretical source level.

This extrapolation leads to apparently high values for the source level and can lead to erroneous conclusions about the impact on marine mammals and fish for the following reasons:

- Far-field source levels do not apply in the near field of the array, where the sources do not add coherently; sound levels in the near field are, in fact, lower than would be expected from far field estimates;
- Source-level calculations are generally based on theoretical point sources with sound propagating equally in all directions. This is not easily replicated in real-world conditions: and,

- The majority of published data for underwater sources is based on deep water measurements. Sound propagation in shallow water is significantly more complex as sound does not propagate as efficiently as it would in deep water.

Details of typical underwater noise levels are set out in Table 12-1 below.

Table 12-1: Table of typical underwater noise levels (Excerpt from Appendix 1 NPWS 2014 [2])

Source	SPL dB re:1μPa @1m	Sound Duration Seconds	Peak Frequency Hertz	Bandwidth Hertz
Super Tanker 337m long @18knots	185	Constant	23	5-100
Dredging (Suction/Hopper dredge)	177	Constant	80-200	20-8,000
Tug vessel (while towing)	145-170	Constant	-	37-5,000
Fishing vessel 12m long @7knots)	150	Constant	300	250-1,000

12.2.2 Underwater Noise Criteria

The criteria used to assess the significance of the underwater noise effects are presented in Table 12-2. Underwater noise criteria are the subject of ongoing research. In many cases, species-specific data is sparse or does not currently exist and must be extrapolated from similar species. The criteria are selected from the best international practices and publications. The threshold for otter has been presented in Section 11.2.5 above.

Table 12-2: Underwater Noise Impact Criteria

Organism	Impact Type	Threshold dB	Data Source
Human Diver	Annoying but not harmful	160 dB re: 1μPa SPL_{Peak}	Norro et al (2010)
	Just audible	145 dB re: 1μPa SPL_{RMS}	Parvin et al. (2002)
Eggs and Larvae	Mortality of fish eggs and larvae	>210 dB re 1μPa^2/s SEL_{cum} >207 dB re: 1μPa SPL_{Peak}	Popper et al., (2014)
Fish[Note 1]	Mortality/ PTS in adult fish	210 dB re 1μPa^2/s SEL_{cum} >207 dB re: 1μPa SPL_{Peak}	Popper et al., (2014)
	Recoverable injury in adult fish	203 dB re 1μPa^2/s SEL_{cum} >207 dB re: 1μPa SPL_{Peak}	Popper et al., (2014)
	Temporary Threshold Shift (TTS)	186 dB re 1μPa^2/s SEL_{cum}	Popper et al., (2014)
Fish[Note 2]	Mortality/ PTS in adult fish	207 dB re 1μPa^2/s SEL_{cum}	Popper et al., (2014)

Organism	Impact Type	Threshold dB	Data Source
		>207 dB re: 1μPa SPL_{Peak}	
	Recoverable injury in adult fish	203 dB re 1μPa²/s SEL_{cum} >207 dB re: 1μPa SPL_{Peak}	Popper et al., (2014)
	Temporary Threshold Shift (TTS)	186 dB re 1μPa²/s SEL_{cum}	Popper et al., (2014)
Fish Note 3	Mortality/ PTS in adult fish	219 dB re 1μPa²/s SEL_{cum} >213 dB re: 1μPa SPL_{Peak}	Popper et al., (2014)
	Recoverable injury in adult fish	216 dB re 1μPa²/s SEL_{cum} >213 dB re: 1μPa SPL_{Peak}	Popper et al., (2014)
	Temporary Threshold Shift (TTS)	186 dB re 1μPa²/s SEL_{cum}	Popper et al., (2014)
Cetaceans	Permanent Threshold Shift (PTS) [SPL_{Peak}]	230 dB re: 1μPa SPL_{Peak} 198 dB re 1μPa²/s SEL	NPWS (2014)
	Temporary Threshold Shift (TTS) and Behaviour effects	183 dB re: 1μPa SPL_{Peak} 183 dB re: 1μPa²/s SEL	NPWS (2014)
Pinnipeds	Permanent Threshold Shift (PTS)	218 dB re: 1μPa SPL_{Peak} 186 dB re 1μPa SEL	NPWS (2014)
	Temporary Threshold Shift (TTS) and Behaviour effects	212 dB re: 1μPa SPL_{Peak} 171 dB re: 1μPa²/s SEL	NPWS (2014)
Mustelids (Sea Otters)	Permanent Threshold Shift (PTS)	219 dB re 1μPa²/s SEL	Finneran & Jenkins (2012)

Note 1: Fish: swim bladder is not involved in hearing.
Note 2: Fish: swim bladder involved in hearing.
Note 3: Fish: no swim bladder.

The underwater noise impact thresholds used in this chapter are set out generally by Popper et al. (2014) [3], NPWS (2014) [2], NOAA (2013) [4] and Finneran & Jenkins (2012) [5].

12.2.3 Predicted Underwater Levels

The predicted peak-to-peak source level from sources, like piling, could be calculated using the equation by Nedwell et al. (2005) [6]

$$SL = 24.3D + 179$$

Where D is the pile diameter (m).

12.2.3.1 Transmission loss

There are various methods to model sound propagation between a source and a receiver. These range from simple models that assume sound spreads according to a 10 log (r) or 20 log (r) relationship, where r is the distance in meters, to more complex acoustic models like ray tracing, normal mode, parabolic equation, wavenumber integration and energy flux models. Additionally, semi-empirical models offer a balance between simplicity and complexity.

In acoustically shallow waters, sound propagation is largely influenced by multiple interactions with the seabed and water surface (Lurton 2002 [7] ; Etter 2013 [8]; Urick 1983 [1]; Kinsler et al. 1999 [9]). In deeper waters, sound travels further without encountering these boundaries, while in shallow waters, sound is frequently reflected and absorbed by both.

When selecting a propagation model, it is essential to ensure it is appropriate for the specific application and provides an acceptable level of accuracy based on the context. In some cases - such as when underwater noise poses a low risk, bathymetry variations are not significant, or the sound is non-impulsive - a simple (N log R) model may be adequate, especially if other uncertainties have a greater impact than the model itself. However, in situations involving very high source levels, impulsive sound, complex source and propagation characteristics, sensitive receivers and low uncertainty in assessment criteria, a more advanced modelling approach is necessary.

The propagation loss used in this chapter assessment is calculated using the following formula, unless otherwise stated:

$$TL = 15\log_{10} R + \log_{10}(H\beta) + \frac{\beta R \theta_L^2}{4H} - 7.18 + \alpha_W R \ (1)$$

Where:

- R is the range in m;
- H is the water depth (m);
- β is the bottom loss;
- θ_L the limiting angle; and;
- α_W is the absorption coefficient of sea water, this value is a frequency dependant term [10].

