3FMProject

Bringing Dublin Port To 2040

Environmental Impact Assessment Report

Chapter 12

Noise and Vibration

Volume 2 Part 3

Comhlacht Chalafort Átha Cliath Dublin Port Company

rps A Tetra Tech Company

Third & Final Masterplan Project

12 NOISE & VIBRATION

This chapter of the Environmental Impact Assessment Report (EIAR) assesses the potential impact of the 3FM Project on Noise and Vibration in the receiving environment. The likely significant effects of the project caused by noise and vibration are examined and measures to avoid, prevent, and reduce these likely significant effects are proposed, where they are necessary. The assessment on terrestrial noise and vibration is presented in Section 12.1 and the assessment on underwater noise is presented in Section 12.2.

12.1 Terrestrial Noise and Vibration

12.1.1 Introduction

This section contains an assessment of the predicted terrestrial noise and vibration impacts associated with the proposed 3FM Project. Full details of the proposed 3FM Project are contained in EIAR Chapter 5 – Project Description.

12.1.2 Methodology

12.1.2.1 Noise Guidance Documents

This section includes a summary of Irish and international guidance documents that have been used as reference material for the purposes of completing the Noise and Vibration Assessment.

Environmental Protection Agency (EPA) Office of Environmental Enforcement (OEE) - Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)

This document relates primarily to noise surveys and assessments for EPA licensed facilities but in the absence of any other directly applicable guidance documents, it provides useful reference material for the purposes of completing the noise assessment for the proposed 3FM Project.

The EPA published two earlier documents in relation to the survey, assessment and management of noise emissions from licensed facilities, namely the Environmental Noise Survey Guidance Document (commonly referred to as NG1) and Guidance Note for Noise in Relation to Scheduled Activities - 2nd Edition (commonly referred to as NG2). These two documents have been withdrawn with the publication of NG4.

NG4 provides detailed consideration of a range of noise related issues including basic background to noise issues, various noise assessment criteria and procedures, noise reduction measures, Best Available Techniques (BAT) and the detailed requirements for noise surveys. NG4 provides typical limit values for noise from licensed sites, namely:

- Daytime (07:00 - 19:00) - 55dB $L_{Ar,T}$;
- Evening (19:00 - 23:00) - 50dB $L_{Ar,T}$:
- Night-time (23:00 - 07:00) - 45dB $L_{Aeq,T}$.

In the description of the limits above, the $L_{Aeq,T}$ is the equivalent continuous sound level over the measurement period and $L_{Ar,T}$ is equal to the L_{Aeq} but includes an additional penalty of 5dB(A) to account for any tonal or impulsive characteristics to the noise source.

While consideration is given to these threshold limits in the general context of the noise assessment for the proposed project, the proposed project is located in the context of an urban/suburban environment where existing noise levels regularly exceed the typical noise limits set out in NG4 for EPA licensed sites.

Other EPA guidelines such as Guidelines on the Information to be Contained in Environmental Impact Statements [2022] and Advice Notes on Current Practice (in the Preparation of Environmental Impact Statements) [2003] have been considered also in the preparation of this Noise and Vibration Chapter.

National Roads Authority (NRA) Guidelines for the Treatment of Noise and Vibration in National Road Schemes (2004)

The purpose of this document is to provide guidance on the treatment of noise and vibration during the planning and design of national road schemes. The guidelines are not mandatory but are recommended to achieve appropriate consistency with respect to the treatment of noise and vibration during the various stages of road scheme planning and development.

Construction Phase

The NRA Guidelines list maximum permissible noise levels typically deemed to be acceptable for the construction phase of road schemes (See Table 12.1.1). These values are indicative only and more stringent limits may be applied where pre-existing noise levels are low.

Table 12.1.1 Maximum Permissible Noise Levels at the Façade of Dwellings During Construction

Days & Times	$L_{Aeq\ (1\ hr)}$ dB	$L_{pA(max)slow}$ dB
Monday to Friday 07:00 – 19:00hrs	70	80
Monday to Friday 19:00 – 22:00hrs	60*	65*
Saturday 08:00 – 16:30hrs	65	75
Sunday Bank Holidays 08:00 – 16:30hrs	60*	65*

** Construction activity at these times. Other than that required in respect of emergency works, will normally require explicit permission of the relevant local authority.*

Operational Phase

There are currently no Irish standards or limits governing the assessment of noise and/or vibration associated with either new or existing roads. Article 77 of the Roads Act (1993) deals with noise. It outlines the powers of the Minister to make regulations in respect of noise limits, measurement and mitigation. No specific guidance in respect of noise or noise limits is contained within the Roads Act.

The NRA Guidelines sets out to establish desirable design goals for new national road schemes having regard to EU Directive 2002/49/EC. The guidelines stipulate that all future national road schemes should be designed to meet the following design goal:

Day-evening-night 60dB L_{den} (free field residential facade criteria).

Mitigation measures are only deemed necessary when the following three conditions are satisfied at designated sensitive receptors:

- The combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal;
- The relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place; and
- The contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

British Standard BS5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites

This British Standard consists of two parts and covers the need for protection against noise and vibration of persons living and working in the vicinity of construction and open sites. The standard recommends procedures for noise and vibration control in respect of construction operations and aims to assist architects, contractors and site operatives, designers, developers, engineers, local authority environmental health officers and planners.

Part 1 of the standard provides a method of calculating noise from construction plant, including:

- Tables of source noise levels;
- Methods for summing up contributions from intermittently operating plant;
- A procedure for calculating noise propagation;
- A method for calculating noise screening effects; and
- A way of predicting noise from mobile plant, such as haul roads.

The standard also provides guidance on legislative background, community relations, training, nuisance, project supervision and control of noise and vibration.

The ABC method outlined in Section E3.2 of the British Standard has been used for the purposes of determining whether the predicted noise levels from the construction activities will result in any significant noise impact at the nearest noise sensitive properties.

Table 12.1.2 outlines the applicable noise threshold limits that apply at the nearest noise sensitive receptors. The determination of what category to apply is dependent on the existing baseline ambient (L_{Aeq}) noise level (rounded to the nearest 5dB) at the nearest noise sensitive property. For daytime, if the ambient noise level is less than the Category A threshold limit, the Category A threshold limit (i.e. 65dB) applies. If the ambient noise level is the same as the Category A threshold limit, the Category B threshold limit (i.e. 70dB) applies. If the ambient noise level is more than the Category A threshold limit, the Category C threshold limit (i.e. 75dB) applies.

Table 12.1.2 Noise Threshold Limits at Nearest Sensitive Receptors

	Threshold Limits [dB(A)]		
	Category A	**Category B**	**Category C**
Night-time (23:00 - 07:00)	45	50	55
Evening and Weekends (19:00 - 23:00 Weekdays, 13:00-23:00 Saturdays, 07:00-23:00 Sundays)	55	60	65
Weekday daytime (07:00-19:00) and Saturdays (07:00-13:00)	65	70	75

Dublin City Council (DCC) – Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition

Prior to the commencement of work on a site within the DCC area, DCC require a construction and demolition plan to be developed in accordance with this guide. The guide is a best practice guidance document aimed at ensuring that demolition and construction work does not have an adverse impact on those living and working near the demolition/construction activities. The guide presents a risk based approach taking into account the locality, nature of the work and the expected duration of work.

The guide contains two risk assessment tables, whereby cells are ticked based on the categories that are most applicable to the project. A total risk assessment table is subsequently completed based on the sub-total numbers from the initial two risk assessment tables. Once the risk category has been determined from the total risk assessment, good practice measures are outlined within the guide for the particular project.

World Health Organisation (WHO) - Guidelines for Community Noise

In 1999, the World Health Organisation (WHO) proposed guidelines for community noise. In this guidance, a L_{Aeq} threshold daytime noise limit of 55dB is suggested for outdoor living areas in order to protect the majority of people from being seriously annoyed. A second daytime limit of 50dB is also given as a threshold limit for moderate annoyance.

The guidelines suggest that an internal L_{Aeq} not greater than 30dB for continuous noise is needed to prevent negative effects on sleep. This is equivalent to a façade level of 45dB L_{Aeq}, assuming open windows or a free-field level of about 42dB L_{Aeq}. If the noise is not continuous, then the internal level required to prevent negative effects on sleep is a $L_{Amax,fast}$ of 45dB. Therefore, for sleep disturbance, the continuous level as well as the number of noisy events should be considered.

While consideration is given to these threshold limits in the general context of the noise assessment for the proposed project, the proposed project is located in the context of an urban/suburban environment where existing noise levels regularly exceed the typical noise limits set out in the WHO Guidelines.

World Health Organisation (WHO) - Night Noise Guidelines for Europe

The *Night Noise Guidelines for Europe* was published in 2009 on the back of extensive research completed by a WHO working group. Considering the scientific evidence on the threshold of night noise exposure indicated by $L_{night,outside}$ as defined in the Environmental Noise Directive (2002/49/EC), an $L_{night,outside}$ of 40dB should be the target of the night noise guideline (NNG) to protect public, including the most vulnerable groups such as children, the chronically ill and the elderly. An interim target of 55dB is recommended where the NNG cannot be achieved. These guidelines are applicable to Member States of the European Region and may be considered as an extension to the previous WHO Guidelines for Community Noise (1999). The guidelines do not expand on the noise limits applicable to non-continuous noise and hence the guidance included in the 1999 guidelines is still applicable in relation to this.

In the context of the existing environment in the vicinity of the proposed project, noise levels in the study area regularly exceed the 40dB night noise limit included in this document.

World Health Organisation (WHO) - Methodological Guidance for Estimating the Burden of Disease from Environmental Noise

In 2012, the WHO published the Methodological Guidance for Estimating the Burden of Disease from Environmental Noise. This document outlines the principles of quantitative assessment of the burden of disease from environmental noise, describes the status in terms of the implementation of the European Noise Directive and reviews evidence on exposure-response relationships between noise and cardiovascular diseases.

World Health Organisation (WHO) – Environmental Noise Guidelines for the European Region

In 2018, the WHO published the Environmental Noise Guidelines for the European Region. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise from various sources. The guidelines set out to define recommended exposure levels for environmental noise in order to protect population health.

The guidelines are intended to be suitable for policymaking in the WHO European Region. They focus on the most used noise indicators L_{den} and/or L_{night}, which are provided for exposure at the most exposed facade, outdoors. The guidelines provide specific recommendations for various noise sources, including road traffic noise.

For average noise exposure, the guidelines recommends reducing noise levels produced by road traffic below 53 dB L_{den}. The guidelines also recommend a night-time exposure value of 45 dB L_{night} for road traffic noise, on the basis that 3% of the participants in studies were highly sleep-disturbed at a noise level of 45.4 dB L_{night}.

UK Department of Transport (Welsh Office) - Calculation of Road Traffic Noise [CRTN]

This Calculation of Road Traffic Noise (CRTN) guidance document outlines the procedures to be applied for calculating noise from road traffic. These procedures are necessary to enable entitlement under the Noise Insulation Regulations (NI) 1995 to be determined but they also provide guidance appropriate to the calculation of traffic noise for more general applications e.g. environmental appraisal of road schemes, highway design and land use planning.

The document consists of three different sections, covering a general method for predicting noise levels at a distance from a highway, additional procedures for more specific situations and a measurement method for situations where the prediction method is not suitable. The prediction method constitutes the preferred calculation technique but in a small number of cases, traffic conditions may fall outside the scope of the prediction method and it will then be necessary to resort to measurement. The prediction method has been used in this instance to determine the likely traffic noise increases as a result of the proposed project.

Environmental Noise Directive (END) 2002/49/EC

END 2002/49/EC was transposed into Irish legislation in the form of the Environmental Noise Regulations, 2006. The legislation sets out the manner by which Strategic Noise Maps must be prepared in Ireland for large agglomerations, major roads, major railways and major airports. Strategic Noise Maps were prepared for the Dublin Agglomeration from 2012 onwards and a Noise Action Plans (NAP) published for consultation.

The proposed project will alter the noise environment in the vicinity of Dublin Port and hence will alter the Strategic Noise Maps in this area. Under the requirements set out under END, the Strategic Noise Maps are required to be updated every five years. The changes brought about by the proposed project will be incorporated into the updated Strategic Noise Maps for the Dublin Agglomeration as part of this ongoing update process.

12.1.2.2 Vibration Guidance Documents

The NRA Guidelines for the Treatment of Noise & Vibration in National Road Schemes is one of the few Irish guidance documents that gives recommendations relating to vibration from construction phase activities in Ireland. The guidelines recommend that vibration is limited to the values set out in Table 12.1.3 in order to ensure that there is little or no risk of even cosmetic damage to buildings. These values and the values indicated in Table 12.1.4 should be used as guidance for monitoring vibration levels from the construction phase of the proposed scheme.

Table 12.1.3 Recommended Vibration Level Thresholds for NRA Schemes

Allowable Vibration Velocity (Peak Particle Velocity) at the Closest Part of Any Sensitive Property to the Source of Vibration, at a Frequency of:		
Less than 10Hz	10 to 50 Hz	50 to 100 Hz (and above)
8mm/s	12.5mm/s	20mm/s

Limits of transient vibration, above which cosmetic damage could occur, are also given numerically in Table 12.1.4 (Ref: BS5228-2:2009+A1:2014). Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 12.1.4, and major damage to a building structure can occur at values greater than four times the tabulated values (definitions of the damage categories are presented in BS7385-1:1990, 9.9).

Table 12.1.4 Transient Vibration Guide Values for Cosmetic Damage (Ref BS5228-2:2009+A1:2014)

Type of Building	Peak Particle Velocity (PPV) (mm/s) in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings.	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Unreinforced or light framed structures. Residential or light commercial buildings.	15 mm/s at 4 Hz increasing to 20 mm/S at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

British Standard BS 7385 (1993) Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration indicates that cosmetic damage should not occur to property if transient vibration does not exceed 15mm/s at low frequencies rising to 20mm/s at 15Hz and 50mm/s at 40Hz. These guidelines refer to relatively modern buildings and therefore, these values should reduce to 50% or less for more sensitive buildings.

The human body is an excellent detector of vibration, which can become perceptible at levels which are substantially lower than those required to cause building damage. The human body is most sensitive to vibration in the vertical direction (foot to head). The effect of vibration on humans is guided by British Standard 6472:1992. This standard does not give guidance on the limit of perceptibility, but it is generally accepted that vibration becomes perceptible at levels of approximately 0.15 to 0.3 mm/s.

BS 6472 defines base curves, in terms of rms acceleration, which are used to assess continuous vibration. Table 5 of the Standard states that in residential buildings, the base curve should be multiplied by 1.4 at night and by 2 to 4 during the daytime to provide magnitudes at which the probability of adverse comment is low.

In order to assess human exposure to vibration, ideally, measurements need to be undertaken at the point at which the vibration enters the body, i.e. measurements would need to be taken inside properties. However, various conversion factors have been established to convert vibration levels measured at a foundation to levels inside buildings, depending on the structure of the building.

Where vibration is intermittent or occurs as a series of events, the use of Vibration Dose Values (VDVs) is recommended in BS6472 for the assessment of subjective response to vibration. The VDVs at which it is considered there will be a low probability of adverse comment are drawn from BS 6472 and presented in Table 12.1.5.

Table 12.1.5 Threshold Values for the Evaluation of Disturbance due to Vibration

Place	Daytime 16 Hour VDV ($ms^{-1.75}$)	Night-time 8 Hour VDV ($ms^{-1.75}$)
Critical working Area	0.11	0.09
Residential	0.22 – 0.43	0.13
Office	0.43	0.36[1]
Workshops	0.87	0.73

These VDV thresholds do not apply unless night-time work was a regular activity at these premises.

12.1.2.3 Assessment Methodology for Determining Noise Impacts

General Significance Criteria

Table 12.1.6 contains the general significance criteria that can been used for determining the level of impact associated with a particular aspect of the proposed project. Different aspects of noise from the proposed project (e.g. construction, plant/equipment, traffic etc.) are assessed using the different methodologies as described in the relevant guidance document. Where feasible, the significance criteria have been used in the various assessments included in this chapter having regard to the sensitivity of receptors.

Table 12.1.6 Criteria to Define the Sensitivity of Receptors

Sensitivity	Description	Examples of receptor
High	Receptors where occupants or activities are particularly susceptible to noise	Residential Quiet areas for outdoor recreation Religious institutions (e.g. churches and cemeteries) Schools during the daytime
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	Offices Restaurants Sports grounds where noise is not a normal part of the event (e.g. golf courses and tennis courts)
Low	Receptors where distraction or disturbance from noise will have minimal effect	Commercial buildings not occupied during operational hours Factories and working environments with existing high noise levels Sports grounds and facilities where noise levels are a normal part of activity

The majority of receptors expected to be affected by noise and vibration impacts arising due to the proposed development are the residents of dwellings in the vicinity of the existing port. Residents are deemed to be highly sensitive. The significance of the effect is determined as a function of the sensitivity of the receptor and the magnitude of impact it is exposed to. This is set out in Table 12.1.7

Table 12.1.7 Matrix for Determining Significance of Effect for Receptors of High Sensitivity

Magnitude of Impact (beneficial or adverse)	Significance of effect for receptors of high sensitivity
Major	Large or very large
Moderate	Moderate or large
Minor	Slight
Negligible	Slight
No impact	Neutral

Effects are considered to be significant when identified as likely to have a Moderate, Large or Very Large effect.

12.1.2.4 Construction Noise

The NRA Guidelines for the Treatment of Noise & Vibration on National Road Schemes (2004) British Standard BS 5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites are the standard noise guidance documents for assessing construction phase noise impacts. Section 12.1.2.1 contains a brief description of these guidance documents.

On account of the temporary nature of construction activities, higher noise threshold limits apply to construction phase activities as compared to permanent operational phase activities. The appropriate noise threshold limits for construction phase activities are outlined in Table 12.1.1 and Table 12.1.2. These guidance documents do not apply significance criteria for noise impacts other than outlining permissible threshold limits for noise as outlined in these tables.

12.1.2.5 Traffic Noise

The NRA guidelines (2004) are the primary guidance used in Ireland for the purposes of assessing road traffic noise and determining conditions where mitigation measures are appropriate. A number of UK guidance documents that are used for the purposes of assessing road traffic noise are detailed below and are useful reference material for the consideration of impact level associated with changes in road traffic noise.

As outlined in Section 12.1.2.1, the CRTN is the standard noise guidance document for predicting traffic noise levels from traffic flow information and other relevant road topographical information. While the CRTN provides a methodology for predicting traffic noise levels, it does not provide significance criteria for assessing changes in traffic noise levels.

The Design Manual for Roads and Bridges (DMRB) is a guidance document which was created for the purpose of assessing noise and vibration impacts from road projects. The classification of magnitude of noise impact tables included in Section 3, Part 7 of DMRB Volume 11 are applicable to the assessment of road traffic changes associated with the proposed project.

Table 12.1.8 and Table 12.1.9 present the magnitude of noise impacts for both short-term changes in traffic noise levels and long-term changes in traffic noise levels. The short-term criteria is used for the purposes of assessing the construction phase noise levels and the commencement of operational phase in the year of opening, while the long term criteria has been used for the purposes of assessing long term operational phase traffic noise levels 10 years after the year of opening. An additional column has been included in Table 12.1.8 and Table 12.1.9 to link the magnitude level defined in the DMRB with the significance criteria outlined in Table 12.1.7.

Table 12.1.8 Classification of Magnitude of Noise Impacts in the Short Term

Noise Change $L_{A10,18hr}$	Magnitude of Impact	Equivalent Significance Criteria (See Table 12.1.7)
0	No Change	Neutral
0.1 - 0.9	Negligible	Neutral
1.0 - 2.9	Minor	Minor Adverse/Beneficial Effect
3.0 - 4.9	Moderate	Moderate Adverse/Beneficial Effect
5.0 +	Major	Major Adverse/Beneficial Effect

Table 12.1.9 Classification of Magnitude of Noise Impacts in the Long Term

Noise Change $L_{A10,18hr}$	Magnitude of Impact	Equivalent Significance Criteria (See Table 12.1.7)
0	No Change	Neutral
0.1 - 2.9	Negligible	Neutral
3.0 - 4.9	Minor	Minor Adverse/Beneficial Effect
5.0 - 9.9	Moderate	Moderate Adverse/Beneficial Effect
10.0 +	Major	Major Adverse/Beneficial Effect

12.1.2.6 Vibration

In terms of significance criteria, BS 5228:2009+A1:2014 provides guidance on the effects of vibration levels on residential receptors. Table B1 of Annex B provides an outline of vibration levels and associated effects; this is reproduced in Table 12.1.10. An additional column has been added to the table to link these vibration levels to the equivalent significance criteria as outlined in Table 12.1.7.

Table 12.1.10 Guidance on Effects of Vibration Levels on Sensitive Receptors

Vibration Level	Effect	Significance Criteria (See Table 12.1.7)
0.14 - 0.3 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Neutral
0.3 - 1.0 mm/s	Vibration might be just perceptible in residential environments.	Minor Adverse Effect
1.0 - 10.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.	Moderate Adverse Effect
>10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	Major Adverse Effect

12.1.2.7 Operational Plant/Equipment Noise

There are no mandatory noise limits set out in Irish legislation for operational phase plant/equipment noise. There are several Irish and international guidance documents that are listed in Section 12.1.2.1. These documents are used for the purpose of reference material. The EPA NG4 guidance document sets out the requirements for noise compliance on EPA licensed sites, however the 3FM Project will not be an EPA licensed site and this document will not apply to it. The WHO guidelines and BS8233:2014 set out desirable internal/external noise levels at residential properties for good living conditions and are useful reference points for determining the potential for significant noise impacts at residential properties.

A key element of determining likely noise impacts from plant/equipment noise is the existing ambient (LAeq) and background noise levels (LA90) at the relevant property. Section 12.1.3 provides summary details of various noise surveys completed in the vicinity of various noise sensitive properties and Appendix 12.1 provides detailed information on these surveys. The potential for noise impacts associated with plant/equipment noise has been determined in the context of reference noise guidance documents and the existing ambient/background noise levels recorded in the noise surveys.

12.1.2.8 Methodology for Noise Monitoring

A baseline noise survey was completed involving unattended and attended noise measurements to record the existing noise environment at the nearest noise sensitive receptors to the proposed project. Figure 12.1.1 to Figure 12.1.7 illustrate the locations of all baseline noise monitoring locations. These noise monitoring locations are listed below under the separate headings of unattended noise monitoring locations and attended noise monitoring locations.

Unattended Noise Monitoring Locations (U-NMLs)

The unattended noise monitoring locations are permanent noise monitoring locations set up in the vicinity of the port to record existing noise levels in different directions from the port area. These include:

- Marina (U-NML1, Figure 12.1.1) – the marina is located just north of Pigeon House Road / Coastguard Cottages;
- P&O Site (U-NML2, Figure 12.1.2) – this NML is located on the western end of the port site;
- Clontarf (U-NML3, Figure 12.1.3) – this NML is located off Clontarf Road on the grounds of Scoil Ui Chonaill GAA Club.

Attended Noise Monitoring Locations (A-NMLs)

The attended noise monitoring locations were completed over daytime, evening and night-time periods at particular sensitive residential locations that have the potential to be impacted by the proposed project. These include:

- Coastguard Cottages (A-NML1, Figure 12.1.4);
- Glass Bottle site (A-NML2, Figure 12.1.5);
- Sandymount (A-NML3, Figure 12.1.6);
- ESB site (A-NML4, Figure 12.1.7).

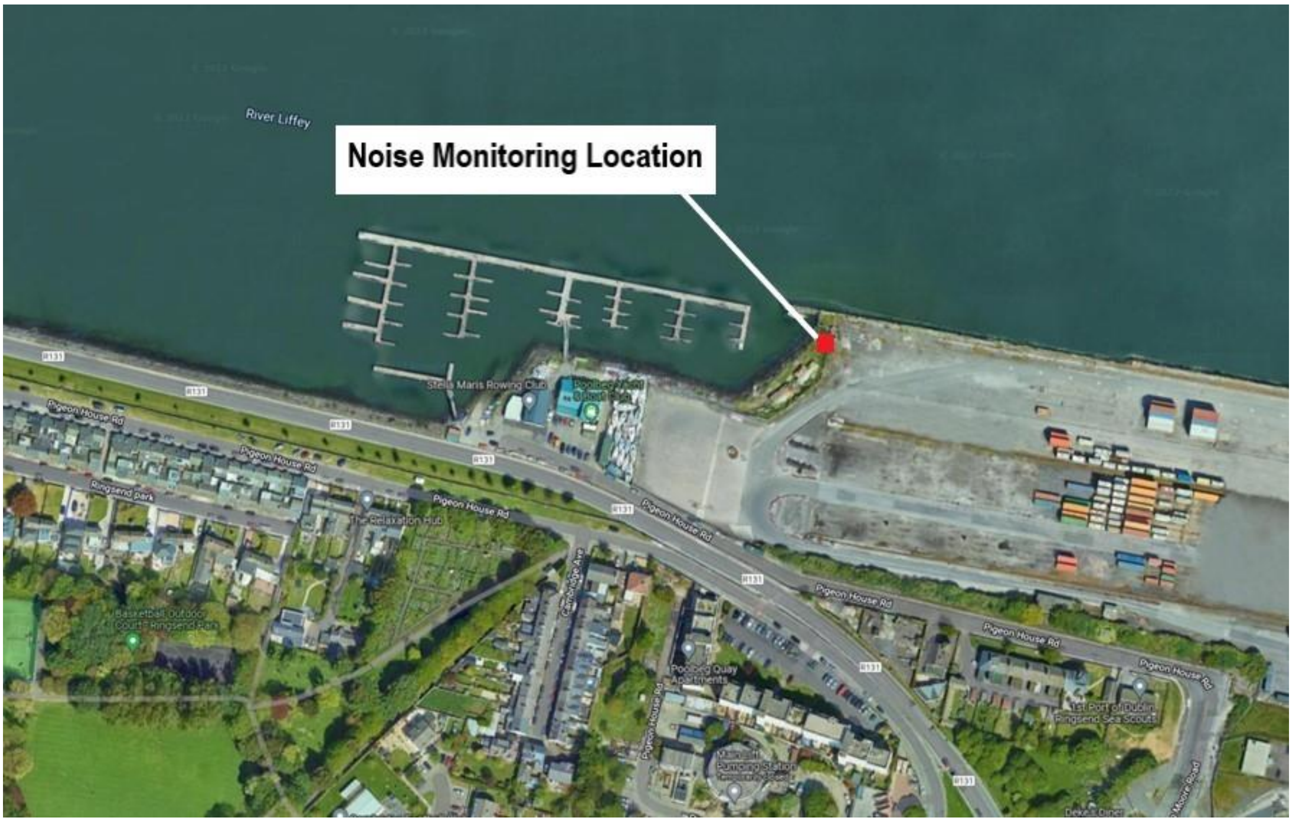

Figure 12.1.1 Marina Noise Monitoring Location (U-NML1)

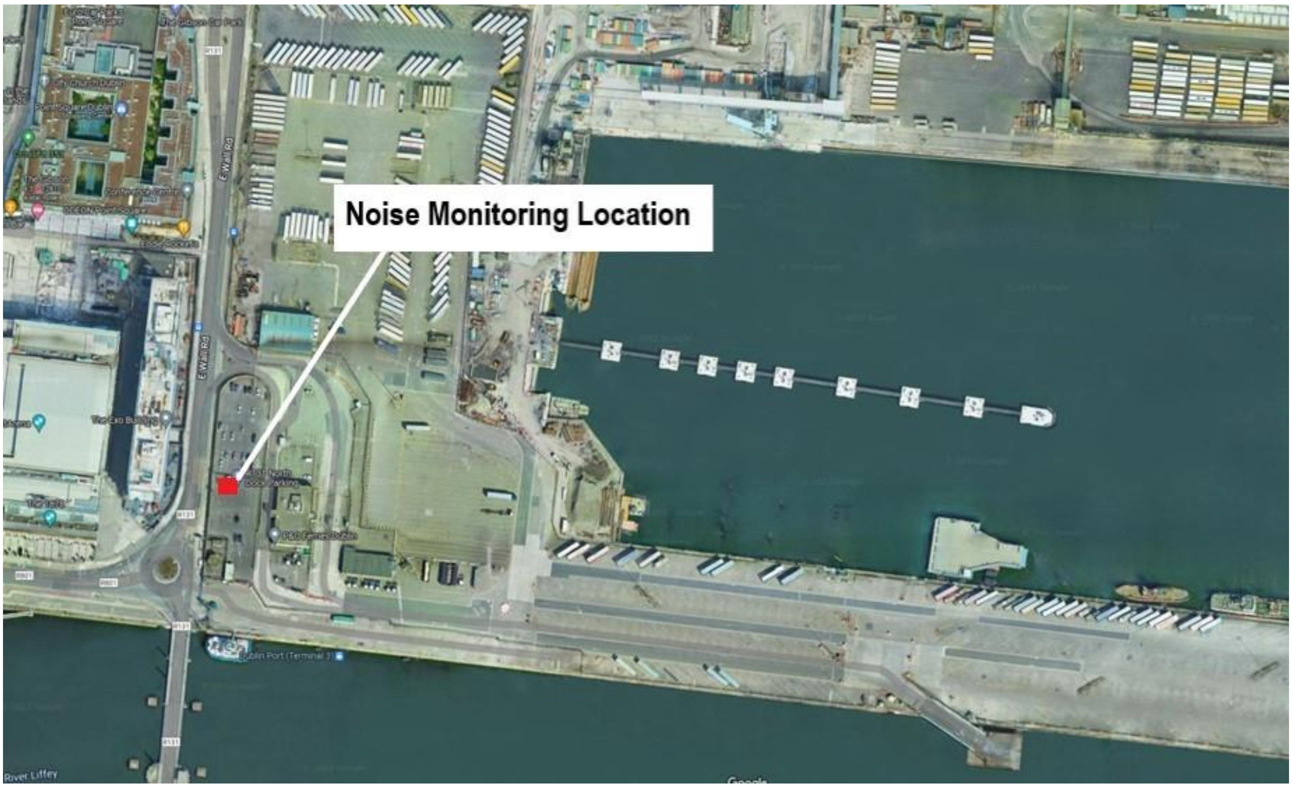

Figure 12.1.2 P&O Noise Monitoring Location (U-NML2)

Figure 12.1.3 Clontarf Noise Monitoring Location (U-NML3)

Figure 12.1.4 Coast Guard Cottages Noise Monitoring Location (A-NML1)

Figure 12.1.5 Glass Bottle Site Noise Monitoring Location (A-NML2)

Figure 12.1.6 Sandymount Noise Monitoring Location (A-NML3)

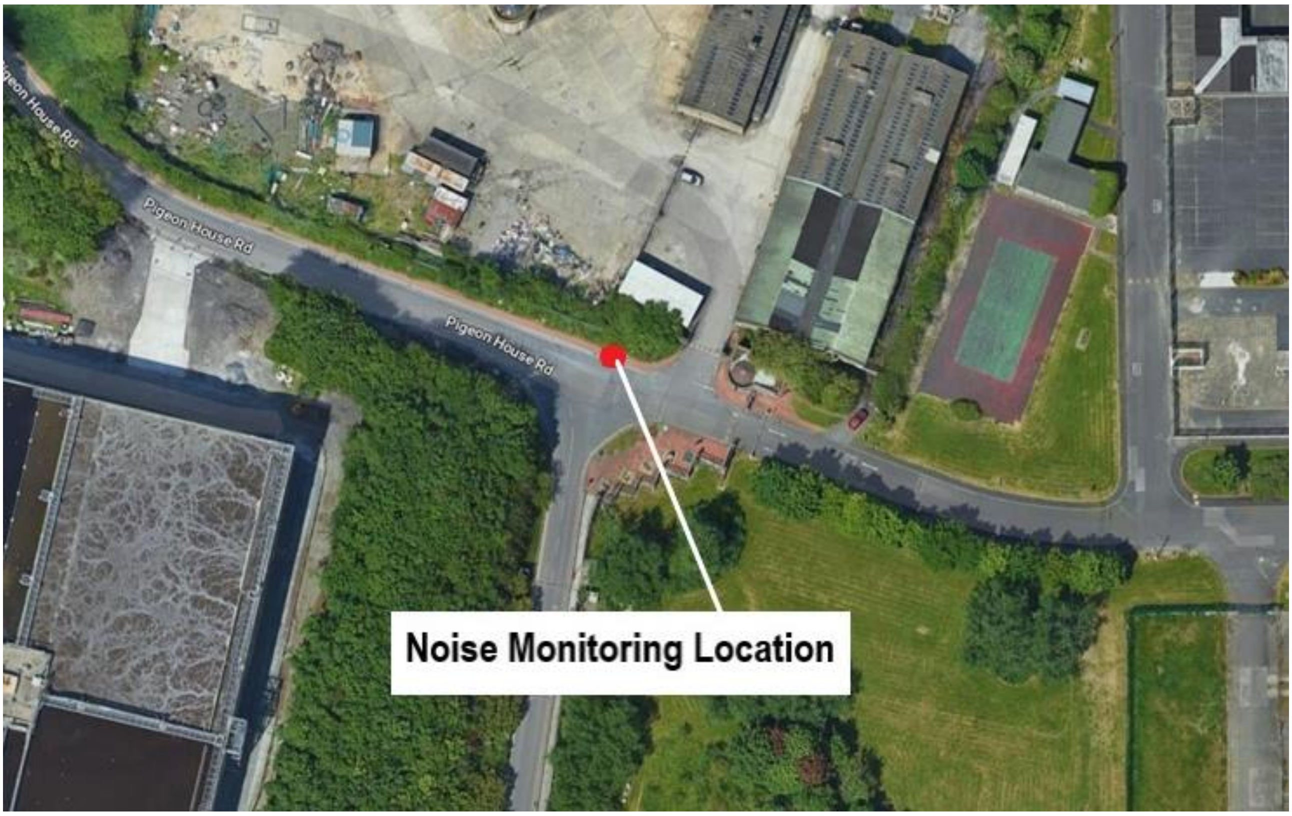

Figure 12.1.7 ESB Noise Monitoring Location (A-NML4)

The baseline noise monitoring survey was completed at various locations and dates between March and June 2023 using the following noise monitoring equipment:

- Norsonic Nor140 Sound Level Meter (BS EN IEC 61672-1:2003 Class 1) [Serial No: 1402995]
- Norsonic Sound Calibrator 1251 [Serial No: 33739]

The microphone was placed at a height of 1.2 - 1.5m above ground level. The sound level meter was accurately calibrated before and after use with no drift observed. The weather conditions during the noise monitoring survey were in accordance with the requirements of BS7445: Description and Measurement of Environmental Noise.

The following parameters were recorded during each monitoring period:

- LAeq The continuous equivalent A-weighted sound pressure level. This is an "average" of the sound pressure level.
- LAmax This is the maximum A-weighed sound level measured during the sample period.
- LAmin This is the minimum A-weighted sound level measured during the sample period.
- LA10 This is the A-weighted sound level that is exceeded for noise for 10% of the sample period.
- LA90 This is the A-weighted sound level that is exceeded for 90% of the sample period.

In addition to the baseline noise monitoring survey described above, an additional short-term noise monitoring survey was completed in the vicinity of those properties most likely to be impacted by the new SPAR road. The SPAR is listed as a national road scheme within the National Development Plan. This short-term noise monitoring survey was completed in accordance with Section 6.3.4 of the NRA Guidelines for the Treatment of Noise & Vibration in National Road Schemes.

Figure 12.1.8 illustrates the location of these short-term noise measurements completed in accordance with the NRA Guidelines. In total, six locations were selected for 15-minute measurements over three consecutive hours between 10:00 – 17:00 as described in Section 6.3.4 of the guidelines. The noise monitoring locations were selected at various distances from the R131 in the vicinity of Pigeon House Road so as to provide valuable existing noise data to validate the noise model used in this impact assessment chapter.

Figure 12.1.8 Short-term Noise Measurement Locations in the Vicinity of Pigeon House Road

Section 12.1.3 provides details of the noise measurement results at locations 1-6 from this short-term noise monitoring survey.

12.1.2.9 Noise Model

The proposed project was modelled using CadnaA noise modelling software. The CadnaA noise modelling software package uses the ISO9613 prediction methodology along with a range of topographical and ordnance data collected on the surrounding area to build up a picture of the noise environment in the vicinity of sensitive receptors in the study area. The software was used to build a 3-dimensional model of all features which may affect the generation and propagation of noise in the vicinity of the existing and proposed Port.

The CadnaA noise model was used for predicting cumulative noise levels at various stage of the construction phase and for predicting the cumulative noise levels from existing and proposed scenarios for the operational phase of the proposed project. The noise model was calibrated using noise measurement data recorded and presented in Section 12.1.3 and the model should good alignment with measurement data from the existing baseline noise environment.

12.1.3 Existing Environment

Section 12.1.2 provides details on the baseline noise monitoring survey completed at various locations and various dates between March and June 2023. The detailed noise monitoring survey measurements are presented in Appendix 12.1.

Using the data included in Appendix 12.1, summary data on the ambient (L_{Aeq}) and background (L_{A90}) noise levels at each noise monitoring location for different periods of the day has been included in Table 12.1.11. This summary data has been presented in the format of a range of recorded noise levels for the relevant time period in question. Where there are significant outlier data measurements within any dataset, these have been disregarded in the context of not presenting a distorted range of noise levels for that measurement period.

