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Foreshore Licence Application for Site Investigations for Oriel Wind Farm, off Co. Louth

Annex IV Risk Assessment

Report for
Oriel Wind Farm Ltd

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1 INTRODUCTION

1.1 Background and document purpose

Oriel Windfarm Limited (Oriel) is an Irish renewable energy company developing the proposed Oriel offshore wind farm ("Oriel Wind Farm" or "the Project") located in the north-west Irish Sea, 22km off the coast of Dundalk, County Louth. The Project will include wind turbines mounted onto a foundation installed into the seabed, an offshore substation and interlinking cabling between the turbines and the substation and an export cable between the substation and the shore.

Oriel was granted a Foreshore Licence in October 2005 from the then Department of Communications, Marine and Natural Resources (DCMNR), giving permission to carry out a technical work plan to investigate the suitability of an area to the east of Dundalk Bay for the construction of an offshore wind farm. The technical work plan included a geotechnical site investigation, an engineering assessment and the completion of an Environmental Impact Statement (EIS).

Following the completion of this work, Oriel applied for a Foreshore Lease in February 2007, to construct an offshore wind farm of up to 330MW potential in an area located off the coast of County Louth, approximately 22km east of Dundalk. For a number of reasons, the development of the project was delayed.

In May 2019, Oriel obtained a Foreshore Licence reference no. FS 006840 for initial surveys in the offshore wind farm area and offshore cable corridor. Oriel undertook both onshore and offshore surveys and commenced the engineering design of the wind park. Oriel now intends to undertake further site investigations of the offshore wind farm area and the offshore cable corridor to investigate the stability of the soil (seabed sediments) for the design of foundations and the detailed routeing of the inter array and export cables.

This report forms part of a Foreshore Licence Application to the Department of Housing, Local Government and Heritage (DHLGH) seeking permission to undertake site investigation works within the proposed development site to support the Project. The purpose of this report is to provide the information required to enable the Competent Authority (DHLGH) to determine whether the proposed site investigation works could have potential effects on species listed under Annex IV of the Habitats Directive (termed Annex IV species).

1.2 Relevant consultation responses

The licence application was open for public consultation between 15th December 2021 to 27th January 2022. Responses relevant to this Annex IV 12 Risk Assessment (under Article 12 of the Habitats Directive) are provided in Table 1.1.

Table 1.1: Relevant responses from prescribed bodies and public submissions to the consultation

Statutory Body	Applicant's Response
National Parks and Wildlife Service Applying the precautionary principle and noting that the "there is potential for some behavioural disturbance of cetaceans in response to survey vessel noise" and that the area of potential	Oriel notes the observations of National Parks and Wildlife Service. As outlined in Section 7.2.2 of the Non-Statutory Environmental Report, which accompanied the application, Oriel confirms that the best practice guidelines, "Guidance to manage the risk to marine

Statutory Body	Applicant's Response
disturbance will be highly localised i.e., within a few hundred metres radius. NPWS would suggest that application of "Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters" for works that would occur in applicable geographical areas is appropriate and consistent with other licensing of this nature in the Foreshore.	mammals from man-made sound sources in Irish waters" (DAHG 2014), will be implemented for the geophysical surveys and a qualified and experienced marine mammal observer (MMO) will be employed aboard the survey vessels during all multibeam, single beam, side-scan sonar and sub-bottom profiling.
Marine Institute Oriel Windfarm Ltd submitted a foreshore application for site investigation works to be carried out in a defined area off the Co. Louth coast and along cable route corridors towards the coastline south of Dunany Point, Co. Louth. In addition to the application form and a number of charts and maps the applicants submitted a number other documents including, inter alia: • FS007383 Foreshore Licence Application for Marine Survey: Supporting Information • FS007383 Foreshore Licence Application: Non-Statutory Environmental Report • FS007383 Foreshore Licence Application: Supporting information for the Stage 1 Screening for Appropriate Assessment • FS007383 Foreshore Licence Application: Supporting information for the Stage 2 Appropriate • Assessment The overall aim of the site investigations is to collect the necessary data and information required to inform the engineering and detailed design of the cable route and proposed windfarm areas as well as identifying the wider ecological characteristics of the foreshore licence area. It is noted the installation of a windfarm and associated infrastructure in the area in the future would be the subject of a separate Foreshore Lease / Licence application and is not the subject of this current application. A number of geophysical methodologies are proposed, including following acoustic-based techniques: • Multibeam Echosounder (MBES) system for detailed bathymetric mapping; • Side Scan Sonar for detailed seabed morphology and seafloor mapping; • Magnetometer for detecting geomorphological anomalies and ferrous obstructions; • Sub-bottom Profiling (SBP), both single and multi-sourcings, to identify and	Oriel notes the Marine Institute' observations. Oriel refers to Section 3.3 of the NIS, which addressed potential in-combination effects. The effects considered included other potential geophysical/geotechnical surveys which might be carried out in the area. The conclusion of the in-combination effects assessment, in relation to other geophysical/geotechnical surveys, was as follows: *"There is the potential for works associated with site investigations at Cooley Point, Braymore Point, Clogher Head and the North Irish Sea Array to take place within the schedule of works for this application, for example, as the licences granted provide a five year period within which to complete the works. In view of the similarity of the nature of the works between these applications, and the potential for in-combination effects, particular in relation to underwater noise, Oriel will maintain awareness of the scheduling associated with these other licences, and engage with the licence holders, as required.* ***However, in view of the low sound power levels of the acoustic equipment used in such surveys, which are spatially discrete, and of short duration, it is concluded that such surveys will not result in likely significant in-combination effects."*** (emphasis added)

Statutory Body	Applicant's Response
characterise the layers of sediment/rock underneath the seafloor along the cable route corridor; • Ultra-high-resolution multi-channel seismic (UHRS) to identify and characterise the layers of sediment/rock underneath the seafloor within the windfarm site. • Intertidal geophysical surveys including seismic, electrical resistivity and electromagnetic methods. Up to 10 static acoustic monitoring devices (SAM) In addition, a number of geotechnical and ecological surveys are also proposed comprising the following methodologies: • Metocean Survey • Boreholes • Vibrocoring/Gravity Coring • Static Acoustic Monitoring of Cetaceans (CPODs) • Water Quality Sondes • Benthic and intertidal video, grabs and cores • Fish and shellfish GPS Tracking The proposed site investigation methods are relatively standard and have been used in similar investigations in Irish waters and internationally. It is intended that the proposed survey works would be phased over a period of 3 years following award of licence and specific survey scope will range from 4 weeks to 2 years in duration. There are no licenced aquaculture sites within the proposed site investigation area on the Foreshore and therefore impacts on aquaculture are not considered likely. There is commercial fishing activity within the proposed site investigation area on the Foreshore and therefore, some interaction with fishing activity may occur. Notwithstanding this, it is noted that the applicant has appointed a Fisheries Liaison Officer who will engage with the fishing community and fisheries organisation in the area during investigations. The AA Screening and the subsequent NIS identifies a number of risks to conservation features (e.g., Natura sites) likely to result from the proposed activity. As mitigation, a number of actions are suggested that should reduce the risk. Among these is the use of marine mammal observers (MMO) during operations including a 'soft start' protocol, notwithstanding the conclusion	

Statutory Body	Applicant's Response
that impact on marine mammals was not considered sufficient to warrant consideration under Stage 2 (AA). The MI is satisfied that such measures will mitigate any risk to marine mammals in the immediate area during the site investigations. However, it is advised that DHLGH identify any similar geophysical/geotechnical surveys that might be carried out along the eastern seaboard and ensure that they not coincide with this survey in order to avoid potential cumulative displacement effects.	
Irish Whale and Dolphin Group *General* The Irish Whale and Dolphin Group (IWDG) was established in December 1990 and is an All-Ireland group "dedicated to the conservation and better understanding of cetaceans (whales, dolphins and porpoises) in Irish waters through study, education and interpretation". While the IWDG is primarily concerned with cetaceans we have broadened our comments to include all marine mammals. IWDG welcomes the opportunity to comment on this foreshore licence. *Ultra High Resolution Seismic (UHRS)* Page 9- UHRS does not consider the use of airguns with lower frequency output. Furthermore the parameters given for boomers and sparkers do not cover the Applied Acoustics Squid 500/2000 and the Applied Acoustics S-Boom with a source level of 222dB. Nor does it cover the Huntec boomer with frequencies of 0.5 to 8 kHz. The exact impact of higher frequency sources remains largely unknown. *Ultra Short Baseline (USBL) and Multibeam Systems* Page 9- USBL. Most Kongsberg systems use frequencies between 21 and 31 kHz (see https://www.kongsberg.com/maritime/products/Acoustics-Positioning-and- Communication/acoustic-positioning-systems/hipap-models/). The Sonardyne Wideband Sub-Mini 6 Plus (WSM6+) and Sonardyne Type 8300 Compatt 6 operate and from 19 to 34 kHz (see https://www.sonardyne.com/wpcontent/uploads/2021/06/Sonardyne_8370_WSM6-1.pdf and https://www.strsubsea.com/uploads/Sonardyne-8300-3111-Compatt-6.pdf). Therefore the stated frequencies of typical frequencies of 20 to 40 kHz should reflect the real numbers and the examples given of 19 to 34 kHz. Page 35 Table 4.4. USBL source level should be considered to have a maximum source level of 206	Oriel notes the submission of the Irish Whale and Dolphin Group. *Ultra High Resolution Seismic (UHRS)* Oriel confirms that an Airgun will not be used. Currently, the preferred geophysical survey contractor has proposed to use a GSO 1 Sparker with dominant frequencies listed as between 400 - 1800 Hz and 200-1000 joules energy. Specification sheets can be shared. Sparker sub-bottom profilers (SBPs) generate sounds of similar characteristics to airguns, and therefore the evidence of effects relating to airguns can be applied to these sources with more confidence than others. While larger sparker SBPs operated at high energy may result in comparable source levels to a mini airgun, sparker SBPs generate energy at lower amplitudes than even small airgun arrays and consequently potential effects on marine species can be expected to be proportionally lower. Work to quantify the emitted sound fields from sparker SBPs is ongoing, but initial results support the assumption of a reduced potential of effects on marine mammals (Halvorsen & Heaney 2018, cited in the AA Screening document.). *Ultra Short Baseline (USBL) and Multibeam Systems* Oriel confirms that the typical frequencies of the USBL will be 19 to 34 kHz. This revision in frequency range is not considered to affect the conclusions of the assessment made in respect of effect on marine fauna. For the Sonardyne Type 8370-1111 beacon the source level under battery power is given as 184 dB re. 1 µPa @ 1 m which is less than the source level given and assessed in the AA Screening (~200dB re 1µPa @1m (peak)). Oriel confirms that the currently proposed multibeam system uses 400-700 kHz, not the frequency range quoted in application (70-100kHz). Lower frequency "high power" MBES

