CP1146 CARRICKMINES TO POOLBEG PROJECT

Natura Impact Statement

CP1146-RPS-00-XX-RP-N-RP1020
A1 C02
1 November 2024

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
S3 P01	Draft for Client Review	[redacted]			04/07/2024
S3 P02	Updates to Underwater (subsea) noise assessment section				25/07/2024
S5 P01	Client Comments				15/08/2024
S5 P02	Additional Client comments				12/09/2024
S5 P03	Additional Client comments				20/09/2024
S5 P04	Additional Client comments				25/10/2024
A1 C02	Final				01/11/2024

Approval for issue

[redacted]	1 November 2024

Prepared by:

RPS

Prepared for:

EirGrid

Dublin | Cork | Galway | Sligo | Kilkenny
rpsgroup.com

RPS Group Limited, registered in Ireland No. 91911
RPS Consulting Engineers Limited, registered in Ireland No. 161581
RPS Engineering Services Limited, registered in Ireland No. 99795
The Registered office of each of the above companies is West Pier Business Campus, Dun Laoghaire, Co. Dublin, A96 N6T7

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EXECUTIVE SUMMARY

The CP1146 Carrickmines to Poolbeg project is a proposed new underground electricity cable from the Carrickmines 220 kV substation to the Poolbeg 220 kV substation and includes a section of marine cable. The marine section is located between Blackrock Park and Shelley Banks car-park on the Poolbeg peninsula, Co. Dublin.

There is currently insufficient baseline geophysical, geotechnical and environmental information available to fully inform the preliminary and detailed design of the marine elements of the CP1146 Carrickmines to Poolbeg project. In order to progress the design elements of the project and carry out the necessary environmental assessments, further baseline data must be obtained. Therefore, further SI information and environmental surveys must be undertaken.

This report has been prepared by RPS, on behalf of EirGrid, in support of the Maritime Usage Licence Application (MULA) to the Maritime Area Regulatory Authority (MARA). The MULA is for site survey and investigation works (the 'SI works') to inform engineering design. The results of these surveys will also provide baseline data for subsequent environmental assessments, e.g. Appropriate Assessment (AA).

The SI works include geophysical, geotechnical and environmental investigations in the marine environment as summarised below.

- Marine geophysical surveys.
- Marine environmental/ ecological surveys.
- Metocean surveys.
- Marine geotechnical investigations.

This Natura Impact Statement (NIS) provides the Competent Authority with the information required for their Appropriate Assessment (AA) of the marine site investigation (SI) works for the CP1146 Carrickmines to Poolbeg project.

A Supporting Information for Screening for Appropriate Assessment (SISAA) report was prepared for the SI works and identified the presence of European sites within the potential Zone of Influence (ZoI) of the SI works. The SISAA concluded it cannot be excluded on the basis of objective scientific information that the SI works, individually or in combination with other plans or projects, will have a significant effect on the following European sites:

- Rockabill to Dalkey Island SAC
- Lambay Island SAC
- South Dublin Bay and River Tolka Estuary SPA
- North Bull Island SPA (wintering waterbirds)
- North-West Irish Sea SPA (seabird species)
- Dalkey Island SPA (seabird species)

Therefore, the SISAA concludes that an Appropriate Assessment is required and that a Natura Impact Statement (NIS) be prepared to assist MARA, the Competent Authority, in conducting an Appropriate Assessment (AA) should they agree with the findings of the SISAA.

The purpose of this NIS is to provide MARA with information for the purposes of Article 6 of the Habitats Directive on the implications of the SI works, on its own or in-combination with other plans or projects, for one or more than one European site, in view of the conservation objectives of the site or sites.

Within this NIS, best practice construction and mitigation measures have been proposed for the avoidance of adverse effects to the European sites within the project ZoI. The implementation of best practice construction design measures and site-specific mitigation during the SI works will ensure that the SI works do not adversely affect the integrity of the site(s) concerned.

1 INTRODUCTION

1.1 Overview

EirGrid was established to act as the independent Transmission System Operator (TSO), in line with the requirements of the EU Electricity Directive. EirGrid became operational as the TSO on 1 July 2006 and is a public limited company, registered under the Companies Acts.

While EirGrid operates the flow of power on the grid and plans for its future, ESB Networks is responsible for carrying out maintenance, repairs and construction on the grid as the Distribution System Operator. ESB is the licenced Transmission System Owner pursuant to the Electricity Regulation Act, 1999. EirGrid uses the grid to supply power to industry and businesses that use large amounts of electricity. The grid also powers the distribution network. This supplies the electricity used every day in homes, businesses, schools, hospitals, and farms.

Dublin's electricity infrastructure is ageing and reaching its end of life. Work must be done to transform and modernise the city's electricity infrastructure, so Dublin can continue to develop and thrive, while increasingly using power from renewable sources.

The Powering Up Dublin Programme is a critical programme that will strengthen key electricity infrastructure in Dublin and the surrounding areas, making the city 'renewable ready.' This programme is set to replace and upgrade five 220kV circuits across Dublin city and the surrounding areas.

As part of the ongoing upgrade and development of Ireland’s electrical grid, EirGrid are undertaking a programme to replace and upgrade five of the 220kV circuits across Dublin city and the surrounding areas. This is part of EirGrid’s wider Dublin programme, to ensure continued reliability of electrical supply across the city, while also enabling future development and possible offshore wind farm development.

Replacing the existing circuits in an offline route means the new circuit follows a separate route to the existing circuit. The advantage of this is that there are minimal disruptions to the existing circuit and no, or very few, planned outages would be needed during construction.

Due to the electricity needs of Dublin, an online replacement is not feasible. For this reason, offline installation will be considered for the replacement of this circuit. EirGrid proposes to replace all the existing circuits with cross-linked polyethylene (XLPE) cable primarily on an offline route. These XLPE cables are more efficient and robust, which will enable the grid to carry more power, making the city ‘renewable ready’.

The programme is set to replace and upgrade five 220kV circuits across Dublin city, with this report focusing on the marine section of one of the cable circuits to be replaced, i.e., the CP1146 Carrickmines to Poolbeg project.

1.2 Purpose of the Report

This report has been prepared by RPS, on behalf of the EirGrid, to provide information on the marine site investigation (SI) works proposed to be undertaken for the CP1146 Carrickmines to Poolbeg project in support of the Maritime Usage Licence Application (MULA) to MARA. The MULA is for site survey and investigation works to inform engineering design and environmental assessment. The results of these surveys will also provide baseline data for any subsequent environmental assessments, e.g., Appropriate Assessment (AA) – should one be required.

This NIS presents a scientific examination of the SI works and the relevant European Sites to identify and characterise any possible implications of the SI works individually or in combination with other plans or projects in view of the conservation objectives of the relevant European sites, and any further information required to enable MARA, as the Competent Authority, to carry out an Appropriate Assessment.

1.3 Statement of Authority

The technical competence of the authors is outlined below:

[redacted] is a Senior Scientist in the Environmental Services Business Unit in RPS. She has over 10 years’ experience in the marine ecology field. She holds an honours degree in Marine Science from NUI, Galway, and a master’s in marine biology from UCC. [redacted] has contributed to numerous marine environmental projects including appropriate assessments, Annex IV species reports, natura impact statements and EIA chapters.

[redacted] is a Scientist in the Environmental Services Business Unit in RPS. She holds a Bachelor's Degree in Marine Science from the University of Galway and Master's Degree in Climate Change and Managing the Marine Environment from Heriot-Watt University Edinburgh. She has three years' experience working in consultancy, assisting on a wide range of projects from offshore renewable energy projects to flood relief schemes, including marine and terrestrial surveys. She is a qualifying CIEEM member.

[redacted] is Technical Director in the Environmental Services Business Unit in RPS. He has over 24 years' experience. He holds an honours degree in Civil Engineering (B.E.) from NUI, Galway, a postgraduate diploma in Environmental Sustainability from NUI, Galway, and a Master's in Business Studies from the Irish Management Institute/ UCC. [redacted] is also a Chartered Engineer and Project Management Professional with the Project Management Institute (PMI-PMP). He has managed the delivery of numerous environmental projects including marine and terrestrial projects that have required environmental impact assessment, appropriate assessment, and Annex IV species reports.

1.4 Legislation

1.4.1 European Legislation

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (as amended) (the Habitats Directive) provides protection for habitats and species of European importance; Council Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version) (the Birds Directive) aims to protect all of the 500 wild bird species naturally occurring in the European Union (EU). Areas designated for protection under the Habitats Directive are described as Special Areas of Conservation (SAC) and those designated under the Birds Directive, as Special Protection Areas (SPA) and the sites are known collectively as Natura 2000 sites (see section 1.4.2.4). As each member of the EU is required to designate areas in their jurisdictions, the establishment of this network of Natura 2000 sites under Articles 3 to 9 of the Habitats Directive is the key measure to protect nature and biodiversity in the EU.

Articles 6(3) and 6(4) of the Habitats Directive set out the decision-making tests for plans and projects likely to have a significant effect on or to adversely affect the integrity of Natura 2000 sites. Article 7 of the Habitats Directive extends the scope of its articles 6(3) and 6(4) to the Birds Directive.

Article 6(3) establishes the requirement for Appropriate Assessment (AA):

> "*Any plan or project not directly connected with or necessary to the management of the* [Natura 2000] *site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subjected to appropriate assessment of its implications for the site in view of the site's conservation objectives. Considering the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the public.*"

Further detail on the stages of AA is provided in Section 1.4.2 below.

The Habitats and Birds Directives have been transposed into Irish Legislation under, amongst other things, the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011), as amended.

Each Natura 2000 site has assigned Conservation Objectives (COs) and a list of Qualifying Interests (QI). The CO concept appears in the eighth recital of Habitats Directive which reads:

"*whereas it is appropriate, in each area designated, to implement the necessary measures having regard to the conservation objectives pursued*". Article 1 then explains that "*conservation means a series of measures required to maintain or restore the natural habitats and the populations of species of wild fauna and flora at a favourable status*".

The National Parks and Wildlife Service (NPWS) has established COs for each Natura 2000 site in Ireland. These are published on their website. NPWS advise in the general introductory notes of their site-specific conservation objectives (SSCO) series publications, that an appropriate assessment based on their:

"*published conservation objectives will remain valid even if the CO targets are subsequently updated, providing they were the most recent objectives available when the assessment was carried out*." NPWS advise that to assist in that regard, it is essential that the date and version are included when objectives are cited.

1.4.2 National Legislation

1.4.2.1 Maritime Area Planning Act

The following definitions in relation to Appropriate Assessment (AA) are included in Section 2(1) of the Maritime Area Planning Act, 2021 (as amended), hereafter the "MAP Act":

> *"Screening for appropriate assessment" shall be construed in accordance with, as appropriate—*
>
> > *(a) section 177U of the Act of 2000, or*
> >
> > *(b) Part 5 of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011)*
>
> *"Appropriate assessment" shall be construed in accordance with, as appropriate—*
>
> > *(a) section 177V of the Act of 2000, or*
> >
> > *(b) Part 5 of the European Communities (Birds and Natural Habitats) Regulations (S.I. No. 477 of 2011);*

where the Act of 2000 refers to the Planning and Development Act 2000 (as amended).

The European Communities (Birds and Natural Habitats) Regulations 2011 has also been amended.

Under Section 112 of the MAP Act, MARA has been designated as a competent authority for the purposes of Part 5 of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011)*;* and appropriate assessments to which that Part applies.

MARA is required to carry out a screening for Appropriate Assessment (AA) in accordance with Section 117(4)(a) of the MAP Act.

Where MARA determines that an AA is required it shall carry out the AA in accordance with Section 117(7)(a) of the MAP Act.

1.4.2.2 Screening In for Appropriate Assessment

Under Regulation 42(6) of the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) the competent authority shall determine that an AA of a plan or project *is required* where the plan or project is not directly connected with or necessary to the management of the site as a European Site and if it cannot be excluded, on the basis of objective scientific information following screening under this Regulation, that the plan or project, individually or in-combination with other plans or projects, will have a significant effect on a European site.

1.4.2.3 Appropriate Assessment

In accordance with Section 117(6)(a), MARA requires that the applicant prepare and submit a Natura Impact Statement (NIS) as defined in Regulation 2 of the European Communities (Birds and Natural Habitats) Regulations, 2011 (as amended):

> *"Natura Impact Statement" means a report comprising the scientific examination of a plan or project and the relevant European Site or European Sites, to identify and characterise any possible implications of the plan or project individually or in-combination with other plans or projects in view of the conservation objectives of the site or sites, and any further information including, but not limited to, any plans, maps or drawings, scientific information or data required to enable the carrying out of an Appropriate Assessment.*

Following receipt of the NIS, MARA will, under Section 117(6)(b), satisfy itself as to the adequacy of the NIS and then write to the applicant to require them to give notice to the public that the application and supporting information has been provided to MARA. Following a consultation period of not less than 30 days, MARA will then carry out an AA in accordance with Section 117(7)(a).

1.4.2.4 European Sites and Natura 2000 Sites

The term European site is defined in the European Communities (Birds and Natural Habitats) Regulations 2011 (as amended) as:

> *"European Site" means—*
> *(a) a candidate site of Community importance,*
> *(b) a site of Community importance,*
> *(c) a candidate special area of conservation,*
> *(d) a special area of conservation,*
> *(e) a candidate special protection area, or*
> *(f) a special protection area;*

The term Natura 2000 is defined in the same Regulations as:

> *"Natura 2000" means the European network of special areas of conservation under the Habitats Directive and special protection areas under the Birds Directive, provided for by Article 3(1) of the Habitats Directive and, for the purposes of these Regulations, includes European Sites.*

As such, and as adopted in this report, the term European site refers to one of the sites comprising the Natura 2000 network.

2 PROJECT DESCRIPTION

2.1 Location

The CP1146 Carrickmines to Poolbeg project is a proposed new underground electricity cable from the Carrickmines 220 kV substation to the Poolbeg 220 kV substation and includes a section of marine cable as shown in Figure 2-1. The cable route for the CP1146 Carrickmines to Poolbeg project traverses the administrative areas of two local authorities: Dun Laoghaire Rathdown County Council and Dublin City Council.

A site location map of the marine section of the CP1146 Carrickmines to Poolbeg project, showing the MULA area (redline boundary), is presented in Figure 2-2 below. Note that the cable route element shown in the figure below represents a 500m wide routing corridor and that final routing will be determined following the surveys being described in this project description. More detailed drawings are provided in Appendix A.

The Area of Interest (AoI) of this report is an area of 2101 Ha extending from Blackrock Park to the Shelley Banks car park on the Poolbeg peninsula. The majority of geophysical and geotechnical surveys will be conducted within the 500m wide corridor, however, some addition surveys may be required within the wider South Dublin Bay area, e.g. environmental walk-over surveys. Therefore the entire 2101 Ha area is the subject of the MULA.

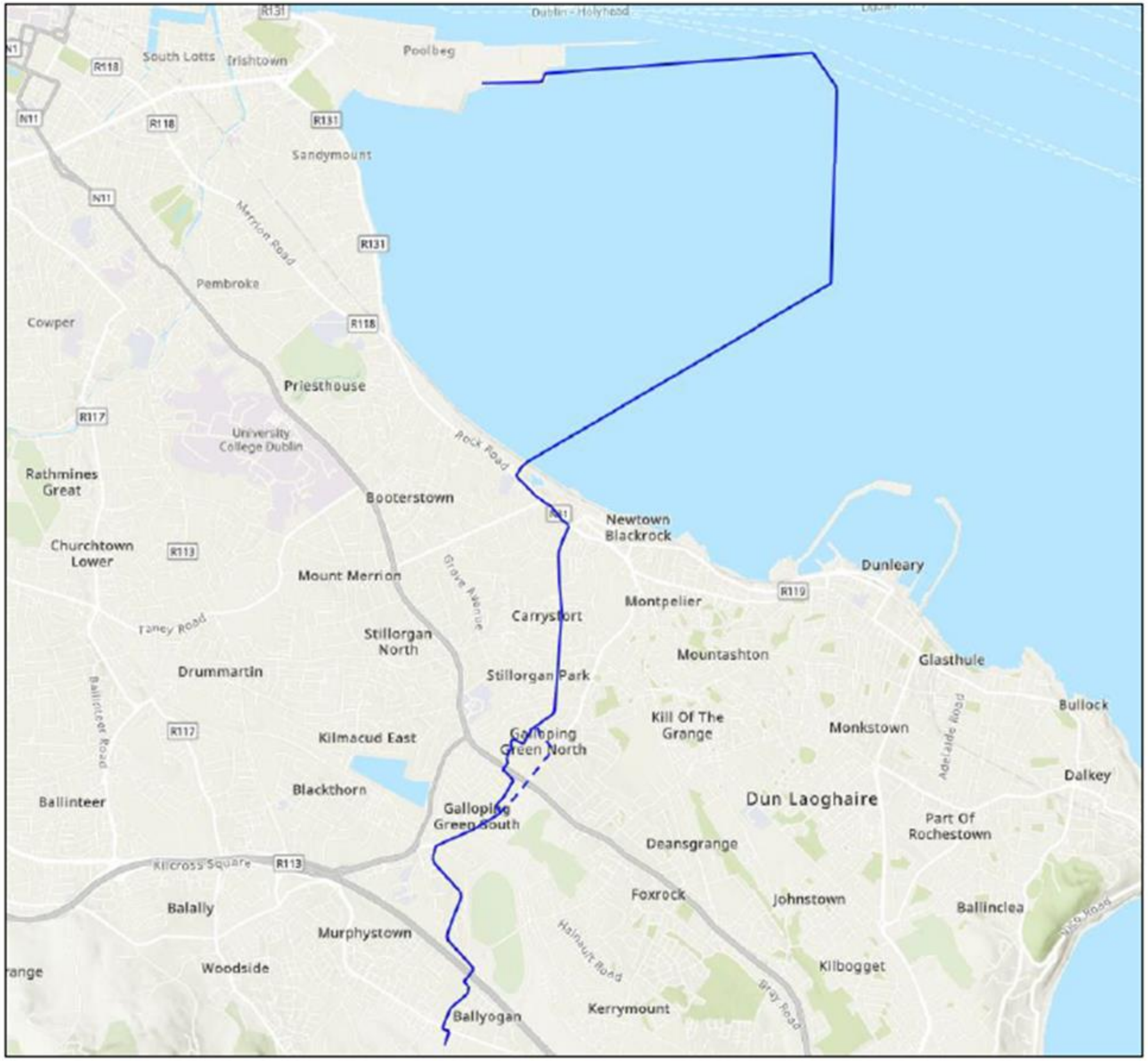

Figure 2-1 Proposed Entire Route of CP1146 Carrickmines to Poolbeg project

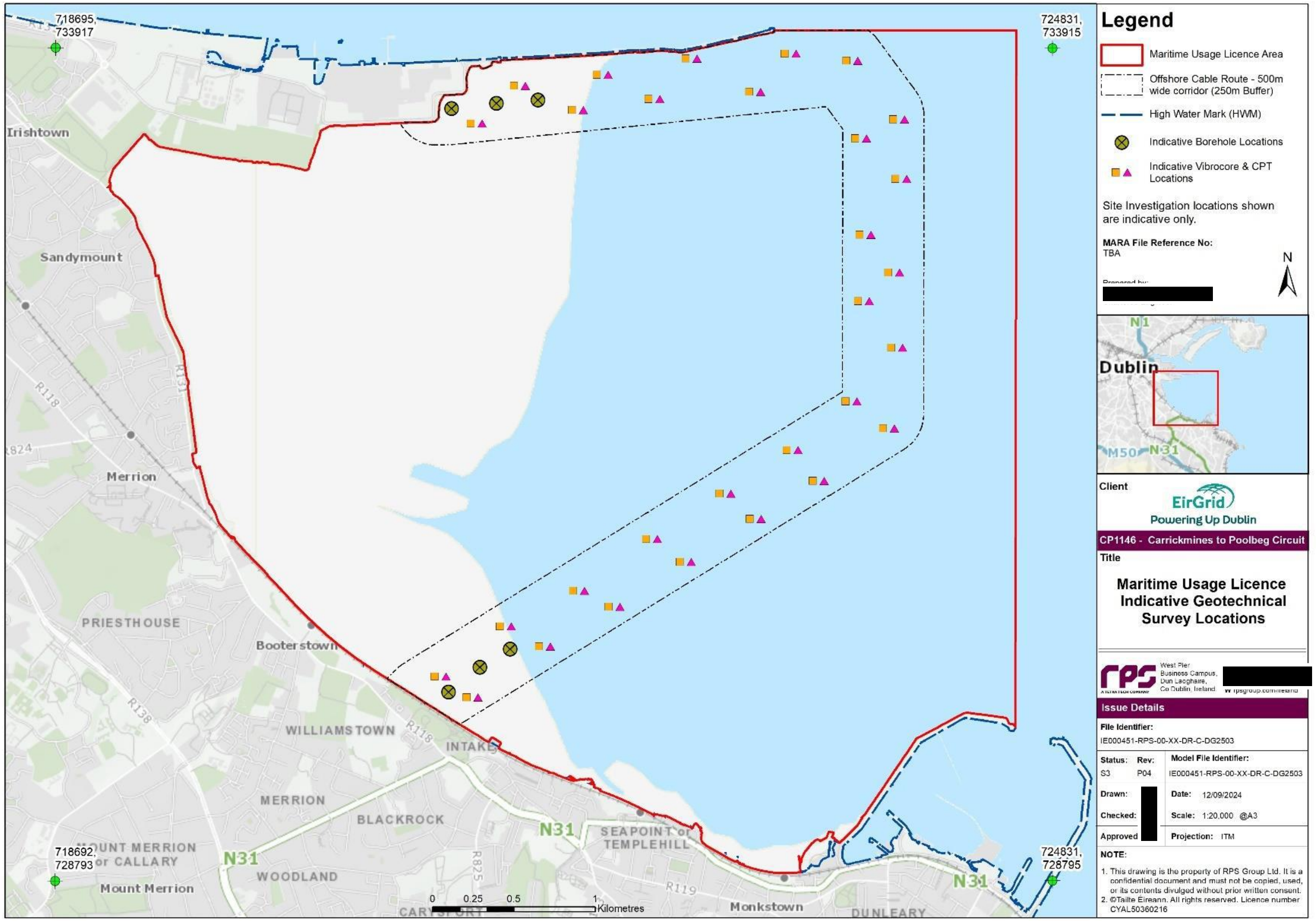

Figure 2-2 Proposed Marine Cable Section of CP1146 Carrickmines to Poolbeg project (500m wide route corridor) and MULA Area

2.2 Description of the Marine Site Investigation Works

2.2.1 Overview

In order to provide a reliable basis for design development, and to support the consenting and construction phases of the marine section of the CP1146 Carrickmines to Poolbeg project, surveys and investigations are necessary. The aim of the SI works is to acquire data to a high quality and specification within the AoI as summarised below and described in the following sections.

Marine SI Works comprise the following elements:

Table 2.1 Marine Site Investigation Surveys

Survey Type	Survey Elements
Marine Geophysical Surveys	Drop-down camera/ video
	ROV
	Multi Beam Echosounder (MBES)
	Side Scan Sonar (SSS)
	Sub-bottom profiler (SBP)
	Magnetometer
	Ultrashort Baseline (USBL) acoustic positioning system
	Seismic Refraction
	Ground Penetrating Radar
	Drones/ UAVs
Marine Environmental/ Ecological Surveys	Benthic sampling/ grab samples
	Water samples
	Conductivity, Temperature, Depth (CTD) water measurements
	Static underwater noise recorders
	Shipping and navigation surveys
	Marine archaeology surveys
	Marine habitat surveys
	Other ecological surveys
Metocean Surveys	Acoustic Doppler Current Profiler (ADCP)
Geotechnical Investigations/ Surveys	Geotechnical Boreholes
	Vibro-core Sampling
	Cone Penetration Test (CPT)

It should be noted that all locations shown are provisional only and subject to change on-site due to the presence of obstructions/ refusals at individual locations, i.e. where a physical object, e.g. a subsurface boulder, prevents the borehole, CPT, etc., from going to its target depth. In such circumstances, the borehole location is moved to another nearby location away from the obstruction and the operation repeated.

The following drawings have been prepared in support of the MULA:

- Proposed Licence Area Map (Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502)
- Maritime Usage Licence Indicative Geotechnical Survey Locations (Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2503)
- Maritime Usage Licence Indicative Benthic Sample Locations Map (Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2504)
- Maritime Usage Licence Indicative ADCP Locations Map (Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2505)

The drawings are included in Appendix A to this report.

2.2.2 Marine Geophysical Surveys

The geophysical survey scope is intended to provide significant seabed and sub-seabed information. It is therefore foreseen to gather, as a minimum, detailed information on:

- Water depths, to lowest astronomical tide (LAT), throughout the AoI;
- The nature of any seabed features, obstructions, sediments, and shallow geological conditions throughout the AoI;
- The nature of the sub-seabed conditions and horizons down to circa 10-15m below chart datum (CD) depending on the geological conditions encountered and the choice of system used;
- Seabed conditions/ hazards to any SI works equipment which may need to be located on the seabed;
- Seabed habitats to inform further benthic surveys and preparation of environmental assessments; Identify sensitive marine habitats which will need to be avoided during geotechnical and environmental sampling;
- Archaeological features within the AoI;
- Unexploded ordnance (UXO).

The foreseen scope of the SI works will consist of primarily non-intrusive survey methods, in that they will not physically interact with the seabed, such as Multi Beam Echosounder (MBES), sub-bottom profiler (SBP), Side Scan Sonar (SSS) and Magnetometer surveys but may also incorporate visual surveys (e.g., drop down video, ROV, etc.) pending the development of the project's ground model.

Figure 2-3 Typical offshore geophysical survey vessel (GeoSurveyor XI Call Sign; ORVI)

As detailed in Section 2.2.3 below some intrusive seabed sampling will also be undertaken during the geophysical survey campaign to ground-truth geophysical data, assist in early seabed characterisation and provide data for benthic analyses and archaeological interpretation.

Typical nearshore vessels for geophysical surveys will be circa 10 – 20m in length. See Figure 2-3 for an example of a geophysical survey vessel. A smaller nearshore vessel may be required to complete surveys in the intertidal area, see Figure 2-4 for an example of a typical nearshore vessel.

Figure 2-4 Typical nearshore geophysical survey vessel (RV GEO)

A brief description of the geophysical survey methods has been provided in the subsequent sections. The exact technical specifications of the equipment to be used will not be known until the survey contract has been awarded, however such vessels and equipment will be within the parameters assessed within this document.

Typical acoustic properties of equipment are provided in Section 2.2.6.

The intertidal area will be subject to surveys using predominantly terrestrial geophysical survey methods and techniques such as Ground Penetrating Radar (GPR), shallow seismic refraction, electrical resistivity, magnetometer, drones and photogrammetry.

2.2.2.1 Multibeam Echo sounder

Full 100% coverage of the area concerned associated with the survey and area classification will be required. Surveys shall identify the level, nature, and detailed coverage of the seabed to ensure identification of features on the seabed within the area shown, identify potential large upstanding archaeological features and guide habitat mapping with the backscatter function if available. Processing of data sets shall include processing for archaeological indicators. The area shall be surveyed in such a way as to produce a comprehensive data-set required to enable the generation of multiple sections through the survey area in any direction.

Method: A remote sensing acoustic device which will be either attached to the vessel(s) hull at the bow or mounted on a side pole.

Indicative Equipment:

- Teledyne Reson Seabat T50-R;
- R2 Sonic 2024 (see Figure 2-5); or
- similar.

Figure 2-5 MBES R2Sonic 2024

Swath width: Swath width will be optimised to provide 100% seafloor coverage with typical swath widths of 3 to 6 times water depth depending on arrangement of equipment hardware.

Location: MBES survey may be performed throughout the entire sub-tidal area illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A). The survey area is 2101 Ha.

2.2.2.2 Side Scan Sonar (SSS)

Method: A submerged acoustic device (SONAR – Sound Navigation & Ranging) for imaging areas of the seafloor will be either hull mounted or towed.

Indicative Equipment:

- Kongsberg Geoacoustic 160
- Edgetech 4200 (see Figure 2-6);
- C-Max CM2 system;
- Klein Hydro Scan; or
- similar.

Swath width: The swath width will be based on the water depth encountered. A 100% overlap between each swath is envisaged.

Location: SSS survey may be performed throughout the entire sub-tidal area illustrated in in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A). The survey area is 2101 Ha.

Figure 2-6 Edgetech 4200 SSS

2.2.2.3 Sub-bottom Profiling

A typical sub bottom profiling (SBP) survey is completed using single or multi-channel seismic reflection systems such as Chirp, Sparker, or Parametric system. Sub bottom profiling over the site and specified runs is yet to be determined.

The geophysical SBP survey shall identify the bed level and the nature, thickness, and location of the sub surface strata to rock head.

The survey shall include both items detailed below:

1. Completion of specified runs.
2. Completion of a Free Line Survey.

Method: SBP are acoustic devices for imaging sections of the seabed. The images produced are used to produce profiles beneath the seafloor, enabling delimitation of major sedimentary interfaces. They are either mounted on the vessel / pole or towed behind the vessel.

Figure 2-7 Left - Applied Acoustics AA300 being deployed & Right - Typical Hull Mounted SBP - Edgetech 3300

Indicative Equipment:

- Edgetech 3100;
- Edgetech 3300 (see Figure 2-7);
- Geopulse 5430A (pinger system);
- 400 Joule Generic sparker;
- Innomar Parametric (dual frequency); or
- similar.

Swath width: n/a

Location: SPB survey may be performed throughout the entire sub-tidal area illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A). The survey area is 2101 Ha.

2.2.2.4 Magnetometer

The magnetometer survey will be undertaken at suitable line spacing to ensure complete coverage of the seabed for archaeological purposes (and in line with UAU guidelines), i.e., identify large metal debris or metallic archaeological remains.

Method: Magnetometers provide information on embedded magnetic/ferrous objects such as cable crossings, debris and potentially UXO’s. They are towed from the vessel.

Indicative Equipment:

- Geometrics G-882 caesium vapour magnetometer – see Figure 2-8;
- Marine Magnetics SeaSPY,
- G-Tec Magwing System; or
- similar.

Figure 2-8 Geometrics G-882

Survey spacing: Line spacing will be dependent on water depth encountered, with additional runs of higher density line spacing within areas where any magnetic signal is recorded.

Location: Magnetometer surveys may be performed throughout the entire sub-tidal area illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A). The survey area is 2101 Ha.

2.2.2.5 Ultrashort Baseline (USBL) – Acoustic Positioning System

An ultrashort baseline acoustic positioning system is a highly accurate and precise method of underwater acoustic positioning. It determines the orientation and position of the transponders relative to the transceiver and can be used during the set up and positioning of other geophysical and geotechnical survey equipment.

Figure 2-9 Applied Acoustics EasyTrak Nexus Model EZT-2691

Method: The system consists of a transceiver unit and a set of transponders. The transceiver unit emits acoustic signals, which are picked up by the transponders.

Indicative Equipment:

- Applied Acoustics EasyTrak Nexus Model EZT-2691 (Figure 2-9); or
- similar.

Location: USBL surveys may be performed throughout the entire sub-tidal area illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A). The survey area is 2101 Ha.

2.2.2.6 Seismic Refraction (Beach and Intertidal)

The seismic refraction method utilizes the refraction of seismic waves as they pass through various rock or soil layers to analyse underground geological conditions and structures.

Figure 2-10 Geometrics Geode Seismograph

Method: Seismic refraction profiles will be conducted using onshore survey tools during low tide in the intertidal zone. A sound source (typically a sledgehammer striking a metal plate) will generate compressional wave energy. These refracted waves will be captured by a series of geophones and logged on a digital seismograph. The locations and elevations of the geophones will be documented using GPS technology.

Indicative Equipment:

- Geophone Arrays:
  - Geosense 4.5 Hz Geophones;
  - Mark Products L-28LB Geophone;
  - Geospace GS-11D Geophone; or
  - similar
- Digital Seismographs
  - Geometrics Geode Seismograph (Figure 2-10);
  - Seistronix RAS-24;
  - ABEM Terraloc Pro; or
  - similar

Location: Refraction Seismic methods may be undertaken throughout the entire inter-tidal areas illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A).

2.2.2.7 Ground Penetrating Radar (Beach and Intertidal)

Ground Penetrating Radar (GPR) utilizes the reflection of electromagnetic waves as they are returned by rock or soil layers to analyse underground geological conditions and structures.

Method: GPR will be completed during low tide in the intertidal zone. A GPR trolley will be pushed over the area to be scanned or a GRP array will be towed using an ATV and the results analysed by a technician to determine subsurface characteristics.

Figure 2-12 Stream X Towed GPR System

Figure 2-11 Leica DS2000 GPR Trolley

Indicative Equipment:

- IDS GeoRadar Stream X Towed GPR System (see Figure 2-12)
- IDS GeoRadar Stream DP GPR System
- Leica DS2000 GPR System (see Figure 2-11); or
- similar.

Location: Refraction Seismic methods may be undertaken throughout the entire inter-tidal areas illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A).

2.2.2.8 Drones

Drones or Unmanned Aerial Vehicles (UAVs) are capable of mapping coastal and intertidal areas with a high degree of vertical accuracy. Drones or UAVs equipped with a high-resolution camera can be used to collect high resolution spatial data for coastal and intertidal surveys.

Method: Drones/UAVs will be used to survey intertidal.

Location: Drone surveys may be undertaken throughout the inter-tidal areas illustrated in Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2502 (Appendix A).

2.2.3 Marine Environmental/ Ecological Surveys

The aim of the proposed environmental surveys is to collect baseline data which will be used to inform the environmental assessments. Environmental surveys will cover both the onshore area above the high-water mark and areas below the high water mark including intertidal and subtidal areas. This will include a benthic sampling programme using grab sampling, video or still photographs and, where deemed necessary, the deployment of static acoustic monitoring to measure marine mammal activity and other background noise.

2.2.3.1 Benthic Sampling/ Grab Samples

Seabed samples will be recovered to inform benthic habitat distribution mapping as well as contamination testing (where relevant). Standard sampling techniques for subtidal and intertidal collection will be employed to include collection of macrofauna and associated sediment particle size and organic content, as described below.

Macrofaunal grab samples may be taken with a number of different grab types depending on the substrate type, e.g., Day grab, Van Veen, mini-Hamon (not suitable for undisturbed samples). The benthic sampling will be complemented by video and still photography. Seabed sampling will likely be undertaken as part of either the geophysical or geotechnical surveys or may be a standalone survey.

Indicative Quantity: It is anticipated that 11 no. stations will be required to be sampled. Three (3 no.) replicate benthic samples will be obtained at each sampling station. Two benthic samples from each sampling station will be processed for macro-invertebrate benthos larger than 1 mm. The remaining one sample will be analysed for sediment particle size analysis and sediment chemistry. Samples will be sent to a suitably accredited (NMBAQC level participation) laboratory for analysis and reporting which will include benthic analysis, sediment particle size analysis and sediment chemistry. GPS coordinates and depths will be recorded for each location.

Method: Camera will be used to ensure seabed is suitable for sampling prior to using grab. Surface grab samples will be taken by box corer, grab sampler (e.g., Day grab, Van Veen grab or similar). These devices are typically deployed from a crane on the vessel.

Depth: Grab sample will be taken on the seabed at depths ranging between -4m CD and -10m CD. It is estimated that each sample will have a size up to $0.1m^2$.

Location: Grab sampling will be performed within the area defined in CP1146-RPS-00-XX-DR-C-DG2504 (Appendix A). The final sampling locations will be determined based upon interpretation of the geophysical data and selected to sample different marine habitats.

2.2.3.2 Water Samples

Water sampling and profiling will be taken in sufficient locations to provide an even distribution of results across the site. Two water samples shall be taken at each location. Each water sample shall be analysed for the following: conductivity, temperature, pH, dissolved oxygen and turbidity. Where suitable, parameters will be tested in situ to receive accurate data. A Niskin bottle (or similar) will be used to obtain a sufficient sample of water at the surface (< 1m depth) and a second sample just above the seabed (~1m) for the subsequent chemical analysis.

2.2.3.3 Conductivity, Temperature and Depth

Conductivity, Temperature, Depth (CTD) water measurements shall be taken at a number of locations at three depths, i.e. near-surface, mid-water, and near-seabed. Measurements shall be taken only after stabilisation of the temperature at each location.

2.2.3.4 Static Underwater Acoustic Recorders

Static underwater acoustic recorder(s) may be deployed within the sea in the AoI. The recorder(s) will be Wildlife Acoustics Model: SM2M Unit with hydrophones contained in a single unit (see Figure 2-13) , or similar. The location for the deployment of the recorder(s) will be determined based on factors such as tide, sediment and currents, as well as distance from shipping/ onshore noise sources that may impact on baseline noise levels. This information will be collected as part of the early SI works and therefore deployment locations are not yet known although they will be within the MUL area.

Figure 2-13 Deployment of static underwater acoustic recorders

2.2.3.5 Other Environmental Surveys

Further marine environmental surveys will be undertaken during the course of the project's development comprising the following:

- Shipping and Navigation Surveys
  - The need for shipping and navigation surveys will be determined following consultation with the relevant stakeholders. These will be shore-based visual vessel traffic surveys.
- Marine Archaeology Surveys
  - The aim of the proposed surveys, which will be undertaken by a suitably qualified archaeologist, are to collect baseline data which will be used to inform the cultural heritage impact assessment. Surveys will be undertaken in advance of any intrusive survey work and generally coordinated with the geophysical survey proposed herein. Surveys will comprise an identification programme using marine magnetometer survey (see Section 2.2.2.4), side scan sonar (see Section 2.2.2.2) data analysis and diving as required in order to identify and assess metallics and other targets. They may include dive surveys, wade surveys and archaeological walkover surveys.
- Marine Habitat Surveys
  - The aim of the proposed surveys, which will be undertaken by a suitably qualified marine ecologist, are to collect baseline habitat data which will be used to inform the environmental assessments, e.g., Appropriate Assessment (AA). Surveys will be undertaken in advance of any geotechnical survey work and generally coordinated with the geophysical survey proposed herein. Surveys will comprise drop down camera and/or Remote Operated Vehicle (ROV) inspection and diving as required in order to identify benthic habitats.
  - Intertidal walkover surveys habitat characterisation sampling, with core samples to be analysed for Fauna, Particle Size Analysis & Total Organic Carbon, and chemical analysis, e.g., heavy and trace metals, hydrocarbons, and polycyclic aromatic hydrocarbons (PAH);

    It is expected that a minimum of 9 primary transect stations are selected per landfall location, with 3 sampling points along each, (minimum 9 transects and a minimum total of 27 sampling points).
- Other Ecological Surveys
  - Terrestrial habitat walkover surveys (including protected and notable flora, and invasive alien plants and animals);
  - Bats roost assessment surveys;
  - Mammal surveys (including otters); and
  - Bird surveys including wintering bird surveys (low and high tide surveys), breeding bird surveys (vantage point surveys, boat based surveys).

It should be noted that these surveys will straddle both the marine and the terrestrial environments.

2.2.4 Metocean Surveys

The main purpose of the meteorological and oceanographic (metocean) campaign is to collect accurate wind wave, temperature, current and water levels information from the project site. The information collected will be used to inform engineering design and environmental assessments. The exact details of the surveys (equipment, locations, and deployment/retrieval methods) will be confirmed upon appointment of a preferred contractor.

2.2.4.1 Equipment Deployment & Recovery Vessel

The methodology for deployment of metocean monitoring equipment will be using a suitable vessel to either tow and/or lift and deploy from vessel deck via onboard crane. An example of a suitable vessel for this scope would be a shallow draft anchor handling tug or a utility type vessel such as that shown in Figure 2-14 or similar.

Figure 2-14 Ocean Energy DP1 Multi Cat 2309

2.2.4.2 Acoustic Doppler Current Profiler (ADCP) to measure ocean currents.

An Acoustic Doppler Current Profiler (ADCP) is used to collect data on water movements, current speeds, and directions.

Indicative Quantity: Three.

Method: Deployed to the seabed via a crane from a survey vessel for a duration of at least 5 weeks to capture a full lunar cycle including spring and neap tides.

Indicative Equipment: The ADCP unit (Figure 2-15) is mounted in a seabed frame (circa 1.8 m wide and 0.6 m high) with a weight of approximately 300 kg. This will be attached to a ground line, a clump weight and to an acoustic release system carrying a rope retrieval system. The precise equipment utilised will depend on the water depths at the locations proposed for survey.