Table 12.1.11 Summary of Noise Monitoring Survey

Noise Monitoring Location	Range of Measured Noise Levels dB(A)		
	Daytime (07:00 – 19:00)	Evening (19:00 – 23:00)	Night-time (23:00 – 07:00)
Marina (U-NML1) March 2023)	Ambient Noise Level (LAeq)		
	50-62	47-58	46-62
	Background Noise Level (LA90)		
	44-58	43-54	41-54
P&O (U-NML2) March 2023	Ambient Noise Level (LAeq)		
	53-66	50-62	45-62
	Background Noise Level (LA90)		
	45-60	42-56	37-56
Clontarf (U-NML3) March 2023	Ambient Noise Level (LAeq)		
	49-63	49-59	40-56
	Background Noise Level (LA90)		
	35-55	34-53	28-49
Coastguard Cottages (A-NML1) June 2023	Ambient Noise Level (LAeq)		
	56-62	52-59	48-57
	Background Noise Level (LA90)		
	51-55	49-54	45-52
Glass Bottle Site (A-NML1) June 2023	Ambient Noise Level (LAeq)		
	46-58	43-48	43-47
	Background Noise Level (LA90)		
	42-51	40-43	41-44
Sandymount (A-NML1) June 2023	Ambient Noise Level (LAeq)		
	64-65	65-67	49-63
	Background Noise Level (LA90)		
	51-55	48-53	41-45
ESB (A-NML1) June 2023	Ambient Noise Level (LAeq)		
	54-65	-	47-54
	Background Noise Level (LA90)		
	49-50	-	46-49

As described in Section 12.1.2, a short-term noise monitoring survey was completed in the vicinity of Pigeon House Road in accordance with the methodology described in Section 6.3.4 of the NRA Guidelines for the Treatment of Noise & Vibration in National Road Schemes. Table 12.1.12 presents the measured noise levels recorded during this survey. The noise monitoring locations included within this survey are illustrated in Figure

12.1.8. Section 6.3.4 of the NRA Guidelines describes how these short-term measurements over three consecutive hours can be used to derive values for $L_{A10(18\text{-hour})}$ and L_{den}.

Table 12.1.12 Short-Term Noise Measurement Survey in Accordance with NRA Guidelines

Measurement Time	Measured Noise Levels dB(A)		
	L_{Aeq}	L_{A10}	L_{A90}
Location 1 (See Figure 12.1.8)			
10:16 - 10:31	69.2	71.1	57.2
11:08 - 11:23	69.4	72.3	60.8
12:02 - 12:17	70.5	72.6	62.1
Derived $L_{A10(18\text{-hour})}$	71		
Location 2 (See Figure 12.1.8)			
10:33 - 10:48	80.4	77.4	64.9
11:26 - 11:41	72.5	75.6	61.7
12:20 - 12:35	73.3	76.7	65.6
Derived $L_{A10(18\text{-hour})}$	76		
Location 3 (See Figure 12.1.8)			
10:51 - 11:06	62.3	65	56.3
11:44 - 11:59	64.1	66.1	58.7
12:38 - 12:53	62.6	65.2	57.9
Derived $L_{A10(18\text{-hour})}$	64		
Location 4 (See Figure 12.1.8)			
13:11 - 13:26	60.4	62.7	53.1
14:04 - 14:19	61.4	62.8	53.9
14:56 - 15:11	59.5	61.7	51.2
Derived $L_{A10(18\text{-hour})}$	61		
Location 5 (See Figure 12.1.8)			
13:28 - 13:43	66.5	69.7	58.7
14:21 - 14:36	66.7	70	59.2
15:14 - 15:29	65.1	68.6	57
Derived $L_{A10(18\text{-hour})}$	68		
Location 6 (See Figure 12.1.8)			
13:46 - 14:01	69.2	72.7	61.7
14:38 - 14:53	68.5	72.1	60.2
15:32 - 15:47	68.8	72	59.6
Derived $L_{A10(18\text{-hour})}$	71		

12.1.4 Impact Assessment – Construction Phase

12.1.4.1 Construction Noise - General

A detailed noise model was created of the port and surrounding noise sensitive receptors in order to predict the cumulative noise level associated with construction phase activities at the nearest noise sensitive properties. In order to create the noise model, it was necessary to define the various plant and equipment used as part of the construction phase activities. Table 12.1.13 includes a list of the most significant plant/equipment to be used during the construction phase for the proposed project.

Table 12.1.13 Plant and Equipment to be Used During Construction Phase (Ref: BS5228:2009+A1:2014)

Activity / Plant (Reference from Annex C & D, BS5228:2009+A1:2014)	Power Rating (kW)	Equipment Size, Weight (Mass), Capacity	Sound Power Level (dB)
Breaking Road Surface: Mini Excavator with Hydraulic Breaker (C5 - Ref 2)	-	1.5t	111
Road Planning: Road Planer (C5 - Ref 7)	185	17t	110
Removing Broken Road Surface: Wheeled Excavator (C5 - Ref 11)	112	17t	101
Rolling and Compaction: Vibratory roller (C5 - Ref 27)	20	3t	95
Haulage: Road Lorry - Full (C6 - Ref 21)	270	39t	108
Lifting: Wheeled Mobile Telescopic Crane (C4 - Ref 38)	610	400t	106
Clearing Site: Tracked excavator (C2 - Ref 3)	102	22t	106
Clearing Site: Wheeled backhoe loader (C2 - Ref 8)	62	8t	96
Ground Excavation: Dozer (C2 - Ref 12)	142	20t	109
Ground Excavation: Tracked excavator (C2 - Ref 14)	226	40t	107
Ground Excavation: Wheeled loader (C2 - Ref 27)	193	-	108
Poker Vibrator (C4 - Ref 33)	-	-	106
Power: Diesel Generator (C4 - Ref 83)	3	210kg	93
Distribution of Material: Tipper Lorry (C8 - Ref 20)	-	-	107
Piling: Tubular Steel Piling - hydraulic hammer - (C3 - Ref 3)	-	240mm diameter	116
Piling: Sheet Steel Piling - hydraulic jacking - power pack (C3 - Ref 10)	147	6t	96
Pumping Water: Water pump (C2 - Ref 45)	20	6 in	93
Dredging: Trailing Suction Hopper Dredge			114

The construction activities associated with the 3FM Project will take place over a period of approximately 15 years. Noise construction activity will be located in different areas of the construction site at different times throughout the duration of construction. The potential for construction noise impacts at residential properties will vary year by year depending on the nature and location of construction activities taking place at any one time. A detailed description of the construction phase is contained in Chapter 5.

Section 12.1.4 contains a construction noise impact assessment for the 3FM Project. As detailed in Section 12.1.4.2, this section focuses on areas where there is potential for significant construction noise impacts at residential receptors depending on the location and nature of construction activities in that particular area.

12.1.4.2 Construction Phase Noise Impacts

Before addressing areas where there is potential for significant construction noise impacts, there are areas where there is no potential for significant construction noise impacts. This is based largely on account of the distance between these areas and the nearest worst-case construction activities.

The nearest worst-case construction phase activities to Clontarf will be in approximate year 6 where a range of activities such as dredging and demolition of existing structures will be taking place. Figure 12.1.9 illustrates a model output of noise levels from these activities in the direction of Clontarf.

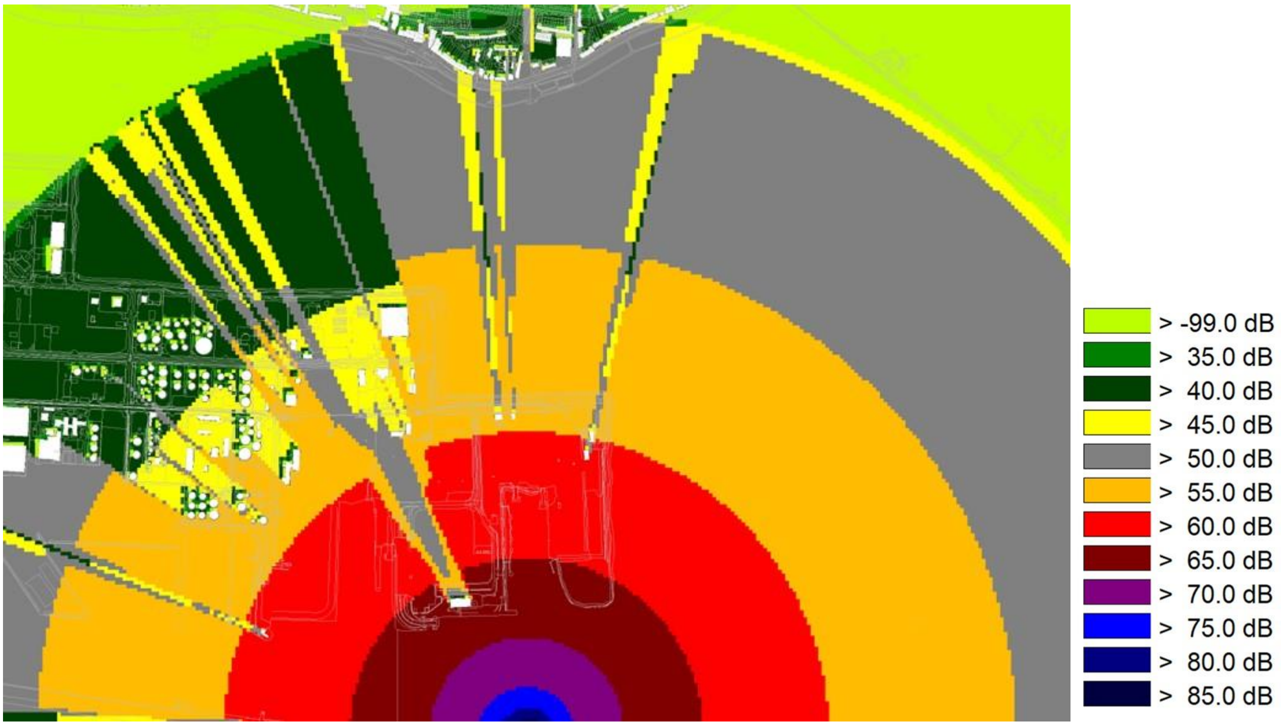

Figure 12.1.9 Noise Model of Construction Noise Levels at Clontarf

Figure 12.1.9 illustrates that worst-case construction noise levels in the direction of Clontarf will be below 50dB(A) at Clontarf, which is significantly below the most onerous construction phase noise threshold limit of 65dB(A) included in BS5228:2009+A1:2014. On this basis, construction phase noise impacts at Clontarf are considered to be negligible.

The nearest worst-case construction phase activities to Sandymount will be in approximate years 7-11 where a range of plant/equipment will be used for the construction of Area O. Figure 12.1.10 illustrates a model output of noise levels from these activities in the direction of Sandymount.

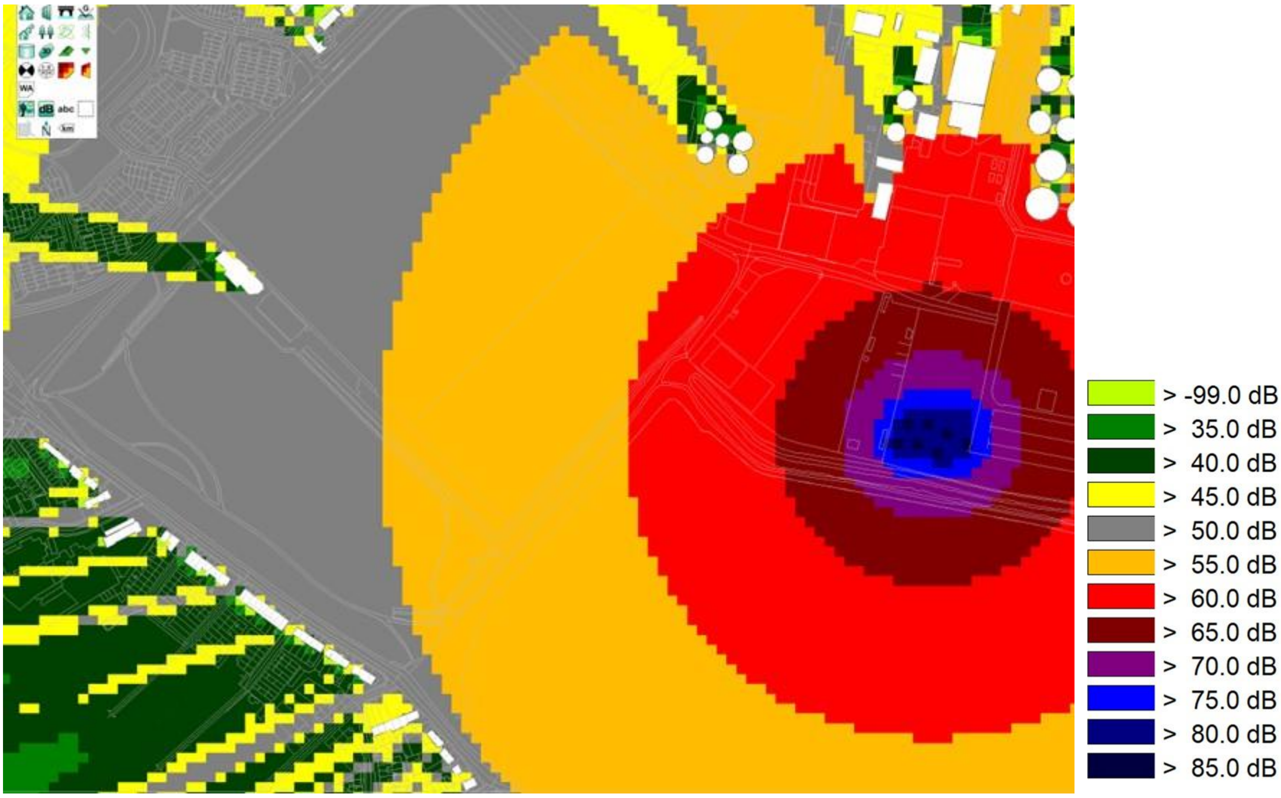

Figure 12.1.10 Noise Model of Construction Noise Levels at Sandymount

Figure 12.1.10 illustrates that worst-case construction noise levels in the direction of Sandymount will be below 50dB(A) at Sandymount, which is significantly below the most onerous construction phase noise threshold limit of 65dB(A) included in BS5228:2009+A1:2014. On this basis, construction phase noise impacts at Clontarf are considered to be negligible.

To the west of the port, the distance between construction activities and the nearest residential receptors and the substantial screening effect of commercial buildings in this area will mean that construction noise levels will be significantly below the most onerous construction phase noise threshold limit of 65dB(A) included in BS5228:2009+A1:2014. On this basis, construction phase noise impacts west of the port are considered to be negligible.

The most significant potential for worst-case construction noise impacts from the 3FM Project will be in the areas around Pigeon House Road and Coastguard Cottages. During construction years 4-8, there is potential for worst-case construction noise levels greater than 65dB(A) for properties in the vicinity of Pigeon House Road and Coastguard Cottages based on worst-case assumptions for construction activity.

Figure 12.1.11 illustrates the noise model outputs for Year 4 at properties on Pigeon House Road and Coastguard Cottages. This is based on worst-case assumptions of plant/equipment active at any one time. Figure 12.1.12 illustrates specific properties in the vicinity of these construction works and Table 12.1.14 presents worst-case predicted construction noise levels at these properties.

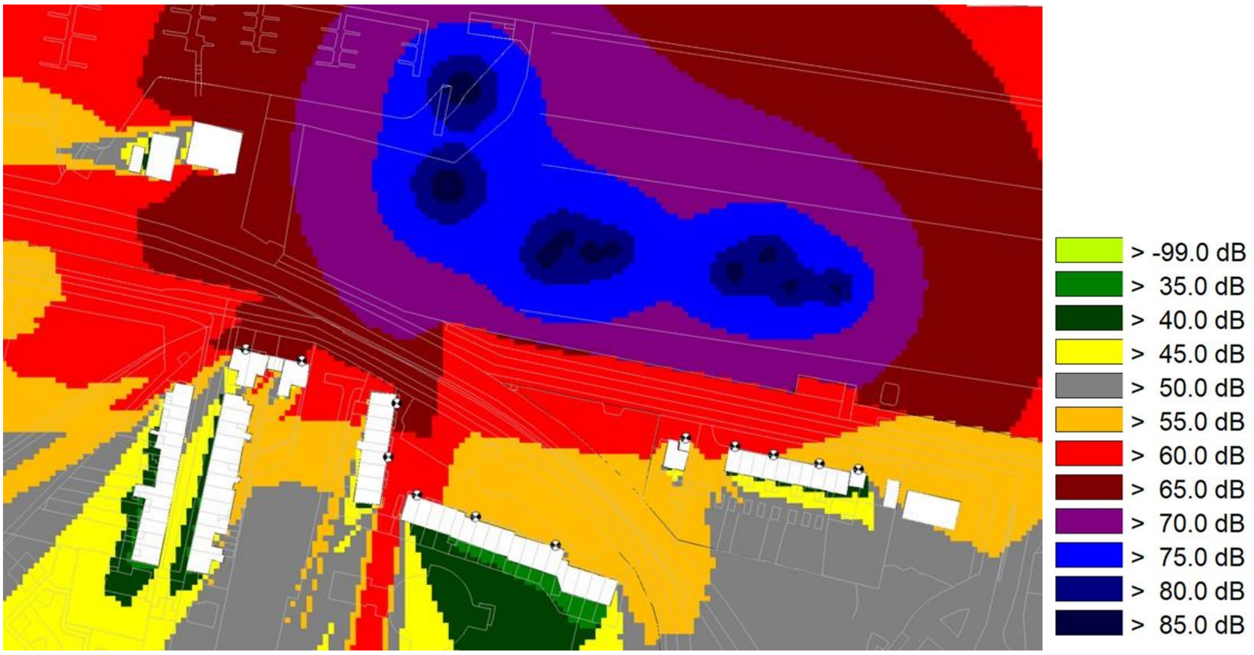

Figure 12.1.11 Noise Model of Worst-Case Construction Noise Levels During Year 4 at Pigeon House Road / Coastguard Cottages

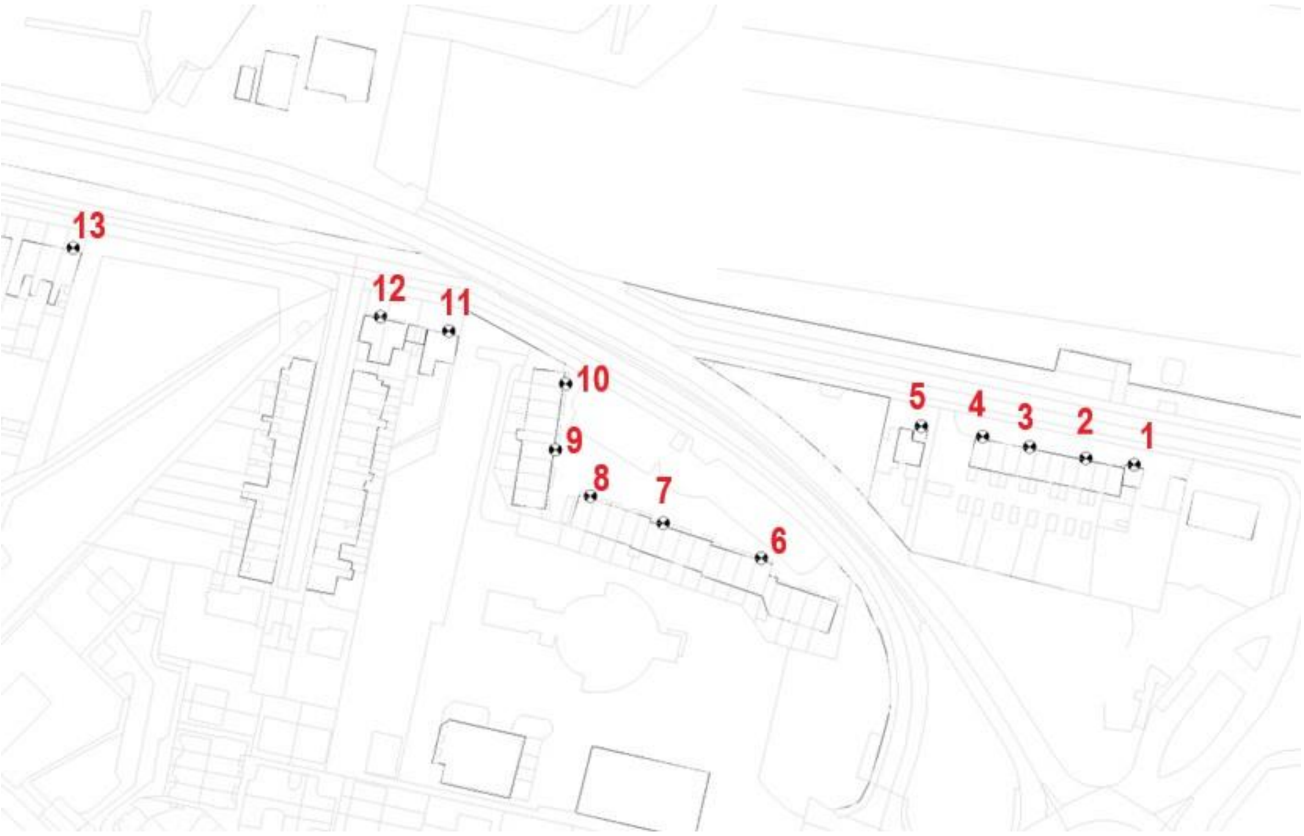

Figure 12.1.12 Location Specific Properties Along Pigeon House Road / Coastguard Cottages to Illustrate Worst-Case Construction Noise Levels in Table 12.1.14

Table 12.1.14 Worst-Case Prediction Noise Levels at Individual Properties Along Pigeon House Road / Coastguard Cottages

Receptor Reference (See Figure 12.1.12)	Worst-Case Predicted Noise Level in Year 4 dB(A)	Applicable BS5228 Noise Threshold Limit dB(A)
1	58.5	65
2	59.2	65
3	59.9	65
4	60.5	65
5	60.8	65
6	59.9	65
7	60.0	65
8	63.6	65
9	64.6	65
10	67.0	65
11	65.0	65
12	66.3	65
13	58.6	65

Figure 12.1.13 illustrates the noise model outputs for Year 6 at properties on Pigeon House Road. This is based on worst-case assumptions of plant/equipment active at any one time. Figure 12.1.14 illustrates specific properties in the vicinity of these construction works and

Table 12.1.15 presents worst-case predicted construction noise levels at these properties.

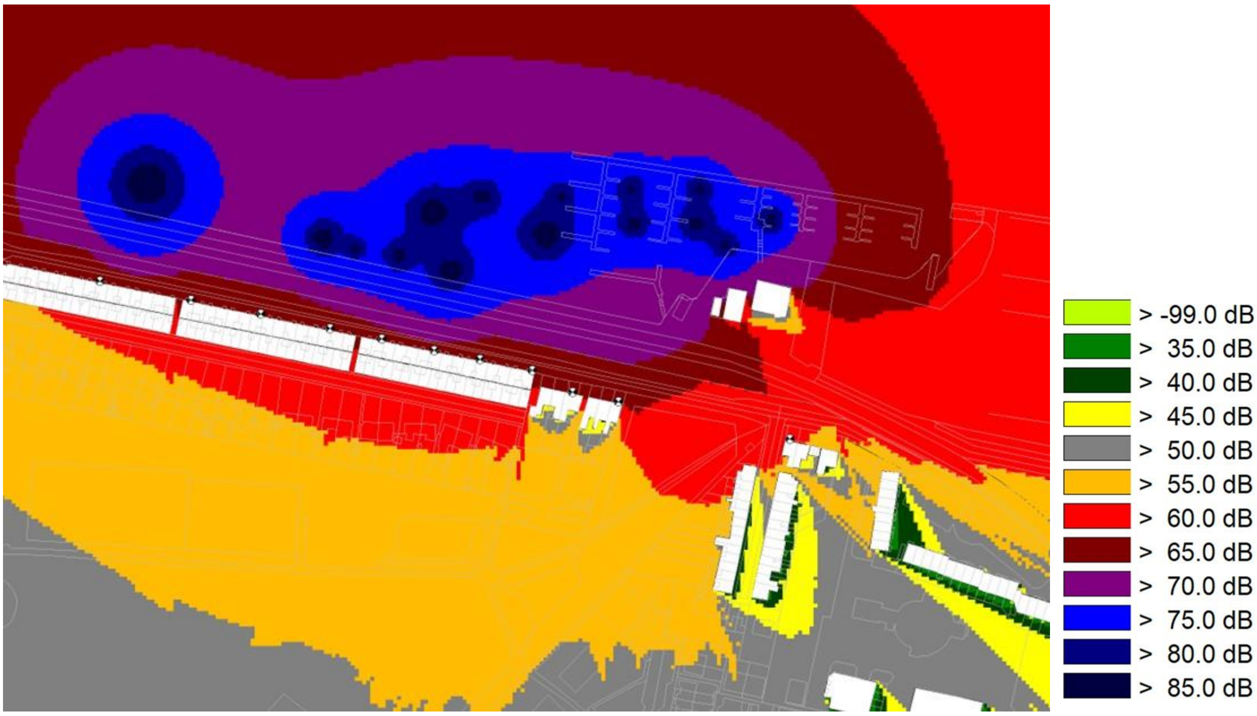

Figure 12.1.13 Noise Model of Construction Noise Levels During Year 6 at Pigeon House Road

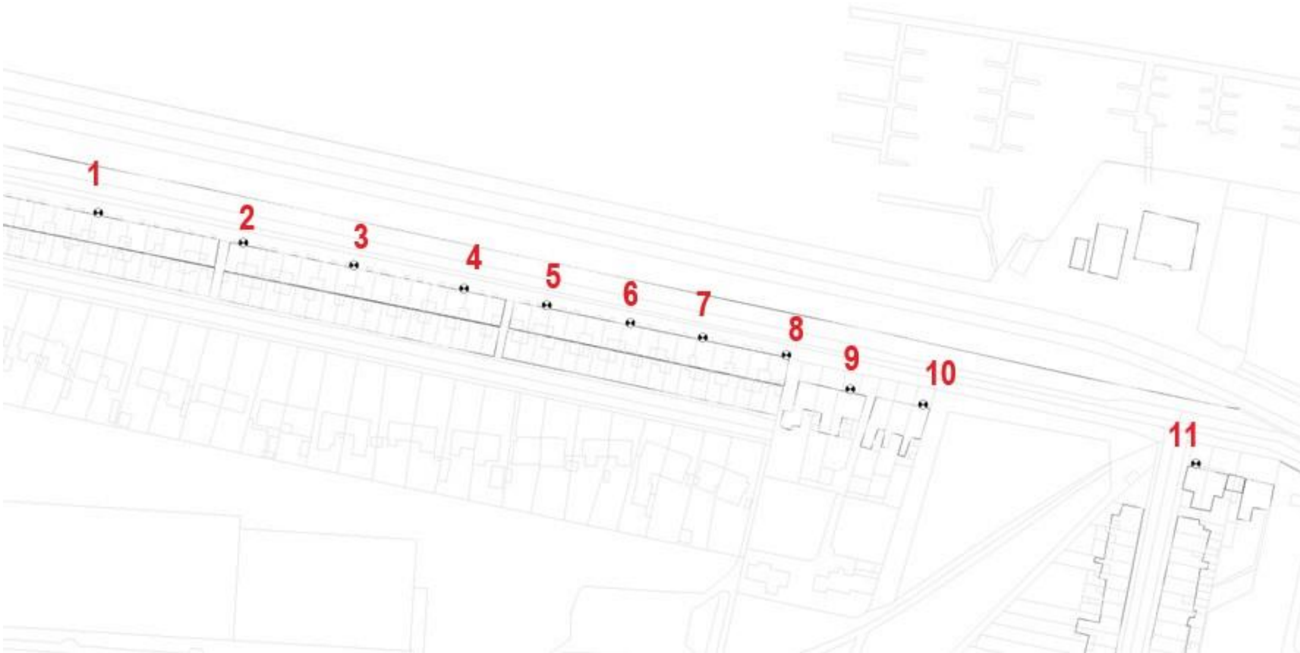

Figure 12.1.14 Location Specific Properties Along Pigeon House Road to Illustrate Worst-Case Construction Noise Levels in

Table 12.1.15 Worst-Case Prediction Noise Levels at Individual Properties Along Pigeon House Road

Receptor Reference (See Figure 12.1.14)	Worst-Case Predicted Noise Level in Year 6 dB(A)	Applicable BS5228 Noise Threshold Limit dB(A)
1	64.7	65
2	65.0	65
3	65.9	65
4	67.4	65
5	68.0	65
6	67.9	65
7	67.0	65
8	65.5	65
9	66.5	65
10	65.6	65
11	60.4	65

On the basis of these worst-case construction noise levels in this area are considered to be significant (Moderate/Major). There will be a requirement for mitigation measures to be in place to ensure that the relevant BS5228:2009+A1:2014 noise threshold limit is not exceeded at the nearest noise sensitive properties. Noise mitigation measures in this area are presented in Section 12.1.7.

12.1.4.3 Construction Phase Traffic Noise Impacts

As part of the construction phase noise impact assessment construction, construction phase traffic flows over the construction period between 2026 and 2040 were assessed. The highest concentration of construction traffic during this period will be in the second half of 2038, primarily related to construction vehicles movements to the works at Areas K, L and O. It is estimated 17,088 construction vehicles movements (two-way movement) will take place during this six-month period, averaging as 2,848 over each month period during this period. This equates to less than 140 construction vehicles movements per day.

The UK Design Manual for Roads and Bridges (DMRB, Volume 11, Section 3, Part 7) states that it takes a 25% increase or a 20% decrease in traffic flows in order to get a 1dB(A) change in traffic noise levels. On this basis of traffic flow levels on the routes by which construction traffic will be travelling to the construction site and worst-case daily construction traffic levels presented above, traffic noise levels associated with the construction phase of the proposed project will be less than 1dB(A) at noise sensitive receptors along these routes. It is generally accepted that it takes an approximate 3dB(A) increase in noise levels to be perceptible to the average person (Ref: NRA *Guidelines for the Treatment of Noise and Vibration in National Road Scheme,* 2004). Based on this reference, traffic noise increases associated with the construction phase on the local road network will have a negligible/minor noise impact at these properties.

12.1.4.4 Construction Phase Vibration Impacts

Some of the construction phase activities associated with the proposed construction phase have the potential to result in vibration impacts at sensitive receptors if sufficiently close to the respective receptor. Activities included in the proposed construction phase that have the potential to result in vibration impacts include piling and to a lesser extent rock armour activities and dredging.

BS5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and open Sites - Part 2: Vibration gives pages of reference data relating to measured vibration levels associated with different types of piling activities in different ground strata. BS5228:2009+A1:2014 references vibration levels measured for various types of bored piling / cast-in-situ piling (using hammer), a technique which reflects the type of piling that will be conducted as part of the proposed project.

Reference 11 from Table D1 of BS5228:2009 indicates that bored piling on loose rock over weathered rock over rock, gives a measured PPV of 1.2mm/s at 30m. The nearest piling activity associated with the proposed project will be between the piling activities associated with the construction of the SPAR and the properties on the Pigeon House Road. The nearest properties on Pigeon House Road are approximately 40m from the nearest construction piling activity and on the basis of the reference above, this would indicate that piling vibration levels from piling activities will be less than 1mm/s.

On the basis of the vibration threshold limits outlined in Table 12.1.3 and Table 12.1.4, the vibration impacts during the construction phase will be minor. While there will be a minor vibration impact associated with the construction phase of the proposed project, it would be prudent for vibration monitoring to be completed during the worst-case phase of piling in this area to ensure that there are no significant vibration effects experienced. Section 12.1.7 provides details on proposed construction phase vibration mitigation measures.

Chapter 16 Cultural Heritage provides details on the potential for construction phase activities to impact on cultural heritage locations in the vicinity of proposed 3FM construction works. The chapter contains a range of cultural heritage management measures (including vibration monitoring) for all aspects of the works to minimise potential impacts and maximise potential benefits at these cultural heritage locations. These measures are not repeated in this chapter.

12.1.4.5 Dublin City Council Construction and Demolition Plan

Section 12.1.2.1 summarises the requirement to complete a construction and demolition plan prior to the commencement of work on a site as set out in the DCC Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition. This guide presents a risk-based approach to be completed taking into account the locality, nature of work and the expected duration of work.

This section contains risk assessment for the 3FM Project. Table 12.1.16 details the Risk Assessment A for locality / site information, while Table 12.1.17 presents the Risk Assessment B for work information. Table 12.1.18 contains the Total Risk Assessment based on Risk Assessments A and B.

Table 12.1.16 DCC Guide Risk Assessment A

	Low	Medium	High
Expected duration of work			
Less than 6 months			
6 months to 12 months			
Over 12 months			x
Proximity of nearest sensitive receptors			
Greater than 50m from site	x		
Between 25m and 50m			
Less than 25m			
Hospital or school within 100m			
Day time ambient noise levels			
High ambient noise levels (>65dB[A])			
Medium ambient noise levels (>65dB[A])		x	
Low ambient noise levels (>65dB[A])			
Working Hours			
7am – 6pm Mon-Fri; 8am-1pm Sat	x		
Some extended evening or weekend work			
Some night time working, including likelihood of concrete power floating at night			
SUBTOTAL A	**2**	**1**	**1**

Table 12.1.17 DCC Guide Risk Assessment B

	Low	Medium	High
Location of works			
Majority within existing building			
Majority external			x
External Demolition			
Limited to two weeks			
Between 2 weeks and 3 months			
Over 3 months			x
Ground works			
Basement level planned			
Non percussive methods only			
Percussive methods for less than 3 months			
Percussive methods for more than 3 months			x
Piling			
Limited to 1 week			
Bored piling only			
Impact or vibratory piling			x
Vibration generating activities			
Limited to less than 1 week			
Between 1 week and 1 month			
Greater than 1 month			x
SUBTOTAL B	**0**	**0**	**5**

Table 12.1.18 DCC Guide Total Risk Assessment

	Low	Medium	High
Risk Assessment A	2	1	1
Risk Assessment B	0	0	5
Total	2	1	6

On the basis of the total risk assessment score, the 3FM Project will be in the high-risk category. Section 12.1.7 provides details on the good practice measures detailed in the DCC guide that are to be applied during the construction phase based on high-risk category.

12.1.5 Impact Assessment – Operational Phase

12.1.5.1 Traffic Noise Impact from SPAR

Sections 12.1.5.2 – 12.1.5.3 contain an assessment of the proposed SPAR during the operational phase.

12.1.5.2 Introduction

Section 12.1.2 describes the recommendations include in the NRA Guidelines for the treatment of noise and vibration in national road schemes for achieving the relevant design goal below on all new national road schemes. These guidelines have been used for the purposes of modelling and assessing the SPAR as the SPAR has been designated as a national road scheme under the National Development Plan 2021-2030.

Day-evening-night 60dB L_{den} (free field residential facade criteria)

Mitigation measures are only deemed necessary when the following three conditions are satisfied at designated sensitive receptors:

- The combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal:
- The relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place;
- The contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

As detailed in Section 2.3 of the NRA Guidelines, the 60dB Lden design goal has been derived from the previously used design standard of 68dB(A) $L_{A10(18hour)}$. Section 12.1.2 provides information on the CadnaA noise modelling software used for the purposes of modelling noise from the SPAR road. The noise models completed in this assessment have been prepared using hourly traffic levels prepared by the traffic consultants for the 3FM Project. The CadnaA noise modelling software provides noise model outputs in the form of $L_{A10(18hour)}$ predicted noise levels and these are transposed to Lden predicted noise levels using the formulae included in Section 3 of the NRA Guidelines.

12.1.5.3 Noise Model Predictions

Detailed noise models were prepared for the 3FM Project for the following scenarios:

- Do Nothing Scenario (R131) – 2040;

- Do Something Scenario (R131 + SPAR) 2040.

Comparison of the Do Nothing 2040 and Do Something 2040 scenarios was used for the purposes of determining the requirement for mitigation measures as detailed in the NRA Guidelines (See Introduction above and Section 12.1.2).

In order to complete noise modelling exercise as described above, a range of noise sensitive receptors along Pigeon House Road / Coastguard Cottages and areas where future residential properties will be located on the Glass Bottle site were selected so as to be representative of property groups most likely to be impact by noise form the proposed SPAR. Figure 12.1.15 to Figure 12.1.17 illustrate the location of properties used in the noise modelling exercise.