Statutory Body	Applicant's Response
dB re 1µPa@1m and not 200dB. See page 53 Kongsberg (2016) Product Description. Boomer or sparker comments as for page 9. Multi-beam systems lower then 70 kHz should not be allowed on surveys as these use higher source levels and may need appropriate review before used. *High Resolution Geophysical Surveys* Page 18. Suggests that disturbance of from HRGS (High Resolution Geophysical Surveys) would be limited to a few hundred metres from source for marine mammals. This is not what is suggested by a review document published by the JNCC (2020) which suggests a zone of disturbance of 5km. *Low Frequency Baleen Whales* Page 38 Table 4.3. Low Frequency baleen whales (Southall et al, 2019) should be included inconsideration of functional hearing groups as minke or humpback whales may be present in the site area. *Mitigation Measures* The document does not mention mitigation measures that will be employed during geophysical and geotechnical surveys. This is not compliant with requirements by the NPWS and DAHG (2014) guidelines. As the assessment does not mention any mitigation measures that will be applied it should not proceed currently. The assessment should recognize the requirement for mitigation measures in the surveys suggested and must be included in the assessment.	systems typically have source levels approximately 10 dB higher than systems operating at >100 kHz (Hildebrand, 2005). Hildebrand JA (2005). Impacts of anthropogenic sound. In: Reynolds JE, Perrin WF, Reeves RR, Montgomery S & Ragen TJ (Eds). Marine mammal research: conservation beyond crisis. Baltimore: Johns Hopkins University Press pp 101-124. *High Resolution Geophysical Surveys* Various JNCC reports (e.g. 2020, 2021) repeat recommended effective deterrence ranges (EDRs) for harbour porpoises from noise from a range of activities. These are considered very conservative and do not necessarily reflect the latest evidence; for example, piling has a 26km EDR which was questioned by Graham *et al*. (2109) and Benhemma-Le Gall *et al*. (2021). For HRGS, the JNCC reports recommend a 5km EDR in relation to the porpoise features of Special Areas of Conservation; this too does not correspond to the evidence presented by Halvorsen & Heaney (2018), cited and reflected in the AA Screening document. • Benhemma-Le Gall A, Graham IM, Merchant N D & Thompson PM (2021). Broad-Scale Responses of Harbor Porpoises to Pile-Driving and Vessel Activities During Offshore Windfarm Construction. *Frontiers in Marine Science* **8**: 664724 doi: 10.3389/fmars.2021.664724 • Graham IM, Merchant ND, Farcas A, Barton TR, Cheney B, Bono S & Thompson PM (2019). Harbour porpoise responses to pile-driving diminish over time. *Royal Society Open Science* **6**: 190335. http://dx.doi.org/10.1098/rsos.190335 • JNCC (2020). Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland). JNCC Report No. 654, Joint Nature Conservation Committee, Peterborough, ISSN 0963-8091. https://data.jncc.gov.uk/data/2e60a9a0-4366-4971-9327-2bc409e09784/JNCC-Report-654-FINAL-WEB.pdf • JNCC (2021). Impulsive noise in the Southern North Sea SAC (2015 to 2020). Joint Nature Conservation Committee final report to Defra.

Statutory Body	Applicant's Response
	http://sciencesearch.defra.gov.uk/Document.aspx?Document=15220_JNCC2021_NoiseHpSACs_JNCC-Final.pdf *Low Frequency Baleen Whales* Table 4.3 provides details of the relevant marine mammals (i.e. those which are qualifying interests of relevant sites) and auditory injury criteria to impulsive and non-impulsive noise by functional hearing group. No sites for baleen whales are within the zone of influence for the survey and thus they were not included in this table. However, baleen whales are considered in the assessment and their auditory injury criteria are included in Table 6.2. *Mitigation Measures* The mitigation measures to be implemented for marine mammals are described in Section 7.2.2 of the Non-statutory Environmental Report. Oriel confirms that the best practice guidelines, "Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters" (DAHG 2014), will be implemented in full for the geophysical surveys and a qualified and experienced marine mammal observer (MMO) will be employed aboard the survey vessels during all multibeam, single beam, side-scan sonar and sub-bottom profiling. The European Court of Justice has ruled, "in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site" (Case C-323/17.) Consequently, mitigation measures must not be included in Appropriate Assessment screening. This is the reason why there is no reference to compliance with the DAHG 2014 guidance in the report Supporting information for the Stage 1 Screening for Appropriate Assessment, which was submitted with the licence application.

1.3 Legislative context

The *Foreshore Act 1933* (as amended), requires that a lease or licence must be obtained from the Minister for Housing, Local Government and Heritage for the carrying out of works or placing structures or material on, or for the occupation of or removal of material from, State-owned foreshore.

The 1992 EU Habitats Directive (Council Directive 92/43/EC) and Birds Directive (2009/147/EC) are transposed into Irish law by Part XAB of the *Planning and Development Act 2000* (as amended) and the *European Communities (Birds and Natural Habitats) Regulations 2011* (as amended).

In addition to the requirement to consider potential effects of a plan or project on European Sites under Article 6(3) of the Habitats Directive (covered separately by submission of Stage 1 Screening for Appropriate Assessment, Report Reference: J.PARK.473 – Report No. 1.1, November 2021, and Supporting information for the Stage 2 Appropriate Assessment, Report Reference: J.PARK.473 – Report No. 1.2), the Directive requires consideration of the potential effects on species listed under Annex IV of the Directive (termed Annex IV species). Under Article 12, Annex IV species are afforded strict protection throughout their range, both inside and outside of designated protected areas.

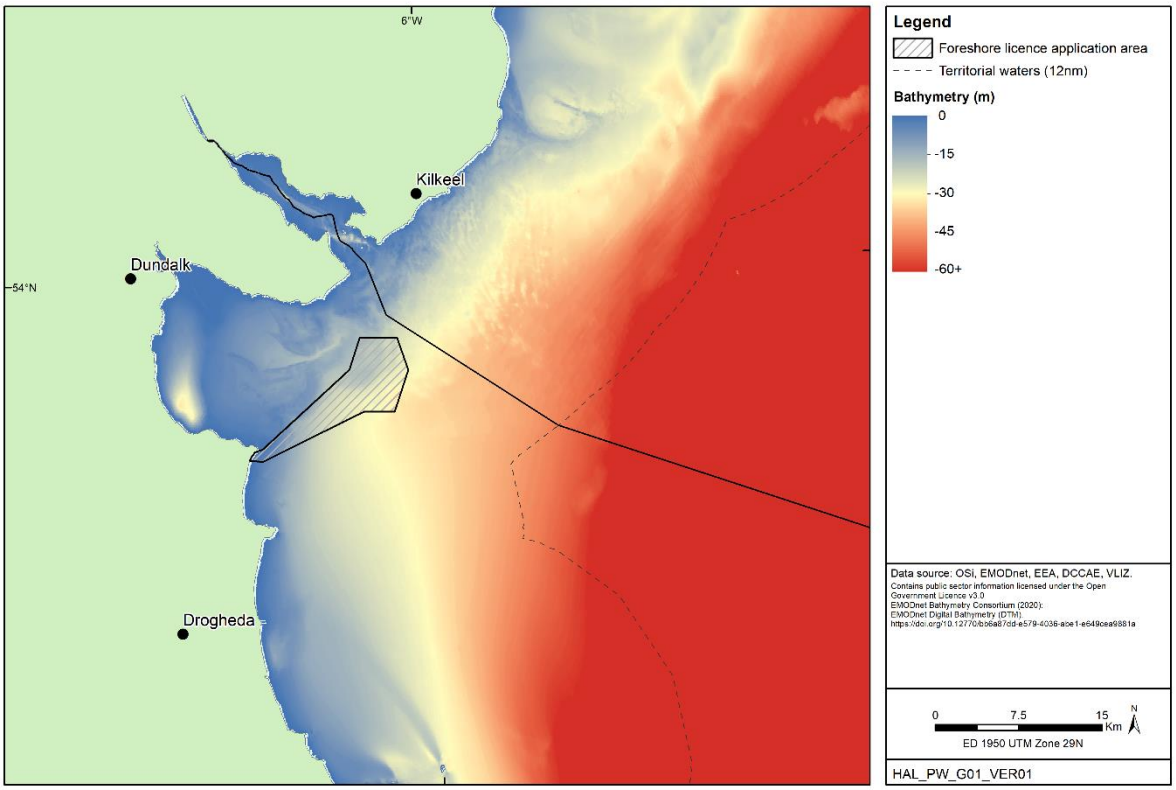
2 PROJECT DESCRIPTION

2.1 Location

The Foreshore licence application area comprises the Oriel offshore wind farm area and the offshore cable corridor (Figure 2.1). The offshore wind farm area is located off the coast of County Louth to the east of Dundalk Bay, approximately 22km east of Dundalk, 18km east of Blackrock, 5km south of the Cooley Peninsula and 10km north-east of Dunany Point. The offshore wind farm area covers approximately 27.8km^2 and is broadly hexagonal in shape with a length of approximately 5.3km west to east and 6.7 km north to south.