The limiting angle, θ_L, is the larger of θ_g and θ_c where θ_g is the maximum grazing angle for a skip distance and θ_c is the effective plane wave angle corresponding to the lowest propagating mode. The formulas to calculate these angles are:

$$\theta_g = \sqrt{\frac{2Hg}{c_w}} \ (2)$$

$$\theta_c = \frac{c_w}{2fH} \ (3)$$

Where:

- g is the sound speed gradient in water; and
- f is the frequency.

The bottom loss β is approximated as the following equation:

$$\beta \approx \frac{0.477\left(\rho_s/\rho_w\right)\left(c_w/c_s\right)K_s}{\left[1-\left(c_w/c_s\right)^2\right]^{\frac{3}{2}}} \ (5)$$

Where:

- ρ_s is the density of sediment;
- ρ_w the density of water;
- c_s is the sound speed in the sediment;
- c_w is the sound speed in water and;
- K_s is the sediment attenuation coefficient.

Irish coasts are mapped by INFORMAR.

> *"INFOMAR is Ireland's national seabed mapping programme and is funded by the Department of Environment, Climate and Communications (DECC). It is jointly managed by Geological Survey Ireland and Marine Institute and is tasked with fully mapping Ireland's territorial waters for the sustainable development of Ireland's marine resource. INFOMAR will continue until the end of 2026, enabling effective management and accelerated growth to support Harnessing Our Ocean Wealth."*

Bathymetry data was sourced to identify the different depths of the Lower Suir Estuary for insertion into the above equation. The wide dataset is used principally to calculate an average value, which is then incorporated into the modelling process. It should be noted that the data is sourced from LiDAR, primarily reflecting rock or ground surfaces, with softer materials such as mud generally excluded from capture.

Following analysis of the locality, the Site and the Proposed Development, three paths were considered to evaluate the depths. The three paths are:

- Sound travels downriver toward the sea,
- Sound travels upriver towards Waterford City; and,
- Sound travels through Cheekpoint area.

Following a review of the profile depths along the three paths, it was noted no significant variation is presented, and an average of the depths was used. The average depth used in this analysis is -8.3m.

Due to the proximity of sensitive protected species and the potential for high levels of underwater noise from impact piling in particular, this EIAR includes this specific assessment of underwater noise levels.

12.2.4 Port of Waterford Masterplan

The Port of Waterford Masterplan [11] presents the Environmental Objectives, Targets and Indicators regarding underwater noise, which is detailed in Table 12-3 below.

Table 12-3: Excerpt from Table 9.4 from POW Masterplan [11]

Environmental Topic	Objectives	Targets	Indicators	Responsible Authority and Possible Data
Acoustics	A2: To minimise acoustic impacts to local communities and aquatic environment during the operational stage.	To achieve a 'Good Environmental Status' ('GES') for the acoustic aquatic environment from direct and indirect activities as part of the Master Plan	Underwater acoustics shall comply with the Marine Strategy Framework Directive (2008/56/EC) to 'not adversely affect the marine environment'.	POW monitoring and reporting

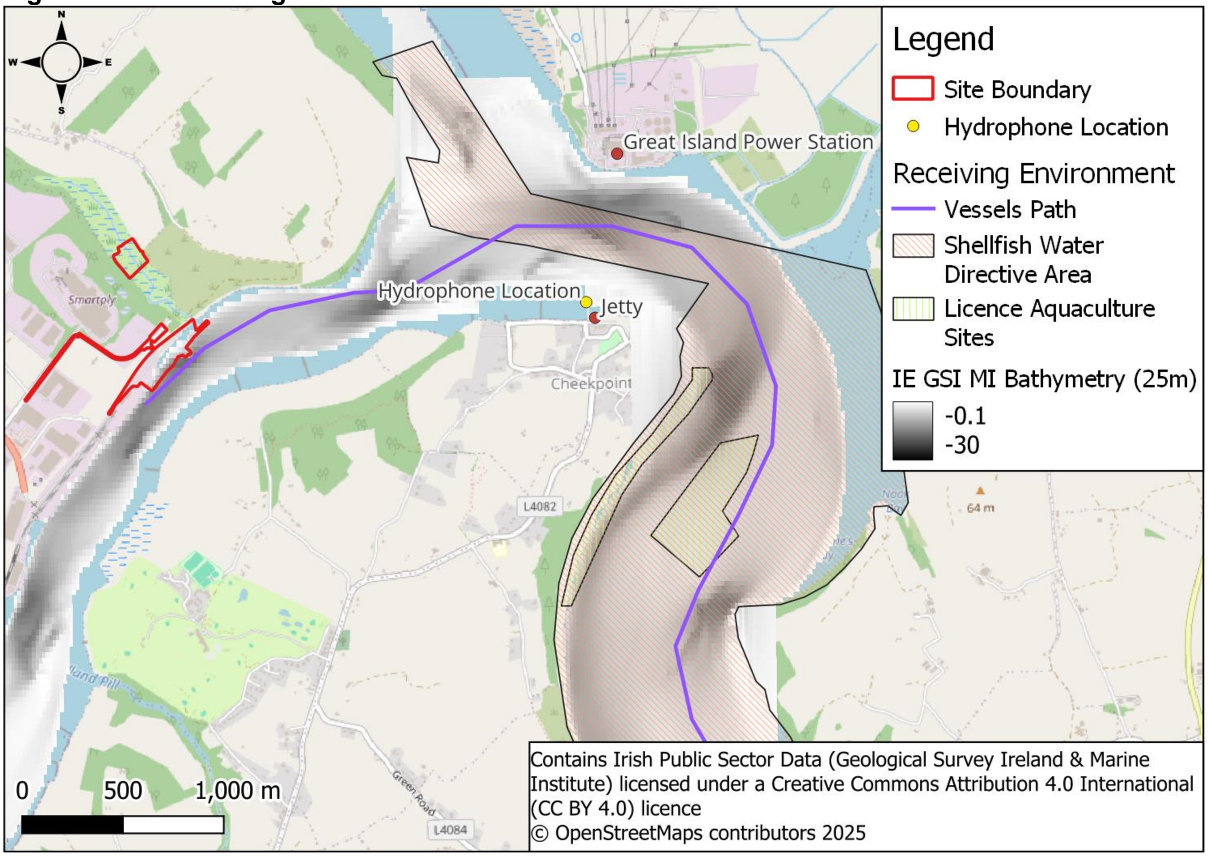
12.3 Receiving Environment

Underwater noise levels can be divided into three typical categories:

- Background noise level (no dominant sound, low noise level);
- Biological noise level (louder sounds not attributable to anthropogenic sources); and,
- Shipping noise (louder sounds attributable to shipping traffic).