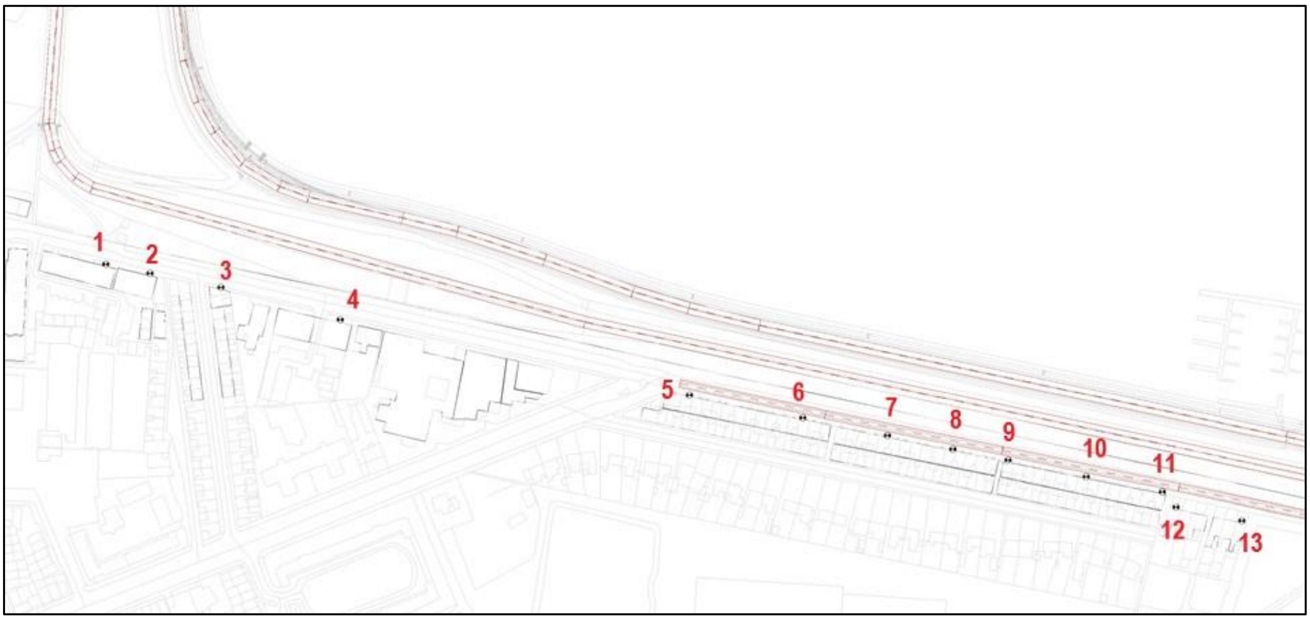

Figure 12.1.15 Noise Sensitive Properties Modelled (Part 1)

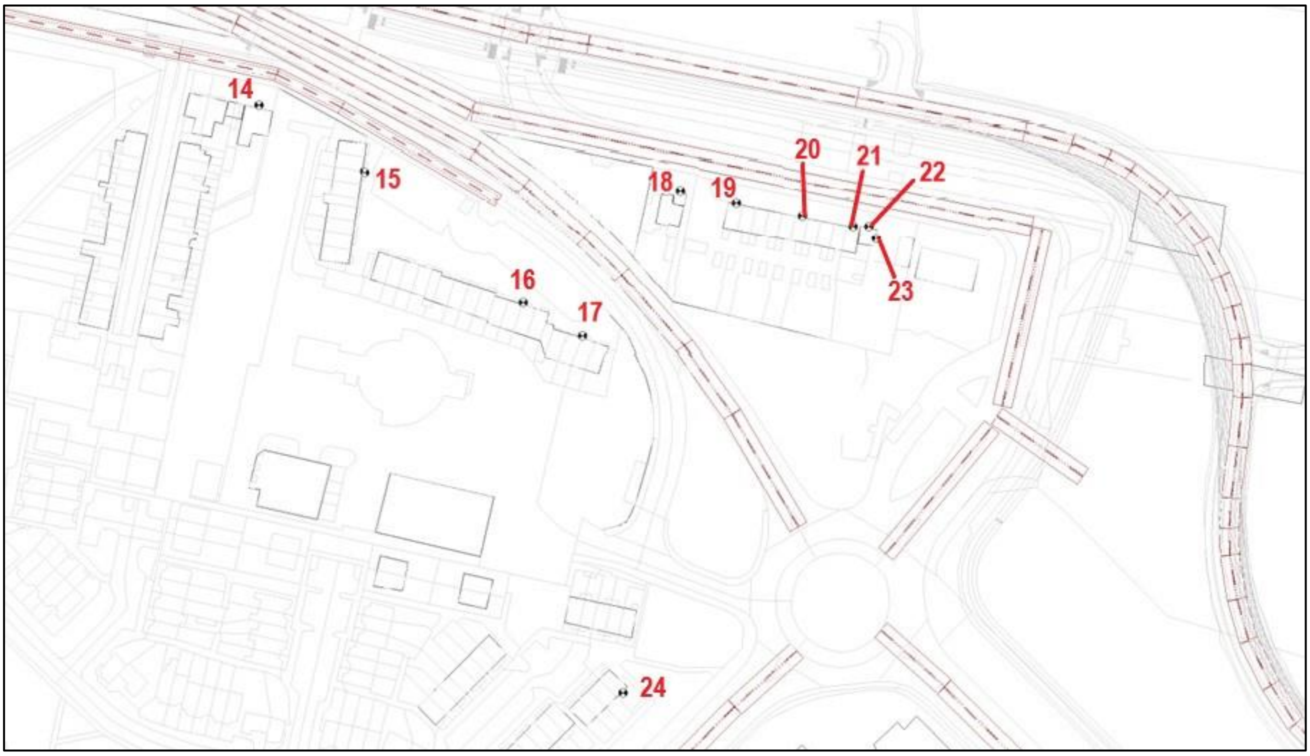

Figure 12.1.16 Noise Sensitive Properties Modelled (Part 2)

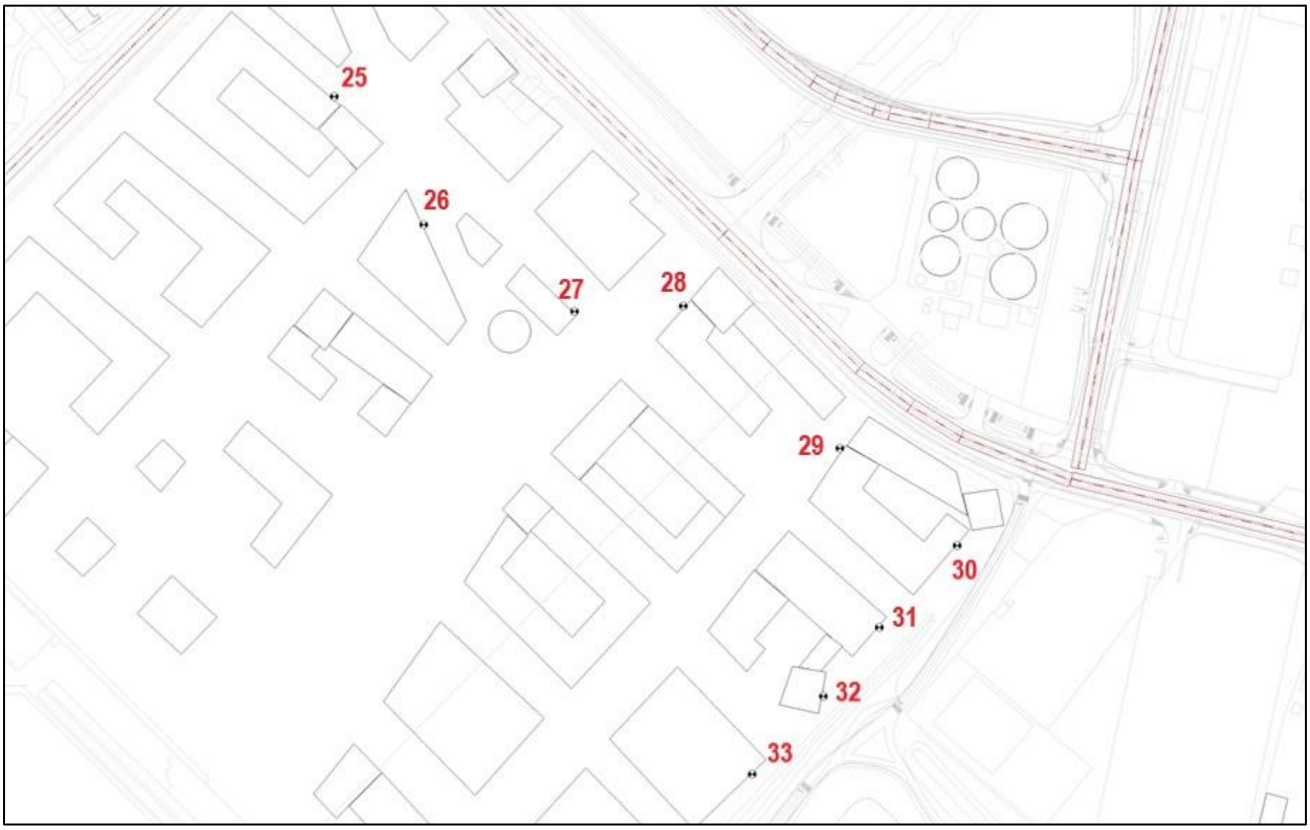

Figure 12.1.17 Noise Sensitive Properties Modelled (Part 3)

Table 12.1.19 presents noise model outputs for the noise sensitive receptors included in Figure 12.1.15 to Figure 12.1.17 for the Do Nothing (2040) and Do Something (R131 + SPAR, 2040) scenarios.

Table 12.1.19 Noise Model Outputs for the SPAR

Receptor Number	Address [Height modelled]	Modelled Scenarios (Lden) dB(A)		Mitigation Required
		Do Nothing 2040	Do Something (R131 + SPAR) 2040	
1	York Road (1) [9m]	67.1	64.6	N
2	York Road (2) [9m]	67.5	65.1	N
3	York Road (3) [4m]	67.8	65.6	N
4	York Road (4) [9m]	67.9	66.1	N
5	1 Pigeon House Road [1.5m]	66.4	65.1	N
6	12 Pigeon House Road [1.5m]	66.6	65.3	N
7	19 Pigeon House Road [1.5m]	66.6	65.3	N
8	24 Pigeon House Road [1.5m]	66.6	65.3	N
9	30 Pigeon House Road [1.5m]	66.7	65.4	N
10	37 Pigeon House Road [1.5m]	66.8	65.4	N
11	44 Pigeon House Road [1.5m]	66.8	65.5	N
12	46 Pigeon House Road [4m]	66.8	65.7	N
13	51 Pigeon House Road [4m]	67.4	66.3	N
14	64 Pigeon House Road [4m]	69.1	67.2	N
15	Poolbeg Quay Apartments (1) [11.5m]	67.4	65.0	N
16	Poolbeg Quay Apartments (2) [11.5m]	67.8	64.4	N
17	Poolbeg Quay Apartments (3) [11.5m]	68.5	64.7	N
18	70 Pigeon House Road [4m]	60.8	61.0	N
19	71 Pigeon House Road [4m]	59.3	60.4	Y
20	76 Pigeon House Road [4m]	58.5	59.9	Y
21	79 Pigeon House Road [4m]	58.4	59.1	N
22	80 Pigeon House Road (1) [4m]	58.6	60.4	Y
23	80 Pigeon House Road (2) [5m]	60.0	60.4	N
24	13 Leukos Road [4m]	65.6	65.4	N
25	Glass Bottle Residential (1) [16m]	54.8	55.0	N
26	Glass Bottle Residential (2) [16m]	54.7	52.4	N
27	Glass Bottle Residential (3) [16m]	53.6	54.5	N
28	Glass Bottle Residential (4) [16m]	62.0	60.8	N
29	Glass Bottle Residential (5) [16m]	56.1	57.0	N
30	Glass Bottle Residential (6) [16m]	52.1	56.1	N
31	Glass Bottle Residential (7) [16m]	50.5	54.7	N
32	Glass Bottle Residential (8) [16m]	49.0	53.6	N
33	Glass Bottle Residential (9) [16m]	47.2	52.0	N

The noise model outputs for the Do Nothing (2040) and Do Something (2040) scenarios indicate that the three conditions for the requirement of mitigation measures as detailed in the NRA Guidelines are satisfied for receptors 19, 20 and 22.

On the basis of the noise analysis included in Table 12.1.19, potential noise impacts in the vicinity of Pigeon House Road are considered to be significant (Moderate). There will be a requirement for mitigation measures to be in place for the SPAR. Proposed mitigation measures for the SPAR are detailed in Section 12.1.7.

12.1.5.4 Plant/Equipment Noise Impact

Sections 12.1.5.5 and 12.1.5.6 contain an impact assessment of plant/equipment noise from the proposed 3FM Project when operational. The primary sources of operational plant/equipment noise will be from the proposed new Ro-Ro and Lo-Lo operations at Areas K, L, N and O.

12.1.5.5 Introduction

Section 12.1.5.6 includes an assessment of the potential noise impact associated with the new plant/equipment associated with the 3FM Project. A full description of the operational phase of the proposed project is contained in Chapter 5 Project Description. In summary, new operational phase activities with the potential to generate significant noise levels are proposed in the following areas:

- Area K & O – Area K (Ro-Ro Terminal) and Area O (Ro-Ro Overflow Storage) will operate as a single terminal. Area K operations will be adjacent to Berth 42-45 and will include Ro-Ro operations, trailer parking, limited container stacking and the use of handling equipment. Area O will be utilised as a trailer parking waiting area or storage facility, as well as shunting, in conjunction with Area K.
- Areas N & L – These Lo-Lo Areas will operate as a singe terminal, with Area N to be utilised primarily for container exports and Area O to be utilised primarily for container imports. A new berthing quay at Area N will be utilised for both imports and exports.

Figure 12.1.18 illustrates the location of each of these Areas in the overall context of the port. A new maritime village will be location in the general vicinity of the existing marina but will not generate any significant plant/equipment noise.

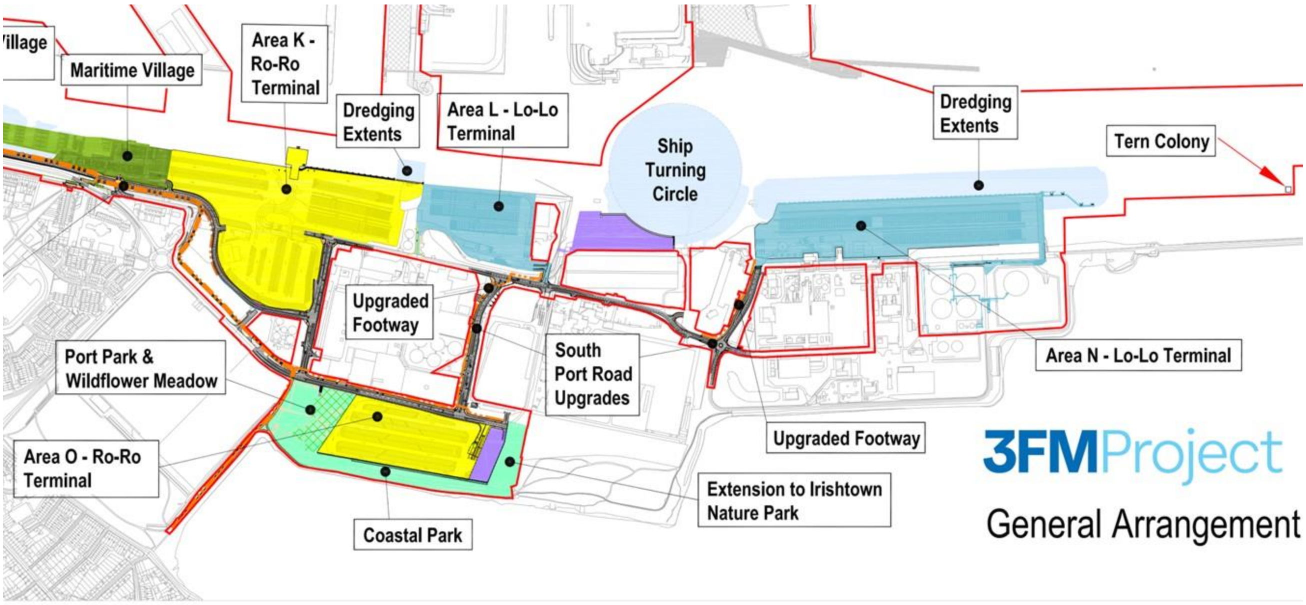

Figure 12.1.18 Location of Areas K, N, L and O

12.1.5.6 Description of Plant/Equipment

Table 12.1.20 provides a description of the various items of plant/equipment that will be in use in each of Areas K, N, L and O. In Area K, the container stacking area has been located in the north-eastern corner of the Area to maximise the distance between this activity and the nearest noise sensitive properties at Coastguard Cottages. Aside from electrified shunters, all handling equipment utilised within this Area will operate in this north-eastern corner of the area.

Table 12.1.20 Description of Plant/Equipment to be Utilised in Areas K, N,L & O

Area	Plant/Equipment
K	• E-Rubber tyred gantries (x4) • Reach stackers (x4) • Refrigerated units • Electrified internal terminal tractors • HGVs
N	• Ship to shore cranes (x6) • E-Rubber tyred gantries (x8) • Reach stackers (x4) • Refrigerated units • Electrified internal terminal tractors • HGVs
L	• E-Rubber tyred gantries (x6) • Refrigerated units • Electrified internal terminal tractors • HGVs
O	• Electrified internal terminal tractors • HGVs

Table 12.1.21 includes reference noise source data (Sound power level – Lw) for the various items of plant/equipment listed in Table 12.1.20. The reference noise source data included in this table has been used for the purposes of generating a detailed CadnaA noise model of the activities in each area to predict noise levels from each area at the nearest noise sensitive properties. This noise source data has been taken from a number of different studies completed in relation to port plant/equipment noise. Shiavoni et al (2022) summarises the recent results and research regarding port noise sources in order to provide a comprehensive database of sources that can be used for purposes such as the noise modelling of port noise. This paper details information regarding the sound power levels of noise sources operating in port areas from an array of port studies including the REPORT project, the EU funded EFFORTS project, the FP7 SILENV project and other relevant papers and reports.

The data included in Shiavoni et al (2022) is based on data that is several years old. There has been a significant recent change in the manufacture and supply of port plant/equipment with several large suppliers (e.g. Konecrane, Terberg) now providing plant/equipment that is fully electrified and a number of ports have already started to deploy this plant/equipment. While the power source change from diesel engine to electrification in itself facilitates a substantial reduction in noise emissions, further significant noise reduction is achieved in container handling with these new items of plant/equipment in the form of a range of features (e.g. automation, sensors, silent gears, silent motors etc.). These new developments make these new items of plant/equipment significantly different from the standard banging noise typical of the majority of existing port container handling operations.

The 3FM Project will be not become operational until post-2035 and advances in the reduction of noise from port plant/equipment that have already become apparent over the past one to two years will be substantially augmented by the time that plant/equipment will be commissioned for the 3FM Project. For the purposes of this assessment, items of electrified plant/equipment that are currently available (i.e. terminal tractors, cranes, reach stackers) are included within the noise model as these items of electrified plant/equipment will be the norm at the stage when plant/equipment will be commissioned for this project.

Table 12.1.21 Source Noise Data Used in Noise Model for the Proposed Areas K, N & O

Item of Plant/Equipment	Sound Power Level (L_W) dB(A)
Ship	101
Ship to Shore Gantry (SSG) Crane	111
Electric Rubber Tyre Gantry (RTG) Crane	101
Electric Rail Mounted Gantry	101
Reefer container	86
Electric Reach Stacker	96
Electric Terminal Tractor	94
HGV	104
Ramp Noise	115*
Container Handling Activity	112*

* *Additional 5dB has been added to these Lw Noise Levels to account for tonal/impulsive nature*

In Table 12.1.21, a 5dB correction has been added to noise sources which have a particular tonal/impulsive nature as recommended in the EPA NG4 guidelines. These noise sources are included in the noise model as additional to the noise from the operation of the particular item of plant/equipment (e.g. crane). A proportionality correction of these items being active for 10% of any daytime period is assumed which is deemed to be very conservative on account of the very short nature of these noise sources.

On the basis of the plant/equipment detailed in Table 12.1.20 and Table 12.1.21, a detailed noise model was generated. The items of plant/equipment active at any one time in all areas for are presented in Table 12.1.22.

Table 12.1.22 Description of Plant/Equipment Active for Noise Model

Area	Plant/Equipment Active at Any Time
	Option1
K	• E-Rubber tyred gantries (x4) • Reach stackers (x4) • Electrified internal terminal tractors (x4) • HGVs (x3) • Ship (x1) • Container handling • Ramp (x1)
N	• Ship to shore cranes (x6) • E-Rubber tyred gantries (x8) • Reach stackers (x4) • Electrified internal terminal tractors (x4) • HGVs (x3) • Ship (x1) • Container handling
L	• E-Rubber tyred gantries (x6) • Electrified internal terminal tractors (x3) • HGVs (x3) • Container handling
O	• HGVs (x3) • Electrified internal terminal tractors (x3)

Noise levels were modelled at a range of the nearest noise sensitive receptors located in all directions from the port lands. The locations of all of the noise sensitive receptors included within the model are illustrated in Figure 12.1.19 to Figure 12.1.26.

Figure 12.1.19 Nearest Noise Sensitive Receptors Modelled (Overview)

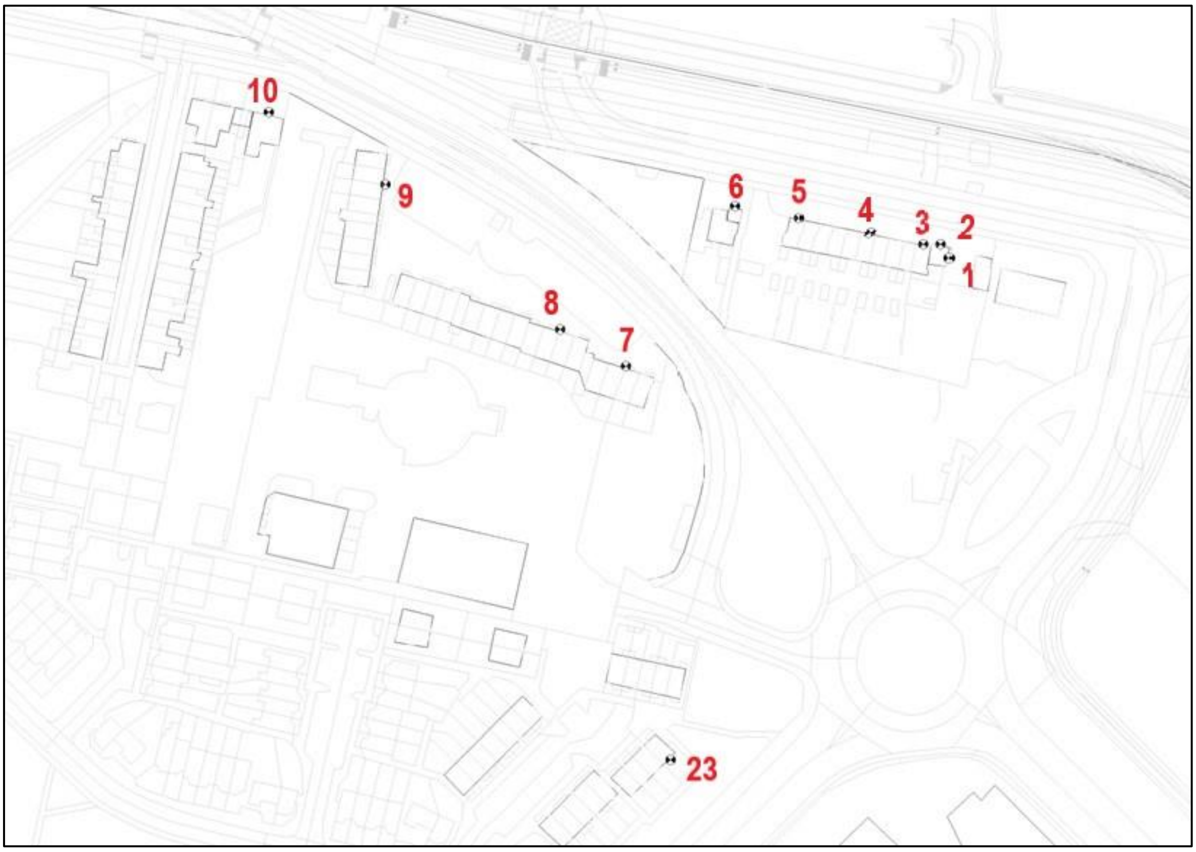

Figure 12.1.20 Nearest Noise Sensitive Receptors Modelled (Part 1 – Coastguard Cottages)

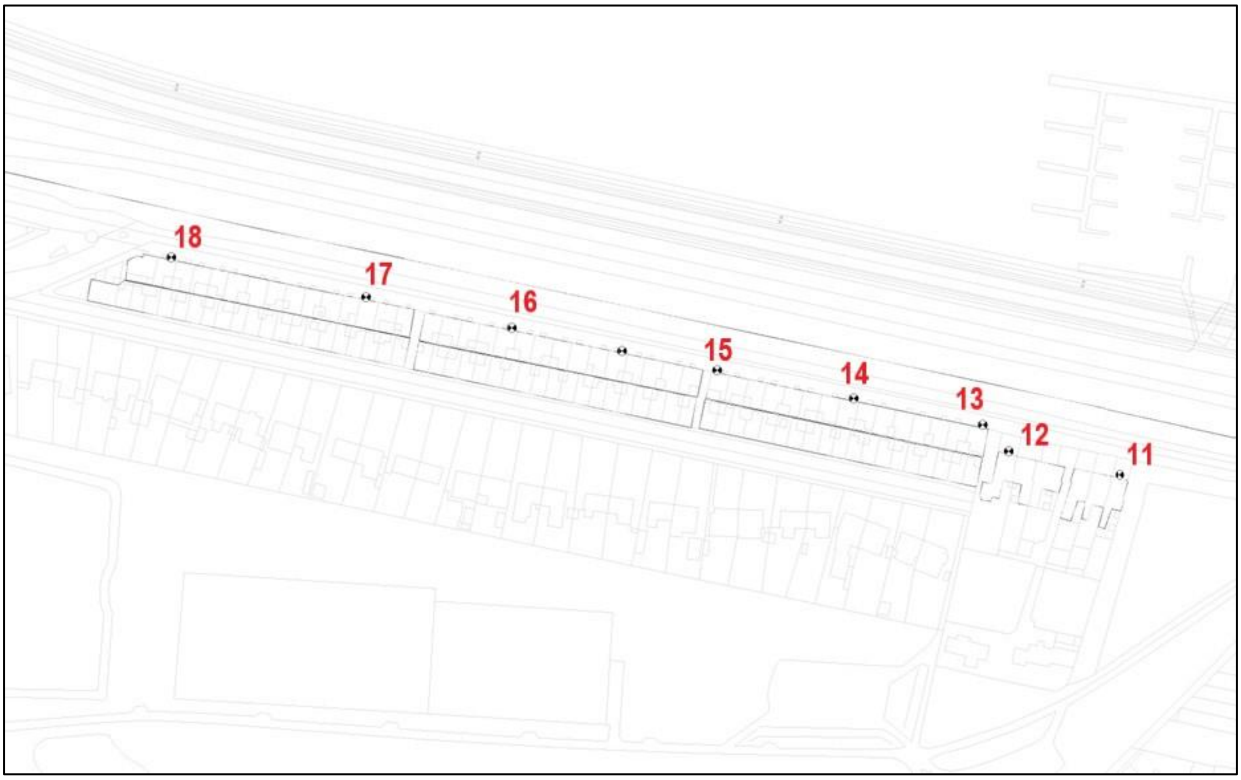

Figure 12.1.21 Nearest Noise Sensitive Receptors Modelled (Part 2 – Pigeon House Road)

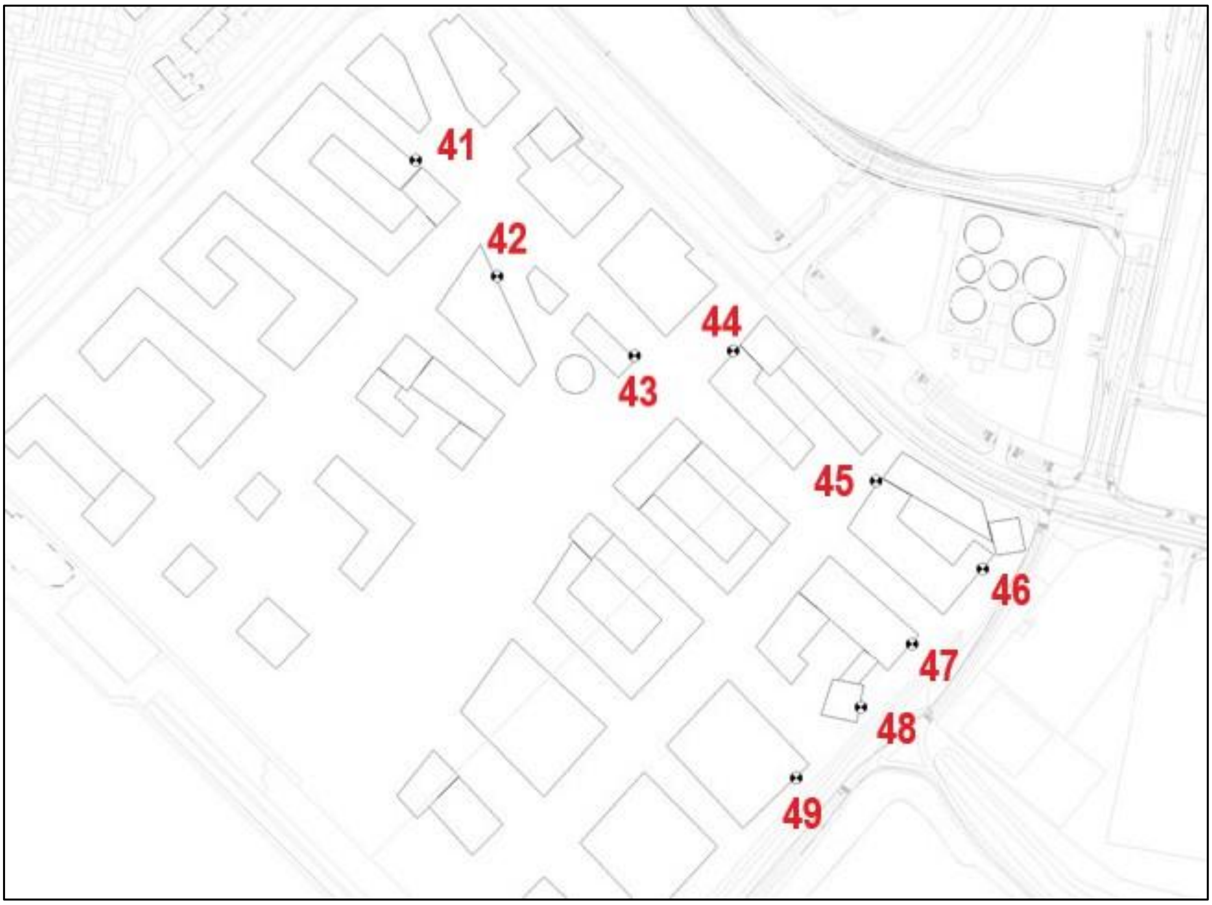

Figure 12.1.22 Nearest Noise Sensitive Receptors Modelled (Part 3 – Glass Bottle Site)

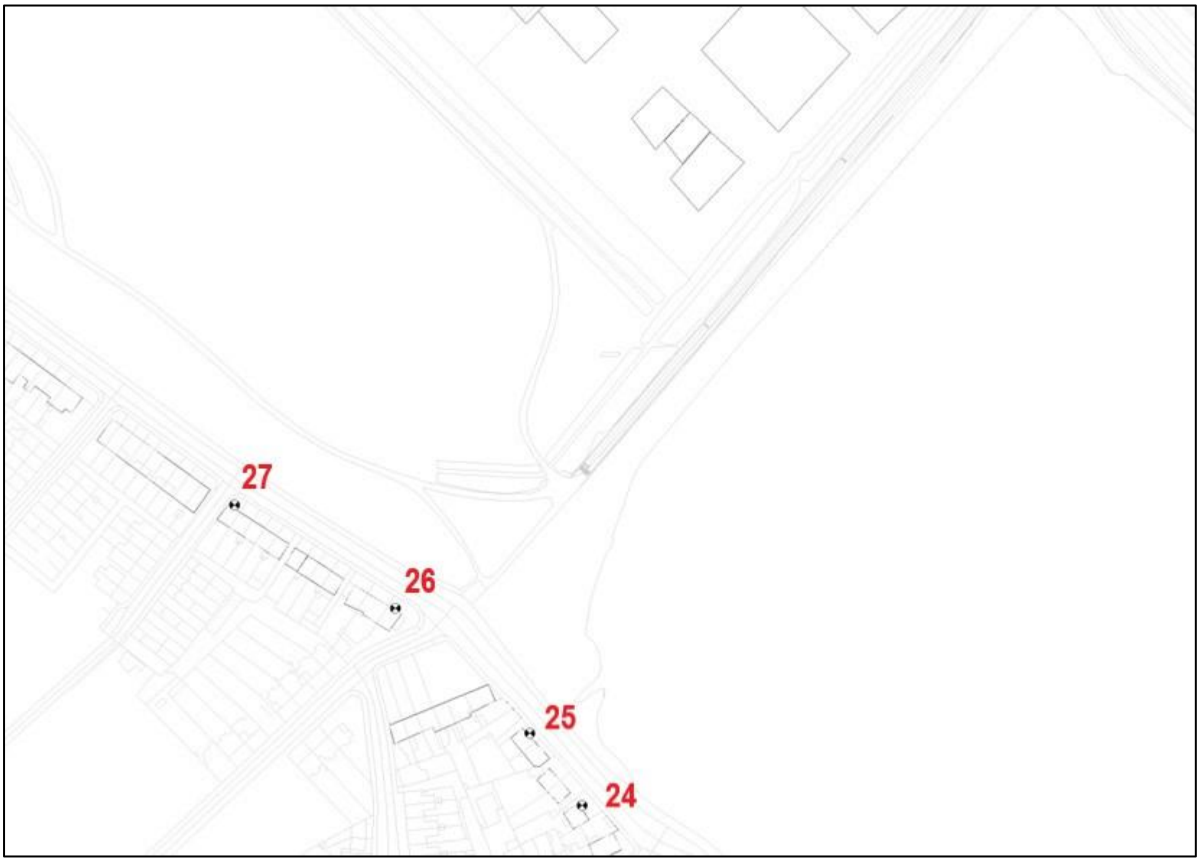

Figure 12.1.23 Nearest Noise Sensitive Receptors Modelled (Part 4 - Sandymount)

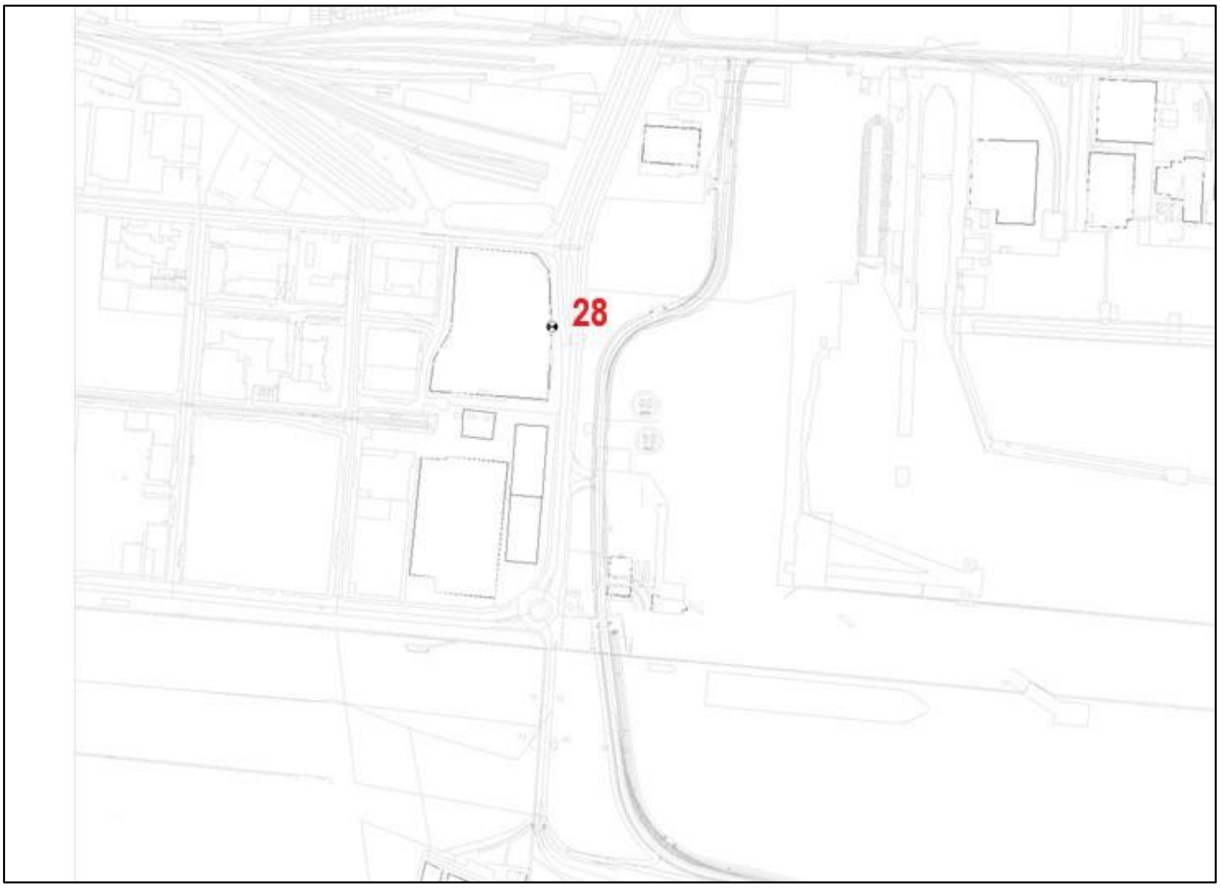

Figure 12.1.24 Nearest Noise Sensitive Receptors Modelled (Part 5 – West of Port)

Figure 12.1.25 Nearest Noise Sensitive Receptors Modelled (Part 6 – Clontarf)

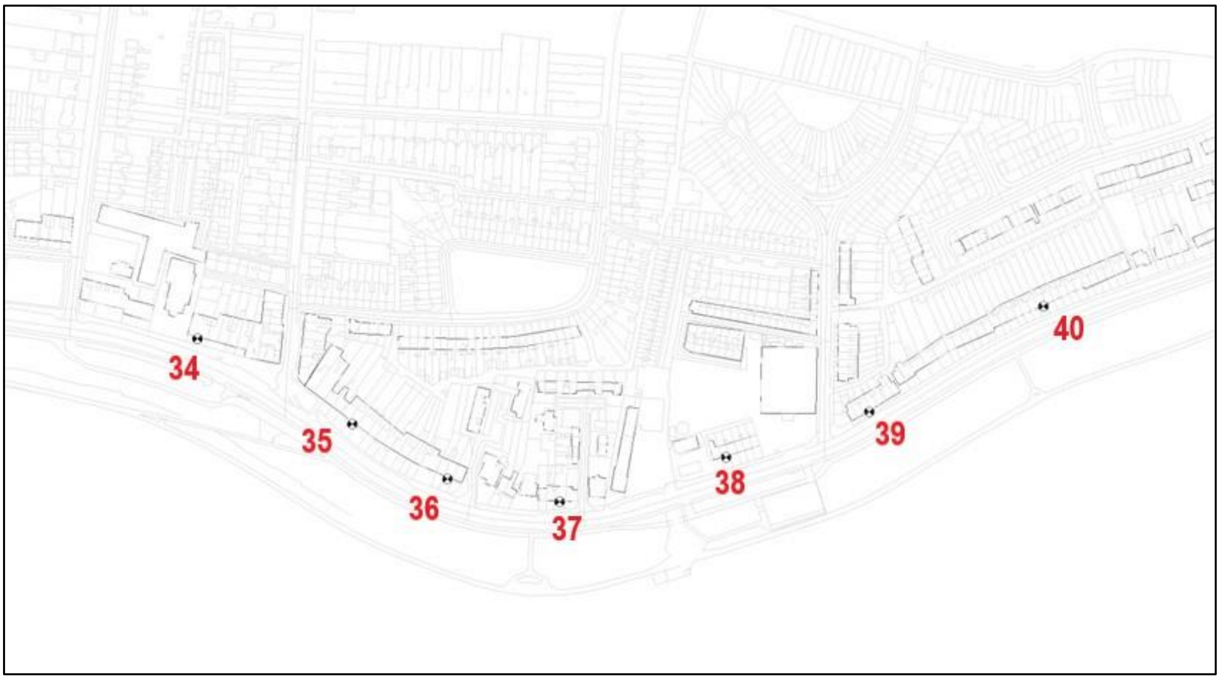

Figure 12.1.26 Nearest Noise Sensitive Receptors Modelled (Part 7 – Clontarf)

Table 12.1.23 contains predicted noise levels derived from the noise model at the nearest noise sensitive properties.