The offshore cable corridor is approximately 11km in length and covers an area of approximately 25km^2. The corridor is approximately 4km at its widest point, southwest of the offshore wind farm area, and narrows to approximately 1km at its narrowest point, just before landfall 700m south of Dunany Point.

Figure 2.1: Map of Foreshore Licence Application Area



2.2 Proposed site investigations

The site investigations will include:

- Geophysical surveys
- Geotechnical and sediment sampling
- Environmental/ecological surveys and sampling
- Oceanographic and meteorological survey.

Table 2.1 provides information on each of the elements of the works and an indication of their duration. It is anticipated that the survey works will commence in Q2 2022 subject to approval of the Foreshore Licence application, appointment of a suitable contractor, availability of vessels and suitable weather conditions. To allow for unforeseen delays, approval of a Foreshore Licence for a 3 year period is sought.

Table 2.1: Summary of surveys and indicative programme

Activity	Location	Proposed sample numbers	Duration
Geophysical Survey	Offshore windfarm area and offshore cable route	• Multibeam Echosounder (MBES) system for detailed bathymetric mapping • Side Scan Sonar (SSS) to achieve detailed seabed morphology and seafloor mapping • Magnetometer to detect geomorphological anomalies and ferrous obstructions • Sub-bottom Profiling (SBP), both single and multi-sources, to identify and characterise the layers of sediment/rock underneath the seafloor • Ultra-high-resolution multi-channel seismic (UHRS) to identify and characterise the layers of sediment/rock underneath the seafloor within the offshore site area. • Intertidal geophysical surveys including seismic, electrical resistivity and electromagnetic methods.	4 weeks (weather dependent)
Geotechnical Survey and Sediment Sampling	Offshore windfarm area and offshore cable route	27 no. deep investigation locations at proposed structure locations (25 wind turbines sites and two options for the offshore substation location). Each deep investigation location will require up to 3 drilled boreholes with a target depth of 50m below the seabed.	4-8 months (weather dependent; will be extended if unforeseen ground conditions are discovered)
		41 no. shallow investigation locations along proposed inter-array and export cable routes. Each location will require one vibrocore or gravity core with a target depth of 3m below the seabed.	
		Up to 6 no. deep investigation locations in the intertidal area. Each location would be a drilled borehole with a target depth of up to 50m.	
		Up to 12 no. shallow investigation locations in the intertidal area. Each location would be an excavated trial pit or borehole with a target depth of 3m below the beach. Excavated locations to be backfilled immediately on completion of the investigation. Cores and CPTs may be taken from the boreholes or trial pits.	
Environmental monitoring/ ecological sampling	Offshore windfarm area and offshore cable route	<u>FPODs or CPODs</u> Proposed to deploy up to 6 FPOD or CPOD devices to provide acoustic assessment of the presence/absence and species types of cetaceans (whales and dolphins). Each device will require a robust, heavy weight mooring blocks of *ca*. 250kg, clump chain and rope with either an acoustic release mechanism and benthic buoy or a robust mooring with a surface marker buoy. Batteries must be replaced and data downloaded every 3/4	≤ 24 months (weather dependent)

Activity	Location	Proposed sample numbers	Duration
		months. Deployment and servicing would be undertaken from a survey vessel.	
	Offshore windfarm area and offshore cable route	Water Quality Sondes Proposed to deploy up to 6 sondes for water quality monitoring of parameters including turbidity, salinity, temperature, pH, dissolved oxygen, electrical conductivity. Each sonde will require a robust, heavy weight mooring block, clump chain and rope with either an acoustic release mechanism and benthic buoy or a robust mooring with a surface marker buoy.	
	Offshore windfarm area and offshore cable route	Benthic and intertidal Benthic survey techniques may include drop down video (DDV) and deployment of a mini Hamon grab or van Veen grab to obtain samples of 1-5kg in mass each. Manual digging may be used in the intertidal zone to collect the samples. Samples would be analysed to determine the benthic faunal community present and sediment geochemistry.	
	Offshore windfarm area and offshore cable route	Fish and shellfish GPS Tracking Up to 6 sondes may be deployed for the tracking of fish or shellfish within the windfarm and export cable corridor. Each sonde will require a robust, heavy weight mooring block, clump chain and rope with either an acoustic release mechanism and benthic buoy or a robust mooring with a surface marker buoy	
Oceanographic and meteorological	Offshore windfarm area and offshore cable route	All metocean survey works will occur at one location within the marine survey area. Data will be collected via a floating weather station, which will include a wave rider and a wind measurement LiDAR current profiler. The wave rider will be used to collect wave height and current data across the site, while the LiDAR system will be used to measure the wind characteristics within the site.	≤ 24 months (may be greatly reduced if findings are in line with existing data collected from previous surveys)

2.3 Description of the proposed survey works

2.3.1 Geophysical survey

The purpose of the geophysical survey is to determine the sediment conditions within the survey area in order to update the information gathered by previous surveys. This additional data will be used to better understand the sub-surface structure, in particular the sub-surface stratigraphy, and to confirm the bedrock elevation. The information will be used to assess the stability of the sub-surface soil for the design of foundations and the detailed routeing of the inter array and export cables.

The objectives of the geophysical survey are to:

- Produce detailed bathymetric mapping;
- Obtain detailed seabed morphology;
- Identify the nature of the seabed;
- Acquire both shallow and deep geological cross-sections of the wind farm site;

- Confirm the export cable route within the cable route corridor.

The geophysical survey will include bathymetric, side scan sonar, magnetometry and seismic sounding of the proposed site. Details of the exact survey equipment will be made available prior to commencement of the works; however, it is envisaged that the geophysical data acquisition will involve the following acoustic-based techniques:

- Multibeam Echosounder (MBES) system for detailed bathymetric mapping.
- Side Scan Sonar (SSS) for detailed seabed morphology and seafloor mapping.
- Magnetometer for detecting geomorphological anomalies and ferrous obstructions.
- Sub-bottom Profiling (SBP) to identify and characterise the layers of sediment/rock underneath the seafloor along the cable route corridor.
- Ultra-high-resolution multi-channel seismic (UHRS) to identify and characterise the layers of sediment/rock underneath the seafloor within the windfarm site.
- An ultra-short baseline acoustic positioning (USBL) system may be used to assist in the positioning of towed equipment relative to the vessel.

The geophysical survey will comprise transects with a total length of *ca*. 84km and a distance of 1km between each transect (Figure 2.2).

MBES

The MBES system will be used to provide detailed bathymetric mapping throughout the survey area. An MBES is a type of sonar (acoustic surveying) used in seabed mapping wherein acoustic waves are used to indicate depth-to-seabed. The device is typically affixed to a vessel's hull or towed in its wake. The process is non-intrusive, and the device will not make contact with the seabed at any point. The currently proposed multibeam system will have a frequency range of 400-700 kHz with sound pressure levels in the range of 225-231dB re1µPa at 1 metre range[1].

SSS

The side scan sonar will be used to achieve detailed seabed morphology and seafloor mapping of the survey area. The survey is carried out using a sonar device attached to a vessel that emits a fan-shaped pulse down towards the sea floor across a wide-angle perpendicular to the path of the sensor through the water. The intensity of the acoustic reflections from the seafloor of this fan shaped beam is recorded in a series of cross-track slices. When stitched together along the direction of motion, these slices form an image of the sea bottom within the swath (coverage width) of the beam. The equipment will operate within a frequency range of 100-500kHz with source levels at 235dB re 1µPa at 1 metre range.

Magnetometer

A magnetometer detects ferrous objects and as such is used to locate and identify ferrous objects on or buried in the seabed within the range of the magnetometer. The device precisely measures the earth's magnetic field and detects any anomalies, which represent ferrous objects such as lost anchors, sunken ships and buried pipes. The magnetometer is typically towed behind a survey vessel or affixed to a vessel's hull. The process is non-intrusive, and the device will not make any physical contact with the seabed at any point.

[1]https://cdn1.shipserv.com/ShipServ/pages/profiles/54162/documents/EM-710-Product-Description.pdf

The G-882 Marine Magnetometer may be taken as an indicative example to be used in the completion of these works. The datasheet for this device in included in Appendix A of the Non-statutory Environmental Report.