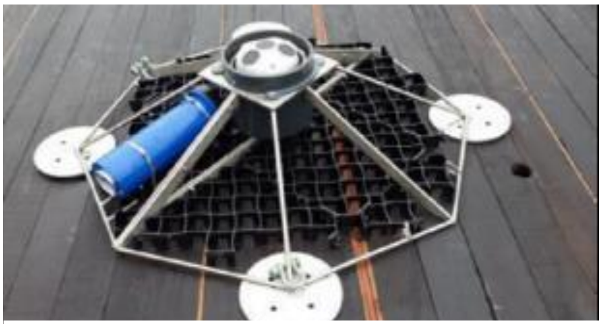

Figure 2-15 Typical seabed frame with ADCP (Ocean Scientific International Ltd)

Location: Indicative locations for the deployment of ADCP are illustrated on Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2505 (Appendix A). The actual locations will be determined based upon interpretation of the geophysical data and following a navigation safety assessment.

2.2.5 Marine Geotechnical Investigations

The aim of the geotechnical survey is to provide sufficient geotechnical data to allow the characterisation of the sub-seabed strata and composition of the seabed and the level of Rock head (including follow on coring to confirm rock head).

Normal industry standards for performance of all positioning, drilling, sampling, SPT testing, CPTu testing, laboratory testing and analysis and reporting will apply. Material sampling, in situ testing, data logging, laboratory testing and reporting (factual and interpretative) will be required.

The works will include the following:

- Sampling/ coring boreholes at 6 locations to a maximum of 20m investigation depth below seabed level.
- Vibro-cores at c. 30 locations.
- Cone Penetration Testing – CPT at 30 locations (at the vibro-core locations).

The indicative quantities given above relate to the requirements for the preliminary geotechnical campaign, the final quantity, location, and specification of equipment will be determined following interpretation of the geophysical survey data and considering environmental constraints (i.e., proximity to sensitive receptors). The final proposed locations will be subject to environmental conditions.

2.2.5.1 Geotechnical Boreholes

Indicative Quantity: 6 focused primarily at the landfall locations of the cable routes.

Method: A drill head is lowered to the seabed from the drilling platform (where used) via a drill string. The drill head penetrates the seabed via rotation of the drill string and the application of a downward pressure. Soils and rock samples are then retrieved for laboratory testing via the drill string.

Figure 2-16 Jack-up Barge and drill rig

Sample Diameter: up to 102mm.

Depth: Up to 20m below the seabed, or refusal.

Indicative Equipment: Indicative equipment to be used would be Camacchio 205 or Comacchio 602 drill rigs using traditional drill string or a triple core barrel system (e.g., Geobor 'S') and associated ancillary equipment (water bowser, air compressor).

Depending on the specifics of each borehole location the drill rig and ancillary equipment may be deployed in two different methods, the choice of method will be determined based on the geophysical surveys, tidal working windows, as well as availability of plant and equipment.

Figure 2-17 Landing Craft deploying onto beach (MV Spanish Jonh II)

For investigations at all borehole locations where there is sufficient depth of water (draft) to deploy a jack-up barge, the drill rig and equipment can be mounted on a jack up barge and boreholes completed from this barge during any phase of the tide (see Figure 2-16).

For investigations located within the intertidal zone where sufficient time is available between inundation by tides, a tracked borehole / CPT rig and ancillary equipment may be deployed from a small landing craft (see Figure 2-17) to complete the borehole during the intertidal window.

Location: Indicative geotechnical locations for the boreholes are illustrated on Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2503 (Appendix A). The final borehole locations will be determined based upon interpretation of the geophysical data and selected based on the preliminary engineering design. The micro siting of individual geotechnical site investigation locations will take into consideration environmental constraints such as the position of sensitive habitats or archaeological features.

2.2.5.2 Vibro-core Sampling

Indicative Quantity: 30 vibrocores.

Method: Gravity or piston core (self-weight penetration sampler), deployed from a works vessel equipped with Dynamic Positioning. An example of a suitable vessel for this scope would be a shallow draft anchor handling tug or a utility type vessel such as that shown in Figure 2-14 (above) or similar.

Sample Diameter: up to 150mm.

Depth: Vibrocore up to 6m depth.

Indicative Equipment: The exact equipment to be used will be confirmed following a tender process to procure the site investigation contractor.

Location: Vibro-core sampling will be performed at representative locations within the cable route corridor - Refer to Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2503 (Appendix A). The final sampling locations will be determined based upon interpretation of the geophysical data and selected based on the preliminary engineering design. Some locations may need to be avoided due to environmental reasons including sensitive archaeological features or unsuitable substrate types.

2.2.5.3 Cone Penetration Testing (CPT)

Indicative Quantity: 30 CPT

Method: Cone Penetration Test (CPT) using a cone penetrometer deployed from a works vessel. An example of a suitable vessel for this scope would be a shallow draft anchor handling tug or a utility type vessel such as that shown in Figure 2-14 (above) or similar.

Sample Diameter: 32 mm (standard cone diameter).

Depth: CPT up to 6m depth, or refusal.

Indicative Equipment: The exact equipment to be used will be confirmed following a tender process to procure the site investigation contractor.

Location: Cone Penetration Testing will be performed at representative locations within the cable route corridor - Refer to Dwg Ref: CP1146-RPS-00-XX-DR-C-DG2503 (Appendix A). The final sampling locations will be determined based upon interpretation of the geophysical data and selected based on the preliminary engineering design. Some locations may need to be avoided due to environmental reasons including sensitive archaeological features or unsuitable substrate types.

2.2.6 Marine Noise Level Summary

All survey works that involve the use of acoustic instrumentation will follow the *Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters* (DAHG, 2014).

A summary of the noise sources, for the main activities proposed to be undertaken as part of the SI works surveys is included in Table 2.2 (see Appendix B: Subsea Noise Technical Report for further detail).

Table 2.2 Summary of Noise Sources and Activities Included in the Subsea Noise Assessment

Equipment	Source level [SPL] (as used in model)	Primary decidecade bands (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessel, Geophysical	161 dB SPL	10-16,000 Hz	Based on <20 m generic survey vessel.	Non-impulsive
Survey vessel, Geotechnical	168 dB SPL	10 – 25,000 Hz	Based on <30 m tug with dynamic positioning system	Non-impulsive
MBES	187 dB SPL (Spherical equivalent level)	200,000-800,000 Hz	Based on Reason SeaBat T50 & R2 Sonic 2024.	Impulsive
SSS	166 dB SPL (Spherical equivalent level)	100,000-1,000,000 Hz	Generic SSS from 400-1,000 kHz.	Impulsive
USBL	190 dB SPL	18,000-31,500 Hz	Active with non-hull mounted SSS* & during vibro-core operations, 2 Hz ping rate, ping length 10 ms.	Impulsive
SBP-parametric (P-SBP)	204 dB SPL	80,000-150,000 Hz (Primary) 2,000-22,000 Hz (Secondary)	Source level adjusted for sediment effects and beam widths. Based on Innomar Standard, worst-case for shallow water.	Impulsive
SBP-chirper/pinger (C-SBP)	181 dB SPL	2,000-12,000 Hz	Generic shallow water SBP of chirper/pinger type. Source level adjusted for sediment effects and beam widths.	Impulsive
SBP-sparker/UHRS (S-SBP)	184 dB SPL	600 – 6,300 Hz	Based on GeoSource 400. Firing rate of 1 Hz assumed	Impulsive
ADCP	114 dB SPL	500,000-1,260,000 Hz	Based on suitable ADCP for depths <100 m (e.g. Nortek	Impulsive

Equipment	Source level [SPL] (as used in model)	Primary decidecade bands (-20 dB width)	Source model details	Impulsive/non-impulsive
(**Not modelled given high frequency**)			AWAC, Teledyne Reason Sentinel, Workhorse or Monitor) Source level adjusted for sediment effects and beam widths.	
Drilling/ rotary coring (Boreholes, no USBL)	145 dB SPL	10-500,000 Hz	Based on published levels (Erbe, et al., 2017; Fisheries and Marine Service, 1975; MR, et al., 2010; L-F, et al., 2023)	Non-impulsive
Vibro-coring & CPT	187 dB SPL	50 – 16,000 Hz	Based on levels from previous work & (Reiser, et al., 2010)	Non-impulsive

*If the SSS and SBP are hull-mounted, there is no need for a positioning device (USBL) and this noise source should be removed from consideration.

2.2.7 Programme and Timescale

EirGrid propose a site investigation activities schedule that will be phased over a two-year period. The intention is to begin survey activities as soon as feasible following license award, with a phased programme of investigations, capitalising on suitable weather windows over this time period. This phased approach will progress the overall development towards detailed design stage. It is worth noting that the exact survey schedule is dependent on the availability of the supply chain and therefore exact timelines for the surveys cannot be determined until closer to the time.

The exact dates for the surveys are to be determined pending the appointment of survey contractors but based on the estimated scope of works to be conducted the duration of each SI works phase scope has been estimated in Table 2.3 below. The estimated durations are subject to change based on variables such as weather conditions onsite, unforeseen seabed conditions, unforeseen obstructions etc.

Mobilisation location will be dependent on the survey contractor, who may choose to mobilise from their home port, port of previous job or local port. The local port options for mobilisation, for example, could include Dublin, Dún Laoghaire, Howth or Malahide depending on vessel size and marine traffic restrictions. Any changes to the anticipated SI works schedule and port mobilisation locations are not predicted to affect the findings in this assessment.

It is proposed to complete a number of follow on geophysical surveys to determined seabed mobility, these will be completed over the course of the two year license period.

Table 2.3 Estimated SI works Schedule

Phase	Scope of Work	Total No of SI Locations	Estimated Duration
Phase One	Marine Geophysical Surveys	n/a	4-6 weeks (weather dependent)
	Benthic Sampling	11	4-6 days (weather dependant)
	Intertidal Sampling	27	2-3 days (tide/weather dependant)
Phase Two	Vibrocore & CPT Sampling	30	4-6 weeks
	Borehole Sampling	6	4-6 weeks
Phase Three	Follow up Marine Geophysical Surveys	n/a	4-6 weeks (weather dependent)
All Phases	Other Environmental/ Ecological Surveys	Varies	As appropriate to environmental/ ecological survey requirements.

2.3 General Survey Requirements

All appointed survey contractors shall obtain and comply with all necessary marine operational permits including routine and customary vessel/crew/equipment clearances from Customs Agencies, Port Authorities, Marine Survey Office, etc.

2.3.1 Quality Assurance

Each of the appointed survey contractors shall comply with the following as a minimum:

- Quality and Environmental Management Systems based on ISO9001:2015.
- Provision of Quality Management Plans for all the marine operations.
- Provision of site and activity specific Method Statements for all the marine operations within their scope.

2.3.2 Health & Safety

Health, safety, environment, and welfare considerations will be a priority in the evaluation of possible contractors for the various survey scopes and will be actively managed during the course of the survey scopes of work.

Appointed contractors will be required to comply with all legislation relevant to the activities within their scope of work.

Prior to survey works taking place, both Project Supervisor for Design Process (PSDP) and Project Supervisor for Construction Stage (PSCS) will be appointed under the relevant legislation and project / survey specific HSE plans will be put in place which will form part of the survey project execution plans.

Temporary barriers, warning notices, lighting, and other measures necessary to provide for the safety of the workers on the site and/or the public will be erected and maintained for the duration of the SI works.

2.3.3 Working Hours

The working hours for the SI works are proposed to be 24 hours a day, seven days a week.

Tides, weather conditions and/or sea-state will impact on the working hours, and it may be necessary to temporarily suspend operations when adverse weather conditions and/or sea-states are encountered or forecast. Similarly, equipment maintenance and repair may impact on operational activities resulting in a break in sound-producing activity.

Where this is a break in sound-producing activity, recommencement of sound producing activities shall only occur after the successful implementation of the measures contained in the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014).

2.3.4 Vessels

All vessels will be fit for purpose, certified and capable of safely undertaking all required survey work. Marine vessels will be governed by the provisions of the Sea Pollution Act 1991, as amended, including the requirements of MARPOL. In addition, all vessels will adhere to published guidelines and best working practices such as: the National Maritime Oil/HNS Spill Contingency Plan (NMOSCP), Marine Pollution Contingency Plan (MPCP), Chemicals Act 2008 (No. 13 of 2008), Chemicals (Amendment) Act 2010 (No. 32 of 2010) and associated regulations.

Vessels shall have a Health, Safety and Environmental Managements system which should conform to the requirements of the latest International Maritime Organization (IMO), Safety of Life at Sea (SOLAS) and environmental requirements for their classification and with any national requirement of the territorial or continental / EEZ waters to be operated in.

The SI works will be undertaken from vessels in accordance with the relevant guidelines required to manage the risk to marine mammals from man-made sound sources in Irish waters.

3 APPROPRIATE ASSESSMENT METHODOLOGY

3.1 Guidance

This NIS has been compiled in compliance with the EU and national guidance documents that pertain to Member States' fulfilling their requirements under the EU Habitats Directive, with particular reference to Article 6(3) and 6(4) of that Directive. The methodology followed in relation to this NIS in accordance with the following guidance:

- EC (2000). Communication from the Commission on the Precautionary Principle. Office for Official Publications of the European Communities, Luxembourg;
- EC (2002). Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg. European Commission;
- EC, (2007). Guidance document on the strict protection of animal species of Community interest under the Habitats Directive 92/43/EEC. European Commission;
- DoEHLG (2009, rev. 2010). Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities. Department of the Environment, Heritage and Local Government;
- EC (2013). Interpretation Manual of European Union Habitats. Version EUR 28. European Commission, Luxembourg;
- EC (2018). European Commission Notice C (2018) 7621 'Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC', Office for Official Publications of the European Communities, Luxembourg;
- OPR (2021) OPR Practice Note PN01 Appropriate Assessment Screening for Development Management, Office of the Planning Regulator;
- EC (2021). European Commission Notice C (2021) 6913 'Assessment of plans and projects in relation to Natura 2000 sites – Methodological guidance on Article 6(3) and (4) of the Habitats Directive 92/43/EEC', Office for Official Publications of the European Communities, Luxembourg.

3.2 Stages

Appropriate Assessment (AA) is a four-stage process with tests at each stage. The four stages are summarised diagrammatically in Figure 3-1 below. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required.

Stages 1-2 deal with the main requirements for assessment under Article 6(3) of the Habitats Directive. Stage 3 is a precursor to Stage 4 which is the main derogation step of Article 6(4).

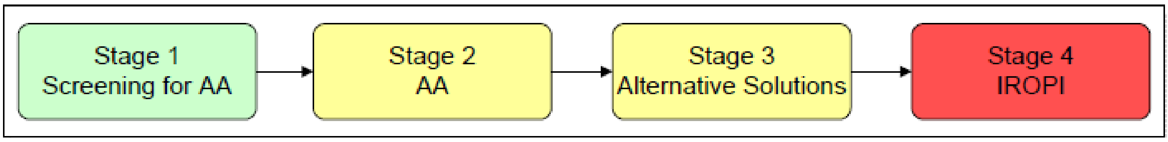

Figure 3-1 Four Stages of Appropriate Assessment

The screening for AA carried out by the competent authority (Stage 1), will determine whether an AA (Stage 2) of the proposed project is required. The purpose of the screening stage is to determine, on the basis of a preliminary assessment and objective criteria, whether a plan or project, alone and in-combination with other plans or projects, could have significant effects on a European site in view of the site's conservation objectives. Where significant effects are likely, uncertain or unknown at screening stage, a second stage AA will be required. In this case, a NIS must be prepared to assist the competent authority to conduct the Stage 2 AA. If it is not possible during Stage 2 to reduce impacts to acceptable, non-significant levels by avoidance and/or mitigation, Stage 3 of the process must be undertaken which is to objectively assess whether alternative solutions exist by which the objectives of the plan or project can be achieved. If it can be demonstrated that there are no reasonable alternative solutions, the AA progresses to Stage 4. This final stage is undertaken when it has been determined that negative impacts on the integrity of a European site will result from a plan or project and there are no alternative solutions. At Stage 4 of the AA process, it is the characteristics of the plan or project itself that will determine whether or not the competent authority can allow it to progress. This is the determination of Imperative Reasons for Overriding Public Interest (IROPI).

While there is no prescribed form or content for reporting (DoEHLG, 2009) the methodology and format adopted in this report has been in accordance with the European Commission Methodological Guidance on the provision of Article 6(3) and 6(4) of the 'Habitats' Directive 92/43/EEC (EC, 2021) and the European Commission Guidance 'Managing Natura 2000 sites' (EC, 2018), and guidance prepared by the NPWS (DoEHLG, 2009).

3.3 Identification of Relevant European sites

3.3.1 Source-Pathway-Receptor Model

Relevant European sites were identified in the Supporting Information for Screening for Appropriate Assessment (SISAA) report (RPS report ref: CP1146-RPS-00-XX-RP-N-RP1019), based on the identification of a 'zone of influence' (ZoI) of the SI works using a Source-Pathway-Receptor (S-P-R) model (OPR, 2021) where:

- A 'source' is defined as the individual element of the proposed works that has the potential to impact on a European site, its qualifying features, and its COs;
- A 'pathway' is defined as the means or route by which a source can affect the ecological receptor; and
- A 'receptor' is defined as QI of European sites being assessed for which COs have been set.

An S-P-R model is a standard tool used in environmental assessment. In order for an effect to be likely, all three elements of this mechanism must be in place. The absence or removal of one of the elements of the mechanism results in no likelihood for the effect to occur. The S-P-R model was used to identify a list of European sites, and their QIs, to which the SI works are linked. These are termed as 'relevant' sites/QIs throughout this report.

3.3.2 Adverse effects on the integrity of European sites

The European Commission's 2018 Notice (EC, 2019) advises that the purpose of the AA is to assess the implications of the plan or project in respect of the site's COs, either individually or in-combination with other plans or projects. The conclusions should enable the competent authorities to ascertain whether the plan or project will adversely affect the integrity of the site concerned. The focus of the AA is therefore specifically on the species and/or the habitats for which the European sites is designated.

EC (2019) also emphasises the importance of using the best scientific knowledge when carrying out the AA in order to enable the competent authority to conclude with certainty that there will be no adverse effects on the integrity of the site. This guidance notes that it is at the time of adoption of the decision authorising implementation of the project that there must be no reasonable scientific doubt remaining as to the absence of adverse effects on the integrity of the site in question.

As regards the meaning of 'integrity,' this relates to ecological integrity. This can be considered as a quality or condition of being whole or complete. In a dynamic ecological context, it can also be considered as having the sense of resilience and ability to evolve in ways that are favourable to conservation.

The 'integrity of the site' can be usefully defined as (EC, 2019):

"The coherent sum of the site's ecological structure, function and ecological processes, across its whole area, which enables it to sustain the habitats, complex of habitats and/or populations of species for which the site is designated."

EC (2019) notes that if the competent authority considers the mitigation measures are sufficient to avoid the adverse effects on site integrity identified in the AA, they will become an integral part of the specification of the final plan or project or may be listed as a condition for project approval.

EC (2019) advises that it is for the competent authority, in the light of the conclusions made in the appropriate assessment on the implications of a plan or project for the European sites concerned, to approve the plan or project. This decision can only be taken after they have made certain that the plan or project will not adversely affect the integrity of the site. That is the case where no reasonable scientific doubt remains as to the absence of such effects.

EC (2019) also reaffirms that the authorisation criterion laid down in the second sentence of Article 6(3) of the Habitats Directive integrates the precautionary principle and makes it possible effectively to prevent the protected sites from suffering adverse effects on their integrity as the result of the plans or projects. A less stringent authorisation criterion could not as effectively ensure the fulfilment of the objective of site protection intended under that provision. The onus is therefore on demonstrating the absence of adverse effects rather than their presence, reflecting the precautionary principle. It follows that the appropriate assessment must be sufficiently detailed and reasoned to demonstrate the absence of adverse effects, in light of the best scientific knowledge in the field.

3.3.3 Consideration of ex-situ effects

EC (2019) advises that Member States, both in their legislation and in their practice, allow for the Article 6(3) safeguards to be applied to any development pressures, including those which are external to European sites, but which are likely to have significant effects on any of them.

The CJEU developed this point when it issued a ruling that determined *inter alia* that Article 6(3) of the Habitats Directive must be interpreted as meaning that an appropriate assessment must on the one hand, catalogue the entirety of habitat types and species for which a site is protected, and, on the other, identify and examine both the implications of the Project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect the COs of the site.

In that regard, consideration has been given in this NIS to inform AA to implications for habitats and species located both inside and outside of the European sites considered in the SISAA with reference to those sites' COs where effects upon those habitats and/or species are liable to affect the COs of the sites concerned.

3.3.4 Conservation objectives

The COs for each European site are to maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the site has been selected.

The favourable conservation status of a habitat is achieved when:

- Its natural range, and area it covers within that range, are stable or increasing;
- The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- The conservation status of its typical species is favourable.

The favourable conservation status (or condition, at a site level) of a species is achieved when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The COs of European sites published by the National Parks and Wildlife Service (NPWS) note that an AA based on the most up to date COs (which are defined by a list of attributes and targets) will remain valid even if the targets are subsequently updated, providing they were the most recent objectives available when the assessment was carried out.

The most up-to-date COs for the European sites being considered have been used in this NIS. Details in relation to the QIs of SACs is based on publicly available data sourced from the NPWS.

3.3.5 In-combination effects

Article 6(3) of the Habitats Directive requires that in-combination effects with other plans or projects are also considered. As set out in EC (2018), significance will vary depending on factors such as magnitude of impact, type, extent, duration, intensity, timing, probability, cumulative effects and the vulnerability of the habitats and species concerned.

EC (2021) notes that cumulative environmental effects can be defined as effects on the environment caused by the combined action of past, current, and future activities. Although the effects of one development may not be significant, the combined effects of several developments together can be significant.

EC (p.14, 2021) also notes that “in-combination provision concerns other plans or projects that have been already completed, approved but uncompleted, or proposed (i.e., for which an application for approval or consent has been submitted).” And furthermore (p.31, ibid): “In addition to the effects of the plans or projects that are the main subject of the assessment, it may be appropriate to consider the effects of already completed plans and projects, including those preceding the date of transposition of the directive or the date of designation of the site. The effects of such completed plans and projects would typically form part of the site's baseline conditions which are considered at this stage.”

Plans and projects that have been approved in the past but have not yet been implemented or completed should be included in the in-combination provision. As regards other proposed plans or projects, on grounds of legal certainty it would seem appropriate to restrict the ‘in-combination’ provision to plans that have been proposed, (i.e., for which an application for approval or consent has been submitted) (EC, 2021).

This mirrors the advice contained in EC (2018) which advises that other plans or projects which are completed, approved but uncompleted, or proposed should be considered. EC (2018) specifically advises that “as regards other proposed plans or projects (i.e., other projects not proposed by the Applicant), on grounds of legal certainty it would seem appropriate to restrict the in-combination provision to those which have been actually proposed, i.e., for which an application for approval or consent has been introduced”.

The ability for impacts arising from the proposed project to overlap with those from other projects, plans and activities to result in adverse effects are considered. This means that, in most examples, an overlap of the physical extents of the impacts arising from the two (or more) projects, plans or activities must be established for an in-combination effect to arise. For example, for a cumulative sedimentation effect to be established between the proposed project and another project, it must be established that the extent of sediment release from both projects has the potential to overlap and may affect a receptor at the same location.

Exceptions to this exist for certain mobile receptors that may move between, and be subject to, two or more separate physical extents of impact from two or more projects. For example, species such as otter may be affected by water quality impacts from the project, as well as those from other projects where the extent of another area affecting water quality does not directly overlap with that of the project. Where relevant, mitigation is proposed as necessary to prevent adverse in-combination effects.

3.4 Ecological Data

3.4.1 Desk Study

A desk study was completed to assess the potential for QIs of European sites within the ZoI of the SI works to occur and the potential for relevant QIs to be adversely affected. The desktop study had particular regard for the following sources:

- Carter, MI, Boehme, L, Cronin, MA, Duck, C, James Grecian, W, Hastie, GD, Jessopp, MJ, Matthiopoulos, J, McConnell, BJ, Morris, CD, Moss, SEW, Thompson, D, Thompson, P & Russell, DJF (2022), 'Sympatric seals, satellite tracking and protected areas: habitat-based distribution estimates for conservation and management', Frontiers in Marine Science, vol. 9, 875869. https://doi.org/10.3389/fmars.2022.875869;
- CSO (2024). Statistics of Port Traffic Q4 and Year 2023. Available at: https://www.cso.ie/en/releasesandpublications/ep/p-spt/statisticsofporttrafficq4andyear2023/data/ Accessed October 2024;

- Cummins, S., Lauder, C., Lauder, A. & Tierney, T. D. (2019) The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018. Irish Wildlife Manuals, No. 114. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland;
- Department of Arts, Heritage and the Gaeltacht (DAHG) (2014) Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters. Dublin, Ireland, Department of Arts, Heritage and the Gaeltacht, 58pp;
- Distribution records for QI of European sites held online by the National Biodiversity Data Centre (NBDC) (www.biodiversityireland.ie). Accessed October 2024;
- EMODnet (2024) Map Viewer. Available at: https://emodnet.ec.europa.eu/geoviewer/ . Accessed October 2024;
- Environmental Protection Agency (EPA) online interactive mapping tools (https://gis.epa.ie/EPAMaps) and (https://www.catchments.ie/maps/) for water quality data including surface and ground water quality status, and river catchment boundaries. Accessed October 2024;
- Geohive online data catalogue (https://www.geohive.ie/pages/data). Accessed October 2024;
- Geological Survey Ireland (GSI) (https://www.gsi.ie/en-ie/Pages/default.aspx) Accessed October 2024;
- IAMMWG. (2023). Review of Management Unit boundaries for cetaceans in UK waters (2023). JNCC Report 734, JNCC, Peterborough, ISSN 0963-8091. https://hub.jncc.gov.uk/assets/b48b8332-349f-4358-b080-b4506384f4f7;
- Information on ranges of mobile QI populations in Volume 1 of NPWS' Status of EU Protected Habitats and Species in Ireland (NPWS, 2019), and associated digital shapefiles obtained from the NPWS Research Branch;
- Irish Whale and Dolphin Group Sightings Log https://iwdg.ie/browsers/sightings.php/ Accessed October 2024;
- JNCC (2019) The UK Approach to assessing Conservation Status for the 2019 Article 17 reporting under the EU Habitats Directive. Joint Nature Conservation Committee, Peterborough. Available to download from https://jncc.gov.uk/article17;
- Macklin, R., Brazier, B. & Sleeman, P. (2019). Dublin City otter survey. Report prepared by Triturus Environmental Ltd. for Dublin City Council as an action of the Dublin City Biodiversity Action Plan 20152020;
- Mapping of European site boundaries and Conservation Objectives for relevant sites, available online from the NPWS included site synopsis, European site Data form and Conservation Objective Supporting Documents where available (https://www.npws.ie/protected-sites). Accessed October 2024;
- Mullen, E., Marnell, F. & Nelson, B. (2021) Strict Protection of Animal Species. National Parks and Wildlife Service Guidance Series, No. 2. National Parks and Wildlife Service, Department of Housing. Local Government and Heritage;
- NPWS (2009) Threat Response Plan: Otter (2009-2011). National Parks & Wildlife Service, Department of the Environment, Heritage & Local Government, Dublin;
- Ordnance Survey of Ireland maps and aerial photography (https://osi.ie). Accessed October 2024; and
- Woodward, I., Thaxter, C.B., Owen, E. & Cook, A.S.C.P., (2019). Desk-based revision of seabird foraging ranges used for HRA screening, Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate, ISBN 978-1-912642-12-0.

4 STAGE 1 SCREENING FOR APPROPRIATE ASSESSMENT

4.1 SISAA Report

Through an assessment of the S-P-R model, which considered the ZoI of effects from the SI works, the following findings were reported by RPS in the SISAA report (RPS report ref: CP1146-RPS-00-XX-RP-N-RP1019):

The SI works are not connected with or necessary to the management of the nature conservation interest of any European site.

In the absence of mitigation, as a result of visual and above water noise disturbance associated with the SI works, disturbance of QI species is possible at the following European sites:

- South Dublin Bay and River Tolka Estuary SPA (wintering waterbirds)
- North Bull Island SPA (wintering waterbirds)
- North-West Irish Sea SPA (seabird species)
- Dalkey Island SPA (seabird species)

In the absence of mitigation the SI works, have the potential to contribute to habitat loss, alteration, and/or fragmentation non-annexed wetland habitat and roost sites at the following European site

- South Dublin Bay and River Tolka Estuary SPA

In the absence of mitigation, the geophysical, geotechnical and metocean surveys will introduce subsea noise that has the potential to impact on harbour porpoise, grey and harbour seals at the following European Sites:

- Rockabill to Dalkey Island SAC (harbour porpoise)
- Lambay Island SAC (harbour porpoise, grey seal and harbour seal)

In the absence of mitigation measures, there is the potential for there to be in-combination effects from other projects and therefore in-combination effects are screened in for further assessment.

See Table 4.1 for a full list of impacts considered in the SISAA and the conclusions contained in that report.

The SISAA report concludes that it cannot be excluded, on the basis of objective information, the SI works, individually or in-combination with other plans or projects, will have a significant effect on the integrity of the European sites mentioned above. It is recommended that a Natura Impact Statement (NIS) be prepared to assist MARA in conducting an Appropriate Assessment should they agree with the findings of the SISAA.

Table 4.1 Summary of Impacts assessed during SISAA and Likely Significant Effects Identified

Impact	Potential source of impact	Description of Effect Pathway	Relevant Receptors	Likely significant effects identified in Screening?
Visual and above water noise disturbance.	Vessel activity associated with the marine geophysical and geotechnical surveys, metocean surveys, and marine environmental surveys (including intertidal/beach surveys).	Potential for direct impacts by disturbing species, leading to displacement from the area.	Marine mammals, otter, birds.	Yes, for QI bird species of the South Dublin Bay and River Tolka Estuary SPA, North Bull Island SPA, North-West Irish Sea SPA and Dalkey Island SPA.
Habitat loss, alteration and/ or fragmentation.	Interactions with the seabed resulting from geotechnical surveys (borehole drilling, metocean surveys and marine environmental works (grab sampling).	Potential for direct effects on sensitive habitats and indirect effects to species which rely on those habitats for feeding and/or breeding.	Marine habitats, marine mammals, otter, fish, birds.	Yes, for the non-annexed wetland habitat/roost sites of the South Dublin Bay and River Tolka Estuary SPA.
Increased suspended sediment concentrations (SSC)	Interactions with the seabed resulting from geotechnical surveys (borehole drilling), metocean surveys and marine environmental works (grab sampling).	Potential for direct effects on sensitive habitats and indirect effects to species which rely on those habitats for feeding and/or breeding.	Marine habitats, marine mammals, otter, fish, birds.	No. Given the water depth, tidal influence, the nature of Dublin Bay, any sediment from SI works entering the water column will rapidly disperse. There will be no likely significant effects on the Annex I habitats as a result of increased SSC.
Underwater noise, including injury and or displacement of Annex II marine mammals, otter, and fish from underwater noise and/or the presence of increased marine traffic (visual).	Noise emissions and increased marine traffic from geophysical and geotechnical (borehole drilling and vibrocores) equipment, vessels and metocean devices associated with marine geophysical surveys, metocean surveys, and marine environmental surveys. May cause injury and/or displacement of Annex II marine mammals, otter, and fish.	Potential for direct effects on species in the marine environment including injury, disturbance and/or displacement.	Marine mammals, otter, fish, birds.	Yes, for marine mammals of the Rockabill to Dalkey Island SAC and Lambay Island SAC.
Accidental pollution event.	Vessel activity associated with the marine geophysical and geotechnical surveys, metocean surveys and marine environmental surveys.	Potential for direct effects on marine habitats and species, and indirect effects through contamination of supporting habitats.	Marine habitats, marine mammals, otter fish, birds.	No. Given the nature of the SI works, their limited scale and duration, and the insignificant increase in vessel activity relative to baseline levels, it is considered highly unlikely that there will be a pollution incident, e.g., accidental spills of small quantities of fuel.

Impact	Potential source of impact	Description of Effect Pathway	Relevant Receptors	Likely significant effects identified in Screening?
Risk of collision	Vessel activity associated with the marine geophysical and geotechnical surveys, and marine environmental surveys.	Potential for direct effects to large species in the marine environment.	Marine mammals, otter.	No. A maximum of two vessels will be operating at any one time within the proposed survey area. Dublin Port is a major shipping area and therefore collisions between survey vessels and harbour porpoise, grey and harbour seals will be extremely unlikely.
In-combination effects	In-combination effects from other consented or planned projects within the ZoI.	Potential for direct effects on marine habitats and species, and indirect effects through contamination of supporting habitats.	Marine habitats, marine mammals, otter fish, birds	Yes.

5 STAGE 2 NATURA IMPACT STATEMENT

5.1 Relevant European sites

The following sections identify, through a scientific examination of ecological data and evidence, the European Sites and relevant QIs that were screened in for AA. Each of these QIs will be assessed to determine whether or not the SI works, alone or in-combination with other plans or projects, will have an adverse effect on the QI and as a result impact on the integrity of the European site in view of their Conservation Objectives (COs). The MULA Area of Interest (AoI) is considered to be within the Zone of Influence (ZoI) of the following European sites:

- Rockabill to Dalkey Island SAC;
- Lambay Island SAC;
- South Dublin Bay and River Tolka Estuary SPA;
- North Bull Island SPA;
- North-West Irish Sea SPA; and
- Dalkey Island SPA;

It was determined that further assessment is required to determine whether the SI works are likely to adversely affect the integrity of these European sites with or without mitigation measures.

A summary of the COs including conservation status relevant to the screened in European Sites listed above can be found in Appendix D.

5.2 Baseline Description of Relevant Qualifying Interests of SACs

The following section discusses the QIs that were screened in for Stage 2 AA from the SACs listed in 5.1.

5.2.1 Harbour porpoise *Phocoena phocoena* [1351]

South Dublin Bay is adjacent to the Rockabill to Dalkey Island SAC and Lambay Island SAC of which harbour porpoise is a QI species. There are sixteen European sites designated for harbour porpoise in Ireland. Irish waters are covered by two JNCC Management Units (MU) for harbour porpoise, namely: the Celtic and Irish Sea (CIS) MU and the West Scotland (WS) MU. The MU that overlaps the proposed MULA Area for harbour porpoise is the CIS MU. Abundance of harbour porpoise in the CIS MU is estimated at 62,517 animals (JNCC, 2022). Estimates of density are available for coastal waters in survey stratum 5 of the phase II ObSERVE aerial surveys. These data suggested that harbour porpoise occurs in densities of between 0.150 to 0.968 animals per km^2 (Paradell et al., 2024), in Stratum 5 (Irish Sea).

The CO for harbour porpoise is to maintain the favourable conservation condition of these QIs, as defined through the attributes and targets in the NPWS (2013d) Conservation Objectives document. The screened in EU sites, including QIs, COs and relative conservation status are listed in Appendix D.

5.2.2 Grey Seal *Halichoerus grypus* [1364]

Lambay Island SAC is the closest SAC to the proposed SI works which is designated for grey seal. The grey seal is one of two seal species found in Ireland. It is found on both sides of the North Atlantic Ocean although the greatest proportion of the population is found in UK waters. It occurs in greatest numbers on the western seaboard of Ireland although significant numbers also occur on the east and southeast coasts. The grey seal generally breed in Irish waters from September to December on remote and generally undisturbed areas, including offshore islands.

Carter et al. (2022)[1] states the maximum foraging range for the UK and Ireland for grey seal is up to 448 km. However, this maximum range is not likely in most situations. Due to the foraging differences noted by region, the Carter et al 2022 paper (including the supplementary material[2]) further examined the various regions modelled in the study (10 regions in total). For the Irish North Sea (Region 7) the typical foraging distances were found to be significantly less and ranged up to approximately 100 km for grey seals.

Lambay Island is within the maximum foraging range of 100 km and therefore it is possible that grey seals may utilise South Dublin Bay. North Bull island, which is located 1 km to the north of the AoI boundary is known as an important haul out site for grey seals, even though they are recorded as having a seasonal presence arriving late April or early May and leaving late October or early November to breed and moult[3], therefore presence within Dublin Bay and the surrounding environs is possible. No haul out sites are recorded in South Dublin Bay.

The CO for grey seal is to maintain the favourable conservation condition of these QIs, as defined through the attributes and targets in the NPWS (2013e) Conservation Objectives document. The screened in EU sites, including QIs, COs and relative conservation status are listed in Appendix D.

5.2.3 Harbour Seal *Phoca vitulina* [1365]

Lambay Island SAC is the closest SAC to the proposed SI works which is designated for harbour seal. Harbour seal is one of two seal species found in Ireland. It is found on both sides of the North Atlantic Ocean. Harbour seal generally breed in Irish waters from May to July. The species is more commonly found ashore in sheltered bays, inlets and enclosed estuaries. Harbour seals in Lambay Island SAC occupy both aquatic habitats and intertidal shorelines that become exposed during the tidal cycle (NPWS, 2013f). The species is present at the site throughout the year including during breeding (May to July), moulting (August to September) and non-breeding foraging and resting phases. Harbour seals are vulnerable to disturbance while hauled out or in shallow waters. This disturbance can occur prior to and during the annual breeding season, which takes place during the months of May to July (NPWS, 2013f).

Carter et al. (2022) states the maximum foraging range for the UK and Ireland for harbour seal is up to 273 km. However, this maximum range is not likely in most situations. Due to the foraging differences noted by region, the Carter et al., (2022) paper (including the supplementary material) further examined the various regions modelled in the study (10 regions in total). For the Irish North Sea (Region 7) the typical foraging distances were found to be significantly less and ranged up to approximately 80 km for harbour seal. Lambay Island SAC is within the maximum foraging range of 80 km and therefore it is possible that harbour seals may utilise South Dublin Bay.

The CO for harbour seal is to maintain the favourable conservation condition of these QIs, as defined through the attributes and targets in the NPWS (2013e) Conservation Objectives document. The screened in EU sites, including QIs, COs and relative conservation status are listed in Appendix D.

5.3 Baseline Description of Relevant SPAs

The following sections discuss the SPAs that were screened in for Stage 2 AA which are also listed in Section 5.1.

The SPAs listed below share the same CO (i.e. depending on current status, either to maintain or restore favourable conservation status) and attributes. These are listed in Appendix D for further information.

5.3.1 South Dublin Bay and River Tolka Estuary SPA (004024)

This site is selected for the protection of 13 populations of wintering waterfowl and seabirds. Common tern (*Sterna hirundo*) and Arctic tern (*Sterna paradisaea*) breed on a man-made mooring known as the CPL

[1] Available: Frontiers | Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management (frontiersin.org) Accessed October 2024

[2] Available: https://www.frontiersin.org/articles/10.3389/fmars.2022.875869/full#supplementary-material Accessed October 2024

[3] https://www.dublinbaybiosphere.ie/news/north-bull-island-seal-survey/ Accessed October 2024

Dolphin within the Dublin Docks. The South Dublin Bay and River Tolka Estuary SPA is an important passage area for tern species including common, Arctic and Roseate Tern (*Sterna dougalii*) (NPWS, 2014a).

These species vary considerably in their ecology due to adaptations and specialisations that influence their uses of different habitats, and the resulting behaviours affects how species are distributed across a site as a whole. Reliance on and use of alternative habitats varies between species, through time, from seasonally through to daily, and different habitats may be used by day and night (Shepherd *et al.* 2003, cited in NPWS, 2014a). Different waterbird species utilise habitats in different ways. When tidal flats are covered at high water, intertidally foraging waterbirds are unable to forage, and may move to nearby fields to feed. Some species are generalists, and make use of a range of habitats, for example the Black-tailed godwit (*Limosa limosa*) forage across intertidal mudflats but also readily use grassland habitats. Some species switch their habitat preference as food supplies become depleted, e.g., Light-bellied brent geese (*Branta bernicla*) exploit grasslands when intertidal seagrass and algae become depleted. Thus, the area designated as a SPA can represent a variable portion of the overall range of the listed waterbird species. There are several roost locations to the north and south at the proposed landfall locations. Four of these roost sites are located within the 500 m proposed cable route corridor (Figure 5-1). To the south between Blackrock and Booterstown there are two roost locations; roost ID: NK14, species: Black-headed Gull (*Chroicocephalus ridibundus)*, Common Gull (*Larus canus*), and roost ID: NK09, species: oystercatcher (*Haematopus ostralegus)*. Roost sites in close proximity to the proposed cable route corridor include roost ID: NK15, species: oystercatcher and roost ID: NK10, species: Black-headed Gull, Common Gull, Herring Gull (*Larus argentatus*) which are located approximately 200 m from the nearest vibrocore station. Roost NK15 is located between Intake and Booterstown in Co. Dublin, roost NK10 is located to the south-east of the historic Blackrock baths. To the north at Poolbeg along the south wall there are two roost locations within the 500 m proposed cable route corridor; roost ID: SMCA2, species: Purple Sandpiper (*Calidris maritima*), Dunlin (*Calidris alpina*) and Turnstone (*Arenaria)* and roost ID: SMCA1 for turnstone. SMCA2 is approximately 100 m from the nearest vibrocore station and SMCA1 is approximately 200 m from the nearest vibrocore station. Roost SMCA3, species: oystercatcher is located to the south of the Poolbeg Power Station seaside of pigeon house road and is approximately 400 m from the nearest borehole location.