Table 12.1.23 Predicted Noise from Operational Phase Plant/Equipment at Nearest Noise Sensitive Properties

Property Reference	Predicted Operational Phase Noise dB(A)
1	43.1
2	42.7
3	37.1
4	42.6
5	42.4
6	42.3
7	44.3
8	44.0
9	42.7
10	40.1
11	38.4
12	37.8
13	34.5
14	33.9
15	32.7
16	32.3
17	31.4
18	30.7
19	33.7
20	32.1
21	33.0
22	32.5
23	42.2
24	37.8
25	35.5
26	37.5
27	35.9
28	31.1
29	<20.0
30	<20.0
31	<20.0
32	<20.0
33	<20.0
34	25.9
35	38.7
36	38.4
37	39.1
38	38.5
39	39.2
40	38.6
41	41.5
42	42.0
43	42.4
44	42.2
45	42.0
46	43.1
47	42.5
48	42.5
49	41.1

Table 12.1.23 contains predicted noise levels from worst-case operational activities from the 3FM Project at the nearest noise sensitive properties to the proposed project. All predicted noise levels are below guideline limits included in the EPA NG4 guidance document for daytime (55dB L_{AeqT}), evening (50dB L_{AeqT}) and night-time (45 L_{AeqT}) periods. All predicted noise levels are below existing ambient noise levels (L_{Aeq}) in all areas and at or below existing background noise levels (L_{A90}) for all periods of day in all areas. On this basis, the noise impact is considered to be negligible/minor in all areas.

At the Glass Bottle site, there is very little activity currently taking place, which is reflected in the lower ambient and background noise levels. When the site is developed and occupied, ambient and background noise levels will increase when activity increases significantly in this area. This will further reduce any potential for plant/equipment noise impacts in this area.

12.1.5.7 Vibration Impact

The proposed project will not result in any vibration generating activities being placed in close proximity to any of the nearest vibration sensitive receptors in the study area. There will be no vibration impact associated with the operational phase of the proposed project.

12.1.6 Cumulative Noise Impact

This section contains an assessment of the potential for cumulative noise and vibration impacts associated with the 3FM Project in tandem with other planning applications which have planning permission approved or pending.

12.1.6.1 Construction Phase

The construction phase for the 3FM Project will extend over a period of approximately 15 years from the design and procurement phase through to overall completion. Within this period, the construction works will take place in different areas of the 3FM construction site, making it difficult to determine the likelihood of when construction works associated with the 3FM Project may be likely to take place in tandem with the construction of other sites that are currently subject to pending/granted planning permission.

Appendix 12.2 contains a summary of pending/granted planning applications in the general vicinity of Dublin Port. This summary is focussed on larger planning applications and omits smaller sites such as individual residential applications.

As detailed in Section 12.1.4, the proposed 3FM Project is not predicted to generate any significant construction phase noise impacts at properties in Clontarf. A review of pending/granted planning applications in the Clontarf area indicates no substantial planning applications likely to generate significant construction phase noise impacts in this area. Even in the event of a new substantive planning application being granted in the Clontarf area, the predicted construction noise levels from such an application in close proximity to properties in Clontarf will be so far in excess of the predicted construction noise levels from the 3FM Project (which will be < 50dB[A]) such that there will be no cumulative construction noise impact from such a planning application in tandem with the 3FM Project.

Similar to Clontarf, Section 12.1.4 indicates that predicted construction noise levels at the nearest properties in the Sandymount area (i.e. < 50 dB[A]) will be substantially below the noise threshold limits for construction noise as outlined in BS5228:2009+A1:2014. No substantive pending/granted planning applications are currently in the planning system in the vicinity of the nearest properties in Sandymount to the 3FM Project. Any new substantive planning application in the vicinity of these properties will generate construction noise levels far in excess of construction noise levels generated by the 3FM Project in this area. On this basis, there is no likelihood of a significant cumulative construction phase noise impact from the 3FM Project in tandem with any other project in this area.

West of Dublin Port, there are a number of substantial commercial/residential planning applications that are pending/granted. Most notable of these are planning applications DSDZ4208/23, DSDZ4304/23, and DSDZ4085/23. On account of the distance and substantial barrier effects between the 3FM Project construction works and the residential properties that are adjacent to these planning application sites, there will be no significant cumulative construction noise impact at these properties from the 3FM Project in tandem with these planning application sites.

Planning application DSDZ4100/23 relates to changes to the ground floor level elevations of the public house with ancillary restaurant at Capital Dock, Sir John Rogerson's Quay. The nature of this planning application are such that they will not generate any significant construction noise impact at the properties most likely to be impacted by the 3FM Project. On this basis, there will be no significant cumulative construction phase noise impact from this planning application in tandem with the 3FM Project.

There are a number of planning applications within the Dublin Port area on the Poolbeg Peninsula, including 4057/23, 3417/23 and PWSDZ3074/23. These sites are a substantial distance from any of the nearest noise sensitive properties and will not generate any significant cumulative construction noise impact at any residential properties in tandem with the 3FM Project.

There are a number of planning applications associated with the Glass Bottle site that are in various stages of planning, including PWSDZ3207/22, PWSDZ3406/22, PWSDZ4058/22, PWSDZ4380/22, PWSDZ4341/23, and PWSDZ4276/23. A number of these planning applications will result in construction activity taking place adjacent to Sean Moore Road and in relative close proximity to the residential properties west of Sean Moore Road. The EIAR for these planning applications has addressed the potential construction noise impacts associated with these planning applications. The distance of the 3FM Project construction works to these properties is such that it will not result in an additional cumulative construction noise impact at these properties over and above will occur from the Glass Bottle planning application sites.

Section 12.1.4 demonstrates the potential for construction phase noise impacts from the 3FM Project at the nearest properties along York Road / Pigeon House Road / Coastguard Cottages. There are no significant planning application in the vicinity of these properties to generate any additional cumulative construction noise impact over and above what will be produced by the 3FM Project.

Section 12.1.6 details mitigation measures associated with the construction phase for the 3FM Project. The 3FM construction phase Noise & Vibration Management Plan (NVMP) will be an iterative document, which will include for ongoing consideration of future developments and the commencement of new construction processes on sites in the vicinity of the 3FM Project which have the potential to generate cumulative noise impacts.

12.1.6.2 Operational Phase

Section 12.1.5 contains a noise impact assessment of worst-case plant/equipment noise associated with the 3FM Project. As presented in Section 12.1.5, the predicted noise levels from the 3FM Project are below relevant guideline threshold limits and existing ambient (L_{Aeq}) / background (L_{A90}) in the majority of residential areas in the vicinity of the port.

This section contains a consideration of potential cumulative noise impacts associated with the 3FM Project during the operational phase in tandem with any pending/granted planning applications when/if they are operational. Appendix 12.2 contains a summary of pending/granted planning applications in the general vicinity of Dublin Port.

As detailed in Section 12.1.5, the proposed 3FM Project is not predicted to generate any significant operational phase noise impacts at properties in Clontarf. A review of pending/granted planning applications in the Clontarf area indicates no substantial planning applications likely to generate significant operational phase noise impacts in this area. On this basis, there will be no likelihood of a significant cumulative operational phase noise impact from the 3FM Project in tandem with any pending/granted planning applications in this area.

The proposed 3FM Project is not predicted to generate any significant operational phase noise impacts at properties in Sandymount. A review of pending/granted planning applications in the Sandymount area indicates no substantial planning applications likely to generate significant operational phase noise impacts in this area. On this basis, there will be no likelihood of a significant cumulative operational phase noise impact from the 3FM Project in tandem with any pending/granted planning applications in this area.

West of Dublin Port, there are a number of substantial commercial/residential planning applications that are pending/granted. Most notable of these are planning applications DSDZ4208/23, DSDZ4304/23, and DSDZ4085/23. On account of the significant distance and barrier effects between the 3FM operations and the residential adjacent to these planning applications, 3FM operational noise levels will be below existing ambient (L_{Aeq}) and background (L_{A90}) noise levels in this area. On this basis, there will be no significant cumulative operational phase noise impact at these properties from the 3FM Project in tandem with these planning application sites.

Planning application DSDZ4100/23 relates to changes to the ground floor level elevations of the public house with ancillary restaurant at Capital Dock, Sir John Rogerson's Quay. The 3FM Project will not generate any significant noise impact in this area and therefore, there will be no significant cumulative operational phase noise impact from this planning application in tandem with the 3FM Project.

There are a number of planning applications within the Dublin Port area on the Poolbeg Peninsula, including 4057/23, 3417/23 and PWSDZ3074/23. These sites are a substantial distance from any of the nearest noise sensitive properties and will not generate any significant operational noise impact at any residential properties in tandem with the 3FM Project.

There are a number of planning applications associated with the Glass Bottle site that are in various stages of planning, including PWSDZ3207/22, PWSDZ3406/22, PWSDZ4058/22, PWSDZ4380/22, PWSDZ4341/23, and PWSDZ4276/23. This are likely to be supplemented by additional future planning applications. Residential buildings within the Glass Bottle site nearest to the 3FM Project have been included within the noise impact assessment included in this chapter. Portions of the Glass Bottle site are located in relative close proximity to existing residential properties, particularly in the vicinity of Sean Moore Road. The potential operational phase noise impact from the Glass Bottle site has been assessed in the various planning applications associated with the site. The 3FM Project will not generate any significant noise impact at properties in the vicinity of Sean Moore Road or Beach Road and hence will not contribute to any cumulative operational phase noise impact in these areas. In addition, the Glass Bottle site will create substantial barrier effects between the 3FM operations and the properties in this area.

12.1.7 Mitigation Measures

12.1.7.1 Construction Phase – Noise

BS5228:2009+A1:2014

Section 12.1.4 contains an assessment of the noise impact associated with the construction phase of the proposed project at the nearest noise sensitive properties. The assessment of the worst-case predicted construction noise levels using the ABC Method (BS5228:2009+A1:2014) indicates that there is potential for worst-case construction noise levels to exceed the relevant noise threshold limits included in these guidance documents in the vicinity of Pigeon House Road / Coastguard Cottages.

It is proposed that a temporary 4m noise barrier is placed between the construction activities in this area and the nearest noise sensitive properties. Figures 12.1.27 and 12.1.28 illustrate the noise modelled contours with this barrier in place and Tables 12.1.24 and 12.1.25 illustrate worst-case construction noise levels at the nearest noise sensitive properties with this barrier in place. As indicated in Tables 12.1.24 / 12.1.25, the barrier reduces worst-case construction noise levels below the relevant BS5228 noise threshold limit with this barrier in place.

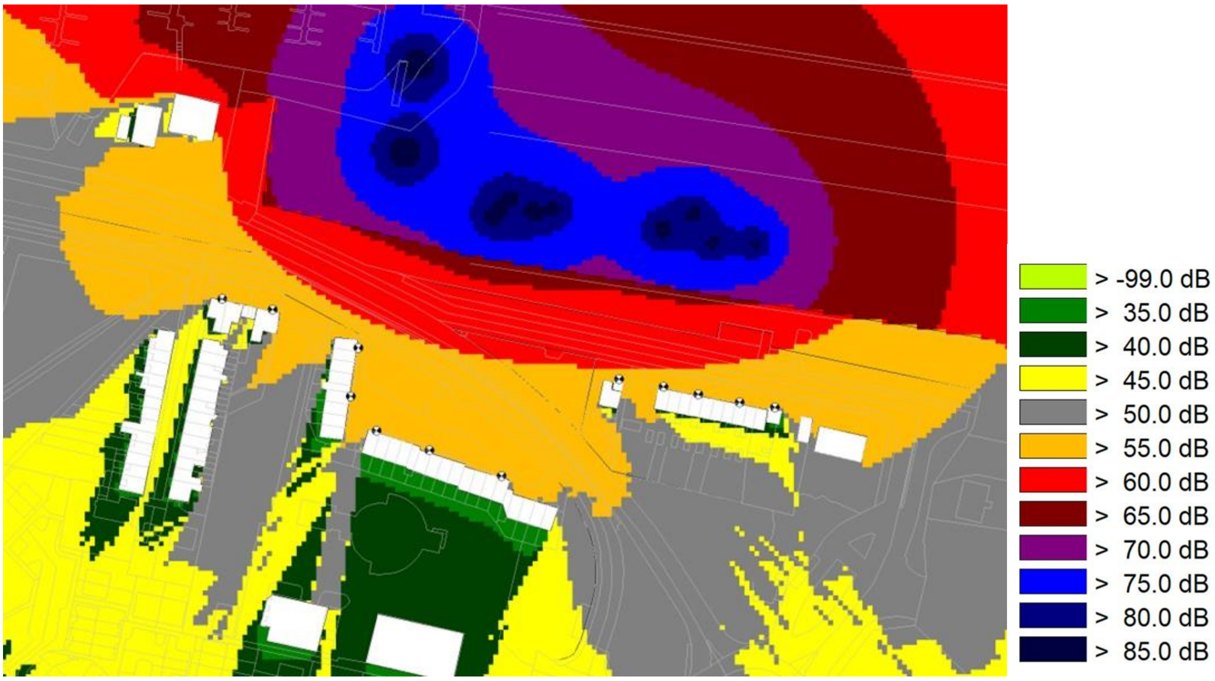

Figure 12.1.27 Noise Model of Worst-Case Construction Noise Levels During Year 4 at Pigeon House Road / Coastguard Cottages with Mitigation

Table 12.1.24 Worst-Case Prediction Noise Levels at Individual Properties Along Pigeon House Road / Coastguard Cottages with Mitigation

Receptor Reference (See Figure 12.1.12)	Worst-Case Predicted Noise Level in Year 4 dB(A) with Mitigation	Applicable BS5228 Noise Threshold Limit dB(A)
1	57.7	65
2	58.2	65
3	58.7	65
4	59.2	65
5	59.5	65
6	58.2	65
7	58.6	65
8	58.8	65
9	60.1	65
10	62.3	65
11	58.4	65
12	57.6	65
13	53.7	65

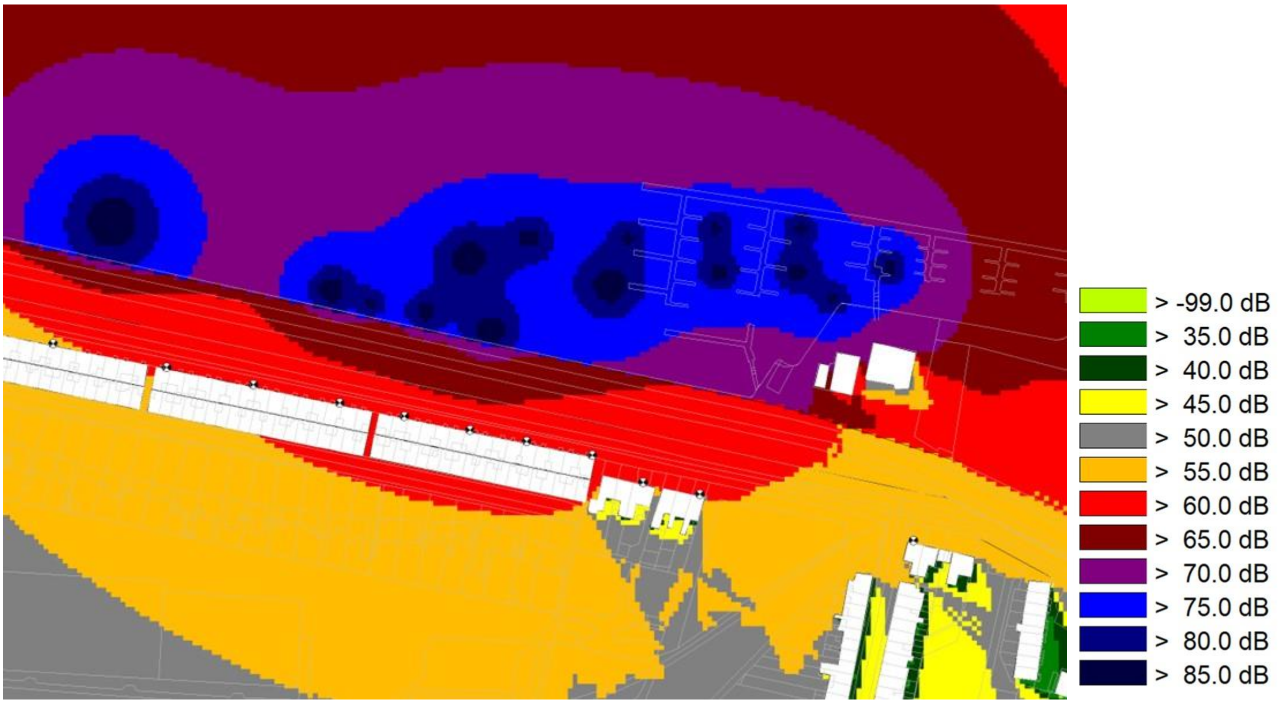

Figure 12.1.28 Noise Model of Construction Noise Levels During Year 6 at Pigeon House Road with Mitigation

Table 12.1.25 Worst-Case Prediction Noise Levels at Individual Properties Along Pigeon House Road with Mitigation

Receptor Reference (See Figure 12.1.14)	Worst-Case Predicted Noise Level in Year 6 dB(A)	Applicable BS5228 Noise Threshold Limit dB(A)
1	58.5	65
2	59.4	65
3	60.3	65
4	61.2	65
5	61.5	65
6	61.5	65
7	61.0	65
8	60.3	65
9	60.9	65
10	60.3	65
11	56.0	65

British Standard BS5228:2009+A1:2014 – Noise and vibration control on construction and open sites: Part 1 - Noise outlines a range of measures that can be used to reduce the impact of construction phase noise on the nearest noise sensitive receptors. These measures should be applied by the contractor where appropriate during the construction phase of the proposed development. Examples of some of the best practice measures included in BS5228:2009+A1:2014 are listed below:

- ensuring that mechanical plant and equipment used for the purpose of the works are fitted with effective exhaust silencers and are maintained in good working order;
- careful selection of quiet plant and machinery to undertake the required work where available;
- all major compressors should be 'sound reduced' models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use;
- any ancillary pneumatic percussive tools should be fitted with mufflers or silencers of the type recommended by the manufacturers;
- machines in intermittent use should be shut down in the intervening periods between work;
- ancillary plant such as generators, compressors and pumps should be placed behind existing physical barriers, and the direction of noise emissions from plant including exhausts or engines should be placed away from sensitive locations, in order to cause minimum noise disturbance.
- Handling of all materials should take place in a manner which minimises noise emissions;
- Audible warning systems should be switched to the minimum setting required by the Health & Safety Authority;

A detailed Construction Environmental Management Plan (CEMP) will be prepared in advance of the construction and will detail all aspects of controlling noise emissions at the nearest noise sensitive properties to the 3FM Project. The CEMP will include various sub-plans which will address specific environmental disciplines, including a Noise & Vibration Management Plan (NVMP). The NVMP will be an iterative document, which will be updated on an ongoing basis and the requirement for temporary noise barriers to reflect the changing nature of the works will be recorded in the NVMP on an ongoing basis in consultation with DCC. The document will detail the requirements for compliance noise monitoring to be completed during each stage of the construction process. A complaints procedure should continue to be operated by the Contractor throughout the construction phase and all efforts should be made to address any noise issues at the nearest noise sensitive properties.

As outlined above, a temporary noise barrier is proposed to ensure the relevant BS5228:2009+A1:2014 noise threshold limit will not be exceeded in years 4-8 in the vicinity of Pigeon House Road / Coastguard Cottages. The NVMP will provide specific details on temporary noise barriers to be deployed in this area during this period and the monitoring requirements to ensure that the appropriate compliance noise monitoring is completed. As the works progress in different areas, the requirement for temporary noise barriers in this area will change to reflect the changing natures of the works.

Section 12.1.9 provides further details on aspects of noise and vibration monitoring which will be required during the construction phase for the 3FM Project.

DCC Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition

Section 12.1.4 includes the total risk assessment completed for the 3FM Project based on the details included within this guide. As stated in Section 12.1.4, the 3FM Project falls into the high risk category in the total risk assessment. Table 12.1.26 to Table 12.1.32 provides details of the good practice measures outlined in the guide for high risk projects. These measures only include the noise-related elements included within the guide.

Table 12.1.26 General considerations

General Considerations	
All site staff shall be briefed on noise mitigation measures and the application of best practicable means to be employed to control noise.	All sites
Good Quality site hoarding should be erected to maximise the reduction in noise levels.	Medium and high risk sites
The contact details of the contractor and site manager shall be displayed to the public, together with the permitted operating hours, including any special permissions given for out of hours work.	Medium and high risk sites
The site entrance shall be located to minimise disturbance to noise sensitive receptors.	Medium and high risk sites
Internal haul routes shall be maintained and steep gradients shall be avoided.	Medium and high risk sites
Material and plant loading and unloading shall only take place during normal working hours unless the requirement for extended hours is for traffic management (i.e. road closure) or health and reasons (application must be made to DCC a minimum of 4 days prior to proposed works).	All sites
Use rubber linings in chutes, dumpers and hoppers to reduce impact noise.	Medium and high risk sites
Minimise opening and shutting of gates through good coordination of deliveries and vehicle movements.	Medium and high risk sites

Table 12.1.27 General considerations

Plant	
Ensure that each item of plant and equipment complies with the noise limits quoted in the relevant European Commission Directive 2000/14/EC.	All sites
Fit all plant and equipment with appropriate mufflers or silencers of the type recommended by the manufacturer.	All sites
Use all plant and equipment only for the tasks for which it has been designed.	All Sites
Shut down all plant and equipment in intermittent use in the intervening periods between work or throttle down to a minimum.	All sites
Power all plant by mains electricity where possible rather than generators.	Medium and high risk sites
Maximise screening from existing features or structures and employ the use of partial or full enclosures for plant.	Medium and high risk sites
Locate movable plant away from noise sensitive receptors.	All sites

Table 12.1.28 Mitigation for vehicle activity

Vehicle Activity	
Ensure all vehicle movements (on site) occur within normal working hours. (Other than where extension of work requiring such movements has been granted in cases of required road closures or for health and safety reasons).	All sites
Plan deliveries and vehicle movements so that vehicles are not waiting or queuing on the public roads. If unavoidable engines should be turned off.	Medium and high risk sites
Minimise the opening and closing of the site access through good coordination of deliveries and vehicle movements.	Medium and high risk sites
Plan the site layout to ensure that reversing is kept to a minimum.	Medium and high risk sites
Where reversing is required use broadband reverse sirens or where it is safe to do so disengage all sirens and use banksmen.	Medium and high risk sites
Rubber/neoprene or similar non-metal lining material matting to line the inside of material transportation vehicles to avoid first drop high noise levels.	Medium and high risk sites

Table 12.1.29 Mitigation for demolition

Demolition Phase	
Employ the use of acoustic screening; this can include planning the demolition sequence to utilise screening afforded by buildings to be demolished.	Medium and high risk sites
If working out of hours for Health and Safety reasons (following approval by DCC) limit demolition activities to low level noise activity unless absolutely unavoidable.	All sites
Use low impact demolition methods such as non-percussive plant where practicable.	Medium and high risk sites
Use rotary drills and 'bursters' activated by hydraulic or electrical power or chemically based expansion compounds to facilitate fragmentation and excavation of hard material.	High risk sites
Avoid the transfer of noise and vibration from demolition activities to adjoining occupied buildings through cutting any vibration transmission path or by structural separation of buildings.	Medium and high risk sites
Consider the removal of larger sections by lifting them out and breaking them down either in an area away from sensitive receptors or off site.	High risk sites

Table 12.1.30 Mitigation for ground works and piling

Ground Works and Piling Phase	
The following hierarchy of groundwork/piling methods should be used if ground conditions, design and safety allows: • Pressed in methods, e.g., hydraulic jacking • Auger/bored piling; • Diaphragm walling; • Vibratory piling or vibro-replacement; • Driven Piling or dynamic consolidation.	Medium and high risk sites
The location and layout of the piling plant should be designed to minimise potential noise impact of generators and motors.	Medium and high risk sites
Where impact piling is the only option utilise a non-metallic dolly between the hammer and driving helmet or enclose the hammer and helmet with an acoustic shroud.	Medium and high risk sites
Consider concrete pour sizes and pump locations. Plan the start of concrete pours as early as possible to avoid overruns.	Medium and high risk sites
Where obstructions are encountered, work should be stopped and a review undertaken to ensure that work methods that minimise noise are used.	Medium and high risk sites
When using an auger piling rig do not dislodge material from the auger by rotating it back and forth. Use alternate methods where safe to do so.	Medium and high risk sites
Prepare pile caps using methods which minimise the use of breakers, e.g., use hydraulic splitters to crack the top of the pile.	Medium and high risk sites

Table 12.1.31 Monitoring

Monitoring	
Establish pre-existing levels of ambient noise by baseline monitoring or use of the noise maps.	Medium and high risk sites
Carry out regular on-site observation monitoring and checks/audits to ensure that BPM is being used at all times. Such checks shall include; • Hours of work • Presence of mitigation measures • Number and type of plant • Construction methods • Site reviews must be recorded and made available for inspection.	High risk sites
Monitor noise and vibration continuously during demolition, piling, excavation and sub and superstructure works at agreed locations and report to DCC at agreed intervals and in an agreed format. To comply with this the following must take place. The monitoring locations for existing sites as agreed with officers of DCC must remain in situ. If additional monitoring is required this will be provided and the new locations will be agreed with DCC. For all new sites the monitoring locations must be agreed with DCC. The results of the monitoring must be forwarded to officers of the Air Quality Monitoring and Noise Control Unit every two weeks in the following format: Provide the construction noise level as defined in British Standard 5228 and the peak particle velocity readings for the hours of operation of the site. This will include the construction noise level for any overtime period worked outside of normal working hours. Provide a report detailing and discussing the noise and vibration levels over the reporting period. If a breach is recorded the follow up action that took place to prevent any further breaches must be included in the report. This information must be provided in electronic format. If results are required owing to complaints the results will be provided as soon as possible by the contractor to DCC.	High risk sites
Appraise and review working methods, processes and procedures on a regular basis to ensure continuous development of BPM	Medium and high risk sites
The ‘ABC’ Method detailed in Paragraph E.3.2 of BS 5228-1:2009 shall be used to determine acceptable noise levels for day, evening and night time work.	Medium and high risk sites
Vibration levels must be kept below 1.0 mm/sec (PPV) where possible. Where levels are expected to exceed this value residents must be warned and an explanation given.	Medium and high risk sites
Contact details for the site manager and liaison officer should be displayed prominently on the site hoarding.	Medium and high risk sites
All staff should be briefed on the complaints procedure and the mitigation requirement and their responsibilities to register and escalate complaints received.	Medium and high risk sites
Send regular updates at appropriate intervals to all identified affected neighbours/ businesses via a newsletter and post relevant information on the site hoarding. Also make the information available via email/website including weekly noise monitoring reports.	Medium and high risk sites
Arrange regular community liaison meetings at appropriate intervals including prior to commencement of the project.	High risk sites
Meet regularly with neighbouring construction sites to ensure activities are coordinated to minimise any potential cumulative issues.	High risk sites

Table 12.1.32 Working hours

Extensions of Working Hours (in Exceptional Circumstances)	
Ensure at least 4 days notice is given to DCC Planning Department when applying for extensions to normal working hours. Do not undertake out of hours work unless permission to do so has been granted.	All sites
The applicant must demonstrate in writing that the works required cannot be carried out during normal working hours. The documentation sent in must be accompanied by a detailed engineering or/and traffic management or/and safety case as to why the works are required outside normal hours. Power floating after 6pm is the only activity that will be permitted during the extensions where they relate to required large concrete pours. All reasonable and appropriate measures to minimise noise associated with these works must be put in place and no works other than those approved may be carried out during extended working hours. The Developer/his agent must give the times and dates of the proposed work, and the mitigation measures that are to be used to minimise noise/disturbance	All sites
Advise neighbours about requirement for and duration of any permitted works outside of normal working hours, and associated environmental mitigation measures being put in place during the course of the extended works, following receipt of approval from DCC	All sites
All complaints will be referred directly to the site liaison person and a reply must issue to the complaint within 3 hours of receipt of the complaint.	All sites
A log of all complaints and a summary of how they were dealt with should be kept and be made available to DCC, as required.	All sites
Any breaches of permitted working hours or permitted extended working hours or developers or subcontractors not carrying out their requirements under this protocol may lead to enforcement action and may also result in the withdrawal of any extension of hours of works for a period that will be at the discretion of DCC.	All sites

12.1.7.2 Operational Phase – Noise

SPAR

Section 12.1.5.1 includes the impact assessment of the SPAR in accordance with the NRA Guidelines for treatment of noise and vibration in national road schemes. Table 12.1.33 presents noise model outputs for the nearest noise sensitive receptors to the proposed SPAR for scenarios with and without the proposed SPAR (i.e. Do Nothing 2040 v Do Something 2040). The noise model outputs indicated that there is a requirement for mitigation measures on the basis of the three conditions for mitigation measures included with the NRA Guidelines.

On the basis of the assessment included in Section 12.1.5.1, a further detailed noise model was prepared which included proposed mitigation measures in the form of a noise barrier in the vicinity of Coastguard Cottages (4m acoustic barrier) and between the SPAR.

Figure 12.1.29 illustrates the location of the proposed noise barrier for the SPAR. In addition to the noise barrier, it is proposed that a low noise road surface (LNRS) is used on the SPAR from its crossing point on the River Liffey to the T-Junction with Pigeon House Road. The extent of LNRS is illustrated in Figure 12.1.30 and Figure 12.1.31 Such a road surface will provide a minimum 3dB(A) additional noise reduction on noise levels generated on the SPAR. Table 12.1.33 provides updates noise model outputs for the Do Something scenario with mitigation measures in place, illustrating that the proposed SPAR will not generate any significant impact at the nearest noise sensitive properties when compared with the Do Nothing scenario.

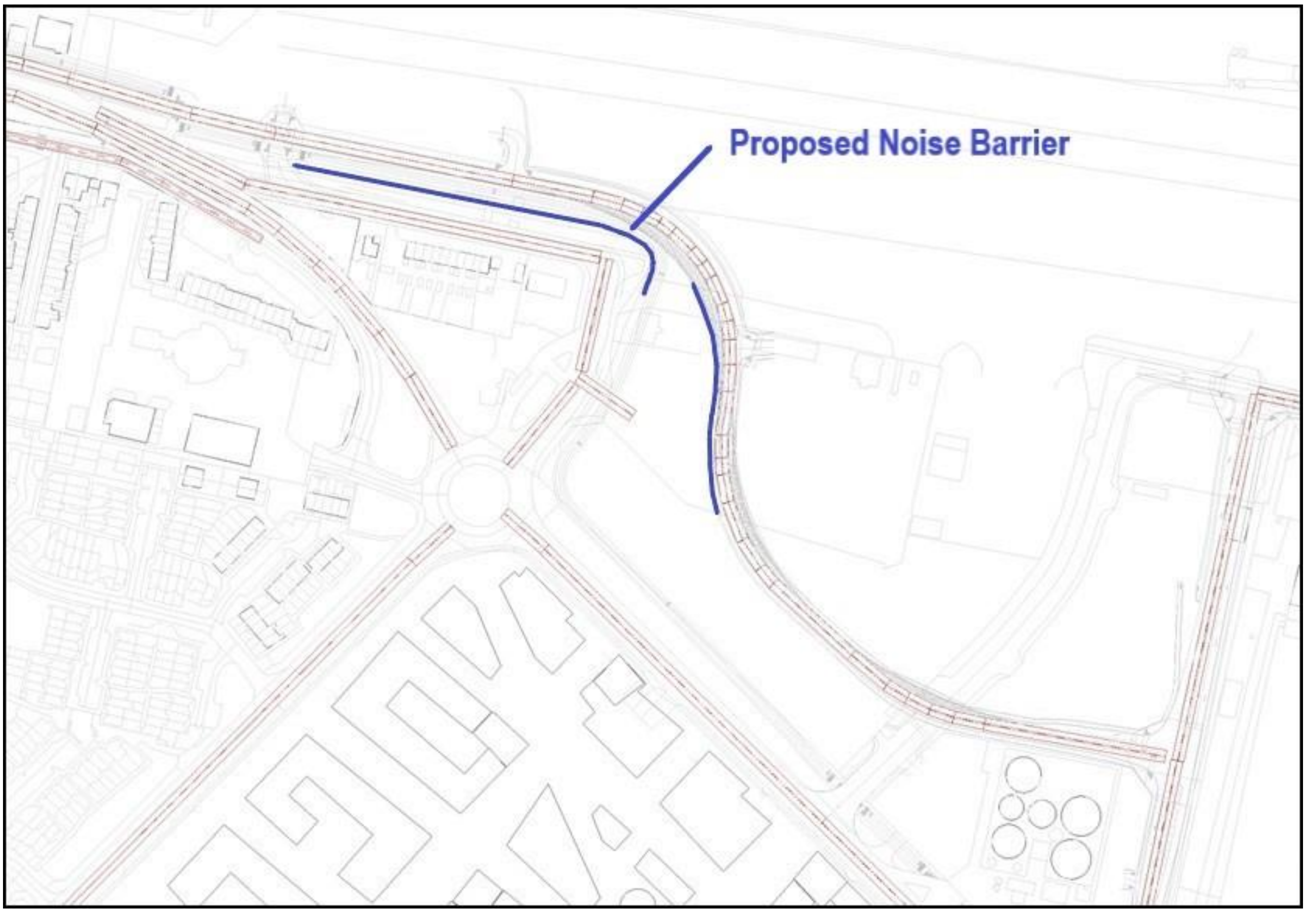

Figure 12.1.29 Proposed Noise Barrier Adjacent to Coastguard Cottages

Figure 12.1.30 Proposed LNRS Along SPAR (Part 1)

Figure 12.1.31 Proposed LNRS Along SPAR (Part 2)

Table 12.1.33 Noise Model Outputs for the SPAR with Mitigation Measures in Place

Receptor Number	Address [Height modelled]	Modelled Scenarios (Lden) dB(A)		
		Do nothing 2040	Do Something (R131 + SPAR) 2040	Do Something (R131 + SPAR) With Mitigation 2040
1	York Road (1) [9m]	67.1	64.6	63.6
2	York Road (2) [9m]	67.5	65.1	64.1
3	York Road (3) [4m]	67.8	65.6	64.5
4	York Road (4) [9m]	67.9	66.1	64.9
5	1 Pigeon House Road [1.5m]	66.4	65.1	63.9
6	12 Pigeon House Road [1.5m]	66.6	65.3	64.1
7	19 Pigeon House Road [1.5m]	66.6	65.3	64.1
8	24 Pigeon House Road [1.5m]	66.6	65.3	64.1
9	30 Pigeon House Road [1.5m]	66.7	65.4	64.2
10	37 Pigeon House Road [1.5m]	66.8	65.4	64.2
11	44 Pigeon House Road [1.5m]	66.8	65.5	64.3
12	46 Pigeon House Road [4m]	66.8	65.7	64.4
13	51 Pigeon House Road [4m]	67.4	66.3	65.0
14	64 Pigeon House Road [4m]	69.1	67.2	66.1
15	Poolbeg Quay Apartments (1) [11.5m]	67.4	65.0	64.0
16	Poolbeg Quay Apartments (2) [11.5m]	67.8	64.4	63.7
17	Poolbeg Quay Apartments (3) [11.5m]	68.5	64.7	64.2
18	70 Pigeon House Road [4m]	60.8	61.0	59.1
19	71 Pigeon House Road [4m]	59.3	60.4	58.1
20	76 Pigeon House Road [4m]	58.5	59.9	57.6
21	79 Pigeon House Road [4m]	58.4	59.1	57.2
22	80 Pigeon House Road (1) [4m]	58.6	60.4	57.3
23	80 Pigeon House Road (2) [5m]	60.0	60.4	57.1
24	13 Leukos Road [4m]	65.6	65.4	65.2
25	Glass Bottle Residential (1) [16m]	54.8	55.0	54.2
26	Glass Bottle Residential (2) [16m]	54.7	52.4	51.8
27	Glass Bottle Residential (3) [16m]	53.6	54.5	53.6
28	Glass Bottle Residential (4) [16m]	62.0	60.8	59.6
29	Glass Bottle Residential (5) [16m]	56.1	57.0	56.5
30	Glass Bottle Residential (6) [16m]	52.1	56.1	56.1
31	Glass Bottle Residential (7) [16m]	50.5	54.7	54.6
32	Glass Bottle Residential (8) [16m]	49.0	53.6	53.6
33	Glass Bottle Residential (9) [16m]	47.2	52.0	51.9

With the proposed mitigation measures in place, the noise impact associated with the SPAR will be reduced to minor adverse to moderate beneficial at the nearest noise sensitive properties.