SBP

The SBP will be used along the cable route corridor only. This device uses reflection seismology to give a 2D image of the sub-seabed geology. It is typically towed behind the vessel during survey works or affixed to the vessel's hull. The process is non-intrusive, and the device will not make any physical contact with the seabed at any point. The Innomar SES-2000 Quattro Parametric SubBottom Profiler[2] is used as an indicative example and the equipment will have a primary frequency of between 85 and 115kHz (with secondary low frequencies of between 2 and 20kHZ) and source levels of 235-245dB re 1µPa at 1 metre range.

UHRS

The UHRS will be used within the offshore wind farm area only, commonly used variants of this technology are known as sparkers and boomers. Currently, the preferred geophysical survey contractor has proposed to use a GSO 1 Sparker with dominant frequencies listed as between 400 - 1800Hz and 200-1000 joules energy. Source levels estimated to be approximately 220dB re 1µPa at 1m[3].

Sparker sub-bottom profilers (SBPs) generate sounds of similar characteristics to airguns, and therefore the evidence of effects relating to airguns can be applied to these sources with more confidence than others. While larger sparker SBPs operated at high energy may result in comparable source levels to a mini airgun, sparker SBPs generate energy at lower amplitudes than even small airgun arrays and consequently potential effects on marine species can be expected to be proportionally lower. Work to quantify the emitted sound fields from sparker SBPs is ongoing, but initial results support the assumption of a reduced potential of effects on marine mammals (Halvorsen & Heaney 2018)

USBL

A USBL beacon may be used to precisely locate towed equipment (such as a sidescan sonar fish) relative to the vessel. Exemplar equipment includes Sonardyne Type 8370-1111 beacon which has a typical operating frequency of 19-34kHz. For this beacon the source level under external power and battery power is 187 and 184 dB re. 1 µPa @ 1 m, respectively[4].

2.3.2 Geotechnical survey

The purpose of the geotechnical survey is to investigate the stability of the soil for the design of foundations and the detailed routeing of the inter array and export cables.

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[2] https://www.innomar.com/sbp-quattro.php

[3]https://www.aaetechnologiesgroup.com/applied-acoustics/products/sub-bottom-profiling/sound-source-sparkers/

[4] https://seatronics-group.com/wp-content/uploads/2020/05/Sonardyne-USBL-Transponder-8370-Datasheet.pdf

Boreholes

Some 27 no. deep investigations will be carried out at potential structure locations (potential wind turbine and offshore substation locations) (Figure 2.2). Each deep investigation location will require up to 3 drilled boreholes with a target depth of 50m below the seabed. Thus, some 81 geotechnical boreholes will be drilled in the offshore wind farm area.

In situ testing will include the option of either down-hole wireline piezocone penetration testing (PCPT) associated to PS logging or down-hole wireline seismic cone testing (SCPT) over the full length of a borehole. These tests involve a shear wave source, located on a downhole probe or on the drilling frame at the surface respectively, and downhole geophones. While the activity can be described as resulting in impulsive sounds, the source levels are minor (70dB). SCPT tests will be executed at a minimum of four of the locations, which will be confirmed following the results of the geophysical survey. Two seismic measurements shall be carried out during each SCPT stroke at a depth interval of 1m; the envisaged number is 40-60 SCPT tests in total.

The boreholes will be advanced by alternating PCPT/SCPT and push/core sampling; requirements will depend on the material type encountered. Within a granular deposit, the boreholes will be advanced by alternating PCPT/SCPT and push sample. Where the sample recovery is poor using the push sampler, a hammer sampler will be used instead. Within the cohesive deposits, the boreholes will be advanced by PCPT/SCPT followed by two push samples. Rotary coring may be used instead of push sampling in suitable materials, in which case the CPT and cores will be alternated.

Up to 6 no. deep investigations will be carried out in the intertidal area. Each location would be a drilled borehole with a target depth of up to 50m.

Vibrocoring / gravity coring

It is estimated that some 41 no. shallow investigations will be required along the proposed inter-array and export cable routes. Each investigation will require one vibrocore or gravity core at each location with a target depth of 3m below the seabed. Figure 2.2 shows an indicative line for the cores. Vibrocoring is performed where cohesionless soil is expected. The vibrocorer will be lowered onto the seabed, after which the vibrocoring process will be started. Upon refusal or at target depth, the vibrocorer will be recovered on deck where the recovery rate is measured.

Gravity core (wireline self-weight penetration sampler) will be performed where cohesive soil is expected. The gravity corer will be lowered on the seabed and will penetrate in the seabed under its own weight. Upon refusal or at target depth, the gravity core will be recovered on deck where the recovery rate is measured.

Up to 12 no. shallow investigation locations will be carried out in the intertidal area. Each location would be an excavated trial pit or borehole with a target depth of 3m below the beach. Excavated locations will be backfilled immediately on completion of the investigation. Cores and CPTs may be taken from the boreholes or trial pits.

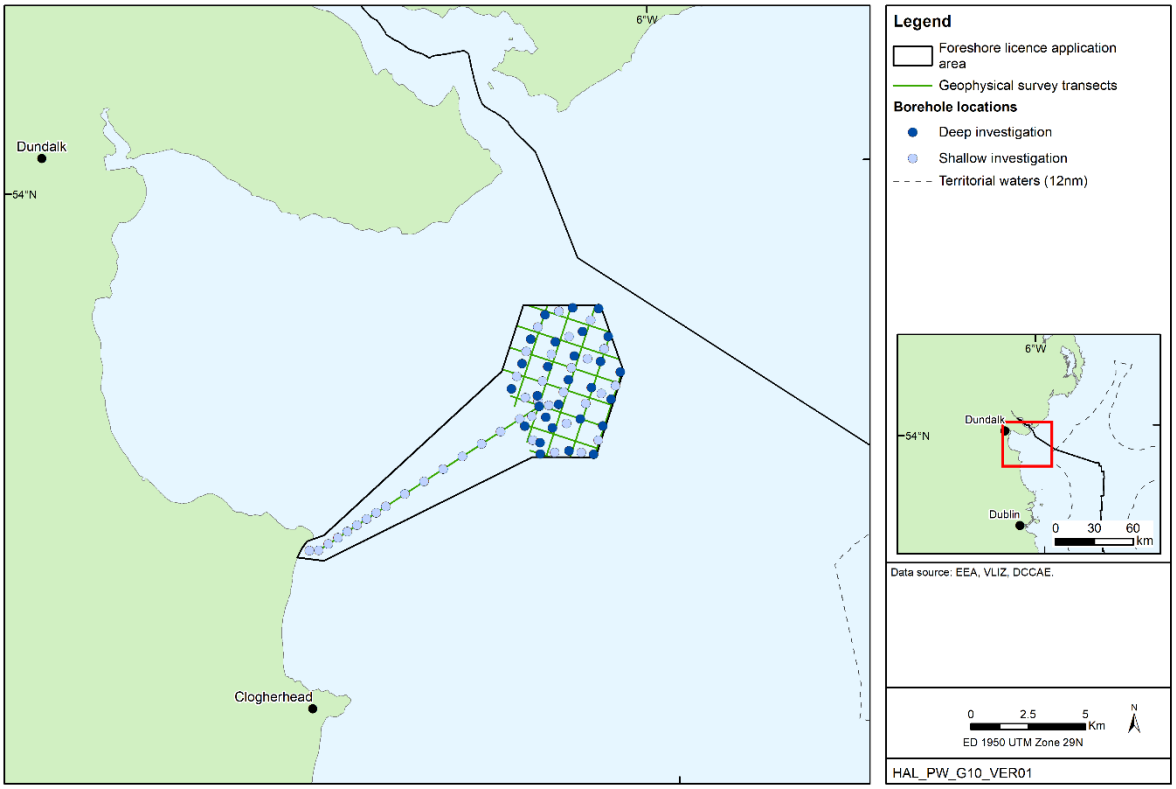
2.3.3 Ecological surveys

The purpose of the ecological surveys is to update the baseline environmental data collected from previous ecological surveys. The ecological scope of work will include the following:

CPODs

It is proposed to deploy up to 6 FPOD or CPOD devices for Static Acoustic Monitoring (SAM) of cetaceans. The devices will provide acoustic assessment of the presence/absence and species types of cetaceans to i) allow for the recording of species difficult to detect visually such as harbour porpoise, ii) provide data on other factors such as diel and tidal presence at the site. A CPOD is a self-contained computer and hydrophone in a sealed sonde approximately 1m in length which log the times and duration of click trains resembling the echo-location clicks produced by porpoises and dolphins. The acoustic device is independent of weather conditions once deployed and thus will ensure high quality data will be collected but only at a small spatial scale (typical detection distances of 250m (porpoises) to 800m (dolphins). Each CPOD will require robust, heavy weight mooring blocks of *ca*. 250kg, clump chain and rope with either an acoustic release mechanism and benthic buoy or a robust mooring with a surface marker buoy. Batteries will be replaced and data downloaded every 3/4 months. Deployment and servicing will be undertaken from a survey vessel.

Figure 2.2: Map of survey sample locations



Water quality sondes

It is proposed to deploy up to 6 sondes for water quality monitoring through the water column – these will be used to monitor a range of parameters including turbidity, salinity, temperature, pH, dissolved oxygen and electrical conductivity. Sondes will be either suspended from a surface marker buoy or a benthic buoy with acoustic release at a range of depths dependent on survey requirements. Each buoy would have a robust mooring on the seabed similar to the CPOD mooring described above.

Benthic and intertidal

Survey techniques will include drop down video (DDV) and deployment of a mini Hamon grab or van Veen grab to obtain samples of 1-5kg in mass each. Manual digging may be used in the intertidal zone to collect the samples. Samples will be analysed to determine the benthic faunal community present and sediment geochemistry.