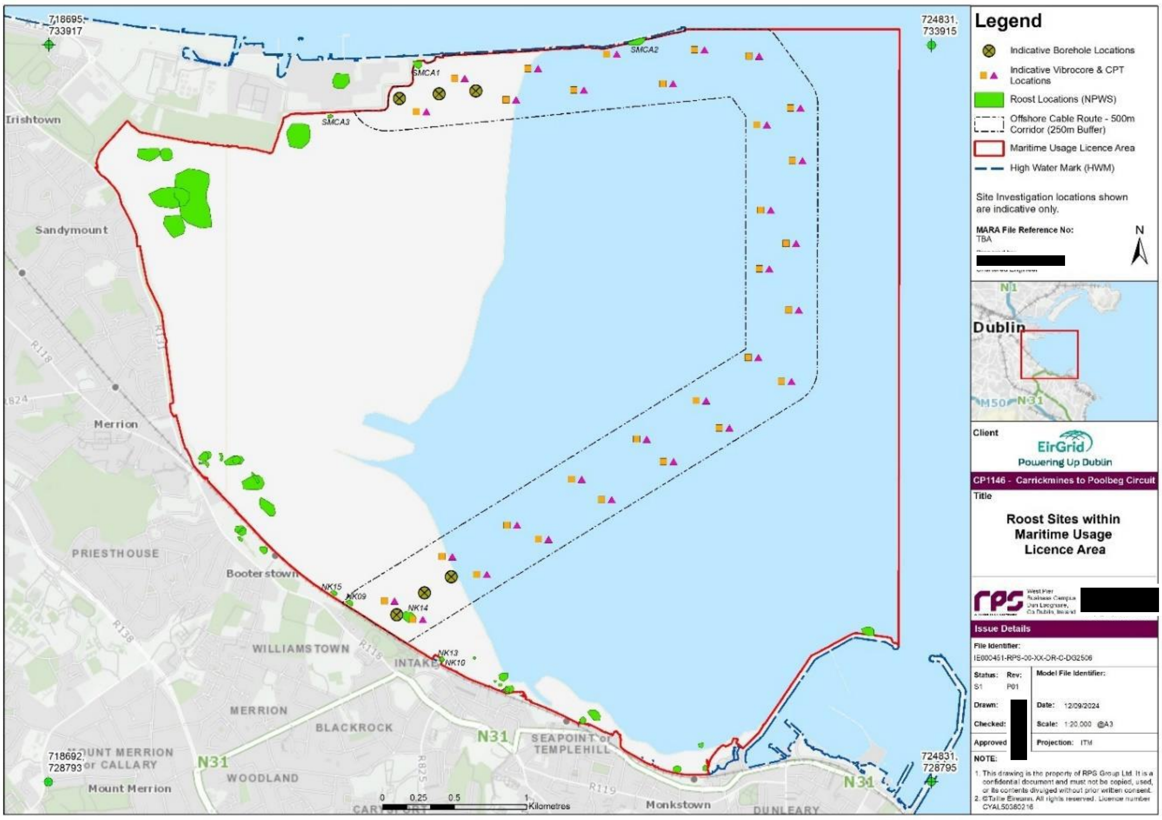

Figure 5-1 Roost Sites within Maritime Usage Licence Area

5.3.2 North Bull Island SPA (004006)

This site is selected for the protection of 17 populations of wintering waterbirds. The site supports internationally important populations of three species, Light-bellied Brent Goose, Black-tailed Godwit, and Bar-tailed Godwit (*Limosa lapponica*). The site is one of the most important in the country for Light-bellied Brent Goose. While some of the birds also frequent South Dublin Bay and the River Tolka Estuary SPA for feeding and/or roosting purposes, the majority remain within the site for much of the winter. The North Bull Island SPA is a regular site for passage waders, especially Ruff (*Calidris pugnax*), Curlew (*Numenius*), Sandpiper (*Scolopacidae*) and Spotted Redshank (*Tringa erythropus*). These are mostly observed in single figures in autumn but occasionally in spring or winter (NPWS, 2014b). North Bull Island is a Ramsar Convention site, and part of the North Bull Island SPA is a Statutory Nature Reserve and a Wildfowl Sanctuary. The sites designated as North Bull Island SPA and South Dublin Bay and River Tolka Estuary SPA are inextricably interlinked because several of the listed waterbird species use habitats within both of the designated sites and make regular movements between them. Although waterbirds may be linked by their dependence on water, different species vary considerably in aspects of their ecology due to many evolutionary adaptations and specialisations to their wetland habitats (NPWS, 2014b). Different species or groups of species may therefore utilise wetland habitats in very different ways which relates to how species are distributed across a site as a whole. Although some waterbird species will be faithful to specific habitats within the SPA, many will at times also use habitats situated within the immediate hinterland of the site or in areas ecologically connected to the SPA. These areas may be used as alternative high tide roosts, as a foraging resource or, be simply flown over, either on migration or on a more frequent basis throughout the non-breeding season as waterbirds move between different areas used (e.g. commuting corridors between feeding and roosting areas) (NPWS, 2014b).

5.3.3 North-West Irish Sea SPA (004236)

This site is selected for the protection of 21 populations of seabirds and provides essential resources for adjacent seabird colonies. The tern populations that is listed for the nearby South Dublin Bay and River Tolka Estuary SPA are also likely to use this SPA as a foraging resource. Informed by two surveys of the western Irish Sea region in 2016 an estimated 120,232 and 34,626 individual marine birds occurred in this SPA during autumn and winter respectively. Those marine bird species whose estimated abundances equalled or exceeded 1% of the total estimated size of the winter assemblage are: Red-throated Diver (*Gavia stellata*) (538), Fulmar (*Fulmarus glacialis*) (506), Little Gull (*Larus minutus*) (391), Kittiwake (*Rissa tridactyla*) (944), Black-headed Gull (508), Common Gull (2,866), Herring Gull (6,893), Great Black-backed Gull (*Larus marinus*) (2,096), Razorbill (*Alca torda*) (4,638) and Guillemot (*Uria aalge*) (13,914) (NPWS, 2023). Estimated summer abundances of Manx Shearwater is of international importance and 106 autumn and winter abundances of Great Northern Diver are or international importance. During the non-breeding period diver species e.g., great northern and red-throated diver in the western Irish Sea are known to concentrate in the shallower coastal areas, with a clear preference for waters of 5-20m (Jessopp et al., 2018). Jessop et al., (2018) recorded fulmars throughout the western Irish Sea which showed a clear preference for deeper waters. Seabird species regularly use the marine waters adjacent to their breeding colonies for non-sites specific maintenance behaviours (e.g. courtship, bathing, preening) as defined in McSorley et al. (2003).

5.3.4 Dalkey Island SPA (004172)

This site is selected for the protection of three populations of breeding and staging marine seabirds, Roseate, Common and Arctic Terns. The site, along with other parts of South Dublin Bay, is used by the three tern species as a major post-breeding/pre-migration autumn roost area (NPWS, 2015a). The site is linked to another important post-breeding/pre-migration autumn tern roost area in and around Dublin Bay (NPWS, 2015a). The origin of the birds is likely to be the Dublin breeding sites (Rockabill and Dublin Docks) though the numbers recorded suggests that birds from other sites, perhaps outside the State, are also present. Common terns can range up to 30 km and Arctic terns can range up to 46 km from nest sites. Towards the end of the breeding season tern species form large aggregations at roost sites along the coast (Burke et al., 2020).

6 ASSESSMENT OF ADVERSE EFFECTS

6.1 Visual and Above Water Noise Disturbance

Dublin Bay supports populations of waders and waterbirds including some seabirds from surrounding SPAs which may utilise the Bay at certain times of the year. The proposed SI works presents the potential for direct visual and above water noise disturbances to the QIs of the following SPAs:

- South Dublin Bay and River Tolka Estuary SPA;
- North Bull Island SPA;
- North-West Irish Sea SPA; and
- Dalkey Island SPA.

The screened in EU sites, including QIs, COs and relative conservation status are listed in Appendix D. Below is a combined synopsis of the measures identified to achieve the COs of these SPAs (extracted from the list of attributes and targets found within the CO documents).

- Ensure long term population trends of QI bird species at SPAs are stable or increasing;
- Ensure no significant decline in the distribution and population of QI bird species (passage, breeding, roosting) other than that occurring from natural patterns of variation;
- Ensure no significant decrease in the distribution, range, timing or intensity of use of suitable habitat to support QI bird species other than that occurring from natural patterns of variation
- Ensure no significant decline in prey/forage biomass availability, including sufficient numbers of locations and areas of suitable habitat;
- Ensure there are no significant increase to barriers of connectivity and site use of the SPA or other ecologically important sites outside the SPA;
- Ensure human activities occur at levels that do not disturb breeding or roosting sites which could have adverse effect on QI bird species;
- Ensure no significant decline in fledged young per breeding QI bird species;
- Ensure no significant disturbance (intensity, frequency, timing and duration) occurs across the site that may impact population size and spatial distribution; and
- Ensure the permanent area occupied by the wetland is stable and not significantly less than 2,192 hectares.

Dublin Bay's mudflats/sandflats are an open environment, meaning visual disturbances would be seen from further and auditory disturbances would travel further given the lack of a built-up environment to absorb any sounds or shield any visuals. However, it should be noted there is an existing level of baseline noise in the area due to industrial and commercial operations at Dublin Port, traffic on nearby roads, the operational railway/ DART line, and normal human activities including walkers in the intertidal area. The intertidal area is free of vehicles/machinery but is a popular area for walkers at low tide resulting in a regular, existing level of disturbance for intertidal birds. There are a number of seabirds known to nest and forage in South Dublin Bay and River Tolka Estuary SPA during the summer months. The presence of construction related visual and above water noise disturbances (e.g., the presence of survey vessels, jack up barges and intertidal walk over surveyors) gives rise to potential disturbance and displacement of these seabirds from their foraging grounds in the bay.

There is potential for visual and above water noise disturbance to roost sites within South Dublin Bay as four roost sites were identified as being within the proposed cable route corridor (NK14, NK09, SMAC2, SMAC1). To the south between Blackrock and Booterstown for common gull (*Larus canus*), black headed gull (*Chroicocephalus ridibundus*) and oystercatcher (*Haematopus Ostralegus*), and to the north along south-wall at Poolbeg for Purple Sandpiper (*Calidris maritima*), Dunlin (*Calidris alpina*) and Turnstone (*Arenaria)*.

However, there are several foraging and roosting grounds available within the South Dublin Bay and River Tolka Estuary SPA, and other coastal areas. Within the AoI, there are 30 intertidal and subtidal roost sites excluding those identified within the 500 m proposed cable route corridor (See Figure 5-1). Six of these roost sites are located to the north-west of the bay at Sandymount Strand and to the south of Pigeon House Road.

These roost sites range from approximately 82 m to 2 km from the proposed cable route corridor. A further 11 roost sites are located between approximately 500 m to 1 km from the proposed cable route corridor opposite Booterstown. The remaining sites are located between Blackrock and Dun Laoghaire Harbour. These sites range from approximately 300 m to 2 km from the proposed cable route corridor. Species identified in the roost sites which are QIs of the South Dublin Bay and River Tolka Estuary SPA and North Dublin Bay SPA (oystercatcher, dunlin and turnstone) within the 500 m proposed cable route corridor are recorded as stable or increasing based on the I-WeBS Dublin Bay trends for 1994-2020 (Kennedy et al., 2023).

These QIs bird species (oystercatcher, dunlin and turnstone) are also listed as QIs for the North Dublin Bay SPA so it is therefore reasonable to assume that they may also utilise the roost sites within the South Dublin Bay and River Tolka Estuary SPA. As stated above, oystercatcher, dunlin and turnstone are recorded as stable or increasing on the I-WeBS Dublin Bay trends for 1994-2020. Given the availability of additional roosts (See Figure 5-1) within South Dublin Bay, coupled with the existing baseline levels of noise and disturbance within the Bay as discussed above, and the temporary nature and short duration of the proposed SI works, there will be no negative impact on population trends including the distribution or population of oystercatcher, dunlin and turnstone within the South Dublin Bay and River Tolka Estuary SPA and those QIs of the North Dublin Bay SPA.

Black headed gulls which are QIs of the South Dublin Bay and River Tolka Estuary SPA the North Dublin Bay SPA are noted to be tolerant of anthropogenic disturbance and have been recorded as utilising extensive urban areas for wintering habitats (Snow and Perrins, 1998). A study carried out on waterbirds in South Dublin Bay found that the area which is used by a variety of gull species including black headed gull, and that gull species were largely habituated to human activity in the area (Phalan and Nairn, 2007). Given the urban nature of the surrounding environment and the presence of public roads and railway tracks, supporting DART, commuter and freight train services, frequent dog walkers at low tide, port activities at Dublin Port (including frequent maintenance dredging of the main channel) and the use of the area for recreational purposes (e.g. sailing), there is an existing baseline level of visual and above water noise disturbance which gull species in the area will have become habituated to. Due to the temporary nature and short duration of the proposed SI works and the existing level of baseline noise and disturbance within the Bay the proposed SI works will not cause significant disturbance to black headed gull within South Dublin Bay. The are additional roosts available in the Bay (See Figure 5-1). Therefore, there will be no significant decline in the distribution or population of black headed gull within the South Dublin Bay and River Tolka Estuary SPA and the North Bull Island SPA.

QI bird species of the North-West Irish Sea SPA can forage considerable distances from their colonies with species such as Manx shearwater (*Puffinus puffinus*) and fulmar (*Fulmarus glacialis*) capable of foraging hundreds of kilometres away (Woodward et al., 2019). Given the limited size, scale and duration of the SI works within the context of these extensive foraging ranges, seabirds from the North-West Irish Sea SPA will not be foraging within the AoI in numbers that would lead to implications to the conservation objectives of those sites (e.g., the ability of these species to access suitable habitats within these sites, effects on the natural distribution/population range of the population etc). Therefore, visual and above water noise disturbance effects due to the proposed SI works will not cause population level effects on those QI species.

The operation of vessels and equipment within the AoI have the potential to disturb nesting/breeding birds within the South Dublin Bay and River Tolka Estuary SPA. A breeding colony of Arctic and common terns are recorded at Dublin Port on four artificial structures. Two of these structures are within the Dublin Docks and are the primary roost locations of terns in Dublin Bay. These structures are known as the ESB and CDL Dolphins and are located on the northern side of the Great South Wall, located approximately 600 m to 900 m northwest of the proposed cable route corridor. The third structure is located to the northern side of the south wall approximately 100 m from the proposed cable route corridor and the fourth structure is located to the north of Promenade Road at north wall in Dublin Port, approximately 2 km northwest from the proposed cable route corridor. Tern species are QIs of the South Dublin Bay and River Tolka Estuary SPA, North-West Irish Sea SPA and the Dalkey Island SPA. Tern species from the North-West Irish Sea SPA and the Dalkey Island SPA were considered here as it is possible that individuals from these SPAs may utilise the man-made structures in the Dublin Docks for nesting/breeding. Therefore, the proposed SI works have the potential to cause visual and above water noise disturbance on nesting/breeding tern species that utilise Dublin Bay. However, terns are known to be resilient to high levels of anthropogenic disturbance and globally records have shown that tern nest in busy areas, e.g., adjacent to airports, military ranges and port terminals[4]. This shows that tern species are becoming increasingly resilient to human activity due to habituation. Common terns have also been shown to be tolerant to disturbance as close as 10 m during surveys (Nisbet, 2000). Dublin Port is a busy area with shipping and industry with the tern colonies located in close proximity to major transport routes and adjacent to industrial areas with regular noise, people and vehicles. The AoI does not overlap these man-made tern nesting structures, the structures are located at their closest point, are 100 m from the proposed cable route corridor on the northern side of the Great South Wall. Given the temporary nature and short duration of the proposed SI works, the existing level of baseline noise and disturbance within the Bay, and as tern species found within Dublin Port are habituated to the busy port environment, it is concluded that the proposed SI will not negatively affect these breeding or roosting sites (and in turn fledged young). Therefore the proposed SI works will have not adversely affect the distribution or population of tern species from the South Dublin Bay and River Tolka Estuary SPA, North-West Irish Sea SPA and the Dalkey Island SPA.

Intertidal walkover surveys at the landfall locations may also disturb bird species found within the immediate vicinity of the landfall locations. The intertidal surveys will introduce typically one to two surveyors at the landfall location. This relative to the background level of intertidal walkers will not cause significant disturbance to QI bird species that may be present. Once human presence is removed the bird species will return and there will be no significant decline in the use of suitable habitat/forage biomass availability or the distribution/population of QI bird species. As stated above, the current situation in South Dublin Bay is of a built-up urban environment that includes the presence of public roads and railway tracks, supporting DART, commuter and freight train services, frequent dog walkers at low tide, port activities at Dublin Port (including frequent maintenance dredging of the main channel) and the use of the area for recreational purposes (e.g. sailing). Based on the nature, scale and likely duration of the proposed SI works and given the availability of additional roost sites within the Bay and that QIs from neighbouring SPA can utilise other foraging grounds the works will not pose any barriers to connectivity within the South Dublin Bay and River Tolka Estuary SPA.

The SI works will result in limited activity around the shore of South Dublin Bay and the nearshore area. The area of works is adjacent to two busy areas where there is near constant activity associated with commercial and industrial processes, railway/ DART line, as well as walkers in the intertidal area. There will be no significant decline in the distribution or populations of QI bird species found within the South Dublin Bay and there will be no barriers to connectivity associated with the proposed SI works including no impacts to prey biomass. Any additional human activity due to the proposed SI works relative to background levels will not disturb breeding or roosting sites (and therefore there will be no significant decline of fledged young) found within the SPA. There will be no permanent land take from the wetland areas associated with the SPA and therefore the proposed SI works will not affect any of the measures of the CO for the SPA.

Out of an abundance of caution, mitigation measures are set out in Section 7 for visual and above water noise disturbance. Incorporating these mitigation measures, the proposed SI works will not affect any of the measures listed above or the CO for QI species within South Dublin Bay and River Tolka Estuary SPA, North Bull Island SPA, North-West Irish Sea SPA and Dalkey Island SPA.

6.2 Habitat Loss, Alteration and/or Fragmentation

The proposed SI works presents the potential for habitat loss, alteration and/or fragmentation to the non-annexed wetland habitat and associated roost sites of the South Dublin Bay and River Tolka Estuary SPA.

The screened in EU sites, including QIs, COs and relative conservation status are listed in Appendix D. Below is a combined synopsis of the measures identified to achieve the COs (extracted from the list of attributes and targets found within the CO documents).

- Ensure long term population trends of QI bird species at SPAs are stable or increasing;
- Ensure no significant decrease in the distribution, range, timing or intensity of use of use of areas by QI bird species other than that occurring from natural patterns of variation
- Ensure no significant decline in the distribution and population of QI bird species (passage, breeding, roosting);

[4] https://www.fws.gov/story/2021-04/its-tern-time-california accessed October 2024

- Ensure no significant decline in prey biomass availability;
- Ensure there are no significant increase to barriers of connectivity;
- Ensure human activities occur at levels that do not disturb breeding or roosting sites which could have adverse effect on QI bird species;
- Ensure the permanent area occupied by the wetland is stable and not significantly less than 2,192 hectares.

As stated above in Section 6.1, four roost sites (NK14, NK09, SMAC2, SMAC1) were identified within the proposed cable route corridor within the South Dublin Bay and River Tolka Estuary SPA. As the proposed SI works will take place within the intertidal and subtidal areas of the South Dublin Bay and River Tolka Estuary SPA there is potential for habitat loss, alteration and fragmentation in the absence of mitigation.

None of the geotechnical survey locations overlap with the four roost sites mentioned above. Therefore, there will be no direct habitat loss, alteration and/or fragmentation to these roost sites. However, as the vibrocore and CPT location to the south of the proposed cable route corridor are within 10 m at their closest point to roost site NK14 for common and black headed gull there is potential for indirect habitat loss as a result of the geotechnical surveys. All other roost sites are over 150 m away from the indicative geotechnical survey locations.

As stated above in Section 6.1, there are several foraging and roosting grounds available within the South Dublin Bay and River Tolka Estuary SPA, and other coastal areas. Within the AoI, there are 30 intertidal and subtidal roost sites excluding those identified within the 500 m proposed cable route corridor (See Figure 5-1). Six of these roost sites are located to the north-west of the bay at Sandymount Strand and to the south of Pigeon House Road. These roost sites range from approximately 82 m to 2 km from the proposed cable route corridor. A further 11 roost sites are located between approximately 500 m to 1 km from the proposed cable route corridor opposite Booterstown. The remaining sites are located between Blackrock and Dun Laoghaire Harbour. These sites range from approximately 300 m to 2 km from the proposed cable route corridor.

Gull species including black headed gull are noted to be tolerant of anthropogenic disturbance and have been recorded as utilising extensive urban areas for wintering habitats (Keogh and Lauder, 2021, Snow and Perrins, 1998). A study carried out on waterbirds in south Dublin Bay found that the area which is used by a variety of gull species including black headed gull, and that gull species were largely habituated to human activity in the area (Phalan and Nairn, 2007). Indirect habitat loss caused by the proposed SI works include increased activity at the roost site due to personal, surveyors, machinery and equipment. This could cause black headed and common gull species to utilise other roosting areas while the proposed SI works are being carried out.

As stated above there are 30 intertidal and subtidal roost sites available outside of the proposed cable route corridor. Gull species utilise urban environments regularly for breeding and roosting and are habituated to the surrounding environment within Dublin Bay which includes two busy areas where there is near constant activity associated with commercial and industrial processes, railway/ DART line, as well as walkers in the intertidal area. Given the nature and scale of the proposed SI works there will be no significant decline in the distribution and population of QI bird species which utilise the nearby roost sites. Indirect habitat loss, alteration and fragmentation of common and black headed gulls that may utilise roost site NK14 will be negligible. Any additional human activity due to the proposed SI works relative to background levels will not disturb breeding or roosting QI species. Once human presence is removed the bird species will return and there will be no significant decline in the use of suitable prey biomass availability or the distribution/ population of QI bird species.

Within the AoI the intertidal area that will be sampled with respect to the sedimentary communities and habitats (i.e., sand, gravelly sand) including sediment removal and disturbance from intrusive techniques will affect small areas in the context of the wider SAC. The total area sampled equates to 164m^2 which is approximately 0.002% of the total mudflat and sandflat area in the SAC (which is 720 ha (NPWS, 2014a)). Once samples are taken, they will be back filled by the regular tidal fluctuations found within the bay. Therefore there will be no permanent land take of the intertidal wetland habitat due to the proposed SI works and therefore the wetland habitat will be stable.

Out of an abundance of caution, mitigation measures are set out in Section 7 for habitat loss, alterations and/or fragmentation. Incorporating theses mitigation measures, the proposed SI works will not adversely affect any of the measures listed above or the CO for QI species within South Dublin Bay and River Tolka Estuary SPA.

6.3 Underwater noise (incl. Injury and/or displacement from increased marine traffic)

Geophysical and geotechnical surveys, as well as survey vessels, have the potential to introduce underwater noise to the marine environment with the potential to impact upon the marine mammal species.

Auditory injury in marine mammals can be defined as a permanent threshold shift (PTS) leading to non-reversible auditory injury, or as 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. With increasing distance from the sound source, where it is audible to the animal, the effect will diminish through identifiable stages (i.e., PTS or TTS in hearing, avoidance, masking, reduced vocalisation) to a point where no significant response occurs. Factors such as local propagation and individual hearing ability can influence the actual effect (DAHG, 2014).

The DAHG “Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters” 2014 contains the following statement:

“It is therefore considered that anthropogenic sound sources with the potential to induce TTS in a receiving marine mammal contain the potential for both (a) disturbance, and (b) injury to the animal.”

This states that TTS constitutes an injury and should thus be the main assessment criteria[5]. However, the guidance goes on to specify the use of thresholds from a 2007 publication (Southall et al., 2007) which has since been superseded (by (Southall, et al., 2019)) and no longer represents best available science, nor reflects best practice internationally. Thus, the following excerpt from the guidance is relevant:

“The document will be subject to periodic review to allow its efficacy to be reassessed, to consider new scientific findings and incorporate further developments in best practice.”

As there has been no such update to date, but the guidance clearly states intent, we have applied the latest guidance, reflecting the current best available method for assessing impact from noise on marine mammals.

A Subsea Noise Technical Report was carried out using indicative noise sources for the SI works. The results of this assessment are presented in full in Appendix B and summarised here.

When assessing the potential impact of underwater noise sources on the marine environment a range of variables such as source level, frequency, duration, and directivity were considered. Increasing the distance from the sound source usually results in attenuation with distance. The factors that affect the way noise propagates underwater include water column depth, pressure, temperature gradients, salinity, as well as water surface and seabed type and thickness. When sound encounters the seabed the amount of noise/sound reflected back depends on the composition of the seabed i.e., mud or other soft sediment will reflect less than rock. The water depth within south Dublin Bay varies depending on the tide but typically ranges between 0-10m with a substrate type, of muds, sands, and gravelly sand. All factors listed above reduce the propagation of the sound, decreasing the zone of influence of the geophysical survey.

The active acoustic instruments, such as those proposed on this survey, operate by emitting extremely short pulses and are highly directional with narrow beams (Ruppell et al, 2022). While the swathe of the sonars and echosounders will have a maximum range of 6 to 60m in diameter, many of the sources used for this survey, such as multibeam, side-scan sonar, sub-bottom profilers (SBP), Ultra Short Base-Line positioning system (USBL), chirper/pinger, and sparker operate at high frequency and attenuate quickly as they spread from the source. Coupled with the narrow beam angle and short duty cycles (‘on’ for microseconds or milliseconds per second) means that surveying sonars have relatively low acoustic impact.

A summary of the equipment likely to be used in the SI Works and modelled for the Subsea Noise technical Report (provided in Appendix B) is summarised in Section 2.2.6.

The SISAA screened in two SACs: Rockabill to Dalkey Island SAC and Lambay Island SAC for the potential for Likely Significant Effects (LSE) from disturbance due to underwater noise. The SAC sites were screened in for the following marine mammal species: harbour porpoise, grey seals and harbour seals.

[5] Injury being the qualifying limit in the Irish Wildlife Act 1976, section 23, 5c : https://www.irishstatutebook.ie/eli/1976/act/39/enacted/en/print#sec23

6.3.1 Underwater Noise Effects to Annex II Grey Seals and Harbour Seals

There is the potential for underwater noise generated during the geophysical survey to result in injury and/or disturbance to grey and harbour seals in the vicinity of the proposed works. A desk-based assessment of underwater sound changes associated with indicative survey equipment and predicted effects on a range of species was carried out and is presented in Appendix B.

Grey and harbour seals have been recorded as largely tolerant to underwater noise (J. Parsons in G.D. Green et al. 1985) with pinnipeds generally being resilient to the effects of regular high intensity underwater noise with localised avoidance recorded in association with underwater noise of up to and greater than 190dB (Harris et al. 2001). Harbour seals are known to frequent areas which are subject to relatively high levels of anthropogenic disturbance including busy ports (Jones et al. 2017), marinas (Bankhead et al. 2023) and offshore wind farms (Russell et al. 2016).

Carter et al (2022) provides habitat based distribution estimates for seals which were considered. Grey seals have a maximum foraging range of up to 448 km whereas harbour seals have a maximum foraging range of up to 273 km. Distance to haul-out sites was noted as the primary driver of distribution for grey and harbour seals in all regions (Carter et al., 2022). Outside of the breeding season, grey and harbour seals foraging trips at sea are connected by haul-out events on land (McConnell et al., 1999; Sharples et al., 2012). At sea distribution estimates of harbour seals were more tightly concentrated in waters surrounding the SAC with hotspots of density extending outwards to ~50 km from the SAC boundary whereas with grey seals these hotspots could often be >150 km from the SAC itself. Carter et al (2022) (supplementary material) further examined the various regions modelled in the study (10 regions in total). For the Irish North Sea (Region 7) the typical foraging distances were found to be significantly less and ranged up to approximately 100 km for grey seals and 80 km for harbour seals.

The closest SAC for grey and harbour seals is Lambay Island SAC (approximately 18 km). This is within the maximum foraging range of 100 km and therefore it is possible that grey and harbour seals utilise Dublin Bay. North Bull island, which is located 1 km to the north of the AoI boundary is known as an important haul out site for grey seals, even though they are recorded as having a seasonal presence arriving late April or early May and leaving late October or early November to breed and moult[6] therefore presence within Dublin Bay and the surrounding environs is possible. No haul out sites are recorded in South Dublin Bay. The proposed SI works will introduce underwater noise into the marine environment which could cause disturbance and or avoidance of the area.

The Subsea Noise Technical Report (Appendix B) demonstrates that the worst-case distances from the sound source for seals (PCW hearing group) for the geophysical surveys is as follows:

- PTS out to 10 m from the sound source.
- TTS could occur within 180 m of the sound source.
- Behavioural disturbance out to 8000 m from the sound source.

For the geotechnical surveys it was as follows:

- PTS out to 10 m from the sound source.
- TTS could occur within 160 m of the sound source.
- Behavioural disturbance out to 5700 m from the sound source.

In order to reduce the above distances in relation to PTS and TTS, it is recommended that mitigation measures be introduced that involve the soft-start to underwater noise producing activities, i.e. the geophysical and geotechnical surveys.

As presented in the Subsea Noise Technical Report, the inclusion of a 20-minute soft start reduces TTS for PCW for all geophysical and geotechnical survey scenarios to less than 10 m from the sound source.

For the geophysical and geotechnical SI works a qualified and experienced MMO will be appointed to monitor for marine mammals (including seals) within the monitored zone i.e. 500 m radial distance of the

[6] https://www.dublinbaybiosphere.ie/news/north-bull-island-seal-survey/ Accessed October 2024

sound source intended for use. The 500 m pre-start-up survey will be conducted at least 30 minutes before the sound-producing activity i.e. those activities listed in **Table 2.2** are due to commence. Sound-producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected within the monitored zone (500 m) by the MMO. In commencing sound producing activities using the equipment listed above, a “Ramp Up” procedure (i.e. 20-minute soft-start) must be used. Once the Ramp-Up procedure commences, there is no requirement to halt or discontinue the procedure at night-time, nor if weather or visibility conditions deteriorate nor if marine mammals occur within a 500 m radial distance, of the sound source. If there is a break in sound output for a period greater than 30 minutes (e.g., due to equipment failure, shut-down, survey line or station change) then all Pre-Start Monitoring and a subsequent Ramp-up Procedure (where appropriate following Pre-Start Monitoring) must be undertaken (DAHG Guidance, 2014). These measures will ensure that impacts on marine mammals (including seals) will be reduced to the lowest possible risk to ensure there is no significant risk to marine mammals from impulsive noise.

The inclusion of a 20-minute soft start and a 500 m pre survey search will further reduce risk to seals that may be found within South Dublin Bay and therefore there will be no adverse effect on the integrity of grey seals and harbour seals that are QI of the Lambay Island SAC (the closest SAC with grey and harbour seals as a QI species). Therefore, it can also be concluded that underwater noise will not have an adverse affect on the integrity of Lambay Island SAC or other European sites.

6.3.2 Underwater Noise Effects to Annex II Harbour Porpoise

The IWDG (2024) sightings data holds 60 records of cetacean sightings within the Dublin Bay area for the period October 2023 to October 2024 including recordings of harbour porpoise. Phase II of the Irish ObSERVE programme (2021-2022) was conducted to investigate the occurrence, distribution and abundance of key marine species in Irelands offshore and coastal regions. According to Paradell et al (2024), greatest abundance and densities were seen in the Irish Sea. The predicted distribution of harbour porpoise for summer highlights the northern section of the Irish Sea as an area of importance (Paradell et al., 2024). Estimates of density are available for coastal waters in survey stratum 5 (Irish Sea) of the phase II ObSERVE aerial surveys. These data suggested that harbour porpoise occurs in densities of between 0.150 to 0.968 animals per km^2 (Paradell et al., 2024).

The closest SAC designated for harbour porpoise is Rockabill to Dalkey Island SAC which is 3 km to the east of the AoI.

The Subsea Noise Technical Report (Appendix B) demonstrates that the worst-case distances from the sound source for harbour porpoise (VHF hearing group) for the geophysical surveys is as follows:

- PTS out to 500 m from the sound source.
- TTS could occur within 2,800 m of the sound source.
- Behavioural disturbance out to 8000 m from the sound source.

For the geotechnical surveys it was as follows:

- PTS out to 490 m from the sound source.
- TTS could occur within 2700 m of the sound source.
- Behavioural disturbance out to 5700 m from the sound source.

In order to reduce the above distances in relation to PTS and TTS, it is recommended that mitigation measures be introduced that involve the soft-start to underwater noise producing activities, i.e. the geophysical and geotechnical surveys.

The inclusion of a 20-minute soft start for the geophysical surveys will reduce PTS to 50 m and TTS to 1,600 m.

The inclusion of a 20-minute soft start for the geotechnical surveys would reduce PTS to 10 m and TTS to 1,500 m.

For the geophysical and geotechnical SI works a qualified and experienced MMO will be appointed to monitor for marine mammals within the monitored zone i.e. 500 m radial distance of the sound source intended for use. The 500 m pre-start-up survey will be conducted at least 30 minutes before the sound-producing activity i.e. those activities listed in **Table 2.2** are due to commence. Sound-producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected within the monitored zone (500 m) by the MMO. In commencing sound producing activities using the equipment listed above, a “Ramp Up” procedure (i.e. 20-minute soft-start) must be used. Once the Ramp-Up procedure commences, there is no requirement to halt or discontinue the procedure at night-time, nor if weather or visibility conditions deteriorate nor if marine mammals occur within a 500 m radial distance, of the sound source. If there is a break in sound output for a period greater than 30 minutes (e.g., due to equipment failure, shut-down, survey line or station change) then all Pre-Start Monitoring and a subsequent Ramp-up Procedure (where appropriate following Pre-Start Monitoring) must be undertaken (DAHG Guidance, 2014). These measures will ensure that impacts on marine mammals (including seals) will be reduced to the lowest possible risk to ensure there is no significant risk to marine mammals from impulsive noise.

For all survey equipment where the threshold for TTS is exceeded beyond the 500 m monitored zone, the zone of impact for TTS is estimated to occur up to 1,600 m from the sound source. Whilst there is the potential for harbour porpoise to occur within the zone of impact for TTS it is highly likely that the presence of vessels will disturb harbour porpoise away from the zone of impact. Although the focus is on mitigation for permanent injury (i.e. PTS), the implementation of the proposed mitigation measures will also reduce the risk of VHF species, i.e. harbour porpoise, experiencing TTS. Further, the equipment causing the TTS is generally narrowband and thus only affects a small portion of the frequency range audible by the VHF species, meaning it has little or no overlap with biologically relevant sounds. The risk of biologically relevant TTS in harbour porpoise is therefore considered to be low.

The inclusion of a 20-minute soft start and a 500 m pre survey search will reduce risk to harbour porpoise that may be found within South Dublin Bay. Therefore, it can also be concluded that underwater noise will not have an adverse affect on the integrity of Rockabill to Dalkey SAC, Lambay Island SAC or other European sites.

6.4 In-combination effects

6.4.1 Identification of other Projects or Plans

A key requirement of the Habitats Directive is that the effects of any project on (a) European site(s) should be considered in-combination with other plans or projects. The impacts of the project have the potential to interact in-combination, both spatially and or temporally, with other plans and projects as described in the following sections.

Other plans/ projects that have the potential to act in-combination with the proposed SI works are considered to be those that are likely to contribute to the effects identified. On this basis, a range of other plans and projects were considered in terms of their potential to have in-combination effects with the proposed SI works. RPS undertook a desk study (i.e., Foreshore Applications, An Bord Pleanála (ABP) website and MARA MULs) to identify other plans, projects and activities within the zone of impact of the proposed SI works which have the potential to give rise to in-combination effects with the proposed SI works. These are summarised below.

6.4.1.1 Projects

MARA’s approach for identifying plans or projects with the potential to act in-combination was used coupled with professional and scientific judgement to identify those relevant plans and projects which have the potential for in-combination effects with the proposed SI works. The key steps for assessing cumulative effects based on MARAs *“stepwise approach”* are as follows:

1. Defining the Cumulative Effects Spatial Scope (CESS);
2. Defining the Cumulative Effects Temporal Scope (CETS);
3. Impact identification;
4. Pathway identification;
5. Prediction;
6. Identification of Plans or Projects that could act in combination;
7. Screening Stage Cumulative Effects Assessment conclusion; and
8. Managing cumulative impacts - to be carried out as part of Stage 2 AA process.

The CESS was identified as 5 km and the CETS was identified as two years. The CESS is based on the acoustic survey equipment deterrence ranges as per JNCC (2020), and the CETS is defined as the Maritime Usage Licence period. However, a further search of projects within the last five years was undertaken to ensure any potential cumulative effect of overlapping licence periods for past projects was considered. The potential impacts were identified in Section 6 of this NIS Report. The pathway and prediction of these impacts are also discussed in in Section 6 of this NIS Report.

A desk study using online sources was undertaken to determine a list of projects within the zone of impact of the proposed SI works which may have the potential to give rise to in-combination effects. These searches are summarised below:

- Foreshore Applications https://www.gov.ie/en/foreshore-notices/; Accessed 21/10/2024.
- EPA Dumping at Sea (DaS) boundaries; https://gis.epa.ie/GetData/Download Accessed 21/10/2024.
- MARA website for Maritime Usage Licences and Maritime Area Consents https://www.maritimeregulator.ie/ Accessed 21/10/2024.
- An Bord Pleanála (ABP) case search for marine Strategic Infrastructure Development and other marine developments https://www.pleanala.ie/en-ie/case-search#pnlAllFilters Accessed 21/10/2024.

The SISAA report concluded that there is the potential for in-combination effects between the proposed SI works and the following projects:

- FS007546 and MUL2300345 both relate to, respectively, a foreshore permission and a MUL for site investigation works associated with the Codling Wind Park.
- FS007188 relates to site investigations for the proposed Dublin Array Offshore Wind Farm.
- FS007029 relates to site investigations for the Dublin Array at Kish and Bray Banks.
- LIC230016 relates to Microsoft Ireland Operations Ltd. application for geophysical survey and site investigations for a proposed subsea fibre optic cable from Anglesey in Wales to Dublin having a landfall in Dublin Port.

A summary of each of the projects screened in from the SISAA is provided in Appendix C of this NIS.

All of these proposed site investigation works include investigations within or adjacent to the AoI for the SI works. There is a spatial and temporal overlap between these five permissions and the SI works and therefore a potential for in-combination effects related to visual and above water noise disturbance and underwater noise. No significant impacts as a result of in-combination effects on habitat loss, alteration and/or fragmentation are likely given the relatively small areas within the AoI that will be disturbed by the projects and the rapid recover of marine sediments due to natural tidal processes.

In terms of underwater noise, all site investigations for all of the above projects will be operating in accordance with the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014). The Carrickmines to Poolbeg geophysical and geotechnical campaigns will last, dependent on weather, 4-6 weeks each, and therefore the likelihood of simultaneous campaigns producing underwater noise within the AoI is deemed to be low.

In relation to visual and above water noise disturbance, the in-combination impacts associated with the presence of boats, machinery and personnel operating in the AoI is also deemed to be low, relative to the existing baseline of activities in the general onshore and Dublin Port areas.

However, it is not possible to completely exclude likely significant in-combination effects where there may be spatial and/or temporal overlap in licenced activities. Therefore, using the precautionary principle suitable mitigation measures are proposed in Section 7.1.4 to be included relating to the possibility of likely significant in-combination effects.

6.4.1.2 Plans

The SISAA report concluded that there is the potential for in-combination effects between the proposed SI works and the following Plan:

- ZD2013

An Bord Pleanála case number ZD2013 relates to a strategic development zone (SDZ), the Poolbeg West planning scheme. This area of land is 34 ha in size and located in the Poolbeg peninsula extending into

Dublin Bay. A Strategic Environmental Assessment (SEA), Screening for AA and AA (based on a submitted Natura Impact Report) were assessed by the Board in reaching a decision to grant approval for the SDZ. They Board found that the SDZ will not adversely affect the integrity of any European sites. The Board also stated that: “all developments proposed under the Planning Scheme will themselves be subject to appropriate assessment when further details of design and location are known.” To the best knowledge of the authors, no individual planning applications have been submitted for projects as part of the Poolbeg West SDZ.

Given the nature, scale and duration of the SI work and that no projects for the SDZ have been submitted for planning permission, it can be concluded that there will be no adverse affects on the integrity of any European site as a result of in-combination effects between the SI works and the Poolbeg West SDZ scheme.