Plant/Equipment Noise

Section 12.1.5.4 contains an assessment of operational phase plant/equipment noise associated with the 3FM Project. The assessment has been completed on the basis of all areas operating at full capacity and all plant operating simultaneously.

Table 12.1.30 contains predicted noise levels from worst-case operational activities from the 3FM Project at the nearest noise sensitive properties to the proposed project. As stated in Section 12.1.5.6, all predicted noise levels are below existing ambient noise levels (L_{Aeq}) and background noise levels (L_{A90}) for all periods of day in all areas.

The assessment in Section 12.1.5 includes a level of electrification of plant/vehicles that is currently available and in use in the UK and globally for port-related plant/vehicles. There has been significant improvement on a global level in the area of port plant electrification, including the application automation and sensors for reducing noise associated with stacking activity. On the basis of the significant improvement in reducing noise from such activity that has taken place in recent years, it would be anticipated that there will be further improvements in reducing noise from port-related plant and vehicles in the years between now and when the proposed 3FM Project will be operational in 2040. Such improvements in port-related plant/vehicles are over and above anything assumed or incorporated into this noise impact assessment.

12.1.7.3 Vibration

As outlined in section 12.1.4.4, the construction phase of the proposed project is not likely to result in any significant vibration impacts at the nearest sensitive receptors. Section 12.1.5.4 clarified how there will be no operational phase activities likely to give rise to vibration impacts at any of the nearest sensitive receptors.

BS5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and open Sites - Part 2: Vibration includes a range of measures for the reduction of vibration associated with piling activities and for general surface-based activities. The contractor will adhere to the mitigation measures included in BS5228:2009+A1:2014 where practicable to reduce vibration levels from general and piling activities to the lowest possible levels.

As a precautionary measure, it is recommended that vibration monitoring is conducted at the nearest properties on Pigeon House Road to the proposed piling works for the SPAR as a verification measure to ensure that no unusual sub-strata features generate unanticipated vibration effects at these properties.

12.1.8 Residual Impact

Sections 12.1.4 and 12.1.5 contain detailed noise impact assessments for the construction and operational phases of the proposed 3FM Project. These assessments indicate that there is potential for significant adverse noise impacts in particular locations without mitigation measures in place.

Section 12.1.7 provides details on specific noise mitigation measures to be applied during the construction and operational phases. With the proposed mitigation measures in place, all residual noise impacts associated with the 3FM Project will be reduced to minor adverse or lower.

12.1.9 Monitoring

Annex IV of Directive 2014/52/EU (Part 7) states that the information requirements under Article 5(1) of the Directive include "a description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases."

Section 8.2 of the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (2022) provides specific commentary on the monitoring requirements under the Directive. This section highlights the role of monitoring in ensuring that the project in practice conforms to the predictions made during the EIA and in demonstrating that the proposal operates as intended.

The guidance also cautions against excessive reliance on monitoring on the basis that this may lead to operational changes that fall outside the scope of the project that was subject to scrutiny during the consent process. It is also states that monitoring post consent should not be used to allow the deferral of the gathering of information that is necessary for the assessment/consent.

The guidelines highlight the importance of ensuring that monitoring is described within the context of the operation of the project processes. On this basis, monitoring descriptions should refer to remedial actions to be taken, responsible parties and should be expressed as 'if-then' scenarios.

12.1.9.1 Construction Phase

Section 12.1.4 includes the noise impact assessment during the construction phase of the 3FM Project. This assessment highlighted the potential for the relevant BS5228:2009+A1:2014 noise threshold limit to be exceeded by the construction works in the vicinity of noise sensitive properties at Pigeon House Road/York Road and Coastguard Cottages. Mitigation measures are included in Section 12.1.7 to ensure these noise threshold limits are not exceeded.

The noise predictions included in Section 12.1.4 are worst-case assumptions of plant/equipment active simultaneously at any one area of construction works. In practice, construction plant/equipment activity will vary continuously throughout the construction works in this area.

As construction activities in the area of Pigeon House Road / Coastguard Cottages will vary in different areas at different times, the properties most likely to be impacted by construction noise will alter on the basis of these changes to the construction works.

There will be a requirement for continuous noise monitoring to be completed in the vicinity of the properties on York Road / Pigeon House Road / Coastguard Cottages during the construction phase. The exact noise monitoring location will change throughout the construction process to be representative of the nearest properties to the proposed works at that particular stage of the works in this area.

The initial noise monitoring location will be agreed in advance of the commencement of the construction phase in consultation with Dublin City Council (DCC). This noise monitoring location will be detailed within the Noise & Vibration Management Plan (NVMP) as part of the Construction Environmental Management Plan (CEMP). The NVMP will remain an iterative live document throughout the construction process and as the works move to different areas in the vicinity of York Road / Pigeon House Road / Coastguard Cottages, the noise monitoring location will remain under review. As the requirement to alter the noise monitoring location becomes apparent on the basis of work changes in this area, a new representative location will be determined and agreed in consultation with DCC.

As part of the NVMP, all granted/pending/new planning applications will remain under review so that the requirement for noise monitoring for the 3FM Project is continuously reviewed where any new construction activities are likely to take place in relative close proximity to properties in the vicinity of the 3FM Project. Any review of noise monitoring requirements associated with potential cumulative construction noise impacts will be completed in consultation with Dublin City Council (DCC).

As detailed in Section 12.1.6, it is recommended that vibration monitoring is conducted at the nearest properties on Pigeon House Road to the proposed piling works for the SPAR as a verification measure to ensure that no unusual sub-strata features generate unanticipated vibration effects at these properties.

Any vibration monitoring locations will be agreed in advance of the commencement of the construction phase in consultation with Dublin City Council (DCC). This vibration monitoring location will be detailed within the Noise & Vibration Management Plan (NVMP) as part of the Construction Environmental Management Plan (CEMP).

12.1.9.2 Operational Phase

Section 12.1.5 presents the assessment of operational noise from the proposed 3FM Project. Section 12.1.7 presents mitigation measures to be included within the proposed 3FM Project to ensure that there are no significant noise impacts at the nearest noise sensitive properties.

As stated in Section 8.2 of the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (2022), noise monitoring must be completed to ensure that the project in practice conforms to the predictions made during the EIA and in demonstrating that the proposal operates as intended.

In order to ensure that the noise predictions and the proposed mitigation measures included in the EIAR accurately reflect a worst-case scenario for the operating scheme, it is proposed that a programme of noise monitoring is undertaken when the 3FM Project is operational.

12.1.10 Conclusion

This chapter contains a detailed terrestrial noise and vibration impact assessment for the proposed 3FM Project. The assessment has been completed for the construction and operational phases of the proposed project and has been completed with reference to a range of relevant noise and vibration guidance documents.

Detailed noise monitoring surveys were completed at various locations in the general vicinity of Dublin Port in order to characterise the existing noise environment at various noise sensitive properties in the vicinity of the port. These surveys provided context for the purposes of completing the impact assessment.

Without mitigation measures in place, there is potential for noise and vibration impacts during construction and operational phases at the most sensitive properties in the vicinity of the port. A range of mitigation measures have been included within this chapter in order to ensure that there will be no significant noise or vibration impact associated with the 3FM Project.

12.2 Underwater Noise

12.2.1 Introduction

This section provides an overview of the potential underwater noise impacts arising during the construction and operation phases of the 3FM Project on the surrounding marine environment. A detailed Project Description of the 3FM Project is presented in Chapter 5 of this EIAR. The assessment has been informed by focussed underwater noise surveys undertaken during the construction phase of the ABR Project. The key underwater noise impacts are generated from piling and dredging. The results from this Section have been used to inform the assessment of potential impact of underwater noise on marine life (Chapter 7, Biodiversity, Flora and Fauna).

12.2.2 Methodology

12.2.2.1 Fundamentals of Underwater Noise

Sound may be defined as the periodic disturbance in pressure from some equilibrium value and is measured as sound pressure. The unit of pressure is given in Pascals (Pa) or Newton per square metre (N/m^2). In order to avoid dealing with a very large range of numbers, e.g. from 0.00002 Pascals to 20,000 Pascals the logarithmic decibel scale is used. This simplifies the same range of numbers, by setting up a logarithmic scale based on a reference pressure.

For historical and scientific reasons, the reference pressure chosen for airborne noise is not the same as that chosen for underwater noise. The reference pressure for underwater noise is 1 μPa so underwater noise levels are referred to as dB re 1 μPa. The acoustic impedance of water is also greater than that of air. This means that there is no direct relationship between decibels in air and decibels in water.

decibels in air ≠ decibels in water

Underwater sound sources are treated somewhat differently to sound sources in air. Peak source levels for underwater noise sources are quoted in dB re 1 μPa at 1 metre. This is a ‘notional’ figure extrapolated from far field measurements as it is not practicable to measure sound levels directly at 1m from an active source such as a ship or a large marine pile. Measurements are taken in what is known as the far field and extrapolated back to a notional 1m from an 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. The actual sound pressure area in the near (Fresnel) field produces an undulating curve, but the extrapolated dashed line indicates a much higher notional source level (Figure 12.2.1).

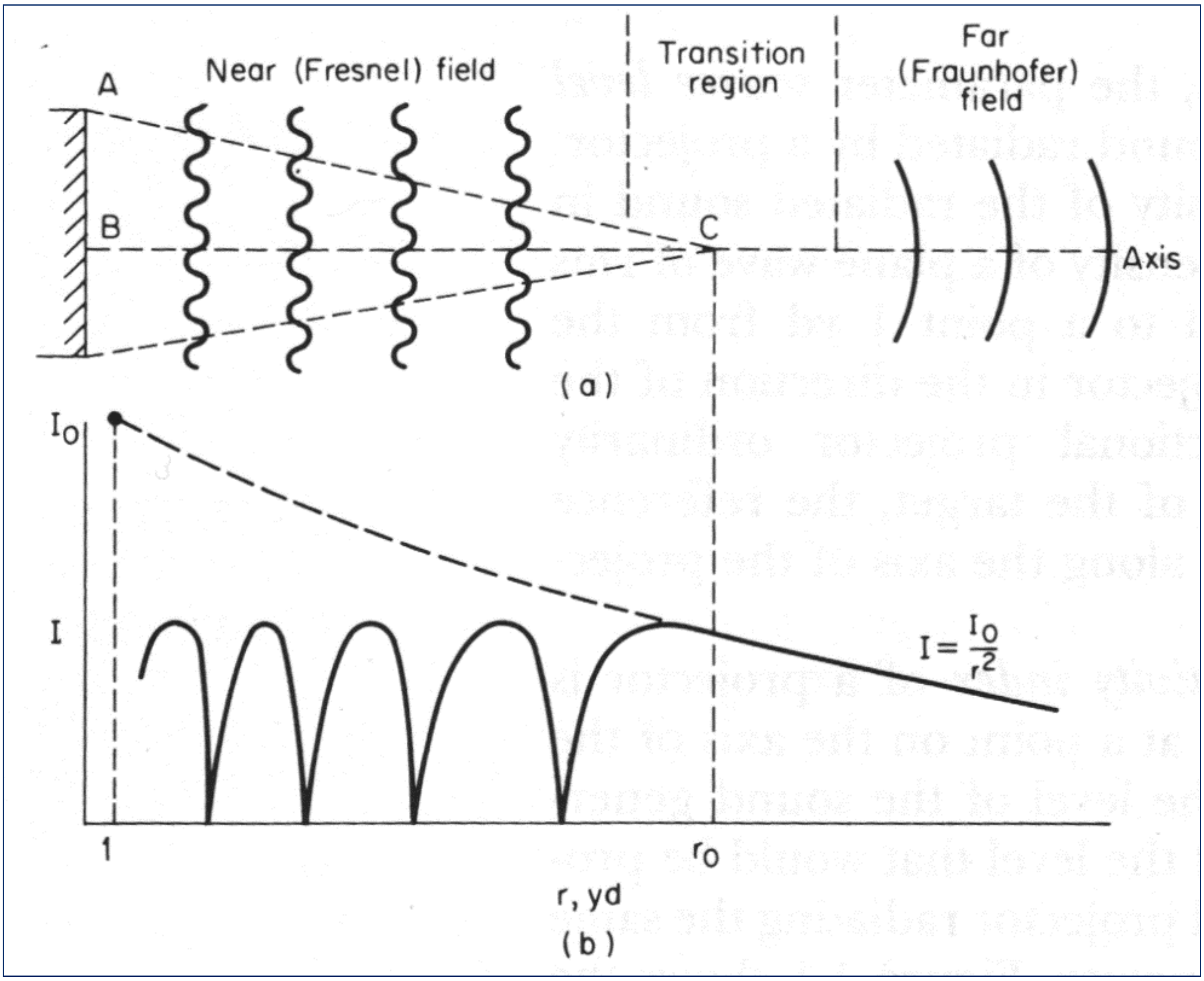

Figure 12.2.1 Underwater Noise Source Level Fields (Urich 1983, Fig. 4)

A table of typical underwater noise levels is set out below in Table 12.2.1.

Table 12.2.1 Typical Underwater Noise Levels - from Richardson et al. (1995)

Source	SPL dB re: 1μPa @ 1m	Peak Frequency Hertz	Bandwidth Hertz
Super Tanker - 337m long @ 18 knots	185	20-30	5-100
Dredging (Suction/Hopper dredge)	177	80-200	20-8,000
Tug vessel (while towing)	145-170	1,000	37-5,000
Fishing vessel (@ 7 knots)	151	250-1,000	250-1,000

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

Acoustic Metrics

This report utilises the standards and definitions set out by "ISO 18405:2017 Underwater Acoustics – Terminology". All times are reported as Coordinated Universal Time.

Peak Sound Pressure Level (L_P)

The peak sound pressure level is the level based on the maximum absolute instantaneous deviation from ambient pressure recorded over a given time interval.

$$L_P = 10 \cdot Log_{10}\left(\frac{Pa^2}{1 \cdot 10^{-12} Pa}\right)$$

Sound Exposure Level (SEL)

The Sound Exposure Level (SEL) is the time integral of the square pressure over a given time period. SEL values for short events are calculated for the duration of that event, e.g. $SEL_{single\ impulse}$.

$$SEL = 10 \cdot Log_{10}\left(\frac{\int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right)$$

For continuous sounds the SEL can be simply calculated from the SPL:

$$SEL = SPL + 10 \cdot Log_{10}(t_2 - t_1)$$

Cumulative Sound Exposure Level (SEL_{cum})

The Sound Exposure Level (SEL) is the time integral of the square pressure over a given time period. SEL_{cum} values are calculated over longer duration and can often be calculated simply by adjusting the SEL for a single event by the total number of events.

$$SEL_{cum} = SEL_{single\ event} + 10\log_{10}(\text{number of events})$$

In this way we might also calculate a "typical" SEL, by using the SEL from a longer exposure to calculate and equivalent single exposure leading to the same cumulative exposure:

$$SEL_{typical} = SEL_{cum\ over\ n\ events} - 10\log_{10}(\text{n})$$

Sound pressure Level (SPL or RMS level)

SPL is the root mean square of the amplitude of a continuous pressure signal in a specified frequency band, for a specified averaging time. SPL is thus equal to the L_{eq} over the same period.

$$SPL = 10 \cdot Log_{10}\left(\frac{\frac{1}{t_2 - t_1} \cdot \int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right)$$

This is functionally equivalent to the deprecated:

$$SPL = 20 \cdot Log_{10}\left(\frac{RMS}{1 \cdot 10^{-6}Pa}\right)$$

Hearing Sensitivity

The frequency, or pitch, of the sound is the rate at which pressure oscillations occur and is measured in Hertz (Hz). When sound is measured in a way which approximates to how a human would perceive it using an A-weighting filter on a sound level meter, the resulting level is described in values of dBA. However, the hearing faculties of marine mammals and fish are not the same as humans, with marine mammals hearing over a wider range of frequencies, fish over a typically smaller range of frequencies and both with different sensitivities. It is therefore important to understand how an animal's hearing varies over the entire frequency range in order to assess the effects of sound on marine life.

Consequently, use can be made of frequency weighting scales to determine the level of the sound in comparison with the auditory response of the animal concerned. A comparison between the typical hearing response curves for fish, humans and marine mammals is shown in Figure 12.2.2. It is worth noting that hearing thresholds are sometimes shown as audiograms with sound level on the y axis rather than sensitivity, resulting in the graph shape being the inverse of the graph shown. It is also worth noting that some fish are sensitive to particle velocity rather than pressure, although paucity of data relating to particle velocity levels for anthropogenic noise sources means that it is often not possible to quantify this effect.

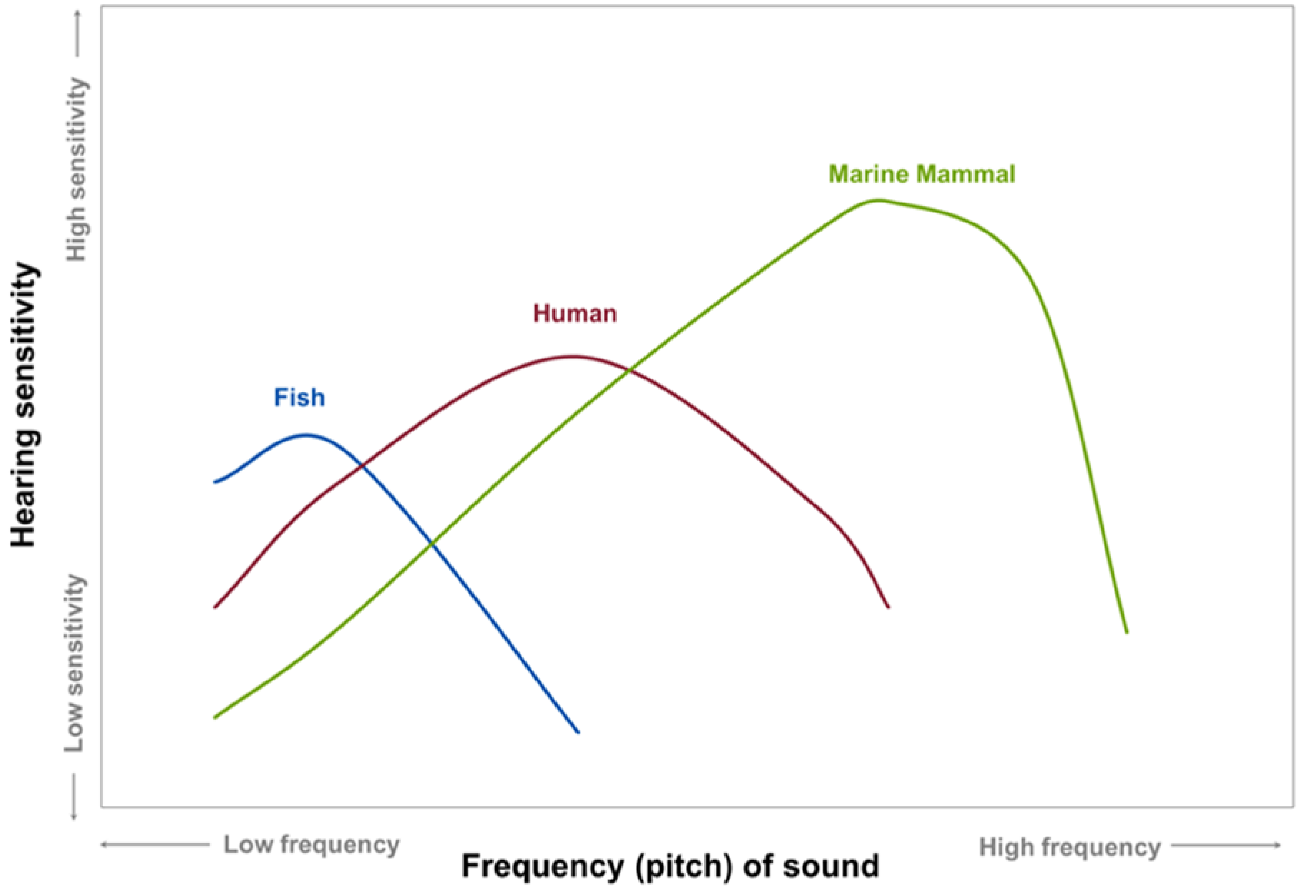

Figure 12.2.2 Comparison between hearing thresholds of different marine animals and humans.

Underwater Sound Propagation

Increasing the distance from the noise source usually results in the level of noise getting lower, due primarily to the spreading of the sound energy with distance, analogous to the way in which the ripples in a pond spread after a stone has been thrown in.

The way that the noise spreads will depend upon several factors such as water column depth, pressure, temperature gradients, salinity, as well as water surface and seabed conditions. Thus, even for a given locality, there are temporal variations to the way that sound will propagate. However, in simple terms, the sound energy may spread out in a spherical pattern (close to the source) or a cylindrical pattern (much further from the source), although other factors mean that decay in sound energy may be somewhere between these two simplistic cases.

In acoustically shallow waters in particular, the propagation mechanism is coloured by multiple interactions with the seabed and the water surface (Lurton, 2002; Etter, 2013; Urick, 1983; Brekhovskikh and Lysanov 2003, Kinsler et al., 1999). Whereas in deeper waters, the sound will propagate further without encountering the surface or bottom of the sea, in shallower waters the sound may be reflected from either or both boundaries (potentially more than once).

At the sea surface, the majority of sound is reflected back into the water due to the difference in acoustic impedance (i.e. sound speed and density) between air and water. However, scattering of sound at the surface of the sea is an important factor with respect to the propagation of sound from a source. In an ideal case (i.e. for a perfectly smooth sea surface), the majority of sound wave energy will be reflected back into the sea (but with the phase reversed, due to the pressure-release nature of the surface). However, for rough waters, much of the sound energy is scattered (Eckart, 1953; Fortuin, 1970; Marsh, Schulkin, and Kneale, 1961; Urick and Hoover, 1956). Scattering can also occur due to bubbles near the surface such as those generated by wind or fish or due to suspended solids in the water such as particulates and marine life. Scattering is more pronounced for higher frequencies than for low frequencies and is dependent on the sea state (i.e. wave height). However, the various factors affecting this mechanism are complex.

Because surface scattering results in differences in reflected sound, its effect will be more important at longer ranges from the source sound and in acoustically shallow water (i.e. where there are multiple reflections between the source and receiver). The degree of scattering will depend upon the water surface smoothness/wind speed, water depth, frequency of the sound, temperature gradient, grazing angle and range from source. Depending upon variations in the aforementioned factors, significant scattering could occur at sea state 3 or more for higher frequencies (e.g. 15 kHz or more). It should be noted that variations in propagation due to scattering will vary temporally (primarily due to different sea-states/wind speeds at different times) and that more sheltered areas (which are more likely to experience calmer waters) could experience surface scattering to a lesser extent, and less frequently, than less sheltered areas which are likely to encounter rougher waters. However, over shorter ranges (e.g. a few hundred meters or less) the sound will experience fewer reflections and so the effect of scattering should not be significant. Consequently, taking into account the sheltered location of Dublin Port and likely distances over which injury will occur, this effect is unlikely to significantly affect the injury ranges presented in this report, although it is possible that disturbance ranges could vary depending on local and seasonal conditions.

When sound waves encounter the seabed, the amount of sound reflected will depend on the geo-acoustic properties of the seabed (e.g. grain size, porosity, density, sound speed, absorption coefficient and roughness) as well as the grazing angle and frequency of the sound (Cole, 1965; Hamilton, 1970; Mackenzie, 1960; McKinney and Anderson, 1964; Etter, 2013; Lurton, 2002; Urick, 1983). Thus, seabed comprising primarily of mud or other acoustically soft sediment will reflect less sound than acoustically harder seabed such as rock or sand. Propagation will also depend on the profile of the seabed (e.g. the depth of the sediment layer and how the geo-acoustic properties vary with depth below the sea floor). The effect is less pronounced at low frequencies (a few kilohertz and below) and so might not be a significant factor to take into account with respect to piling noise (where most of the acoustic energy is at frequencies of a few hundred hertz). A scattering effect (similar to that which occurs at the surface) also occurs at the seabed (Essen, 1994; Greaves and Stephen, 2003; McKinney and Anderson, 1964; Kuo, 1992), particularly on rough substrates (e.g. pebbles).

Another phenomenon is the waveguide effect which means that shallow water columns do not allow the propagation of low frequency sound (Urick, 1983; Etter, 2013). The cut-off frequency of the lowest mode in a channel can be calculated based on the water depth and knowledge of the sediment geo-acoustic properties. Any sound below this frequency will not propagate far due to energy losses through multiple reflections. The cut-off frequency as a function of water depth is shown in Figure 12.2.3 for medium silt. Thus, for a water depth of 7-10 m CD (i.e. the dredged depth range in Dublin Port's navigation channel) the cut-off frequency would be approximately 182-260 Hz.

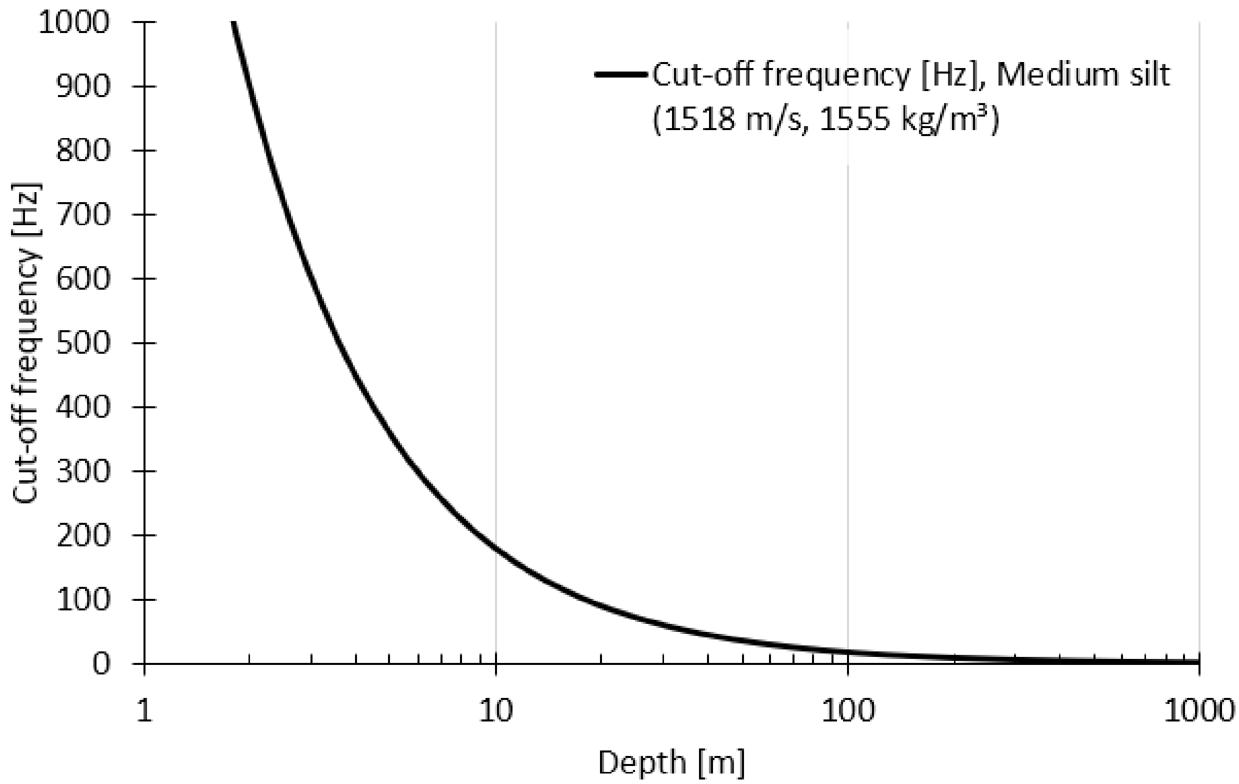

Figure 12.2.3 Shallow water cut-off frequency in "Medium silt" sediments

Activities giving rise to underwater noise

As outlined above the activities giving rise to underwater noise levels during the construction phase are piling and dredging. During the operational phase underwater noise will arise from vessel traffic and annual maintenance dredging.

The piling activity required to strengthen the quay walls at the proposed Ro-Ro Terminal (Area K) and the Maritime Village will have a similar underwater noise profile to that carried out previously under the ABR Project, i.e. the construction of a combi-wall using vibro-piling, impact piling and sheet piling.

The open-piled wharf proposed to form the Lo-Lo Terminal (Area N) requires tubular piles, similar to the king piles used for the ABR Project.

Smaller diameter piles will be required at the finger berth marina, while two larger diameter locating piles will be required to secure the proposed ramp at the Ro-Ro Terminal (Area K).

Further piling is required to support the SPAR Bridge and the suspended deck linking the bridge to the site of Poolbeg Marina.

A combi-wall of tubular king piles and sheet piles will be installed around the south end of the turning circle.

At the tern colony platform with smaller tubular piles will be installed.

A schedule of the pile sizes is provided in Table 12.2.6.

Two types of dredging activity are proposed, Backhoe Dredging and Trailing Suction Hopper Dredging (TSHD). The process has a similar underwater noise profile to work carried out previously at Dublin Port.

12.2.2.2 Assessment Criteria

Noise Sources

In order to determine the potential spatial range of injury and disturbance, assessment criteria have been developed based on a review of available evidence including national and international guidance and scientific literature. The following sections summarise the relevant criteria and describe the evidence base used to derive them.

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Assessment criteria generally separate sound into two distinct types, as follows:

- Impulsive sounds which are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI 1986; NIOSH 1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions; and
- Non-impulsive (continuous) sounds which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous vibro-piling, running machinery, sonar and vessels.

The acoustic assessment criteria for marine mammals and fish in this report has followed the latest international guidance (based on the best available scientific information), that are widely accepted for assessments in the UK, Europe and worldwide.

Injury and Disturbance to Marine mammals

Richardson et al. (Richardson and Thomson 1995) defined four zones of noise influence which vary with distance from the source and level as follows:

- Injury/hearing loss;
- Responsiveness;
- Masking; and
- Audibility.

For this study, it is the zones of injury and responsiveness (i.e., behavioural effects) that are of interest; there is insufficient evidence to properly evaluate masking.

The zone of injury in this study is classified as the distance over which a marine mammal can suffer a Permanent Threshold Shift (PTS) leading to non-reversible auditory injury. Injury thresholds are based on marine mammal hearing-weighted SELs. The hearing weighting function is designed to represent the bandwidth for each group within which acoustic exposures can have auditory effects.

The categories include:

- Low-frequency (LF) cetaceans (i.e. marine mammal species such as baleen whales with an estimated functional hearing range between 7 Hz and 35 kHz);
- Mid-frequency (MF) cetaceans (i.e. marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales with an estimated functional hearing range between 150 Hz and 160 kHz);
- Very High-frequency (VHF) cetaceans (i.e. marine mammal species such as true porpoises, with an estimated functional hearing range between 275 Hz and 160 kHz);
- Phocid pinnipeds (PW) (i.e. true seals with an estimated functional hearing range between 50 Hz and 86 kHz); and
- Otariid pinnipeds (OW) (i.e. sea lions and fur seals with an estimated functional hearing range between 60 Hz and 39 kHz).

These weightings have therefore been used in this study and are shown in Figure 12.2.4. It should be noted that not all of the above categories of marine mammal will be present within the Study Area (as defined in Chapter 7, Section 7.4 Marine Mammals) but criteria are presented in this report for completeness.

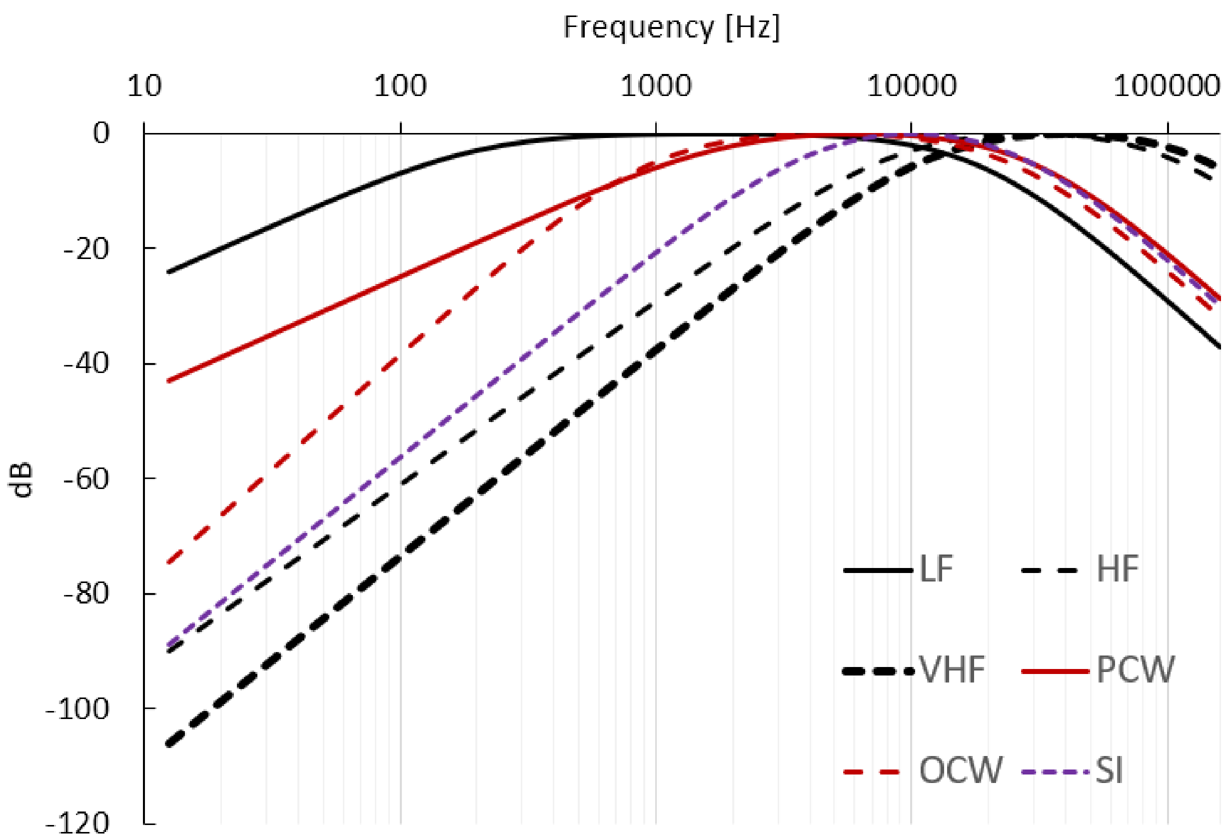

Figure 12.2.4 Marine Mammal Hearing Thresholds (from Southall et al. (2019))

The criteria for impulsive and non-impulsive sound have been adopted for this study given the nature of the sound source used during construction activities. The relevant criteria proposed by Southall *et al*. (2019) are as summarised in Table 12.2.2.