Fish and shellfish GPS tracking

Up to 6 sondes may be deployed for the tracking of fish or shellfish within the windfarm and export cable corridor. Similar to the CPODs and water quality, the sondes will be deployed attached to a robust mooring with either a benthic buoy and acoustic release and/or a surface marker buoy.

2.3.4 Metocean Survey

The purpose of the metocean survey is to obtain site specific atmospheric, wave and wind data over a period of up to 24 months. All metocean survey works will occur at one location within the marine survey area which will be determined following the appointment of a suitable contractor. The data will be collected via a floating weather station, which will include a wave rider and a wind measurement LiDAR current profiler. This equipment will be mounted on specifically designed floating buoys which are moored to the seabed using an anchor chain and clump weights. All equipment including the moorings will be removed following completion of the survey. The wave rider will be used to collect wave height and current data across the site, while the LiDAR system will be used to measure the wind characteristics within the site.

2.4 Survey vessels

Separate survey vessels will be used for each activity. A larger vessel is required to complete the offshore geotechnical works, with smaller vessels used for the geophysical, metocean and ecological surveys. A smaller RHIB type vessel may be used for geophysical works in shallow waters. Land based drilling and excavators may be used for the investigations and surveys within the intertidal zone. The types of vessels are described below.

2.4.1 Offshore vessel

The survey vessel used for offshore geotechnical works will be either a jack-up barge or a Dynamic positioning (DP) vessel. Typical examples of the types of vessels used to undertake these works are provided in Appendix A of the Non-statutory Environmental Report.

Jack-up barges utilise a fixed anchoring system in order to maintain the required position within the site. The vessel consists of a self-elevating platform and four or six “legs”, that are deployed to the ocean floor mooring the vessel in place. The survey works are carried out from the self-elevating platform, which is raised above the water’s surface. If used, the jack-up barge will meet with the following minimum requirements:

- The vessel will have at least four mooring points;
- The self-elevating platform must be permanently manned (i.e. off-shift personnel to stay onboard even if the accommodation is not a permanent equipment of the jack-up);

- The platform must be provided with a class certificate verifying the provision of adequate safety equipment for the type of vessel and the number of on-board personnel; and
- The platform should be certified in compliance with the MODU (Mobile Offshore Drilling Unit) Code[5] and the RenewableUK guidelines[6].

Unlike jack-up barges, DP vessels maintain station via propellers and thrusters with inputs from satellite DGPS signals, allowing the vessels to be positioned over any point on the seabed and maintain position without employing a fixed anchoring system. Using thrusters or propellers, a DP vessel can maintain position within a 2m to 0.5m window depending on the sea state/weather conditions and available power. The vessel may also transit under DP control along a given pre-determined path.

If used, a DP vessel will meet the following minimum requirements:

- The vessel must be fully equipped with a Class II DP system as a minimum;
- Two DP certified operators with the necessary experience must be members of the crew; and
- The offshore works will be carried out on a 24-hour shift basis, with personnel working two 12-hour shifts. This will allow the works to be continuous.

2.4.2 Nearshore vessel

The smaller, nearshore vessel will be used in locations where the water depth is too shallow for the larger, offshore vessel to carry out the works. This vessel does not need to have a dynamic positioning system, however must have full DGPS capability. The vessel is usually held on station by joy-stick control and will deploy an anchor to assist in maintaining station (depending on sea state and weather conditions). The smaller vessel will use similar equipment to the larger vessel to carry out the required survey works.

The nearshore works will be carried out on a 12 hour per day basis, with the vessel returning to port at the end of each day.

There will be no significant discharges from the offshore and nearshore survey vessels, and any discharge would be consistent with obligations under MARPOL, which effectively prevent pollution from such sources. The survey vessels will meet all relevant MARPOL requirements e.g. in relation to Annex I, Annex IV and Annex V on the prevention of pollution by oil, sewage and garbage from ships, respectively, under the Sea Pollution Act 1991 (as amended), and the Sea Pollution (Prevention of Pollution by Garbage from Ships) Regulations 2012 (as amended). The vessels will hold a Shipboard Oil Pollution Emergency Plan (SOPEP).

[5] https://rules.dnv.com/docs/pdf/gl/maritimerules/gl_iv-6-2_e.pdf
[6]https://www.renewableuk.com/news/309151/Guidelines-for-the-Selection-and-Operation-of-Jack-ups-in-the-Marine-Renewable-Energy-Industry.htm

3 RELEVANT ANNEX IV SPECIES

Under Article 12 of the Habitats Directive, Annex IV species are afforded strict protection throughout their range, both inside and outside of designated protected areas. Those Annex IV species that could potentially occur in the survey area and surrounding waters are described below.

3.1 Cetaceans

The survey area lies within Stratum 5 of the ObSERVE surveys, which extends from Carlingford Lough in the north to Carnsore Point in the south, and from the coast offshore to approximately the limit of the Irish EEZ. This area was surveyed a total of four times during the ObSERVE programme, in summer and winter 2015 and 2016. Harbour porpoise were observed throughout this area in all surveys, with density estimates of between approximately 0.7 and 1.0 porpoise per km^2 – the highest estimated across any survey strata. A single small group of bottlenose dolphins were recorded in one survey; waters to the south and west of Ireland are more important for this species. Small numbers of Risso's dolphins and minke whale were also observed in summer. Other cetacean species previously recorded in low numbers in the area include common dolphin, fin whale and humpback whale (Wall *et al.* 2013).

Berrow *et al*. (2011) carried out a visual and passive acoustic survey in a block within the northern Irish Sea, extending from Carlingford Lough, Co. Louth in the north to Bray Head, Co. Wicklow in the south. Harbour porpoise was by far the most commonly recorded marine mammal species, with 51 sightings comprising 83 individuals (estimated density of between 1.54-1.59 animals km^2), 6 minke whales were also recorded. Most sightings of harbour porpoise were east of Rockabill and Lambay Island off north County Dublin and towards the southern end of the survey area east of Greystones, Co. Wicklow. Minke whale sightings were east of Rockabill and Lambay Island off north County Dublin (Berrow *et al*. 2011).

Site specific information on the cetaceans present in the area comes from monthly boat-based surveys completed between May 2018 to May 2020 (with the exception of February, March and April 2020 due to COVID restrictions). Monthly aerial surveys were commenced in April 2020 for 6 months (although it should be noted the primary objective of the aerial survey programme was to assess the abundance and distribution of birds present in the area, APEM 2020) with static acoustic monitoring (SAM) between November 2019 and November 2020 (O'Brien *et al.* 2020).

Harbour porpoise were sighted in every month of the boat-based surveys within the offshore wind farm area and buffer with data from these surveys providing modelled estimates of a monthly average of 0.57 animals per km^2 and monthly peak of 1.33 animals per km^2. SAM results showed porpoises to be present on average 99% of days monitored with detection rates varying between 1-9 detections per hour across the four locations monitored within the survey area, with dolphins rarely detected. Season appeared to influence porpoise presence differently across the survey area, with winter and summer overall important periods for porpoise presence. The effect of diel cycle also varied, although night, morning and/or evening phases often yielded more detections than day phases. Tidal cycle and tidal phase only affected detection rate at some locations, where slack low water coincided with increased detections (O'Brien *et al*. 2020).

Aerial survey of the marine survey area and surrounding area (APEM 2020) indicated that over the 6 month period between April and September 2020, 53 individual cetaceans were observed, of which 45 were recorded as dolphin/porpoise (April: 18 individuals, May: 5,

August: 15, September: 7), 3 harbour porpoise (June: 1 individuals, August: 2) and 3 dolphin species (September). One baleen whale and one minke whale were recorded in September. Very few dolphins were recorded by the boat-based surveys. Minke whale were sighted during the boat-based site-specific surveys between the months of June and October, although most sightings were outside the offshore wind farm area. These sightings provided modelled estimates of a monthly average of 0.04 animals per km^2 and a monthly peak of 0.26 animals per km^2.

IWDG sightings data prepared as part of a Drogheda Port maintenance dredging Foreshore Licence application (FS007359)[7] included validated records of whale and dolphin sightings off the coasts of Louth, Meath and North Dublin in the period 2000-2019. There were 397 separate records, comprising 1,494 individuals. In this period, nine species were confirmed as being sighted within the study area: Harbour porpoise, bottlenose dolphin, minke whale, common dolphin, humpback whale, killer whale, fin whale, northern bottlenose whale and bowhead whale. Of the confirmed species, only the first five were sighted more than once in the period considered. Harbour porpoise was the most commonly sighted species, with 326 sightings totalling 1,101 individuals (including those recorded as 'possible harbour porpoise'), followed by bottlenose dolphin (23 sightings, 228 individuals), minke whale (18 sightings, 22 individuals), common dolphin (6 sightings, 87 individuals) and humpback whale (3 sightings, 3 individuals) (as summarised in Hartley Anderson 2021).

3.1 Other Annex IV species

Otters are widespread in Ireland, found in a variety of aquatic habitats, both freshwater and marine, but otters utilising the marine environment require access to freshwater habitats to drink and bathe (Reid *et al*. 2013). It is noted that the closest source of freshwater appears to be several kilometres south of the proposed cable corridor landfall[8]. The National Biodiversity Data Centre provides a single record from Clogherhead[9] to the south of the cable corridor landfall. The most important areas for otter tend to be characterised by better quality semi-natural river channel with good riparian cover and lower levels of encroachment and or associated disturbance (Macklin *et al*. 2019).

