ESB MONEYPOINT HUB PROJECT

SI Works – Risk Assessment for Annex IV Species

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GLOSSARY

Term	Meaning
Decibel (dB)	A customary scale most commonly used (in various ways) 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), and 20 micro-Pascals is the standard for airborne sound. The dB symbol is followed by a second symbol identifying the specific reference value (i.e., re 1 μPa).
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 (minutes to few hours) 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 (L_E)	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 “SEL” 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 Leq 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 time 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

1 INTRODUCTION

1.1 Overview

Offshore wind will play a significant role in Ireland's decarbonisation. A key part of ESB's strategy is to increase their renewable generation capacity and replace coal fired generation with low-carbon and renewable technologies to assist Ireland in moving towards climate neutrality by 2050 as set out in the National Energy & Climate Plan 2021-2030 (DCCAE, 2020). It is envisaged that much of this renewable generation will come from Floating Offshore Wind (FOW) in deep water areas off the west and south coasts, where Ireland is uniquely positioned to avail of the considerable wind resources.

FOW turbines work by connecting the buoyant substructure of the turbine base to the seabed using a system of anchors and mooring cables. FOW turbines can be deployed in deeper waters and are not as dependent on the condition of the seabed as fixed-bottom turbines, thus allowing floating turbines to utilise the strongest and most consistent winds to generate greater volumes of electricity. In addition, wind installations further offshore have a lesser impact on the environment by significantly reducing the visual impact on the landscape/seascape and reducing impacts on migratory birds through collision.

In Ireland, there is no dedicated port facility that is capable of producing FOW turbines on a scale that is necessary to meet the current and future demands. Based on market consultation and comparative studies, it is considered that any dedicated facility would require a deep-water to act as a staging point and sufficient land availability to facilitate the construction of the floating platform structures.

ESB propose to deliver a dedicated hub facility at Moneypoint for the construction and deployment of FOW turbines. The Moneypoint Generating Station site in County Clare was identified as having the essential physical and geographical attributes to act as a FOW Hub and aligns with the site-specific objectives for Moneypoint set out in the Clare County Development Plan 2023-2029 (Clare County Council, 2023a) and the cross-jurisdictional Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary (Clare County Council, 2023b) which aims to facilitate the long-term sustainable development of the Shannon Estuary.

ESB intends to undertake a survey campaign in the marine area at Moneypoint to inform the engineering design of the proposed Moneypoint Hub Project. The marine surveys will include geophysical, geotechnical, environmental and metocean surveys. These surveys are summarised in Section 2 of this report.

1.2 Purpose of the Report

This document has been prepared by RPS on behalf of the ESB to provide an overview of the marine site investigation works to be undertaken at the Moneypoint site in support of the Maritime Usage Licence to the Maritime Area Regulatory Authority (MARA). The Maritime Usage Licence is for site survey and investigation works to inform engineering design. The results of these surveys will also provide baseline data for any subsequent Environmental Impact Assessment Report (EIAR) and Natura Impact Statement (NIS) should the development be taken forward to the planning/consenting stage.

Under Article 12 of the Habitats Directive, Annex IV species are protected wherever they occur. In Ireland, the Habitats and Birds Directives have been transposed by the European Communities (Birds and Natural Habitats) Regulations 2011, as amended, which provides strict protection for all of the Irish species listed on Annex IV of the EU's Habitats Directive. If these species occur within the Zone of Influence of a project, a risk assessment of the effects of the project on the Annex IV species must be completed. This Risk Assessment for Annex IV Species report has been prepared in order to provide a sufficient level of information to the MARA for them to carry out a risk assessment for Annex IV species.

1.3 Statement of Authority

This report has been prepared by RPS on behalf of the ESB. The technical competence of the authors is outlined below:

Patrick Lyne is a Principal Scientist with RPS. He holds a Bachelor's Degree in Geology (1986); Masters in Internet Systems (2006) and Postgraduate Diplomas in Advanced Marine Sampling (2012) and Environmental Impact Assessment (2015). Patrick is a Chartered Marine Scientist at the Institute of Marine Engineering, Science and Technology (IMarEST) and has 20 years' experience with marine mammals.

Rasmus Sloth Pedersen is a Senior Project Scientist with RPS. He holds a master's degree in biology, biosonar and marine mammal hearing from University of Southern Denmark. Rasmus has over 10 years' experience as a marine biologist and over 8 years' experience with underwater noise modelling and marine noise impact assessments. Rasmus 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.

Gareth McElhinney 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 from NUI, Galway, a postgraduate diploma in Environmental Sustainability from NUI, Galway, and a Masters in Business Studies from the Irish Management Institute/ UCC. Gareth is also a Chartered Engineer. 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 PROJECT DESCRIPTION

2.1 Site Location

Moneypoint is located on the northern shore of the Shannon Estuary in Co. Clare, approximately 3 km west of Killimer and 6 km south-east of Kilrush (Figure 2.1 and Figure 2.2). The site was acquired by ESB in the late-1970s to develop a coal fired power plant as part of its strategy to diversify from oil dependent electricity generation. It consists of both a terrestrial and marine area; along with the interface between the two.

The large industrial facility includes the power station and substations as well as overhead powerlines and towers, wind turbines and ash storage areas. At present, marine operations at the sites existing 380m long jetty structure are limited to coal and Heavy Fuel Oil (HFO) importation. The jetty is connected to the landside by a 105m long approach arm carrying a roadway, conveyor housing, oil and water pipeline and electrical cabling. Moneypoint is one of six terminals within the Shannon Estuary.

The Shannon Estuary handles up to 1,000 ships carrying 12 million tons of cargo per annum (Clare County Council, 2023b). A car and passenger ferry operates between Killimer, Co. Clare, and Tarbert, Co. Kerry all year-round. Fishing activity also takes place in the estuary. Additionally, a large number of pleasure crafts exist year-round in the estuary.

The total area of the Moneypoint Generating station site is approximately 180 hectares (ha) and comprises lands on either side of the Kilrush-Killimer road (N67) as well as an additional c.40 ha within the marine environment, below the High-Water Mark (HWM). The terrestrial area of the site is inter-connected by a service road running beneath the N67. The main station site (c. 130 ha) is located on the south side of the N67; whilst the ash storage area (c. 50 ha) is located to the northwest on the landward side of the N67 where it adjoins the shoreline of Ballymacrinan Bay.

The general land-side ground conditions comprise of solid rock foundation with successive beds of mudstone, siltstone and sandstone overlain by stiff glacial till of variable thickness. The main site is situated adjacent to the deep sheltered water of the Shannon Estuary. The conditions will be verified through site investigation and associated interpretative studies.

Figure 2.1 Location of Moneypoint Generating Station Site in the context of the Shannon Estuary, Co. Clare

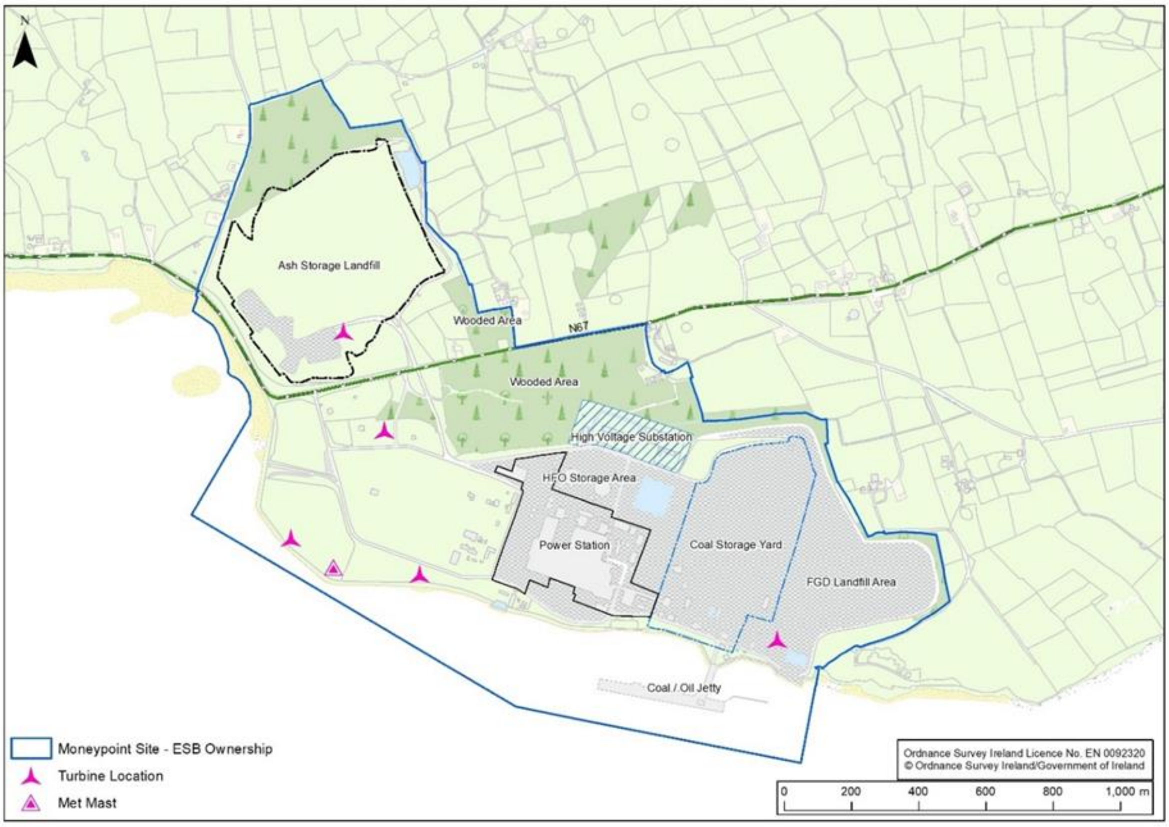

Figure 2.2 Moneypoint Generating Station Site, Co. Clare

2.2 Description of the SI Works

2.2.1 Overview

In order to provide a reliable basis for design and development the following surveys and investigations are considered necessary. The aim of the site investigation is to acquire data to a high quality and specification for the site as summarised below and described in the following sections.

- Phase 1 Marine Site Investigation Works:
  - Task 1: Marine Geophysical Surveys.
  - Task 2: Metocean Surveys.
  - Task 3: Marine Environmental/ Ecological Surveys.
- Phase 2 Marine Site Investigation Works:
  - Task 4: Marine Geotechnical Investigations.
- Phase 2 Land-based Site Investigation Works
  - Land-based site investigations previously consented by Clare County Council (planning reference: P23/32, decision dated 18th April 2023).

These SI works are collectively referred to as the Site Investigation (SI) works throughout this report.

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.

It is noted that the requirement for additional and more refined works may arise as the SI works progress and are analysed. This may include areas of particular interest using more targeted techniques and/or refined borehole locations and quantities.

The following drawings have been prepared in support of the Maritime Usage Licence to the Maritime Area Regulatory Authority (MARA):

- Site Location Map (Dwg Ref: QS-000339-01-D460-007-001-000)
- Maritime Usage Licence Area (Dwg Ref: QS-000339-01-D460-007-002-000)
- Geophysical Survey Area Map (Dwg Ref: QS-000339-01-D460-007-003-000)
- Site Investigation Map (Dwg Ref: QS-000339-01-D460-007-004-000)
- Licensed Aquaculture Sites Map (Dwg Ref: QS-000339-01-D460-007-005-000).

The drawings are included in Appendix A to this report.

2.2.2 Task 1: Marine Geophysical Surveys

The geophysical survey scope is intended to provide significant seabed and sub-seabed information to assist in the consenting, design, and construction phases of the project. It is therefore foreseen to gather, as a minimum, detailed information on:

- Water depths, reduced to LAT, throughout the defined survey area;
- The nature of any seabed features, obstructions, sediments, and shallow geological conditions throughout the defined survey areas;
- The nature of the sub-seabed conditions and horizons down to circa 50m below seabed level (bsbl);
- Seabed conditions/ hazards to any project equipment which may need to be located on the seabed;
- Seabed habitats to inform further benthic surveys and preparation of environmental impact assessment reports (EIAR); Identify sensitive marine habitats which will need to be avoided during geotechnical and environmental sampling;
- Archaeological features within the development area.

The foreseen scope of marine 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.

As detailed in Section 2.2.4 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.

Figure 2.3 Typical offshore geophysical survey vessel (Fugro Discovery IMO 915882)

Typical vessels for geophysical surveys will be circa 15 – 80m in length (smaller vessels may be used in nearshore / shallower water areas). See Figure 2.3 for an example of a geophysical survey vessel.

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, a description of the typical equipment and survey parameters is described. 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, electrical resistivity and magnetometer.

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:

- GeoAcoustics GeoSwath Plus interferometric;
- Teledyne Reson Seabat T50-R;
- R2 Sonic 2024 (see Figure 2.4); or
- similar.

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.

Figure 2.4 MBES R2Sonic 2024 typical configuration and equipment IMO 915882)

Location: MBES survey may be performed throughout the entire area illustrated as “Area A” in Dwg Ref: QS-000339-01-D460-007-003-000 (Appendix A). The estimated survey area is 927.5 hectares (9.27 km^2).

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;
- C-Max CM2 system (see Figure 2.5);
- Klein Hydro Scan; or
- similar.

Swath width: The swath width will be based on the water depth encountered. It is anticipated that the width of each swath will be approximately 50m with a 100% overlap between each swath.

Figure 2.5 **Counting pulley for winch-towed C-Max CM2 SSS**

Location: SSS survey may be performed throughout the entire area illustrated as "Area A" in Dwg Ref: QS-000339-01-D460-007-003-000 (Appendix A). The estimated survey area is 927.5 hectares (9.27 km^2).

2.2.2.3 Sub-bottom Profiling

A typical sub bottom profiling (SBP) survey is completed using a multi-channel seismic reflection system such as a Boomer, Chirp or Sparker 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.

Indicative Equipment:

- Edgetech 3100;
- Edgetech 3300 (see Figure 2.6);
- Geopulse 5430A (pinger system);
- 400 Joule Generic sparker;
- 350 Joule Generic Boomer;
- Innomar Parametric (dual frequency); or
- similar.

Swath width: n/a

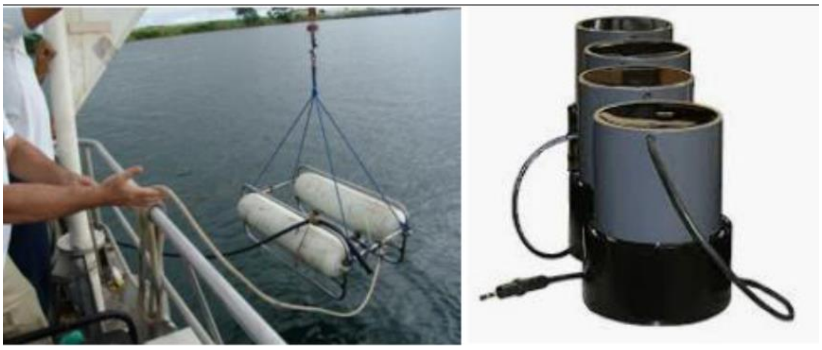

Figure 2.6 **Left - Applied Acoustics AA300 being deployed & Right - Typical Hull Mounted SBP - Edgetech 3300**

Location: SPB survey may be performed throughout the entire area illustrated as "Area A" in Dwg Ref: QS-000339-01-D460-007-003-000 (Appendix A). The estimated survey area is 927.5 hectares (9.27 km^2).

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, 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 2.7;
- Marine Magnetics SeaSPY,
- G-Tec Magwing System,
- or similar.