The receiving environment is a confined channel with air above, and the river base below and the riverbanks on either side. Local anthropogenic activities affecting the noise in the water include the existing Port of Waterford activities, recreational boating / water sports and local fishermen using jetties onto the river; further downstream, the power plant water abstraction and fish alarm system and local salmon farmers. The seabed is primarily composed of silty sand, which contributes to natural sound absorption. Figure 12-2 presents the receiving environment surrounding the Site.

Figure 12-2: Receiving Environment



Underwater noise levels are generally influenced by regular shipping activity in the area. The Site is located in proximity to noise-sensitive receptors due to the proximity of marine species, including fish. Table 12-4 below specifies different species identified in the local river.

Table 12-4: Marine species near the Site

Fish Classification Table 12-2	Types	Species	Impact Type	Threshold dB
Fish: swim bladder is not	Salmon	Designated fish species (‘SAC’ designated)	Mortality/ PTS in adult fish*	>207 dB re: 1μPa^2/s SPL_{Peak}

Fish Classification Table 12-2	**Types**	**Species**	**Impact Type**	**Threshold dB**
involved in hearing.	Brown trout	Non-designated fish species	Recoverable injury in adult fish Temporary Threshold Shift ('TTS')	>207 dB re: 1μPa SPL_{Peak} 186 dB re 1μPa^2/s SEL_{cum}
	Sea trout			
	European eel			
Fish: swim bladder involved in hearing.	Twaite shad	Designated fish species ('SAC' designated)		
	Herring	Non-designated fish species		
	Smelt			
	Sprat			
	Sea Bass			
	Cod			
Fish: no swim bladder.	River lamprey	Designated fish species ('SAC' designated)	Mortality/ PTS in adult fish* Recoverable injury in adult fish Temporary Threshold Shift ('TTS')	>213 dB re: 1μPa^2/s SPL_{Peak} >213 dB re: 1μPa SPL_{Peak} 186 dB re 1μPa^2/s SEL_{cum}
	Sea lamprey			
Marine mammals – Cetaceans (Dolphins & Porpoise)	Common dolphin	Cetaceans	Permanent Threshold Shift ('PTS') Temporary Threshold Shift ('TTS') and Behaviour effects	230 dB re: 1μPa SPL_{Peak} 183 dB re: 1μPa SPL_{Peak}
	Harbour porpoise			
	Bottlenose dolphin			
	Baleen Whale			
	Fin whale – only in the mouth of the estuary very far downstream			
Marine mammals - Seals	Grey seals	Pinniped	Permanent Threshold Shift ('PTS') Temporary Threshold Shift ('TTS') and Behaviour effects	218 dB re: 1μPa SPL_{Peak} 212 dB re: 1μPa SPL_{Peak}
Others	Otter	SAC designated	NA	NA

12.4 Baseline Ambient Underwater Assessment

A hydrophone was installed by the Port of Waterford on 15th January 2023, and it remains deployed. The monitoring location is detailed in Table 12-5 below and shown in Figure 12-3 below.

The location of the hydrophone, ca. 2km east of the Site, is positioned to determine the ambient background sound levels of the receiving environment. Although underwater sound can travel long distances, the levels recorded at the monitoring position are close enough to detect in-water sources of noise associated with port activities, while ensuring the hydrophone is not within the near or transitional fields of any such source. The position also enables an understanding of general ambient sources of noise in the receiving water.

Table 12-5: Noise Monitoring Locations

NM ID	Description of the Location	ITM Easting	ITM Northing
Hydrophone Location	East of the Site, located at Cheekpoint	668509	613907

Figure 12-3: Hydrophone Monitoring Location

Data from the hydrophone from 16th March 2023 until 15th March 2024 was analysed to determine the baseline underwater noise levels in the area.

The hydrophone data did not automatically account for Daylight Savings Time. After 28th March 2023, the data was manually shifted one hour forward and shifted back one hour on 28th October 2023.

The data was saved every second, with each second containing two lines of data. This means that within every one-second interval, two separate data points are recorded. Data analysis was conducted, and results were calculated in the following resolution intervals:

- 10 minutes;
- 1 hour; and,
- 24 hours.

Due to the volume of data, a summary of the different ranges and figures is presented as follows. Data in 24-hour intervals is outlined in Appendix 12-1.

As mentioned in Section 12.3 above, there are three different sources of noise underwater:

- Background noise level;
- Biological noise level; and,
- Shipping noise.

In the following section, the hydrophone dataset has been analysed to determine the most common value for those sources, and the results are presented below.

12.4.1 Shipping Noise

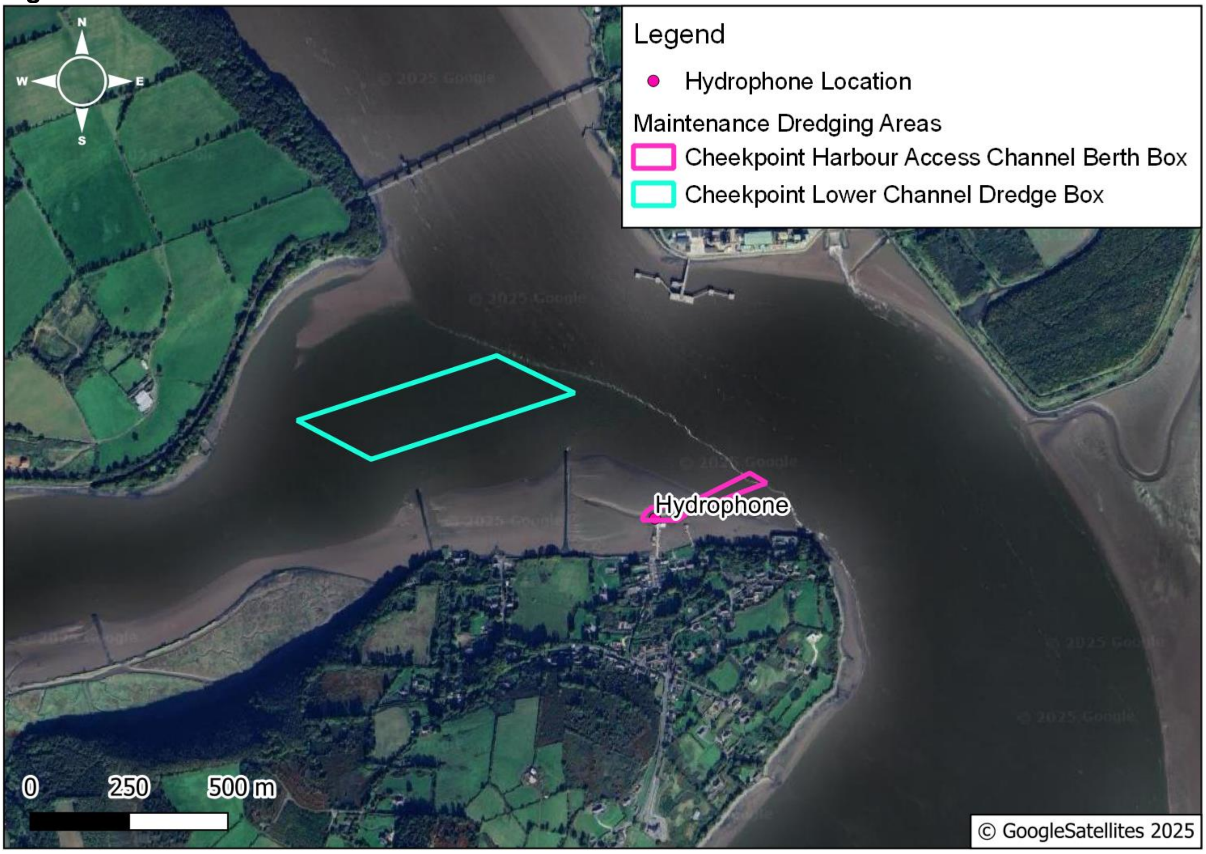
Shipping noise is attributed to two key shipping activities at the Port of Waterford, which are described separately below:

- Dredging activities; and,
- Arrival and departure of a ship.

12.4.1.1 Channel Maintenance Activities

Channel maintenance, which can be categorised as a shipping noise, comprises two common activities: ploughing and dredging. To address the effect of these activities, the closest areas to the hydrophone were selected. Additional areas for maintenance are presented in Section 1.3. Dredging campaigns occur twice a year, at two licence areas near the hydrophone, presented in Figure 12-4 and ploughing generally only occurs at the Cheekpoint Lower Channel Dredge Box area at more regular intervals.

Figure 12-4: Channel Maintenance Activities areas



The data recorded at the hydrophone was analysed to see the impact of each type of maintenance activity. Table 12-6 below shows the days when each type of maintenance took place within the licensed areas. While maintenance was recorded on those days, only the specific times when maintenance was actively occurring were used in the calculation of the sound pressure levels presented below. Ploughing was identified in 28 occurrences, and dredging occurred on 34 occurrences in proximity to the hydrophone from March 2023 to March 2024. The data has been utilised in the assessment of calculating the sound levels associated with the maintenance campaigns but has been omitted from the general noise background within the watercourse.

The data from the hydrophone during the dredging campaigns located in the Areas specified in Figure 12-3 above was analysed to identify the noise level of this activity. Table 12-6 below details the range of sound pressure levels measured at the hydrophone for these two types of dredging.

Table 12-6: Sound Pressure Levels associated with Dredging campaigns

Type of Dredging	Area	Range L_{eq} dB Ref re 1uPa	Most occurrent value L_{eq} dB Ref re 1uPa
Dredging	Cheekpoint Lower Channel Dredge Box	84-128	90
Plough Dredging	Cheekpoint Lower Channel Dredge Box	83-134	95
Ploughing	Cheekpoint Harbour Access Channel Berth Box	85-126	118

As the hydrophone was located near Cheekpoint Harbour, it was expected that the ploughing undertaken in this location would have resulted in the most common value. All of the values located in the dredger work area have been used in the analysis, so the distance to the centre of the work area to the hydrophone has been used to calculate the sound pressure levels at 1m from the source, using the transmission loss formula presented in Section 12.2.3.1 above.

Table 12-7: Sound Pressure Levels associated with Channel Maintenance Activities

Type of Dredging	Area	Distance (m) from Hydrophone to Area	L_{eq} dB Ref re 1uPa
Dredging	Cheekpoint Lower Channel Dredge Box	ca. 635m	175
Ploughing	Cheekpoint Lower Channel Dredge Box	ca. 635m	180
Ploughing	Cheekpoint Harbour Access Channel Berth Box	ca. 130m	158

Dredging typically produces sound pressure levels ranging from 160 to 185dB re1µPa at 1 meter, predominantly generating low-frequency, continuous and non-impulsive noise, similar to commercial ship traffic. The predicted value of 175dB re1µPa at 1 meter aligns with this range. The typical value for dredging is also presented in Table 12-1 above. Considering the uncertainty in the calculations, the predicted value of 175dB re1µPa at 1 meter would be considered suitable and in line with the typical value of 179dB re1µPa at 1 meter.

For ploughing, although specific data is limited, it generally produces sound pressure levels below 190dB re 1 µPa at 1 meter. The noise from ploughing is also continuous and non-impulsive, consistent with the recorded values of 158-180dB re1µPa at 1 meter [12].

In conclusion, the underwater noise levels related to dredging campaigns are within the range of typical values for this type of activity.

12.4.1.2 Vessels

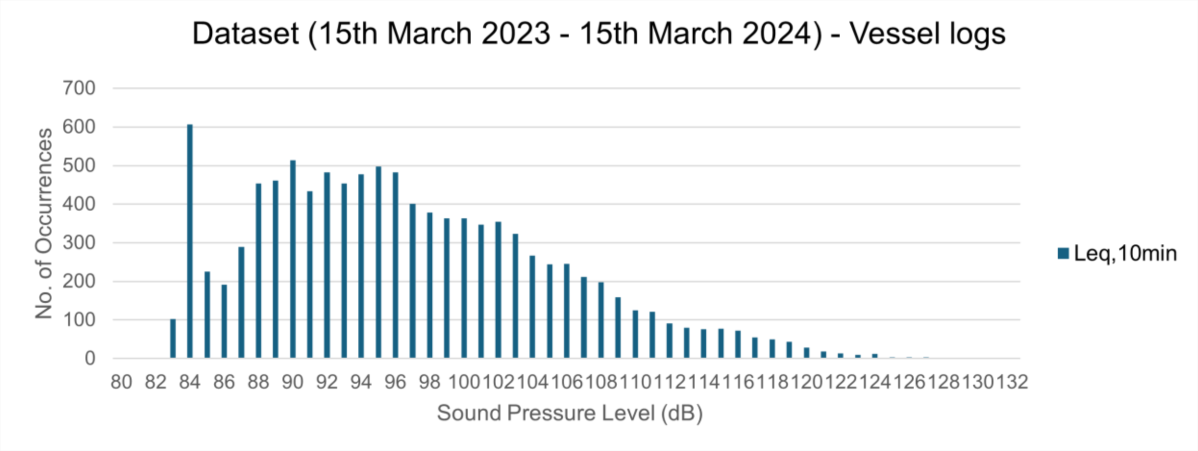
Vessel logs were analysed and compared with the dataset to determine the effect on underwater acoustics.