7 MITIGATION MEASURES

7.1 Mitigation of Adverse Effects

7.1.1 Avoidance of impacts due to visual and above water noise disturbance

In order to avoid direct and indirect impacts on bird species within the South Dublin Bay and River Tolka Estuary SPA, North Bull Island SPA, North-West Irish Sea SPA and the Dalkey Island SPA, the following measures will be implemented.

- Access to the intertidal area for plant and machinery will be via existing access points or the sea.
- Machinery will be fitted with noise reducing features e.g., lining of engine compartments, and where noise reducing features are not possible, noise screens will be used.
- Machinery will be turned off when not in use and will be regularly maintained to limit the noise emissions from the vessel(s).
- An Ecological Clerk of Works (ECoW) will be onsite during the SI works to ensure mitigation measures are implemented on-site. The ECoW shall be suitably qualified, and a member of a relevant professional institute.

7.1.2 Avoidance of impacts due to habitat loss, alteration and/or fragmentation loss

In order to avoid direct and indirect impacts on the identified roost sites of the South Dublin Bay and River Tolka Estuary SPA, the following measures will be implemented.

- Machinery will be fitted with noise reducing features e.g., lining of engine compartments, and where noise reducing features are not possible, noise screens will be used during the proposed SI works.

7.1.3 Avoidance of underwater noise impacts

The inclusion of a 20-minute soft start will effectively reduce TTS for seals (PCW hearing group) to less than 10 m of the sound source for all geophysical and geotechnical survey scenarios.

The inclusion of a 20-minute soft start for the geophysical surveys would reduce PTS for harbour porpoise (VHF hearing group) to 50 m and TTS to 1,600 m.

The inclusion of a 20-minute soft start for the geotechnical surveys would reduce PTS for harbour porpoise (VHF hearing group) to less than 10 m from the sound source and TTS to 1,500 m.

For the geophysical and geotechnical SI works a qualified and experienced MMO will be appointed to monitor for marine mammals within the monitored zone i.e. 500 m radial distance of the sound source intended for use. The 500 m pre-start-up survey will be conducted at least 30 minutes before the sound-producing activity i.e. those activities listed in **Table 2.2** are due to commence. Sound-producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected within the monitored zone (500 m) by the MMO. In commencing sound producing activities using the equipment listed above, a “Ramp Up” procedure (i.e. 20-minute soft-start) must be used. Once the Ramp-Up procedure commences, there is no requirement to halt or discontinue the procedure at night-time, nor if weather or visibility conditions deteriorate nor if marine mammals occur within a 500 m radial distance, of the sound source. If there is a break in sound output for a period greater than 30 minutes (e.g., due to equipment failure, shut-down, survey line or station change) then all Pre-Start Monitoring and a subsequent Ramp-up Procedure (where appropriate following Pre-Start Monitoring) must be undertaken (DAHG Guidance, 2014). These measures will ensure that impacts on marine mammals (including seals) will be reduced to the lowest possible risk to ensure there is no significant risk to marine mammals from impulsive noise.

For all survey equipment where the threshold for TTS is exceeded beyond the 500 m monitored zone, the zone of impact for TTS is estimated to occur up to 1,600 m from the sound source. Whilst there is the potential for harbour porpoise to occur within the zone of impact for TTS. In addition, it is highly likely that the presence of vessels will disturb harbour porpoise away from the zone of impact. Although the focus is on mitigation for permanent injury (i.e. PTS), the implementation of the proposed mitigation measures will also reduce the risk of very high frequency cetaceans i.e. harbour porpoise experiencing TTS. Further, the equipment causing the TTS is generally narrowband and thus only affects a small portion of the frequency range audible by the VHF cetaceans, meaning it has little or no overlap with biologically relevant sounds. The risk of biologically relevant TTS in harbour porpoise is therefore considered to be low.

Standard risk avoidance and/or risk reduction measures will be in place on survey vessels, as required under Section 4.3.4 of the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014). As required by the DAHG Guidelines (2014), survey activity will be planned to commence at the innermost part of the Bay to be surveyed and thereafter work outwards, to ensure that marine mammals are not driven into or artificially confined within an enclosed comparatively shallow area.

7.1.4 In-combination effects

EirGrid will coordinate with other licence holders within and immediately adjacent to the AoI boundary to ensure that no temporal overlap occurs between projects in respect of the geophysical and geotechnical activities of the SI works.

8 CONCLUSION

This NIS has examined the potential implications of the proposed project, the SI works, alone and in combination with other plans and projects, on the integrity of the European sites identified below, considering each European site's structure, function, and conservation objectives.

- Rockabill To Dalkey Island SAC
- Lambay Island SAC
- South Dublin Bay and River Tolka Estuary SPA
- North Bull Island SPA
- North-West Irish Sea SPA
- Dalkey Island SPA

The competent authority may use the information contained in this NIS for establishing its own complete, precise, and definitive findings and conclusions to ensure all reasonable scientific doubt has been removed regarding the effects of the proposed SI works on relevant European sites.

Following a comprehensive evaluation of the potential direct, indirect, and in-combination effects on the qualifying interests of relevant European sites, mitigation measures have been prescribed where necessary. Consequently it has been concluded in this NIS that the proposed SI works, either alone or in-combination with any other plan or project, will not adversely affect the integrity of any European Site.

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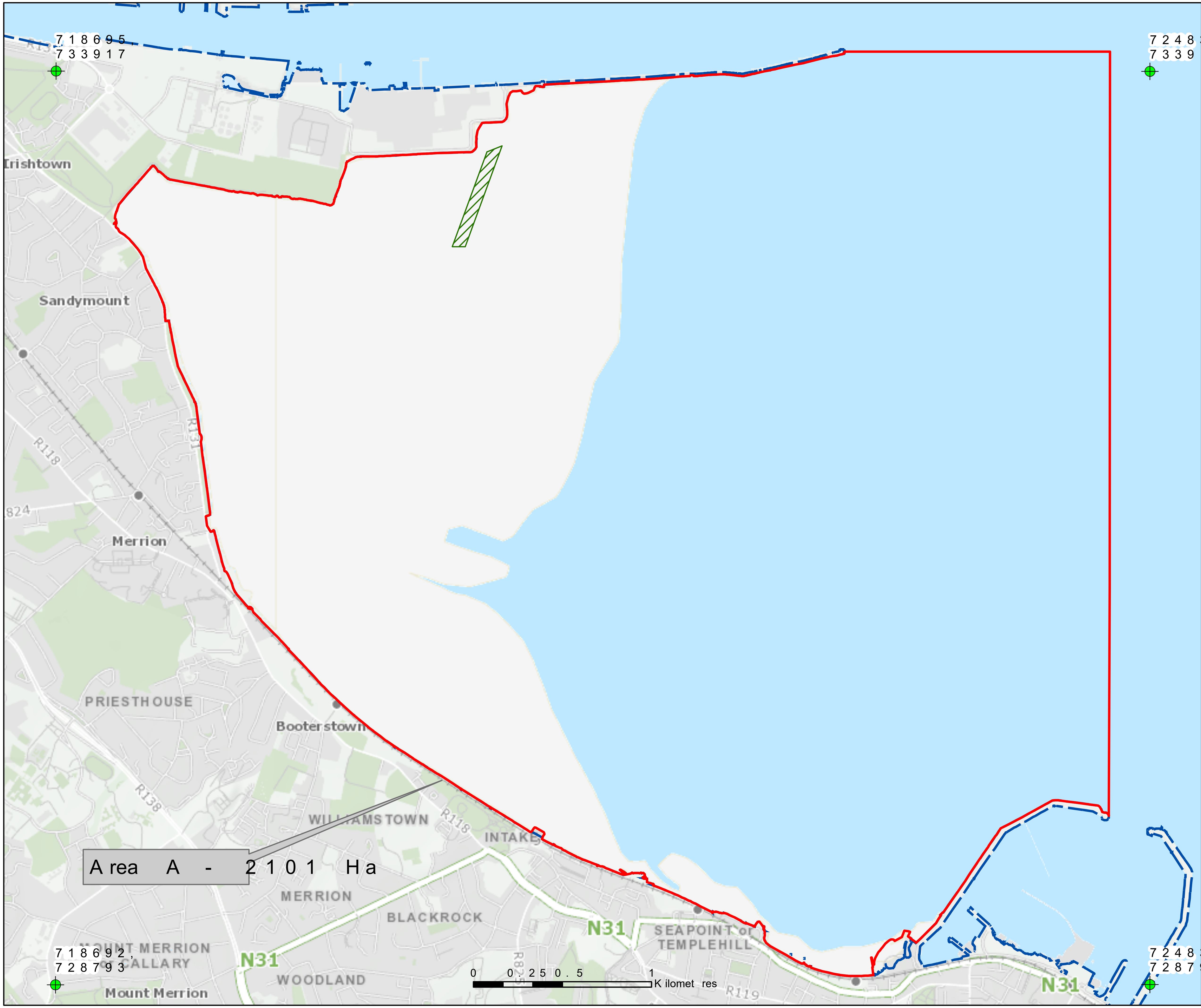
Appendix A
Drawings



Legend

Maritime Usage Licence Area

Private Foreshore – Folio DN44335F

High Water Mark (HWM)

Where the licence area adjoins o
abuts the land the High Wa
as defined by the Chief Bounda
Surveyor is the boundary of t
area.

MARA File Reference No:
MUL240010

N

Prepared by:
[redacted]
Chartered Engineer

Client

EirGrid
Powering Up Dublin

Carrickmines to Poolbeg Cable Replacement

Title

Proposed Licence Area Map

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File Identifier:
IE000451-RPS-00-XX-DR-C-DG2502

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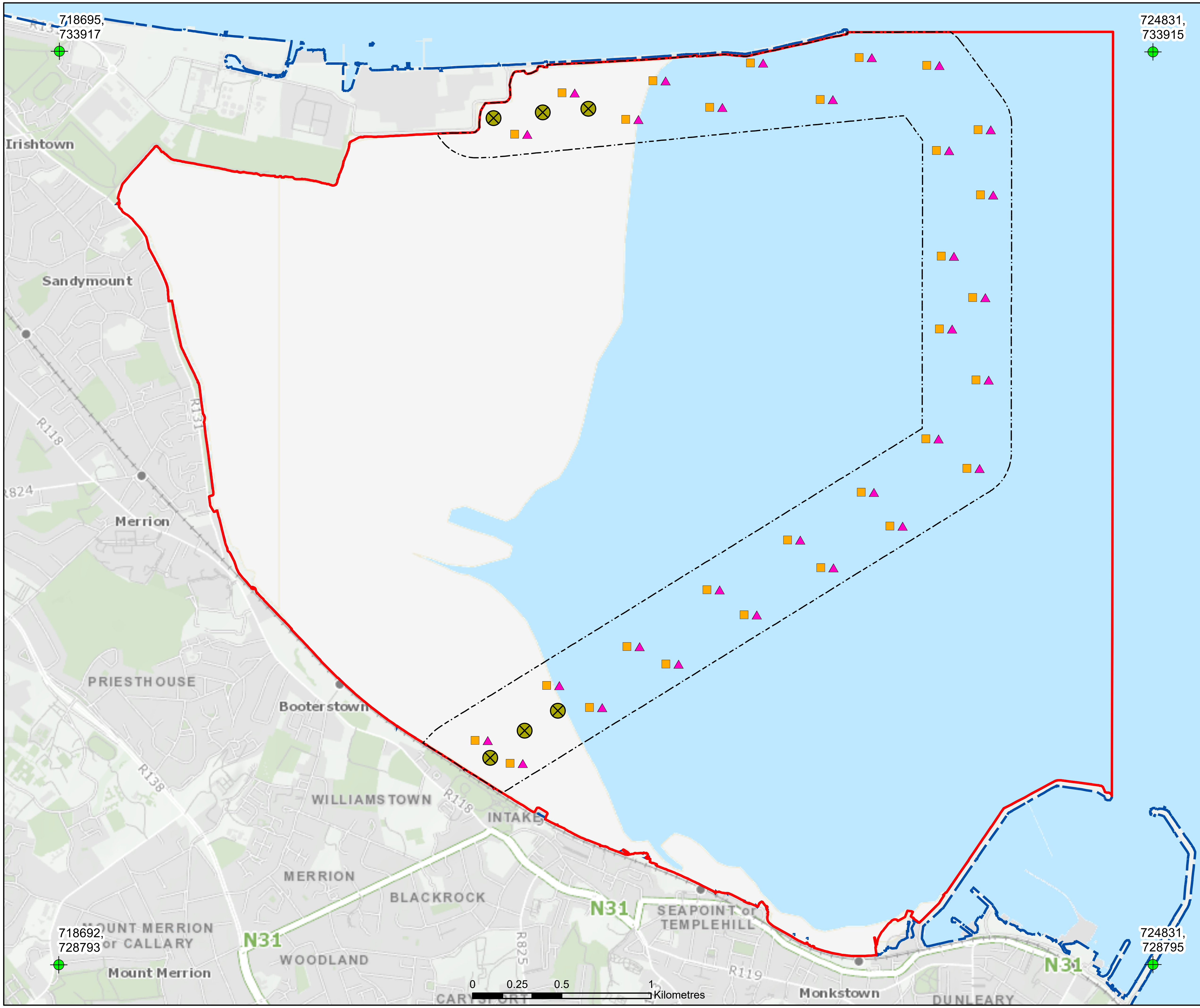

Legend

- Maritime Usage Licence Area
- Offshore Cable Route - 500m wide corridor (250m Buffer)
- High Water Mark (HWM)
- Indicative Borehole Locations
- Indicative Vibrocore & CPT Locations

Site Investigation locations shown are indicative only.

MARA File Reference No:
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Prepared by: [redacted]
Chartered Engineer

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CP1146 - Carrickmines to Poolbeg Circuit

Title

Maritime Usage Licence Indicative Geotechnical Survey Locations

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S5	P01	IE000451-RPS-00-XX-DR-C-DG2503

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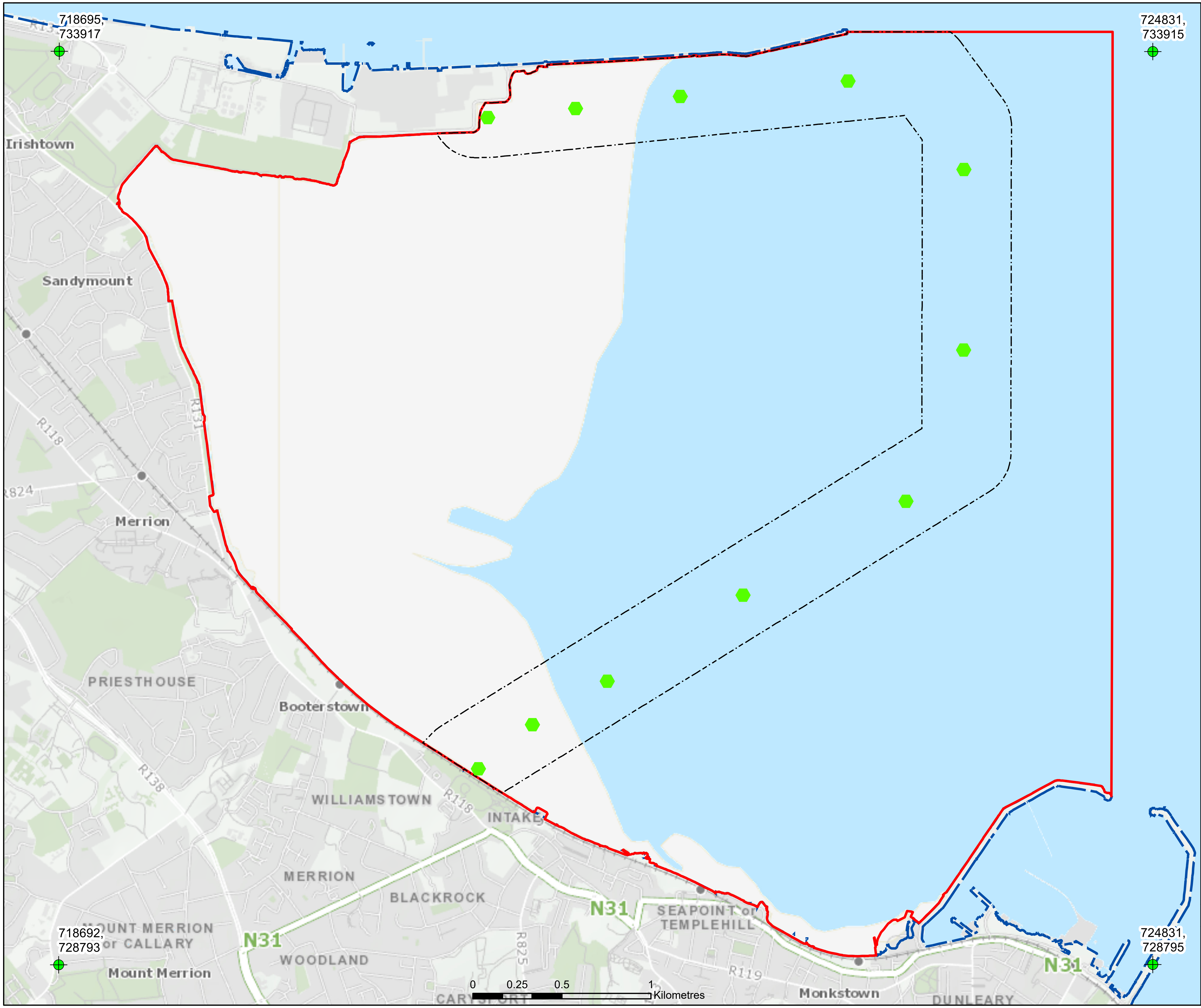

Legend

Maritime Usage Licence Area

Offshore Cable Route - 250m Buffer

High Water Mark (HWM)

Indicative Benthic Sampling Locations

Benthic Sample locations shown are indicative only.

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Title

Maritime Usage Licence Indicative Benthic Sample Locations

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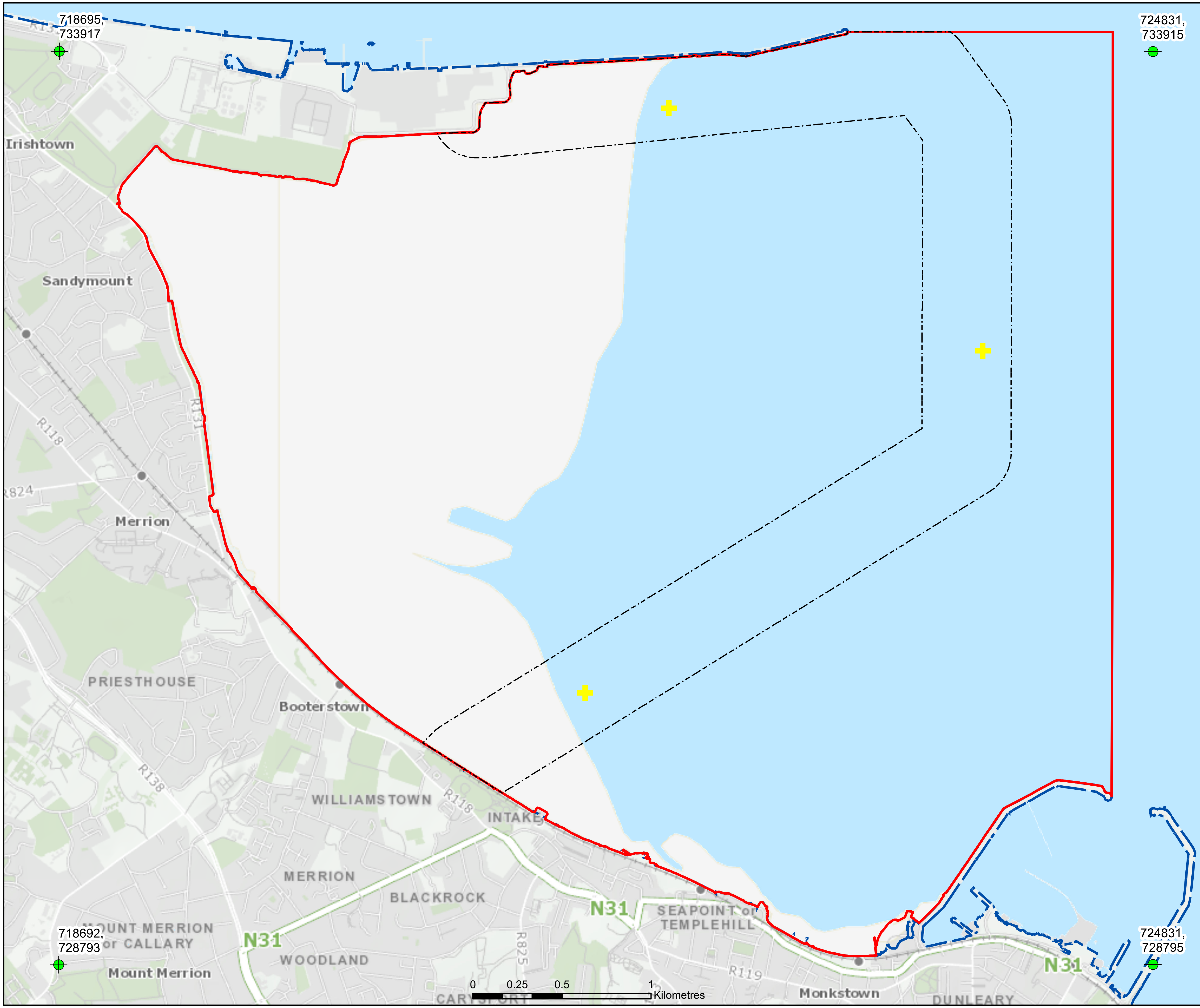

Legend

- Acoustic Doppler Current Profiler Indicative Locations
- Offhsore Cable Route - 250m Buffer
- Maritime Usage Licence Area
- High Water Mark (HWM)

ADCP deployment locations shown are indicative only.

MARA File Reference No:
MUL240010

Prepared by: [redacted]
Chartered Engineer

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Title

Maritime Usage Licence Indicative ADCP Locations

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IE000451-RPS-00-XX-DR-C-DG2505

Status:	Rev:	Model File Identifier:
S5	P01	IE000451-RPS-00-XX-DR-C-DG2505

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Appendix B
Subsea Noise Technical Report

C2 - Restricted

CP1146 CARRICKMINES TO POOLBEG PROJECT

Subsea Noise Technical Report

CP1146-RPS-00-XX-RP-N-RP1021
A1 C01
23 October 2024

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
S3 P01	Draft for Client Review	[redacted]			18/07/2024
S5 P01	Draft				15/08/2024
S5 P02	Additional Client comments				12/09/2024
A1 C01	Final				23/10/2024

Approval for issue

[redacted] 23 October 2024

Prepared by:

RPS

Prepared for:

EirGrid

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Contents

Tables

Figures

Glossary

Term	Meaning
Decibel (dB)	A relative scale most commonly used for reporting levels of sound. The actual sound measurement is compared to a fixed reference level and the "decibel" value is defined to be $10 \cdot \log_{10}$(“actual”/”reference”), where (“actual”/”reference”) is a power ratio. The standard reference for underwater sound pressure is 1 micro-Pascal (μPa), while 20 micro-Pascals is the standard for airborne sound. The dB symbol is often followed by a second symbol identifying the specific reference value (i.e. re 1 μPa).
Grazing angle	A glancing angle of incidence (the angle between a ray incident on a surface and the line perpendicular to the surface).
Permanent Threshold Shift (PTS)	A total or partial permanent loss of hearing caused by some kind of acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear and thus, a permanent reduction of hearing acuity.
Temporary Threshold Shift (TTS)	Temporary loss of hearing as a result of exposure to sound over time. Exposure to high levels of sound over relatively short time periods will cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The mechanisms underlying TTS are not well understood, but there may be some temporary damage to the sensory cells. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time.
Sound Exposure Level (SEL)	The cumulative sound energy in an event, formally: “ten times the base-ten logarithm of the integral of the squared pressures divided by the reference pressure squared”. Equal to the often seen “L_E” or “dB SEL” quantity. Defined in: ISO 18405:2017, 3.2.1.5
Sound Pressure level (SPL)	The average sound energy over a specified period of time, formally: “ten times the base-ten logarithm of the arithmetic mean of the squared pressures divided by the squared reference pressure”. Equal to the deprecated “RMS level”, “dB_{rms}” and to L_{eq} if the period is equal to the whole duration of an event. Defined in ISO 18405:2017, 3.2.1.1
Peak Level, Peak Pressure Level (L_P)	The maximal sound pressure level of an event, formally: “ten times the base-ten logarithm of the maximal squared pressure divided by the reference pressure squared” or “twenty times the base-ten logarithm of the peak sound pressure divided by the reference pressure, where the peak sound pressure is the maximal deviation from ambient pressure”. Defined in ISO 18405:2017, 3.2.2.1
Source Level (SL)	Taken here to mean the level (SEL/SPL/L_P) at 1 meter range. If not otherwise stated, it is assumed the source is omnidirectional (equal level in all directions). For sources larger than 1 m in radius, the Source Level is back-calculated to 1 m.
Decidecade	Used to refer to a step in frequency, similar to “one-third-octave”, defined as a ratio of $10^{0.1} \approx 1.259$ (one third octave is 21/3 ≈ 1.260). Used interchangeably with “3rd octave”.
Noise	Sound that is irrelevant, unwanted or harmful to the organism(s) in question. Noise is often detrimental, but not necessarily so.
Kurtosis	A statistical measure of “peakedness” of a distribution (of e.g. pressure values in a sound pulse). Defined in ISO 5479:1997

Acronyms

Term	Meaning
ADD	Acoustic Deterrent Device
ADCP	Acoustic Doppler Current Profiler
LF	Low Frequency (Cetaceans)
HF	High Frequency (Cetaceans)
VHF	Very High Frequency (Cetaceans)
MF	Mid Frequency (Cetaceans) – **DEPRECATED** only for reference to NOAA/NMFS 2018 groups
OW/OCW	Otariid pinnipeds/Other Carnivores in water (refers to the same weighting and animal groups)
PW/PCW	Phocid pinnipeds
NMFS	National Marine Fisheries Service
RMS	Root Mean Square
SEL	Sound Exposure Level, [dB]
SPL	Sound Pressure Level, [dB]
L_P	Peak Pressure Level, [dB]
SL	Source Level [dB]
TTS	Temporary Threshold Shift
PTS	Permanent Threshold Shift
SSS	Side Scan Sonar – Towed sonar device typically positioned 10-15 m above the sediment. Its main purpose is to characterise the sediment surface texture.
MBES	Multibeam Echosounder – Uses multiple narrow beams to measure the depth across a swath below the vessel.
SBP	Sub-Bottom Profiler – Any device/system that uses acoustics to record echoes from within the sediment. Examples include seismic arrays, sparkers, boomers, chirpers, pingers and associated recorder array.
USBL	Ultra Short Baseline Array – Small array of at least 4 hydrophones and a pinger to measure positions of equipment under water.
UHRS	Ultra High-Resolution Seismic survey – Usually a sparker driven sub-bottom characterisation system.
c.	Circa, i.e., approximately
CPT	Cone Penetration Testing – insertion/pushing of rod with standardised, cone-shaped front into sediment to measure various characteristics of the sediment.

Units

Unit	Description
dB	Decibel (Sound)
Hz	Hertz (Frequency)
kHz	Kilohertz (Frequency)
kJ	Kilojoule (Energy)
km	Kilometre (Distance)
km^2	Kilometre squared (Area)
m	Metre
ms	Millisecond (10^{-3} seconds) (Time)
ms^{-1} or m/s	Metres per second (Velocity or speed)
kn	Knots (speed), 1 kn = 0.514 m/s, 1 m/s = 1.944 kn
µPa	Micro Pascal
Pa	Pascal (Pressure: newton/m^2)
psu	Practical Salinity Units (parts per thousand of equivalent salt in seawater, weight-based)
kg/m^3	Specific density (of water, sediment or air)
Z	Acoustic impedance [$kg/(m^2 \cdot s)$ or $(Pa \cdot s)/m^3$]

Units will generally be enclosed in square brackets e.g.: “[m/s]”

1 INTRODUCTION

The CP1146 Carrickmines to Poolbeg project is a proposed new underground electricity cable from the Carrickmines 220 kV substation to the Poolbeg 220 kV substation and includes a section of marine cable. The marine section is located between Blackrock Park and Shelley Banks car-park on the Poolbeg peninsula, Co. Dublin

This Subsea Noise Technical Report presents the results of a desktop study considering the potential effects of underwater noise on the marine environment from the proposed geophysical and geotechnical surveys in Dublin Bay (hereafter referred to as “SI Works”) for the CP1146 Carrickmines to Poolbeg project. The other surveys to be undertaken as part of the SI Works, have not been modelled as they will either not result in underwater noise or will not have any appreciable effect on receptors, e.g. the metocean device (ADCP) operates at frequencies well above the hearing ranges of sensitive receptors.

The aim of the SI Works is to acquire data to a high quality and specification for the site. The SI Works covers an area of 2101 Ha within Dublin Bay between the south side of the Poolbeg peninsula and Dun Laoghaire West Pier. The sediment within the survey area is mostly silty to sandy and water properties in the area are relatively stable given the lack of major river outflows and a modest tidal range. Geophysical and geotechnical surveys such as those proposed for the SI Works use equipment that generate loud and potentially injurious noise to marine life.

Sound is readily transmitted in the underwater environment and there is potential for the sound emissions from anthropogenic sources to adversely affect marine life such as marine mammals or fish. At close ranges from a noise source with high noise levels, permanent or temporary hearing damage may occur to marine species, while at a very close range gross physical trauma is possible. At long ranges (several kilometres) the introduction of any additional noise could, for the duration of the activity, potentially cause behavioural changes, for example to the ability of species to communicate and to determine the presence of predators, food, underwater features, and obstructions.

This report provides an overview of the potential effects due to underwater noise from the SI Works on the surrounding marine environment based on the Southall et al. 2019 and Popper et al. 2014 frameworks for assessing impact from noise on marine mammals and fish.

Consequently, the primary purpose of the underwater noise assessment is to predict the likely range of onset for potential physiological and behavioural effects due to increased anthropogenic noise as a result of the SI Works.

1.1 Statement of Authority

[redacted]s a Senior Project Scientist with RPS. He holds a master’s degree in biology, biosonar and marine mammal hearing from University of Southern Denmark. [redacted] has over 11 years’ experience as a marine biologist and over 9 years’ experience with underwater noise modelling and marine noise impact assessments. [redacted] has co-developed commercially available underwater noise modelling software, as well developed multiple source models for e.g. impact piling, seismic airgun arrays and sonars.

[redacted] is an Associate in Acoustics with RPS. He holds a BA BAI in Mechanical Engineering from Trinity College Dublin (2004) and a PhD in Acoustics and Vibration from Trinity College Dublin (2008). He is a Chartered Engineer with Engineers Ireland. [redacted]has 20 years’ experience in environmental projects including planning applications and environmental impact assessments for a wide range of strategic infrastructure projects.

[redacted] is Technical Director in the Environmental Services Business Unit in RPS. He has over 24 years’ experience. He holds an honours degree in Civil Engineering (B.E.) from NUI, Galway, a postgraduate diploma in Environmental Sustainability from NUI, Galway, and a Master’s in Business Studies from the Irish Management Institute/ UCC. [redacted] is also a Chartered Engineer and Project Management Professional with the Project Management Institute (PMI-PMP). He has managed the delivery of numerous environmental projects including marine and terrestrial projects that have required environmental impact assessment, appropriate assessment, and Annex IV species reports.

2 ASSESSMENT CRITERIA

2.1 General

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 assessment 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, momentary (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI, 2005; ANSI, 1986; NIOSH, 1998). This category includes sound sources such as seismic surveys, impact piling and underwater explosions. Additionally included here are sounds under 1 second in duration with a weighted kurtosis over 40 (see note below*).
- **Non-impulsive** (and continuous) sounds which can be broadband, narrowband or tonal, momentary, 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, some sonar equipment and vessels. Additionally included here are sounds over 1 second in duration with a weighted kurtosis under 40 (see note below*).

  * Note that the European Guidance: “Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications” (MSFD Technical Subgroup on Underwater Noise, 2014) includes sonar as impulsive sources (see Section 2.2). However, the guidance suggests that *“all loud sounds of duration less than 10 seconds should be included”* as impulsive.

  This contradicts research on impact from impulsive sounds suggesting that a limit for “impulsiveness” can be set at a kurtosis[1] of 40 (Martin, et al., 2020). See examples in Appendix A, Impulsiveness.

  This latter criterion has been used for classification of impulsive versus non-impulsive for sonars and similar sources. The justification for departing from the MSFD criterion is that the Southall et al. 2019 and the Popper et al. 2014 framework limits are based on the narrower definition of impulsive as given in “Impulsive sounds” above.

There is scope for some sounds to be classified as both impulsive and non-impulsive, depending on the criteria applied. Examples are pulses from sonar-like sources that can contain very rapid rise times (<0.5 ms), sweep a large frequency range and have high kurtosis. However, given that the scientific work carried out to identify impulsive thresholds were done with “pure” impulses (from a near instantaneous event), sonar-like sounds are sometimes not included in this, impulsive, category. This argument ignores that sounds used for establishing the non-impulsive thresholds (often narrowband slowly[2] rising pulses), are markedly less impulsive (lower kurtosis, narrower bandwidth) than what is sometimes seen in pulses from sonar-like sources and are thus also not representative for all sonar-like pulses.

Given impulsive sound’s tendency to become less impulsive with increased range, a minimal range can be established where the noise is no longer impulsive (here kurtosis <40 is used) (Appendix A, Impulsiveness). This range is established using raytracing, but as the effect varies with exact depth and range of source and receiver, the transition range to non-impulsive used for exposure modelling is doubled from the modelled range where kurtosis goes below 40.

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 (Southall, et al., 2019; Popper, et al., 2014).

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[1] Statistical measure of the asymmetry of a probability distribution.

[2] Slowly in this context is >10 ms – slow relative to the integration time of the auditory system of marine mammals.

2.2 Effects on Marine Animals

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Richardson *et al.* (1995) defined four zones of noise influence which vary with distance from the source and level, to which an additional zone has been added "zone of temporary hearing loss". These are:

- **The zone of audibility**: This is defined as the area within which the animal can detect the sound. Audibility itself does not implicitly mean that the sound will affect the animal.
- **The zone of masking**: This is defined as the area within which sound can interfere with the detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how animals detect sound in relation to masking levels (for example, humans can hear tones well below the numeric value of the overall sound level). Continuous sounds will generally have a greater masking potential than intermittent sound due to the latter providing some relative quiet between sounds. Masking only occurs if there is near-overlap in sound and signal, such that a loud sound at e.g., 1000 Hz will not be able to mask a signal at 10,000 Hz[3].
- **The zone of responsiveness**: This is defined as the area within which the animal responds either behaviourally or physiologically. The zone of responsiveness is usually smaller than the zone of audibility because, as stated previously, audibility does not necessarily evoke a reaction. For most species there is very little data on response, but for species like harbour porpoise there exists several studies showing a relationship between received level and probability of response (Graham IM, 2019; Sarnoci´nska J, 2020; BOOTH, 2017; Benhemma-Le Gall A, 2021).
- **The zone of temporary hearing loss**: The area where the sound level is sufficient to cause the auditory system to lose sensitivity temporarily, causing loss of "acoustic habitat": the volume of water that can be sensed acoustically by the animal. This hearing loss is typically classified as Temporary Threshold Shift (TTS).
- **The zone of injury / permanent hearing loss**: This is the area where the sound level is sufficient to cause permanent hearing loss in an animal. This hearing loss is typically classified as Permanent Threshold Shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g., underwater explosions), physical trauma or acute mortal injuries are possible.

For this study, it is the zones of injury (PTS) that are of primary interest, along with estimates of behavioural impact ranges. To determine the potential spatial range of injury and behavioural change, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describe the evidence base used to derive them.

2.2.1 Irish Guidance Interpretation

We note that the DAHG "Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters" 2014 (Department of Arts, Heritage and the Gealtacht, 2014) contains the following statement:

"It is therefore considered that anthropogenic sound sources with the potential to induce TTS in a receiving marine mammal contain the potential for both (a) disturbance, and (b) injury to the animal."

This states that TTS constitutes an injury and should thus be the main assessment criteria[4]. However, the guidance goes on to specify the use of thresholds from a 2007 publication (Brandon L. Southall, 2007) which has since been superseded (by (Southall, et al., 2019)) and no longer represents best available science, nor reflects best practice internationally. Thus, the following excerpt from the guidance is relevant:

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[3] The exact limit of how near a noise can get to the signal in frequency before causing masking will depend on the receivers' auditory frequency resolution ability, but for most practical applications noise and signal frequencies will need to be within 1/3rd octave to start to have a masking effect.

[4] Injury being the qualifying limit in the Irish Wildlife Act 1976, section 23, 5c : https://www.irishstatutebook.ie/eli/1976/act/39/enacted/en/print#sec23

"The document will be subject to periodic review to allow its efficacy to be reassessed, to consider new scientific findings and incorporate further developments in best practice."

As there has been no such update to date, but the guidance clearly states intent, we have applied the latest guidance, reflecting the current best available method for assessing impact from noise on marine mammals.

2.3 Thresholds for Marine mammals

The zone of injury in this study is classified as the distance over which a fleeing marine mammal can suffer PTS leading to non-reversible auditory injury. Injury thresholds are based on a dual criteria approach using both un-weighted L_P (maximal instantaneous SPL) and marine mammal hearing weighted SEL. The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. The categories include:

- **Low Frequency (LF) cetaceans**: Marine mammal species such as baleen whales (e.g. minke whale *Balaenoptera acutorostrata*).
- **High Frequency (HF) cetaceans**: Marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales (e.g., bottlenose dolphin *Tursiops truncatus* and white-beaked dolphin *Lagenorhynchus albirostris*).
- **Very High Frequency (VHF) cetaceans**: Marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100 kHz) (e.g., harbour porpoise *Phocoena phocoena*).
- **Phocid Carnivores in Water (PCW)**: True seals, earless seals (e.g., harbour seal *Phoca vitulina* and grey seal *Halichoreus grypus*); hearing in air is considered separately in the group PCA.
- **Other Marine Carnivores in Water (OCW)**: Including otariid pinnipeds (e.g., sea lions and fur seals), sea otters and polar bears; in-air hearing is considered separately in the group Other Marine Carnivores in Air (OCA).
- **Sirenians (SI)**: Manatees and dugongs. This group is only represented in the NOAA guidelines.

These weightings are used in this study and are shown in Figure 2-1. It should be noted that not all of the above hearing groups of marine mammals will be present in the SI Works survey area, but all hearing groups are presented in this report for completeness.

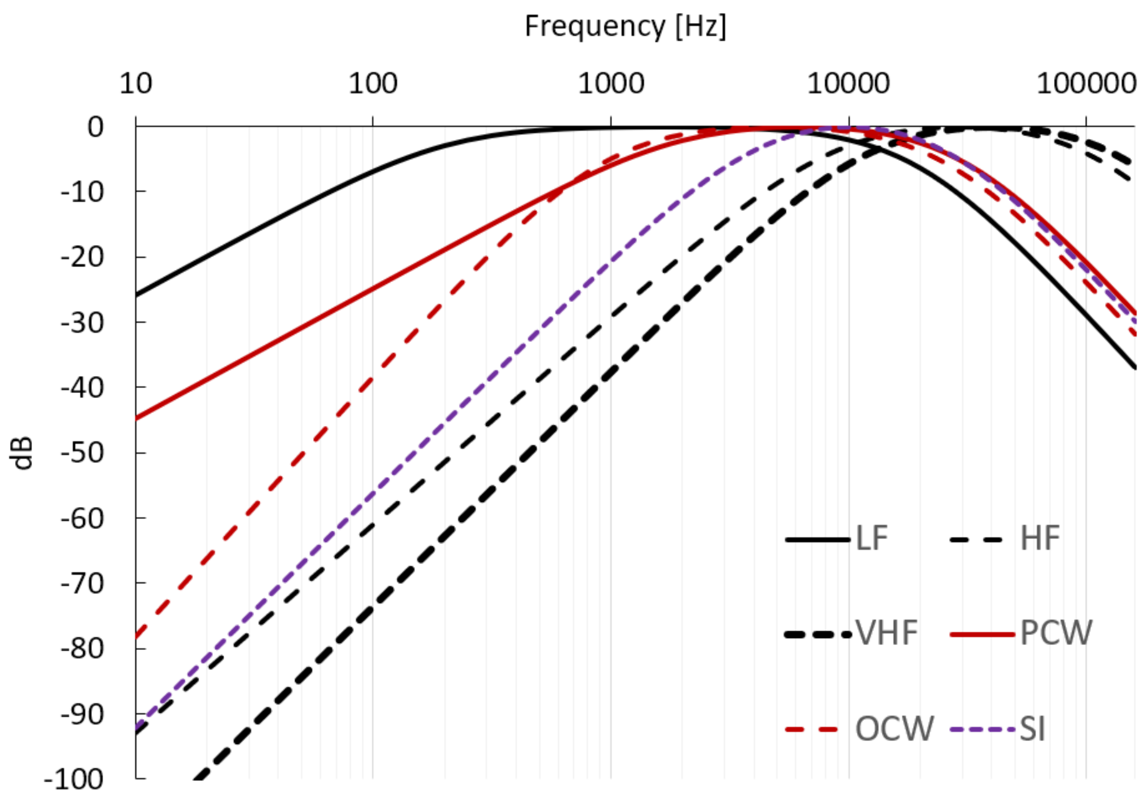

Figure 2-1: Auditory weighting functions for seals, whales and sirenians (NMFS, 2018; Southall et al. 2019)

Both the criteria for impulsive and non-impulsive sound are relevant for this study given the nature of the sound sources used during the SI Works. The relevant PTS and TTS criteria proposed by Southall *et al*. (2019) are summarised in Table 2-1.