Figure 2.7 Geometrics G-882

Survey spacing: 25m centres, 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 area illustrated as "Area A" in Dwg Ref: QS-000339-01-D460-007-003-000 (Appendix A). The estimated survey area is 927.5 hectares (9.27 km^2).

2.2.3 Task 2: 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.

2.2.3.1 Equipment Deployment & Recovery Vessel

The methodology for deployment of metocean monitoring equipment will be through the use of a suitable vessel to either tow &/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 2.8 or similar.

Figure 2.8 Dennis Murphy IMO 9268784

2.2.3.2 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 at the project site. ADCP systems use sound to measure the current direction and velocity and ping at frequencies that vary by device type from 38 kHz to several MHz's.

Indicative Quantity: 1.

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 (see Figure 2.9) is mounted in a seabed frame (circa 1.8m wide and 0.6m high) with a weight of approx. 300kg. This will be attached to a ground line, a clump weight and to an acoustic release system carrying a rope retrieval system.

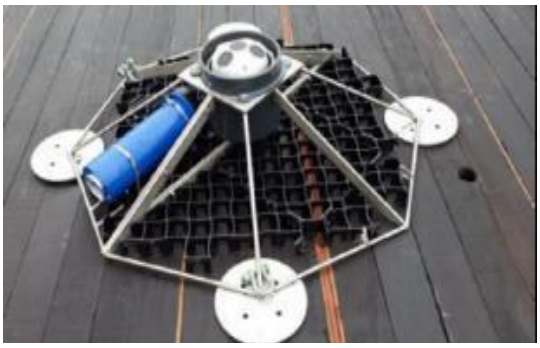

Figure 2.9 Typical seabed frame with ADCP (Ocean Scientific International Ltd)

Location: An indicative location for the deployment of the ADCP is illustrated on Dwg Ref: QS-000339-01-D460-007-004-000 (Appendix A). The actual location will be determined based upon interpretation of the geophysical data and following a navigation safety assessment.

2.2.4 Task 3: Marine Environmental/ Ecological Surveys

The aim of the proposed environmental surveys is to collect baseline data which will be used to inform the EIAR. This will comprise a benthic sampling programme using grab sampling, video or still photographs and static acoustic monitoring to measure marine mammal activity and other background noise.

2.2.4.1 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.

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 complimented 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 approximately 20 no stations will be required to be sampled. It is proposed that two grab samples will be taken at each sampling location, one for macrofaunal analysis and particle size analysis and one for sediment chemistry analysis. 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 and thereby ensuring reefs will not be damaged. Surface grab sample 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 -15mCD and -25mCD. It is estimated that each sample will have a sample up to $0.1m^2$.

Location: Grabs Sampling will be performed within the area of privately held foreshore held by ESB - Refer to Dwg Ref: QS-000339-01-D460-007-004-000 (Appendix A). The final sampling locations will be determined based upon interpretation of the geophysical data and selected to sample different marine habitats.

2.2.4.2 Static Underwater Acoustic Recorders

It is intended to deploy static underwater acoustic recorder(s) within the area of the ESB foreshore. The recorder(s) will be Wildlife Acoustics Model: SM2M Unit with hydrophones contained in a single unit (see Figure 2.10), or similar. The location for the deployment of the recorder(s) is yet to be determined.

Figure 2.10 Deployment of static underwater acoustic recorders

Indicative Quantity: It is anticipated that one static recorder will be deployed.

Method: The recorder will be deployed from a vessel and anchored to the seabed by way of chains, ropes and/ or weights for the duration of the deployment. Deployment is typically from the back of a vessel, usually by means of an 'A' frame or winch. A tethered buoy will be attached to the recorder to facilitate recovery of the recorder, ropes, chains, and weights. It is anticipated that a recorder will be deployed for a two-to-three-week duration.

Depth: The recorders will be positioned within the water column. A marker buoy will clearly highlight the location of the recorder.

Location: An indicative location for the deployment of the static underwater noise recorder is illustrated on Dwg Ref: QS-000339-01-D460-007-004-000 (Appendix A). The actual location will be determined based upon interpretation of the geophysical data and following a navigation safety assessment.

2.2.4.3 Other Environmental Surveys

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

- Ornithology surveys
  - Bird sighting surveys will be undertaken either from a vessel or aerially in addition to onshore vantage point locations.
- Marine Mammal surveys
  - Complimentary to the Static Acoustic Monitoring ongoing within the Shannon estuary, vessel based sighting surveys will be undertaken.
- Shipping and Navigation Surveys
  - The need for Shipping and Navigation surveys will be determined following consultation with the relevant stakeholders.
- Marine Archaeology Surveys
  - The aim of the proposed surveys, which will be undertaken by a suitable qualified archaeologist are to collect baseline data which will be used to inform the EIAR. 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.
- Marine Habitat Surveys
  - The aim of the proposed surveys, which will be undertaken by a suitable qualified marine ecologist, are to collect baseline habitat data which will be used to inform the EIAR and Appropriate Assessment. 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.

2.2.5 Task 4: 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 20 locations to a maximum of 30m investigation depth below seabed level.

- Vibro-cores at c.25 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. The geotechnical survey will be undertaken from either a dedicated geotechnical vessel (length 50-90m, see Figure 2.11) or alternatively a jack-up barge.

Figure 2.11 Typical Offshore geotechnical survey vessel – Fugro Synergy IMO 9452488

2.2.5.1 Geotechnical Boreholes

Indicative Quantity: 20 focused primarily in the survey area in front of the Moneypoint Site.

Method: A drill head is lowered to the seabed from the vessel via a drill string and stabilised using a seabed frame. 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.

Sample Diameter: up to 102mm.

Depth: Up to 30m below the seabed or refusal.

Indicative Equipment: Drilling equipment used will follow the ISO and API technical specifications for drilling equipment. Indicative equipment to be used would be traditional API drill string or a triple core barrel system (e.g., Geobor 'S') or similar (see Figure 2.12). For investigation within the intertidal zone, a tracked borehole / CPT rig and ancillary equipment would be used.

Location: Indicative geotechnical locations for the boreholes are illustrated on Dwg Ref: QS-000339-01-D460-007-004-000 (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 micrositing of individual geotechnical site investigation locations will take into consideration environmental constraints such as the position of sensitive habitats or archaeological features.

Figure 2.12 Typical marine drill (Fugro)

2.2.5.2 Vibro-core Sampling

Indicative Quantity: 25 vibrocores

Method: Gravity or piston core (self-weight penetration sampler)

Sample Diameter: up to 150mm

Depth: Vibrocore up to 3m 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 development area - Refer to Dwg Ref: QS-000339-01-D460-007-004-000 (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 project surveys is included in Table 2.1 (see Appendix B: Subsea Noise Technical Report for further detail).

Table 2.1 Summary of Noise Sources and Activities Included in the Subsea Noise Assessment

Equipment	Source level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessel (based on “Fugro Discovery”, IMO 9152882)	165 dB SPL	10-2,500 Hz	(Wittekind, 2014; Simard, et al., 2016; Heitmeyer, 2001)	Non-impulsive
Multibeam echosounder Based on: “Teledyne Reson Seabat T50-R”, “Kongsberg GeoAcoustics GeoSwath Plus interferometric” & “R2 Sonic 2024”	182 dB SPL (ping rate dependent, equivalent spherical level)	200,000 Hz & 250,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer.	Impulsive
Side scan sonar Based on: “Kongsberg Geoacoustic 160”, “Edgetech 4200”, “C-Max CM2 system” & “Klein Hydro Scan”	170 dB SPL (ping rate dependent, equivalent spherical level)	300,000 – 445,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer.	Impulsive
Sub-bottom profiler 1 Based on: “Edgetech 3100, “Edgetech 3300, “Geopulse 5430A, “400 Joule Generic sparker”, “350 Joule Generic Boomer”	188 dB SPL (ping rate dependent, off-axis level) 220 dB L_P (on-axis)	600 – 12,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer as well as generic models for Sparker and Boomer.	Impulsive

Equipment	Source level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/non-impulsive
Sub-bottom profiler 2 Based on: "Sub-bottom profiler 1" & "Innomar Parametric (dual frequency)"	197 dB SPL (ping rate dependent, off-axis level) 247 dB L_P (on-axis)	1000 – 4,000 Hz & 85,000 – 115,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer.	Impulsive
Vibro-coring / drilling	195 dB SPL	10 – 3,000 Hz	(Bureau of Ocean Energy Management) (Center for Marine Acoustics, 2023)	Non-impulsive

2.2.7 Land-based Site Investigations

In January 2023, ESB applied to Clare County Council for planning permission for the onshore site investigation works at Moneypoint Generating Station.

The land-based SI works comprise the drilling of boreholes and excavation of trial pits at various locations cross the site above the High-Water Mark. The investigation aims to determine the sub surface strata and composition of the ground and the level of rockhead (including follow on coring to confirm rock head).

It is proposed that approximately 26 no borehole stations and shallow exploratory investigations will be undertaken. The methods to be employed during the investigation works are cable percussive boreholes, rotary core boreholes, and trial pits. It is anticipated that the maximum depth of the boreholes will be 20m. Trail pits are anticipated to be a maximum of 4.5m deep.

Planning permission for the onshore site investigation works was granted by Clare County Council on 18th April 2023. The expiry date of the grant is 17th April 2028.

2.2.8 Programme and Timescale

ESB propose a site investigation activities schedule that will be phased over a total of 1.5 years (18 months). 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. The exact mobilisation dates will not be known until the process of procuring a contractor is complete.

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 project phase scope has been estimated in Table 2.2 below. The estimated durations are subject to change based on variables such as weather conditions onsite, unforeseen seabed conditions, unforeseen obstructions etc. ESB will consult with relevant stakeholders where appropriate prior to the commencement of the surveys.

Table 2.2 Estimated Project Schedule

Phase	Scope of Work	Total No of SI Locations	Survey Area	Estimated Duration	Estimated Commencement date
Phase One SI	Marine Geophysical Surveys	n/a	927.5 ha	4-6 weeks	Q1 2024
	Benthic Sampling	20	40 ha	4-6 weeks	Q1/Q2 2024
	Deployment of Static Underwater Acoustic Recorders	1	n/a	4-6 weeks	Q1/Q2 2024
	Metocean Surveys (ADCPs)	1	n/a	4-6 weeks	Q1/Q2 2024
Preliminary Engineering Design to be undertaken in Q3 / Q4 2024					

Phase	Scope of Work	Total No of SI Locations	Survey Area	Estimated Duration	Estimated Commencement date
Phase Two SI	Marine Geotechnical Boreholes	20		2-3 months	Q4 2024 / Q1 2025
	Vibrocore Sampling	25		2-3 months	Q4 2024 / Q1 2025
	Land-based Site Investigations	26	105 ha	2-3 months	Q4 2024 / Q1 2025
Finalised Engineering Design (Q1 2025)					

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.

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-state are encountered or forecast. Similarly, equipment maintenance and repair may impact on operational activities resulting in downtime.

Following downtime or suspension of operations, 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 RISK ASSESSMENT FOR ANNEX IV SPEICES

3.1 Legislative Context

Under Article 12 and 13 of the Habitats Directive, Member States must establish systems of strict protection for animal and plant species which are particularly threatened, and which are listed on Annex IV of the Directive. Article 16 provides for derogations from these legal protections under certain, specific, circumstances. Article 12, 13 and 16 of the Habitats Directive are transposed into Irish law by Regulations 51, 52 and 54 of the European Communities (Birds and Natural Habitats) Regulations 2011, as amended.

Annex IV species are afforded strict protection throughout their range, both inside and outside of designated protected areas. It is an offence to:

- Deliberately capture or kill any specimen of these species in the wild;
- Deliberately disturb these species particularly during the period of breeding, rearing, hibernation and migration;
- Deliberately take or destroy eggs of these species in the wild;
- Damage or destroy a breeding or resting place of such an animal[1];
- Deliberately pick, collect, cut, uproot, or destroy any specimen of [plant] species in the wild; or
- Keep, transport, sell, exchange, offer for sale or offer for exchange any specimen of [animal or plant] species taken in the wild, other than those taken legally as referred to in Article 12(2) of the Directive[2].

The granting of another statutory consent (e.g., planning permission; MARA licence) does not remove the obligation to obtain a derogation licence in the event of the consented works being likely to not conform with the strict protections afforded to Annex IV species. As such, an application for derogation may have to be made to the Minister for Housing, Local Government & Heritage via the National Parks and Wildlife Service (NPWS) under Regulation 54, in addition to an application for development consent. If satisfied that an application meets the criteria for derogation, the Minister may grant a derogation licence, which may be subject to such conditions, restrictions, limitations, and requirements as the Minister considers appropriate, and these will be specified in the licence.

3.2 Methodology

This risk assessment for Annex IV species has had regard to the following guidance:

- European Commission (2021) Guidance document on the strict protection of species of community interest under the Habitats Directive. C. (2021) 7301 final. Brussels.
- 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 (2021) Guidance on the Strict Protection of Certain Animal and Plant Species under the Habitats Directive in Ireland. National Parks and Wildlife Service Guidance Series, No. 2. Department of Housing. Local Government and Heritage.

This risk assessment for Annex IV species broadly follows the methodology structure outlined in NPWS (2021), as follows:

- Use existing information to determine the probability of the protected species being present in the area affected by the works.

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[1] Including any action resulting in damage to, or destruction of, a breeding or resting place of an animal. Breeding or resting places are protected even when the animals are not using them.

[2] National Parks and Wildlife Service (2021) Guidance on the Strict Protection of Certain Animal and Plant Species under the Habitats Directive in Ireland.

- Ecological survey, if required.
- Examination of impacts and mitigation measures and satisfactory alternatives (if required). For each species or species group, an assessment was made against each of the strict protections taking into account project details and the available evidence base for each species.

If the examination of impacts concludes that the proposed project will not conform with the strict protections afforded to Annex IV species, then an application will be made for a derogation licence under Regulation 54 of the Regulations.

3.3 Relevant Annex IV Species

All species listed under Annex IV with the potential to be impacted by the proposed SI works are required to be assessed. Of the animal and plant species on Annex IV known to occur in Ireland[3], the following species were identified as relevant to the proposed development:

- All bat species.
- Otter.
- All cetacean species.
- All turtle species.

Relevance was assessed based on the potential for the species to be present within the zone of impact of the SI works. For land-based SI works, the zone of impact will be limited to the footprint of the Moneypoint site above the HWM, while for the marine-based survey works the zone of impact extends to the boundary of the geophysical survey area as shown in the drawings in Appendix A.

As a precautionary measure, all Annex IV species with the potential to occur within the Shannon Estuary are considered. Where there is no evidence that an Annex IV species has the potential to occur in the vicinity of Moneypoint, these species were not included in this assessment.

This element of the assessment comprised a desktop review, a terrestrial field survey and professional judgement/knowledge of the geographical area.

The following sources were consulted during the desktop review:

- Irish Whale and Dolphin Group Sightings Log https://iwdg.ie/browsers/sightings.php/;
- Distribution records for Annex IV species held online by the National Biodiversity Data Centre (NBDC) www.biodiversityireland.ie;
- NPWS (2019) The Status of EU Protected Habitats and Species in Ireland. Volume 3: Species Assessments. Unpublished Report, National Parks and Wildlife Service. Department of Culture, Heritage and the Gaeltacht, Dublin; and
- Previous survey reports and literature reviews specific to the Moneypoint area (MERC, 2021; Inis, 2010).