Five species of marine turtle have been recorded in the seas around Ireland and the UK: leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), green turtle (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*). The leatherback turtle is the largest of the marine turtles and is the only species of turtle to have developed adaptions to cold water (Goff & Stenson 1988).

A significant majority of turtle sightings recorded in Irish waters are of the leatherback turtle (King & Berrow 2009), which migrates into the waters of the Celtic and Irish Seas in response to the distribution of the gelatinous zooplankton which make up their favoured diet (Doyle *et al.* 2008, Fossette *et al.* 2010). Tagging studies show that they migrate across the Atlantic from the eastern American mainland and the Caribbean (Hays *et al*. 2004, Doyle *et al*. 2008). Sightings in the wider region are concentrated off the south and west of Ireland, the southwest of England and the west coast of Wales but also in the Irish Sea. Most sightings occur in the summer, peaking in August (Penrose & Gander 2016, Botterell *et al*. 2020). The decadal trend of records in the UK and Ireland for leatherback turtles generally increased, peaking in the 1990s from which it has since decreased. Data from the National

[7] https://www.gov.ie/en/foreshore-notice/31be7-fs007359-drogheda-port-company-maintenance-dredging-temporary-licence/
[8] https://gis.epa.ie/EPAMaps/
[9] https://maps.biodiversityireland.ie/Map/Terrestrial/Species/119290

Biodiversity Data Centre[10] reflects these patterns with the predominance of sightings in the south and west of Ireland, and relatively few sightings in the Irish Sea, the latest of which was recorded in 2004. Aerial surveys for the ObSERVE project from 2015-2016 recorded a handful of leatherback turtle sightings at the southern limits of Irish offshore waters in summer; none were observed in the Irish Sea (Rogan *et al*. 2018). No marine turtles were recorded during the monthly boat-based and aerial surveys of the proposed Oriel windfarm.

[10] https://maps.biodiversityireland.ie/Species/128443

4 RISK ASSESSMENT

4.1 Potential impacts associated with survey activities

With respect of the proposed survey activities, the main sources of potential effect relevant to Annex IV species are identified as:

- physical presence of the survey vessels,
- underwater noise including from the vessel and survey equipment,
- in-combination effects.

4.1.1 Physical presence of the survey vessels

The physical presence of the survey vessels (offshore and nearshore vessels) may influence the distribution and movements of sensitive Annex IV species in the water column, specifically cetaceans. As hearing specialists, any displacement of marine mammals is most likely associated with acoustic disturbance, which is discussed below. There may also be responses from marine mammals to the general physical presence of vessels (Sparling *et al.* 2015), along with the risk of collisions from vessels in transit. However, the physical presence of the vessels around areas of existing shipping activity, and their temporary presence, are anticipated to cause no more than temporary and localised low-level behavioural responses similar to those from established vessel traffic, such that significant effects are not predicted.

4.1.2 Underwater noise including from the vessel and survey equipment

Context

Studies on the potential effects of underwater noise from marine survey have tended to focus on seismic survey using airgun arrays. While the proposed survey activities will generate significantly less noise than airgun sources, these studies are relevant to the consideration of potential noise effects on Annex IV species and are therefore summarised here.

Evidence of the effects of seismic surveys on odontocetes is limited but of note are studies in the Moray Firth observing responses to a 10 day 2D seismic survey (Thompson *et al.* 2013). The 2D seismic survey took place in September 2011 and exposed a 200km^2 area to noise throughout that period; peak-to-peak source levels generated by the 470 cubic inch airgun array were estimated to be 242-253 dB re 1 µPa at 1m. Within 5-10km from the source, received peak-to-peak SPLs were estimated to be between 165 and 172 dB re 1 µPa, with SELs for a single pulse between 145 and 151 dB re 1 µPa^{2}s. A relative decrease in the density of harbour porpoises within 10km of the survey vessel and a relative increase in numbers at distances greater than 10km was reported; however, these effects were short-lived, with porpoise returning to affected areas within 19 hours after cessation of activities.

More recently, the effects of a large 3D seismic survey conducted in the Danish sector of the North Sea on harbour porpoise echolocation activity were examined (Sarnocińska *et al*. 2020). The source comprised a 3,570in^3 airgun array and the survey lasted 103 days, with seismic activity occurring on all but 17 days, covering an area of 1,121km^2. Acoustic loggers were deployed inside and adjacent to the seismic survey area, before, during and after the survey over a total duration of 9 months. Three different measures of porpoise activity showed a dose-response effect, with the lowest activity closest to the source vessel, and

activity increasing up to a range of 8-12km, beyond which baseline acoustic activity was attained and no general displacement could be detected compared to reference stations at 15km from the seismic activity. The lowest porpoise acoustic activity was recorded at SELs for a single pulse of 155dB re 1 μPa^2s - a similar level to that estimated by Thompson *et al*. (2013) at distances where harbour porpoise detections were reduced.

Overall, it was concluded that while short-term disturbance was induced, the survey did not lead to long-term or broad-scale displacement (Thompson *et al*. 2013). Further acoustic analyses revealed that for those animals which stayed in proximity to the survey, there was a 15% reduction in buzzing activity associated with foraging or social activity; however, a high level of natural variability in the detection of buzzes was noted prior to survey (Pirotta *et al*. 2014). Passive acoustic monitoring provided evidence of short-term behavioural responses also for bottlenose dolphins, but no measurable effect on the number of dolphins using the Moray Forth SAC could be revealed (Thompson *et al*. 2013). Direct observations of disturbance specifically related to SCPT or hammer sampling methods are not available, however, in view of their comparatively small impulsive noise sources relative to that of the evidence available for seismic survey presented above, or studies related to wind farm pile driving (e.g. Brandt *et al*. 2018, Dähne *et al.* 2013, Graham *et al*. 2019), behavioural effects from their use would be expected to be much smaller and unlikely to be distinguishable from the effects of survey vessel noise.

Noise from the presence and movement of vessels could also potentially disturb marine mammals foraging within or close to sites for which they are a qualifying feature. Reported responses include avoidance, interrupted foraging behaviour, changes in swimming speed, direction and surfacing patterns, and alteration of the intensity and frequency of calls (review in Erbe *et al*. 2019). Chronic exposure has also been linked to an increase in stress-related hormones (Rolland *et al.* 2012). Harbour porpoises, white-sided dolphins and minke whales have been shown to respond to survey vessels by moving away from them, while white-beaked dolphins have shown attraction (Palka & Hammond 2001). A study on captive harbour porpoises in a semi-natural net-pen complex in a Danish canal, recorded their behaviour while simultaneously measuring underwater noise of vessels passing the enclosure; reaction to noise was defined to occur when a highly stereotyped ‘porpoising’ behaviour was observed. Porpoising occurred in response to almost 30% of vessel passages; the most likely behavioural trigger were medium- to high- frequency components (0.25–63kHz octave bands) of vessel noise, while low- frequency components of vessel noise and additional pulses from echo-sounders could not explain the results (Dyndo *et al*. 2015). A tagging study of a small number of free-ranging porpoises in Danish coastal waters estimated that porpoises encountered vessel noise 17-89% of the time (from evaluation of the wideband sound and movement tag recordings). Occasional high-noise levels (coinciding with a fast ferry) were associated with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96dB re 1 mPa (16 kHz third-octave, Wisniewska *et al.* 2018).

More evidence is available on bottlenose dolphins, especially for coastal populations. Shore-based monitoring of the effects of boat activity on the behaviour of bottlenose dolphins off the US South Carolina coast, indicated that slow moving, large vessels, like ships or ferries, appeared to cause little to no obvious response in bottlenose dolphin groups (Mattson *et al*. 2005). Pirotta *et al*. (2015) used passive acoustic techniques to quantify how boat disturbance affected bottlenose dolphin foraging activity in the inner Moray Firth. The presence of moving motorised boats appeared to affect bottlenose dolphin buzzing activity (foraging vocalisations), with boat passages corresponding to a reduction by almost half in the probability of recording a buzz. The boat effect was limited to the time where a boat was physically present in the sampled area and visual observations indicated that the effect

increased for increasing numbers of boats in the area. Dolphins appeared to temporarily interrupt their activity when disturbed, staying in the area and quickly resuming foraging as the boat moved away.

Noise sources and propagation

As outlined in Section 2, the planned survey will use high-resolution geophysical survey (HRSG) sources to obtain detailed bathymetry and shallow geological data to support wind farm array and export cable planning. Equipment used will include a Multibeam Echosounder (MBES), Side Scan Sonar (SSS), Sub-bottom Profiler (SBP) and Ultra-High-Resolution multi-channel Seismic (UHRS).

Calibrated measurements of the acoustic characteristics of electromechanical sources used in HRGS have, until recently, been lacking, with assessments reliant upon manufacturer specifications. However, a study commissioned by the US Bureau of Ocean Energy Management (BOEM) provided calibrated measurements of source characteristics under controlled test tank conditions for a variety of equipment used in HRGSs (Crocker & Fratantonio 2016, Crocker *et al*. 2019). Table 4.1 summarises indicative source characteristics of the equipment (and comparable equipment) to potentially be used in the planned survey, drawing on manufacturer specifications where possible. Source levels provided are those reported for the sources operated at the maximum power tested. In addition to those sources described in Table 4.1, there an ultra-short baseline (USBL) system may be used to monitor the position of towed equipment. The USBL system consists of a multi-element transducer mounted on the hull of the vessel and a transponder attached to the towed equipment (e.g. side-scan sonar). The hull-mounted transducer emits an acoustic pulse that is detected by the transponder, which replies with its own acoustic pulse, and its position is subsequently determined from the range and angle of the pulse as received by the transducer. USBL equipment is widely used by offshore commercial and research vessels where positional accuracy of towed survey equipment is critical. The emitted pulses will be short pulse width ‘pings’, approximately in the range of 19-33kHz and with a source level of up to 187 dB re 1µPa @1m (peak).