Records logging when a vessel arrived or departed from the Port of Waterford were reviewed. As the hydrophone is located ca. 2km east of the port, an hour before and an hour later have been selected to analyse the effect of different vessels. Based on shipping routes, the distance is circa 300m from the hydrophone. The dataset analysed in this case has a 10-minute resolution, the full range of sound pressure measured and the most occurrent value is presented in Table 12-8 below. The number of occurrences of each value presented in the range is shown in Figure 12-5.

Table 12-8: Sound Pressure Levels associated with Vessels

Type of Anthropogenic Source	Range L_{eq} dB Ref re 1uPa	Most Occurrent Value L_{eq} dB Ref re 1uPa
Vessels	83-131	84dB

Figure 12-5: No. of occurrences for vessel logs



12.4.2 Biological Noise

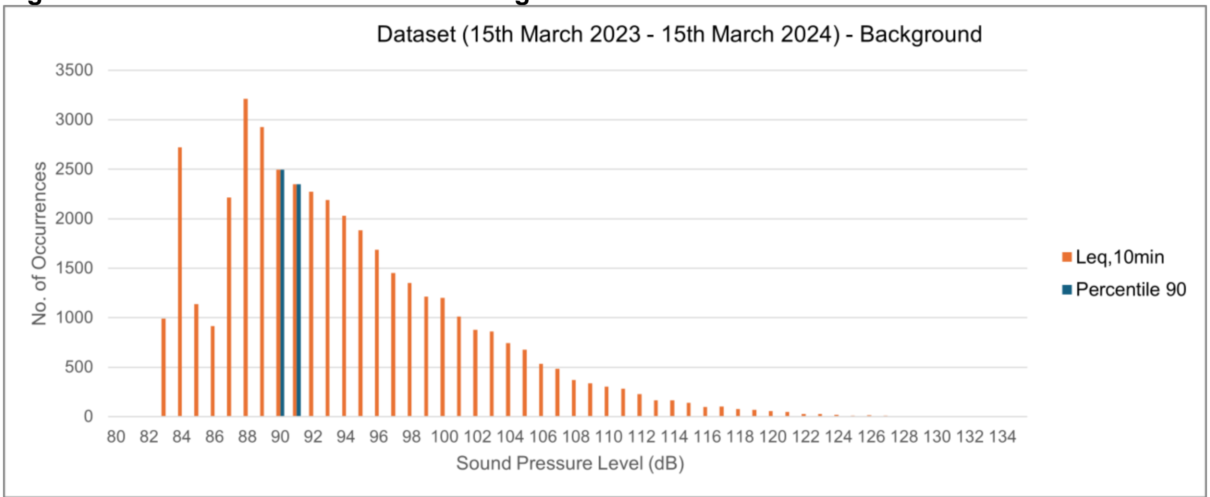
Biological noise in underwater acoustics refers to sounds generated by living organisms in marine environments. This noise can arise from various sources, including marine mammals, fish, crustaceans and other aquatic creatures. Biological noise was considered to be part of the background noise recorded by the hydrophone during its deployment.

12.4.3 Background Noise

Background noise is noise that is not caused by activities associated with the Port of Waterford, including shipping along the river and dredging campaigns. Marine life, such as fish, crustaceans, and mammals, produces sounds for communication. Hydrodynamic factors like currents, tides and waves generate consistent noise, with rainfall and wind contributing to surface agitation. Geophysical sources, including earthquakes, underwater volcanoes and thermal vents, add low-frequency sounds, while ice movements in polar regions also create distinct underwater noise.

The dataset from the hydrophone has been analysed when vessel noise or dredging has not been conducted and assessed. A statistical analysis was performed to determine the value that occurs most frequently throughout a whole year. The number of occurrences is shown in Figure 12-6. The most occurring value is 88dB, with 3,211 occurrences in 41,983 samples. The 90 percentile is calculated, and the values that occur near the 90% percentile are indicated in Figure 12-5 below, with values of 90 and 91dB.

Figure 12-6: No. of occurrences for background noise

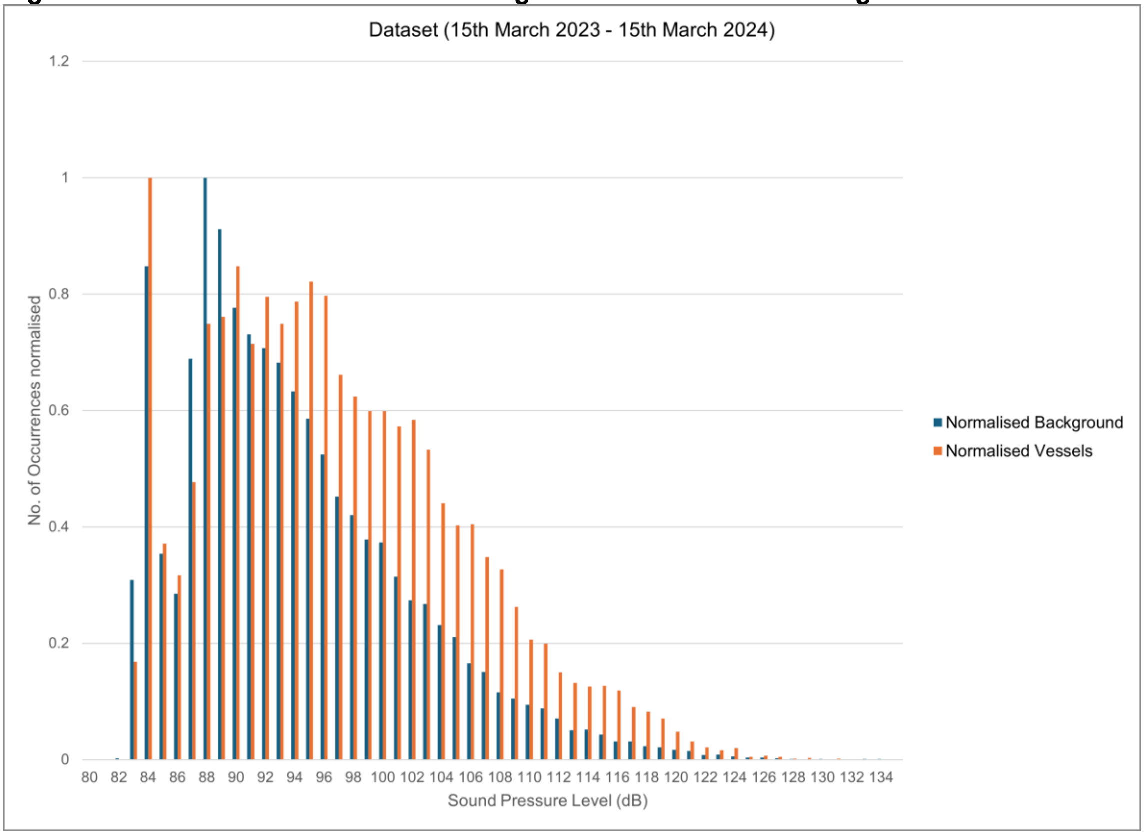


12.4.4 Conclusion of the Ambient Underwater Assessment

The ambient underwater noise levels in the area ranged from 82dB to 134dB. The typical noise sources were anthropological noise due to the presence of vessels arriving and departing the Port and dredging activities in the surrounding area.