3.4 Evidence Base

3.4.1 Ecological Surveys

To inform the future environmental assessment of the Moneypoint Hub Project, terrestrial ecological surveys have been undertaken in 2022 and 2023. The ecological study area was defined based on the ESB's land ownership boundary and refined based on the areas within which physical works are required for the construction and operation of the project. This area is to the south and east of the N67 road, excludes the power station, HFO area and substations, but includes the coal yard and FGD landfill to the east of the site. The study area for the terrestrial ecological surveys is shown in Figure 3.1.

[3] https://www.npws.ie/legislation

Figure 3.1 Ecological Survey Area for Moneypoint Hub Project

3.4.2 Bats

All native bat species in Ireland receive the same level of strict protection. With respect to the SI works, the presence or otherwise of bats is typically relevant only to onshore SI activities; as although bats are known to forage over water and along coastlines, they will not interact with underwater works.

Bat surveys were undertaken across the Moneypoint site in June through October 2023 to inform the proposed development of the Moneypoint Hub Project. The bat surveys comprised:

- Static detector (activity) surveys;
- Potential bat roost (PBR) surveys;
- Dawn/ dusk surveys including transects; and
- Emergence/ re-entry surveys of structure.

Bat numbers on-site were moderate with the activity mainly confined to foraging and commuting along scrub and wooded areas within the site. The following bat species were recorded on the static detectors:

- Myotis spp.;
- Pipistrellus spp.;
- *Pipistrellus pipistrellus* (Common pipistrelle);
- *Pipistrellus pygmaeus* (Soprano pipistrelle);
- *Nyctalus leisleri* (Leisler's bat);
- *Plecotus auritus* (Brown long eared bat); and
- *Rhinolophus hipposideros* (Lesser horseshoe bat)

The preliminary ground level roost assessments identified 14 trees with features suitable for roosting bats. Of these 14 trees, the visual assessment categorised all 14 trees as having 'Low' bat roosting suitability. No trees with 'Moderate' or 'High' roosting suitability were identified.

The preliminary ground level roost assessments identified six buildings suitable for roosting bats. Of these, the visual assessment categorised five buildings as having ‘Low’ bat roosting suitability and one building as having ‘Moderate’ bat roosting suitability. No buildings with ‘High’ roosting suitability were identified.

Bat emergence and re-entry surveys for two derelict structures and four actively used buildings were carried out. During the emergence survey of the derelict structure BS4 (shown on Figure 3.1) a lesser horseshoe bat call was picked up on the Elekon M2 batlogger in proximity to the structure. A roost inspection of structure BS4 was undertaken on 31st October 2023, under licence from the NPWS, to determine if Lesser horseshoe bats are present or if the roost is in use by other bat species. No Lesser horseshoe bats were encountered during the visit, but evidence of bat activity was clear. Further surveys of BS4 are planned to confirm its use as a roost.

3.4.3 Otter

Otter (*Lutra lutra*) occurs throughout Ireland, including along the coasts in County Clare (NPWS, 2019) with populations also found along rivers, lakes, and coasts, where fish and other prey are abundant, and where the bank-side habitat offers plenty of cover. The otter is an opportunistic predator with a broad and varied diet. They have diverse habitat preferences: lakes, canals, riverine (streams up to major river systems) marshland and estuaries. Otters that live nearer to the coast tend to require access to freshwater for bathing purposes, while any aquatic environment which has nearby vegetation or rock cover will be used by otters (NPWS, 2019).

Although otters are a mobile species, they have defined territories. Females have territories of 7.5 ± 1.5km in length along a riverine environment and 6.5 ± 1.0km in coastal environments, while male otter territory along rivers is approximately 13.2 ± 5.3km in length with a high degree of variability (Reid et al., 2013).

The main threats to otter include pollution, particularly organic pollution resulting in fish kills; and accidental deaths, e.g., road traffic and fishing gear (NPWS, 2019). The most recent Article 17 conservation assessment for otters in Ireland deemed the species as being in favourable conservation status (NPWS, 2019).

Otters are a QI of the Lower River Shannon Estuary SAC, which the SI works is within.

Based on a survey completed in 2010 to inform other works within the Moneypoint site, evidence of otter activity was found to the east of the coal-loading jetty within the industrial site. Evidence was also found along the rocks above the HWM at Ballymacrinan Bay. Otter spraints were found on the rock armour to the front of the site to the east of the site jetty. Fresh spraints were also identified to the east of the power station. During a 2013 otter survey within the Moneypoint site, no holts or other tracks/signs were identified within the site (Inis, 2013). Mapping carried out by NPWS (2012) indicates that otter commute along the foreshore at Moneypoint.

For the proposed future development, an otter activity survey was conducted within the Moneypoint site on 16th June 2022 which confirmed that otters are using the foreshore and rock armour to the south. Three couch/seat areas were found on the grassland/rock armour interface close to freshwater outfalls. Similar evidence has been confirmed from surveys conducted in September 2023. Old and fresh spraints were recorded all along the rock armour. No otter holts were recorded in June 2022, but two possible holts were located by surveys in 2023 at the bridge to the jetty and at a pier just west of the jetty, which indicates that otters are quite active in the area, using the site for resting, cleaning, and feeding, but breeding may also occur within the Moneypoint site. Otter activity recorded during the site surveys is illustrated in Figure 3.2.

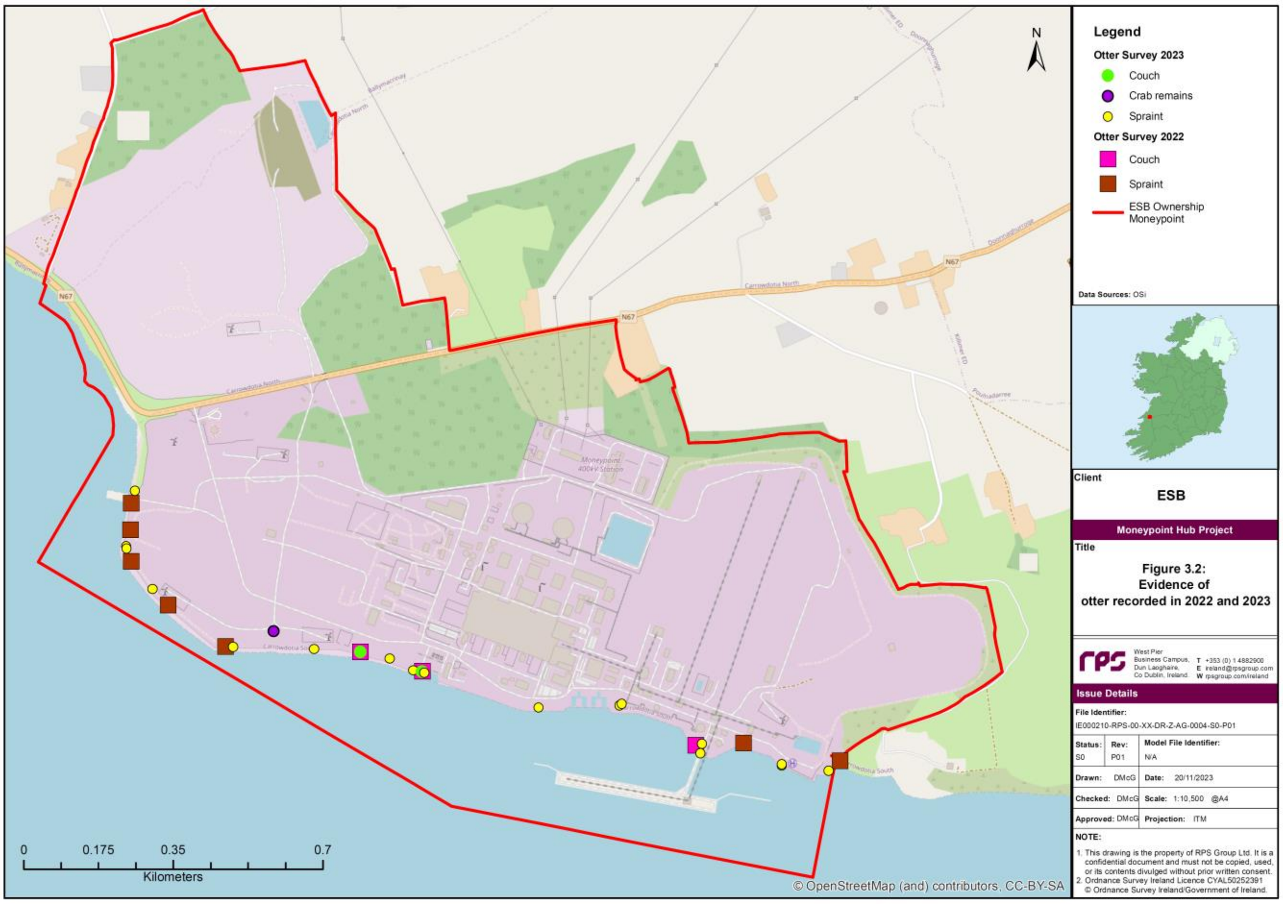

Figure 3.2 **Evidence of Otter Activity at the Moneypoint Hub Site**

3.4.4 Cetaceans

Twenty-five species of cetacean have been recorded in the waters around Ireland. The Irish Whale and Dolphin Group (IWDG) holds 117 records of cetacean sightings off the coast of County Clare for the period November 2022 to November 2023 (IWDG, 2023). Species identified include bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), and humpback whale (*Megaptera novaeangliae*). Within the Shannon Estuary bottlenose dolphin were noted as the most frequently recorded species (34 sightings recorded between November 2022 to November 2023) with just one sighting of harbour porpoise in the outer reaches of the estuary at Loop Head over the same time period (IWDG, 2023). No other cetacean species was recorded in the Shannon Estuary between November 2022 to November 2023.

The Shannon Estuary is one of the most important areas for bottlenose dolphins in Ireland, and the species is a qualifying interest of the Lower River Shannon SAC. In addition, the Shannon Estuary (SHE) management unit (MU) is one of two management units in the Republic of Ireland recognised for bottlenose dolphin (JNCC, 2022). The SHE MU bottlenose dolphin is considered a distinct inshore population in western Irish waters of the British Isles and interchange of animals with Welsh waters of the Irish Sea is likely to be minimal (JNCC, 2022). The potential for adverse effects arising from the SI works on bottlenose dolphins is assessed against the conservation objectives of the SAC in the separate report Supporting Information for Screening for Appropriate Assessment (RPS ref: IE000210RP0026).

MERC Consultants carried out a preliminary overview of marine ecological data for the Moneypoint Hub project (MERC, 2021). This review identified that bottlenose dolphins are present throughout the year and are genetically discrete compared to bottlenose dolphins found elsewhere in Irish waters (Mirimin et al. 2011) and that the estuary is an important calving area (MERC, 2021). The population is estimated at around 145 individuals with only 80 adults (Baker et al., 2018 in MERC, 2021). This small, genetically discrete population is potentially vulnerable to even small increases in adult mortality or a reduction in reproduction rates (Blásquez et al., 2021 in MERC, 2021). An overview of existing data on bottlenose dolphin populations in the

Lower Shannon Estuary shows that there is a well-known hotspot for the species in the waters off Moneypoint Power Station (MERC, 2021). Rogan et al (2000) recorded bottlenose dolphins in the estuary all year round with a peak from May to September and noted the presence of neo-natal calves from July to September as evidence of a well-defined breeding season in the Shannon Estuary. There are no density estimates for the Lower River Shannon Estuary SAC but equating the abundance to the surface area of this SAC (683 km^2) would give an estimate of 0.212 animals per km^2. Other density estimates are available for the coastal waters along the west coast of Ireland in survey stratum 7 of the ObSERVE aerial surveys. These data suggested that bottlenose dolphin occurs in densities of between 0.160 to 1.161 animals per km^2 (Rogan et al., 2018).

MERC (2021) described the results of static acoustic monitoring (SAM) in the vicinity of Moneypoint, with respect to bottlenose dolphins. The longest SAM dataset at Moneypoint is used as the reference point for acoustic detections elsewhere in the estuary. Dolphin detections at Moneypoint typically range from 50-93% of days monitored and are affected by season as well tidal and diel cycles. Seasonal variation in foraging suggested that Moneypoint is an important feeding site during winter and spring (Carmen et al. 2021 in MERC, 2021).

A cetacean desktop literature review was conducted by Inis Environmental Consultants Ltd. in 2010 to inform the Moneypoint Windfarm development planning application. This review noted that neonatal calves were recorded from July to September 2010 highlighting that the area is an important nursery area. Large groups of bottlenose dolphins were frequently observed in the narrow waters at Kilcredaun and in the mouth of the estuary. This area has been identified as a 'Critical Area' for bottlenose dolphin within the Shannon Estuary (Ingram and Rogan, 2002). A second critical area was identified further east into the estuary around Moneypoint and Tarbert/ Killimer. Both of these areas are located in deep parts of the estuary within fast tidal currents (Ingram and Rogan, 2002).

Harbour porpoise (Phocoena phocoena) are widespread around the Irish coast (Wall, D. et al., 2013 as cited in NBDC, undated) and the Celtic and Irish Seas (CIS) MU is recognised for the management of harbour porpoise in Celtic and Irish waters (JNCC, 2022). Abundance of harbour porpoise in the CIS MU is estimated at 62,517 animals (JNCC, 2022). However, very few sightings of harbour porpoise have been recorded within the Shannon Estuary with no recorded sightings between November 2022 and November 2023 (IWDG, 2023). There was one sighting adjacent to Moneypoint in 2018 (IWDG), and strandings have been recorded as far up the estuary as Foynes (O'Callaghan et al, 2021). Violent interactions have been recorded between bottlenose dolphins and harbour porpoise (Ross and Wilson, 1996; Gross et al., 2020) and suggested reasons for this aggression include interspecies territoriality, defence of group members, food competition, feeding interference and object-orientated play (Gross et al., 2020). From the lack of recorded sightings of harbour porpoise within the Shannon Estuary, it is likely that they largely avoid the area. As a result, it is considered unlikely for harbour porpoise to be encountered within the SI works area during operations. Estimates of density are available for coastal waters in survey stratum 7 of the ObSERVE aerial surveys. These data suggested that harbour porpoise occurs in densities of between 0.037 to 0.262 animals per km^2 (Rogan et al., 2018), along the west coast of Ireland although as described above these will relate to coastal waters outside the Shannon Estuary.

3.4.5 Turtles

Four Annex IV species of turtle are known to occur in Ireland (leatherback turtle, Kemp's Ridley turtle, loggerhead turtle and hawksbill turtle)[4]. Leatherback turtle (*Dermochelys coriacea*) has been reported on a number of occasions around the Irish coastline and in the Irish Sea, most recently in 2020. Between 2000 and 2020, 164 observations of leatherback turtles were recorded in Irish waters (NBDC, 2023a). Leatherbacks are known to have an 'atypical migration pattern', as while they must return to tropical waters to breed and reach preferred nesting grounds, they are known to spend the summer months in productive temperate waters, like Ireland's, feeding on jellyfish and sea squirts (Doyle, 2007). A leatherback turtle at the mouth of the Shannon Estuary about 2 miles east of Loop Head, Co. Clare was reported to IWDG in June 2007[5]. Most records of leatherback turtle are reported in coastal waters, and rarely within estuaries.

[4] https://www.npws.ie/legislation Accessed online 20 December 2022.

[5] Leatherback Turtles now arrived | Irish Whale and Dolphin Group (iwdg.ie).

Loggerhead turtles (*Caretta caretta*) have been recorded all along the west coast of Ireland[6] and between 2000 and 2019, 25 observation of loggerhead turtles were recorded in Irish waters (NBDC, 2022b), however, only one loggerhead turtle has been observed in the vicinity of the Shannon Estuary at Kilbaha, Loop Head in 1998 (NBDC, 2022b).