Table 2-1: PTS and TTS onset acoustic thresholds (Southall *et al., 2019*; Tables 6 and 7)

Hearing Group	Parameter	Impulsive [dB]		Non-impulsive [dB]	
		PTS	TTS	PTS	TTS
Low frequency (LF) cetaceans	L_P, (unweighted)	219	213	-	-
	SEL, (LF weighted)	183	168	199	179
High frequency (HF) cetaceans	L_P, (unweighted)	230	224	-	-
	SEL, (MF weighted)	185	170	198	178
Very high frequency (VHF) cetaceans	L_P, (unweighted)	202	196	-	-
	SEL, (HF weighted)	155	140	173	153
Phocid carnivores in water (PCW)	L_P, (unweighted)	218	212	-	-
	SEL, (PW weighted)	185	170	201	181
Other marine carnivores in water (OCW)	L_P, (unweighted)	232	226	-	-
	SEL, (OW weighted)	203	188	219	199
Sirenians (SI) (NOAA only)	L_P, (unweighted)	226	220	-	-
	SEL, (OW weighted)	190	175	206	186

These updated marine mammal injury criteria were published in March 2019 (Southall, et al., 2019). The paper utilised the same hearing weighting curves and thresholds as presented in the preceding regulations document NMFS (2018) with the main difference being the naming of the hearing groups and introduction of additional thresholds for animals not covered by NMFS (2018). A comparison between the two naming conventions is shown in Table 2-2.

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 2-2: Comparison of Hearing Group Names between NMFS (2018) and Southall *et al.* (2019)

NMFS (2018) hearing group name	Southall *et al*. (2019) hearing group name
Low-frequency cetaceans (LF)	LF
Mid-frequency cetaceans (MF)	HF
High-frequency cetaceans (HF)	VHF
Phocid pinnipeds in water (PW)	PCW
Otariid pinnipeds in water (OW)	OCW
Sirenians (SI)	Not included

2.4 Disturbance to Marine Mammals

Disturbance thresholds for marine mammals are summarised in Table 2-3. Note that the non-impulsive threshold can often be lower than ambient noise for coastal waters with some human activity, meaning that ranges determined using this limit will tend to be higher than actual ranges. However, the levels are unweighted and ranges to threshold will be dominated by low-frequency sound, which for most hearing groups is outside their hearing range. For hearing groups with low thresholds this can mean that their range to TTS/PTS is *larger* than the range to the behavioural threshold, e.g., the PTS threshold for impulsive sound for the VHS group is 155 dB SEL, while the behavioural threshold is 160 dB SPL. For a typical scenario, for 1 second's exposure (SEL equals SPL for 1-second durations) that means the range to the behavioural threshold will be approximately twice the range to the PTS threshold (a difference of 5 dB). This is just one of the reasons why this behavioural threshold should be interpreted with caution.

Table 2-3: Disturbance Criteria for Marine Mammals Used in this Study based on Level B harassment of NMFS (National Marine Fisheries Service, 2005)

Effect	Non-Impulsive Threshold	Impulsive Threshold
Disturbance (all marine mammals)	120 dB SPL	160 dB $SEL_{\text{single impulse}}$ or 1-second SEL

2.5 Injury and Disturbance to Fishes

The injury criteria used in this noise assessment are given in Table 2-4 and Table 2-5 for impulsive noises and continuous noise respectively. L_P and SEL criteria presented in the tables are unweighted. Physiological effects relating to injury criteria are described below (Popper, et al., 2014):

- **Mortality and potential mortal injury**: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g., a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.

- **Recoverable injury ("PTS" in tables and figures)**: Tissue damage and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.

  The PTS term is used here to describe this, more serious impact, even though it is not strictly permanent for fish. This is to better reflect the fact that this level of impact is perceived as serious and detrimental to the fish.

- **Temporary Threshold Shift (TTS)**: Short term changes (minutes to few hours) in hearing sensitivity may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, and also cause deterioration in communication between individuals, affecting growth, survival, and reproductive success. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure.

Popper et al. 2014 does not set out specific TTS limits for L_P and for disturbance limits for impulsive noise for fishes. Therefore publications: "Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual" (WSDOT, 2020) and "Canadian Department of Fisheries and Ocean Effects of Seismic energy on Fish: A Literature review" (Worcester, 2006) on effects of seismic noise on fish are used to determine limits for these:

- The criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2020). The manual suggests an un-weighted sound pressure level of 150 dB SPL (assumed to be duration of 95 % of energy) as the criterion for onset of behavioural effects, based on work by (Hastings, 2002). Sound pressure levels in excess of 150 dB SPL are expected to cause temporary 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. The threshold is implemented here as either single impulse SEL or 1 second SEL, whichever is greater.
- The report from the Canadian Department of Fisheries and Ocean "Effects of Seismic energy on Fish: A Literature review on fish" (Worcester, 2006) found large differences in response between experiments. Onset of behavioural response varied from 107-246 dB L_P, the 10th percentile level for behavioural response was 158 dB L_P.

Given the large variations in the data from the two sources above, we have rounded the value to 160 dB L_P as the behavioural threshold for fishes for impulsive sound, and 150 dB SPL for non-impulsive sound.

Note that while there are multiple groups of fish presented, we have used the thresholds of the more sensitive group for all fish thus covering all fishes (203/186 PTS/TTS for impulsive sound & 222/204 PTS/TTS for non-impulsive sound). These lower thresholds also cover "Eggs and Larvae.

Table 2-4: Criteria for onset of injury to fish and sea turtles due to impulsive noise. For this assessment the lowest threshold for any group is used for all groups (shown in bold).

Type of animal	Unit	Mortality and potential mortal injury [dB]	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
Fish: no swim bladder (particle motion detection) Example: Sharks.	SEL	219[1]	216[1]	186[1]	150[3]
	L_P	213[1]	213[1]	193[2]	160[2]
Fish: where swim bladder is not involved in hearing (particle motion detection). Example: Salmonoids.	SEL	210[1]	203[1]	186[1]	150[3]
	L_P	207[1]	207[1]	193[2]	160[2]
Fish: where swim bladder is involved in hearing (primarily pressure detection). Example: Gadoids (cod-like).	SEL	207[1]	**203[1]**	**186**	**150[3] [SPL]**
	L_P	207[1]	**207[1]**	**193[2]**	**160[2]**
Sea turtles	SEL	210[1]	(*Near*) High* (*Mid*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-
Eggs and larvae	SEL	210[1]	(*Near*) Moderate (*Mid*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-

[1] (Popper et al. 2014) table 7.4, [2] (Worcester, 2006), [3] (WSDOT, 2020)

* Indicate (range) and risk of effect, e.g., "(Near) High", meaning high risk of that effect when near the source.

Where Popper et al. 2014 present limits as ">" 207 or ">>" 186, we have ignored the "greater than" and used the threshold level as given.

Relevant thresholds for non-impulsive noise for fishes relating to PTS, TTS, and behaviour are given in Table 2-5. Note that for the behaviour threshold we have used the impulsive threshold as basis for the continuous noise threshold, in absence of better evidence.

Table 2-5: Criteria for fish (incl. sharks) due to non-impulsive noise from Popper et al. 2014, table 7.7.

Type of animal	Unit	Mortality and potential mortal injury	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
All fishes	SEL	(*Near*) Low (*Mid*) Low (*Far*) Low	222†	204†	150 [SPL]*

*Based on the impulsive criteria.

†Based 48 hours of 170 dB SPL and 12 hours of 158 dB SPL

3 THE SITE ENVIRONMENT

3.1 SI Works Area of Interest

The SI Works Area of Interest (AoI) and nearby surroundings are characterised by shallow water (c. 14 m at the deepest extents), generally silty to sandy sediment and stable water properties (Figure 3-1).

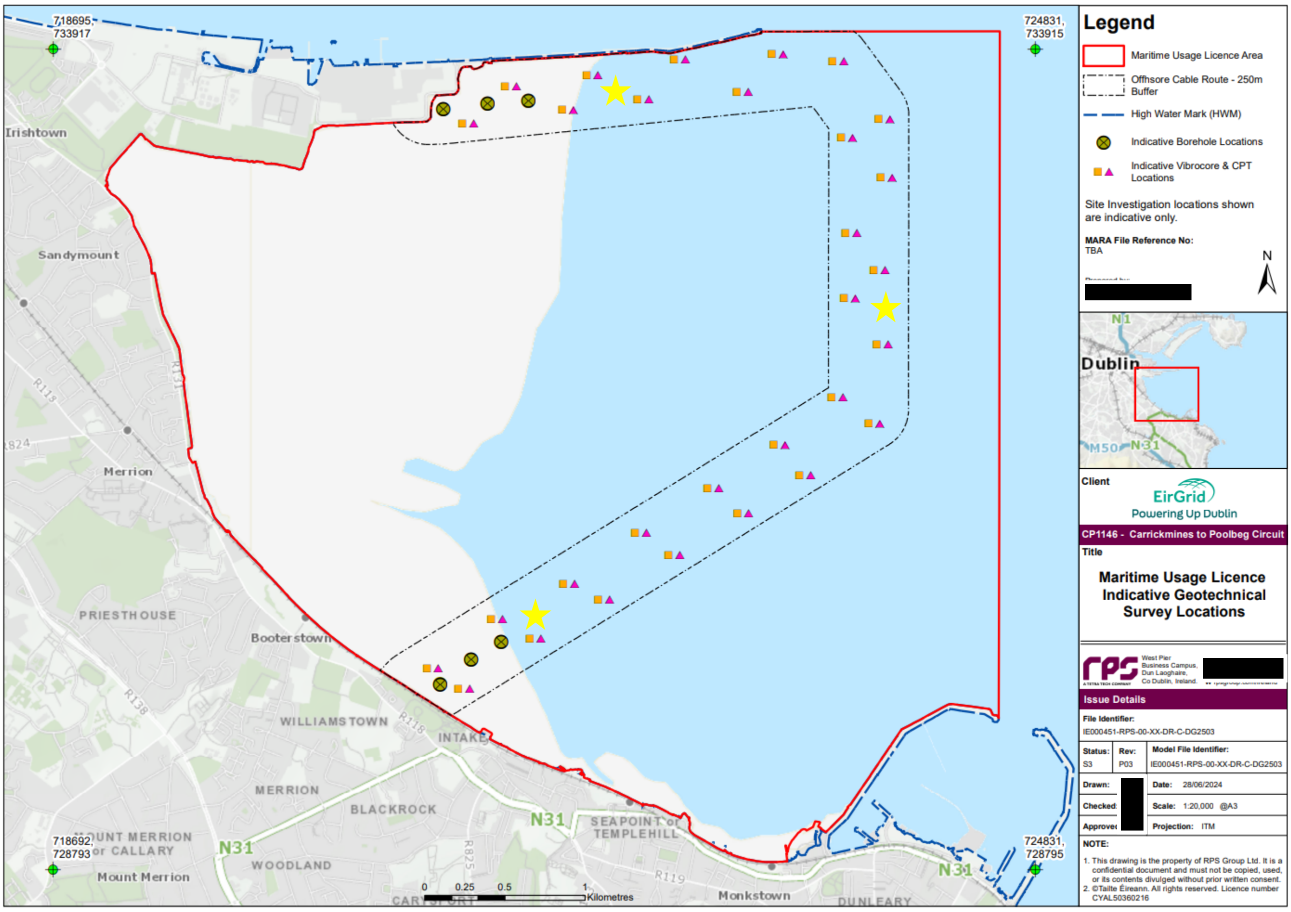

Figure 3-1: Maximal extent of surveys (red line). Indicative cable route (dot-dash line) with indicative locations for boreholes and geotechnical sampling locations. Additionally (yellow stars) are 3 indicative locations for ADCP deployments.

The maximal area to be surveyed is 2101 Ha of depths up to 14 meters (at mean high water springs "MHWS").

The survey speed is expected to be 4 knots (2.1 m/s), limited by the survey equipment. The survey transects plan is yet to be determined so reasonable worst-case locations throughout the survey area have been used as basis for the modelling rather than a specific survey plan.

3.2 Water Properties

Water properties were determined from historical data for the area. Where a range of values are expected or observed, the value resulting in the lowest transmission loss was chosen for a more conservative assessment (more noise at range). Thus, this also covers seasonal variation.

- Temperature: 18°C – maximal summer temperature given by seatemperature.net for the past seven years for bay Dublin.

- Salinity: 34.5 psu – Measurements in relation to Ringsend Wastewater Treatment Plant Upgrade Project[5]
- Soundspeed profile: Assumed uniform given high mixing as a result of tidal flows and generally shallow water and absence of river outflows.

3.3 Sediment Properties

Sediment properties are based on sediments given in Table 3-1.

Sediment types are informed by the "Folk 7-class Classification" from EMODnet Geology[6] (European Commision, 2024). A sediment model (Ainslie, 2010) was used to derive the acoustic properties of the sediment from the grain size. (Table 3-1).

Table 3-1: Sediment Properties for the two survey areas.

Site	Sediment type (ISO 14688-1:2017)	Density [kg/m³]	Soundspeed [m/s]	Grain size [mm] (nominal)
Outer/deeper part of the Survey area	Medium Silt	1551	1544	0.011
Inner/shallower part of the Survey area	Sand	2123	1801	0.35

[5] "Ringsend WwTP - EIAR modelling services" Figure 5.39 available online (2024/07/11)

[6] https://drive.emodnet-geology.eu/geoserver/gtk/wms

4 SOURCE NOISE LEVELS

Underwater noise sources are usually quantified in dB scale with values generally referenced to 1 µPa pressure amplitude as if measured at a hypothetical distance of 1 m from the source (called the Source Level). In practice, it is not usually possible to measure at 1 m from a source, but the metric allows for comparison and reporting of different source levels on a like-for-like basis. In reality, for a large sound source, 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 an imagined acoustic centre point. Therefore, the stated sound pressure level at 1 m does not occur for large sources. In the acoustic near-field (i.e. close to the source), the sound pressure level will be significantly lower than the value predicted by the back-calculated source level (SL).

4.1 Source Models

The noise sources and activities investigated during this assessment are summarised in Table 4-1.

Note that:

1. The ping rate, and therefore the SPL and SEL of the sound source varies with the local depth.

2. Due to differences in sediment, the angle at which the sediment will tend to reflect sound back into the water column changes. As we use this information to derive practical source levels for highly directional sources, this will change with sediment type (further information below and in Appendix A & Figure 8-7).

3. To account for the shallow depth, and therefore assumed short duration of pulses from Multibeam Echo-Sounder (MBES), Side Scan Sonar (SSS) and pinger/chirper, we have assessed the weighted kurtosis in order to determine impulsiveness (Section 2.1).

Sonars and echosounders generally use tone pulses of either constant frequency or as a frequency sweep. These pulses are typically windowed to limit “spectral leakage[7]”. We assume use of a Von Hann window (sometimes “Hanning”) which gives effective attenuation of frequencies outside the intended frequencies. This means that while a sonar with a centre frequency of 200 kHz is well above the hearing range of any marine mammal, there will be energy at 100 kHz c. 50 dB lower than the source level at 200 kHz. This is accounted for in the assessment. Note that this might contrast with some guidelines, such as the “JNCC guidelines mitigation during geophysical surveys” (JNCC, 2017), which state that “*Multi-beam surveys in shallower waters (<200m) are not subject to these requirements* [mitigation for protection of European Protected Species]”. However, given the fact there is substantial energy outside the nominal frequency range of any echo sounder (see example in Figure 4-1), we have included this energy spread here.

[7] Acoustic phenomenon where a sharp change in pressure produces sound in a wide frequency range (similar to an ideal impulse) outside the intended frequencies.

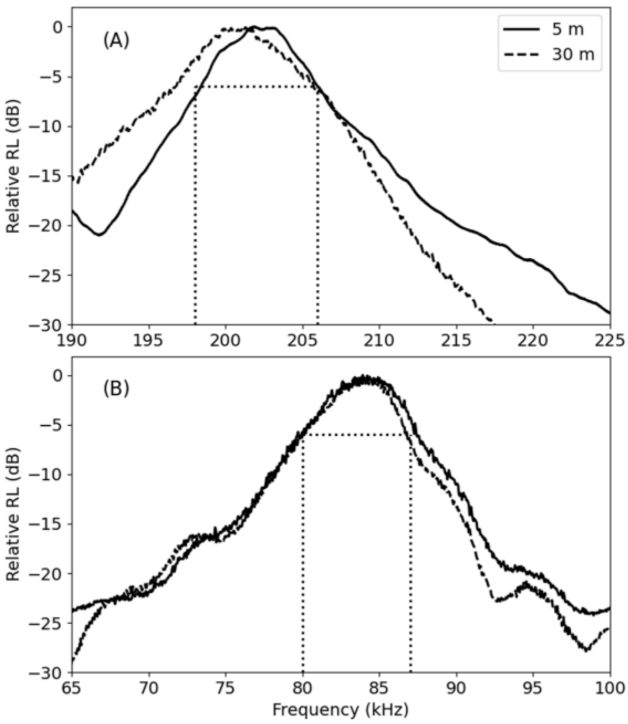

Figure 4. The relative received levels (RLs, in decibels (dB)) of the signals of the acoustic frequency bandwidth of the dual-frequency echosounder used in this study, as observed at two different depths. The dotted lines indicate the −6 dB acoustic bandwidths of 198–206 (**A**) and 80–87 kHz (**B**). The peak frequencies of the two channels were found to be 201.5 (**A**) and 84 kHz (**B**).

Figure 4-1. Example of recorded levels from an echosounder showing significant energy outside the nominal frequencies, necessitating assessment at those frequencies too (Burnham, et al., 2022).

Highly directional sources with narrow beams (sonars and echosounders) will tend to ensonify only a narrow cone of water at any given time. For multibeam echosounders or side scan sonars, the beam(s) sweeps though the water, side to side, to get wider sediment coverage. For this type of sonar, we have converted the source to an omnidirectional source with the same acoustic energy as the original but represented as omnidirectional. This simplifies the calculation process, but yields identical results, and means that we account for the probabilistic nature of an animal being “ensonified” by the source.

For beams only directed vertically down or up, such as sub-bottom profilers or ADCPs, we incorporate the directivity of the beam as well as the ability of the sediment to reflect the sound emitted. This means that we can account for the fact that primarily, a narrow cone directly below/above the source is ensonified with high sound levels and also that a significant attenuation occurs in the sediment where sound enters at steep angles. In practice, we use the angle with the highest level after accounting for directivity combined with sediment loss to a range of 100 m.

Table 4-1: Summary of Sound Sources and Activities Included in the Subsea Noise Assessment

Equipment	Source level [SPL] (as used in model)	Primary decidecade bands (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessel, Geophysical	161 dB SPL	10-16,000 Hz	Based on <20 m generic survey vessel.	Non-impulsive
Survey vessel, Geotechnical	168 dB SPL	10 – 25,000 Hz	Based on <30 m tug with dynamic positioning system	Non-impulsive
MBES	187 dB SPL (Spherical equivalent level)	200,000-800,000 Hz	Based on Reason SeaBat T50 & R2 Sonic 2024.	Impulsive

Equipment	Source level [SPL] (as used in model)	Primary decidecade bands (-20 dB width)	Source model details	Impulsive/non-impulsive
SSS	166 dB SPL (Spherical equivalent level)	100,000-1,000,000 Hz	Generic SSS from 400-1,000 kHz.	Impulsive
USBL	190 dB SPL	18,000-31,500 Hz	Active with non-hull mounted SSS* & during vibro-core operations, 2 Hz ping rate, ping length 10 ms.	Impulsive
SBP-parametric (P-SBP)	204 dB SPL	80,000-150,000 Hz (Primary) 2,000-22,000 Hz (Secondary)	Source level adjusted for sediment effects and beam widths. Based on Innomar Standard, worst-case for shallow water.	Impulsive
SBP-chirper/pinger (C-SBP)	181 dB SPL	2,000-12,000 Hz	Generic shallow water SBP of chirper/pinger type. Source level adjusted for sediment effects and beam widths.	Impulsive
SBP-sparker/UHRS (S-SBP)	184 dB SPL	600 – 6,300 Hz	Based on GeoSource 400. Firing rate of 1 Hz assumed	Impulsive
ADCP (**Not modelled given high frequency**)	114 dB SPL	500,000-1,260,000 Hz	Based on suitable ADCP for depths <100 m (e.g. Nortek AWAC, Teledyne Reason Sentinel, Workhorse or Monitor) Source level adjusted for sediment effects and beam widths.	Impulsive
Drilling/ rotary coring (Boreholes, no USBL)	145 dB SPL	10-500,000 Hz	Based on published levels (Erbe, et al., 2017; Fisheries and Marine Service, 1975; MR, et al., 2010; L-F, et al., 2023)	Non-impulsive
Vibro-coring & CPT	187 dB SPL	50 – 16,000 Hz	Based on levels from previous work & (Reiser, et al., 2010)	Non-impulsive

*If the SSS and SBP are hull-mounted, there is no need for a positioning device (USBL) and this noise source should be removed from consideration.

The ADCP has not been modelled due to its lowest frequency being significantly above the upper frequency limit of hearing of any marine animal. Furthermore, the extremely high frequencies will attenuate rapidly with range, meaning that on top of the spreading loss there will be an additional c. 140 dB/km loss from absorption[8].

In addition to the activities outlined above, there may also be grab sampling. However, this activity has not been modelled given the low noise levels associated with the activity.

[8] See e.g., APPENDIX A, Figure 8-12 or http://resource.npl.co.uk/acoustics/techguides/seaabsorption/ for further information.

All other surveys undertaken in the intertidal area, e.g. environmental walkover surveys, intertidal sampling, etc. have not been included in this assessment as they will not result in underwater noise.

4.1.1 Equipment

This section presents details on each sound source individually. Combined sources, with expected combination of active equipment, are presented in Section 4.1.2.

4.1.1.1 Survey Vessel, Geophysical

A small survey vessel of up to 20 m in length, travelling at 4 knots (equipment limited), has been assessed in this report as this represents the anticipated vessel parameters for the geophysical and geotechnical surveys. Broadband level of the vessel is 161 dB SPL with decidecade band levels given in Figure 4-2 (maximal band level is 150 dB SPL at the 25 Hz band). Smaller vessels will have lower emitted levels and are therefore covered by this assessment.

This vessel is also used as a proxy for a suitable platform for support vessels, representing generic machinery noise.

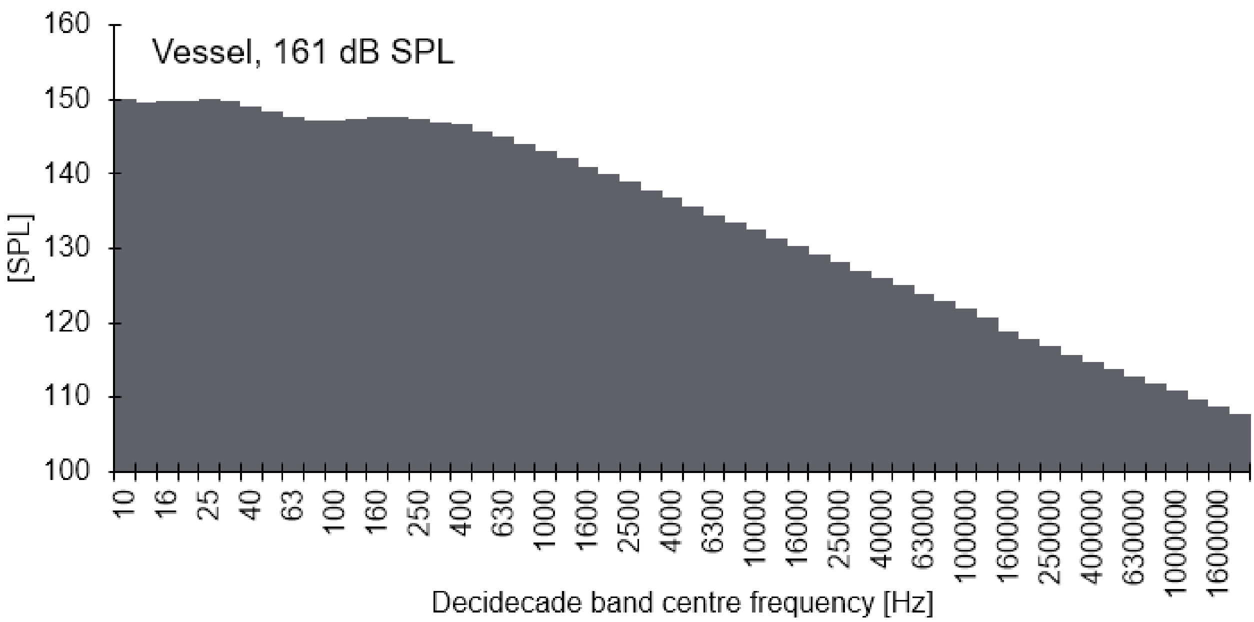

Figure 4-2. Vessel source band levels. Broadband level: 161 dB SPL. Based on generic survey craft at 4 kn.

4.1.1.2 Survey Vessel, Geotechnical

A small survey vessel of up to 30 m in length, travelling at 4 knots transiting to SI locations (equipment limited), has been assessed in this report as this represents the anticipated vessel parameters for carrying out the geotechnical survey. Broadband level of the vessel is 168 dB SPL with decidecade band levels given in Figure 4-2 (maximal band level is 157 dB SPL at the 400 Hz band). Smaller vessels will have lower emitted levels and are therefore covered by this assessment.

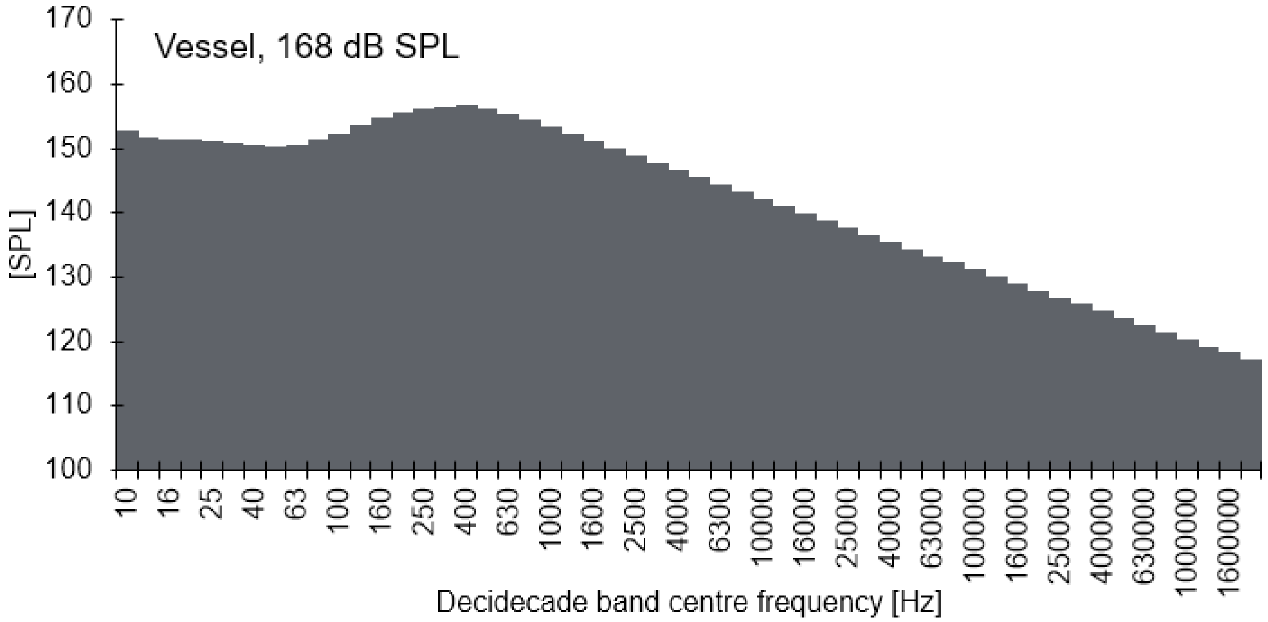

Figure 4-3. Vessel source band levels. Broadband level: 168 dB SPL. Based on generic tug with DP system at 4 kn.

4.1.1.3 Multibeam Echosounder (MBES)

The “Reason SeaBat T50-P”, “R2 Sonic 2024”, or similar shallow water model, is a likely MBES for this survey. Nominal frequencies from 200 kHz to 800 kHz have been modelled. The equivalent spherical level is 187 dB SPL (maximally 179 dB SPL in each band). Band levels are presented in Figure 4-4.

Given the shallow water (<14 m depth), it is likely that shorter pulses will be used as they offer sufficient energy for a clear returning echo. This will increase kurtosis (“impulsiveness”) for realistic ping rates for the depth. Therefore, the MBES is modelled as an impulsive noise source.

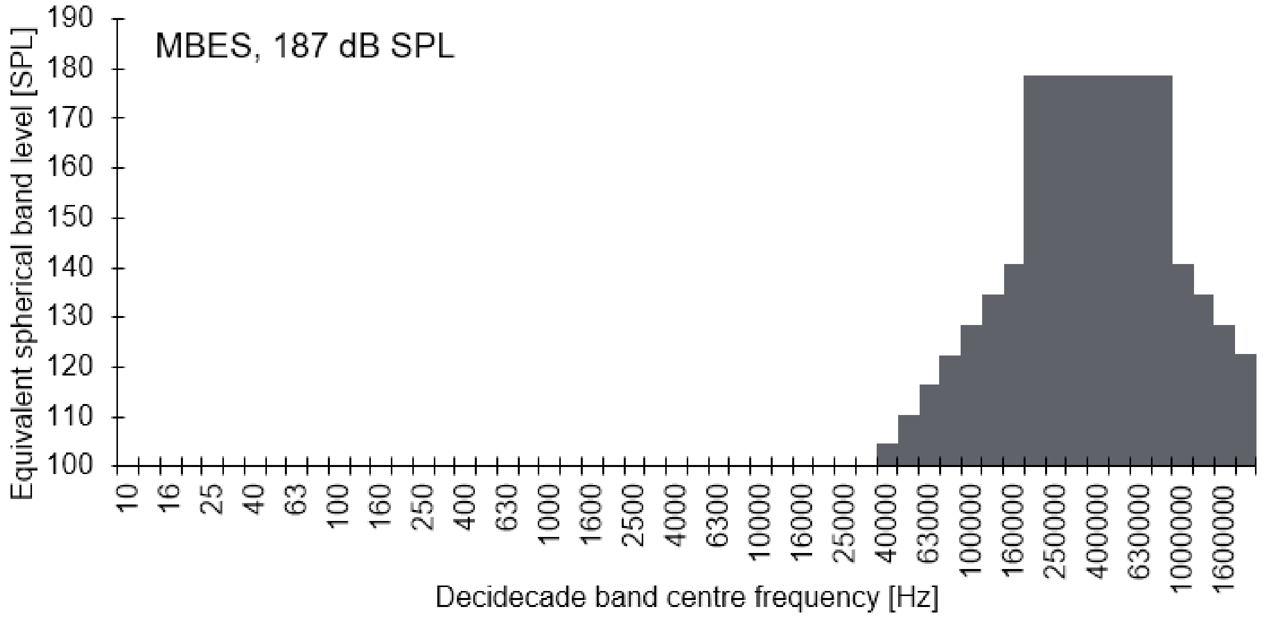

Figure 4-4. MBES source band levels as equivalent spherical/omnidirectional levels.

4.1.1.4 Side Scan Sonar (SSS)

No specific model of side scan sonar (SSS) has been determined for the survey, except for specification of nominal frequencies of 100 – 1,000 kHz. To address this uncertainty, a generic SSS model has been generated from seven commonly used SSS systems (from EdgeTech, C_MAX and Klein Systems). We have used the 90th percentile level as the representative level. The equivalent spherical broadband level is 166 dB SPL (Figure 4-5).

Given the shallow water (<14 m depth), it is likely that shorter pulses will be used as they offer sufficient energy for a clear returning echo. This will increase kurtosis ("impulsiveness") for realistic ping rates for the depth. Therefore, the SSS is modelled as an impulsive noise source.

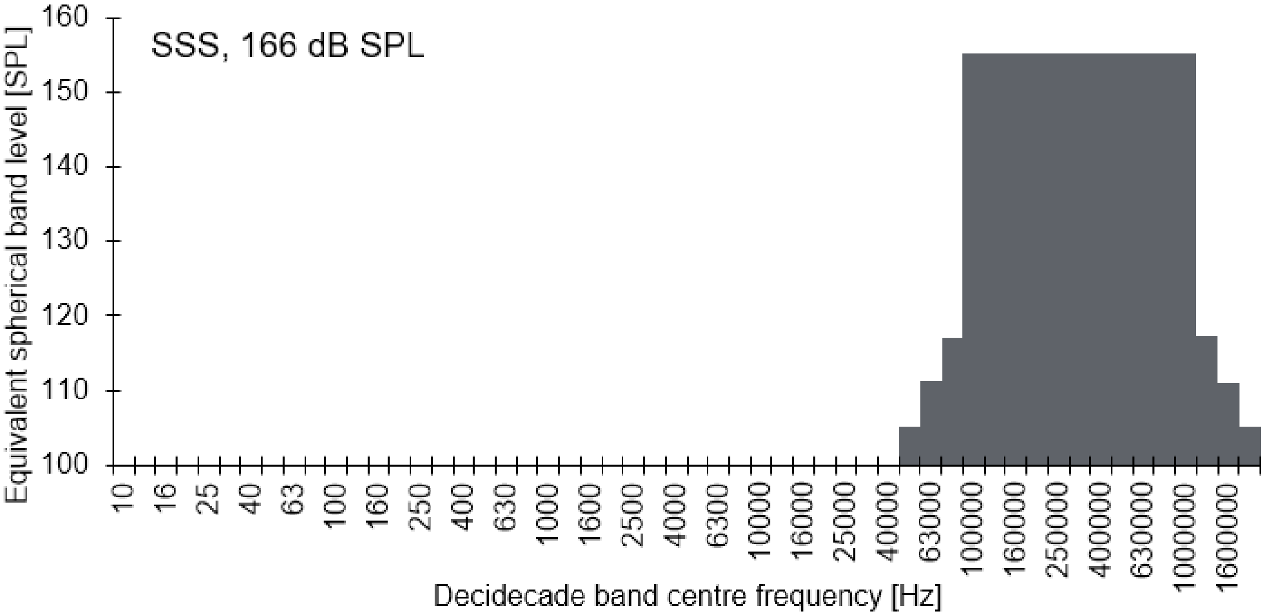

Figure 4-5. SSS source band levels as equivalent spherical/omnidirectional levels.

4.1.1.5 Ultra Short Base-Line positioning system (USBL)

If the SSS or SBP is deployed as a towfish (towed behind the vessel), its accurate positions will need to be known. A USBL positioning system is a common solution. This is also the case for the deployed Vibro-corer units. Here, a generic USBL is used, with a 10 ms pulse length and 2 Hz ping rate, consistent with popular models (Edgetech BATS, IxBlue GAPS, Sonardyne Ranger). A max SPL [L_P] of 210 dB have been modelled, giving an SPL of 190 dB (Figure 4-6).

The relatively short pulses and slow repetition of pulse gives a weighted kurtosis over the limit value (40), therefore, the USBL is modelled as an impulsive noise source.

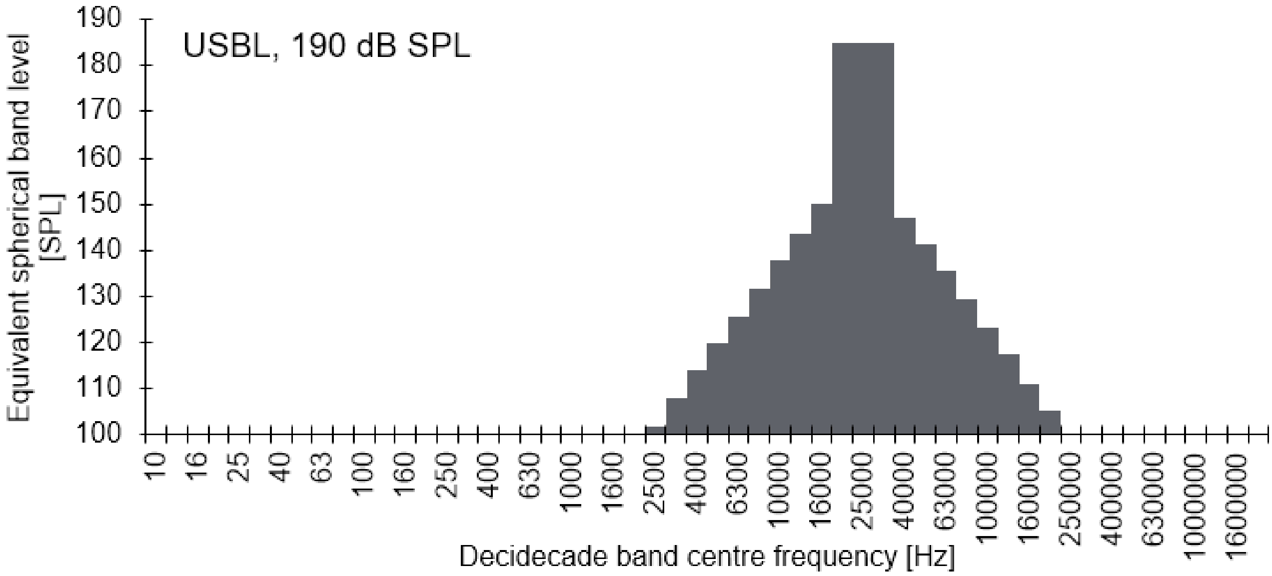

Figure 4-6. USBL source band levels.

4.1.1.6 Sub-bottom Profilers (SBP)

4.1.1.6.1 Parametric SBP (P-SBP)

The survey might use a parametric sub-bottom profiler (SBP) such as the “Innomar standard”. These SBPs use two higher frequencies (“primary frequencies”) to generate an interference pattern at lower frequencies (“secondary frequencies”). This means that the secondary beam can be made extraordinarily narrow, leading to a much smaller sound impact (Appendix A, Figure 8-8). We account for these differences in beam pattern by including the sediment reflection loss at high incidence angles (see Appendix A, Figure 8-7) to reduce the effective source level accordingly.

The source level for the P-SBP is split into two regions according to the nominal frequencies, accounting for some spectral leakage (Figure 4-7) and assuming the full range of frequencies is used during the survey (a conservative assumption). The total, broad band level for the parametric SBP is 204 dB SPL, with the secondary frequencies being 144 dB SPL.

Given the shallow water (<14 m depth), it is likely that shorter pulses will be used as they offer sufficient energy for a clear returning echo. This will increase kurtosis (“impulsiveness”) for realistic ping rates for the depth. Therefore, the P-SBP is modelled as an impulsive noise source.