Figure 12-7 represents the normalised number of occurrences of the background noise values and the vessel values, excluding dredging campaigns. Refer to section 12.4.1 for dredging.

Figure 12-7: No. of occurrences for background noise vs vessels logs



12.5 Characteristics & Potential Effects of the Proposed Development

The potential for noise arising from the Proposed Development has two distinct phases:

- Construction Phase; and,
- Operational Phase.

12.5.1 Construction Phase

The main activities required during construction with potential underwater noise effects are outlined in Table 12-9. Noise levels during construction will be significantly higher than those currently arising from normal port operations. Demolition works outside the water column have not been assessed as they are not relevant to underwater noise.

Additionally, the existing dolphin, comprising a reinforced concrete deck on steel piles, together with a steel access gangway, will be partially demolished, and the supporting piles will be cut to riverbed level. Demolished concrete will be transported to a land-based area within the Site for crushing and reuse as part of the fill material for reclamation, subject to meeting relevant specifications. This work will be of a short duration. Therefore, the noise for this operation will be less significant than the piling activities presented in Table 12-9 below.

For the reclamation works (refer to Section 3.3.1.3), about 160,000 tonnes of local rock will be imported to infill the area behind the wharf up to its level, covered with a subbase layer, and finished with concrete paving, requiring minimal on-site concrete pouring. This work will be done in tandem with the piling works. The assessment for the Construction Phase, which focused on piling works, represents the worst-case scenario. Therefore, the reclamation works are expected to have a less significant effect and were not evaluated further.

Table 12-9: Construction Phases with potential underwater noise impact.

Construction Activity	Details	Extent/Duration	Noise Levels dB re: 1μPa @ 1m
Delivery of piles (by sea if required)	Vessel traffic, similar to existing	Cargo vessel deliveries to port similar to existing shipping traffic	170dB SPL_{RMS}
Support vessel	Safety requirement	Full piling period	150 dB SPL_{RMS}
Operation of jack up barge	Support equipment (hydraulics, crane, etc.)	Full piling period	150 dB SPL_{RMS}
Vibratory Piling	Required for piling works	Full piling period	170 dB SPL_{RMS}
Impact Piling		Full piling period	250 dB (worst-case) SPL_{Peak}

Noise from the impact piling will represent the worst-case noise event during construction. Noise levels from construction of the Proposed Development will be contained in the shipping channel close to the source due to the shallow water column (silty floor to water surface), and the acoustic absorption within the mud and silts and will not therefore propagate out to the wider bay / open sea area to any significant extent.

The assessment of underwater noise effects will be carried out on the basis of the impact of piling noise during construction, as all other activities will have lower effects due to their lower noise emission.

Table 12-10 above indicates that impact piling, with a noise level of 250dB (peak), will result in the worst-case underwater noise effects, as other activities are 80dB quieter.

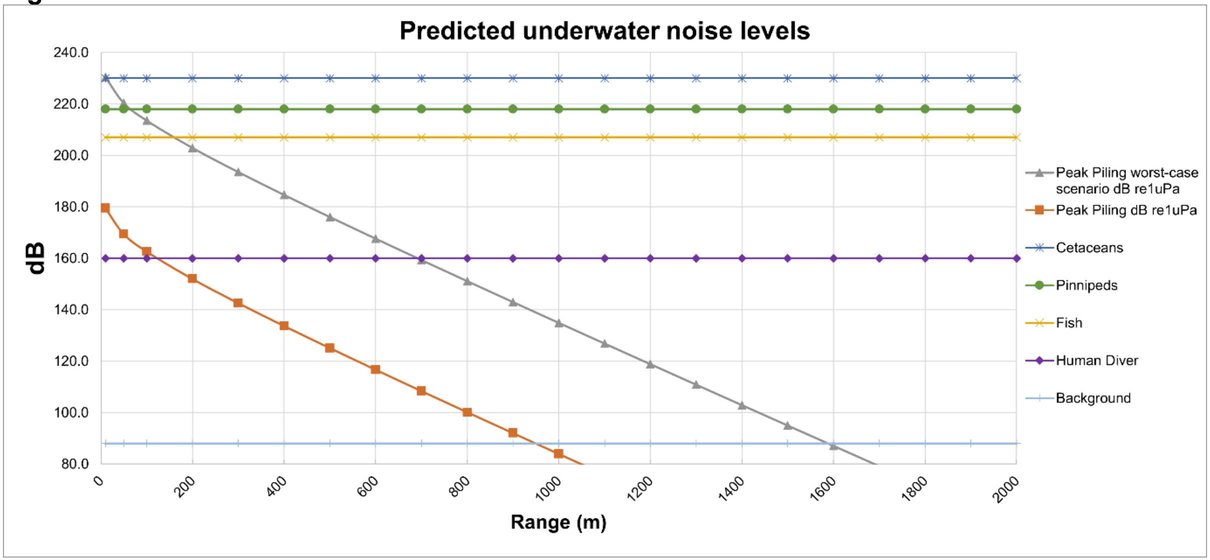
The choice of piling method is a complex issue involving the need to drive the pile fully to ensure long-term stability, a parameter that varies with site-specific soil conditions. While the noise level arising during vibratory pile driving is lower.

For the Proposed Development, the expected diameter for piling is between 750 and 825mm. Using 825mm as a worst-case scenario, this results in a predicted source level of 199dB re 1μPa at 1m.

As outlined in Table 12-10 above, the worst-case underwater noise effect will be during impact piling driving with a SPL Peak of 250dB.