Other turtle species have been less commonly observed in Irish waters. The last record of hawksbill turtle (*Eretmochelys imbricata*) in Ireland was in 1983[7] off the coast of Cork, and the closest recorded sighting of Kemps Ridley turtle (*Lepidochelys kempii*) was in 1992 at Banna Strand in Co. Kerry (NBDC, 2022c).

It can, therefore, be concluded that the occurrence of turtles in Irish waters is rare, with the leatherback and loggerhead turtles the most common species. These species are most commonly observed in coastal waters and are not generally found in estuaries. No turtle sightings have been recorded at the Moneypoint site in the Shannon Estuary.

3.5 Examination of Impacts to Strict Protections

3.5.1 Bats

Based on the available evidence base, the proposed SI works including access/egress from each location will not result in any direct or indirect impacts on any structure or feature which could be used by roosting bats. Therefore, there is no likelihood of the SI works resulting in any bats being captured or killed and disturbed during periods of breeding, rearing or hibernation. No breeding site or resting place of such animals will be damaged or destroyed during the SI works.

Any artificial lighting used will be localised to either the vessels or at onshore borehole locations. Moneypoint Power station is active 24/7 and existing artificial lighting is used extensively across the site. Therefore, given the existing levels of artificial lighting on-site, there is no likelihood of any significant disturbance or displacement of foraging, commuting, or migrating bats.

Given that the SI works conform with the strict protections afforded to bat species and based on the current evidence base, it is considered that no derogation is required.

The proposed SI works will not offend the system of strict protection of bats under Article 12 of the Habitats Directive.

3.5.2 Otter

The SI works (both terrestrial and marine) will result in limited activity around the shore of Moneypoint power station. The station operates on a 24-hour, seven day a week schedule. There is therefore constant activity on-site including personnel, vehicle movements, deliveries, noise, artificial lighting, etc. It can be reasonably assumed that any otter activity on the site will be habituated to the existing site operations and/or avoid the areas where there are on-going operations. It is considered highly unlikely that there would be any significant disturbance to otter as a result of the SI works. Therefore, based on the current evidence base, it is considered that no derogation is required, and the proposed SI works will not offend the system of strict protection of otter under Article 12 of the Habitats Directive.

3.5.3 Cetaceans

Potential impacts to cetaceans, and on the strict protections afforded to these species, associated with the SI works are:

- Underwater noise generated during the geophysical and geotechnical surveys resulting in injury and/or disturbance;
- Accidental pollution event; and
- Collision risk with survey vessels, resulting in injury.

[6] https://maps.biodiversityireland.ie/Map/Terrestrial/Species/128438 Accessed online 15 June 2022.

[7] https://maps.biodiversityireland.ie/Species/128441 Accessed online 15 June 2022.

3.5.3.1 Underwater Noise

An underwater (subsea) noise assessment was carried out using indicative noise sources for the marine SI works. The assessment and results are presented in the Subsea Noise Technical Report in Appendix B.

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 at Moneypoint ranges between 20-40m with a mixed substrate type, of muds, sands, coarse gravels, and exposed bedrock. 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 mostly directional or omni-directional (e.g., sparker) (Ruppell et al, 2022). The range of the geophysical equipment will be limited principally by water depth and attenuation particularly of high frequency sources such as multi-beam and side scan sonar systems.

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

Auditory injury in cetaceans 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 is expected to 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).

Should the noise levels from sources exceed the thresholds, there is the potential for underwater noise generated during the geophysical survey to result in injury and/or disturbance to Annex IV marine mammal species in the vicinity of the SI works.

Marine mammal species can be split into functional hearing groupings, according to their frequency-specific hearing sensitivity (Southall et al., 2019). Bottlenose dolphin is considered a high frequency cetacean (HF), harbour porpoise a very high frequency cetacean (VHF) and otters are included as Other marine Carnivores in Water (OCW). See Table 3.1 below for a list of species contained within each functional hearing group.

Table 3.1 Functional Marine Mammal Hearing Groups for Marine Mammal Species

Southall *et al.* (2019) Hearing Group Name	Species Included in Group
Low-frequency cetaceans (LF)	Baleen whales (minke, fin and humpback whale).
High-frequency cetaceans (HF)	Most toothed whales and dolphins (bottlenose, common and Risso's dolphin, killer, and pilot whales).
Very high-frequency cetaceans (VHF)	Certain toothed whales and porpoises (harbour porpoise).
Other marine carnivores in water (OCW)	Includes sea lions, walrus, otters.
Phocid carnivores in water (PCW)	Earless seals (including harbour and grey seal).

Southall et al. (2019) provides impact thresholds for both PTS and TTS, addressing both peak sound pressure levels (SPL) and sound exposure levels (SEL) and these are provided below in Table 3.2. It should be note that although the DAHG (2014) guidance refers to Southall et al. (2007), the more recent Southall et al. (2019) outlines more precautionary thresholds than those outlined in 2007 for PTS and TTS.

Table 3.2 Summary of PTS and TTS Onset Thresholds (Southall et al., 2019)

Hearing Group	Parameter	Impulsive		Non-Impulsive	
		TTS	PTS	TTS	PTS
High-frequency (HF) cetaceans (e.g., bottlenose dolphin)	L_P (unweighted)	224	230	-	-
	L_E (HF weighted)	170	185	178	198
Very High frequency (VHF) cetaceans (e.g., harbour porpoise)	L_P (unweighted)	196	202	-	-
	L_E (VHF weighted)	140	155	153	173
Other Marine Carnivores in Water (OCW) (e.g., otters)	L_P (unweighted)	226	232	-	-
	L_E (OCW weighted)	188	203	199	219

From Table 6.1 and Table 6.2 of the Subsea Noise Technical Report (Appendix B; and reproduced in Table 3.3 and Table 3.4 below), it can be seen that the greatest minimal starting range to avoid TTS for a fleeing animal is 3.1 km for VHF species (i.e., harbour porpoise). For HF species (i.e., bottlenose dolphin) the minimal starting range is 280m.

Note: the highlighted cells in Table 3.4 are the changes from the results presented in Table 3.3 due to the inclusion of the parametric sub-bottom profiler.

Table 3.3 Summary of risk ranges from noise exposure without parametric sub-bottom profiler, L_E. All are risk ranges to TTS limits

Condition	LF	HF	VHF	PCW	OCW	Fish
1 second exposure TTS risk [m]	20	0	90	5	0	0
10-minute exposure TTS risk [m]	1700	200	2900	970	70	13
50-minute exposure TTS risk [m]	3900	580	5700	2400	210	50
Minimal starting range to avoid TTS [m] for fleeing animal	2000	41	3100	950	2.5	1
Peak [dB L_P] range [m]	<20	<20	<20	<20	<20	<50
Behavioural response range [m]	510	510	510	510	510	2000

Table 3.4 Summary of risk ranges from noise exposure with parametric sub-bottom profiler, L_E. All are risk ranges to TTS limits

Condition	LF	HF	VHF	PCW	OCW	Fish
1 second exposure TTS risk [m]	20	33	430	5	0	0
10-minute exposure TTS risk [m]	1700	500	2900	970	70	43
50-minute exposure TTS risk [m]	3900	770	5700	2400	210	100
Minimal starting range to avoid TTS [m] for fleeing animal	2000	280	3100	950	2.5	5
Peak [dB L_P] range [m]	<20	<20	<20	<20	<20	<50
Behavioural response range [m]	510	510	510	510	510	2000

At shorter ranges < 500-1000 m the inclusion of a parametric SBP in the combined source determines the risk ranges for TTS, while without a parametric SBP or at longer ranges the sparker determines the risk ranges for TTS.

Risk ranges for the Vibro-coring (covering drilling as well) are all at or below 300 m for species expected to be present (but >700 m for the LF hearing group).

The following focuses on the three hearing groups relating to Harbour porpoises (VHF), Seals (PCW) and Common and Bottlenose dolphins (HF). The remaining hearing groups are either assumed not present (LF) or have risk ranges that are considered too low to be significant (OCW and Fish). The focus is on minimal starting range for a fleeing animal to avoid TTS, with notes on what equipment determines this range (i.e., what equipment, if quieter, would reduce the range).

For porpoises (VHF hearing group) the minimal starting range to avoid TTS risk is 3100 m. The maximum area of impact of would be 30.2 km^2 (based on a radius of 3.1 km). This range is mainly determined by the sparker. If the sparker output is reduced, the range will be determined by the parametric SBP if used. The baseline characterisation showed that harbour porpoises are unlikely to be encountered in the Shannon Estuary and therefore the risk of a TTS would be negligible. Coastal densities of harbour porpoise (i.e. outside the Shannon Estuary) were predicted to be in the region of 0.037 to 0.262 animals per km^2 (Rogan et al., 2018) and, applying the highest estimate, the maximum number of animals affected would be eight. Any potential injury to animals can be compared against the population of the CIS MU of 62,517 animals and therefore even if this small number of individuals were to be affected this would constitute a very small proportion of the MU population (i.e. 0.01%).

The HF hearing group (which includes bottlenose dolphins) has minimal starting ranges to avoid TTS at <50 m (or approximately 300 m if using parametric SBP). The maximum area of impact of would be 0.283 km^2 (based on a radius of 0.3 km). Bottlenose dolphin are known to occur within the Shannon Estuary and the population of this species has an estimated size of 145 animals with an estimated density of 0.212 animals per km^2. Applying this estimate, there is considered to be low risk of encountering an animal(s) within the impacted area (i.e. 0.06 animals within 0.283 km^2 = 0.04% of the MU). Coastal densities of bottlenose dolphin (i.e. outside the Shannon Estuary) were predicted to be in the region of 0.160 to 1.161 animals per km^2 (Rogan et al., 2018) and, applying the more conservative estimate, the risk is still likely to be low (0.328 animals within 0.283 km^2 = 0.20% of the MU). Therefore, whilst any effects to individuals are compared against a relatively small population size and could therefore be meaningful in this respect, the risk is considered to be low due to the small impact ranges predicted.

For all hearing groups the TTS risk range for peak pressure is below 50 meters.

The large risk ranges for the VHF and PCW groups mean that extra care must be taken in establishing presence of these animal groups prior to starting a survey line.

Bottlenose dolphin is the main cetacean species of concern as it is known to be present within the SI works area. A pre-activity MMO search in accordance with best practice guidelines shall be undertaken prior to any geophysical survey activity being undertaken. The mitigation measures proposed (see below) will be effective over the maximum predicted injury range for HF cetaceans and therefore there will be no residual risk of injury to bottlenose dolphin individuals during the surveys.

As discussed in Section 3.4.4, harbour porpoise is rarely encountered in the vicinity of the SI works area. However, in accordance with the precautionary principle it is considered appropriate that harbour porpoises be included in all Marine Mammal Observer (MMO) activities and searches as part of mitigation measures to be implemented during the SI works.

The Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014) will be followed for the duration of the SI works. Sound producing activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Should there be a break in sound-producing activity for a period greater than 30 minutes sound-producing activity shall not recommence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO. If a break of greater than 30 minutes occurs during hours of darkness then sound-producing activities shall not re-start until daylight hours and only after the MMO has completed the effective visual monitoring in accordance with the DAHG Guidance (2014.). It is proposed that impacts on marine mammals will be reduced to the lowest possible risk to ensure there is no significant risk to marine mammals from impulsive noise.

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). These measures will be implemented in accordance with the strict protection requirements provided for under Article 12 to prevent any potential temporary disturbance of cetacean species within the Zone of Influence of the SI works during operations. The measures include the requirement to have an MMO on-board at all times during geophysical surveys. As required by the DAHG Guidelines (2014), survey activity will be planned to commence at the innermost part of the estuary 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.

The following is an extract from Section 4.3.4(ii) of the DAHG Guidelines (2014) of the measures to protect marine mammals.

Multibeam, single beam, side-scan sonar & sub-bottom profiler surveys (sound producing activities): applicable additional measures extracted from DAHG Guidelines (2014).

1. A qualified and experienced marine mammal observer (MMO) shall be appointed to monitor for marine mammals and to log all relevant events using standardised data forms.
2. Sound producing activities shall not commence if marine mammals are detected within a 500m radial distance of the sound source intended for use, i.e., within the Monitored Zone.

Pre-Start Monitoring

3. Sound producing activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring, as determined by the MMO, is not possible the sound-producing activities shall be postponed until effective visual monitoring is possible.
4. An agreed and clear on-site communication signal must be used between the MMO and the Works Superintendent as to whether the relevant activity may or may not proceed, or resume following a break (see below). It shall only proceed on positive confirmation with the MMO.
5. In waters up to 200m deep, the MMO shall conduct pre-start-up constant effort monitoring at least 30 minutes before the sound-producing activity is 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 by the MMO.
6. This prescribed Pre-Start Monitoring shall subsequently be followed by a Ramp-Up Procedure which should include continued monitoring by the MMO.

Ramp-Up Procedure

7. In commencing sound producing activities using the above equipment, the following Ramp-up Procedure (i.e., “soft-start”) must be used, including during any testing of acoustic sources, where the output peak sound pressure level from any source exceeds 170 dB L_P:
   a. A controlled build-up of acoustic energy output shall occur in consistent stages to provide a steady and gradual increase over the ramp-up period.
   b. Where the acoustic output measures outlined in steps (a) and (b) are not possible according to the operational parameters of any such equipment, the device shall be switched “on” and “off” in a consistent sequential manner over a period of 20 minutes prior to commencement of the full necessary output.
8. In all cases where a Ramp-Up Procedure is employed the delay between the end of ramp-up and the necessary full output must be minimised to prevent unnecessary high-level sound introduction into the environment.
9. 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 500m radial distance, of the sound source, i.e., within the Monitored Zone.

Breaks in sound output

10. 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.

Reporting

11. Full reporting on MMO operations and mitigation undertaken must be provided to the Regulatory Authority.

These measures will ensure that the SI works conform with the strict protections afforded to cetaceans (namely bottlenose dolphin and harbour porpoise). Therefore, in view of the current evidence base, it is considered that no derogation is required, and the proposed SI works will not offend the system of strict protection of cetaceans under Article 12 of the Habitats Directive.

3.5.3.2 Accidental Pollution Risk

The SI works will result in a slight increase in the number of vessels using the area for a temporary period. Although the increase is slight, this could in theory increase the risk of an accidental release of pollutants (e.g., fuels, oils, and lubricants) to the marine environment, which has the potential to result in toxic effects to Annex I benthic habitats and in turn on Annex II species that rely on these habitats for food.

Given the limited scale and temporary (lasting more than one day to less than a year) nature of the SI works, and that all vessels utilised will comply with the most up to date guidelines and professional standards[8] it is considered highly unlikely that there will be a pollution incident, e.g., accidental spills of small quantities of fuel. Therefore, it is considered that no derogation is required, and the proposed SI works will not offend the system of strict protection of cetaceans under Article 12 of the Habitats Directive.

3.5.3.3 Risk of collision

Vessel strikes are a known cause of mortality in marine mammals (Laist et al., 2001). Non-lethal collisions have also been documented (Laist et al., 2001; Van Waerebeek et al., 2007). Injuries from such collisions can be divided into two broad categories: blunt trauma from impact and lacerations from propellers. Injuries may result in individuals becoming vulnerable to secondary infections or predation.

It is expected that a maximum of two vessels would be operating at any one time within the survey area. Due to the nature of the surveys, the vessels would be stationary, or travelling at low speeds.