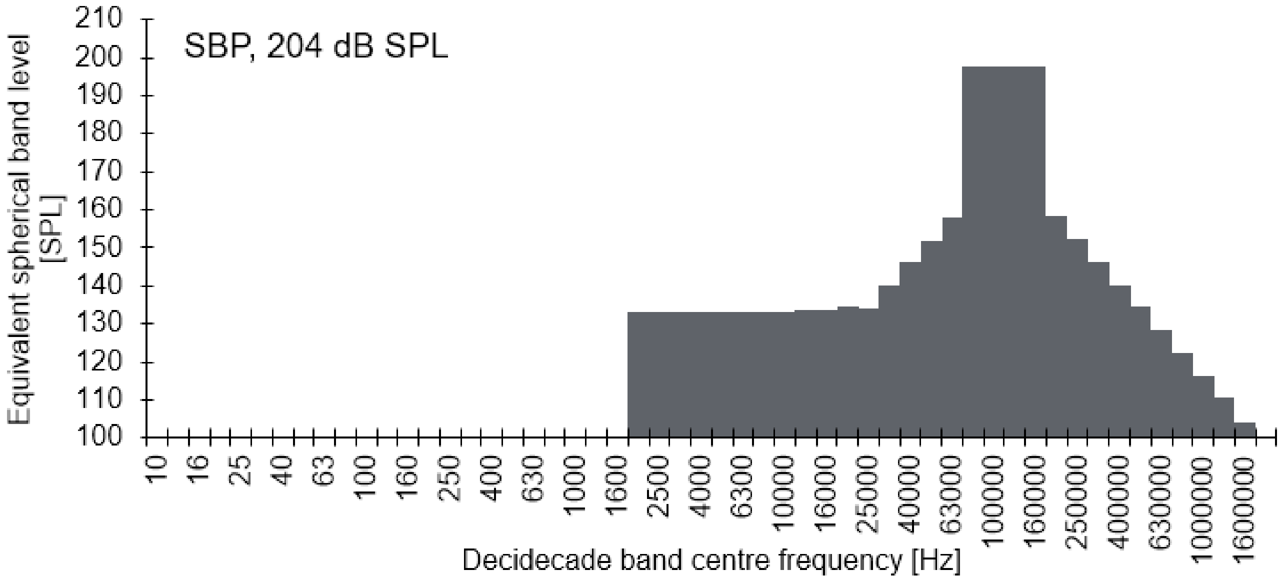

Figure 4-7. Parametric SBP source band levels as equivalent spherical/omnidirectional levels. Primary frequencies 85 kHz – 150 kHz, secondary frequencies 2 kHz – 22 kHz.

4.1.1.6.2 Chirper/Pinger SBP (C-SBP)

A chirper or pinger type SBP might be used for the survey. As no specific model has been specified, we have used a generic model based on common SBPs of this type. These have wide beams and therefore a comparatively higher noise impact, relative to their in-beam source levels. A single SBP source has been generated to represent both these sources as they are acoustically similar. Total broadband level for this SBP is 181 dB SPL with band levels given in Figure 4-8.

Given the shallow water (<14 m depth), it is likely that shorter pulses will be used as they offer sufficient energy for a clear returning echo. This will increase kurtosis (“impulsiveness”) for realistic ping rates for the depth. Therefore, the C-SBP is modelled as an impulsive noise source.

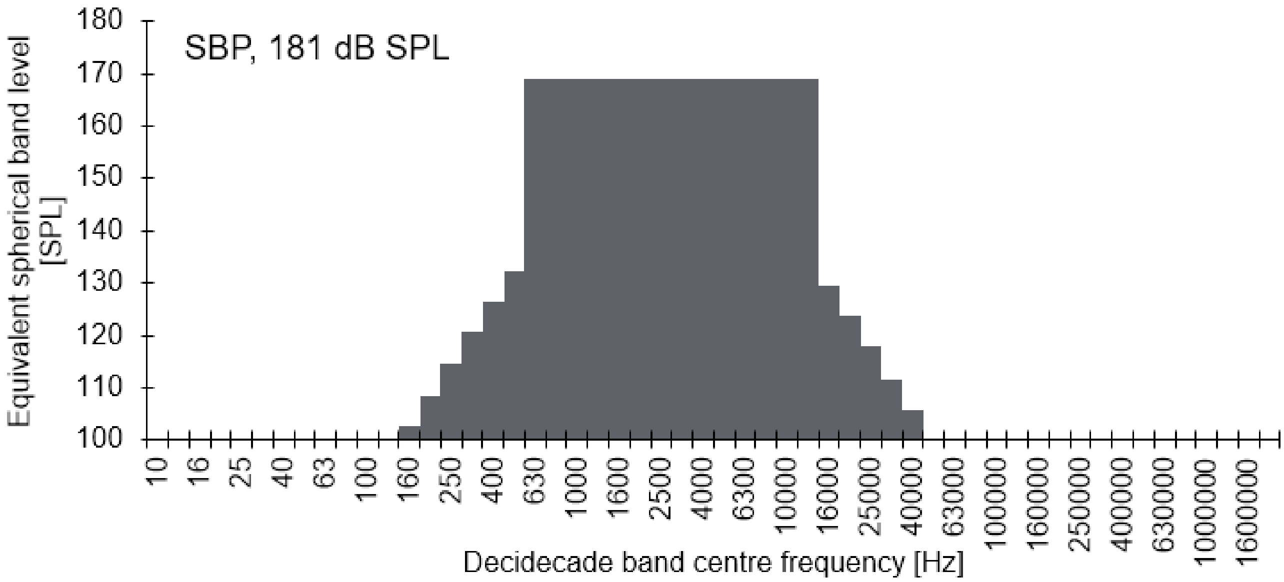

Figure 4-8. Chirper/Pinger type SBP band levels.

4.1.1.6.3 Sparker SBP (S-SBP)

A sparker type SBP (sometimes "UHRS") might be used during the survey. As no specific model has been specified, we have used a generic model based on common SBPs of this type and an energy per firing of 400 J and 1 firing per second. The total broadband level for this SBP is 184 dB SPL, with band levels given in Figure 4-8. Levels at frequencies below 100 Hz are taken from a spectral analysis of the timeseries in Figure 4-10.

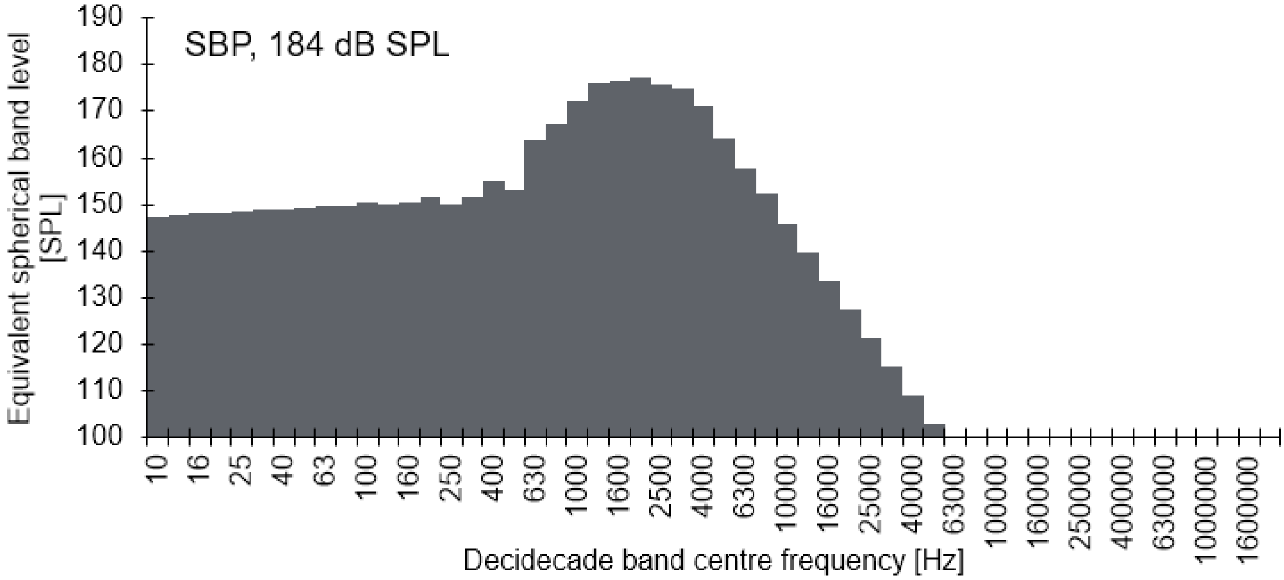

Figure 4-9. Chirper/Pinger type SBP band levels.

The very short impulses and slow repetition mean that this source is modelled as an impulsive noise source.

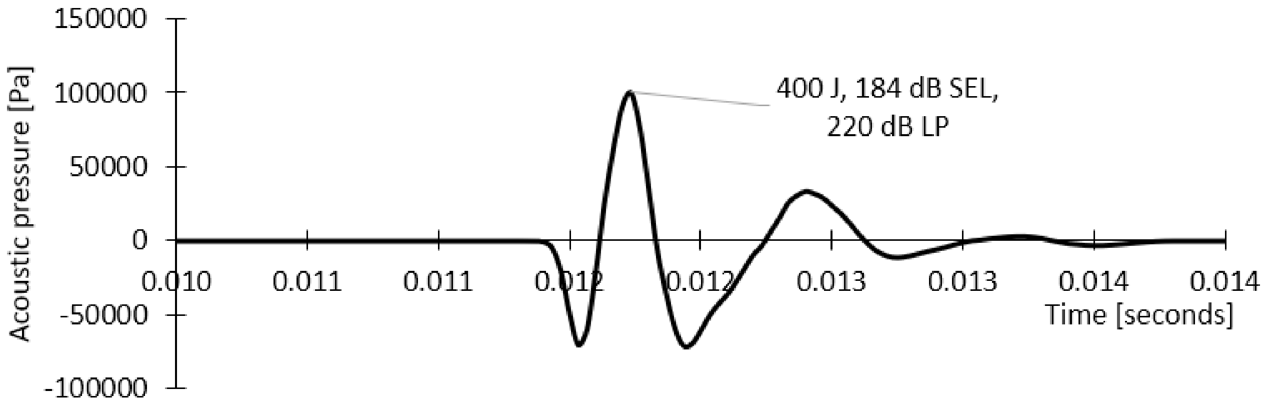

Figure 4-10. Example of an impulse from a sparker type SBP.

4.1.1.7 Boreholes Drilling

Boreholes are planned in the shallow parts of the SI Works area, with a drill of c. 0.1 m diameter. Recordings from similar equipment has informed the source levels used here (Erbe, et al., 2017; Fisheries and Marine Service, 1975; MR, et al., 2010; L-F, et al., 2023) Figure 4-11. This activity is a non-impulsive sound source with a broadband level of 145 dB SPL.

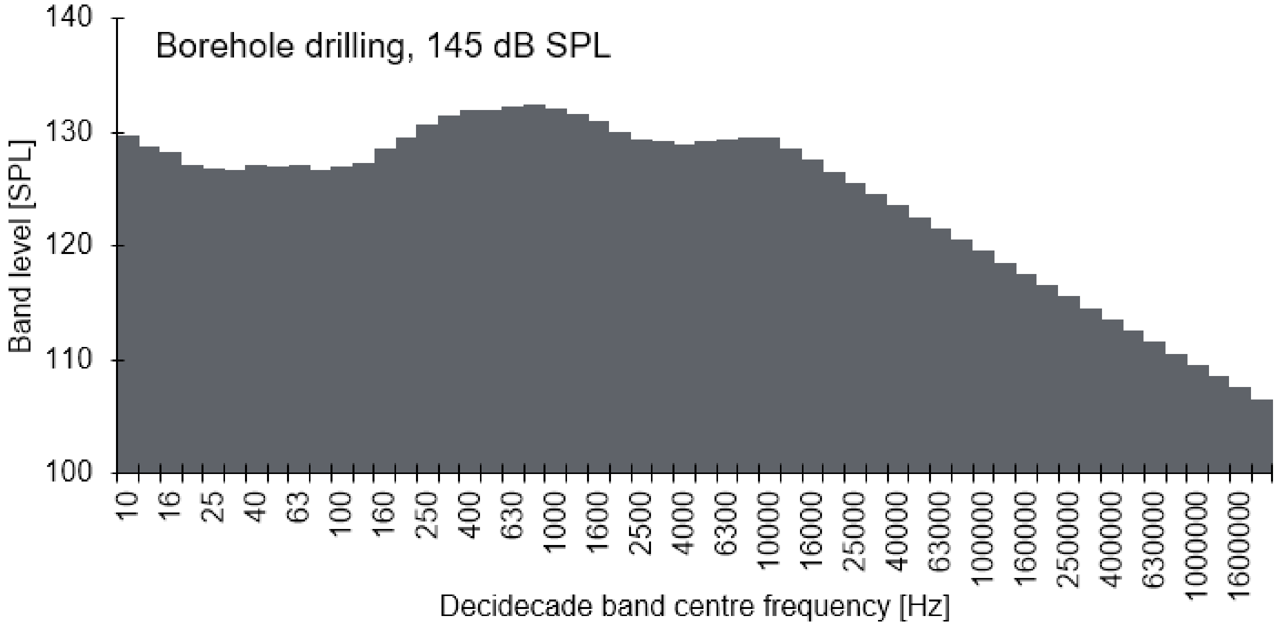

Figure 4-11. Band levels for drilling, Levels above 25 kHz are extrapolated based on trend in bands at lower frequencies.

4.1.1.8 Vibro-coring & CPT

For extraction of physical samples and sediment testing, vibro-coring and Cone Penetration Testing (CPT) will be carried out. Band levels are shown in Figure 4-11. The "Vibro-coring & CPT" activity is a non-impulsive sound source with a broadband level of 187 dB SPL.

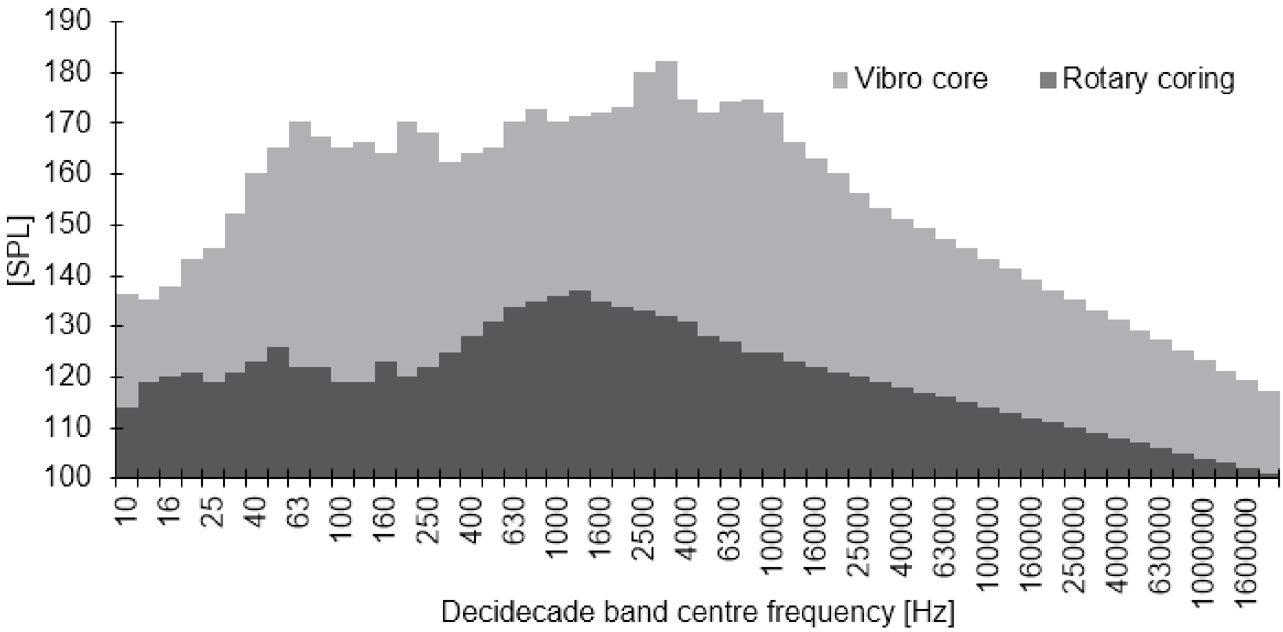

Figure 4-12. Band levels vibro-coring and CPT. Levels above 25 kHz are extrapolated based on trend in bands at lower frequencies.

4.1.2 Combined Sources

The relevant equipment for each survey type has been grouped into six scenarios that represent the most combinations for the survey equipment proposed to be used in the SI works.

MBES and SSS are active for all combined sources of the geophysical survey.

The “Vessel” noise source is active for all sources of both geophysical and geotechnical surveys.

4.1.2.1 Geophysical Survey (Parametric SBP & USBL Active)

This scenario assumes the geophysical survey is using a parametric SBP and that a towfish is deployed requiring an active USBL. Total broadband level of 204 dB SPL.

Active equipment:

- Vessel
- MBES
- SSS
- USBL
- Parametric SBP

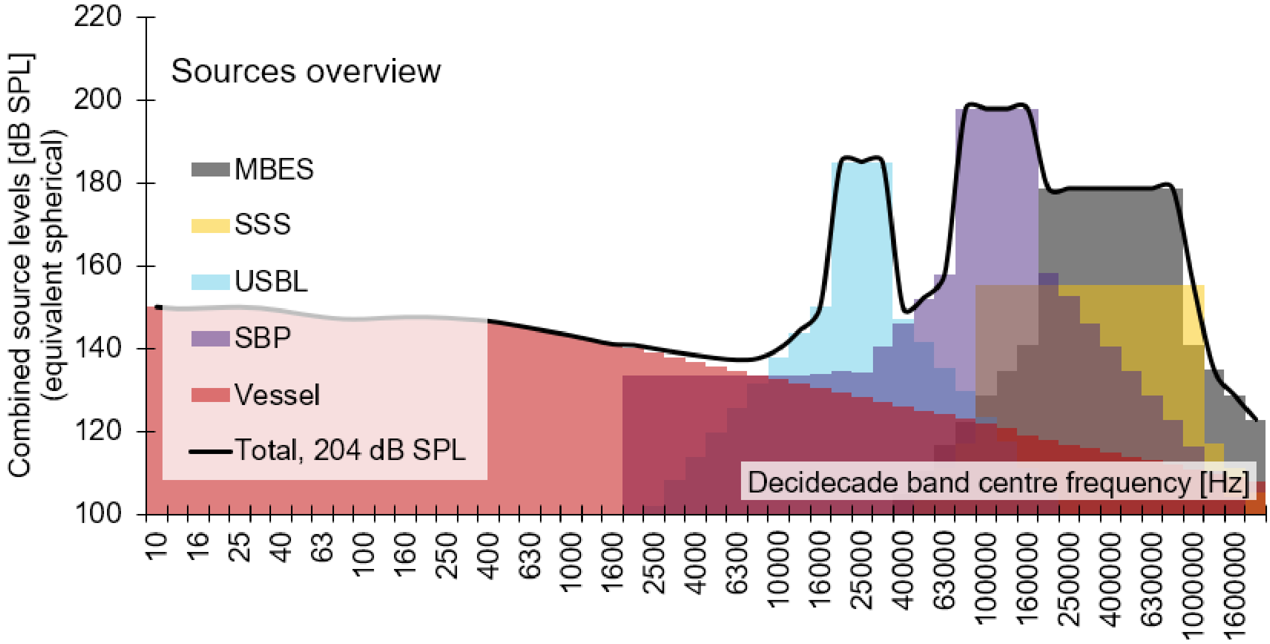

Figure 4-13. Source band level during geophysical survey (parametric SBP & USBL active).

4.1.2.2 Geophysical Survey (Parametric SBP & USBL Not Active)

This scenario assumes the geophysical survey is using a parametric SBP and that there is no need for a USBL (hull mounted SBP and SSS with known positions). Total broadband level of 204 dB SPL.

Active equipment:

- Vessel
- MBES
- SSS
- Parametric SBP

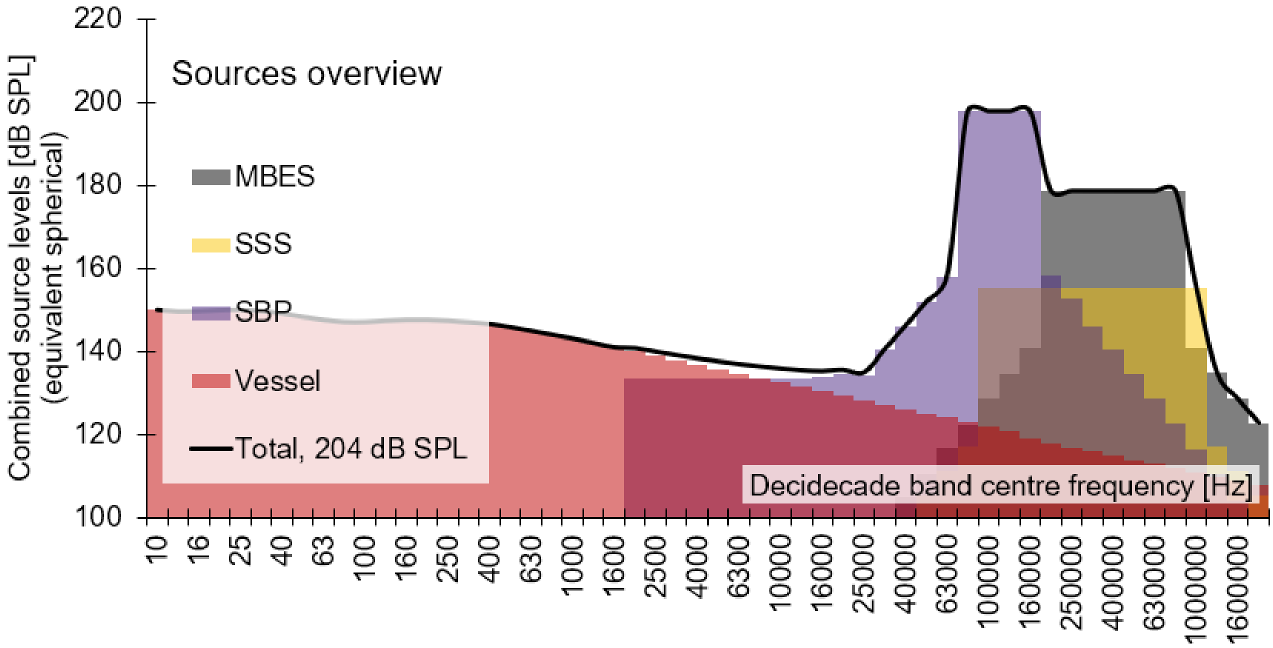

Figure 4-14. Source band level during geophysical survey (parametric SBP & USBL not active).

4.1.2.3 Geophysical Survey (Chirper/Pinger SBP & USBL Active)

This scenario assumes the geophysical survey is using a chirper or pinger type SBP and that a towfish is deployed requiring an active USBL. Total broadband level of 191 dB SPL.

Active equipment:

- Vessel
- MBES
- SSS
- USBL
- Chirper/pinger SBP

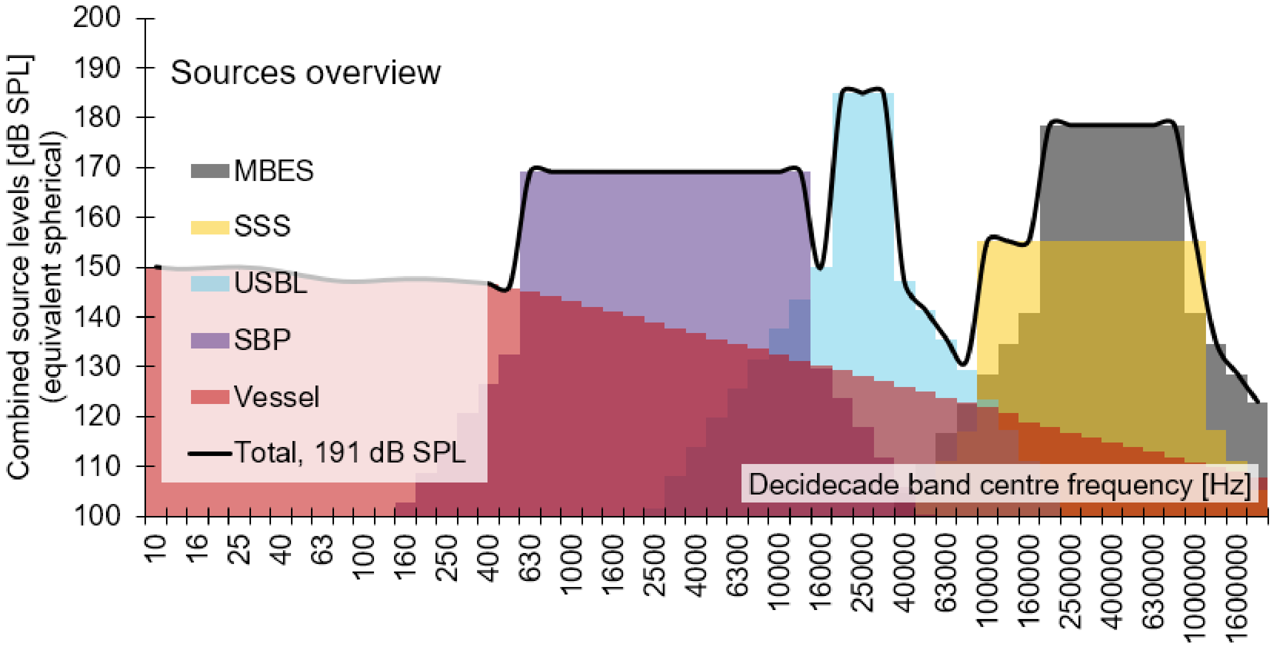

Figure 4-15. Source band level during geophysical survey (chirper/pinger SBP & USBL active).

4.1.2.4 Geophysical Survey (Chirper/Pinger SBP & USBL Not Active)

This scenario assumes the geophysical survey is using a chirper or pinger type SBP and that there is no need for a USBL (hull mounted SBP and SSS, with known positions). Total broadband level of 183 dB SPL.

Active equipment:

- Vessel
- MBES
- SSS
- Chirper/pinger SBP

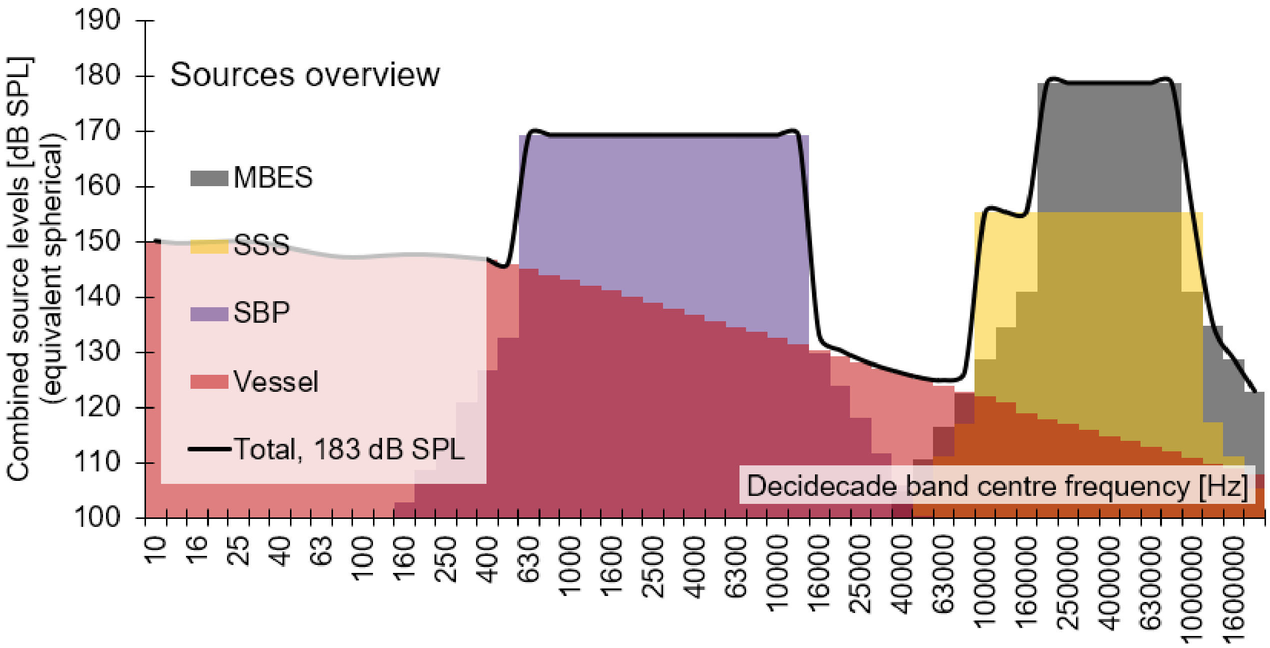

Figure 4-16. Source band level during geophysical survey (chirper/pinger SBP & USBL not active).

4.1.2.5 Geophysical Survey (Sparker SBP & USBL Active)

This scenario assumes the geophysical survey is using a sparker type SBP and that a towfish is deployed requiring an active USBL. Total broadband level of 191 dB SPL.

Active equipment:

- Vessel
- MBES
- SSS
- USBL
- Sparker

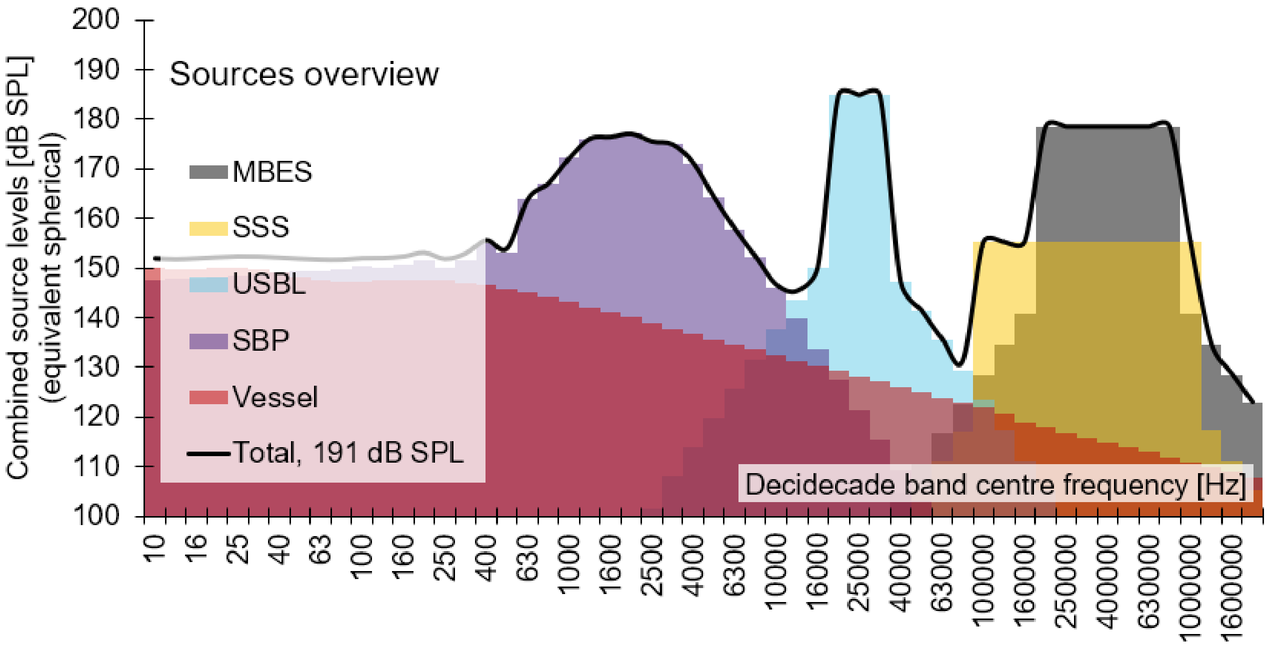

Figure 4-17. Source band level during geophysical survey (sparker SBP & USBL active).

4.1.2.6 Geophysical Survey (Sparker SBP & USBL not Active)

This scenario assumes the geophysical survey is using a sparker type SBP and that there is no need for a USBL (hull mounted SBP and SSS, with known positions). Total broadband level of 185 dB SPL.

Active equipment:

- Vessel
- MBES
- SSS
- Sparker

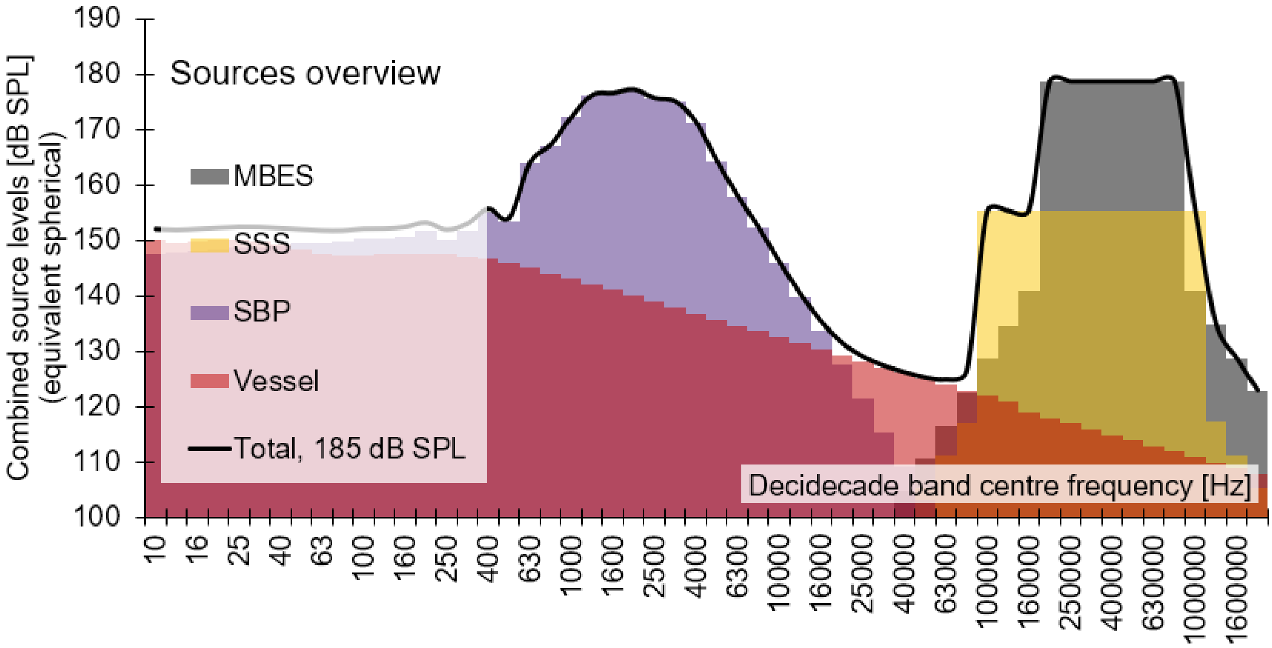

Figure 4-18. Source band level during geophysical survey (sparker SBP & USBL not active).

4.1.2.7 Soft Start Source (Geophysical)

During soft starts, it is assumed that any SBP and USBL will not be active but the MBES and/or the SSS will be active. Total broadband level of 179 dB SPL.

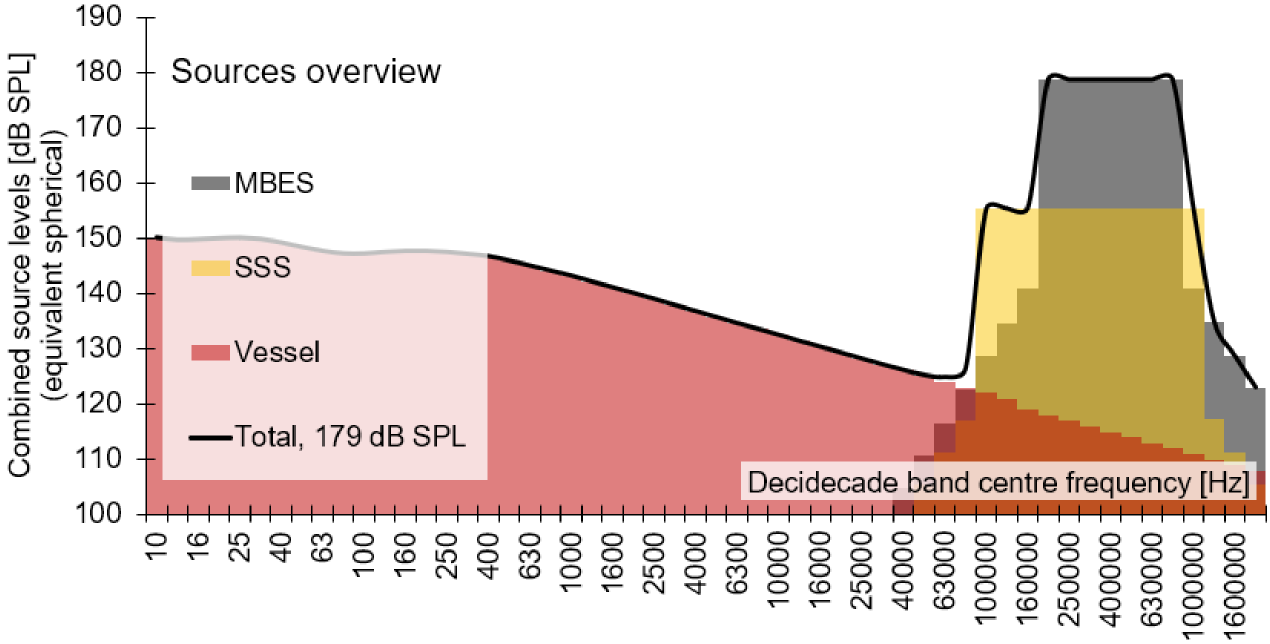

Figure 4-19. Source band level during geophysical survey soft start.

4.1.2.8 Geotechnical Survey (Drilling, boreholes)

Equipment related to drilling boreholes are active. Additionally, the "Vessel" source is active to account for support vessels and general machinery. Total broadband level of 162 dB SPL.

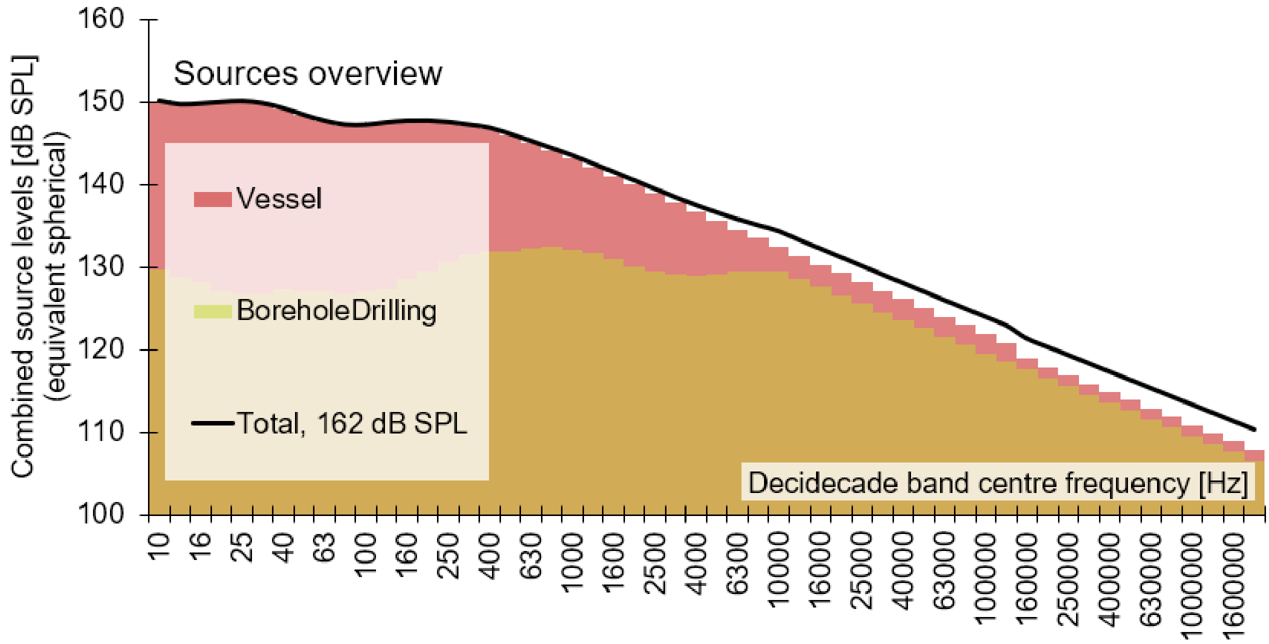

Figure 4-20. Source band level during geotechnical survey – borehole drilling.

4.1.2.9 Geotechnical Survey (Vibro-coring & CPT)

Vibro-coring, CPT, vessel (geotechnical) and USBL are active. Total broadband level of 192 dB SPL.