These updated marine mammal injury criteria were published in March 2019 (Southall *et al*., 2019). This paper utilised the same hearing weighting curves and thresholds as presented in the preceding regulations document NMFS (2018) (and prior to that Southall *et al.* (2007)) with the main difference being the naming of the hearing groups and introduction of additional thresholds for animals not covered by NMFS (2018).

For avoidance of doubt, the naming convention used in this report is based upon those set out in Southall *et al*. (2019). Consequently, this assessment utilises criteria which are applicable to both NMFS (2018) and Southall *et al*. (2019).

Table 12.2.2 Summary of PTS and TTS onset acoustic thresholds (Southall et al., 2019; Tables 6 and 7).

Hearing Group	Parameter	Impulsive		Non-impulsive	
		PTS	TTS	PTS	TTS
Low frequency (LF) cetaceans	Peak, dB re 1 µPa (unweighted)	219	213	-	-
	SEL, dB re 1 µPa²s (LF weighted)	183	168	199	179
High frequency (HF) cetaceans	Peak, dB re 1 µPa (unweighted)	230	224	-	-
	SEL, dB re 1 µPa²s (MF weighted)	185	170	198	178
Very high frequency (VHF) cetaceans	Peak, dB re 1 µPa (unweighted)	202	196	-	-
	SEL, dB re 1 µPa²s (HF weighted)	155	140	173	153
Phocid carnivores in water (PCW)	Peak, dB re 1 µPa (unweighted)	218	212	-	-
	SEL, dB re 1 µPa²s (PW weighted)	185	170	201	181
Other marine carnivores in water (OCW)	Peak, dB re 1 µPa (unweighted)	232	226	-	-
	SEL, dB re 1 µPa²s (OW weighted)	203	188	219	199

Under current legislation in Ireland[1], it is an offence to disturb or injure a marine mammal whether this occurs via introduced sound or another anthropogenic source. The induction of temporary or permanent tissue damage and a Temporary Threshold Shift (TTS) in hearing sensitivity, which can have negative effects on the ability to use natural sounds (e.g. to communicate, navigate, locate prey) for a period of minutes, hours or days may constitute such an injury. It is therefore considered that anthropogenic sound sources with the potential to induce TTS in a receiving marine mammal contain the potential for both disturbance and poses a risk to the fecundity of the animal and thus to a part of the local population. Permanent Threshold Shift (PTS) is a permanent hearing injury and is thus a serious impact even with no prolonged or repeated exposure.

The NMFS (2018) and Southall et al. (2007 & 2019) guidelines define TTS as a 6 dB shift in the hearing threshold. Although animals are able to recover fully from TTS, particularly as they move away from a source,

[1] The EC Directive on the conservation of natural habitats and of wild flora and fauna (the Habitats Directive, Council Directive 92/43/EEC) transposed into national law by the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011).

hearing loss may become permanent if TTS occurs over a sustained period of time (and exceeds the PTS threshold), and if hearing does not return to pre-impact levels. Thus, the distinction between TTS and PTS depends on whether there is complete recovery of the individual's hearing or not.

This assessment considers the potential for a permanent injury to occur by considering the anthropogenic noise in relation to the energy thresholds that could lead to TTS. The impact from peak pressure (L_P) levels has also been considered, but the ranges are much smaller than for SEL (even for a single blow) and are therefore not included further in the assessment. Thus, as per the NPWS guidance (Department of Arts, heritage and the Gealtacht, 2014), this assessment considers whether there is the potential for injury to occur. Note that the NPWS guidance specifically refers to now deprecated thresholds for marine mammals (Brandon L. Southall, 2007), and that the ones used here represent an updated and more conservative assessment than would be the case using the older methodology.

The most likely response of a marine mammal to noise levels that could induce TTS is to flee from the ensonified area (Southall et al., 2007) and subsequently the onset of TTS can be referred to as the fleeing response. This is therefore a behavioural response that overlaps with disturbance ranges and animals exposed to these noise levels are likely to actively avoid hearing damage by moving away from the area.

Beyond the area in which injury may occur, the effect on marine mammal behaviour is the most important measure of impact. Significant (i.e. non-trivial) disturbance may occur when there is a risk of animals incurring sustained or chronic disruption of behaviour or when animals are displaced from an area, with subsequent redistribution being significantly different from that occurring due to natural variation.

To consider the possibility of significant disturbance resulting from the 3FM Project, it is therefore necessary to consider the likelihood that the sound could cause non-trivial disturbance, the likelihood that the sensitive receptors will be exposed to that sound and whether the number of animals exposed are likely to be significant at the population level. Assessing this is a very difficult task due to the complex and variable nature of sound propagation, the variability of documented animal responses to similar levels of sound, and the availability of population estimates, and regional density estimates for all marine mammal species.

The (NMFS, 2005) guidance sets the marine mammal level B harassment threshold for continuous noise at 120 dB re 1 μPa (rms). Considering the paucity and high-level variation of data relating to onset of behavioural effects due to continuous sound, it is recommended that any ranges predicted using this number are viewed as probabilistic and potentially over-precautionary.

Southall et al. (2007) presents a summary of observed behavioural responses due to multiple pulsed sound, although the data are primarily based on responses to seismic exploration activities (rather than for piling). Although these datasets contain much relevant data for low-frequency cetaceans, there are no strong data for mid-frequency or high-frequency cetaceans. Low frequency cetaceans, other than bow-head whales, were typically observed to respond significantly at a received level of 140 to 160 dB re 1 μPa (rms). Behavioural changes at these levels during multiple pulses may have included visible startle response, extended cessation or modification of vocal behaviour, brief cessation of reproductive behaviour or brief/minor separation of females and dependent offspring. The data available for mid-frequency cetaceans indicate that some significant response was observed at a sound pressure level of 120 to 130 dB re 1μPa (rms), although the majority of cetaceans in this category did not display behaviours of this severity until exposed to a level of 170 to 180 dB re 1μPa (rms). Furthermore, other mid-frequency cetaceans within the same study were observed to have no behavioural response even when exposed to a level of 170 to 180 dB re 1μPa (rms).

A more recent study is described in Graham et al. (2017). Empirical evidence from piling at the Beatrice offshore wind farm was used to derive a dose-response curve for harbour porpoise. The unweighted single pulse SEL contours were plotted in 5 dB increments and applied the dose-response curve to estimate the number of animals that would be disturbed by piling within each stepped contour. The study shows a 100% probability of disturbance at an (un-weighted) SEL of 180 dB re 1μPa^{2}s, 50% at 155 dB re 1μPa^{2}s and dropping to approximately 0% at an SEL of 120 dB re 1μPa^{2}s.

According to Southall et al. (2007) there is a general paucity of data relating to the effects of sound on pinnipeds in particular. One study using ringed, bearded and spotted seals (Harris et al., 2001) found onset of a significant response at a received sound pressure level of 160 to 170 dB re 1 μPa (rms), although larger numbers of animals showed no response at noise levels of up to 180 dB re 1 μPa (rms). It is only at much higher sound pressure levels in the range of 190 to 200 dB re 1 μPa (rms) that significant numbers of seals were found to exhibit a significant response. For non-pulsed sound, one study elicited a significant response on a single harbour seal at a received level of 100 to 110 dB re 1 μPa (rms), although other studies found no response or non-significant reactions occurred at much higher received levels of up to 140 dB re 1 μPa (rms). No data are available for higher noise levels and the low number of animals observed in the various studies means that it is difficult to make any firm conclusions from these studies.

Southall et al. (2007) also notes that, due to the uncertainty over whether high-frequency cetaceans may perceive certain sounds and due to paucity of data, it was not possible to present any data on responses of high frequency-cetaceans. However, Lucke et al. (2008) showed a single harbour porpoise consistently showed aversive behavioural reactions to pulsed sound at received sound pressure levels above 174 dB re 1 μPa (peak-to-peak) or a SEL of 145 dB re 1 μPa^{2}s, equivalent to an estimated[2] rms sound pressure level of 166 dB re 1 μPa.

Clearly, there is much intra-category and perhaps intra-species variability in behavioural response. As such, a conservative approach should be taken to ensure that the most sensitive cetaceans remain protected.

The High Energy Seismic Survey workshop on the effects of seismic (i.e. pulsed) sound on marine mammals ("Summary of Recommendations Made by the Expert Panel at the HESS Workshop on the Effects of Seismic Sound on Marine Mammals" 1997) concluded that mild behavioural disturbance would most likely occur at rms sound levels greater than 140 dB re 1 μPa (rms). This workshop drew on studies by Richardson (1995) but recognised that there was some degree of variability in reactions between different studies and mammal groups. Consequently, for the purposes of this study, a precautionary level of 140 dB re 1 μPa (rms) is used to indicate the onset of low-level/trivial marine mammal disturbance effects for all mammal groups for impulsive sound.

This assessment adopts a conservative approach and uses the NMFS (2005b) Level B harassment threshold of 160 dB re 1 μPa (rms) for impulsive sound. Level B Harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including,

[2] Based on an analysis of the time history graph in Lucke et al. (2007) the T90 period is estimated to be approximately 8 ms, resulting in a correction of 21 dB applied to the SEL to derive the rms_{T90} sound pressure level. However, the T90 was not directly reported in the paper.

but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. This is similar to the JNCC (2010) description of non-trivial disturbance and has therefore been used as the basis for onset of behavioural change in this assessment.

It is important to understand that exposure to sound levels in excess of the behavioural change threshold stated above does not necessarily imply that the sound will result in significant disturbance. As noted previously, it is also necessary to assess the likelihood that the sensitive receptors will be exposed to that sound and whether the numbers exposed are likely to be significant at the population level.

Change in Assessment Criteria

There have been two changes in assessment criteria that will result in risk ranges being much larger that for previous assessments:

1. Change from using DAHG[3] PTS limits from 2014:
   198 dB SEL for porpoises and 186 dB SEL for seals. These are now 155 dB SEL for porpoises and 185 for seals, a decrease of 43 dB and 1 dB respectively.
2. Change from using PTS (hearing injury) to using TTS (temporary hearing impact) as limit, further lowering the thresholds from 155 to 140 dB SEL (porpoises), 185 to 170 dB SEL (seals), a decrease of 15 dB for both groups.

These two factors, reflecting an update in scientific consensus and the DAHG guidance setting TTS as the limit for injury (Department of Arts, heritage and the Gealtacht, 2014), mean that the assessment limits have decreased by 58 dB and 16 dB for porpoises and seals respectively, leading to large increases in risk ranges.

Injury and Disturbance to Fish

Adult fish not in the immediate vicinity of the noise generating activity are generally able to vacate the area and avoid physical injury. However, larvae and eggs are not highly mobile and are therefore more likely to incur injuries from the sound energy in the immediate vicinity of the sound source, including damage to their hearing, kidneys, hearts and swim bladders. Such effects are unlikely to happen outside of the immediate vicinity of even the highest energy sound sources.

For fish, the most relevant criteria for injury are considered to be those contained in the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al*., 2014). Sea Turtles are not included in this assessment. Popper *et al*. (2014) guidelines do not group by species but instead broadly group fish into the following categories based on their anatomy and the available information on hearing of other fish species with comparable anatomies:

- Group 1: Fishes with no swim bladder or other gas chamber (e.g. elasmobranchs, flatfishes and lampreys). These species are less susceptible to barotrauma and are only sensitive to particle motion, not sound

[3] Department of Arts, Heritage and the Gaeltacht: Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters, January 2014

pressure. Basking shark Cetorhinus maximus, which does not have a swim bladder, falls into this hearing group;

- Group 2: Fishes with swim bladders but the swim bladder does not play a role in hearing (e.g. salmonids). These species are susceptible to barotrauma, although hearing only involves particle motion, not sound pressure;
- Group 3: Fishes with swim bladders that are close, but not connected, to the ear (e.g. gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than Groups 1 and 2, extending to about 500 Hz;
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring Clupea harengus, sprat Sprattus spp. and shads (Alosinae)). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kilohertz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3; and
- Fish eggs and larvae: separated due to greater vulnerability and reduced mobility. Very few peer-reviewed studies report on the response of eggs and larvae to anthropogenic sound.

The guidelines set out criteria for injury due to different sources of noise. Those relevant to the Project are considered to be those for injury due to impulsive piling. The criteria include a range of indices including SEL, rms and peak sound pressure levels. Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres). It should be noted that these qualitative criteria cannot differentiate between exposures to different noise levels and therefore all sources of noise, no matter how noisy, would theoretically elicit the same assessment result. However, because the qualitative risks are generally qualified as “low”, with the exception of a moderate risk at “near” range (i.e. within tens of metres) for some types of animal and impairment effects, this is not considered to be a significant issue with respect to determining the potential effect of noise on fish.

The criteria used in this noise assessment for impulsive piling are given in Table 12.2.3. In the table, both peak and SEL criteria are unweighted.

We will use the lowest thresholds to cover all fishes. Note that Lamprey have higher thresholds (no swim bladder) than do salmon (with swim bladder, but not for hearing).

To simplify the terminology used in the results section we have abbreviated “Potential Mortality”/”Recoverable injury” to PM/RI. Note that in plots and maps PM corresponds to “PTS” and RI to “TTS”.

Table 12.2.3 Criteria for onset of injury to fish and sea turtles due to impulsive piling (Popper et al., 2014).

Type of animal	Parameter	Mortality and potential mortal injury (PM/PTS)	Recoverable injury (RI/TTS)
Fish: no swim bladder (particle motion detection)	SEL, dB re 1 μPa²s	>219	>216
	Peak, dB re 1 μPa	>213	>213
Fish: where swim bladder is not involved in hearing (particle motion detection)	SEL, dB re 1 μPa²s	210	203
	Peak, dB re 1 μPa	>207	>207
Fish: where swim bladder is involved in hearing (primarily pressure detection)	SEL, dB re 1 μPa²s	207	203
	Peak, dB re 1 μPa	>207	>207
Eggs and larvae	SEL, dB re 1 μPa²s	>210	(*Near*) Moderate (*Intermediate*) Low (*Far*) Low
	Peak, dB re 1 μPa	>207	

The criteria used in this noise assessment for non-impulsive sound are given in Table 12.2.4.

Table 12.2.4 Criteria for onset of injury to fish due to non-impulsive sound (Popper et al., 2014)

Type of animal	Mortality and potential mortal injury	Recoverable injury
Fish: no swim bladder (particle motion detection)	(*Near*) Low (*Intermediate*) Low (*Far*) Low	(*Near*) Low (*Intermediate*) Low (*Far*) Low
Fish: where swim bladder is not involved in hearing (particle motion detection)	(*Near*) Low (*Intermediate*) Low (*Far*) Low	(*Near*) Low (*Intermediate*) Low (*Far*) Low
Fish: where swim bladder is involved in hearing (primarily pressure detection)	(*Near*) Low (*Intermediate*) Low (*Far*) Low	170 dB re 1 μPa (rms) for 48 hours Taken here to be 219 dB SEL over 24 hours
Eggs and larvae	(*Near*) Low (*Intermediate*) Low (*Far*) Low	(*Near*) Low (*Intermediate*) Low (*Far*) Low

Behavioural reaction of fish to sound has been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish's body. The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders[4].

Highly sensitive species such as herring have elaborate specialisations of their auditory apparatus, known as an otic bulla – a gas filled sphere, connected to the swim bladder, which enhances hearing ability. The gas filled swim bladder in species such as cod and salmon may be involved in their hearing capabilities, so although there is no direct link to the inner ear, these species are able to detect lower sound frequencies and as such are considered to be of medium sensitivity to noise. Flat fish and elasmobranchs have no swim bladders and as such are considered to be relatively less sensitive to sound pressure.

The most recent criteria for disturbance are considered to be those contained in Popper *et al*. (2014) which set out criteria for disturbance due to different sources of noise. The risk of behavioural effects is categorised in relative terms as "high", "moderate" or "low" at three distances from the source, as shown in Table 12.2.5.

Table 12.2.5 Criteria for onset of behavioural effects in fish and sea turtles for impulsive and non- impulsive sound (Popper et al., 2014)

Type of animal	Relative risk of behavioural effects	
	Impulsive sound	Non-impulsive sound
Fish: no swim bladder (particle motion detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low
Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low
Fish: where swim bladder is involved in hearing (primarily pressure detection)	(Near) High (Intermediate) High (Far) Moderate	(Near) High (Intermediate) Moderate (Far) Low
Eggs and larvae	(Near) Moderate (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low

It is important to note that the Popper *et al*. (2014) criteria for disturbance due to sound are qualitative rather than quantitative. Consequently, a source of noise of a particular type (e.g. piling) would result in the same predicted potential impact, no matter the level of noise produced or the propagation characteristics.

Therefore, the criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011) are also used in this assessment for predicting the extent of behavioural effects due to impulsive piling. The manual suggests an un-weighted sound pressure level of 150 dB re 1 μPa (rms) as the criterion for onset of behavioural effects, based on work by (Hastings, 2002). Sound pressure levels in excess of 150 dB re 1 μPa (rms) are expected to cause temporary

[4] It should be noted that the presence of a swim bladder does not necessarily mean that the fish can detect pressure. Some fish have swim bladders that are not involved in the hearing mechanism and can only detect particle motion.

behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection). It is important to note that this threshold is for onset of potential effects, and not necessarily an ‘adverse effect’ threshold.

12.2.2.3 Underwater Noise sources and Propagation Loss

Noise sources are usually described in dB re 1 µPa as if measured at 1 m from the source. In practice, it is not usually possible to measure at 1 m from a source, but this method allows different source levels to be compared and reported on a like-for-like basis. This method of specification involves assuming that the source is infinitesimally small so that at 1 m from this imagined point the sound pressure levels can be defined. In reality, for a large sound source such as a pile this imagined point at 1 m from the acoustic centre does not exist. Furthermore, the energy is distributed across the source and does not all emanate from this imagined acoustic centre point. Therefore, the stated sound pressure level at 1 m does not actually occur for large sources, such as piles. In the acoustic near-field, the sound pressure level will be significantly lower than would be predicted using this method.

The sound generated and radiated by a pile as it is driven into the ground is complex, due to the many components which make up the generation and radiation mechanisms. However, a wealth of experimental data is available which allow us to predict with a good degree of accuracy the sound generated by a pile at discrete frequencies. Third octave band noise spectra have been presented in literature for various piling activities (e.g. Matuschek and Betke 2009; De Jong and Ainslie 2008; Wyatt 2008; J. R. Nedwell et al. 2007; J. Nedwell and Howell 2004; Jeremy Nedwell et al., 2003; CDoT 2001; Nehls et al., 2007; Thomsen et al., 2006).

The source Sound Exposure Level is linked to the hammer energy E according to the methodology described in De Jong and Ainslie (2008), as follows:

$$\text{SEL} = 120 + 10\log_{10}\left(\frac{\beta E c_0 \rho}{4\pi}\right)$$

Where β is the acoustic energy conversion efficiency (in this case taken to be 0.5%), c_0 is the speed of sound in seawater in m/s, and ρ is the density of seawater in kg/m^3.

A more recent study by von Pein et al. provides a wider range of parameters:

$$\Delta SEL = 10log_{10}\left(\frac{E_1}{E_0}\right) + 16.7log_{10}\left(\frac{d_1}{d_0}\right) - 10log_{10}\left(\frac{m_{r,1}}{m_{r,0}}\right) + 750\frac{10log_{10}(|R|^2)}{2\cot\varphi}\left(\frac{1}{h_1} - \frac{1}{h_0}\right)$$

Where E = hammer energy, d = pile diameter, m = ram weight, R = reflection coefficient, φ the propagation angle and h the water depth.

12.2.2.4 Construction Phase Model

The underwater noise from each of the piling scenarios set out in Table 12.2.6 have been modelled. Each of the piling operations have been assessed according SEL. All piling locations were modelled using dBSea. From previous measurement analysis, the peak source level and third octave band information for 1.2 m diameter piling is known. As outlined in Section 12.2.5 piling noise level is proportional to pile diameter. Because we are piling in similar circumstances and location to the measurements, the extrapolation of source levels can be simplified to a simple ratio of diameters or piling energy. In the case of this model the pile diameter was used to extrapolate the source levels by using a correction factor. This correction factor is added to the 1.2 m diameter pile third octave band information and the subsequent levels are summed to obtain the new source level of the new pile size. The correction factor is given by:

$$\Delta\text{peak or }\Delta\text{SEL} = L_{peak}\ or\ SEL + 16.7\log_{10}\left(\frac{pile\ diameter}{1.2}\right)$$

Where $pile\ diameter$ is the diameter of the pile needing its source level calculated and 1.2 m is the diameter of the measured pile. When calculating the SEL of an impulsive source, the crest factor is an important factor to consider, as its exclusion can lead to overestimating levels. The crest factor is the dB difference between the peak value and the average value of a signal and is subtracted from the SEL source level. From measurements made previously, the crest factor was calculated for each measured location. A crest factor of 30dB was chosen for the underwater noise model, which is a conservative estimate.

Overview of Piling Activity During Construction Phase

Modelling has been carried out at each of the locations noted in Table 12.2.6. In the case of extensive piling, such as the Ro-Ro Terminal (Area K) and Lo-Lo Terminal (Area N), separate models have been developed for the east and west end of the proposed activity, with Area N having both 2 and 5 piling rigs operating continuously modelled. The assessment of piling at Area K was taken to be representative of similar piling required at the Maritime Village.

The SPAR Road will be installed primarily with vibratory driving until rock is met (approximately 30 m down). After this the inside will be excavated by coring or auger drill. A socket will then be drilled in the rock below the pile toe, for later infilling through the pile with stell reinforced concrete. These operations are either much quieter (excavating the pile) and/or occur well into the sediment and are not assessed further (source levels similar to dredging, 177 dB SPL).

Table 12.2.6 Piling sizes and peak source levels for impact piling.

Location	Piling Required	Installation method assessed	Level	Approximate location (UTM 29N)
SPAR Bridge	1.02 m dia. 22.2 mm thick round piles.	Impact piling	204 dB $SEL_{single\ blow}$	East: 684621 North: 5914337
SPAR Road	1.2 m dia. 10mm thick round piles	Vibration piling	206 dB $SEL_{single\ blow}$	East: 684768 North: 5914204
SPAR Road	1.2 m dia. 10mm thick round piles	Vibration piling	206 dB $SEL_{single\ blow}$	East: 685120 North: 5914116
Ro-Ro Terminal (Area K) Impact piling	1.42 m dia. 25.4mm thick round piles	Impact piling	206 dB $SEL_{single\ blow}$	East: 686035 North: 5914067

Location	Piling Required	Installation method assessed	Level	Approximate location (UTM 29N)
Ro-Ro Terminal (Area K) Vibro piling	1.4 m wide sheet piles	Vibration	207 dB SPL	East: 686035 North: 5914067
Marina Finger Berths	1.02 m dia. 22.2 mm thick round piles.	Impact piling	204 dB $SEL_{single\ blow}$	East: 684898 North: 5914234
Ro-Ro Ramp	2.4 m dia. 40 mm thick guide (round) piles.	Impact piling	210 dB $SEL_{single\ blow}$	East: 685858 North: 5914125
Area N (West)	1.63 m dia. 22 mm thick round piles	Impact piling	207 dB $SEL_{single\ blow}$	East: 687034 North: 5914020
Area N (East)	1.63 m dia. 22.2 mm thick round raking piles.	Impact piling	207 dB $SEL_{single\ blow}$	East: 687682 North: 5914060
Area N x5 rigs simultaneously	1.63 m dia. 22.2 mm thick round raking piles.	Impact piling	207 dB $SEL_{single\ blow}$	East: 687329, 687682, 687128, 687529 North: 5914024, 5914060, 5913950, 5913951
NORA Dolphin	1.02 m dia. 22.2mm thick round piles.	Impact piling	204 dB $SEL_{single\ blow}$	East: 687805 North: 5914060
Tern Colony	0.51 m dia. 22 mm thick Round piles	Impact piling	199 dB $SEL_{single\ blow}$	East: 688289 North: 5914064
Turning Circle, King piles Impact piling	2.03 m dia. 22 mm thick Round piles	Impact piling	209 dB $SEL_{single\ blow}$	East: 686664 North: 5913976
Turning Circle, sheet piles Impact piling	1.4 m pair Sheet piles	Vibration	207 dB SPL	East: 686664 North: 5913976

The locations and installation types presented above are a worst-case representation covering the locations/areas with piling and the results are valid for comparable pile sizes and similar locations should the final installation plan change.

Piling Source Levels

For this Project, underwater noise measurements were carried out while king piles and sheet piles were being driven in the Liffey channel at Ocean Pier. Measurements were carried out while impact and vibratory piling was being carried out on 1.2 m diameter 'king' piles and vibratory piling on 1.46 m wide sheet piles. Measurements were carried out various distances from the source and the measurement data was used to calculate a source level at 1 metre for the king piles and a propagation loss factor for the Liffey channel area.

A summary of the broadband level of the various piling source is given in Table 12.2.7, with the impact piling leading to the largest impact ranges and therefore forming the basis of the assessment:

Table 12.2.7 Underwater Noise Modelling parameters. Broadband levels 250 – 20,000 Hz.

Parameter	Duration/blow count	Unweighted	Weighted for VHF group	Weighted for PCW group	Weighted for OCW group
Impact piling	Single blow	210 dB SEL	192	205	205
	1 hour (1.5 sec/blow, 50% duty cycle: 1200 blows/hour)	241 dB SEL	223	236	236
Vibration piling, round piles	1 second	211 dB SPL	164	198	196
	1 hour	247 dB SEL	199	234	231
Vibration piling, sheet piles	1 second	204 dB SPL	187	202	202
	1 hour	239 dB SEL	223	237	238

The values in Table 12.2.7 were used as basis for the propagation modelling (see Appendix 12.3 – Source band levels).

12.2.2.5 Operational Phase Model

A user-defined vessel source was used to model the shipping traffic as part of the operational phase of the 3FM Project. This source uses third octave band levels found in Abrahamsen (2012) which describe the noise emissions of a vessel travelling at 8 knots. This type of vessel at this speed is an accurate representation of the average shipping traffic arriving at and leaving Dublin Port. Only the SEL level type is necessary to model due to the non-impulsive nature of shipping noise. Two scenarios were modelled: one with the vessel source placed in the port area and one with the vessel further east in the navigation channel to cover two typical scenarios.

12.2.3 Existing Environment

Dublin Bay is home to Dublin Port and Dun Laoghaire Harbour along with a number of smaller harbours and marinas. Marine traffic includes large cargo ships, passenger cruise ships, large ferry vessels, fast ferries, trawlers and leisure traffic. The main shipping channels from the Irish Sea are north and south of the Burford Bank towards the entrance to Dublin Harbour between the Great South Wall and North Bull Wall. The dredged shipping channel on the eastern approaches to the port extends up the River Liffey as far as Tom Clarke Bridge.

The central port area from Berth 53 to the Alexandra Basin West is heavily trafficked by vessels on a daily basis. This working area in Dublin Port is relatively noisy in comparison to the greater Dublin Bay area. Noise in the port area is generated from shipping and a multitude of industrial sources. The port is accessed via the dredged navigation channel which extends some 2.5 km from the Great South Wall light to Berth 53. The channel is approximately 200 m wide and is currently 10 m deep (Chart Datum). This narrow shallow channel has the effect of confining noise from the port within that area and a short section of the channel and the River Liffey upstream.

12.2.3.1 Sensitivity of the Receiving Environment

Dublin Port has been a commercial seaport at its current location since the 1700's. The area surrounding the port includes a mix of heavy industry, commercial, residential, conservation and amenity space. There are several water intakes and outflows in the inner port area associated with industrial developments. The flow noise from these, along with commercial and leisure vessel traffic increases local underwater noise levels in the port area. Maintenance dredging is carried out annually over a 4–6-week period between April and September contributing to the baseline underwater noise levels.

Marine mammals in outer Dublin Bay, east of the Poolbeg lighthouse include Phocids, Very High Frequency Cetaceans, High Frequency Cetaceans and Other Marine Carnivores (otters). Some Low Frequency Cetaceans have been recorded occasionally. Diving seabirds including auk species, and shallow divers such as terns and gulls are also present. West of the Poolbeg Lighthouse in the area enclosed by the Great South Wall and the North Bull Wall there have been relatively few sightings harbour porpoise, but small numbers of seals are found more regularly. Diving seabirds in the area are mainly shallow divers such as terns.

12.2.3.2 Ambient noise levels

The port continues to operate as normal. Construction work on the Alexandra Basin Redevelopment (ABR) Project (29N.PA0034) is nearing completion and the MP2 Project (ABP-304888-19) is currently under construction at the port. During construction piling works for the ABR Project, underwater noise levels were measured and reported in Table 12.2.8. Noise levels due to shipping at the Poolbeg Oil Jetty are elevated for the short period of time when a vessel passes and drop to background noise levels afterwards. Shipping noise Alexander Basin area remains elevated for most of the day due to ship berthing and loading/unloading activity. Typical noise levels (10^{th} to 90^{th} percentile) are 115-151 dB SPL (Figure 12.2.5) with natural background levels changing with the tide (increased level with increased depth, low tide 07:41 – high tide 14:19).

Note that "90th percentile" is the level over 90 % of the measurements, corresponding to the "LA10" often used to describe the level exceeded 10 % of the time (and 10th percentile corresponds to "LA90").

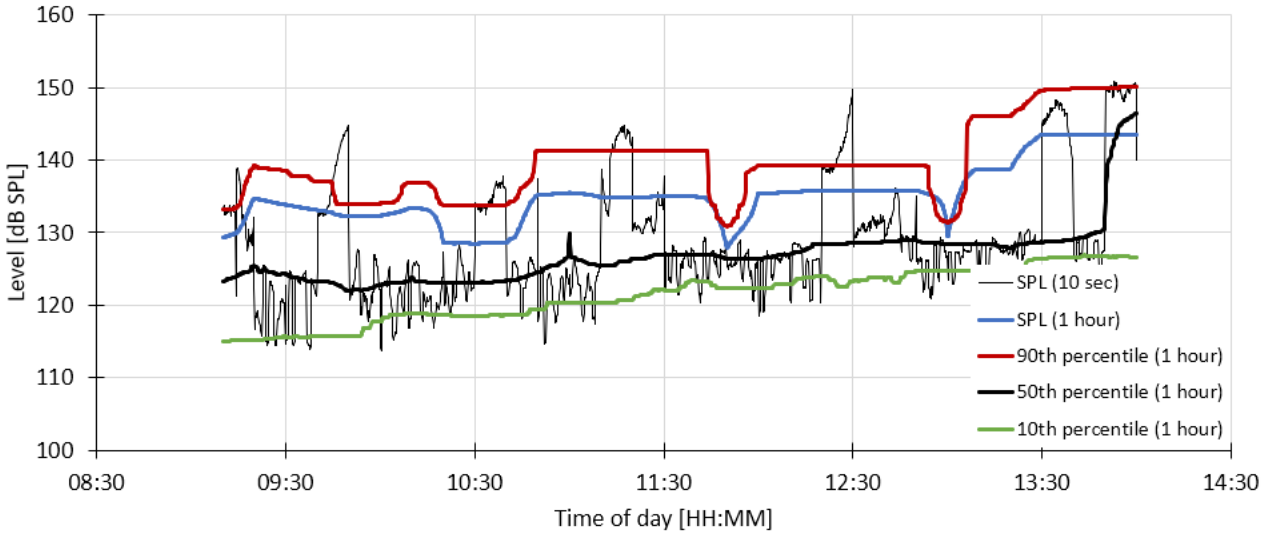

Figure 12.2.5 Example of noise levels measured in Dublin Port 2017 over a ~5-hour period (23 Nov 2017)

The piling noise levels in Table 12.2.8 were measured while piling was taking place on the Ocean Pier quay wall (which is enclosed in Alexandra Basin West). A notable feature of the piling noise was the intermittent nature of the noise source. While piling is underway 'all day', the actual piling strikes occur for one third of working hours. This is due to the need to ensure the piles are properly aligned, piling depth checks, changes in piling settings, meal breaks and equipment checks. The average 'striking period' duration was under 12 minutes with breaks of varying duration in between 'striking periods'. The inter-strike interval was 1.56 seconds (1,560 milliseconds), rounded to 1.5 seconds. A typical pile strike is shown in Figure 12.2.6.

Table 12.2.8 Measured noise levels at Dublin Port (2017)

Noise type	Level
Natural Background (10th percentile)	115-127 dB SPL
Typical levels (Median/50th percentile)	122-146 dB SPL
Vessels, Vibro piling, dredging (90th percentile)	131-151 dB SPL
Peak levels in 10 min duration (~200 m from piling)	140-168 dB L_P

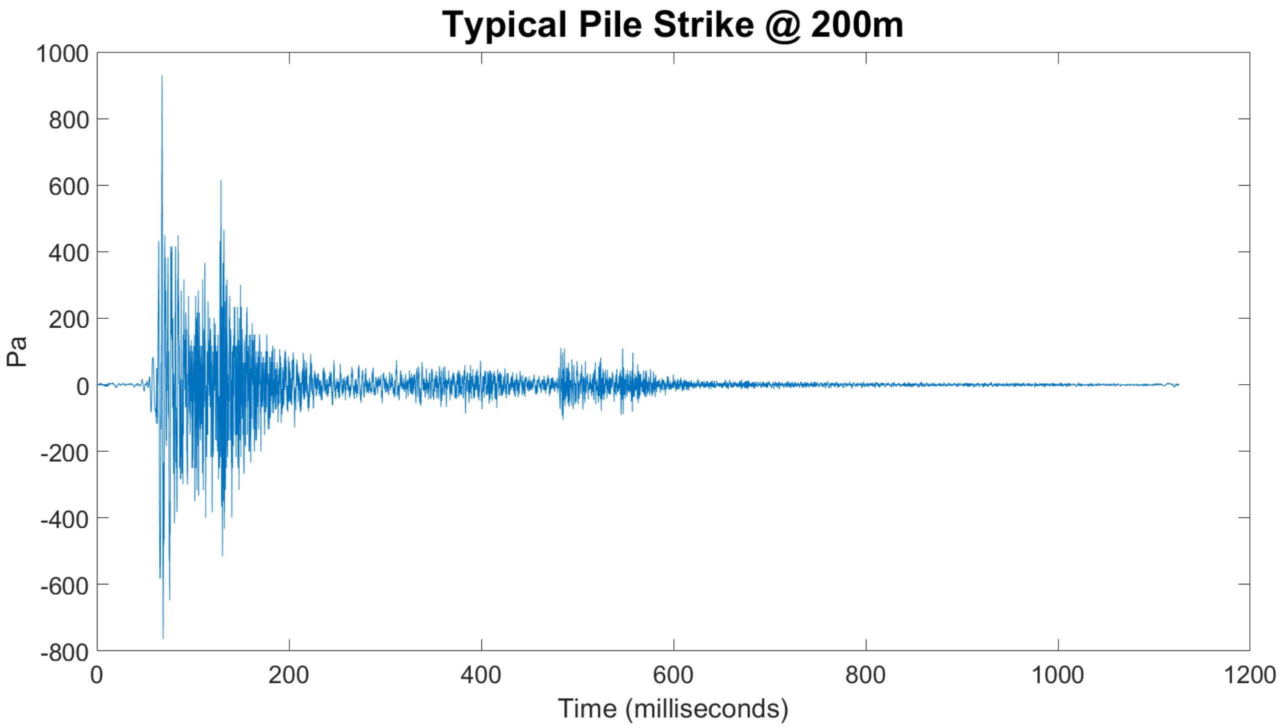

Figure 12.2.6 Typical piling strike measured at 200 metres from the source.

12.2.3.3 Sediment

The seabed in the port area has been described as a mix of fine sand and clay, leading to a moderately stiff mix of clayey sand. The sediment properties used for propagation modelling is presented in Table 12.2.9.

Table 12.2.9 Sediment properties used for propagation modelling

Sediment density [kg/m³]	Sediment soundspeed [m/s]	Sediment attenuation [dB/λ] (compressional waves)[5]	Sediment Grain Size [mm]	ISO 14688-1:2017 name
1555	1518	0.17	0.0111	Medium silt

12.2.3.4 Water properties

Water properties are based on conditions leading to the minimal transmission loss within the measured values for the site:

1. Higher temperatures – higher soundspeed
2. Lower salinities – less absorption at higher frequencies
3. Larger depth – less absorption of low frequencies into the sediment

The water properties used for propagation modelling is presented in Table 12.2.10.

[5] Shear waves ignored.