The Lower Shannon Estuary is a busy shipping area, and Moneypoint is one of six terminals within the Shannon Estuary that handle up to 1,000 ships carrying 12 million tons of cargo per annum (Clare County Council, 2023b). Moneypoint accepts on average six to eight shipments per year. Bottlenose dolphins are likely to be habituated to marine traffic, and the increase in vessel traffic as a result of the proposed surveys is very low and temporary. On this basis it is predicted that collisions between survey vessels and bottlenose dolphins and harbour porpoise will be extremely unlikely. No likely significant effects are predicted as a result of collision with survey vessels. Therefore, it is considered the proposed SI works do not present a collision risk and therefore will not offend the system of strict protection of cetaceans (in particular bottlenose dolphin) under Article 12 of the Habitats Directive in this regard.

3.5.4 Turtles

Data on turtle hearing is limited, however, turtles are adapted to detect sound in water and are known to detect sound at less than 1,000 Hz (Popper et al., 2014). While the majority of the survey equipment to be used operates across higher frequency range (see Section 2.2.6), injury and disturbance to turtles due to noise impacts is unlikely given the rarity of turtle occurrence. Due to the rarity of turtles within the Shannon Estuary, the limited scale and duration of the survey activities, it is concluded that there will be no significant disturbance, injury, or death of turtle species as a result of the SI works. There will be no deterioration or destruction of breeding sites or resting places.

While the DAHG (2014) guidelines do not specifically refer to turtles, the MMO will monitor for the presence of turtles. This precautionary measure will ensure that the works conform with the strict protections afforded to turtles, in the extremely unlikely event of turtles being present within the SI works area. Therefore, in view of the current evidence base, it is considered that no derogation is required, and the proposed SI works will not offend the system of strict protection of turtles under Article 12 of the Habitats Directive.

[8] For example: MARPOL, provisions of the Sea Pollution Act 1991 (as amended), National Maritime Oil/HNS Spill Contingency Plan (NMOSCP), Chemicals Act 2008 (No. 13 of 2008) and Chemicals (Amendment) Act 2010 (No. 32 of 2010), and associated Regulations and Marine Pollution Contingency Plan (MPCP).

4 SUMMARY & CONCLUSION

In summary, the potential for injury or disturbance to occur to Annex IV species as a result of the SI works is considered to be low. This risk will be further reduced by the implementation of the mitigation measures outlined in this document and the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014). It is concluded that the SI works will not give rise to significant impacts to species listed under Annex IV of the Habitats Directive.

Specifically, the SI works will not impact any of the Annex IV species ability to maintain its population on a long-term basis as a viable element of its natural habitats, nor will the natural range of the species be reduced or likely to be reduced for the foreseeable future as a result of the SI works. The habitat available to Annex IV species will also continue to be sufficiently large to maintain its populations on a long-term basis.

Following the assessment of the evidence base and available information on relevant Annex IV species, it is concluded that the SI works comply with the system of strict protections afforded by Article 12 of the Habitats Directive and Regulations 51 and 52 of the European Communities (Birds and Natural Habitats) Regulations 2011, as amended. This applies to the following Annex IV species:

- All bat species;
- Otter;
- All cetacean species; and
- All turtle species.

Based on the current available evidence, no derogation licence(s) are considered necessary for the SI works.

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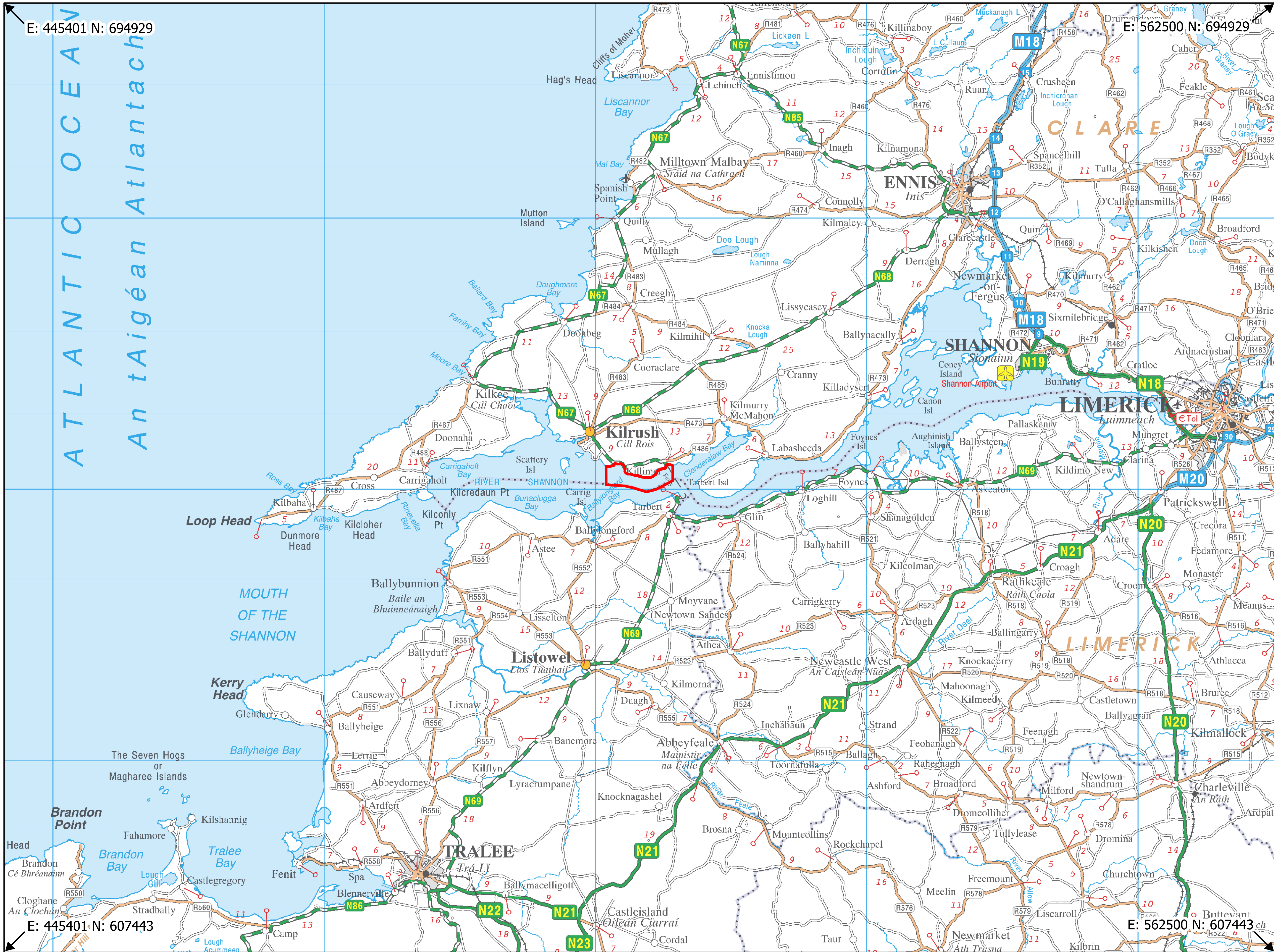
Appendix A
Drawings



Legend

Area A, 927.53ha

N

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22/09/2023

Map Projection:
Irish Transverse Mercator (ITM)

0 5 10 15 km

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	22/09/23	LICENCE APPLICATION	TO'R	D.H	M.H	D.H

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☐ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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Engineering and Major Projects is a division of ESB.

Energy for generations

CLIENT: ESB Generation & Trading

PROJECT: Moneypoint Hub Project Site Investigation

CONTRACT

PRODUCTION UNIT: Civil, Environmental & Renewable Engineering

DRAWING TITLE: Map 1: Location Map
Maritime Area Regulatory Authority (MARA)

DRAWN	PRODUCED	VERIFIED	APPROVED	APPROVAL DATE
T. O'Rourke	D. Hogan	M. Hogan	D. Hogan	22/09/2023

CLIENT REF.	Revision	NO. OF SHEETS	SIZE	SCALE
00-00	0	00-00	A3	1:350,000

DRAWING NUMBER QS-000339-01-D460-007-001-000

Legend

- Area A, 927.53ha
- Privately held Foreshore by ESB

N

NOTE:

Area A: 927.53ha Marine Licence Application Area

Area of privately held foreshore is 67.12ha as per Folio CE57420F & CE2029L

Area of privately held foreshore in the Marine environment: 40.59ha

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22/09/2023

Map Projection:
Irish Transverse Mercator (ITM)

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0 250 500 750 1,000 m

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	22/09/23	LICENCE APPLICATION	TO'R	D.H	M.H	D.H

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☐ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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CLIENT: ESB Generation & Trading

PRODUCTION UNIT: Civil, Environmental & Renewable Engineering

PROJECT: Moneypoint Hub Project Site Investigation

CONTRACT

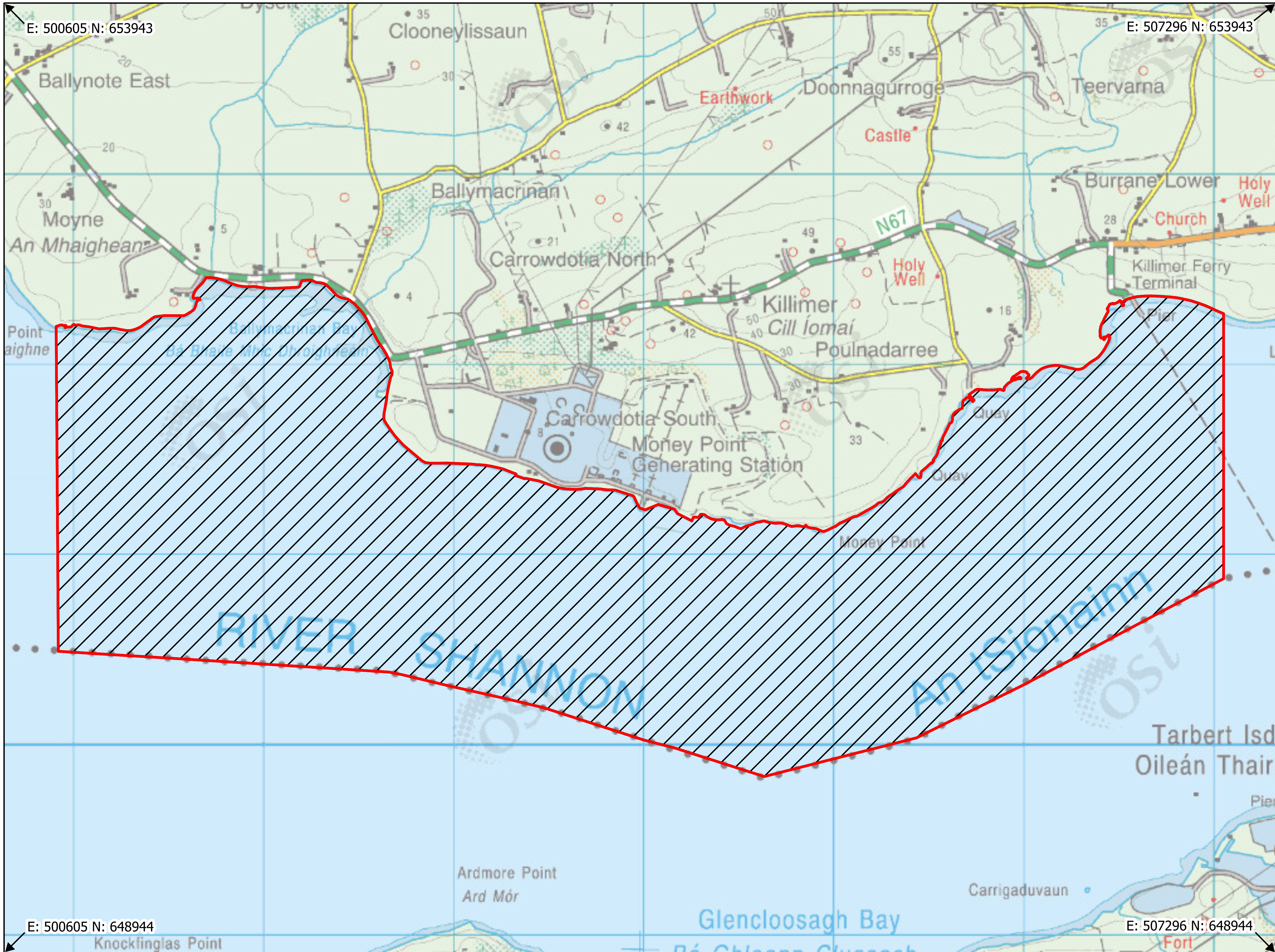
DRAWING TITLE:

Map 2: Licence Map
Maritime Area Regulatory Authority (MARA)

DRAWN	PRODUCED	VERIFIED	APPROVED	APPROVAL DATE
T. O'Rourke	D. Hogan	M. Hogan	D. Hogan	22/09/2023

CLIENT REF.	Revision	NO. OF SHEETS	SIZE	SCALE
00-00	0	00-00	A3	1:20,000

DRAWING NUMBER: QS-000339-01-D460-007-002-000



Legend

- Area A, 927.53ha
- Geophysical Surveys - 927.53ha

N

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ESB
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Co. Dublin, Ireland.
22/09/2023

Map Projection:
Irish Transverse Mercator (ITM)

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0 250 500 750 1,000 m

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	22/09/23	LICENCE APPLICATION	TO'R	D.H	M.H	D.H

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☐ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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Engineering and Major Projects is a division of ESB.

CLIENT: ESB Generation & Trading

PROJECT: Moneypoint Hub Project Site Investigation

CONTRACT

PRODUCTION UNIT: Civil, Environmental & Renewable Engineering

DRAWING TITLE: Map 3: Geophysical Survey Area Map
Maritime Area Regulatory Authority (MARA)

DRAWN	PRODUCED	VERIFIED	APPROVED	APPROVAL DATE
T. O'Rourke	D. Hogan	M. Hogan	D. Hogan	22/09/2023

CLIENT REF.	Revision	NO. OF SHEETS	SIZE	SCALE
00-00	0	00-00	A3	1:20,000

DRAWING NUMBER: QS-000339-01-D460-007-003-000

Legend

- Area A, 927.53ha
- Privately held Foreshore by ESB
- Grab Samples (20 in number) / Vibrocores (25 in number)
- ADCP - Indicative Location
- Underwater Noise Recorder - Indicative Location
- Borehole - Indicative Location (20 in number)

N

NOTE:

Points illustrated on map are are indicative only. The Marine Geophysical Surveys will be used to microsite the exact locations of geotechnical boreholes, environmental grab samples and vibrocores.