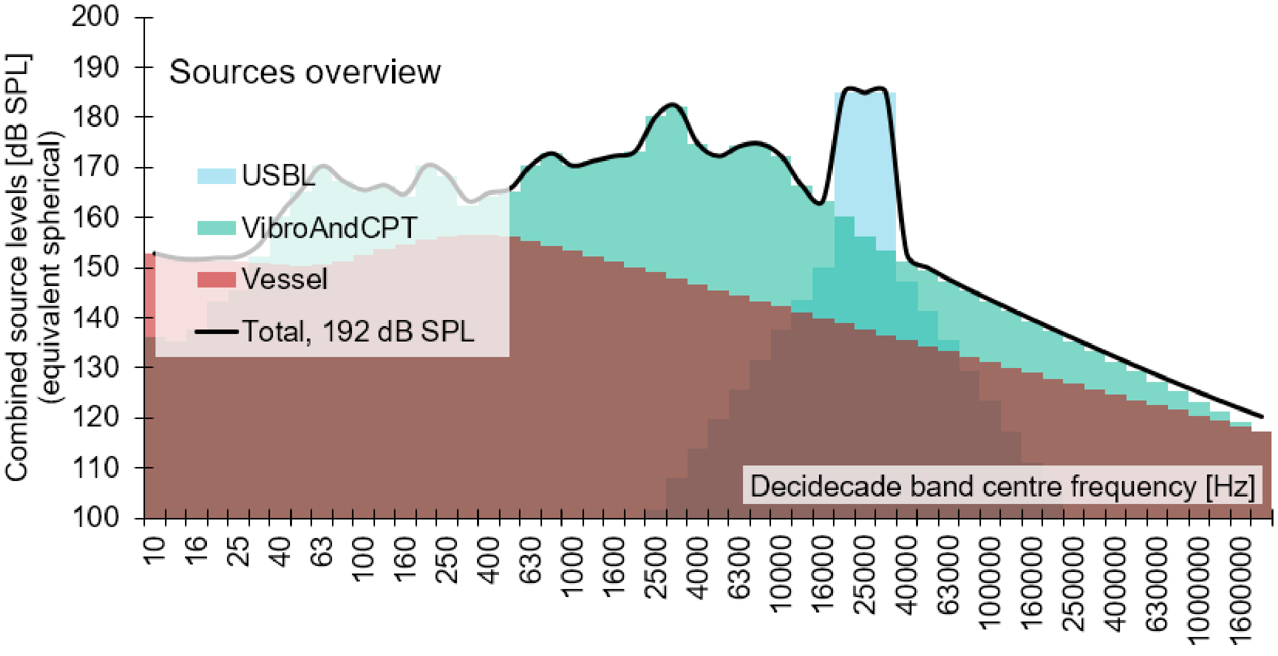

Figure 4-21. Source band level during geotechnical survey – vibro-coring and CPT.

4.1.2.10 Soft Start Source (Geotechnical – Vibro-coring & CPT)

As the geotechnical survey plans to use a USBL, it is likely that some form of soft start will need to be considered. Here, the vessel itself (with no active USBL) will perform this function. Total broadband level of 168 dB SPL.

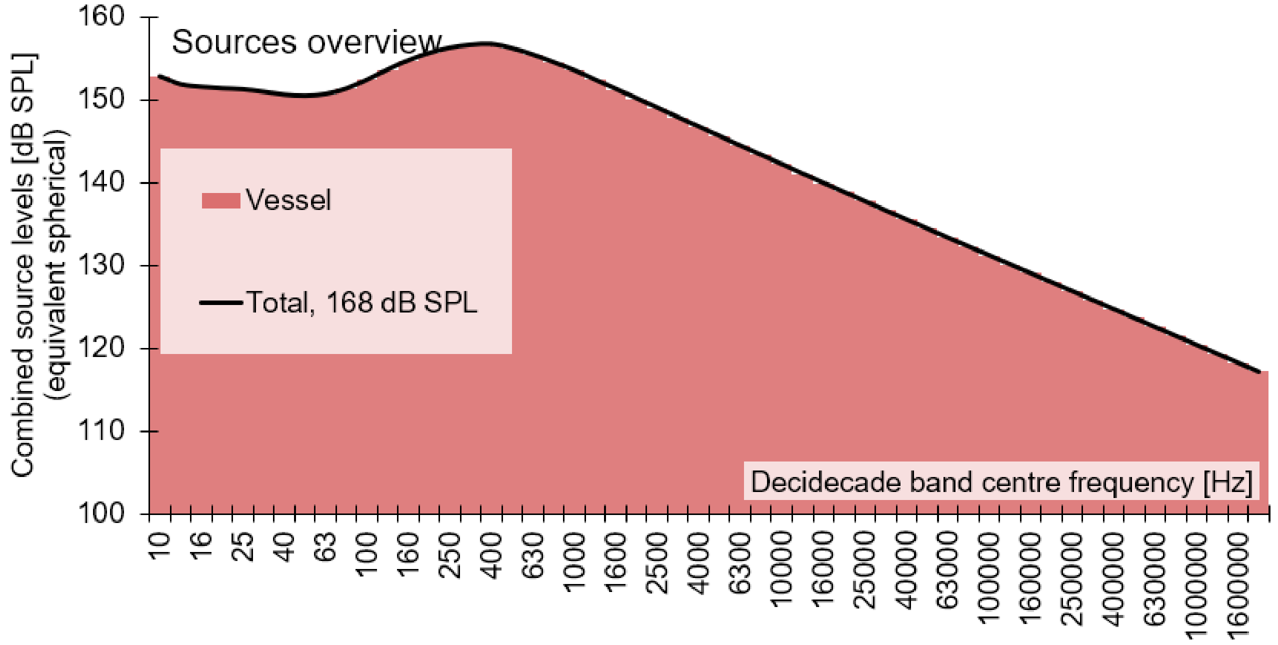

Figure 4-22. Source band level during geotechnical (vibro-core & CPT) survey soft start.

5 SOUND PROPAGATION MODELLING METHODOLOGY

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 a $10 \cdot \log_{10}$(range) or $20 \cdot \log_{10}$(range) relationship, to full acoustic models (e.g., ray tracing, normal mode, parabolic equation, wavenumber integration and energy flux models). In addition, semi-empirical models are available which lie somewhere in between these two extremes in terms of complexity (e.g., (Rogers, 1981; Weston, 1971))[9].

For simpler scenarios, such as this one, where the sediment is relatively uniform and mostly flat or where great detail in the sound field is not needed, the speed of these simpler models is preferred over the higher accuracy of numerical models and are routinely used for these types of assessments. For this assessment, we have used the “Roger’s” model (Rogers, 1981), which is suitable to depths of c. 200 m and generally softer sediments.

This model will tend to underestimate the transmission losses (leading to estimates greater than actual impact), primarily due to the omission of surface roughness, wind effects and shear waves in the sediment.

5.1 Modelling Assumptions

The main assumptions made for the modelling are:

1. A soft start where no SBP and no USBL is active, but MBES and/or SSS is active (section 4.1.2.7) is a feasible and practical option for the survey operator. This gives the VHF group a c. 9-18 dB reduction in received level for the duration of the soft start, depending on exact equipment configuration.
2. Animals fleeing the area will not return within a 24-hour period.
3. Animals flee for up to 2 hours, after which they will be up to 10.8 km and 3.6 km away for marine mammals and fish, respectively.
4. Modelling assumes high tide; this is a worst-case assumption.
5. Results assume a transition from impulsive (kurtosis >40) to non-impulsive (kurtosis <40) at a 500 m distance from the source. This means that all ranges greater than 500 m are assessed against the non-impulsive thresholds. This assumption is also applicable for the assessment of behavioural disturbance.

5.2 Exposure Calculations (dB SEL)

To compare modelled levels with the two impact assessment frameworks (Southall et al. 2019 & Popper et al. 2014) it is necessary to calculate received levels as exposure levels (SEL), weighted for marine mammals and unweighted for fishes. For ease of implementation, sources have generally been converted to an SPL source level, meaning converting to SEL from SPL or from a number of events. The conversion is relatively easy:

To convert from SPL to SEL, the following relation can be used:

$$SEL = \mathrm{SPL} + 10 \cdot Log_{10}(t_2 - t_1) \qquad (1)$$

Or, where it is inappropriate to convert SEL from one event to SEL cumulative by relating to the number of events as:

$$SEL_{,n\ events} = SEL_{\ single\ event} + 10 \cdot Log_{10}(n) \qquad (2)$$

[9] This model is compared to measurements in the paper (Rogers, 1981) describing it and is capable of accurate modelling in acoustically simpler scenarios. Simpler meaning shallow in relation to the wavelengths and with no significant sound speed gradient in the water column.

And SPL from SEL:

$$SPL = SEL_{single\ event} + 10 \cdot Log_{10}\left(\frac{n}{t_2 - t_1}\right) \tag{3}$$

As an animal swims away from the sound source, the noise it experiences will become progressively more attenuated; the cumulative, fleeing SEL is derived by logarithmically adding the SEL to which the mammal is exposed as it travels away from the source. This calculation is used to estimate the approximate minimum start distance for an animal in order for it to be exposed to sufficient sound energy to result in the exceedance of a threshold, or to check if a set exclusion zone is sufficient for an activity (e.g. will an exclusion zone of 500 m be sufficient to prevent exceeding a PTS threshold). It should be noted that the sound exposure calculations are based on the simplistic assumption that the animal will continue to swim away at a constant speed. The real-world situation is more complex, and the animal is likely to move in a more varied manner. Reported swim speeds are summarised in Table 5-1 along with the source papers for the assumptions.

For this assessment, we used a swim speed of 1.5 m/s for marine mammals, and 0.5 m/s for fishes, including sharks.

For very long fleeing durations, the ambient sound itself can exceed the thresholds, e.g., an ambient sound level of 117.5 dB, weighted for the VHF group, will exceed the non-impulsive TTS threshold of 153 dB SEL after 2 hours' exposure[10]. For this assessment, we consider fleeing durations of 2 hours (7200 seconds, allowing 10800 m of fleeing), meaning that weighted levels of 117.5 dB SPL will exceed the VHF group's non-impulsive TTS threshold in the fleeing model.

Table 5-1: Swim speed examples from literature

Species	Hearing Group	Swim Speed (m/s)	Source Reference
Harbour porpoise	VHF	1.5	Otani *et al.,* 2000
Harbour seal	PCW	1.8	Thompson, 2015
Grey seal	PCW	1.8	Thompson, 2015
Minke whale	LF	2.3	Boisseau *et al.,* 2021
Bottlenose dolphin	HF	1.52	Bailey and Thompson, 2010
White-beaked dolphin	HF	1.52	Bailey and Thompson, 2010
Basking shark	Fish (unweighted)	1.0	Sims, 2000
All other fish groups	Fish (unweighted)	0.5	Popper *et al.,* 2014
Sea turtles	Fish (unweighted)	0.56-0.84 & 0.78-2.8	(F, et al., 1997; SA, 2002)

[10] 117.5 dB SPL + 10*$\log_{10}$(3600 seconds) = 153.1 dB SEL, TTS non-impulsive threshold for the VHF group is 153 dB SEL.

6 RESULTS AND ASSESSMENT

Results are presented here as the geographical “risk range” to an auditory threshold (TTS/PTS/Behavioural), as given in Sections 2.3 and 2.5. A given risk range specifies the expected range, within which, a receiver would exceed the relevant threshold. Risk ranges are given for the 90th percentile value.

Several result types are presented for each activity to inform this assessment and to provide flexibility in mitigation:

1. **“1 second exposure risk range”:**
   This is the range of acute risk of impact from the activity (a one second exposure) and is presented to indicate instantaneous risk and for comparison with other studies. This assumes a stationary animal (during the 1-second exposure) with all equipment operating at full power and does not include a soft start.

2. **“Minimal starting range for a fleeing animal with no soft start”:**
   The minimal range a fleeing animal needs to start fleeing from to avoid being exposed to noise exceeding its TTS/PTS threshold. Animals are moving in a straight line away from the source at a constant speed of 1.5 m/s (0.5 m/s for fish, including sharks).

3. **“Minimal starting range for a fleeing animal with a 20 min soft start with no SBP and no USBL active”:**
   The minimal range a fleeing animal needs to start fleeing from to avoid being exposed to noise exceeding its TTS/PTS threshold. Animals are moving in a straight line away from the source at a constant speed of 1.5 m/s (0.5 m/s for fish, including sharks).

4. **“Behavioural response range”:**
   The range at which the behavioural limit for the marine mammals (160/120 dB SPL impulsive/non-impulsive) or the fishes (including sharks) (150 dB SPL) is exceeded. No hearing group weightings are applied when assessing against this threshold.

6.1 Assumptions and Notes on Results

The results should be read while keeping the following in mind:

- Results are rounded to the nearest 2 significant digits. This can lead to some curious appearing overlaps in risk ranges.
- Results for behavioural disturbance mainly rely on the non-impulsive threshold of 120 dB SPL (for marine mammals), as the impulsive noise transitions to non-impulsive at c. 500 m. This means that there are large ranges of disturbance, but should be considered in relation to, for example, the radiated noise from common vessels, which will also exceed this threshold to ranges of 500-5000 m (assuming 160-175 dB SPL source level).
- The soft start has little effect on the TTS ranges for the VHF group when the USBL is active. This is due to the relatively low threshold for TTS for the VHF group (153 dB SEL) and the logarithmic nature of transmission losses. A constant reduction of received level with a multiplication of range – a 3-6 dB reduction per doubling of distance, such as from 2 km to 4 km (until ranges become large enough for absorption to become significant) – means that fleeing is not very effective at reducing received level.
- Animals are modelled as fleeing in straight lines. Where sites are very confined, the maximal risk ranges will be restricted by line-of-sight ranges (and cut short where they meet land).
- Modelling assumed a maximal fleeing time of 7200 seconds (2 hours). This allows for 10.8 km of fleeing for marine mammals (3.6 km for fish).
- Modelling is limited to a range of 15 km from the source.
- No modelling of risk ranges for *mortality* for fishes are presented as risk ranges to PTS (recoverable injury) are all smaller than 30 m.

- No results are presented for assessment against the L_P thresholds as, for all scenarios, the risk ranges to the TTS thresholds were <30 m for fish (TTS: 193 dB L_P) and <20 m for marine mammals (VHF TTS: 196 dB L_P).
- Results are *only* given in relation to the behavioural thresholds (SPL) and TTS/PTS thresholds for sound exposure level (SEL).
- The hearing group “Fish” includes sharks and are for unweighted received levels assessed against the lowest thresholds for fishes as found in guidance (Popper, et al., 2014).

6.2 Results – Tabulated

For all geophysical survey results, the vessel, SSS and MBES sources are active. Only the type of SBP and presence of a USBL is changing between the scenarios modelled.

6.2.1 Geophysical Survey (Parametric SBP & USBL Active)

This scenario assumes that the geophysical survey is using a parametric SBP and that a towfish is deployed, requiring an active USBL (Section 4.1.2.1).

Risk ranges for exceeding PTS is below 50 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 500 m with no soft start.

A soft start of 20 minutes will allow sufficient time for the VHF group to swim away to reduce the PTS exceedance risk range to 50 m.

The soft start itself has a PTS risk range of 50 m for the VHF group. Therefore, extension of the soft start duration will not decrease the PTS risk range further.

Table 6-1: Risk ranges for exceeding the behavioural threshold for all hearing groups during Geophysical survey (Parametric SBP & USBL active).

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	4000	4000	4000	4000	4000	380

Table 6-2: Risk ranges for exceeding the TTS threshold for all hearing groups during Geophysical survey (Parametric SBP & USBL active).

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	40	770	<10	<10	<10
Fleeing receiver, no soft start	80	310	2700	140	<10	130
Fleeing receiver, 20 min soft start	<10	<10	1500	<10	<10	<10

*See Comments, Section 6.1 on results limitations.

Table 6-3. Risk ranges for exceeding the PTS threshold for all hearing groups during Geophysical survey (Parametric SBP & USBL active).

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	240	<10	<10	<10
Fleeing receiver, no soft start	<10	50	500	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	50	<10	<10	<10

6.2.2 Geophysical Survey (Parametric SBP & USBL Not Active)

This scenario assumes that the geophysical survey is using a parametric SBP and that there is no need for a USBL as the SBP and SSS are hull-mounted with known positions (Section 4.1.2.2).

Risk ranges for exceeding PTS is below 40 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 470 m with no soft start.

A soft start of 20 minutes will allow sufficient time for the VHF group to swim away to reduce the PTS exceedance risk range to 50 m.

The soft start itself has a PTS risk range of 50 m for the VHF group. Therefore, extension of the soft start duration will not decrease the PTS risk range further.

Table 6-4: Risk ranges for exceeding the behavioural threshold for all hearing groups during Geophysical survey (Parametric SBP & USBL not active).

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	1100	1100	1100	1100	1100	330

Table 6-5: Risk ranges for exceeding the TTS threshold for all hearing groups during Geophysical survey (Parametric SBP & USBL not active).

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	40	500	<10	<10	<10
Fleeing receiver, no soft start	<10	230	640	30	<10	120
Fleeing receiver, 20 min soft start	<10	<10	160	<10	<10	<10

Table 6-6. Risk ranges for exceeding the PTS threshold for all hearing groups during Geophysical survey (Parametric SBP & USBL not active).

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	210	<10	<10	<10
Fleeing receiver, no soft start	<10	40	470	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	50	<10	<10	<10

6.2.3 Geophysical Survey (Chirper/Pinger SBP & USBL Active)

This scenario assumes that the geophysical survey is using a chirper or pinger type SBP and that a towfish is deployed requiring an active USBL (Section 4.1.2.3).

Risk ranges for exceeding PTS is below 10 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 490 m with no soft start.

A soft start of 20 minutes will allow sufficient time for the VHF group to swim away to reduce the PTS exceedance risk range to 50 m.

The soft start itself has a PTS risk range of 50 m for the VHF group. Therefore, extension of the soft start duration will not decrease the PTS risk range further.

Table 6-7: Risk ranges for exceeding the behavioural threshold for all hearing groups during Geophysical survey (Chirper/pinger SBP & USBL active).

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	5700	5700	5700	5700	5700	270

Table 6-8: Risk ranges for exceeding the TTS threshold for all hearing groups during Geophysical survey (Chirper/pinger SBP & USBL active).

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	10	750	<10	<10	<10
Fleeing receiver, no soft start	140	250	2800	160	<10	30
Fleeing receiver, 20 min soft start	<10	<10	1600	<10	<10	<10

Table 6-9. Risk ranges for exceeding the PTS threshold for all hearing groups during Geophysical survey (Chirper/pinger SBP & USBL active).

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	110	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	490	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	50	<10	<10	<10

6.2.4 Geophysical Survey (Chirper/Pinger SBP & USBL Not Active)

This scenario that assumes that the geophysical survey is using a chirper or pinger type SBP and that there is no need for a USBL as the SBP and SSS are hull mounted with known positions (Section 4.1.2.4).

Risk ranges for exceeding PTS is below 10 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 120 m with no soft start.

A soft start of 20 minutes will allow sufficient time for the VHF group to swim away to reduce the PTS exceedance risk range to 50 m.

The soft start itself has a PTS risk range of 50 m for the VHF group. Therefore, extension of the soft start duration will not decrease the PTS risk range further.

Table 6-10: Risk ranges for exceeding the behavioural threshold for all hearing groups during Geophysical survey (Chirper/pinger SBP & USBL not active).

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	5200	5200	5200	5200	5200	90

Table 6-11: Risk ranges for exceeding the TTS threshold for all hearing groups during Geophysical survey (Chirper/pinger SBP & USBL not active).

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	70	<10	<10	<10
Fleeing receiver, no soft start	70	<10	490	30	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	170	<10	<10	<10

Table 6-12. Risk ranges for exceeding the PTS threshold for all hearing groups during Geophysical survey (Chirper/pinger SBP & USBL not active).

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	10	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	120	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	50	<10	<10	<10

6.2.5 Geophysical Survey (Sparker SBP & USBL Active)

This scenario assumes the geophysical survey is using a Sparker type SBP and that a towfish is deployed requiring an active USBL (Section 4.1.2.5).

Risk ranges for exceeding PTS is below 10 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 490 m with no soft start.

A soft start of 20 minutes will allow sufficient time for the VHF group to swim away to reduce the PTS exceedance risk range to 50 m.

The soft start itself has a PTS risk range of 50 m for the VHF group. Therefore, extension of the soft start duration will not decrease the PTS risk range further.

Table 6-13: Risk ranges for exceeding the peak pressure level impulsive threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL active).

Risk ranges (L_P thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
TTS	10	<10	20.1	10	<10	30.1
PTS	10	<10	20.1	10	<10	10

Table 6-14: Risk ranges for exceeding the behavioural threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL active).

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	8000	8000	8000	8000	8000	290

Table 6-15: Risk ranges for exceeding the TTS threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL active).

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	10	750	<10	<10	<10
Fleeing receiver, no soft start	220	250	2700	180	<10	30
Fleeing receiver, 20 min soft start	<10	<10	1500	<10	<10	<10

Table 6-16. Risk ranges for exceeding the PTS threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL active).

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	110	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	490	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	50	<10	<10	<10

6.2.6 Geophysical Survey (Sparker SBP & USBL Not Active)

This scenario assumes the geophysical survey is using a Sparker type SBP and that there is no need for a USBL as the SBP and SSS are hull mounted with known positions (Section 4.1.2.6).

Risk ranges for exceeding PTS is below 10 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 50 m with no soft start.

A soft start of 20 minutes will not reduce this range for the VHF group.

The soft start itself has a PTS risk range of 50 m for the VHF group. Therefore, extension of the soft start duration will not decrease the PTS risk range further.

Table 6-17: Risk ranges for exceeding the peak pressure level impulsive threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL not active).

Risk ranges (L_P thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
TTS	10	<10	20.1	10	<10	30.1
PTS	10	<10	20.1	10	<10	10

Table 6-18: Risk ranges for exceeding the behavioural threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL not active).

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	7900	7900	7900	7900	7900	120

Table 6-19: Risk ranges for exceeding the TTS threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL not active).

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	50	<10	<10	<10
Fleeing receiver, no soft start	160	<10	330	60	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	160	<10	<10	<10

Table 6-20. Risk ranges for exceeding the PTS threshold for all hearing groups during Geophysical survey (Sparker SBP & USBL not active).

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	<10	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	50	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	50	<10	<10	<10

6.2.7 Geotechnical Survey (Drilling, boreholes)

This scenario assumes the drilling and vessel source is active (Section 6.2.7).

No soft start has been modelled for this activity; this is based on:

1. Risk ranges for exceeding PTS are below 10 meters for all groups.
2. The sampling platform (vessel or barge) will itself emit similar noise to the sampling activity and will serve as a type of soft start exceeding normal soft start durations.
3. The geotechnical equipment itself cannot easily be operated at reduced noise output.

Table 6-21: Risk ranges for exceeding the behavioural threshold for all hearing groups during drilling.

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	<20	<20	<20	<20	<20	<10

Table 6-22: Risk ranges for exceeding the TTS threshold for all hearing groups during drilling.

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	<10	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	<10	<10	<10	<10

Table 6-23. Risk ranges for exceeding the PTS threshold for all hearing groups during drilling.

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	<10	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	<10	<10	<10	<10

6.2.8 Geotechnical Survey (Vibro-coring & CPT)

This scenario assumes the vessel, vibro-corer, CPT and USBL sources are active (Section 4.1.2.9).

Risk ranges for exceeding PTS is below 10 m for all groups except the VHF group, which risks exceeding the PTS threshold to a range of 490 m with no soft start.

A soft start of 20 minutes will allow sufficient time for the VHF group to swim away to reduce the PTS exceedance risk range to less than 10 m.

Table 6-24: Risk ranges for exceeding the behavioural threshold for all hearing groups during Vibro-coring and CPT.

Behavioural Threshold exceedance Risk ranges (SPL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
Non-impulsive	5700	5700	5700	5700	5700	270

Table 6-25: Risk ranges for exceeding the TTS threshold for all hearing groups during Vibro-coring and CPT.

TTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	10	750	<10	<10	<10
Fleeing receiver, no soft start	130	250	2700	160	<10	20
Fleeing receiver, 20 min soft start	<10	<10	1500	<10	<10	<10

Table 6-26. Risk ranges for exceeding the PTS threshold for all hearing groups during Vibro-coring and CPT.

PTS Threshold Exceedance Risk ranges (SEL thresholds)	LF [m]	HF [m]	VHF [m]	PCW [m]	OCW [m]	Fish [m]
One second	<10	<10	110	<10	<10	<10
Fleeing receiver, no soft start	<10	<10	490	<10	<10	<10
Fleeing receiver, 20 min soft start	<10	<10	<10	<10	<10	<10

6.3 Results Summary

6.3.1 Geophysical Survey

PTS – hearing injury

Apart from the VHF hearing group, all risk ranges to PTS exceedance for fleeing receivers is below 50 m with no soft start.

For the VHF hearing group, the risk range for PTS exceedance for fleeing receivers is up to 500 m with no soft start and below 50 m with a 20-minute soft start.

TTS – temporary hearing impairment

Apart from the VHF hearing group, all risk ranges to TTS exceedance for fleeing receivers is below 310 m with no soft start and below 10 m with a 20-minute soft start.

For the VHF hearing group, the risk range for TTS exceedance for fleeing receivers is up to 2800 m with no soft start and below 1600 m with a 20-minute soft start.

Behavioural disturbance

Ranges for behavioural disturbance for all hearing groups except Fish is up to 8 km (driven by the sparker type SBP). For Fish the range for behavioural disturbance is much less at up to 380 m (driven by the parametric SBP & USBL).

6.3.2 Geotechnical Survey

Drilling, Boreholes

The drilling of boreholes has virtually no risk of exceeding PTS or TTS thresholds for any hearing group, with all risk ranges to PTS and TTS exceedance below 10 m.

Behavioural threshold is also not exceeded beyond 20 m.

Vibro-coring & CPT with USBL

PTS – hearing injury

The VHF group has a PTS exceedance risk for moving receivers to 490 m with no soft start, reducing to under 10 m with a 20-minute soft start.

All remaining hearing groups have PTS risk exceedance ranges for moving receivers below 10 m, even with no soft start.

TTS – temporary hearing impairment

The VHF group has a TTS exceedance risk for moving receivers to 2700 m with no soft start, reducing to 1500 m with a 20-minute soft start.

All remaining hearing groups have risk ranges for PTS exceedance for moving receivers at or below 260 m, with no soft start, reducing to below 10 m with a 20-minute soft start.

Behavioural disturbance

Ranges for behavioural disturbance for all hearing groups except Fish is up to 5700 m (driven by the USBL). For Fish the range for behavioural disturbance is much less at up to 270 m (driven by the USBL).

7 CONCLUSIONS

This assessment concludes that the risk of inducing hearing injury (PTS – Permanent Threshold Shift) following noise from the SI Works is below 50 m with no soft start for all hearing groups except the VHF group . The VHF group (harbour porpoise) has an injury risk up to 500m from the active noise sources with no soft start. Applying a 20-minute soft start reduces the injury risk to below 50 m.

There is risk of inducing temporary hearing effects (TTS – Temporary Threshold Shift). This extends to c. 3000 m for the VHF group (harbour porpoise) and below c. 300 m for remaining marine mammals and fishes. Introducing a 20-minute soft start, where only some equipment is active, will reduce the risk of TTS for the VHF group to within 1600 m, and to below 10 m for the remaining marine mammals and fishes.

Behavioural disturbance ranges of up to 8,000 m have been modelled for the geophysical survey for marine mammals while the Sparker type SBP is active. For the geotechnical survey, the use of a USBL means that behavioural disturbance ranges up to 5,700 m. The low noise levels of the borehole drilling means that the behavioural disturbance limit is within 20 m.

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Appendix A – Acoustic Concepts and Terminology

Sound travels through water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). Because sound consists of variations in pressure, the unit for measuring sound is usually referenced to a unit of pressure, the Pascal (Pa). The unit usually used to describe sound is the decibel (dB) and, in the case of underwater sound, the reference unit is taken as 1 µPa, one micro-pascal, whereas airborne sound is usually referenced to a pressure of 20 µPa. To convert from a sound pressure level referenced to 20 µPa to one referenced to 1 µPa, a factor of 20 log (20/1) i.e. 26 dB has to be added to the former quantity. Thus, a sound pressure of 60 dB re 20 µPa is the same as 86 dB re 1 µPa, although care also needs to be taken when converting from in air sound to in water sound levels due to the different sound speeds and densities of the two mediums resulting in a conversion factor of approximately 62 dB for comparing intensities (watt/m²), see Table 8-1 , below.

Table 8-1: Comparing sound quantities between air and water.

	Constant intensity		Constant pressure	
Properties	**Air**	**Water**	**Air**	**Water**
Soundspeed (C) [m/s]	340	1500	340	1500
Density (ρ) [kg/m³]	1.293	1026	1.293	1026
Acoustic impedance (Z=C·ρ) [kg/(m²·s) or (Pa·s)/m³]	440	1539000	440	1539000
Sound intensity (I=p²/Z) [Watt/m²]	1	1	22.7469	0.0065
Sound pressure (p=(I*Z)^{½}) [Pa]	21	1241	100	100
Particle velocity (I/p) [m/s]	0.04769	0.00081	0.22747	0.00006
dB re 1 µPa²	146.4	**181.9**	160.0	**160.0**
dB re 20 µPa²	**120.4**	155.9	**134.0**	134.0
Difference dB re 1 µPa² & dB re 20 µPa²	**61.5**		**26.0**	

All underwater sound pressure levels in this report are described in dB re 1 µPa². In water, the sound source strength is defined by its sound pressure level in dB re 1 µPa², referenced back to a representative distance of 1m from an assumed (infinitesimally small) point source. This allows calculation of sound levels in the far-field. For large, distributed sources, the actual sound pressure level in the near-field will be lower than predicted.

There are several descriptors used to characterise a sound wave. The difference between the lowest pressure deviation (rarefaction) and the highest pressure deviation (compression) from ambient is the peak to peak (or pk-pk) sound pressure (L_{P-P} for the level in dB), Note that L_{P-P} can be hard to measure consistently, as the maximal duration between the lowest and highest pressure deviation is not standardised. The difference between the highest deviation (either positive or negative) and the ambient pressure is called the peak pressure (L_P for the level in dB). Lastly, the average sound pressure is used as a description of the average amplitude of the variations in pressure over a specific time window (SPL for the level in dB). SPL is equal to the L_{eq} when the time window for the SPL is equal to the time window for the total duration of an event. The cumulative sound energy from pressure is the integrated squared pressure over a given period (SEL for the level in dB). These descriptions are shown graphically in Figure 8-1 and reflect the units as given in ISO 18405:2017, “Underwater Acoustics – Terminology”.

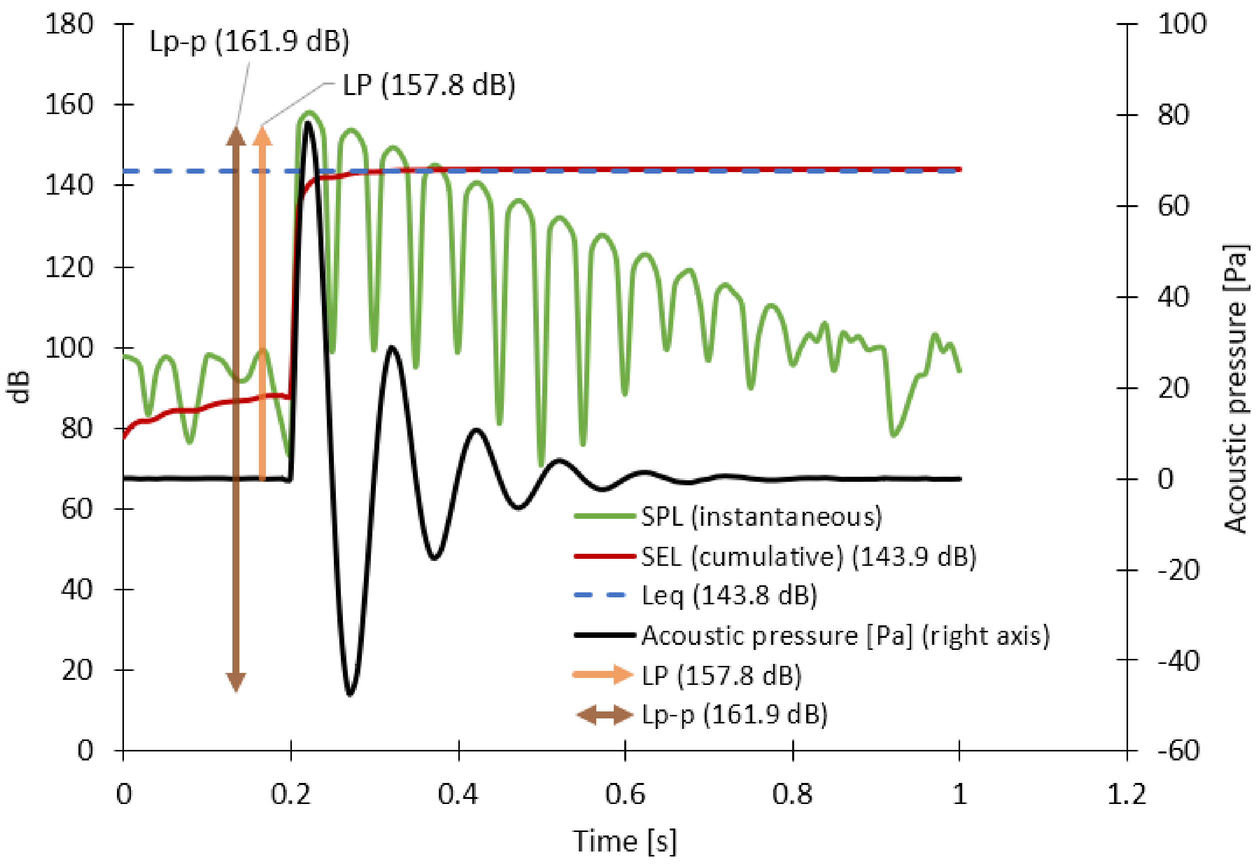

Figure 8-1: Graphical representation of acoustic wave descriptors ("LE" = SEL).

The sound pressure level (SPL[11]) is defined as follows (ISO 18405:2017, 3.2.1.1):

$$SPL = 10 \cdot Log_{10}\left(\frac{\overline{p^2}}{1 \cdot 10^{-12} Pa}\right) \qquad (1)$$

Here $\overline{p^2}$ is the arithmetic mean of the squared pressure values. Note that L_P is simply the instantaneous SPL (ISO 18405:2017, 3.2.2.1).

The peak sound pressure level, L_P, is the instantaneous decibel level of the maximal deviation from ambient pressure and is defined in (ISO 18405:2017, 3.2.2.1) and can be calculated as:

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

Another useful measure of sound used in underwater acoustics is the Exposure Level, or SEL. This descriptor is used as a measure of the total sound energy of a single event or a number of events (e.g. over the course of a day). This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis. Historically, use was primarily made of SPL and L_P metrics for assessing the potential effects of sound on marine life. However, the SEL is increasingly being used as it allows exposure duration and the effect of exposure to multiple events over e.g. a 24-hour period to be taken into account. The SEL is defined as follows (ISO 18405:2017, 3.2.1.5):

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

To convert from SEL to SPL the following relation can be used:

$$SEL = \mathrm{SPL} + 10 \cdot Log_{10}(t_2 - t_1) \qquad (3)$$

[11] Equivalent to the commonly seen "RMS-level".

Converting from a single event to multiple events for SEL:

$$SEL_{n\ events} = SEL_{single\ event} + 10 \cdot Log_{10}(n) \quad (4)$$

The frequency, or pitch, of the sound is the rate at which these oscillations occur and is measured in cycles per second, or 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 dB(A). 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 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 8-2. Note 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 sound sources means that it is often not possible to quantify this effect. Marine reptiles (mostly sea turtles) have relatively poor hearing underwater, lacking a good acoustic coupling mechanism from the sea water to the inner ear.

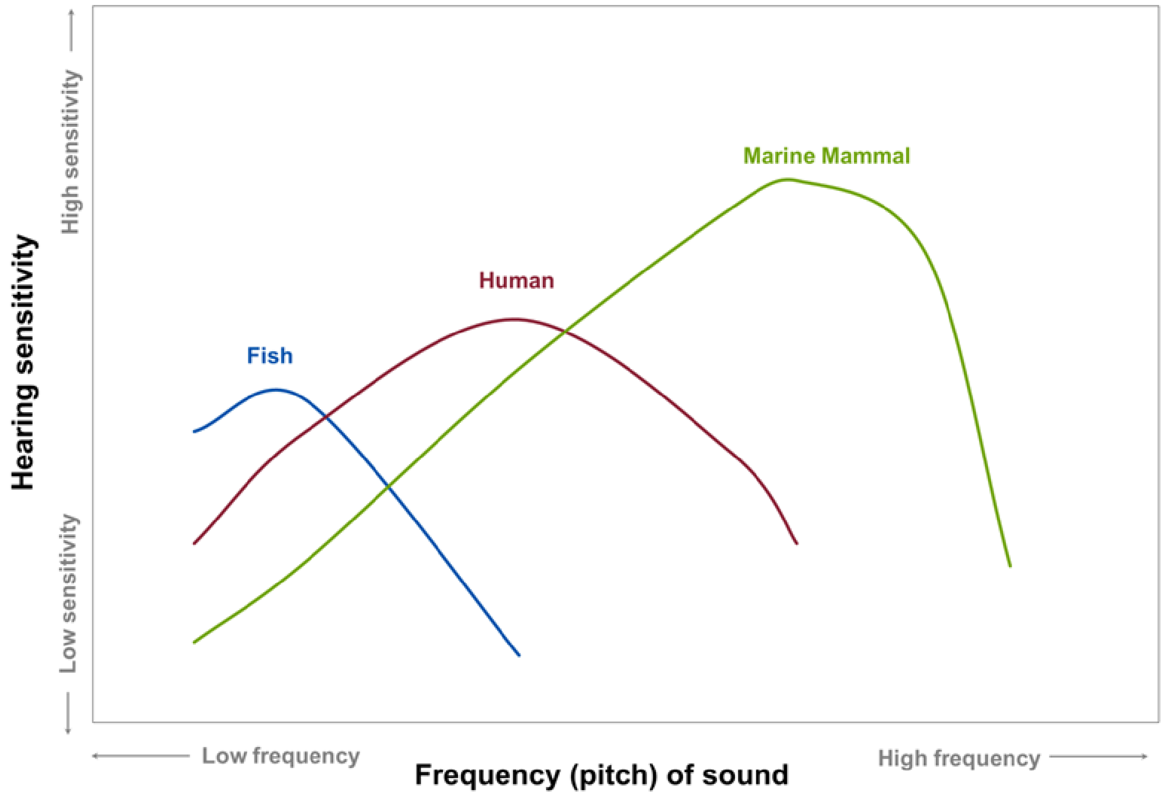

Figure 8-2: Comparison between hearing thresholds of different marine animals and humans.

Impulsiveness

The impulsiveness of a source can be estimated from the kurtosis of the weighted signal (as suggested by Matin et al. in "Techniques for distinguishing between impulsive and non-impulsive sound in the context of regulating sound exposure for marine mammals", Journal of the Acoustical Society of America, 2020)

The consequence of this is that the same equipment can be both impulsive and non-impulsive, depending o marine mammal presence and the local environment.

Below is an example of a hull mounted echo sounder at 15 m depth and at 250 m depth.

In shallow water the ping rate can be high as reflections from the sediment return quickly, but the single pulse duration is usually shorter as less energy in the signal is required due to the short range the pulse must travel. This leads to high repetition rate (decreases kurtosis) and shorter pulses (increases kurtosis). Figure 8-3 shows an example where this leads to a non-impulsive source, to be compared to the thresholds for non-impulsive noise.