Table 12.2.10 Water properties used for propagation modelling

Temperature [°C]	Salinity [psu]	Soundspeed [m/s]	Density [kg/m³]
17.6	26.4	1505	1021

12.2.4 Impact Assessment - Underwater Noise Modelling

12.2.4.1 dBSea Model

There are several methods available for modelling the propagation of sound between a source and receiver ranging from very simple models which simply assume spreading according to distance from source such as 10 log(r) or 20 log(r) relationships to computationally intensive acoustic models (e.g. ray-tracing, normal-mode, parabolic equation, wavenumber integration and energy flux models). Semi-empirical models lie somewhere in between and provide a practicable balance for environmental impact assessment modelling. Sound propagation modelling for this assessment was carried out using dBSea, an underwater noise prediction and visualisation software package, using parabolic equation and raytracing methods. dBSea allows the input of user defined equations in order to model sound propagation over distance.

12.2.4.2 Underwater Noise Sources

dBSea allows the input of user-defined noise sources with specified third octave band levels. Each source is stated as either SPL or SEL per third octave band. In the case of this model, the assessment period is set to 3600 seconds. It is reasonable to assume that a species will move away from a noise source if it becomes disturbed and exposure of one hour at the maximum level is a conservative estimate of overall exposure. In total, twelve noise models were created in the dBSea model: seven impact piling source locations, two sheet piling source locations, one dredging location all during the construction phase and two shipping source locations during the operating phase. All noise sources are assumed to radiate sound energy equally in all directions.

12.2.4.3 Marine Species Weightings

dBSea allows the weighting of results to reflect the different hearing systems of various marine species. Southall defines eight distinct hearing groups among marine species and results for three of these groups have been modelled: high frequency cetaceans (HF), very high frequency cetaceans (VHF) and other marine carnivores in water (OCW). The HF group contains species such as the common dolphin, the VHF group contains species such as harbour porpoises and the OCW group contains all non-phocid marine carnivores which in this case are taken to represent otters. Unweighted results were also modelled in order to represent the hearing capabilities of fish.

12.2.4.4 Model Validation

A range of measurements undertaken from earlier work nearby was used to compare the modelling outputs to the measured data to estimate the confidence in the modelling and apply corrective measures, if needed. This comparison (Figure 12.2.7) shows that the model tends to underestimate the transmission loss for shorter ranges 0-200 m but has good accuracy for ranges 600-3500 m along the channel.

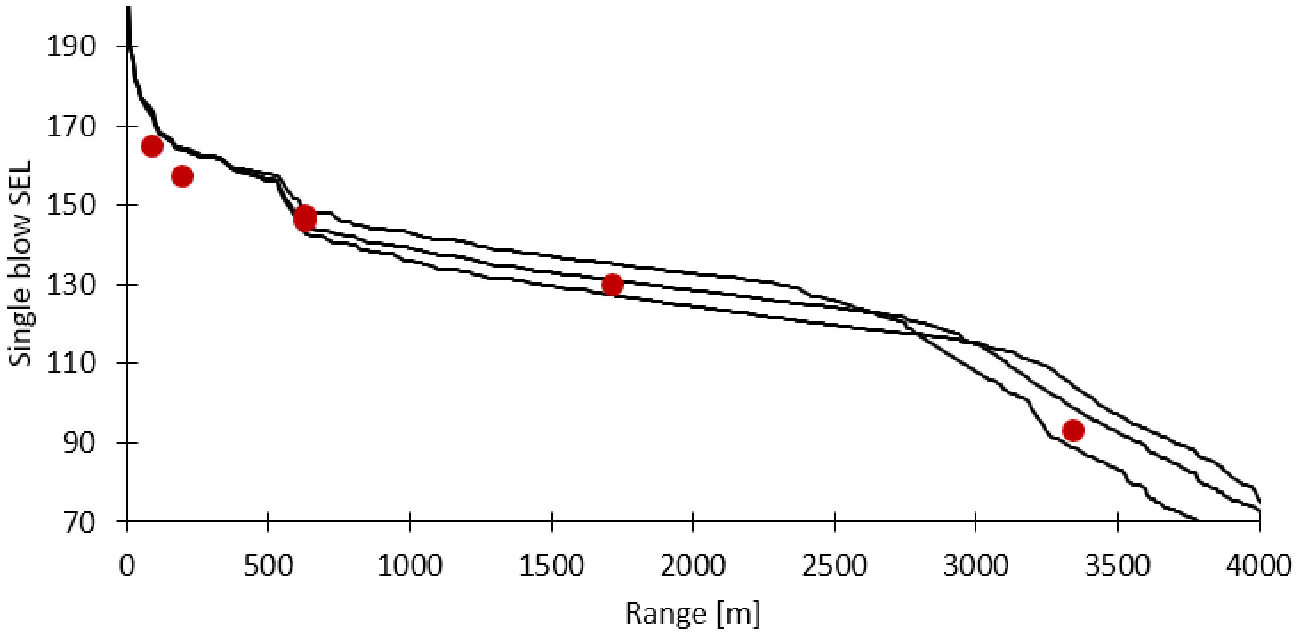

Figure 12.2.7 Comparison of three modelled radials with measured levels. All radials are in the main channel from a measured source (impact piling) east of Alexandra Basin West.

12.2.4.5 Noise Modelling Results

Figures and Tables here give an overview of the *max* range to limits for various activities modelled and the radius at which Temporary Threshold Shift (TTS) or Recoverable injury to fish may occur. Where "typical ranges/levels" is used this means median to 90th percentile covering all the relevant sites included in that summary.

Individual results for all modelled locations and activities are presented in section 12.2.6.

TTS is the main assessment criteria for marine mammals.

Results for Permanent Threshold shift (PTS) and Fish injury are included to allow comparison with studies using this metric as the main criteria.

PTS is not the main assessment criteria and only included for completeness, reflecting limits given in the Southall 2019 framework.

Max ranges are not necessarily representative of the general range of risk, especially for a site like Dublin Port where the noise level in the dredged channel will be much higher than in the surrounding shallower areas.

Results are generally presented as two scenarios based on showing impact of either:

A. "Short Duration":
   - A single blow (impact piling)
   - A one-second exposure (dredging, sheet piling and vessel noise).
   This is "instantaneous" impact, in the sense that an animal cannot swim away to avoid the noise.

B. "Long Duration" - One hours' activity:
   - 1200 blows (impact piling)
   - 3600 seconds (dredging, sheet piling and vessel noise).

This is cumulative impact, and we argue that an animal can leave the area in under an hour (1 m/s for 3600 seconds is 3.6 km – enough to leave the port area.)

12.2.4.6 Short Duration, TTS (single blow or one second)

Impulsive noise, TTS, Single Blow (Figure 12.2.8)

Fishes and OCW groups have negligible TTS risk ranges for a single blow, with the PCW group having typical (mean to 90th percentile) TTS risk ranges of 180 - 300 m. The VHF group has typical TTS risk ranges of 1700 - 2200 m, with a single location, the Ro-Ro ramp showing a TTS risk range to 2700 m along the dredged channel (extending to the entrance to Dublin Port, between the North and South wall). There is large variation in the modelled risk ranges due to variation in pile size, depth (2-10 m) and underwater geometry near the various sources (confined or more open) leading to a wide range on transmission losses in different directions.

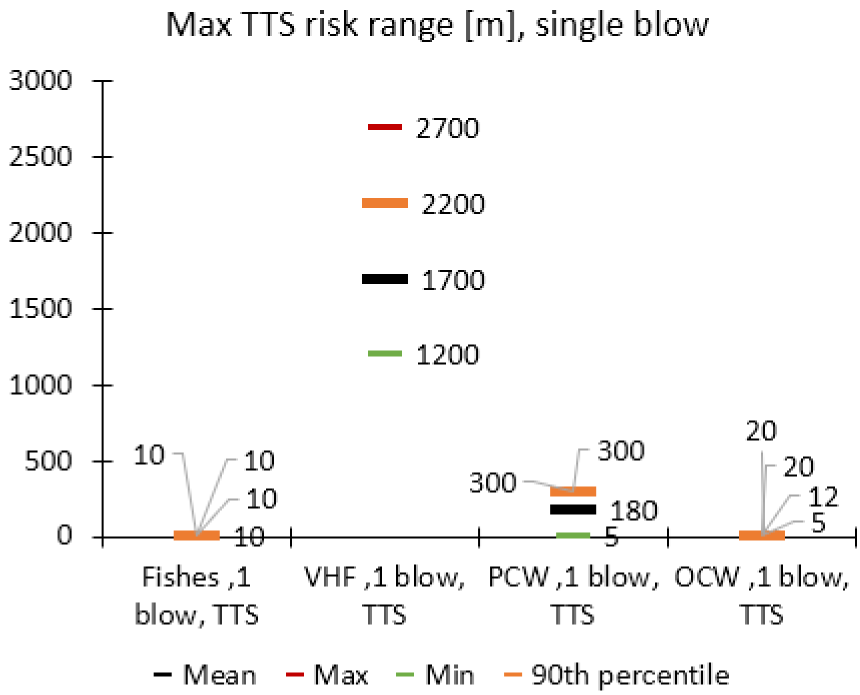

Figure 12.2.8 Overview of TTS risk ranges for a single blow for impact piling. Where no data is shown the range was under 5m.

Continuous Noise, TTS, 1 Second

For one second exposure none of the assessed hearing groups had TTS risk ranges >5m for Dredging or Vessel noise. The PCW group had TTS risk range of <20 m for Sheet piling and the VHF group <180 m.

12.2.4.7 Long Duration, TTS (1200 blows or one hour)

Impulsive noise, TTS, 1200 Blows (Figure 12.2.9)

Risk ranges for TTS for an hour for Fishes is typically 170 - 280 m, with a maximal risk range of 300 m.

Risk ranges for the OCW group after an hours’ exposure typically extend to 1000 - 1400 m.

The risk ranges for both the PCW and VHF group are limited by the extend of the port area and the North and South wall at the inlet to the Dublin port. Both groups are likely to have their TTS threshold exceeded throughout the modelled area, even in the shallower parts between the dredged channel and Bull Island (during high tide).

Note that “5000 m” and “3800 m” are limited by the modelled area (and extent of the port inside South and North wall).

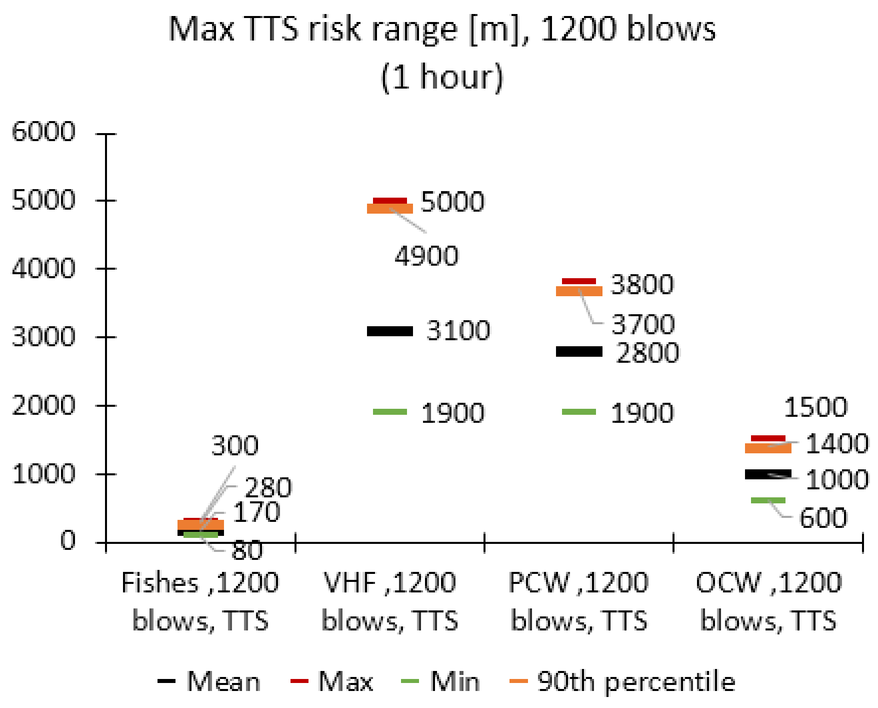

Figure 12.2.9 Overview of TTS risk ranges for 1200 blows for impact piling.

Continuous Noise, TTS, 1 Hour

None of the groups show measurable exceedances for the Vessel noise.

For dredging TTS ranges for the Fishes and OCW group are less than 5m while the PCW and VHF group show risk range of 30m and 90m respectively, for one hours’ exposure to dredging.

For Sheet piling the Fishes group show TTS risk ranges of approximately 5m.

The OCW group have risk ranges of 250 - 300m for Sheet piling.

The PCW group have TTS risk ranges to 2200 - 2400m for sheet piling and the VHF group’s risk ranges are again limited by the port enclosed area, with ranges extending to the Dublin port North and South wall.

12.2.4.8 Short Duration, PTS (Single blow or one second)

This section is included to facilitate comparison with other assessment that might use PTS as the main assessment criteria.

Impulsive Noise, PTS, Single Blow (Figure 12.2.10)

The Fishes and OCW group have risk ranges less than 5 m for single blows (their PTS limit is similar to or above the source level). The PCW group had some instances of significant PTS risk ranges (one at 100 m), but risk ranges generally around 30 m. The VHF group has significant PTS risk associated with the impact piling with single blow PTS risk to 500m for the Ro-Ro ramp for animals in the dredged channel. Typical risk ranges are 290 - 500m. There is large variation in the modelled risk ranges due to variation in pile size, depth (2-10m) and underwater geometry near the various sources (confined or more open) leading to a wide range on transmission losses in different directions.

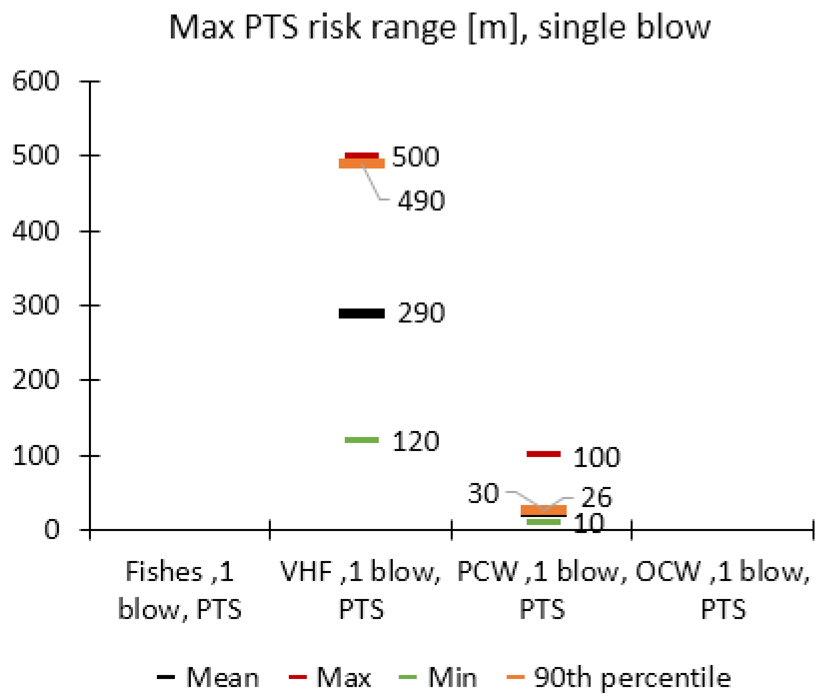

Figure 12.2.10. Overview of PTS risk ranges for a single blow for impact piling. Where no data is shown the range was under 5m.

Continuous Noise, PTS, 1 Second

None of the assessed hearing groups had PTS risk ranges >5m for Dredging, Sheet piling or Vessel noise.

12.2.4.9 Long Duration, PTS (1200 blows or one hour)

Impulsive Noise, PTS, 1200 blows (Figure 12.2.11)

Given the duration (1 hour, 1200 blows) the risk ranges for hearing groups Fishes and OCW are seen as negligible with maximal risk ranges of 150 m and 300 m respectively. For the PCW group animals will have to leave the dredged channel or port area to evade PTS risk, with typical risk ranges of 1400 - 1900 m. For the VHF group the shown risk ranges extent to the limits of the modelled area and the PTS threshold is exceeded for all areas inside the port walls (Dublin North Wall and South Wall).

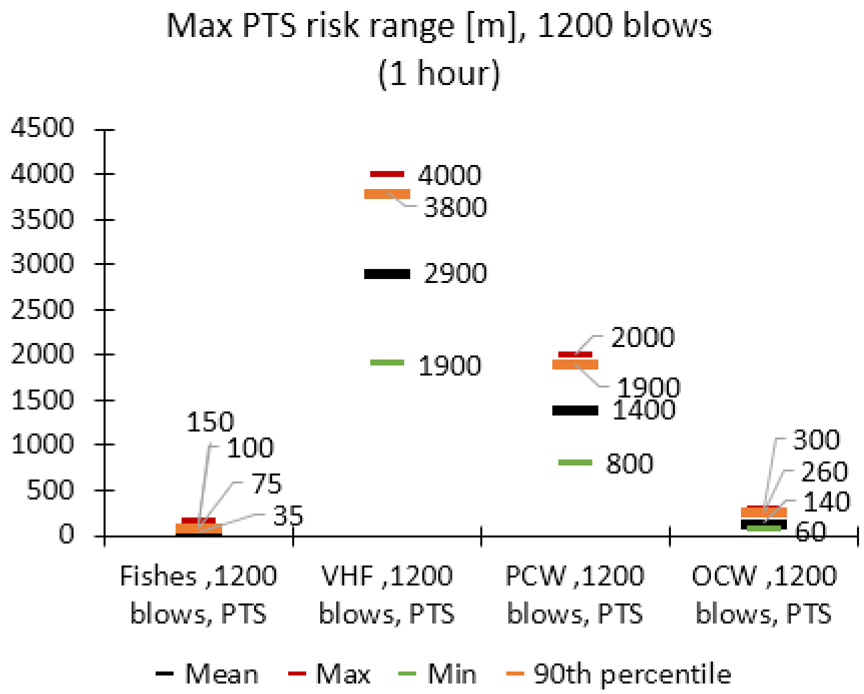

Figure 12.2.11 Overview of PTS risk ranges for 1200 blows for impact piling.

Continuous Noise, PTS, 1 Hour

None of the assessed hearing groups had PTS risk ranges >5m for dredging or vessel noise. The PCW group had PTS risk range of <250 m for sheet piling and the VHF group <1200.

12.2.5 Model Results Summary

In summary the results from modelling show:

1. TTS Limits for the VHF group will be exceeded to ranges up to 2700 m (PTS 500m) for single blows, meaning that a very large area should be free from porpoises before impact piling starts as animals cannot simply flee to avoid exceeding limits. For one hour’s activity (impact piling or vibro piling) any VHF group animal will have PTS limits exceeded if remaining inside the port (as limited by the North and South wall).
2. The PCW group (seals) will have limits exceeded to significant ranges for an hour’s exposure, with TTS risk throughout the port area (PTS risk to approximately 1km).
3. The Fishes group and OCW group (otter) have little to no risk of exceeding their TTS (or PTS) limits during impact piling unless stationary and close to the piling for longer durations (30 - 60minutes). For the largest pile at the Ro-Ro ramp, the Fishes group TTS range for 1 blow is less than 5m, for 10min/200 blows the TTS range is approximately 50m, for 30min/600 blows the TTS range is approximately 100m and for 60min/1200 blows the TTS range is approximately 300m.

Incorporating moving receivers (fleeing response) did not change the above results significantly and have not been pursued further (i.e. the moving receiver would need to start fleeing at ranges comparable to the given TTS/PTS ranges for stationary receivers).

The results presented are a worst-case representation covering the locations/areas with piling and the results are valid for comparable pile sizes and similar locations should the final installation plan change.

12.2.6 Maximal ranges for TTS and PTS risk

In the following the *max* risk ranges for TTS and PTS exceedance are listed in Table 12.2.11 to Table 12.2.27 ordered by the source location or activity. Visual model outputs are provided for max ranges for impact piling. The max range is generally representative for the range along the main channel, but not across the channel, where the shallower water will lead to shorter ranges.

There is large variation in the modelled risk ranges due to variation in pile size, depth (2-10m) and underwater geometry near the various sources (confined or more open) leading to a wide range on transmission losses in different directions.

Table 12.2.11 Max ranges for dredging at the turning circle.

Dredging – Turning Circle					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Dredging	1 second	Turning circle	Fishes	<10	<10
Dredging	1 second	Turning circle	VHF	<10	<10
Dredging	1 second	Turning circle	PCW	<10	<10
Dredging	1 second	Turning circle	OCW	<10	<10
Dredging	1 hour	Turning circle	Fishes	<10	<10
Dredging	1 hour	Turning circle	VHF	90	<10
Dredging	1 hour	Turning circle	PCW	30	<10
Dredging	1 hour	Turning circle	OCW	<10	<10

Table 12.2.12 Max ranges for Impact piling at the SPAR Bridge. (see Figure 12.2.12 and Figure 12.2.13)

Impact Piling – SPAR Bridge					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	SPAR	Fishes	<10	<10
Impact piling	1 blow	SPAR	VHF	1400	250
Impact piling	1 blow	SPAR	PCW	5	100
Impact piling	1 blow	SPAR	OCW	5	<10
Impact piling	1200 blows	SPAR	Fishes	50	80
Impact piling	1200 blows	SPAR	VHF	5000	4000
Impact piling	1200 blows	SPAR	PCW	3200	1000
Impact piling	1200 blows	SPAR	OCW	900	70

Figure 12.2.12. Impact piling, SPAR Bridge, Fish (unweighted) and OCW hearing group.

Figure 12.2.13. Impact piling, SPAR Bridge, VHF and PCW hearing group.

Table 12.2.13 Max ranges for vibration piling at the SPAR road, west.

Vibro Piling – SPAR Viaduct road, West					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Vibration piling	1 second	SPAR viaduct, west	Fishes	<10	<10
Vibration piling	1 second	SPAR viaduct, west	VHF	10	<10
Vibration piling	1 second	SPAR viaduct, west	PCW	10	<10
Vibration piling	1 second	SPAR viaduct, west	OCW	<10	<10
Vibration piling	1 hour	SPAR viaduct, west	Fishes	20	<10
Vibration piling	1 hour	SPAR viaduct, west	VHF	650	30
Vibration piling	1 hour	SPAR viaduct, west	PCW	400	30
Vibration piling	1 hour	SPAR viaduct, west	OCW	30	10

Table 12.2.14 Max ranges for vibration piling at the SPAR road, east.

Vibro Piling – SPAR Viaduct road, East					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Vibration piling	1 second	SPAR viaduct, east	Fishes	<10	<10
Vibration piling	1 second	SPAR viaduct, east	VHF	10	<10
Vibration piling	1 second	SPAR viaduct, east	PCW	10	<10
Vibration piling	1 second	SPAR viaduct, east	OCW	<10	<10
Vibration piling	1 hour	SPAR viaduct, east	Fishes	20	<10
Vibration piling	1 hour	SPAR viaduct, east	VHF	1000	50
Vibration piling	1 hour	SPAR viaduct, east	PCW	450	30
Vibration piling	1 hour	SPAR viaduct, east	OCW	30	10

Table 12.2.15 Max ranges for impact piling at the Marina. (see Figure 12.2.14 and Figure 12.2.15)

Impact Piling - Marina					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Marina	Fishes	<10	<10
Impact piling	1 blow	Marina	VHF	1200	200
Impact piling	1 blow	Marina	PCW	100	10
Impact piling	1 blow	Marina	OCW	5	<10
Impact piling	1200 blows	Marina	Fishes	80	40
Impact piling	1200 blows	Marina	VHF	5000	3800
Impact piling	1200 blows	Marina	PCW	3700	800
Impact piling	1200 blows	Marina	OCW	700	80

Figure 12.2.14. Impact piling, Marina, Fish (unweighted) and OCW hearing group.

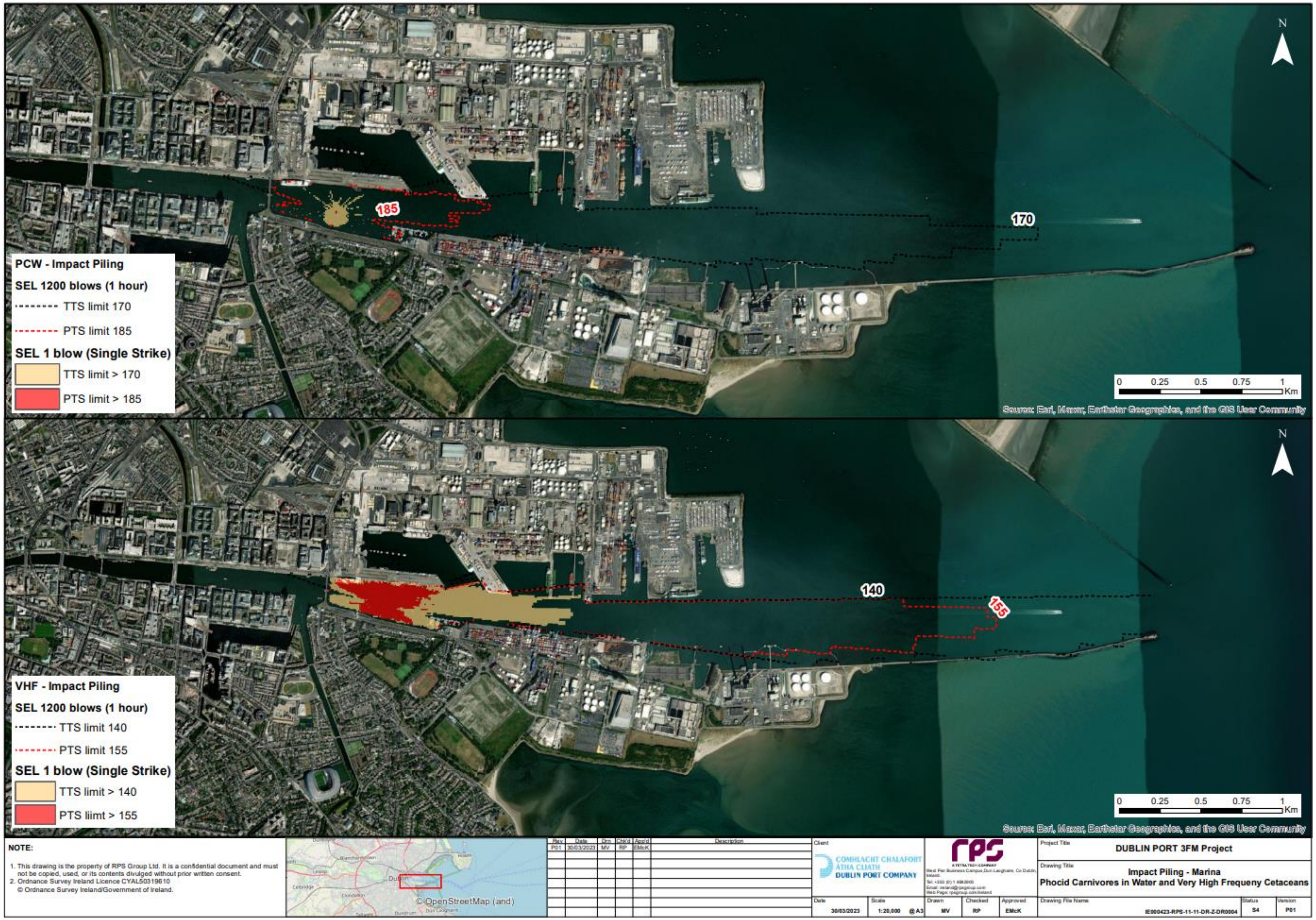

Figure 12.2.15. Impact piling, Marina, VHF and PCW hearing group.

Table 12.2.16 Max ranges for impact piling at the Ro-Ro ramps. (see Figure 12.2.16 and Figure 12.2.17)

Impact Piling – Ro-Ro Ramp					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Ro-Ro	Fishes	<10	<10
Impact piling	1 blow	Ro-Ro	VHF	2700	500
Impact piling	1 blow	Ro-Ro	PCW	300	20
Impact piling	1 blow	Ro-Ro	OCW	20	<10
Impact piling	1200 blows	Ro-Ro	Fishes	300	90
Impact piling	1200 blows	Ro-Ro	VHF	3800	3800
Impact piling	1200 blows	Ro-Ro	PCW	3800	1900
Impact piling	1200 blows	Ro-Ro	OCW	1200	300

Figure 12.2.16. Impact piling, RO-RO ramp, Fish (unweighted) and OCW hearing group.

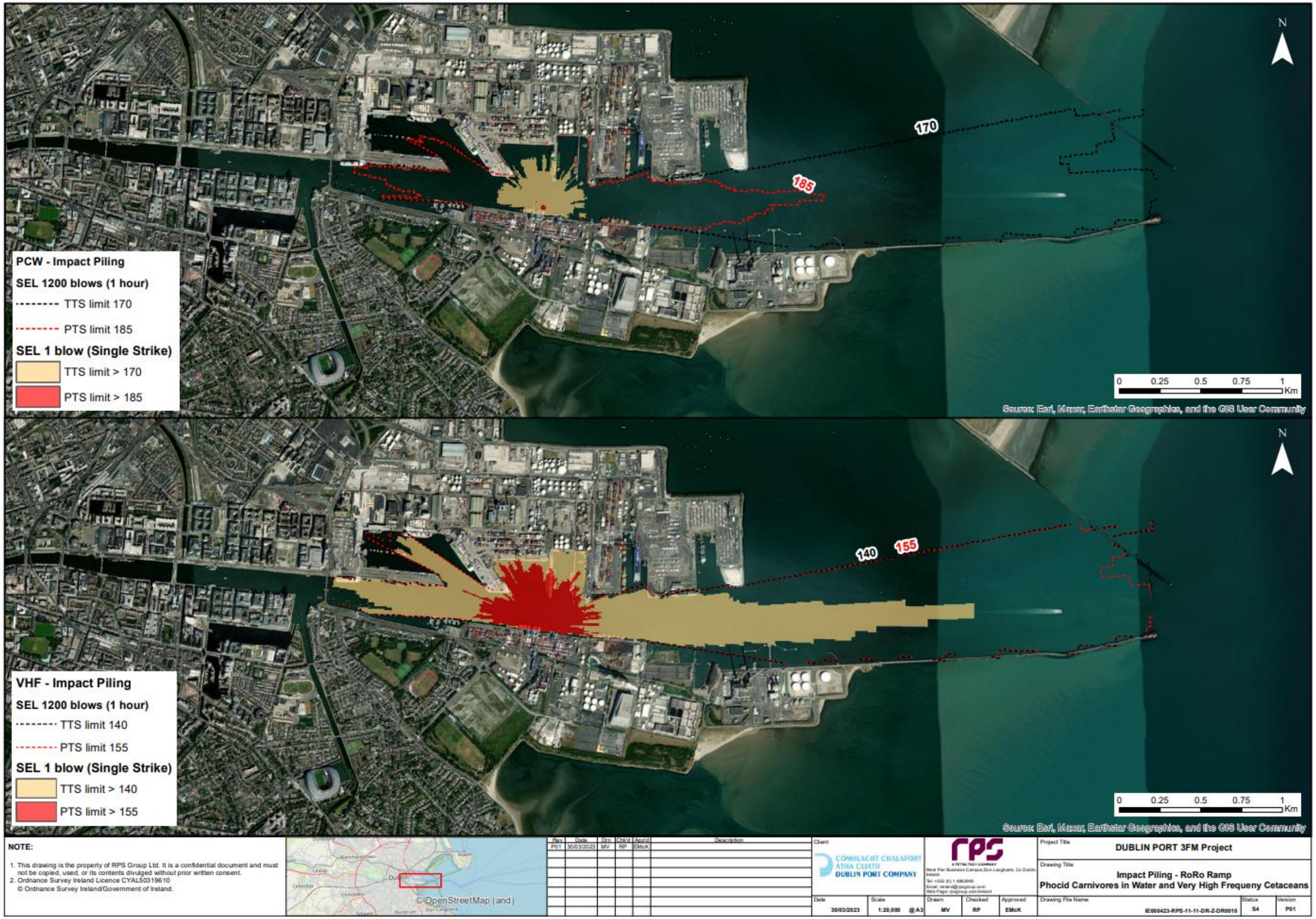

Figure 12.2.17 Impact piling, RO-RO ramp, VHF and PCW hearing group.

Table 12.2.17 Max ranges for impact piling at Area K. (see Figure 12.2.18 and Figure 12.2.19)

Impact piling – Area K, Refronting works,					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Area K, refronting	Fishes	<10	<10
Impact piling	1 blow	Area K, refronting	VHF	2000	500
Impact piling	1 blow	Area K, refronting	PCW	300	20
Impact piling	1 blow	Area K, refronting	OCW	20	<10
Impact piling	1200 blows	Area K, refronting	Fishes	250	100
Impact piling	1200 blows	Area K, refronting	VHF	3500	3500
Impact piling	1200 blows	Area K, refronting	PCW	3500	1700
Impact piling	1200 blows	Area K, refronting	OCW	1300	200

Figure 12.2.18. Impact piling, Area K, Fish (unweighted) and OCW hearing group.

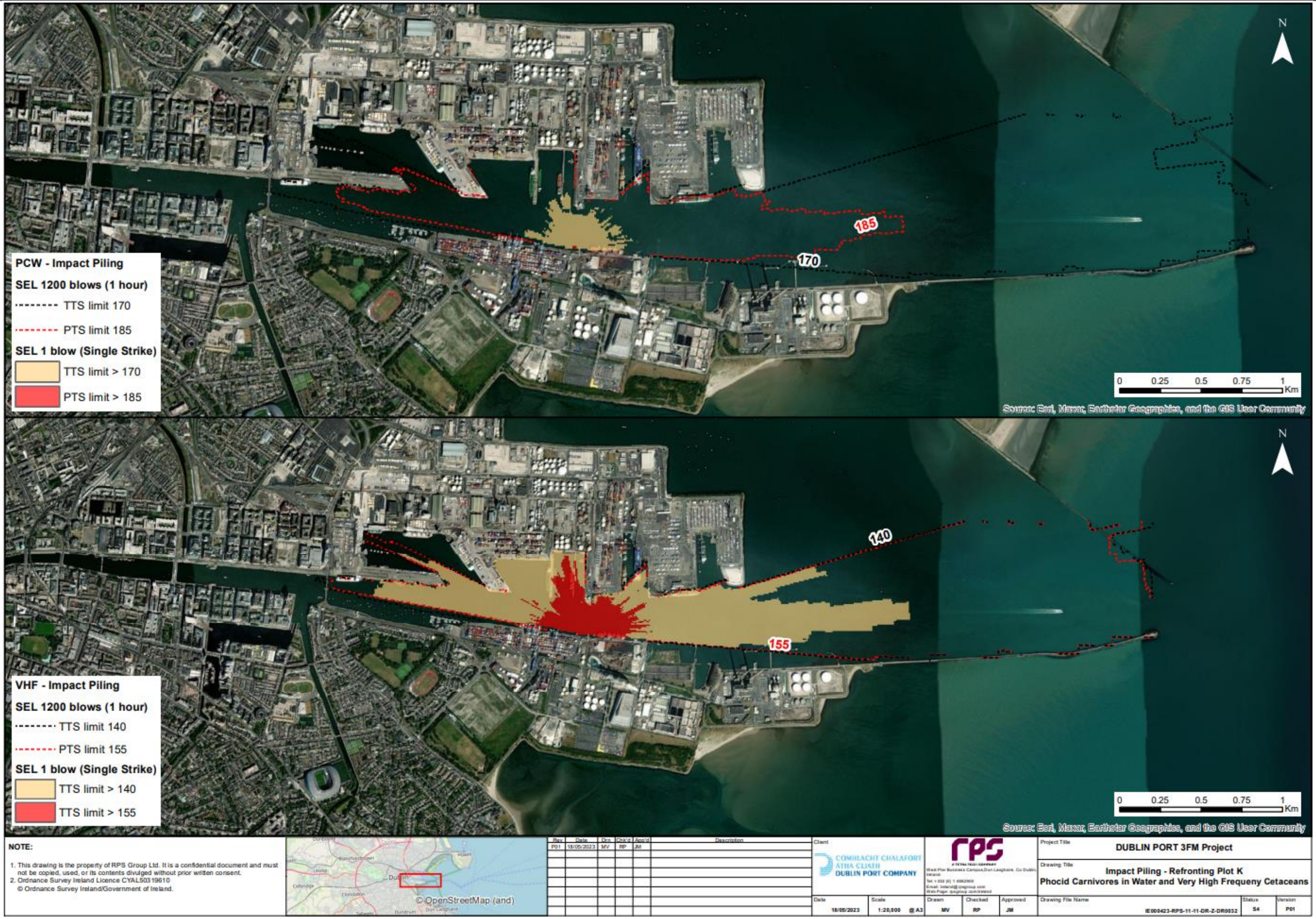

Figure 12.2.19. Impact piling, Area K, VHF and PCW hearing group.

Table 12.2.18 Max ranges for vibration piling at Area K.