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22/09/2023

Map Projection:
Irish Transverse Mercator (ITM)

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0 100 200 300 400 m

0	22/09/23	LICENCE APPLICATION	TO'R	D.H	M.H	D.H
REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

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CLIENT: ESB Generation & Trading

PROJECT: Moneypoint Hub Project Site Investigation

CONTRACT

PRODUCTION UNIT: Civil, Environmental & Renewable Engineering

DRAWING TITLE: Map 4: Site Investigation Map
Maritime Area Regulatory Authority (MARA)

DRAWN	PRODUCED	VERIFIED	APPROVED	APPROVAL DATE
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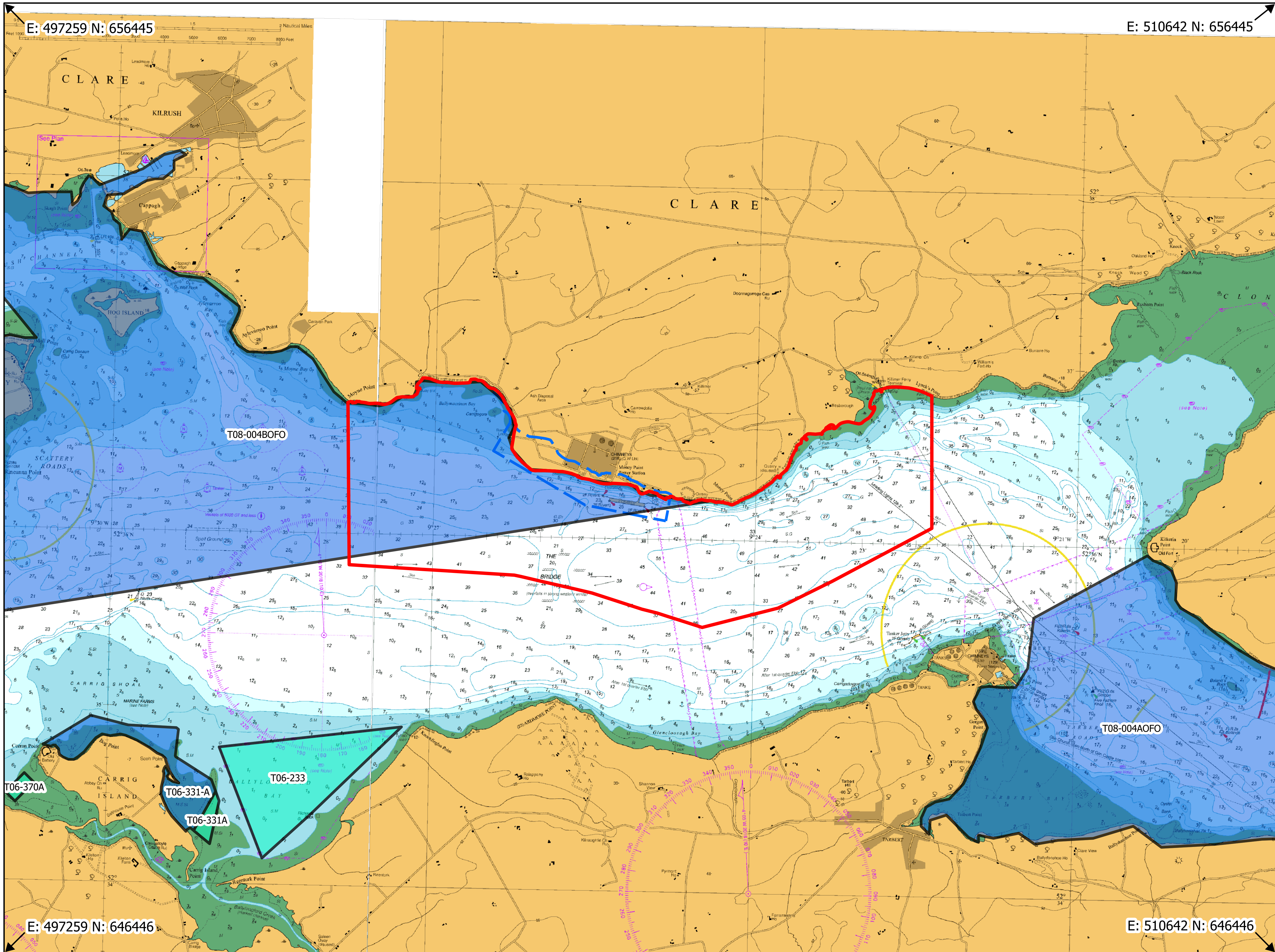
DRAWING NUMBER: QS-000339-01-D460-007-004-000



Legend

- Area A, 927.53ha
- Aquaculture Site
- Fishery Order

N

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21/11/2023

Map Projection:
Irish Transverse Mercator (ITM)

Not to be used for Navigation

0 0.5 1 1.5 2 km

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	21/11/23	LICENCE APPLICATION	TO'R	D.H	M.H	D.H

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☐ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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CLIENT: ESB Generation & Trading

PROJECT: Moneypoint Hub Project Site Investigation

CONTRACT

PRODUCTION UNIT: Civil, Environmental & Renewable Engineering

DRAWING TITLE: Map 5: Licenced Aquaculture Sites Map
Maritime Area Regulatory Authority (MARA)

DRAWN	PRODUCED	VERIFIED	APPROVED	APPROVAL DATE
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00-00	0	00-00	A3	1:40,000

DRAWING NUMBER: QS-000339-01-D460-007-005-000

Appendix B
Subsea Noise Technical Report

C2 - Restricted

ESB MONEYPOINT HUB PROJECT

SI Works – Subsea Noise Technical Report

IE000210RP0028
F01
23 November 2023

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D01	Internal Draft	RSP	JM	GMcE	03 November 2023
A01	Draft for Client Review	RSP	JM	GMcE	08 November 2023
F01	Final	RSP	JM	GMcE	23 November 2023

Approval for issue

GMcE	23 November 2023

Prepared by:

RPS

Prepared for:

ESB

Dublin | Cork | Galway | Sligo
rpsgroup.com

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RPS Consulting Engineers Limited, registered in Ireland No. 161581
RPS Planning & Environment Limited, registered in Ireland No. 160191
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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GLOSSARY

Term	Meaning
Decibel (dB)	A customary scale most commonly used (in various ways) 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), and 20 micro-Pascals is the standard for airborne sound. The dB symbol is 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 (minutes to few hours) 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 (L_E)	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 “SEL” 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 time 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

ACRONYMS

Term	Meaning
ADD	Acoustic Deterrent Device
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*
NMFS	National Marine Fisheries Service
OW/OCW	Otariid pinnipeds/Other Carnivores in water (refers to the same weighting and animal groups)
PTS	Permanent Threshold Shift
PW/PCW	Phocid pinnipeds
RMS	Root Mean Square
L_E	Sound Exposure Level, [dB]
SPL	Sound Pressure Level, [dB]
L_P	Peak Pressure Level, [dB]
TTS	Temporary Threshold Shift
PTS	Permanent Threshold Shift

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)
µPa	Micro Pascal
Pa	Pascal (Pressure)
psu	Practical Salinity Units (parts per thousand of equivalent salt in seawater)
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

1.1 Overview

This Subsea Noise Technical Report presents the results of a desktop study considering the potential for Momentary, Brief and Temporary effects[1] of underwater noise on the marine environment from the site investigation works, which includes a geophysical survey to map the application area (hereafter referred to as "the Project"). The site forms a single contiguous area of approximately 9 km², or a ~1.3 km wide band of 6 km length along the north edge of the Shannon Estuary, centred on the Moneypoint power station, 5 km south-east of Kilrush, Co. Clare.

Sound is readily transmitted into the underwater environment and there is potential for the sound emissions from anthropogenic sources to adversely affect marine mammals and fish. At close ranges from a noise source with high noise levels, permanent or brief 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 Project on the surrounding marine environment based on the Southall et al. 2019 and Popper et al. 2014 framework for assessing impact from noise on marine mammals and fishes.

Consequently, the primary purpose of the subsea noise assessment is to predict the likely range of onset of injury as given in the relevant guidance (Temporary Threshold Shift) and ranges to potential behavioural effects due to anthropogenic noise as a result of the Project.

1.2 Statement of Authority

This report has been prepared by RPS on behalf of the ESB. The technical competence of the authors is outlined below:

Rasmus Sloth Pedersen is a Senior Project Scientist with RPS. He holds a master's degree in biology, biosonar and marine mammal hearing from University of Southern Denmark. Rasmus has over 10 years' experience as a marine biologist and over 8 years' experience with underwater noise modelling and marine noise impact assessments. Rasmus 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.

John Mahon 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. John has 19 years' experience in environmental projects including planning applications and environmental impact assessments for a wide range of strategic infrastructure projects.

Gareth McElhinney 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 Masters in Business Studies from the Irish Management Institute/ UCC. Gareth is also a Chartered Engineer. 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] Effects are defined in accordance with the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (2022), Table 3.4 Description of Effects, pp.50-52.

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 1986; NIOSH 1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions. Also included are sounds under 1 second in duration with a weighted kurtosis over 40 (see note below*).
- Non-impulsive (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.

* 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 (section 2.2 of document). 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[2] of 40 (Martin, et al., 2020). 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 2019 framework limits are based on the narrower definition of impulsive as given above under "Impulse sounds".

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.; Popper, et al., 2014).

2.2 Injury to Marine mammals

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. This assessment has added a fifth zone, the "zone of temporary hearing loss". The five zones are as follows:

- **The zone of audibility**: this is the area within which the animal can detect the sound. Audibility itself does not implicitly mean that the sound will affect the marine mammal.
- **The zone of masking**: this is defined as the area within which noise 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 marine mammals detect sound in relation to masking levels (for example, humans can hear tones well below the numeric value of the overall noise level).
- **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 audibility does not necessarily evoke a reaction. For most species there is very little data on response, but for species like harbour porpoise there exist 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).

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

- **The zone of temporary hearing loss**: The area where the sound level is high enough to cause the auditory system to lose sensitivity for minutes to few hours, causing loss of "acoustic habitat": the volume of water that can be sensed acoustically by the animal. This effect is abbreviated "TTS".
- **The zone of injury / permanent hearing loss**: this is the area where the sound level is high enough to cause tissue damage in the ear. This is usually 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.

  Note that guidance from the Irish regulatory body classifies TTS (hearing loss persisting minutes to few hours) as causing injury, given the potential secondary effects of impacted hearing sensitivity.

For this study, it is the **zones of temporary hearing loss (area within range to TTS risk)**[3] 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.

The zone of injury in this study is classified as the distance over which a marine mammal will likely suffer TTS. Injury thresholds are based on a dual criteria approach using both un-weighted LP (maximal instantaneous SPL) and marine mammal hearing weighted LE. 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 truncates*) 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; air hearing 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 have therefore been used in this study and are shown in Figure 2.1. It should be noted that not all the above categories of marine mammal will be present in the Project area, but criteria are presented in this report for completeness.

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

Note that in Ireland the TTS limits are the main criteria, with PTS limits given for completeness.

[3] Department of Arts, Heritage and the Gaeltacht (2014) p. 11 establishes TTS as an injury.

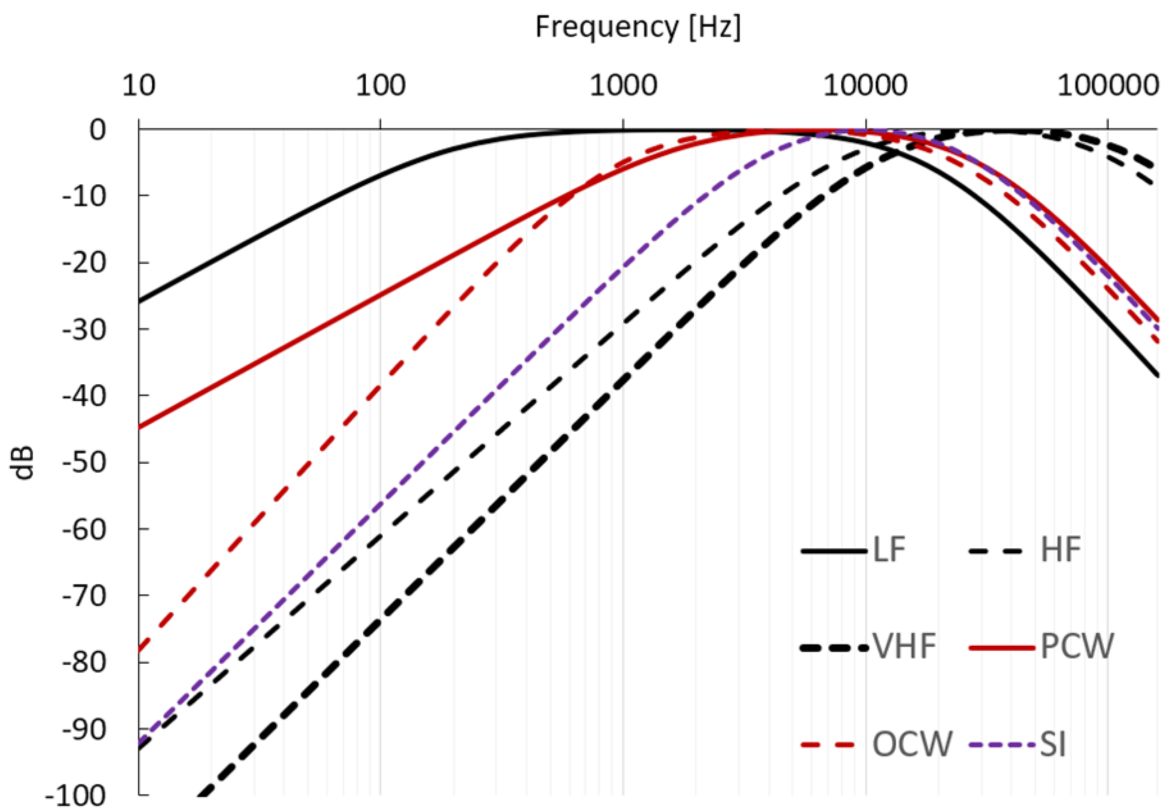

Figure 2.1 **Hearing weighting functions for pinnipeds, cetaceans and sirenians (NMFS, 2018; Southall et al. 2019)**

Table 2.1 **PTS and TTS onset acoustic thresholds (Southall et al., 2019; Tables 6 and 7). TTS criteria in bold**

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

These updated marine mammal injury criteria were published in March 2019 (Southall, et al.). 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 PTS and TTS onset acoustic thresholds (Southall et al., 2019; Tables 6 and 7). TTS criteria in bold

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

2.3 Disturbance to Marine Mammals

Disturbance thresholds for marine mammals are summarised in Table 2.3. These are based on "Level B harassment" of NMFS (National Marine Fisheries Service, 2005). 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.

Table 2.3 Disturbance Criteria for Marine Mammals

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

2.4 Injury and Disturbance to Fish and Sea Turtles

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. Peak pressure level (L_P) and exposure level (L_E) 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, 2011) 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:

1. The criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011). 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 brief 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. Again, the threshold is implemented as either single impulse LE or 1 second LE, whichever is greater.
2. 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 LP, the 10th percentile level for behavioural response was 158 dB L_P, given the large variations in the data, this has been rounded to 160 dB L_P as the behavioural limit for fishes for impulsive noise, given the already considerable variation in the underlying data.

Table 2.4 Criteria for onset of injury to fish and sea turtles due to impulsive noise

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)	L_E	219[1]	216[1]	186[1]	150[3]
	L_P	213[1]	213[1]	193[2]	189[2]
Fish: where swim bladder is not involved in hearing (particle motion detection)	L_E	210[1]	203[1]	186[1]	150[3]
	L_P	207[1]	207[1]	193[2]	189[2]
Fish: where swim bladder is involved in hearing (primarily pressure detection)	L_E	207[1]	203[1]	186	150[3]
	L_P	207[1]	207[1]	193[2]	189[2]
Sea turtles	L_E	210[1]	(*Near*) High (*Intermediate*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-
Eggs and larvae	L_E	210[1]	(*Near*) Moderate (*Intermediate*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-

1 (Popper et al. 2014)

2 (Worcester, 2006)

3 (WSDOT, 2011)

Where Popper et al. 2014 present limits as ">" 207 or ">>" 186, the analysis ignores the "greater than" and uses the threshold level as given.

Relevant limits for fishes relating to PTS, TTS, and behaviour are given in the Table 2.5. Note that for the behaviour limit the impulsive limit has been used as the basis for the continuous noise limit, in the absence of better evidence.