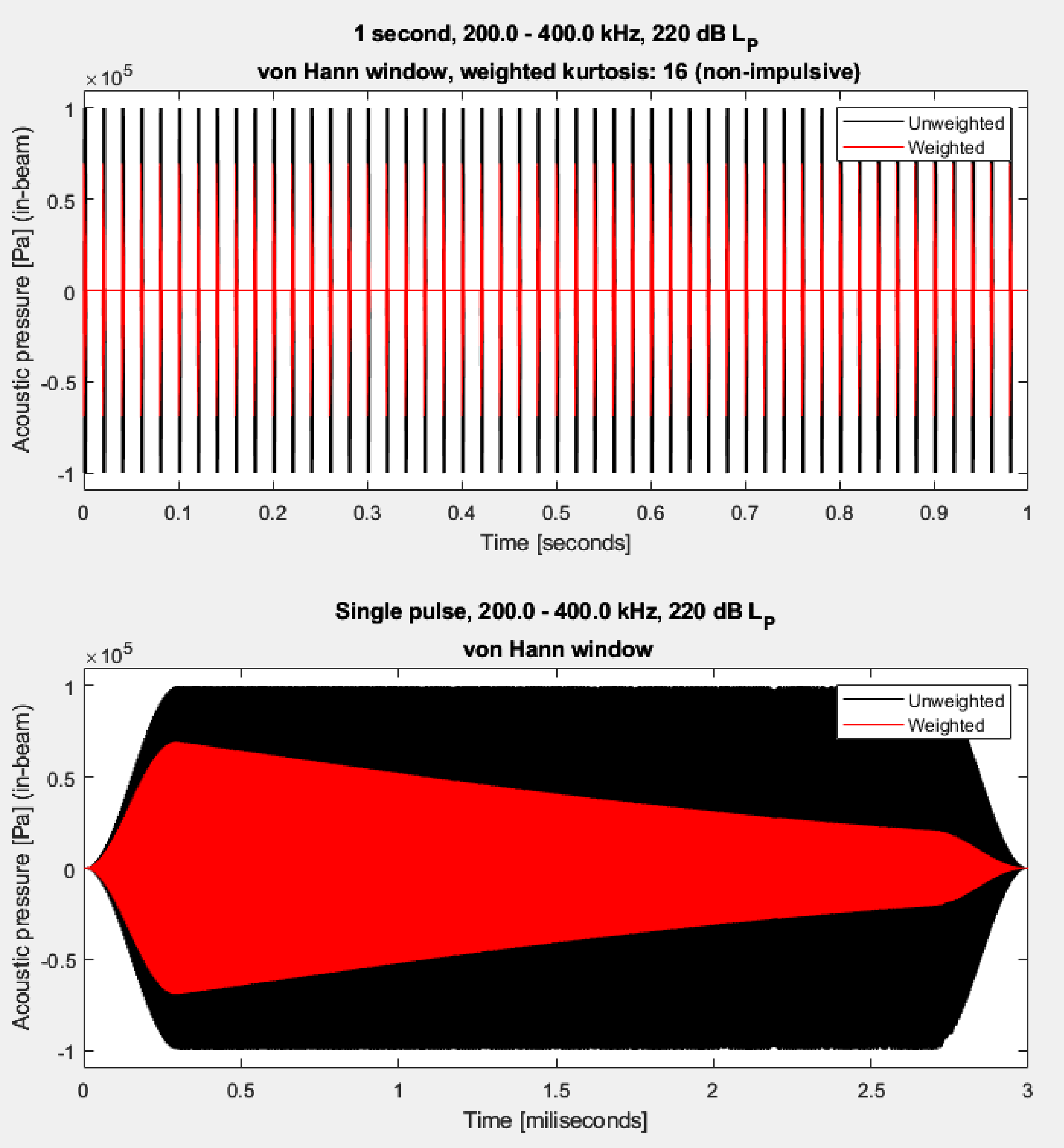

Figure 8-3. Example of a multibeam echosounder at 15 m depth (achieving 50 ping/sec) with a 3 ms ping duration. VHF-weighted kurtosis of 16 – non-impulsive.

In deeper water, the ping rate will usually be slower as echoes take longer to return to the sediment and the pulses will be longer to increase the energy in the pulses and make their echoes easier to detect. This leads to low repetition rate (increases kurtosis) and longer pulses (decreases kurtosis). Figure 8-4 shows an example where this combination resulted in an impulsive source, to be compared to the thresholds for impulsive noise.

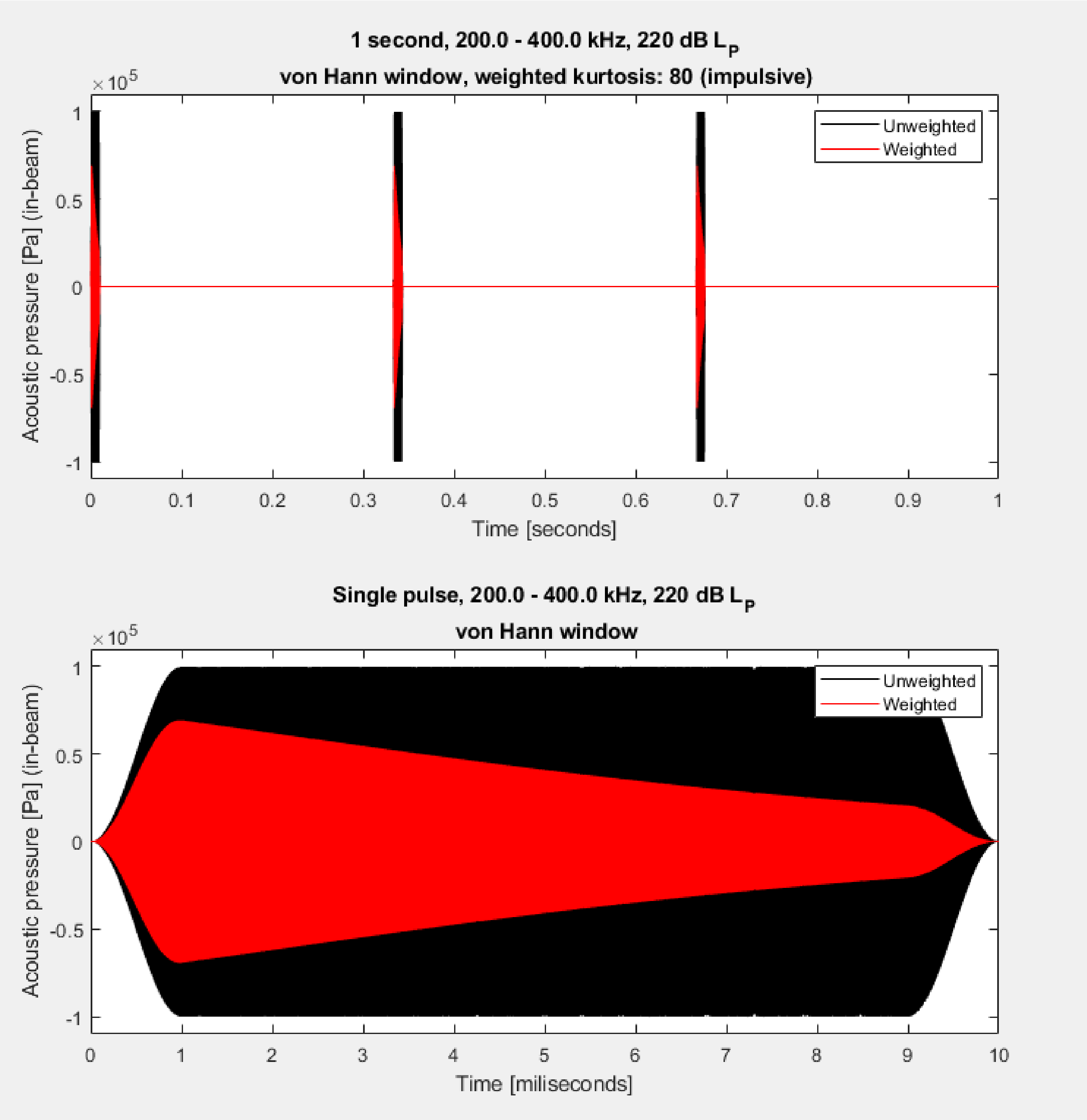

Figure 8-4. Example of a multibeam echosounder at 250 m depth (achieving 3 ping/sec) with a 10 ms ping duration. VHF-weighted kurtosis of 80 – impulsive.

With range, due to multiple reflections and scattering, the kurtosis will decrease with increased range, for shallow water this decrease will be quicker than for deeper water, compare Figure 8-5 & Figure 8-6, where a kurtosis <40 is reached at c. 200 m in 20 m depth, but at over 1000 m at 200 m depth.

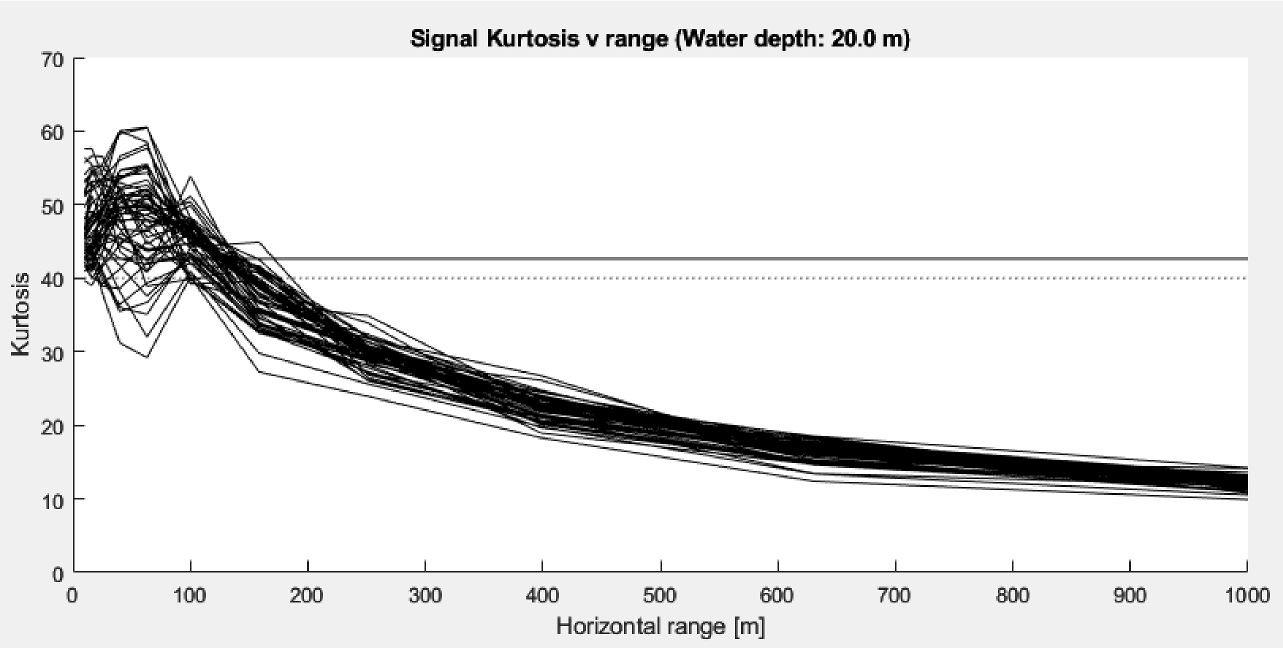

Figure 8-5. Example of USBL signal kurtosis decreasing with range at 20 m depth. Multiple lines are various combinations of source and receiver depths.

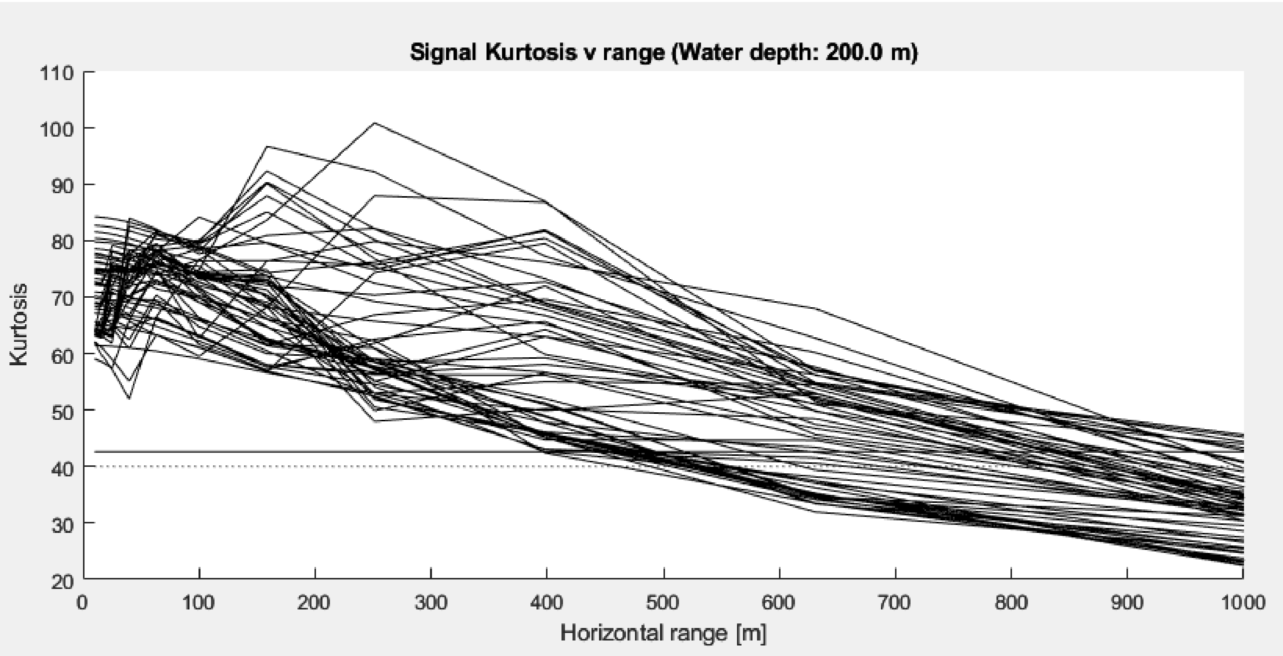

Figure 8-6. Example of USBL signal kurtosis decreasing with range at 200 m depth. Multiple lines are various combinations of source and receiver depths.

Review of Sound Propagation Concepts

Increasing the distance from the sound source usually results in the level of sound 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 sound 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, with no boundaries) or a cylindrical pattern (much further from the source, bounded by the surface and the sediment), although other factors mean that decay in sound energy may be somewhere between these two simplistic cases.

In acoustically shallow waters[12] 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 is reflected many times by the surface and sediment.

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. 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. Generally, the scattering effect at a particular frequency depends on the physical size of the roughness in relation to the wavelength of the frequency of interest.

As 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. within 10-20 times the water depth) the sound will experience fewer reflections and so the effect of scattering should not be significant. Consequently, over the likely distances over which injury will occur, this effect is unlikely to significantly affect the injury ranges presented in this report, and not including this effect will overestimate the impact.

When sound waves encounter the seabed, the amount of sound reflected will depend on the geoacoustic properties of the seabed (e.g. grain size, porosity, density, sound speed, absorption coefficient and roughness) as well as the grazing angle (see Figure 8-7[13]) and frequency of the sound (Cole, 1965; Hamilton, 1970; Mackenzie, 1960; McKinney and Anderson, 1964; Etter, 2013; Lurton, 2002; Urick, 1983). Thus, seabeds comprising primarily of mud or other acoustically soft sediment will reflect less sound than acoustically harder seabeds such as rock or sand. This effect also depends on the profile of the seabed (e.g. the depth of the sediment layers and how the geoacoustic properties vary with depth below the sea floor). The sediment interaction is less pronounced at higher frequencies (a few kHz and above) where interaction is primarily with the top few cm of the sediment (related to the wavelength). 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 and larger).

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[12] Acoustically, shallow water conditions exist whenever the propagation is characterised by multiple reflections with both the sea surface and seabed (Etter, 2013). Consequently, the depth at which water can be classified as acoustically deep or shallow depends upon numerous factors including the sound speed gradient, water depth, sediment type, frequency of the sound and distance between the source and receiver.

[13] The density of “rays” indicate difference in effective propagation angle from the source, with acoustically harder sediments (gravel) having better reflection at steeper angles leading to more “rays” being effectively propagated (no significant bottom attenuation) in the waveguide. Beam shape indicated in left chart, with the black line showing the same received level.

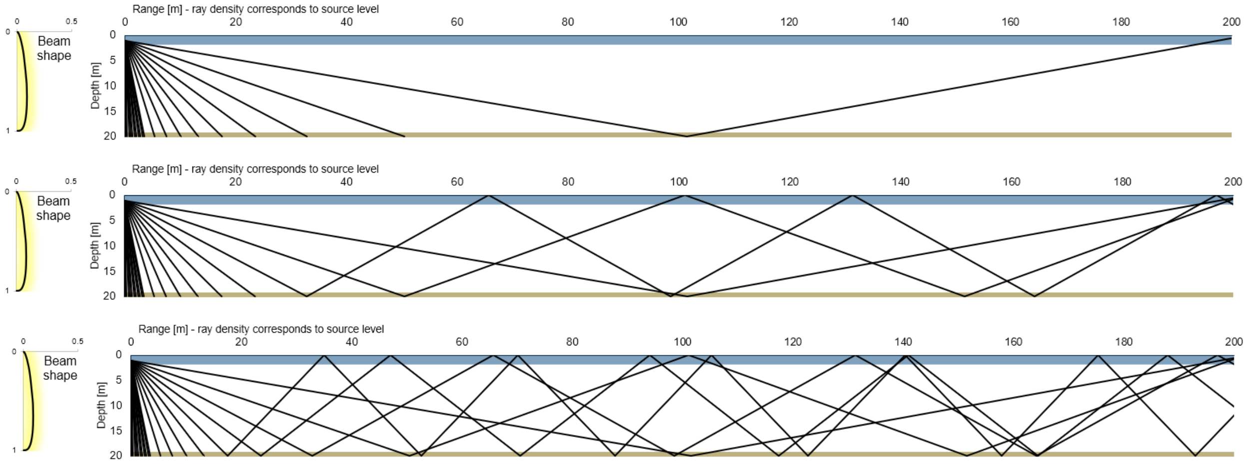

Figure 8-7: Schematic of the effect of sediment on sources with narrow beams. Sediments range from fine silt (top panel), sand (middle panel), and gravel (lower panel).

These sediment effects mean that the directivity of equipment such as sub-bottom profilers have a profound effect on the effective source level – the apparent source level to a far-away receiver.

A parametric SBP such as the “Innomar Medium” or “Standard” sub-bottom profiler use two higher frequencies (“primary frequencies”) to generate an interference pattern at lower frequencies (“secondary frequencies”). This means that the secondary beam can be made extraordinarily narrow, e.g. 5 degrees at -10 dB (Figure 8-8), versus c. 50 degrees for a chirper/pinger type, leading to a much smaller sound impact – even when a parametric sub-bottom profiler has higher sound output within the main beam. We account for these differences in beam pattern by including the sediment reflection loss at high incidence angles (Figure 8-7) to reduce the effective source level accordingly.

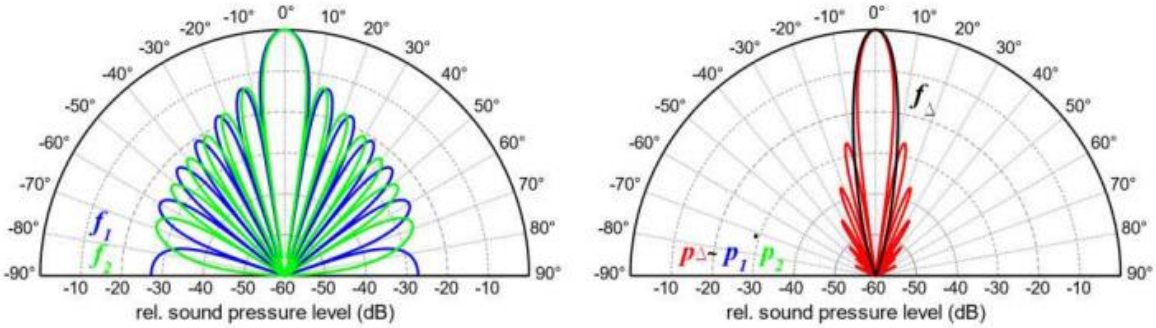

Figure 8-8. Example of a beam pattern on an Innomar SES 2000. Primary frequencies left (f1 & f2), the interference pattern between the primary frequencies means that the beam pattern for the secondary frequency (right plot) is very narrow (Source: Innomar technical note TN-01).

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 geoacoustic 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 8-9 for a range of seabed types. Thus, for a water depth of 10m (i.e. shallow waters typical of coastal areas and estuaries) the cut-off frequency would be approximately 70Hz for sand, 115Hz for silt, 155Hz for clay and 10Hz for bedrock.

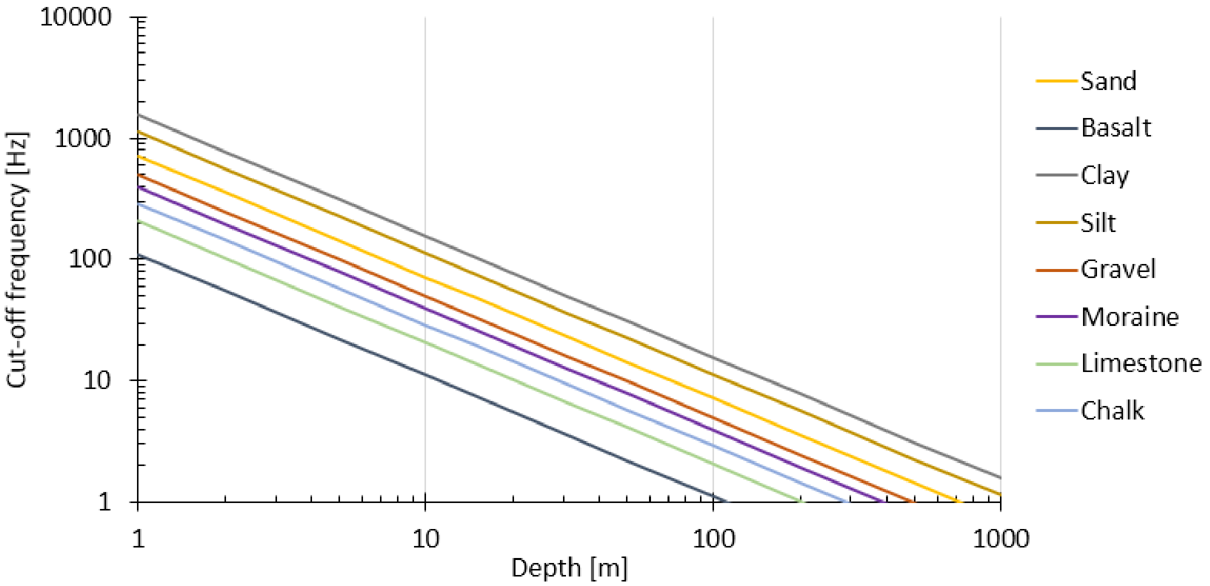

Figure 8-9: Lower cut-off frequency as a function of depth for a range of seabed types.

Changes in the water temperature and the hydrostatic pressure with depth mean that the speed of sound varies throughout the water column. This can lead to significant variations in sound propagation and can also lead to sound channels, particularly for high-frequency sound. Sound can propagate in a duct-like manner within these channels, effectively focussing the sound, and conversely, they can also lead to shadow zones. The frequency at which this occurs depends on the characteristics of the sound channel but, for example, a 25m thick layer would not act as a duct for frequencies below 1.5 kHz. The temperature gradient can vary throughout the year and thus there will be potential variation in sound propagation depending on the season.

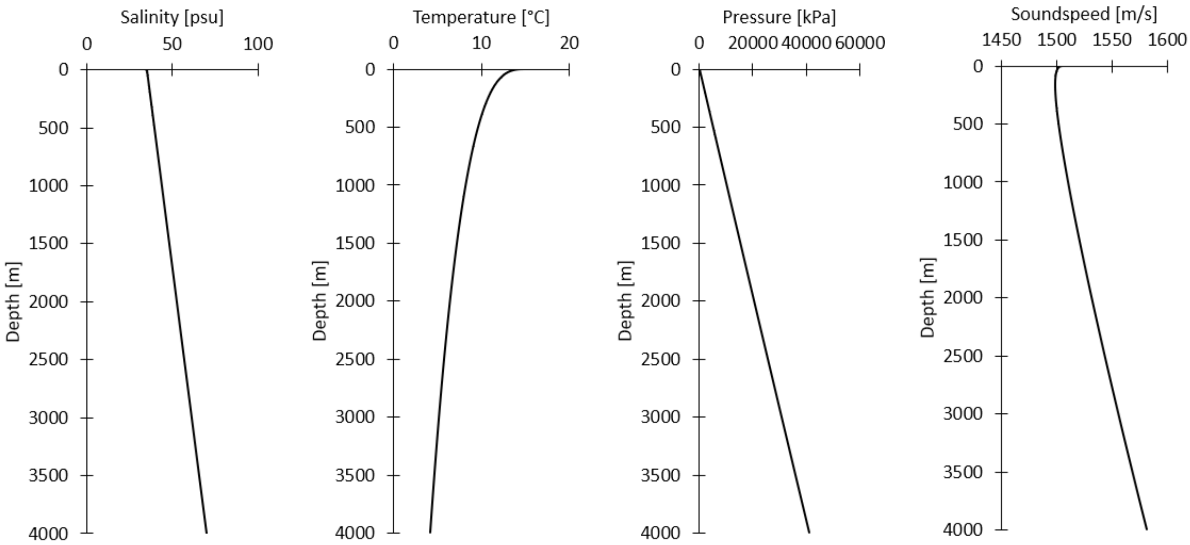

Figure 8-10: Soundspeed profile as a function of salinity, temperature and pressure.

Wind can make a significant difference to the soundspeed in the uppermost layers as the introductions of bubbles decreases the soundspeed and refracts (bends) the sound towards the surface, where the increased roughness and bubbles from the wind will cause increased transmission loss.

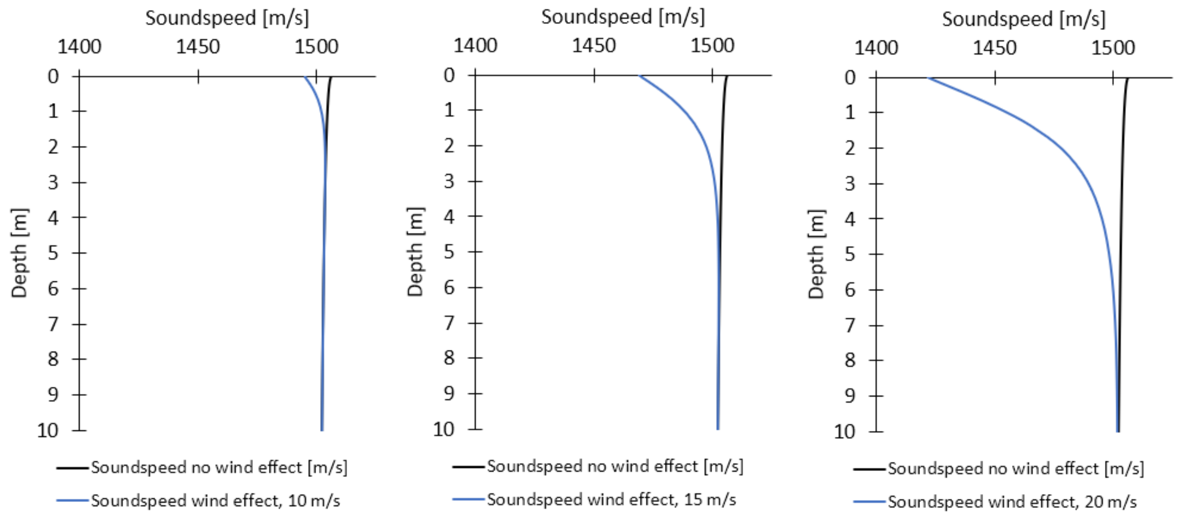

Figure 8-11: Effect of wind (at 10 m height) on upper portion of soundspeed profile.

Sound energy can also be absorbed due to interactions at the molecular level converting the acoustic energy into heat. This is another frequency dependent effect with higher frequencies experiencing much higher losses than lower frequencies. This is shown in Figure 8-12 where the variation of the absorption (sometimes called volume attenuation) is shown for various salinities and temperatures. As the effect is proportional to the wavelength, colder water, with slower soundspeed/period and being slightly more viscous, will have more absorption. Higher salinity slightly decreases absorption at low frequencies (mostly due to increase in soundspeed and wavelength/period), but much higher absorption at higher frequencies where interaction with pressure sensitive molecules of magnesium sulphite and boric acid increase the conversion acoustic energy to heat.

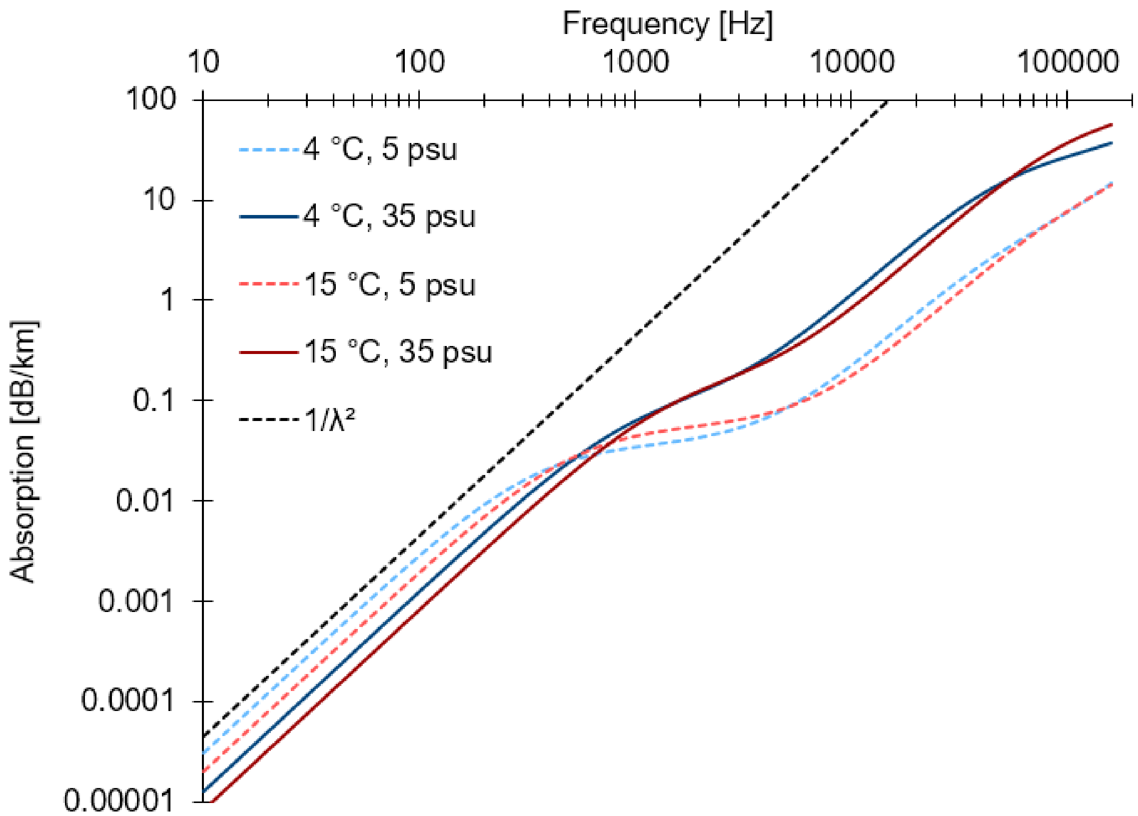

Figure 8-12: Absorption loss coefficient (dB/km) for various salinities and temperature.

Appendix C
List of Other Projects

Table C0.1 List of screened in projects identified as potential in-combination projects following a search of the relevant databases undertaken on the 21/10/2024.

Application reference no.	Project	Approximate Distance from MUL Area	Project Status	Cumulative Effect
FS007546	Codling Wind Park Ltd.	Overlaps with Dublin Cables MUL application area	Determination- 19/05/2023 Grant with Conditions Applied Case is due to be decided by 01/04/2025	Spatial overlap with Dublin Cables Maritime Usage Licence Area within south Dublin Bay. Within the CESS. Possible temporal overlap.
MUL230034	Codling Wind Park Ltd. site investigation works	Overlaps with Dublin Cables MUL application area	Applied to MARA but not determined.	Spatial and temporal overlap with SI works AoI.
FS007188	RWE Renewables Ireland Ltd. Site Investigations for the proposed Dublin Array Offshore Wind Farm.	Overlaps with Dublin Cables MUL application area	Determination 13/01/2023	Spatial overlap with Dublin Cables Maritime Usage Licence Area within south Dublin Bay. Within the CESS. Possible temporal overlap.
FS007029	Innogy Renewables Ireland Ltd. Site Investigation - Dublin Array at Kish and Bray Banks.	Overlaps with Dublin Cables MUL application area	Determination 28/01/2021	Spatial overlap with Dublin Cables Maritime Usage Licence Area within south Dublin Bay. Within the CESS. Possible temporal overlap.
LIC230016	Microsoft Ireland Operations Ltd. Geophysical survey and site investigations for a proposed subsea fibre optic cable having a landfall in Dublin Port, County Dublin and to evaluate options for the route traversing Dublin Bay, across the Irish Sea to Anglesey, Wales.	Less than 1 km	Granted	No spatial overlap with Dublin Cables Maritime Usage Licence Area. Within the CESS. Possible temporal overlap.

Appendix D Conservation Objectives for relevant European Sites

Table C0.2 List of screened in SACs including their conservation objectives and their most recent National Conservation Status (NPWS, 2019a).

Site Name and Qualifying Interest	Attribute	Measure	Target	Conservation Objective	Conservation Status
Rockabill to Dalkey SAC *Phocoena phocoena* (Harbour Porpoise) [1351]	Access to suitable habitat	Number of artificial barriers	Species range within the site should not be restricted by artificial barriers to site use. See map 5, available at: ConservationObjectives.rdl (npws.ie)	To maintain favourable conservation condition of Harbour Porpoise in the SAC	Favourable
	Disturbance	Level of impact	Human activities should occur at levels that do not adversely affect the harbour porpoise community at the site		
Lambay Island SAC Harbour Seal (*Phoca vitulina*) [1365] and Grey Seal (*Halichoerus grypus)* [1364]	Access to suitable habitat	Number of artificial barriers	Species range within the site should not be restricted by artificial barriers to site use. See map 6 and 7, available at: ConservationObjectives.rdl (npws.ie)	To maintain favourable conservation condition of QIs within in the SAC which is defined by the following list of attributes and targets, available at: ConservationObjectives.rdl (npws.ie)	Favourable
	Breeding behaviour	Breeding sites	The breeding sites should be maintained in a natural condition. See map 6 and 7 for known sites, available at: ConservationObjectives.rdl (npws.ie)		
	Moulting behaviour	Moult haul-out sites	The moult haul-out sites should be maintained in a natural condition. See map 6 and 7 for known sites, available at: ConservationObjectives.rdl (npws.ie)		
	Resting behaviour	Resting haul-out sites	The resting haul-out sites should be maintained in a natural		

Site Name and Qualifying Interest	Attribute	Measure	Target	Conservation Objective	Conservation Status
			condition. See map 6 and 7 for known sites, available at: ConservationObjectives.rdl (npws.ie)		
	Disturbance	Level of impact	Human activities should occur at levels that do not adversely affect the harbour grey seal population at the site		

Table C0.3 List of Screened in SPAs including their conservation objectives.

Site Name and Qualifying Interest	Attribute	Measure	Target	Conservation Objective
South Dublin Bay and River Tolka SPA Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] Oystercatcher (*Haematopus ostralegus*) [A130] Ringed Plover (*Charadrius hiaticula*) [A137] Grey Plover (*Pluvialis squatarola*) [A141] Knot (*Calidris canutus*) [A143] Sanderling (*Calidris alba*) [A144] Dunlin (*Calidris alpina*) [A149] Bar-tailed Godwit (*Limosa lapponica*) [A157] Redshank (*Tringa totanus*) [A162] Black-headed Gull (*Chroicocephalus ridibundus*) [A179]	Population trend	Percentage change	Long term population trend stable or increasing	To maintain the favourable conservation condition of the SCI's in South Dublin Bay and River Tolka SPA, defined by a list of attributes and targets available at: https://www.npws.ie/protected-sites/CO004024.pdf Note: Grey Plover is proposed for removal from the list of SCIs for South Dublin Bay and River Tolka Estuary SPA. As a result, a site-specific conservation objective has not been set for this species.
	Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing or intensity of use of areas by Species of Conservation Interests (SCIs) other than that occurring from natural patterns of variation	
Roseate Tern (*Sterna dougallii*) [A192] Arctic Tern (*Sterna paradisaea*) [A194] Common Tern (*Sterna hirundo*) [A193]	Passage population: individuals	Number	No significant decline	
	Distribution: roosting areas	Number; location; area (hectares)	No significant decline	
	Prey biomass available	Kilogrammes	No significant decline	
	Barriers to connectivity	Number; location; shape; area (hectares)	No significant increase	
	Disturbance at roosting and breeding site	Level of impact	Human activities should occur at levels that do not adversely affect the numbers of roseate, Arctic and	

			common tern among the breeding and post-breeding aggregation of terns	
	Breeding population abundance: apparently occupied nests (AONs)	Number	No significant decline in common tern populations	
	Productivity rate: fledged young per breeding pair	Mean number	No significant decline in common tern populations	
	Distribution: breeding colonies	Number; location; area (Hectares)	No significant decline in common tern populations	
Wetland and Waterbirds [A999]	Habitat area	Hectares	The permanent area occupied by the wetland habitat should be stable and not significantly less than the area of 2,192 hectares, other than that occurring from natural patterns of variation. See map 3, available at: [ConservationObjectives.rdl (npws.ie)]	
North Bull Island SPA Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] Shelduck (*Tadorna tadorna*) [A048] Teal (*Anas crecca*) [A052] Pintail *(Anas acuta*) [A054] Shoveler (*Anas clypeata*) [A056] Oystercatcher (*Haematopus ostralegus*) [A130] Golden Plover (*Pluvialis apricaria*) [A140] Grey Plover (*Pluvialis squatarola*) [A141] Knot (*Calidris canutus*) [A143]	Population trend	Percentage change	Long term population trend stable or increasing	To maintain the favourable conservation condition of the SCI's in North Bull Island SPA, defined by a list of attributes and targets available at: https://www.npws.ie/protected-sites/CO004006.pdf
	Distribution	Range, timing and intensity of use of areas	No significant decrease in the range, timing or intensity of use of areas by SCIs other than that occurring from natural patterns of variation	

Sanderling (*Calidris alba*) [A144] Dunlin (*Calidris alpina*) [A149] Black-tailed Godwit (*Limosa limosa*) [A156] Bar-tailed Godwit (*Limosa lapponica*) [A157] Curlew (*Numenius arquata*) [A160] Redshank (*Tringa totanus*) [A162] Turnstone (*Arenaria interpres*) [A169] Black-headed Gull (*Chroicocephalus ridibundus*) [A179]				
North-West Irish Sea SPA Red-throated Diver (*Gavia stellata*) [A001] Great Northern Diver (*Gavia immer*) [A003] Common Scoter (*Melanitta nigra*) [A065] Little Gull (*Larus minutus*) [A177] Black-headed Gull (*Chroicocephalus ridibundus*) [A179] Common Gull (*Larus canus*) [A182] Great Black-backed Gull (*Larus marinus*) [A187] Fulmar (*Fulmarus glacialis*) [A009] Herring Gull (*Larus argentatus*) [A184] Kittiwake (*Rissa tridactyla*) [A188] Guillemot (*Uria aalge*) [A199] Razorbill (*Alca torda*) [A200]	Population size (Including breeding and non-breeding)	Number	Long term SPA population trend is stable or increasing and no significant decline	To maintain or restore the favourable conservation condition of the SCI's in North West Irish sea SPA, defined by a list of attributes and targets available at: https://www.npws.ie/protected-sites/CO004236.pdf
	Spatial distribution	Hectares, time and intensity of use	Sufficient number of locations, area, and availability (in terms of timing and intensity of use) of suitable habitat to support the population	
	Forage spatial distribution, extent and abundance	Location and hectares, and forage biomass	Sufficient number of locations, area of suitable habitat and available forage biomass to support the population target	
	Disturbance across the site	Intensity, frequency, timing and duration	The intensity, frequency, timing and duration of disturbance occurs at levels that do not significantly impact the achievement of targets for population size and spatial distribution	

Manx Shearwater (*Puffinus puffinus*) [A013] Cormorant (*Phalacrocorax carbo*) [A017] Shag (*Phalacrocorax aristotelis*) [A018] Lesser Black-backed Gull (*Larus fuscus*) [A183] Roseate Tern (*Sterna dougallii*) [A192] Common Tern (*Sterna hirun*do) [A193] Arctic Tern (*Sterna paradisaea*) [A194] Little Tern (*Sterna albifrons*) [A195] Puffin (*Fratercula arctica*) [A204]	Barriers to connectivity and site use	Number; location; shape; area (hectares)	The number, location, shape and area of barriers do not significantly impact the site population's access to the SPA or other ecologically important sites outside the SPA	
Dalkey Island SPA Roseate Tern (*Sterna dougallii*) [A192] Common Tern (*Sterna hirundo*) [A193] Arctic Tern (*Sterna paradisaea*) [A194]	Breeding population size	Number	No significant decline	To maintain the favourable conservation condition of the SCI's in Dalkey Island SPA, defined by a list of attributes and targets available at: https://www.npws.ie/protected-sites/CO004236.pdf Note: Conservation objectives were based on neighbouring SPAs (North-West Irish Sea SPA) which contained the same QIs due to no specific conservation objectives document being available for the SPA in question.
	Spatial distribution	Hectares, time and intensity of use	Sufficient number of locations, area, and availability (in terms of timing and intensity of use) of suitable habitat to support the population	
	Forage spatial distribution, extent, abundance and availability.	Location and hectares, and forage biomass	Sufficient number of locations, area of suitable habitat and available forage biomass to support the population target	
	Disturbance across the site	Intensity, frequency, timing and duration	The intensity, frequency, timing and duration of disturbance occurs at levels that do not significantly impact the achievement of targets for population size and spatial distribution	

	Barriers to connectivity and site use	Number; location; shape; area (hectares)	The number, location, shape and area of barriers do not significantly impact the site population's access to the SPA or other ecologically important sites outside the SPA