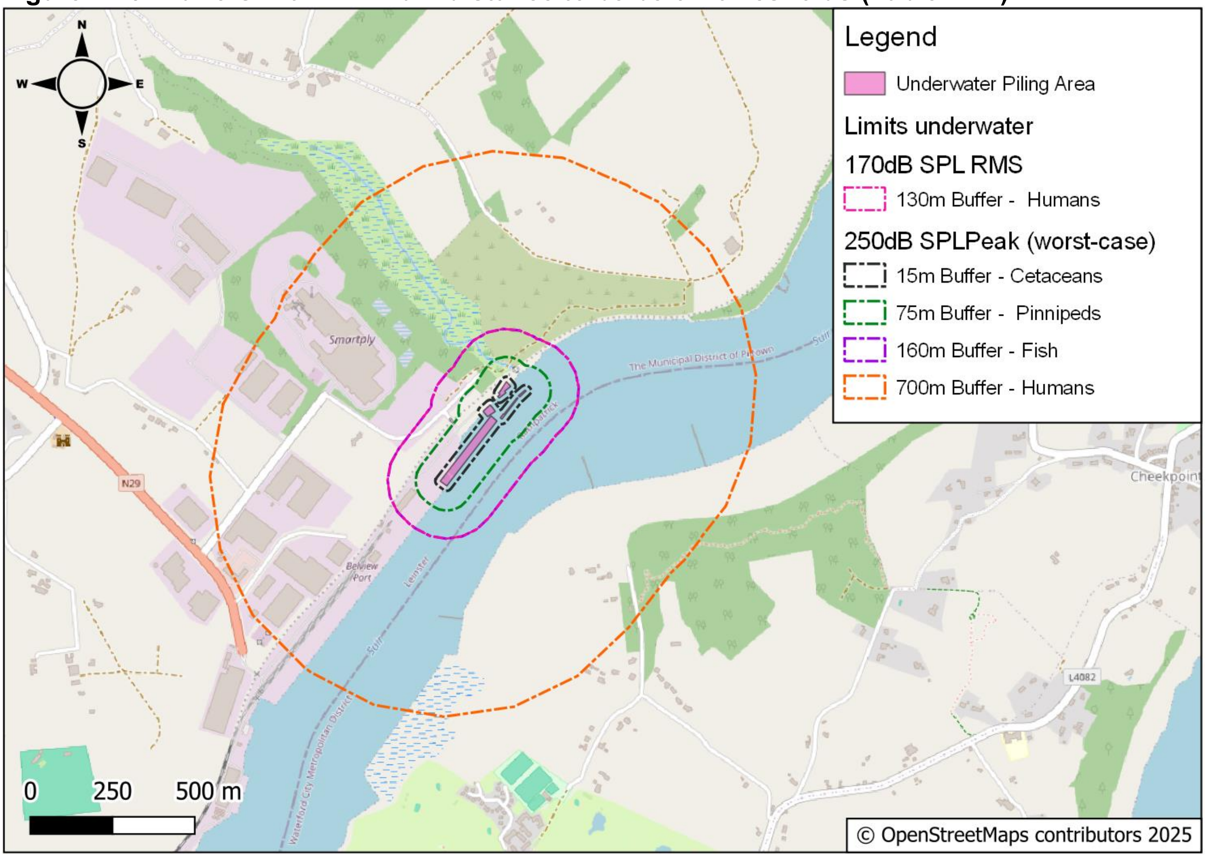
Additionally, the predicted SPL Peak level, with a specified diameter of 825mm, was also calculated. The underwater noise levels have been predicted out to a range of 2,000m and are shown in Figure 12-8 below.

Figure 12-8: Predicted underwater noise levels



The predicted peak level for the worst-case scenario and the piling that may be used during the construction of the Proposed Development is presented against the different peak thresholds discussed in Table 12-4 above. The cetaceans and pinnipeds thresholds are for Permanent threshold shift ('PTS'), for fish, the thresholds used are for Mortality / PTS in adult fish. Using the values shown in Figure 12-8 above, the effects are shown in various buffers for each receptor in Figure 12-9.

Figure 12-9: Buffers with minimum distance to be below thresholds (Table 12-4)



The predicted Site-specific, 170dB SPL_{RMS}, using impact piling for the Proposed Development, was below the thresholds for the different subaquatic species. Regarding human receivers, diving within 150m of the piling works will result in likely discomfort.

In a worst-case scenario, using 250dB SPL_{Peak} and the potential injury zones presented in Table 12-3 above, the areas of effect are as follows:

- Cetacean species could be affected within a 15m range from the piling event;
- Fish species could be affected within a 180-200m range from the piling event;
- Pinnipeds could suffer from Permanent Threshold Shift ('PTS') injuries within 75m of the piling event; and,
- Human divers - the range for discomfort is 700m from the piling event.

The Construction Phase will increase the underwater noise levels in the surrounding area during piling works. These works will be of short duration (one to seven years), negative and in the local area.

Once the piling works are finalised, the underwater noise levels will revert to the existing environment where vessel noise and biological noise are the main sources; refer to Section 12.5.2 below.

12.5.2 Operational Phase

The Proposed Development's ca. 250m wharf extension will increase berthing capacity at the port. This will result in an increase in ship numbers that, along with the current projected growth for the Port of Waterford, could result in an increase of ca. 120 ships per annum. Furthermore, vessels associated with the proposed ORE developments will be departing in the morning and returning in the evenings.

During the Operational Phase, the effect will be confined to vessel traffic at the Port. Underwater noise levels, related to vessels, will remain as they are currently, i.e. elevated levels for a short period in the outer bay as a vessel navigates the channel and elevated levels for short periods (10 to 30 minutes) while the vessel berths in the port. The noise levels associated with shipping traffic are outlined in Table 12-9 above.

Overall, the increase in vessel movements will occur throughout the day and week, rather than resulting in more vessels occupying the river channel at the same time. Therefore, noise levels associated with ongoing shipping and underwater activity were not predicted to increase in emitted sound pressure. However, there will be a rise in the frequency of events involving vessel traffic. Based on recorded underwater sound levels to date, the limited effects observed on fauna behaviour during such movements, and the low number of complaints related to typical shipping underwater noise in the river, the operational impact was assessed as not significant in the long term.

12.5.3 Unplanned Events

As with all industrial facilities, there is some risk that accidents or disasters at the Proposed Development may occur. Such events could result in a risk to the environment. However, risks specific to acoustics will be short in duration, arising only during the event and ceasing upon the event coming under control. Emissions, such as emergency service sirens, onsite alarm systems and or venting noise, are possible under such scenarios.

However, as noise is transient, with the removal of the source of the noise, the impact on the environment will be removed. Furthermore, in the situations outlined above, the use of noise to draw attention to the event and the emergency services responding to it, and to support that a competent response is achieved, generally has a positive impact on on-site and local awareness of the occurrence.