Table 2.5 Criteria for fish from non-impulsive noise from Popper et al. 2014

Type of animal	Unit	Mortality and potential mortal injury	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
All fishes	L_E	-	222	210	150 [SPL]*

*Based on the impulsive criteria.

3 SITE, SURVEY METHOD, AND ENVIRONMENT

3.1 Site Location

Moneypoint is located on the northern shore of the Shannon Estuary in Co. Clare, approximately 3 km west of Killimer and 6 km south-east of Kilrush (Figure 3.1). The site was acquired by ESB in the late-1970s to develop a coal fired power plant as part of its strategy to diversify from oil dependent electricity generation. It consists of both a terrestrial and marine area; along with the interface between the two.

The site investigation works form a single contiguous area of approximately 9 km², or a ~1.3 km wide band of 6 km length along the north edge of the Shannon Estuary, centred on the Moneypoint power station (see Figure 3.2).

The sediment is mainly sand to fine/medium gravel, and depths are <60 m (assuming high tide).

Figure 3.1 Location of Moneypoint Generating Station Site in the context of the Shannon Estuary, Co. Clare

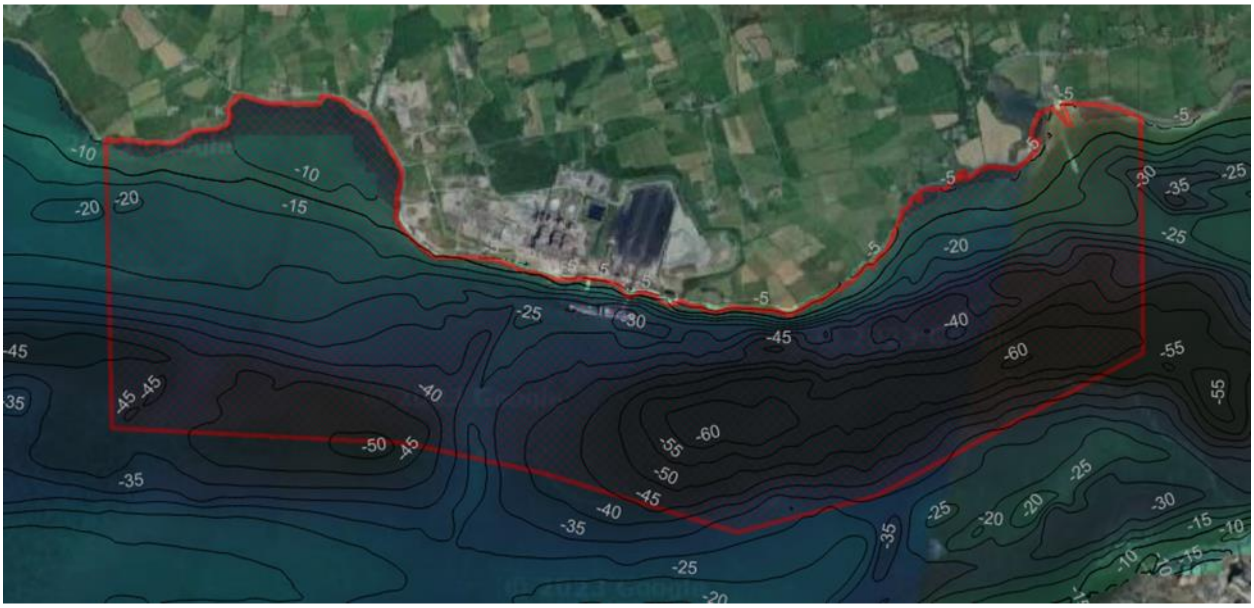

Figure 3.2 Site Investigation Survey Area

3.2 Survey Method

3.2.1 Overview

For a full description of the site investigation works (which includes both geophysical and geotechnical marine site investigations) please refer to Section 2 of the accompanying Assessment of Impact on the Maritime Usage (AIMU) Report.

In summary, the site will be surveyed by a small to medium vessel (15-80 m length, a 70 m vessel forming the basis of this assessment) with various geophysical survey equipment (see Table 4.1 in Section 4), with survey lines to cover the total area. The density of survey lines will depend on the local depth, as the “width of detection” (swath) is a constant angle, thus greater depths will mean that survey lines are spread further apart.

Details on the expected equipment to be used (or representative equipment) can be found in Section 4, Source Noise Levels.

The vessel is assumed to move at 4 knots during surveying (2 m/s). This speed affects the time a stationary receiver is exposed to the survey, and hence a slower speed is precautionary. The actual speed will likely be over 4 knots (> 2 m/s).

Survey line layouts as given in Section 3.2.2 are designed to be representative of the acoustic impact of the survey, not the actual survey layout. The acoustic impact is mainly affected by the survey speed and the total time spent in a given area, not the precise line layout.

3.2.2 Survey Layout Example

For the survey a line spacing of 25 m has been assumed as this is the largest line spacing for the magnetometer, and smaller than any required line spacing for the geophysical equipment. Even if the magnetometer is not equipped/active for all vessels, this spacing will be conservative as it is at least as dense as required for the remaining survey equipment. Where the magnetometer is not in use the actual line spacing will be 2-5 times the local depth, meaning that it is more practical to run survey lines along the shore (consistent depths means consistent swath width). See Figure 3.3 for example of this as well as the assumed 25 m survey grid.

At a speed of 4 knots (2 m/s) the longest transect will be approximately 50 minutes (6200 m / 2.06 m/s / 60 sec/min = 50 min).

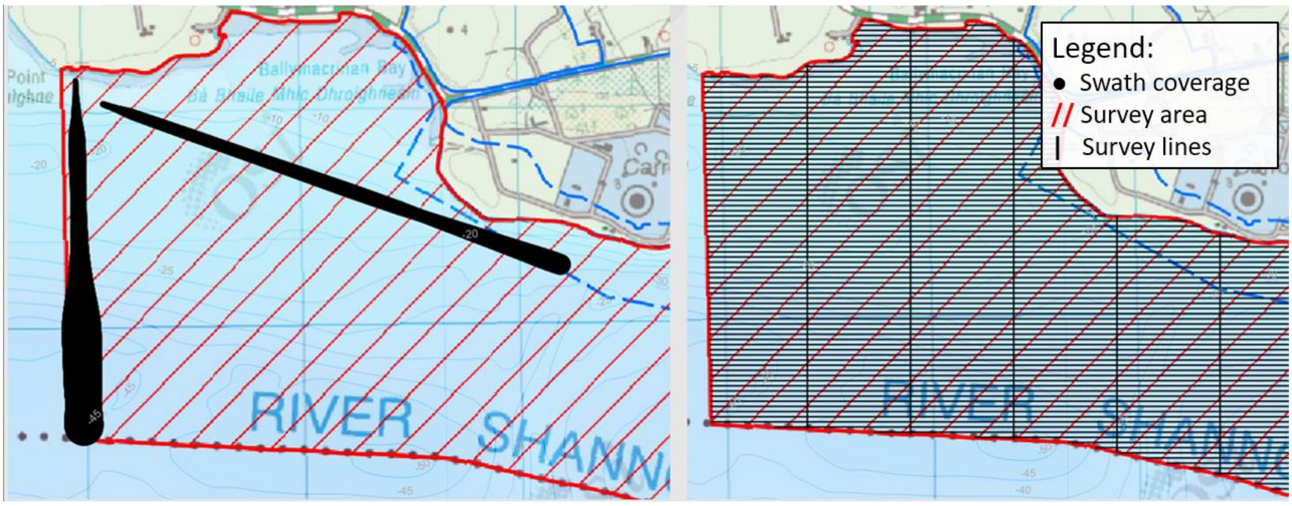

Figure 3.3 Left: Example transects showing swath width (black areas) as an effect of depth. Right: Survey lines given 25 m spacing, and validation transects at 500 m spacing

3.3 Environment

3.3.1 Water Properties

Water properties were determined from historical data for the area. Where a range of values are expected, the value leading to the lowest transmission loss, highest received level, was used, resulting in a more conservative assessment. This use of values leading to lowest transmission loss (highest temperature, lowest salinity, highest tide) also covers seasonal variation at the site.

- Temperature: 20 degrees – Based on maximal temperature given by Met Eireann for Irish marine waters (16 degrees)[4] along with data from seatemperature.net for water temperatures near Shannon town. A higher temperature is more conservative.
- Salinity: Set at 30 psu - lowest, most conservative, value observed 2007-2011 (INFOMAR, 2012).
- Soundspeed profile: Assumed uniform given high mixing as a result of tidal flows. A uniform soundspeed profile is conservative compared to the likely downward refracting soundspeed profiles seen during summer months (higher temperature in the surface leads to higher soundspeeds). No significant halocline is expected, due to the relative proximity to the sea, and distance to the River Shannon outflow into the estuary.

3.3.2 Sediment Properties

Sediment properties are taken from EMODnet[5] "Folk 7-class Classification" and nautical charts[6]. A sediment model (Ainslie, 2010) was used to derive the acoustic properties of the sediments from the grain size. An "acoustically harder" sediment (higher density and soundspeed) will be conservative, in that it will improve sound propagation in the water column. Therefore, while it is expected to find finer, acoustically softer sediments present, these will have higher transmission losses, and will thus be covered by the more conservative assumption of the coarser sediment.

Table 3.1 Sediment properties

Sediment type (Folk 7)	Density [kg/m³]	Soundspeed [m/s]	Grain size [mm] (nominal)
Coarse substrate	2595	2034	3.5

[4] https://www.met.ie/climate/average-monthly-sea-temperature-at-malin-head/

[5] https://emodnet.ec.europa.eu/ sediment model "Folk 7-class" classification.

[6] https://fishing-app.gpsnauticalcharts.com/i-boating-fishing-web-app/fishing-marine-charts-navigation.html

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 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 this imagined acoustic centre point. Therefore, the stated sound pressure level at 1 m does not occur for large sources. For such large source, 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 the subsea noise assessment study are summarised in Table 4.1.

Source levels for the active equipment were combined to produce a “combined” source that represents the survey vessel’s sound signature while actively surveying during the survey (see Figure 4.1 and Figure 4.2).

Note that source levels vary depending on the location of the survey due to the ping rate, and therefore the SPL of the source, varies with the local depth.

Multibeam echosounders have been included in the assessment even though their main frequencies lie well above the hearing range of the VHF hearing group. This is because, given the way the signals are produced some spectral leakage (energy “leakage” into other frequencies due to the acoustic properties of the transducer) will occur, resulting in significant acoustic energy to frequencies audible to both dolphins and porpoises.

As sonars and echosounder have narrow beams and therefore “sweep” through the water body, they are harder to model for expected received level. For the assessment the energy in the beam has been converted to an equivalent spherical source (of lower spherical SPL than the in-beam level) to ensure that a randomly positioned receiver would receive the same energy. Note that while extremely narrow beams (0.1-1 degree) are often stated for sonars and echosounders, this is the width of the beam where the received level drops by a set amount, usually 3 dB (if stated at all). There is a significant amount of acoustic energy outside the beam, and this has been included in the assessment.

The parametric sub-bottom profilers have quite narrow beams directed vertically down, with levels attenuating rapidly as the angle away from vertical increases. For exposure modelling [dB L_E], the source level at an angle corresponding to the specular reflection of the sediment, 47 degrees from vertical[7], has been used for the assessment. This means that for the deeper sites (60 m) there will be a cone of diameter approximately 65 m radius at the sediment (depth of 60 m) which will underpredict the impact for animals. As this zone is a cone, the radius at half depth, is half as big, approximately 33 m at 30 m depth. Risk ranges tend to be larger than 65 m, and animals will be able to hear the vessel approaching with time to evade this cone.

Given that a parametric system introduces a significant increase in sound levels around the most sensitive region of the HF hearing group, compared with the remaining systems, it was chosen to split the assessment into two parts. This assessment presents (a) scenario with no parametric system active and (b) scenario with a parametric system active. This approach provides a better insight into the effect of including a parametric system, while also covering the scenario where no such system is used.

For peak pressure level [dB L_P] propagation modelling the actual directivity of common SBPs has been used to model the peak pressures at range.

[7] There is still reflection at steeper angles, but also a large loss to the sediment, meaning rapid attenuation, with increasing number of surface-bottom reflections.

Table 4.1 Summary of Noise Sources and Activities Included in the Subsea Noise Assessment

Equipment	Source level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessel (based on "Fugro Discovery", IMO 9152882)	165 dB SPL	10-2,500 Hz	(Wittekind, 2014; Simard, et al., 2016; Heitmeyer, 2001)	Non-impulsive
Multibeam echosounder Based on: "Teledyne Reson Seabat T50-R", "Kongsberg GeoAcoustics GeoSwath Plus interferometric" & "R2 Sonic 2024"	182 dB SPL (ping rate dependent, equivalent spherical level)	200,000 Hz & 250,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer.	Impulsive
Side scan sonar Based on: "Kongsberg Geoacoustic 160", "Edgetech 4200", "C-Max CM2 system" & "Klein Hydro Scan"	170 dB SPL (ping rate dependent, equivalent spherical level)	300,000 – 445,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer.	Impulsive
Sub-bottom profiler 1 Based on: "Edgetech 3100, "Edgetech 3300, "Geopulse 5430A, "400 Joule Generic sparker", "350 Joule Generic Boomer"	188 dB SPL (ping rate dependent, off-axis level) 220 dB Lp (on-axis)	600 – 12,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer as well as generic models for Sparker and Boomer.	Impulsive
Sub-bottom profiler 2 Based on: "Sub-bottom profiler 1" & "Innomar Parametric (dual frequency)"	197 dB SPL (ping rate dependent, off-axis level) 247 dB Lp (on-axis)	1000 – 4,000 Hz & 85,000 – 115,000 Hz	Source levels based on von Hann windowed FM or CW pulses at max SPL as given by manufacturer.	Impulsive
Vibro-coring / drilling	195 dB SPL	10 – 3,000 Hz	(Bureau of Ocean Energy Management) (Center for Marine Acoustics, 2023)	Non-impulsive

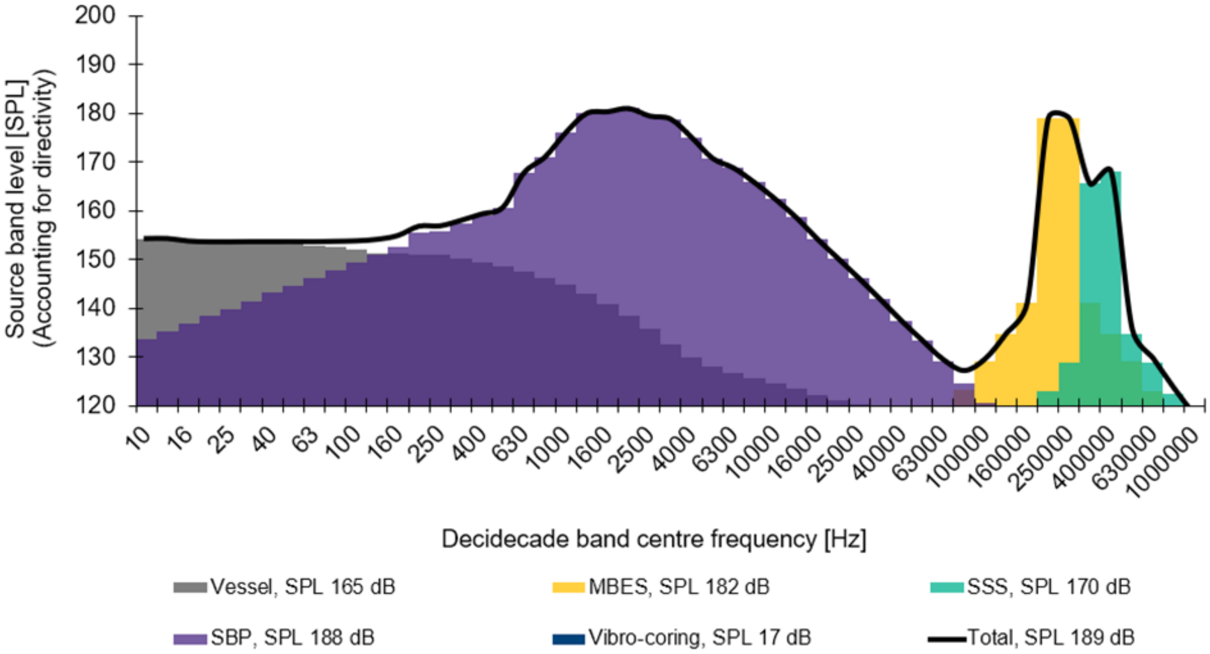

Figure 4.1 **Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey without a parametric SBP (SBP 2 in Table 4.1)**