Area K, Refronting works, Vibro piling					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Vibration piling	1 second	Area K, refronting	Fishes	<10	<10
Vibration piling	1 second	Area K, refronting	VHF	300	<10
Vibration piling	1 second	Area K, refronting	PCW	50	<10
Vibration piling	1 second	Area K, refronting	OCW	<10	<10
Vibration piling	1 hour	Area K, refronting	Fishes	40	<10
Vibration piling	1 hour	Area K, refronting	VHF	3500	1700
Vibration piling	1 hour	Area K, refronting	PCW	3200	300
Vibration piling	1 hour	Area K, refronting	OCW	500	25

Table 12.2.19 Max ranges for impact piling at Area N, single rig, west. (see Figure 12.2.20 and Figure 12.2.21)

Impact Piling – Area N West					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Area N West	Fishes	<10	<10
Impact piling	1 blow	Area N West	VHF	1500	300
Impact piling	1 blow	Area N West	PCW	250	20
Impact piling	1 blow	Area N West	OCW	5	<10
Impact piling	1200 blows	Area N West	Fishes	150	80
Impact piling	1200 blows	Area N West	VHF	2600	2600
Impact piling	1200 blows	Area N West	PCW	2600	1200
Impact piling	1200 blows	Area N West	OCW	1000	100

Figure 12.2.20. Impact piling, Area N west, Single piling rig, Fish (unweighted) and OCW hearing group.

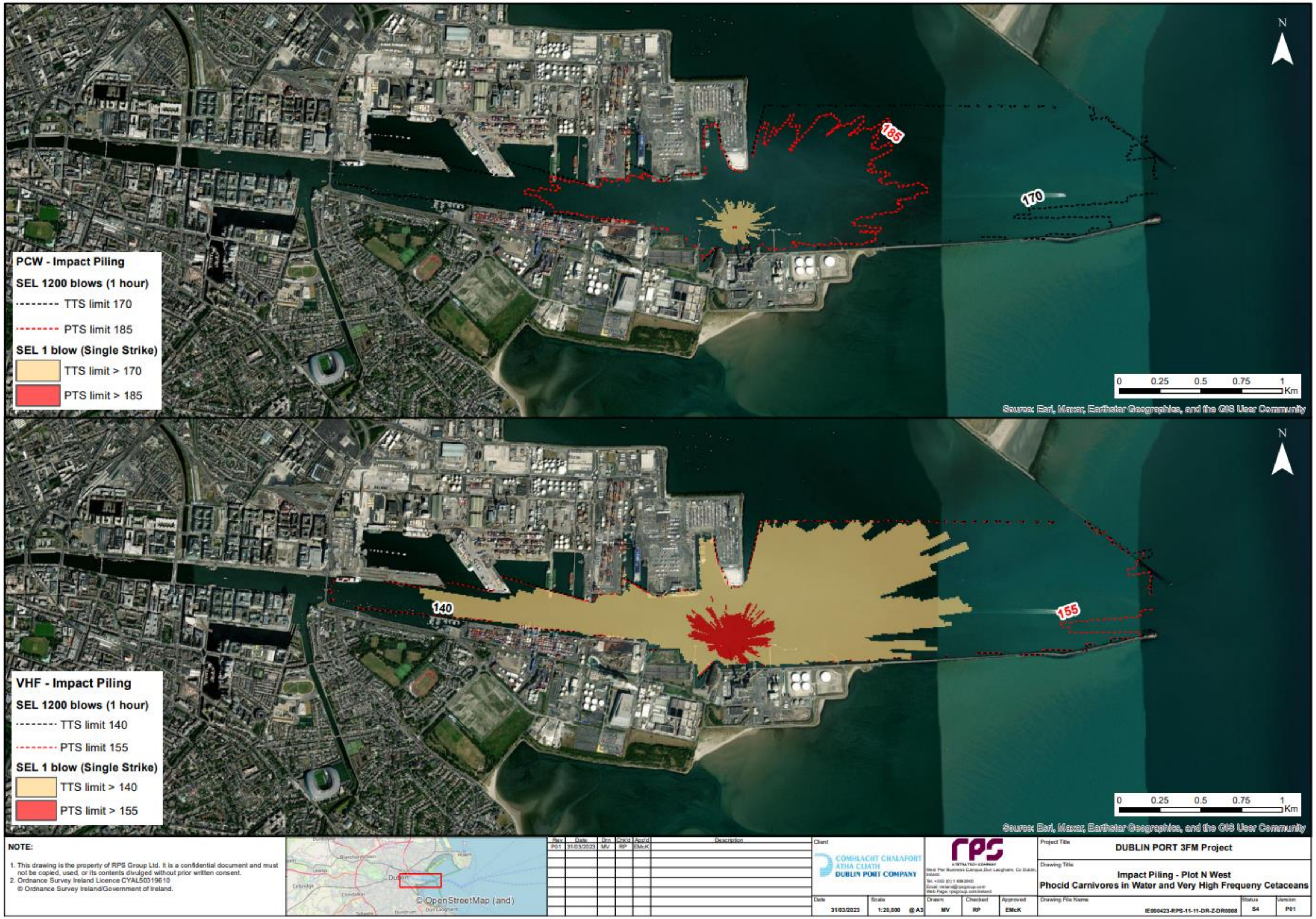

Figure 12.2.21. Impact piling, Area N west, Single piling rig, VHF and PCW hearing group.

Table 12.2.20 Max ranges for impact piling at Area N, single rig, middle location. (see Figure 12.2.22 and Figure 12.2.23)

Impact Piling – Area N Mid					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Area N Mid	Fishes	<10	<10
Impact piling	1 blow	Area N Mid	VHF	1300	200
Impact piling	1 blow	Area N Mid	PCW	100	20
Impact piling	1 blow	Area N Mid	OCW	<10	<10
Impact piling	1200 blows	Area N Mid	Fishes	100	60
Impact piling	1200 blows	Area N Mid	VHF	2400	2400
Impact piling	1200 blows	Area N Mid	PCW	2400	1000
Impact piling	1200 blows	Area N Mid	OCW	700	60

Figure 12.2.22. Impact piling, Area N middle, Single piling rig, Fish (unweighted) and OCW hearing group.

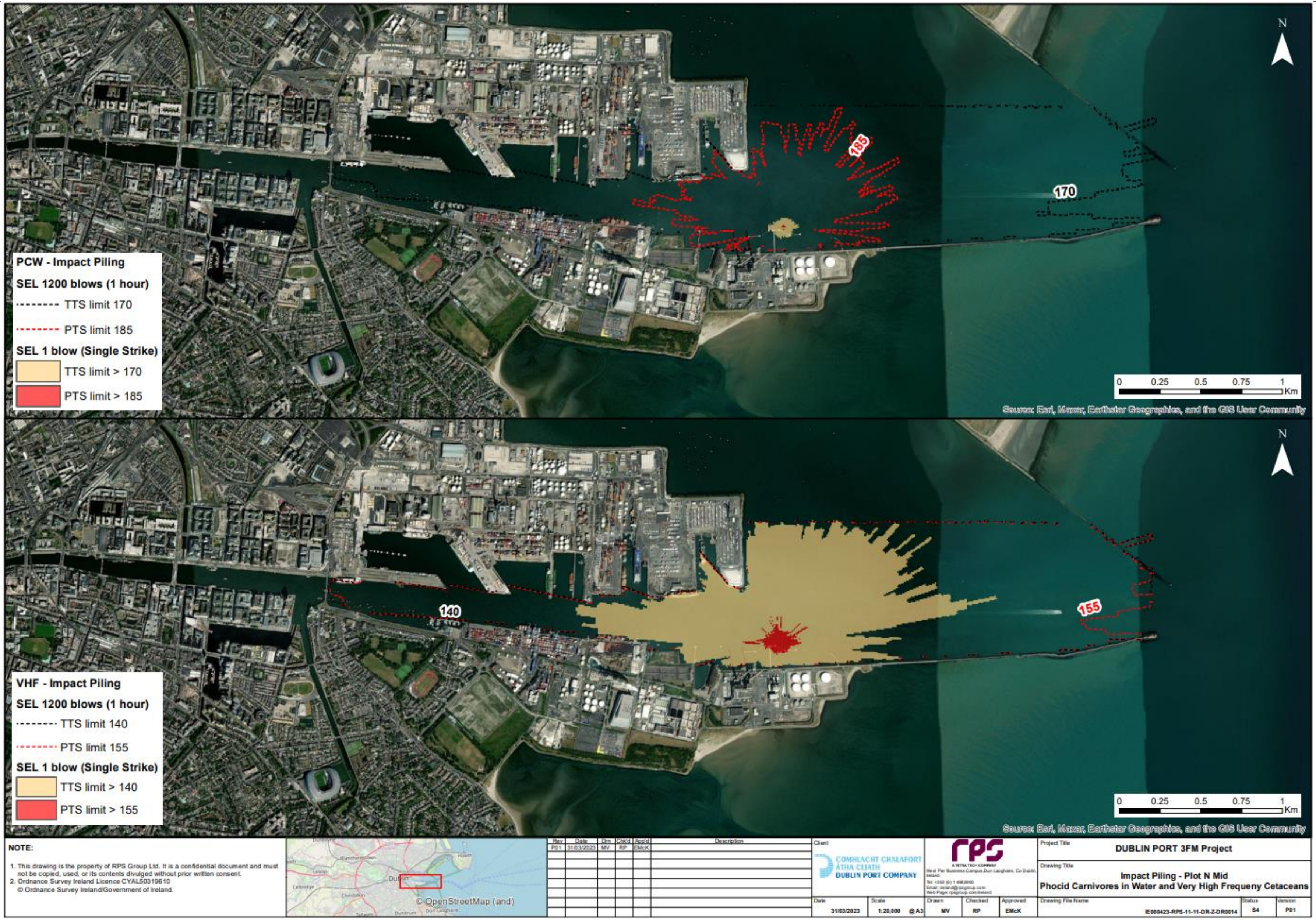

Figure 12.2.23. Impact piling, Area N middle, Single piling rig, VHF and PCW hearing group.

Table 12.2.21 Max ranges for impact piling at Area N, single rig, east. (see Figure 12.2.24 and Figure 12.2.25)

Impact Piling – Area N East					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Area N East	Fishes	<10	<10
Impact piling	1 blow	Area N East	VHF	1500	250
Impact piling	1 blow	Area N East	PCW	150	20
Impact piling	1 blow	Area N East	OCW	10	<10
Impact piling	1200 blows	Area N East	Fishes	160	70
Impact piling	1200 blows	Area N East	VHF	2000	2000
Impact piling	1200 blows	Area N East	PCW	2000	1500
Impact piling	1200 blows	Area N East	OCW	700	70

Figure 12.2.24. Impact piling, Area N east, Single piling rig, Fish (unweighted) and OCW hearing group.

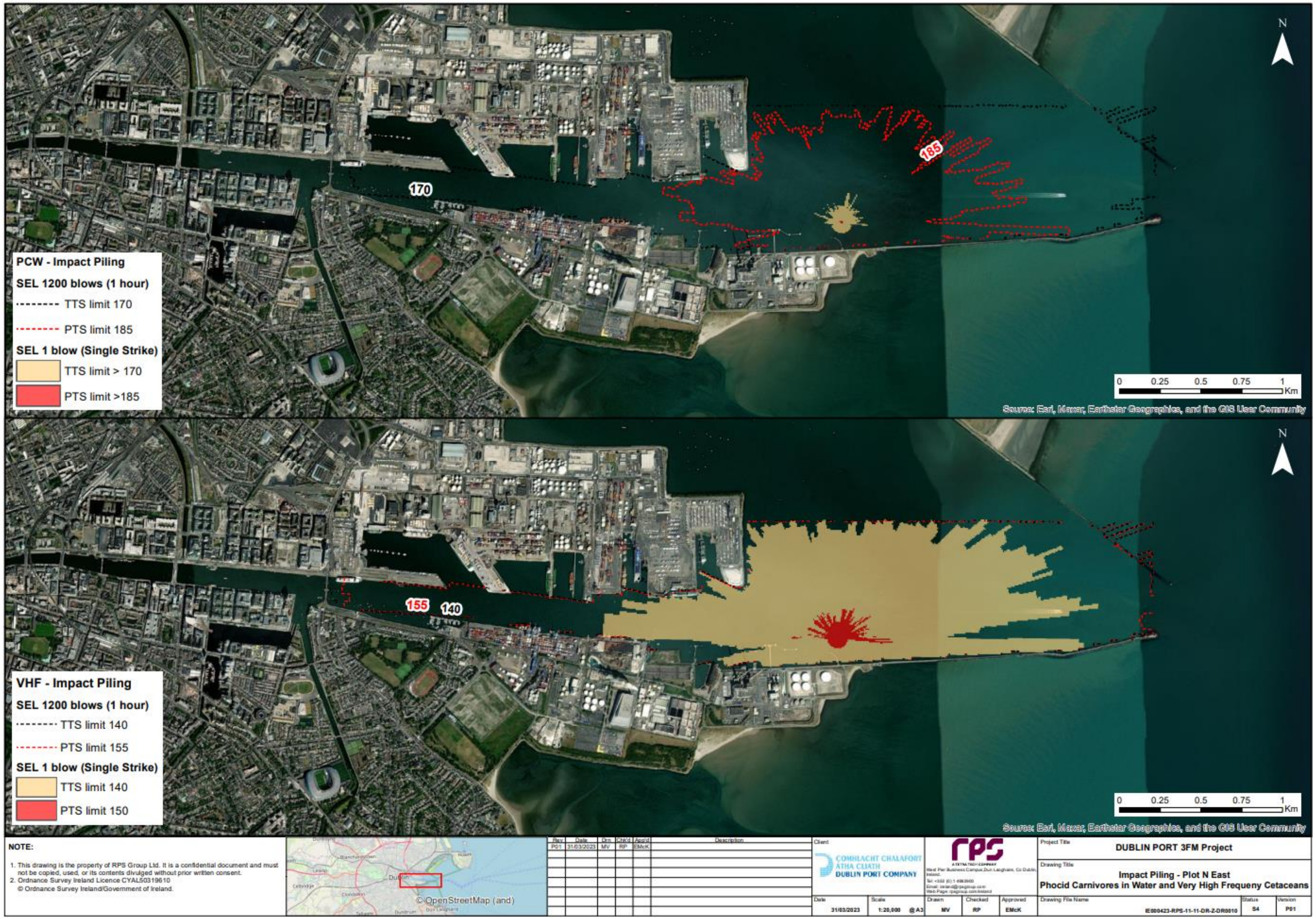

Figure 12.2.25. Impact piling, Area N east, Single piling rig, VHF and PCW hearing group.

Table 12.2.22 Max ranges for impact piling at Area N, 2 rigs simultaneously. (see Figure 12.2.26 and Figure 12.2.27)

Impact Piling – Area N Cumulative					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Area N Cumulative	Fishes	<10	<10
Impact piling	1 blow	Area N Cumulative	VHF	1400	250
Impact piling	1 blow	Area N Cumulative	PCW	100	15
Impact piling	1 blow	Area N Cumulative	OCW	<10	<10
Impact piling	1200 blows	Area N Cumulative	Fishes	180	60
Impact piling	1200 blows	Area N Cumulative	VHF	2000	2000
Impact piling	1200 blows	Area N Cumulative	PCW	2000	1500
Impact piling	1200 blows	Area N Cumulative	OCW	1000	100

Figure 12.2.26. Impact piling, Area N west + east, two piling rigs, Fish (unweighted) and OCW hearing group.

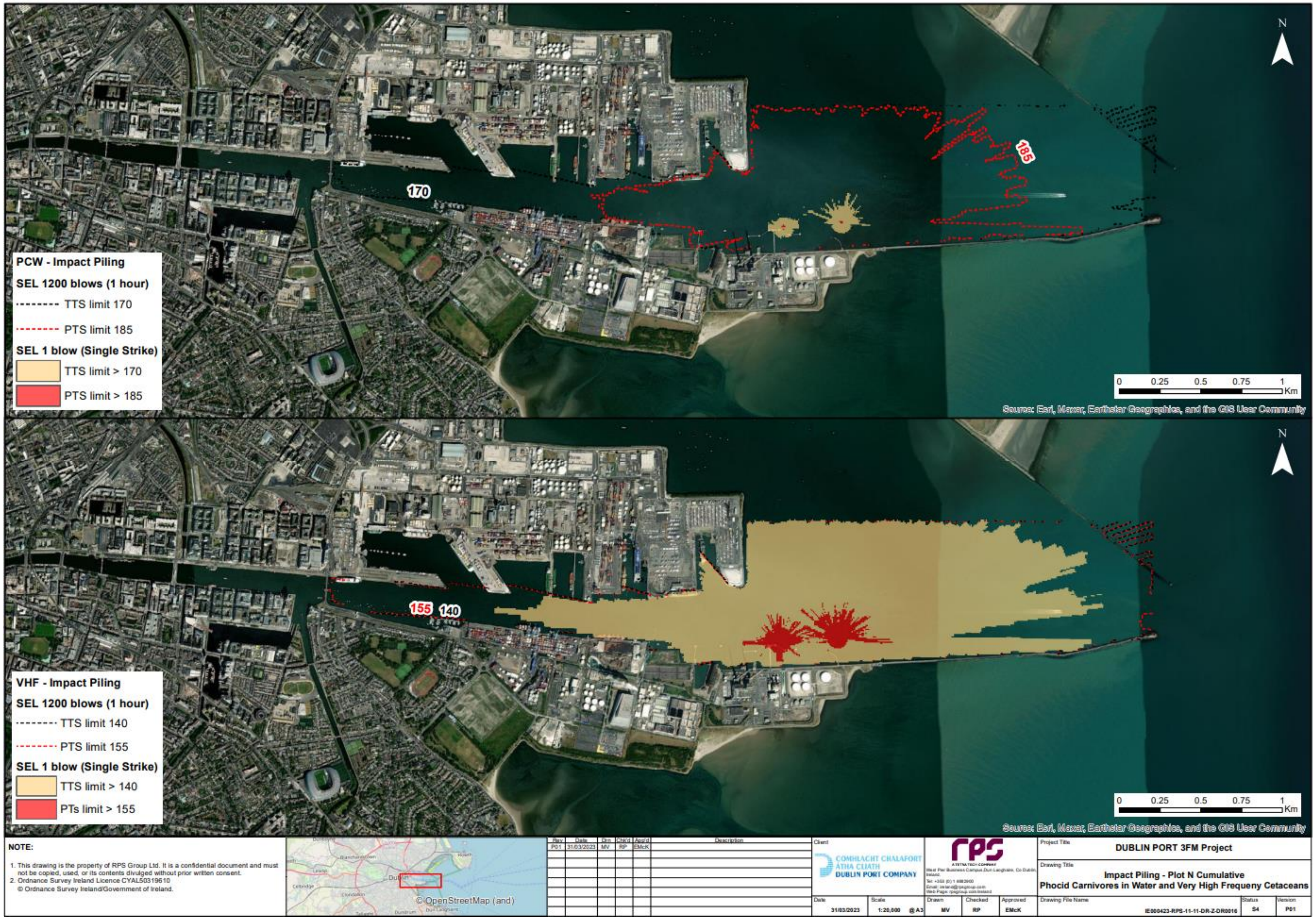

Figure 12.2.27. Impact piling, Area N west + east, two piling rigs, VHF and PCW hearing group.

Table 12.2.23 Max ranges for impact piling at Area N, 5 rigs simultaneously. (see Figure 12.2.28 and Figure 12.2.29)

Impact Piling – Area, N 5 rigs simultaneous					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Area N x4	Fishes	10	<10
Impact piling	1 blow	Area N x4	VHF	2000	400
Impact piling	1 blow	Area N x4	PCW	250	30
Impact piling	1 blow	Area N x4	OCW	20	<10
Impact piling	1200 blows	Area N x4	Fishes	280	150
Impact piling	1200 blows	Area N x4	VHF	2000	2000
Impact piling	1200 blows	Area N x4	PCW	2000	2000
Impact piling	1200 blows	Area N x4	OCW	1500	250

Figure 12.2.28. Impact piling, Area N, five piling rigs, Fish (unweighted) and OCW hearing group.

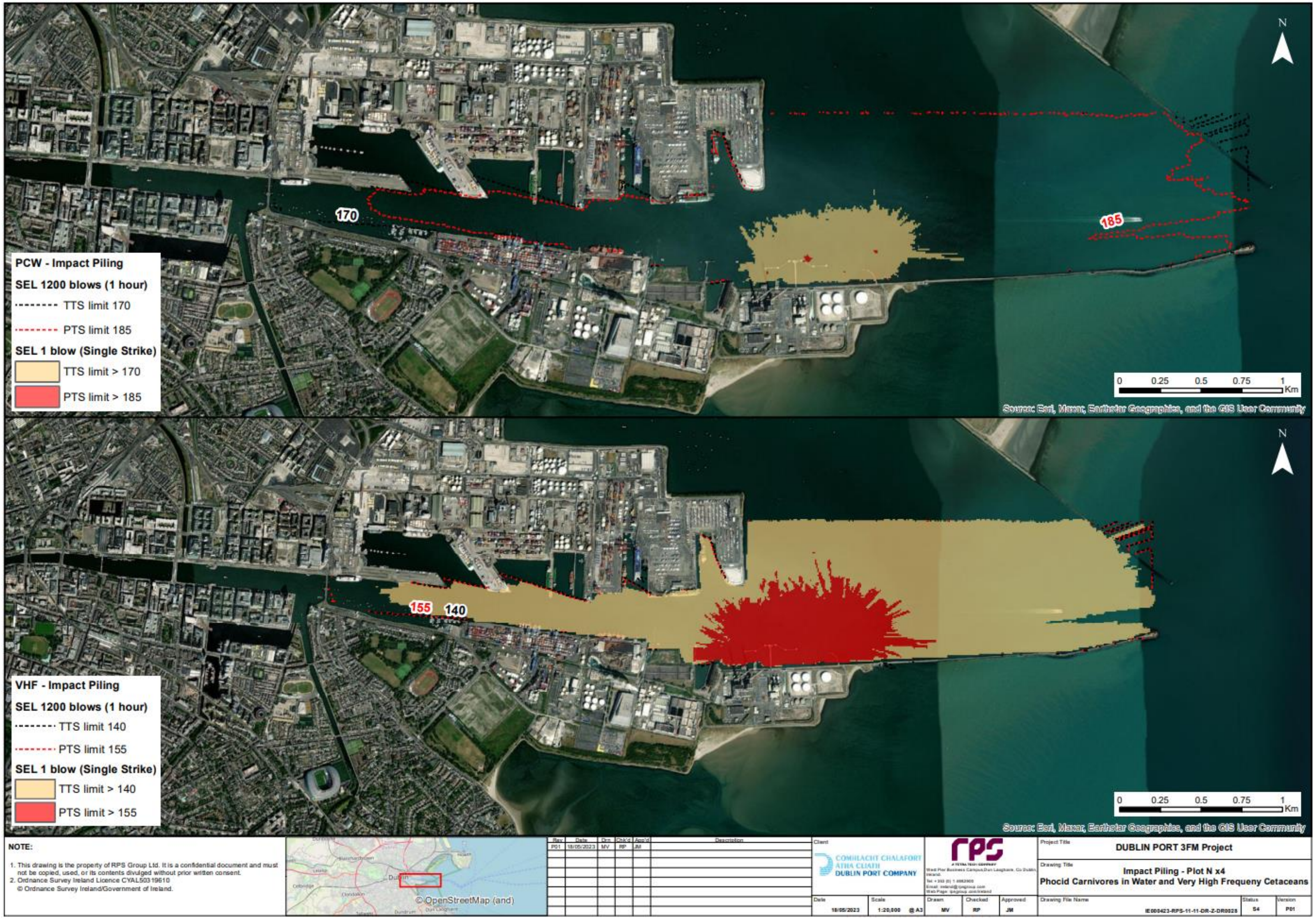

Figure 12.2.29. Impact piling, Area N, five piling rigs, VHF and PCW hearing group.

Table 12.2.24 Max ranges for impact piling at NORA Dolphin. (see Figure 12.2.30 and Figure 12.2.31)

Impact Piling – NORA Dolphin					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	NORA	Fishes	<10	<10
Impact piling	1 blow	NORA	VHF	1500	120
Impact piling	1 blow	NORA	PCW	100	<10
Impact piling	1 blow	NORA	OCW	<10	<10
Impact piling	1200 blows	NORA	Fishes	100	60
Impact piling	1200 blows	NORA	VHF	1900	1900
Impact piling	1200 blows	NORA	PCW	1900	1000
Impact piling	1200 blows	NORA	OCW	600	80

Figure 12.2.30. Impact piling, NORA Dolphin, Fish (unweighted) and OCW hearing group.

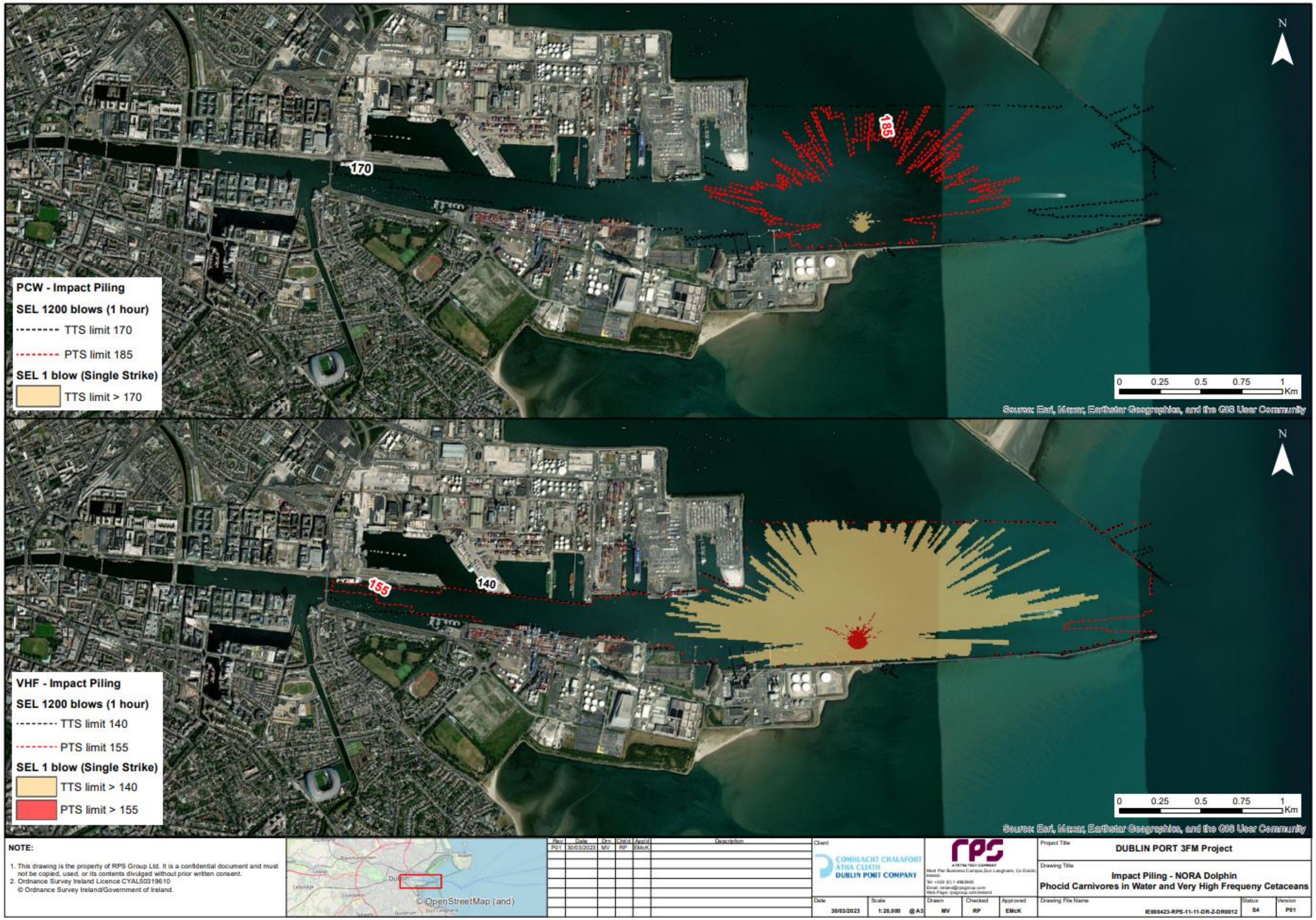

Figure 12.2.31. Impact piling, NORA Dolphin, VHF and PCW hearing group.

Table 12.2.25 Max ranges for vessel noise in main channel, location 1.

Vessel Noise - Channel					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Shipping 1	1 second	Near NORA dolphin	Fishes	<10	<10
Shipping 1	1 second	Near NORA dolphin	VHF	<10	<10
Shipping 1	1 second	Near NORA dolphin	PCW	<10	<10
Shipping 1	1 second	Near NORA dolphin	OCW	<10	<10
Shipping 1	1 hour	Near NORA dolphin	Fishes	<10	<10
Shipping 1	1 hour	Near NORA dolphin	VHF	<10	<10
Shipping 1	1 hour	Near NORA dolphin	PCW	<10	<10
Shipping 1	1 hour	Near NORA dolphin	OCW	<10	<10

Table 12.2.26 Max ranges for vessel noise in main channel, location 2.

Vessel Noise - Channel					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Shipping 2	1 second	Near Ro-Ro ramp	Fishes	<10	<10
Shipping 2	1 second	Near Ro-Ro ramp	VHF	<10	<10
Shipping 2	1 second	Near Ro-Ro ramp	PCW	<10	<10
Shipping 2	1 second	Near Ro-Ro ramp	OCW	<10	<10
Shipping 2	1 hour	Near Ro-Ro ramp	Fishes	<10	<10
Shipping 2	1 hour	Near Ro-Ro ramp	VHF	<10	<10
Shipping 2	1 hour	Near Ro-Ro ramp	PCW	<10	<10
Shipping 2	1 hour	Near Ro-Ro ramp	OCW	<10	<10

Table 12.2.27 Max ranges for dredging noise at Berth 45.

Dredging Noise - Channel					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Dredging	1 second	Berth 45	Fishes	<10	<10
Dredging	1 second	Berth 45	VHF	<10	<10
Dredging	1 second	Berth 45	PCW	<10	<10
Dredging	1 second	Berth 45	OCW	<10	<10
Dredging	1 hour	Berth 45	Fishes	<10	<10
Dredging	1 hour	Berth 45	VHF	50	<10
Dredging	1 hour	Berth 45	PCW	10	<10
Dredging	1 hour	Berth 45	OCW	<10	<10

Table 12.2.28 Max ranges for impact piling at Turning Circle. (see Figure 12.2.32 and Figure 12.2.33)

Dredging Noise - Channel					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Turning Circle	Fishes	<10	<10
Impact piling	1 blow	Turning Circle	VHF	2200	300
Impact piling	1 blow	Turning Circle	PCW	300	20
Impact piling	1 blow	Turning Circle	OCW	<10	<10
Impact piling	1200 blows	Turning Circle	Fishes	280	100
Impact piling	1200 blows	Turning Circle	VHF	3000	3000
Impact piling	1200 blows	Turning Circle	PCW	3000	1600
Impact piling	1200 blows	Turning Circle	OCW	1400	260

Figure 12.2.32. Impact piling, Turning circle, Fish (unweighted) and OCW hearing group.

Figure 12.2.33. Impact piling, Turning circle, VHF and PCW hearing group.

Table 12.2.29 Max ranges for vibration piling of sheet piles at Turning Circle.

Dredging Noise - Channel					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Vibration piling	1 second	Turning Circle	Fishes	<10	<10
Vibration piling	1 second	Turning Circle	VHF	1000	20
Vibration piling	1 second	Turning Circle	PCW	70	<10
Vibration piling	1 second	Turning Circle	OCW	<10	<10
Vibration piling	1 hour	Turning Circle	Fishes	60	<10
Vibration piling	1 hour	Turning Circle	VHF	3000	2800
Vibration piling	1 hour	Turning Circle	PCW	3000	600
Vibration piling	1 hour	Turning Circle	OCW	1000	20

Table 12.2.30 Max ranges for impact piling at Tern Colony. (see Figure 12.2.34 and Figure 12.2.35)

Dredging Noise - Channel					
Activity	**Duration/blowcount**	**Location name**	**Group**	**TTS risk range**	**PTS risk range**
Impact piling	1 blow	Berth 45	Fishes	<10	<10
Impact piling	1 blow	Berth 45	VHF	1350	210
Impact piling	1 blow	Berth 45	PCW	150	10
Impact piling	1 blow	Berth 45	OCW	<10	<10
Impact piling	1200 blows	Berth 45	Fishes	90	35
Impact piling	1200 blows	Berth 45	VHF	3800	3400
Impact piling	1200 blows	Berth 45	PCW	3100	1200
Impact piling	1200 blows	Berth 45	OCW	1000	80

Figure 12.2.34. Impact piling, Tern Colony, Fish (unweighted) and OCW hearing group.

Figure 12.2.35. Impact piling, Tern Colony, VHF and PCW hearing group.

12.2.7 Cumulative Impacts

DPC has considered the phasing of the 3FM Project with riverside construction works associated with the ABR Project and the MP2 Project.

- ABR Project – Riverside construction works are at an advanced stage and will be completed prior to commencement of the 3FM Project. No cumulative impact is therefore envisaged.
- MP2 Project – Construction of riverside Berths 52 & 53 are expected to commence in 2023. This elements of the MP2 Project will be completed prior to commencement of the 3FM Project. No cumulative impact is therefore envisaged for this element of the MP2 Project. The MP2 Project however also requires riverside works on the North Port at Berth 50A and Oil Berth 3 which is scheduled to commence in 2028. DPC will ensure that piling at Area K, opposite to these Berths, does not take place at the same time. This mitigation measure will ensure no cumulative impact.
- Shipping Traffic - The underwater noise impact of shipping traffic in and out of Dublin Port has been quantified in the baseline measurements and modelled. The cumulative impact of these existing underwater noise sources does not alter the impact of the proposed 3FM Project.

Other projects which have the potential to cause a cumulative impact comprise the following:

- Replacement of elements of the ESB/ Uisce Éireann Discharge Channel adjacent to ESB Poolbeg Generating Station – Further to consultation with ESB and Irish Water it is expected that these works will be completed prior to commencement of the 3FM Project. No cumulative impact is therefore envisaged,
- Proposals for Point Bridge (upstream of Tom Clarke Bridge) and Dodder Bridge – These projects are being developed by Dublin City Council (DCC). They are at an early stage in the design process and have not been advanced to planning. Nevertheless, it is likely that the timeframe for these projects will overlap with the 3FM Project. DPC, in consultation with DCC, will ensure that piling at the SPAR Bridge and Point Bridge/Dodder Bridge does not take place at the same time. This mitigation measure will ensure no cumulative impact.

12.2.8 Mitigation Measures

12.2.8.1 Construction Phase

Noise levels arising during the construction phase are significant, especially compared to the limits of the PCW and VHF groups (seals and porpoises) with likely significant hearing impact (TTS) and hearing injury (PTS) following impact piling if present inside the port (inside the South and North wall). The most significant impacts will arise during:

- Impact piling at the proposed Ro-Ro ramps at Area K using 2.4m diameter guide piles.
- Impact piling at Area N, with the potential use of five piling rigs simultaneously.
- Impact piling at the NORA dolphin, given its proximity to the dredged channel.

Levels inside the South and North Walls will exceed both the PTS and TTS limit for the VHF group (harbour porpoises) for the whole port area within an hour (1200 blows) and for the PCW hearing group (seals), the TTS threshold will be exceeded throughout the port, with the PTS limit exceeded to approximately 1km range. Given the above, a range of mitigation measures will be implemented during the construction works. Table 12.2.31 presents a summary of the mitigation measures.

Table 12.2.31 Table of Proposed Mitigation

Impact/Concern	Magnitude	Significance	Proposed Mitigation
Hearing injury or serios impact from underwater noise from impact piling. PCW and VHF groups.	Significant increase in impulsive noise capable of causing serious hearing impact or injury.	Severe risk of exceedance of TTS and PTS limits for VHF and PCW hearing groups.	Marine Mammal Observer to scan prior to impact pile driving in accordance with NPWS guidelines for impact piling, and seek to verify that there are no porpoises within the port walls before impact piling starts and that seals are 1000 m from the piling site. During impact piling at NORA dolphin, Ro-Ro ramp, and “Area N” an additional MMO will be present on the easternmost part pf Dublin Port, north of the Liffey to monitor animals fleeing into the shallow water north of the channel. Use of slow starts of impact piling after MMO verified absence of animals, 30 second inter-blow-intervals for impact piling unless results from monitoring show modelled levels to be higher than real levels.
Fish migration	Assuming fish response to TTS levels, potential intermittent impact on movement upriver.	Slight to none, TTS limits are only exceeded to <50 m for 10 min continuous impact piling (worst case)	Exclusionary period March-May on riverside impact piling works Daytime operation

12.2.8.2 Operational Phase

Underwater noise levels during the operational phase of the 3FM Project are not expected to change the underwater noise levels in any measurable way. No mitigation measures are therefore required for the operational phase.

12.2.9 Monitoring

Underwater noise monitoring surveys will be carried out during the construction phase to verify the modelling assumptions and results.

12.2.10 Conclusions

Given implementation of the proposed mitigation, there is little to no risk of exceedance of TTS or PTS thresholds during the construction phase (minimum two years for Area N).

No significant underwater noise levels will arise during the operation of Dublin Port.