12.6 Proposed Mitigation Measures and/or Factors

12.6.1 Construction Phase

The effect from underwater noise will be limited, with the buffers of effect, presented in Figure 12-8 above, noting most to be within 160m of the piling activity and enabling room for species to avoid the effects while maintaining use of the river channel. The underwater noise levels will increase while piling takes place, i.e. impact piling. This will be an intermittent activity with breaks for placement of piles, alignment checks, etc.

Pile driving activity will be carried out as efficiently as possible to reduce the duration of the piling activity. Pile installation works will be limited to 08:00 – 18:00 Monday to Friday, and 8:00 – 14:00 on Saturdays.

Prior to commencing piling, or re-starting piling following a notable break (30 minutes or longer), lower drops will be used, prior to ramping up to full drops on the pile. This will substantially reduce the noise emission and enable any species within the area of effect to vacate.

Specific mitigation measures and details of compliance with Department of Arts, Heritage and the Gaeltacht (2014) *Guidance to Manage the Risk to Marine Mammal from Man-made Sound Sources in Irish Waters*, such as soft start, use of marine mammal observers and exclusionary periods for piling, are specified in Chapter 6.

For diving, warning notices will be posted at nearby access points, and local information sessions will be organised to indicate the area of concern. Collaboration will be conducted with any groups that need to dive within the zone.

12.6.2 Operational Phase

Underwater noise levels during the Operational Phase of the Proposed Development will not change the underwater noise levels in any measurable way. No mitigation measures were therefore deemed to be required for the Operational Phase.

12.7 Cumulative and In-Combination Effects

A review was undertaken of the Kilkenny County Council ePlan [13], Waterford City and County Council ePlan [14], Wexford County Council Planning Applications website [15], the National Planning Application Database [16] and An Coimisiún Pleanála Mapping Search [17]. At the time of writing this report, there are no other plans or proposed developments that will require underwater construction within the vicinity of the Site or within the wider Waterford Estuary at the proposed commencement of construction activities. The Port is carrying on normal operations, which include shipping traffic and port activities.

Maintenance dredging is also carried out at the Port of Waterford. The operation of dredgers on silty material results in underwater noise levels in the same range as shipping traffic. The cumulative effect of maintenance dredging noise was therefore not regarded as likely to have a significant effect in the overall context of the Proposed Development.

As outlined in Table 12-20, the source noise level from impact piling is 50dB higher than any of the other construction or operation activities. When adding the individual contribution of noise sources, the greatest increase arises from the addition of similar noise levels. Where noise levels differ by more than 10dB, the cumulative noise level is effectively the level of the louder source. This is due to the nature of logarithmic addition of noise levels.

12.8 Interactions with Other Environmental Attributes

- Chapter 6 (Biodiversity). Underwater noise can influence fauna through disturbance of animals; effects on specific species have been outlined in Chapter 6, where relevant; and,

- Chapter 15 (Underwater Cultural Heritage). Vibration arising from piling work during the construction phase has the potential to effect features with cultural heritage value. An assessment of underwater archaeology has been undertaken in Chapter 15.

12.9 Indirect Effects

No indirect effects were predicted from the Proposed Development.

12.10 Residual Effects

No likely significant effects have been predicted arising from underwater noise and the type of activities / process undertaken as part of the Proposed Development during the Construction Phase.

Following the implementation of mitigation, additional control and awareness of the as-built plant will enable the operation of the Proposed Development to be managed, ensuring noise will be controlled.

Therefore, a long-term, negligible effect on underwater species has been predicted.

This assessment has found no likely significant effect of the Proposed Development on noise or vibration during short-term construction and long-term operation.

12.11 Monitoring

The Port has a hydrophone installed at Cheekpoint Harbour. The continuous monitoring will provide information on background (absence of shipping) and ambient (shipping noise included) noise levels, along with linking noise events to specific vessels. This approach ensures that particularly noisy vessels can be identified and communication with operators opened if needed.

Ongoing monitoring of underwater noise in the Lower Suir Estuary will continue for three years after the Construction Phase is finalised. During the Construction Phase, the location of the hydrophone will provide clarity on any notable events within the Site and serve as a warning system for the Applicant and the appointed contractor. Although relocating the hydrophone closer to the construction area may be possible, it was considered to offer limited benefit in identifying potential breaches or impacts on the river.

12.12 Reinstatement

Not applicable – noise is generated through operations onsite. In the event of Site closure, noise emissions will cease.

12.13 Difficulties Encountered in Compiling This Information

Not applicable.

REFERENCES

[1] R. J. Urick, Principles of underwater sound, McGraw-Hill, McGraw-Hill Inc., US, 1975.

[2] NPWS, “Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters,” Department of Arts, Heritage and the Gaeltacht, 2014.

[3] P. et al, “Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.,” Springer, 2014.

[4] NOAA, “Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts,” 2013.

[5] J. Finneran and A. Jenkins, “Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis,” SSC Pacific, 2014.

[6] J. Nedwell, R. Workman and S. Parvin, “The assessment of likely levels of piling noise at Greater Gabbard and its comparison with background noise, including piling noise measurements made at Kentish Flats,” Subacoustech Report, 633R0115, Southampton., 2005. T.

[7] X. Lurton, An Introduction to Underwater Acoustics: Principles and Applications., 2002: Springer-Verlag.

[8] P. C. Etter, Underwater Acoustic Modelling and Simulation, CRC Press, 2013.

[9] L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Sanders, Fundamentals of Acoustics, 4th edition., Wiley, 1999.

[10] P. Rogers, “Onboard Prediction of Propagation in Shallow Water,” Naval Research Laboratory, Washington D.C., 1981.

[11] Port of Waterford, “Port of Waterford Masterplan 2020 - 2044,” Port of Waterford, Waterford, 2019.

[12] Western Dredging Association, *Journal of Dredging,* vol. 17, no. 1, 2019.

[13] Kilkenny County Council, “Kilkenny County Council Planning Portal,” 2025. [Online]. Available: https://kilkennycoco.ie/eng/services/planning/planning-applications/.

[14] Waterford City and County Council, “Waterford City and County Council Planning Search,” 2025. [Online]. Available: https://www.eplanning.ie/WaterfordCCC/SearchTypes. [Accessed 2025].

[15] Wexford County Council, “Planning Applications,” 2025. [Online]. Available: https://experience.arcgis.com/experience/e633a20c35774e8e9473e7ba3b876083. [Accessed 2025].

[16] Department of Housing, Local Government and Heritage, “National Planning Application Database,” 2025. [Online]. Available: https://housinggovie.maps.arcgis.com/apps/webappviewer/index.html?id=9cf2a09799d74d8e9316a3d3a4d3a8de.

[17] An Coimisiun Pleanala, “Map Viewer,” 2025. [Online]. Available: https://www.pleanala.ie/en-ie/Map-search. [Accessed 2025].