Table 4.1: Potential acoustic survey equipment and indicative source characteristics

Equipment	Indicative source characteristics	
	Nominal operating frequency	**Source level**
UHRS sparker/boomer	0.4-1.8kHz	220dB re 1µPa @1m (peak)
Side-scan sonar	100kHz & 500kHz	235 dB re 1µPa @1m (peak)
Multi-beam echosounder	400-700kHz	225-231dB re 1µPa @1m (peak)
Sub-bottom Profiler e.g. Innomar SES-2000 Quattro Parametric	Primary: 85-115kHz Secondary: 2-20kHz	235-245dB re 1µPa @1m (peak)

The propagation of sound in the marine environment is complex and has been the subject of considerable research (e.g. Wang *et al*. 2014). Once a sound is emitted, its characteristics will be altered with distance from source. Changes will affect the amplitude of the signal and its frequency content and, in the case of impulsive sounds, the injurious elements will be reduced through propagation (i.e. pulse duration increases and rise-time decreases with distance). The main process that reduces the amplitude of the sound wave as it propagates is geometrical spreading; while a host of other processes come into play (e.g. reflection, refraction, scattering, reverberation and absorption), many of which are dependent on environmental conditions. The effect of frequency-dependent absorption loss is small on lower frequency sources (e.g. <0.3dB/km at 4kHz), which contributes to seismic survey

noise being detectable by hydrophones hundreds of km from the source, but acts to rapidly attenuate higher frequency sources (e.g. 36dB/km at 100kHz) (Francois & Garrison 1982).

The propagation of noise from seismic surveys has been much investigated; while the process is complex and influenced by many variables, general expectations of broadband received levels from airguns can be made. In terms of peak sound pressure levels, while the nominal source levels for a large airgun array (250-260dB 1 µPa @1m, peak-to-peak) are never reached, levels >230dB re 1 µPa can be expected in close proximity (metres); levels are commonly reported to have decreased below 200dB re 1 µPa at a range of 100-1,000m, and below 160dB re 1 µPa at a range of 10-11km (e.g. Breitzke *et al*. 2008).

The emitted sound fields from HRGS sources such as SBPs, side-scan sonar and echosounders are of much lower amplitude and extent compared to seismic surveys using airguns due to their lower source levels, higher central operating frequencies and greater directionality (narrower beam widths) (e.g. Boebel et al*.* 2005*,* Genesis 2011). However, very few empirical field data are available to quantify these expectations. The most relevant work to date is part of the study funded by the US BOEM: following the calibrated measurements of Crocker & Fratantonio (2016), measurements were made in shallow (≤ 100m depth) open-water environments to investigate the propagation of sound from various HRGS sources (Halvorsen & Heaney 2018). Problems were encountered during the open-water testing resulting in a lack of calibration in the reported sound source levels (Labak 2019). The accompanying advice note (Labak 2019) emphasises that these uncalibrated data should not be used to provide source level measurements, and consequently the reported isopleths (summarising sound propagation) should not replace project-specific sound source verifications. A further project to calibrate these measures and provide an expanded assessment of propagation commenced in 2019.

Despite these caveats, it is worth noting some general patterns observed in Halvorsen & Heaney (2018). In all test environments, broadband received levels from all SBP chirper, echosounder and side-scan sonar devices tested were rapidly attenuated with distance from source, with particularly pronounced fall-off for directional sources when the receiver was outside of the source's main beam. The greatest propagation was generally observed at the deepest test site (100m water depth) from sources generating low frequencies (<10kHz); by contrast, at 100m water depth, some of the highest frequency sources (>50kHz) experienced such attenuation that they were only weakly detectable or undetected by recording equipment. In all open-water test environments, broadband received levels did not exceed 160dB re 1µPa (rms)[11] beyond 200m from any chirper SBP, echosounder or side-scan sonar device tested. While recognising that these results require refining, preliminary evidence suggests that these electromechanical HRGS sources generate a very limited sound field in the marine environment, and of a much lower magnitude than those generated by seismic airgun sources.

It is noted that neither BOEM studies tested a parametric SBP, and that this potential source has the highest indicative source level of those listed in Table 4.1. The mechanism by which these devices generate the low-frequency signal of interest (secondary) requires initial emission of a high amplitude signal (primary). However, the high frequency of this initial signal and its associated narrow beam width (~2 degrees) will limit its horizontal propagation; in the absence of empirical measurements, a similar pattern to that observed

[11] The 160dB re 1µPa (rms) isopleth represents the acoustic exposure criterion for behavioural disruption from impulsive noise as described by NMFS (2016), although this criterion is not universally adopted in policy or guidance elsewhere (such as the UK).

by Halvorsen & Heaney (2018) for chirper SBPs and echosounders can be reasonably assumed for a parametric SBP of this specification.

While independently-measured sound fields are not available for USBL, their nominal source levels and central operating frequencies are such that emitted sounds fields are likely to be very small and of limited/no audibility above that of the concurrently operating survey equipment and vessel. Similarly, noise measurements of emitted sounds from logging involving sound sources including PS logging (entirely downhole) and SCPT (downhole logging with a surface source) are not available. These involve very small noise sources (~70dB) which generate a shear wave that is detected at depth within the borehole. A small (75kg) free fall hammer may be used in sampling should it not be possible to recover samples using a push sampling method. Measurements from the use of a 100kg free fall hammer for standard penetration testing (Erbe & McPherson 2017) recorded source levels of 151-160 dB re 1 μPa^{2}s @ 1 m (20-24kHz), which are likely to be comparable to that which could be generated by the hammer sampling for this survey.

Underwater noise emitted by small leisure craft and vessels <50m tends to have a source level of 160-175 dB re 1μPa@1m, and with greater sound energy in relatively higher frequency (above 1kHz) when compared to large ships; support and supply vessels (50-100m) are expected to have source levels in the range 165-180dB re 1μPa@1m range and with most energy in lower frequencies (OSPAR 2009). For the purpose of this noise assessment, the survey vessel is assumed to be of 50-100m in length. Veirs *et al*. (2016) estimated sound characteristics for a wider variety of ships (from pleasure craft to container ships) in transit across the Haro Strait (west coast of North America). Median received levels of ship noise within the study area were measured to be most elevated above ambient noise at the lower frequencies (20-30dB from 100-1,000Hz), and to a lesser extent also at higher frequencies (5-13dB from 10-40kHz). The use of thrusters for DP has been reported to result in increased sound generation of ~10dB compared to the same vessel in transit: measurements at 600m range to an offshore supply vessel of 79m length recorded broadband SPL (18-3,000Hz) of 148dB re 1μPa (root-mean-squared, rms) when in DP mode, compared to 135.5dB re 1μPa rms when in transit at a speed of 10 knots (Rutenko & Ushchipovskii 2015).

Though much larger than the type of jack-up vessels proposed for use in the survey, underwater noise associated with a jack-up rig of the type used in the offshore oil and gas industry is of a very similar dominant frequency range as that from large merchant vessels, albeit of lower average intensity. Measurements alongside a three-legged jack-up rig drilling in shallow water on the Dogger Bank showed that sound levels were in the order of $L_{p,rms}$ 120dB re 1μPa broadband with most energy between 2-1,200Hz; sound levels dropped off rapidly above 8kHz and were in the region of 15-20dB quieter during operations other than drilling (Todd & White 2012). It was noted that, at lower frequencies, the rig was considerably quieter than its associated support vessels (Todd & White 2012). Measurements of noise generated by shallow drilling in water depths of 7-13m through sand and mudstone produced source levels of 142-145 dB re 1 μPa rms @ 1 m (30-2,000Hz) (Erbe & McPherson 2017).

Cetacean species

Cetacean species, for which sound is fundamental across a wide range of critical natural functions, show high sensitivity to underwater sound. Generally, the severity of effects tends to increase with increasing exposure to noise with both sound intensity and duration of exposure being important. A distinction can be drawn between effects associated with physical (including auditory) injury and effects associated with behavioural disturbance. With respect to injury, risk from an activity can be assessed using threshold criteria of sound

levels, with the most recent criteria presented in Southall *et al*. (2019). Auditory capabilities, and in particular the range of frequencies over which sensitivity is greatest, varies between species and criteria are assigned to functional hearing groups with accompanying injury criteria. Table 4.2 provides details of the relevant cetaceans (i.e. harbour porpoise, bottlenose dolphin, common dolphin, minke whale) listed by functional hearing group, their estimated hearing range and recommended injury criteria, defined as the sound level at which a permanent threshold shift (PTS; permanent hearing damage) is estimated to occur.