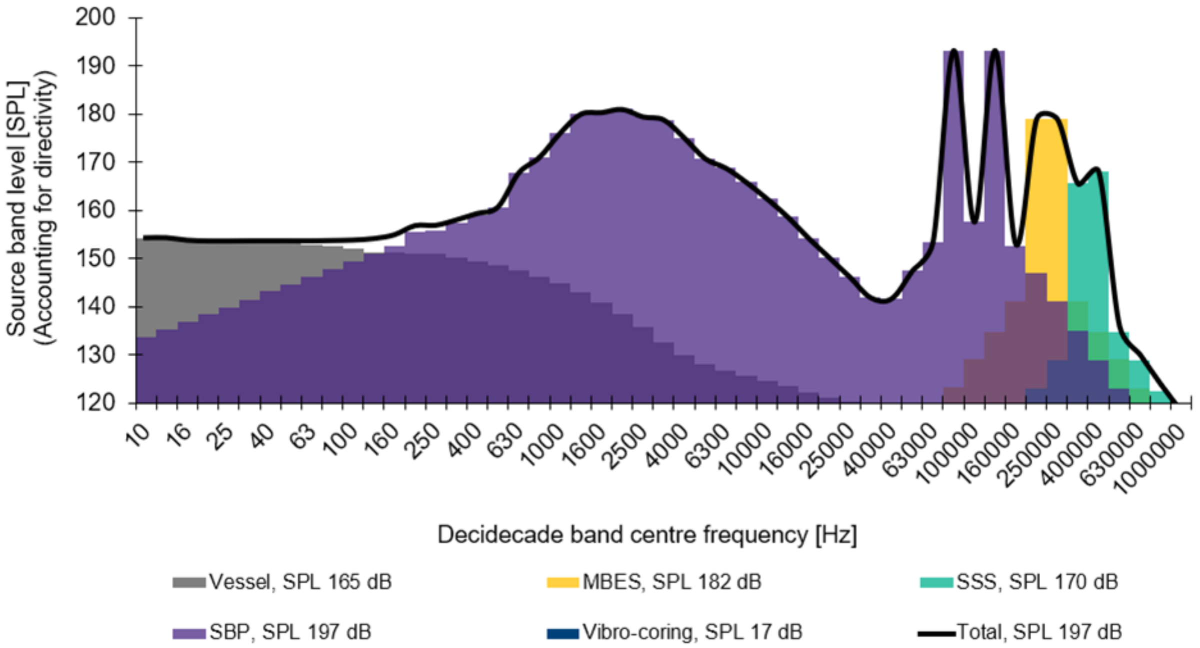

Figure 4.2 **Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey with a parametric SBP (SBP 2 in Table 4.1)**

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 $10\times\log_{10}$(range) or $20\times\log_{10}$(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.

For this project a semi-empirical model ("Roger's" model) was used for calculating transmission losses of SPL and L_E, measures related to acoustic energy, where modelling of peak pressure levels (L_P) was done with full waveform propagation in dBSea's ray tracing algorithm (dBSeaRay).

5.1 Semi-empirical models

For simpler scenarios where the sediment is relatively uniform and mostly flat or where great detail in modelling is not warranted, due to uncertainty in model input or where the source level is relatively low compared to the receiver sensitivity, 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 the "Roger's" model (Rogers, 1981) has been used. This produces very similar output to the also regularly applied "Weston" model (Weston, 1971), but Roger's produces a smoother transition between spherical/cylindrical spreading, mode-stripping and single mode regions of the loss and would normally be preferred unless comparing to earlier work done using the Weston model. Both these models are compared to measurements in the papers describing them and are both capable of accurate modelling in acoustically simpler scenarios[8]. A comparison between Roger's and Weston's model has been included in this report for a 30 m deep scenario to show the similarities in the transmission losses they predict. The Roger's model is, however, preferred, as it is more conservative for lower frequencies, as it does not have "sharp" steps between different propagation regions.

These semi-empirical models will tend to underestimate the transmission losses (leading to estimated greater than actual impact) due primarily to the omission of surface roughness, wind effects and shear waves in the sediment.

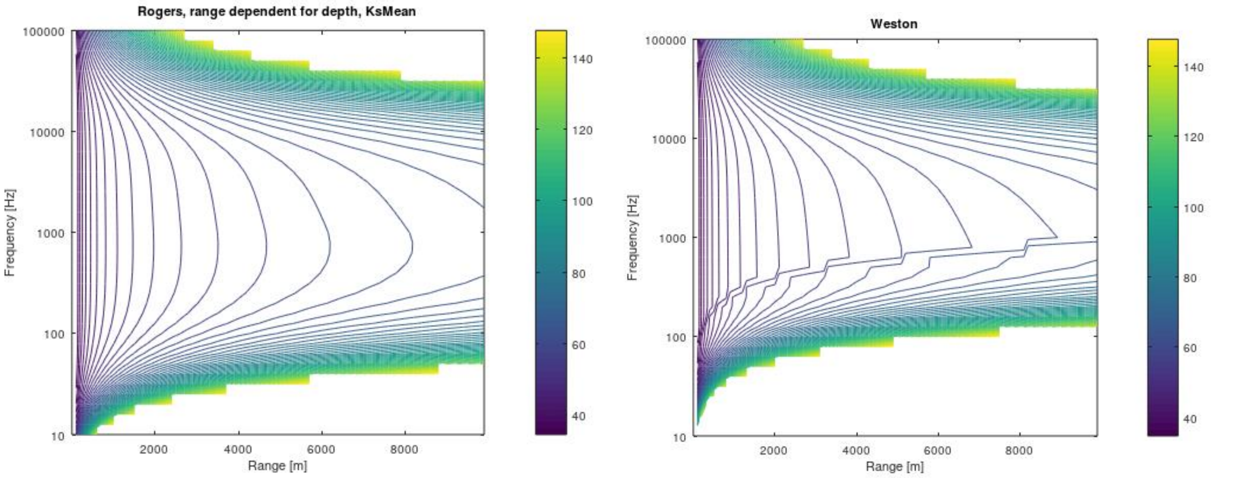

Figure 5.1 Comparison of two semi-empirical models over a sandy bottom at 30 m depth. Transmission loss in dB versus range and frequency

[8] Simpler meaning shallow in relation to the wavelengths and with no significant sound speed gradient in the water column.

5.2 Analytical models

For the impulsive sources dBSea software's ray tracing solver dBSeaRay has been used as this accounts for the full waveform propagation of the impulsive. This means including surface and bottom reflections as well as time-of-arrival in the calculations, as these are important to include to correctly estimate the effects of constructive and destructive interference. dBSea solvers are validated against a range of opensource solvers for so-called "standard scenarios" that have agreed solutions[9].

5.3 Exposure Calculations (dB L_E)

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, L_E, weighted for marine mammals, and unweighted for fish. For ease of implementation sources have generally been converted to an SPL source level. Converting to L_E from SPL or from a number of events is relatively simple:

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

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

Or where it is inappropriate to convert to SPL by relating to the number of events as:

$$L_{E,n\ events} = L_{E,single\ event} + 10 \cdot Log_{10}(n) \quad (2)$$

As a marine mammal swims away from the sound source, the noise it experiences will become progressively more attenuated; the cumulative, fleeing L_E is derived by logarithmically adding the L_E to which the mammal is exposed as it travels away from the source. This calculation was used to estimate the approximate minimum start distance for a marine mammal in order for it to be exposed to sufficient sound energy to result in the onset of potential injury or 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 limit). 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 fairly constant relative speed. The real-world situation is more complex, and the animal is likely to move in a more complex manner.

Reported swim speeds are summarised in Table 5 1 along with the source papers for the assumptions.

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

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	Group 1 fish	1.0	Sims, 2000
All other fish groups	All fish groups	0.5	Popper *et al.,* 2014

[9] https://www.dbsea.co.uk/validation/

6 RESULTS AND ASSESSMENT

Tables of various risk measures are presented in this section. The values given represent a "reasonable worst-case scenario" where the upper 90th percentile value from the results is used, meaning 90% of the results have a smaller risk range than the stated.

Main assumptions for the validity of the results:

- Final equipment configuration is not louder at any decidecade band nor broadband than the presented equipment (Table 4.1, Figure 4.1 and Figure 4.2).
- All ranges are horizontal ranges. Therefore, at a risk range of 50 m, and a depth of 70 m an animal could be >50 m away (deep below the equipment) but be within the beam of a transducer thus experiencing more exposure than at 50 m horizontal range.

Six types of results are presented to inform this assessment:

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 momentary term risk and for comparison with other studies. This assumes a stationary animal (during the 1-second exposure).

2. **"10-minute exposure risk range":**

   This is the risk range for a stationary animal. Over this duration the vessel will have moved 1200 m (at 4 knots). This represents a single survey line going in the north-south direction, the shortest survey line likely.

3. **"50-minute exposure risk range":**

   This is the risk range for a stationary animal. Over this duration the vessel will have moved 6200 m (at 4 knots). This represents a single survey line running east-west, the longest likely single survey line.

4. **"Minimal starting range for a fleeing animal":**

   The minimal range a fleeing animal needs to start fleeing from to avoid being exposed to noise exceeding its TTS limit. All these are for animals moving in a straight line away from the source at a constant speed of 1.5 m/s. This metric forms the main basis of the assessment.

5. **"Peak level risk range":**

   The range of acute risk of impact from peak pressure levels associated with the impulsive sources. This measure is not included in tables as the range to the lowest TTS limit (fish 186 dB L_P) was <50 m (all other groups are shorter).

6. **"Behavioural response range":**

   The range at which the behavioural limit for the marine mammals (160 dB SPL) or the fishes (150 dB SPL) behavioural limits for impulsive noise is exceeded.

6.1 TTS Risk Ranges

The following summarises risks from cumulative noise, split into hearing groups, exposure durations and stationary vs fleeing receiver and risk from peak pressure level.

The assessment is split into two "combined sources":

- **Combined Source A:**

  Survey vessel, multi-beam echosounder, side-scan sonar, sub-bottom profiler excluding parametric models (Figure 4.1).

- **Combined Source B:**

  Same as "A" above, but with the addition of a parametric sub-bottom profiler (Figure 4.2).

6.2 Combined Source A, Without Parametric Sub-Bottom Profiler

This includes all sources given in Table 4.1 except the parametric sub-bottom profiler and the vibrocore. The results are presented in Table 6.1.

Table 6.1 Summary of risk ranges from noise exposure, L_E. All are risk ranges to TTS limits

Condition	LF	HF	VHF	PCW	OCW	Fish
1 second exposure TTS risk [m]	20	0	90	5	0	0
10-minute exposure TTS risk [m]	1700	200	2900	970	70	13
50-minute exposure TTS risk [m]	3900	580	5700	2400	210	50
Minimal starting range to avoid TTS [m] for fleeing animal	2000	41	3100	950	2.5	1
Peak [dB L_P] range [m]	<20	<20	<20	<20	<20	<50
Behavioural response range [m]	510	510	510	510	510	2000

6.3 Combined Source B, With Parametric Sub-Bottom Profiler

The parametric SBP introduces additional energy near the region of most sensitivity of the HF and VHF weighting (dolphins and porpoises). Risk ranges for porpoises are not affected as much by the additional energy at these higher frequencies as the risk ranges are too large already, but the HF group will see increased risk ranges. The results are presented in Table 6.2 with changes from Table 6.1 highlighted.

Table 6.2 Summary of risk ranges from noise exposure, L_E. All are risk ranges to TTS limits

Condition	LF	HF	VHF	PCW	OCW	Fish
1 second exposure TTS risk [m]	20	33	430	5	0	0
10-minute exposure TTS risk [m]	1700	500	2900	970	70	43
50-minute exposure TTS risk [m]	3900	770	5700	2400	210	100
Minimal starting range to avoid TTS [m] for fleeing animal	2000	280	3100	950	2.5	5
Peak [dB L_P] range [m]	<20	<20	<20	<20	<20	<50
Behavioural response range [m]	510	510	510	510	510	2000

6.4 Vibro-coring and Drilling

The results for the Vibro-coring and Drilling modelling are presented in Table 6.3.

Table 6.3 Summary of risk ranges from noise exposure, L_E. All are risk ranges to TTS limits

Condition	LF	HF	VHF	PCW	OCW	Fish
1 second exposure TTS risk [m]	0	0	0	0	0	0
10-minute exposure TTS risk [m]	830	20	510	270	10	0
50-minute exposure TTS risk [m]	2200	70	1400	790	50	20
Minimal starting range to avoid TTS [m] for fleeing animal	740	0	300	75	0	0
Behavioural response range [km]	15	15	15	15	15	1

7 SUMMARY AND CONCLUSIONS

At shorter ranges < 500-1000 m the inclusion of a parametric SBP in the combined source determines the risk ranges for TTS, while without a parametric SBP or at longer ranges the sparker determines the risk ranges for TTS.

Risk ranges for the Vibro-coring (covering drilling as well) are all at or below 300 m for species expected to be present (but >700 m for the LF hearing group).

The following focuses on the three hearing groups relating to Harbour porpoises (VHF), Seals (PCW) and Common and Bottlenose dolphins (HF). The remaining hearing groups are either assumed not present (LF) or have risk ranges that are considered too low to be significant (OCW and Fish). The focus is on minimal starting range for a fleeing animal to avoid TTS, with notes on what equipment determines this range (i.e., what equipment, if quieter, would reduce the range).

For porpoises (VHF hearing group) the minimal starting range to avoid TTS risk is 3100 m. This range is mainly determined by the sparker. If the sparker output is reduced, the range will be determined by the parametric SBP if used.

The HF hearing group (which includes bottlenose dolphins) has minimal starting ranges to avoid TTS at <50 m (or approximately 300 m if using parametric SBP). This range is determined by a sparker if no parametric SBP is used, otherwise the parametric SBP will determine the range.

The seals (hearing group PCW) have minimal starting ranges to avoid TTS at approximately 1 km. The sparker is driving this range.

For all hearing groups the TTS risk range for peak pressure is below 50 meters.

7.1 Mitigation and Limitations

7.1.1 Exclusion Zone – Marine Mammal Observer

The large risk ranges for the VHF and PCW groups mean that extra care must be taken in establishing presence of these animal groups prior to starting a survey line.

Assuming that the main species of concern is the bottlenose dolphin a pre-activity MMO search to 500 m to establish absence of this species will be sufficient to mitigate TTS risk from noise.

7.1.2 Equipment limitations

Any equipment used should not exceed the modelled equipment broadband levels (Table 4.1) or band-wise levels for overall levels (Figure 4.1 and Figure 4.2).

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