Table 4.2: Marine mammal auditory injury criteria to impulsive and non-impulsive noise by functional hearing group

Functional hearing group (species relevant to the survey area)	**Estimated hearing range** (region of greatest sensitivity) [frequency of peak sensitivity]	**Proposed injury (PTS onset) threshold criteria**	
		Impulsive noise (dB re 1µPa, peak, unweighted)	**Non-impulsive noise** $L_{E,24h}$ (dB re 1 µPa²·s)
Low frequency cetaceans Minke whale *(Balaenoptera acutorostrata),* humpback whale *(Megaptera novaeangliae)*	0.2 kHz to 19 kHz	219	199
High-frequency cetaceans Bottlenose dolphin (*Tursiops truncatus*), common dolphin *(Delphinus delphis)*	150 Hz to 160 kHz (8.8 kHz to 110 kHz) [58 kHz]	230	198
Very high frequency cetaceans Harbour porpoise (*Phocoena phocoena)*	275Hz to 160kHz (12kHz to 140kHz) [105kHz]	202	173

Source: Southall et al. (2019). Notes: The region of greatest sensitivity represents parameters f1 and f2, which are the bounds of the flat, central portion of the frequency-weighting curve region; the frequency of peak sensitivity represents parameter f0. $L_{E,24h}$ *= cumulative sound exposure level over 24 hours, weighted according to functional hearing group.*

Of the species likely to occur in the survey area, the harbour porpoise has the lowest threshold criteria for the onset of PTS at 202dB re 1µPa. Given the source characteristics and evidence of propagation presented above, the potential sources in the planned survey (including all geophysical and geotechnical techniques) will not result in received sound levels exceeding this threshold or those of the other Annex IV species beyond more than a few metres from the source. Therefore, given the very small radius (a few metres) within which injury may potentially occur and the relatively low numbers of cetacean species likely to be present during the temporary surveys, the risk of injury is considered to be negligible, particularly with the implementation of mitigation measures (Section 4.2) and significant effects are not considered to be likely.

Underwater noise from the survey vessel itself and the drilling of the shallow boreholes (the noise from which will not be greater than that associated with the vessel) could potentially cause behavioural disturbance of cetaceans present in the area. Reported responses include avoidance, changes in swimming speed, direction and surfacing patterns, alteration of the intensity and frequency of calls (review Erbe *et al*. 2019). Harbour porpoises and

minke whales have been shown to respond to survey vessels by moving away from them, while some other species, such as common dolphins, have shown attraction (Palka & Hammond 2001). Benhemma-Le Gall *et al*. (2021) concluded that increased vessel activity during windfarm construction led to a significant decrease in porpoise acoustic detections and activity at distances of up to 4 km, indicative of some displacement. Wisniewska *et al*. (2018) used sound and movement recording tags on seven porpoises and found that one porpoise had a reaction distance of about 7km to an approaching vessel. However, the response was short lived as regular foraging behaviour resumed 15 minutes after it was first interrupted.

While there is potential for some behavioural disturbance of cetaceans in response to survey vessel noise, the area of potential disturbance will be highly localised (i.e. within a few hundred metres radius), in an open sea habitat (i.e. with movement of animals not restricted by geographic features such as a shoreline), transient and of short overall duration. The increase in underwater noise from the survey vessel activities, relative to existing levels in the wider area from other shipping and fisheries, is expected to be negligible.

Considering the acoustic characteristics of the potential sources and their propagation, the relevant evidence of effects on cetaceans from vessel noise, seismic survey and the proportionally lower potential for effects of the specific sources being used, in addition to the small spatial footprint and short duration (approximately four weeks) of the proposed geophysical surveys, the risk of behavioural disturbance to cetacean species is considered to be extremely low, particularly with implementation of mitigation measures (Section 4.2) and significant effects are not considered to be likely.

Other Annex IV species

There is the potential for disturbance and displacement of otter which may be transiting through or foraging within coastal areas. However, otter are a primarily nocturnal species and given the relevant coastal area does not appear to represent suitable habitat, the risk of disturbance and displacement is negligible.

Available information on potential effects of underwater sound on marine turtles is very limited (Nelms *et al*. 2016). The hearing range of cheloniid species has been estimated as between 50-2,000Hz, with highest sensitivity below 400Hz (Popper *et al*. 2014). For leatherback turtles, measurements made on hatchlings suggested a similar low frequency sensitivity, with sound detection ranging between 50 and 1,200Hz when in water and between 50 and 1,600Hz in air (Dow Piniak *et al*. 2012). Underwater noise generated by the proposed survey may be detectable by leatherback turtles, although their low density and limited seasonal presence in the area dictates that very few individuals are likely to be exposed to noise levels beyond that of the background for the region. Significant effects are not likely.

4.1.3 In-combination effects

A number of early concept offshore wind farm areas are located close to the proposed Oriel survey area. None of these have received consent, and the timing of any potential works for these is uncertain and is highly likely to be outside of the proposed Oriel survey schedule. All of these areas and related cable corridor areas of search have been, or are being, subject to foreshore licence applications for investigative works of a similar nature to that proposed for this application[12]. There is the potential for works associated with site

[12] Cooley Point, Braymore Point, Clogher Head, North Irish Sea Array

investigations at Cooley Point, Braymore Point, Clogher Head and the North Irish Sea Array to take place within the schedule of works for this application, for example, as the licences granted provide a five year period within which to complete the works. In view of the similarity of the nature of the works between these applications, and the potential for in-combination effects, particular in relation to underwater noise, Oriel will maintain awareness of the scheduling associated with these other licences, and engage with the licence holders, as required. However, in view of the low sound power levels of the acoustic equipment used in such surveys, which are spatially discrete, and of short duration, it is concluded that such surveys will not result in likely significant in-combination underwater noise effects to Annex IV species.

4.2 Mitigation Measures

The best practice guidelines, "Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters" (DAHG 2014), will be implemented for the geophysical surveys and a qualified and experienced marine mammal observer (MMO) will be employed aboard the survey vessels during all multibeam, single beam, side-scan sonar and sub-bottom profiling. MMO monitoring will include pre-start monitoring, 'soft-start' ramp-up procedures, line change procedures and procedure for a break in sound output.

As the proposed surveys are to be conducted in waters of less than 200 m deep, the pre-start survey will commence a minimum of 30 minutes prior to the scheduled start time. For all pre-start surveys, a monitored zone of 500 m will be employed, i.e. if a marine mammal is observed within 500 m of the sound source in the 30 minutes prior to the scheduled start, works will be delayed until no marine mammals have been observed in the monitored zone for 30 minutes. If the marine mammals do not leave the area, the survey vessel may alter its course to ensure that the animals are outside the monitored zone when the soft start commences. The Marine Mammal Observer (MMO) will use a distance measuring stick or reticule binoculars to ascertain distances to marine mammals.

A qualified and experienced MMO will be appointed to monitor for marine mammals and to log all relevant events using standardised data forms provided by the DAHG. In order to allow 24-hour working, or for work to commence when visual observation is not possible due to weather conditions or sea state, a proven Passive Acoustic Monitoring (PAM) system and experienced operator(s) will be employed to undertake pre-start surveys during these times.

A soft start is the gradual ramping of power over a set period of time. The UHRS and check-shot logging equipment is assumed to have this capability inbuilt.

Once the soft start commences, there is no requirement to halt or discontinue the procedure at night-time, if weather or visibility conditions deteriorate, or if marine mammals enter the monitored zone (500 m radial distance of the sound source).

The following ramp up procedure will be undertaken in line with the DAHG (2014) guidance:

- Energy output will commence from a low energy start-up and be allowed to gradually build up to the necessary maximum output over a period of up to 40 minutes.
- This controlled build-up of energy output will occur in consistent stages to provide a steady and gradual increase over the ramp-up period.
- If marine mammals enter or are detected within the monitored zone while the ramp-up procedure is under way but incomplete, the energy output will not be increased until the marine mammals are no longer within the monitored zone.

Where the duration of a survey line or station change is greater than 40 minutes, the activity will, on completion of the line/station being surveyed, either cease (i.e., shut down) or preferably undergo a reduction in energy output to a lower state where the peak sound pressure level from any operating source is 170 dB re 1 µPa @ 1 m. Prior to the start of the next line/station, if the power was shut down, all pre-survey monitoring measures and soft start procedures will be followed as for start-up. If there has been a reduction in power, a soft start will be undertaken gradually from the lower output level. The latter sound reduction measure may be applied to line changes at night-time or in daytime conditions of poor visibility. Where the duration of a survey line/station change is less than 40 minutes the activity will continue as normal (i.e. under full output).

If there is a break in sound output for a period greater than 10 minutes (e.g., due to equipment failure, shut-down, survey line/station change) then all pre-survey monitoring measures and ramp-up (soft start) will recommence prior to re-starting.

Geophysical site surveys are of medium duration but any displacement will be relatively short term. Pre, during and post survey monitoring would allow for an assessment of any disruption and if it is evident, then the level can be quantified. Post-survey monitoring would also provide a means to establish if disruption occurred and how long it takes for animals to return to an area and resume site usage.

If surveys are carried out during summer months the species most likely to be exposed to temporary disturbance include harbour porpoise, common and bottlenose dolphin and, to a lesser extent, minke whale.

All vessels will be compliant with the International Convention for the Prevention of Pollution from Ships (MAROL), as per standard good practice, which will reduce the risk of contamination incidents and accidents.

4.3 Conclusion

The risk assessment of the potential impacts on Annex IV species from the proposed survey activities concludes that, with the implementation of mitigation measures:

- the risk of injury to Annex IV species is considered to be negligible, and significant effects are not considered to be likely
- the risk of behavioural disturbance to Annex IV species is considered to be extremely low, and significant effects are not considered to be likely.

Therefore, it is concluded that the proposed survey activities will not give rise to significant impacts to species listed under Annex IV of the Habitats Directive.

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